PROSPECTUS

8,500,000 Shares

Common Stock

$10.00 per share

This is the initial public offering of Tocagen Inc. We are offering 8,500,000 shares of our common stock. Prior to this offering, there has been no public market for our common stock. The initial public offering price of our common stock is $10.00 per share.

Our common stock has been approved for listing on The NASDAQ Global Select Market under the symbol "TOCA."

We are an "emerging growth company" as that term is used in the Jumpstart Our Business Startups Act of 2012 and, as such, we have elected to comply with certain reduced public company reporting requirements for this prospectus and future filings.

Investing in our common stock involves a high degree of risk. See "Risk Factors" beginning on page 12.

	Per Share	Total
Initial Public Offering Price	$10.00	$85,000,000
Underwriting Discounts and Commissions[1]	$ 0.70	$ 5,950,000
Proceeds to Tocagen (before expenses)	$ 9.30	$79,050,000

(1) We have agreed to reimburse the underwriters for certain expenses. See "Underwriting."

We have granted the underwriters a 30-day option to purchase up to a total of 1,275,000 additional shares of common stock from us at the initial public offering price less the underwriting discounts and commissions.

The underwriters expect to deliver the shares of common stock to purchasers on or about April 19, 2017 through the book-entry facilities of The Depository Trust Company.

Neither the Securities and Exchange Commission nor any state securities commission has approved or disapproved of these securities or determined if this prospectus is truthful or complete. Any representation to the contrary is a criminal offense.

Leerink Partners **Evercore ISI** **Stifel**

The date of this prospectus is April 12, 2017

TABLE OF CONTENTS

We have not, and the underwriters have not, authorized anyone to provide any information or to make any representations other than those contained in this prospectus or in any free writing prospectuses prepared by or on behalf of us or to which we have referred you. We take no responsibility for, and can provide no assurance as to the reliability of, any other information that others may give you. This prospectus is an offer to sell only the shares offered hereby, but only under circumstances and in jurisdictions where it is lawful to do so. The information contained in this prospectus or in any applicable free writing prospectus is current only as of its date, regardless of its time of delivery or any sale of shares of our common stock. Our business, financial condition, results of operations and prospects may have changed since that date.

This prospectus includes statistical and other industry and market data that we obtained from industry publications and research, surveys and studies conducted by third parties. Industry publications and third-party research, surveys and studies generally indicate that their information has been obtained from sources believed to be reliable, although they do not guarantee the accuracy or completeness of such information.

For investors outside the United States: We have not, and the underwriters have not, done anything that would permit this offering or possession or distribution of this prospectus in any jurisdiction where action for that purpose is required, other than in the United States. Persons outside the United States who come into possession of this prospectus must inform themselves about, and observe any restrictions relating to, the offering of the shares of common stock and the distribution of this prospectus outside the United States.

PROSPECTUS SUMMARY

This summary highlights information contained in other parts of this prospectus. Because it is only a summary, it does not contain all of the information that you should consider before investing in shares of our common stock and it is qualified in its entirety by, and should be read in conjunction with, the more detailed information appearing elsewhere in this prospectus. You should read the entire prospectus carefully, especially "Risk Factors" and our financial statements and the related notes, before deciding to buy shares of our common stock. Unless the context requires otherwise, references in this prospectus to "Tocagen," "we," "us" and "our" refer to Tocagen Inc.

Overview

We are a clinical-stage, cancer-selective gene therapy company focused on developing first-in-class, broadly-applicable product candidates designed to activate a patient's immune system against their own cancer from within. Our cancer-selective gene therapy platform is built on retroviral replicating vectors, or RRVs, which are designed to selectively deliver therapeutic genes into the DNA of cancer cells. Our gene therapy approach is designed to fight cancer through immunotherapeutic mechanisms of action without the autoimmune toxicities commonly experienced with other immunotherapies. Our founding vision is "No One Should Die Of Cancer" because we believe the immune system can be safely activated to fight the patient's cancer.

We are developing our lead product candidate, Toca 511 & Toca FC, initially for the treatment of recurrent high grade glioma, or HGG, a brain cancer with limited treatment options, low survival rates and, therefore, a significant unmet medical need. Toca 511 is an investigational injectable RRV and Toca FC is an investigational small molecule drug, which we have designed to be used together. In November 2015, we initiated the Phase 2 portion of a randomized, controlled Phase 2/3 clinical trial of Toca 511 & Toca FC in patients with recurrent HGG, which is designed to serve as a potential registrational trial. We completed enrollment of the Phase 2 portion with 187 patients in February 2017 and plan to report top line results in the first half of 2018. In February 2017, the U.S. Food and Drug Administration, or FDA, granted Toca 511 & Toca FC Breakthrough Therapy Designation for the treatment of patients with recurrent HGG. Breakthrough Therapy Designation indicates that preliminary clinical evidence demonstrates the drug may have substantial improvement on one or more clinically significant endpoints over available therapy.

As of May 31, 2016, we have treated 126 recurrent HGG patients with Toca 511 & Toca FC in three ongoing ascending dose Phase 1 clinical trials with three modes of delivery: injection into the cavity wall after surgical resection of the recurred tumor, direct intratumoral injection without resection, and intravenous administration followed, approximately one to two weeks later, by resection with further local vector delivery at the time of resection. In these trials, we observed potential benefits, including durable objective responses, extended overall survival and a favorable safety profile. To date, we have not reached a dose-limiting toxicity. Based on these Phase 1 clinical trial results, in November 2015 we initiated the Phase 2 portion of a Phase 2/3 clinical trial, which is designed to serve as a potential registrational trial in patients with first or second recurrent HGG undergoing resection.

The median overall survival of patients in the Phase 1 resection injection study (in which an ascending range of doses of Toca 511 were injected into the wall of the resection cavity after resection of the tumor) exceeds historical controls across a variety of previously reported clinical trials. As of the data cut-off of May 31, 2016, 43 patients in the resection injection trial had a median overall survival of 12.4 months that was approximately four months longer relative to results from clinical trials of drugs used as standard of care for recurrent HGG. Data from our Phase 1 trial was reported in Science Translational Medicine (Cloughesy et al. 2016). As of the data cut-off of May 31, 2016, the subset of 24 patients in our Phase 1 resection injection trial that mirrors the entry criteria, clinical setting and dosing for patients in our Phase 2/3 clinical trial had median survival of 14.3 months, with an approximately six-month improvement in median overall survival relative to results from clinical trials of drugs used as standard of care for recurrent HGG.

Furthermore, an independent radiology review of magnetic resonance imaging brain scans from our Phase 1 clinical trials identified tumor shrinkage in some patients, including several complete and partial responses. All patients in the resection injection trial with objective responses remain with durable response as of October 2016, for a median of 26.7 months, which compares favorably to a range of durable responses of 2.79 to 9.62 months in a clinical trial of a drug used as standard of care for recurrent HGG. We also documented, for patients in the resection injection trial in some cohorts, changes in immunologic activity including elevations of replicating CD4 (often referred to as "helper" T cells) and CD8 (often referred to as "killer" T cells) T cells in blood, comparing pre- and post-Toca 511 & Toca FC treatment.

We obtained Fast Track Designation (which may lead to expedited regulatory review of new products that treat serious diseases or conditions and demonstrate the potential to address an unmet medical need) from the FDA for Toca 511 & Toca FC for the treatment of recurrent HGG and Orphan-Drug Designation (a designation for a product that treats a rare disease or condition and which, if the product receives the first FDA approval for that disease or condition, may result in a period of regulatory exclusivity, subject to some exceptions) for the treatment of glioblastoma, or GBM, which is a subset of HGG. We plan to seek Orphan-Drug Designation from the FDA for the treatment of HGG.

Based on preclinical data, we believe Toca 511 & Toca FC may have therapeutic benefit in multiple other solid tumor cancers, and we initiated a Phase 1b clinical trial in July 2016 for the intravenous treatment of metastatic colorectal, pancreatic, breast, lung, melanoma and renal cancers, all of which can spread to the brain and other organs. In our ongoing intravenous clinical trial of Toca 511 for the treatment of recurrent HGG, Toca 511 crossed the blood brain barrier and was detected selectively in brain tumors. In our metastatic cancer trial we plan to continue to evaluate safety, presence of Toca 511 genes in tumors of patients with widely-disseminated disease, immunologic activity in blood and tumor such as changes in CD4 and CD8 T cells and clinical activity such as objective tumor response and clinical benefit. We also plan, in this clinical trial, to evaluate Toca 511 & Toca FC in combination with one or more checkpoint inhibitors.

Based on our findings in preclinical studies and clinical trials to date, we believe Toca 511 & Toca FC is a promising candidate for use in combination with surgery, radiation and chemotherapy and we plan to initiate a clinical trial in early 2018 for newly diagnosed HGG to evaluate safety and preliminary efficacy in this setting when Toca 511 & Toca FC is delivered in conjunction with radiation and temozolomide.

Our RRV platform is versatile and we believe it has the potential to deliver a wide variety of genes selectively to cancer cells. Our first RRV-based immunotherapy product candidate, Toca 511 & Toca FC, is designed to directly kill tumor cells and activate the immune system against cancer through a combination of mechanisms. In addition, we are developing other RRVs to selectively deliver genes to cancer cells against validated immunotherapy targets, such as the checkpoint protein PD-L1. We generated preclinical data supporting the potential anti-cancer benefits of an RRV delivering a gene against PD-L1. In 2018, we plan to select an anti-PD-L1 RRV product candidate for further development.

Cancer is the second leading cause of mortality in the United States and accounts for nearly one in four deaths. Our initial proposed indication, recurrent HGG, also referred to as malignant glioma, is the most common and aggressive primary brain cancer. The total number of new diagnoses of HGG expected in 2017 is about 160,000 worldwide and about 14,000 in the United States. HGG recurs in most patients, even after maximal treatment.

Early cancer treatments relied on relatively non-specific and highly toxic small molecule chemotherapies. Over the last 20 years, a new paradigm of cancer research and treatment has emerged that is focused on more targeted therapies. Most recently this has included the emergence of immunotherapies that can stimulate a patient's immune system to slow the growth and the spread of, and ideally, eliminate, cancer cells. These

therapies have shown the potential to provide dramatic efficacy and to extend survival for cancer patients even in cases in which conventional therapies, such as surgery, chemotherapy and radiotherapy, have already been used. In 2013, *Science* magazine named cancer immunotherapy as the biggest breakthrough of the year. With this breakthrough, global pharmaceutical companies as well as a large number of emerging companies are researching and developing new cancer immunotherapy treatments.

Despite these advancements, many current immunotherapies, such as checkpoint inhibitors, CAR and TCR T cells, are limited by their autoimmune and other side effects. Combination treatments are common in cancer, but combinations of immune mediated treatments with systemic cytotoxic chemotherapy may be challenging as chemotherapy is often damaging to the immune system. Thus, immunotherapies effective enough to be able to displace systemic chemotherapy are needed. Consequently, there remains a significant need for immunotherapies that are effective as well as safe and tolerable.

In contrast to current immunotherapies, we believe our RRV platform and lead product candidate have the potential to selectively infect cancer cells to stimulate robust and durable anti-cancer immune responses with minimal toxicity. Our RRVs are designed to selectively integrate into the DNA of cancer cells which then serve as factories to produce more of these RRVs by budding. The progeny RRV infect neighboring cancer cells providing long-term presence of the therapeutic gene or genes. Our novel therapies are designed to break immune tolerance in the tumor microenvironment.

Toca 511 & Toca FC is designed to break immune tolerance through a combination of mechanisms triggered by the conversion of Toca FC into high levels of 5-FU (5-fluorouracil), an anti-cancer agent, by the therapeutic gene delivered by Toca 511 into the cancer cell. Toca 511 & Toca FC treatment is designed for cycles of sustained production of high levels of 5-FU directly in tumors, which we believe is important for robust and durable anti-cancer immune activation. Cancer cell death releases damage-associated molecular patterns, or DAMPs, pathogen-associated molecular patterns, or PAMPs, and cancer neo-antigens, resulting in antigen presentation and activation of T cells. 5-FU is known to kill cancer cells and immune cells when used systemically. When 5-FU is present locally, it kills immune-suppressive myeloid cells in the tumor micro-environment while leaving systemic immune activity clinically intact. The local immune-suppressive myeloid cells include myeloid-derived suppressor cells, or MDSCs, as well as tumor associated macrophages, or TAMs, which are white blood cells recruited and retained by the tumor that contribute to the suppression of normal immune activity against cancer cells. TAMs and MDSCs suppress the number and activity of CD4 and CD8 T cells and work with the lymphocyte-derived suppressor T cells called regulatory T cells, or Tregs.

Our management team members possess significant experience in the field of gene therapy, especially cancer-selective gene therapy and immunotherapy, as well as clinical development and commercialization experience with oncology drugs, including those for the treatment of HGG. We were co-founded by some of the founders, key inventors and scientists of Viagene Inc., which we believe was the first U.S. gene therapy company and which was conducting human clinical trials in cancer immunotherapy as early as 1993.

We have retained worldwide rights to the development and commercialization of therapeutic product candidates derived from our RRV platform in all indications. We have intellectual property protection in major markets worldwide, including 58 issued and granted patents and 75 patent applications (foreign and domestic) on our technology platform and novel product candidates, which we believe will maintain coverage until approximately 2030.

Our Proprietary Technology Platform: Harnessing Cancer Immunotherapy and Gene Therapy Together to Fight Cancer

We believe our investigational gene therapy platform and therapeutic genes represent innovative approaches in cancer-selective immunotherapy which have the potential to drive a safe, powerful and durable immune

response against cancer, without triggering autoimmunity. We chose to utilize RRVs as the basis of our gene therapy platform for cancer-selective immunotherapy because they exhibit several characteristics that we believe allow us to optimize the safety, delivery and persistence of our therapeutic genes in cancer cells. These characteristics include that they:

- replicate readily and persist in the immune-defective environment of cancer;
- are controlled in healthy tissue by normal immune mechanisms;
- only infect dividing cells such as cancer cells;
- bud from, rather than lyse, infected cancer cells, reducing anti-RRV immune activation;
- infect most cancer types; and
- can cross the blood brain barrier.

For our lead product candidate, Toca 511 & Toca FC, we believe cytosine deaminase, or CD, as our therapeutic gene paired with 5-FC (5-fluorocytosine) is a promising choice for the following reasons:

- CD is able to convert the anti-fungal drug, 5-FC, into the broadly applicable anti-cancer drug, 5-FU, in the cancer microenvironment;
- CD provides additional anti-cancer selectivity, as humans do not have this gene;
- the short half-life of 5-FU limits its direct killing to the localized area of the tumor micro-environment;
- local 5-FU has powerful effects on increasing survival in immune competent animals after only a few cycles of 5-FC; and
- MDSCs and TAMS are very sensitive to 5-FU-mediated killing, which may reduce immune tolerance to the cancer.

Our Pipeline

Candidate	Indication	Preclinical	Phase 1	Phase 2/3
Toca 511 & Toca FC	Recurrent high grade glioma	Toca 5 trial 1Q 2017: Fully enrolled 1H 2018: Report top line data		
	Metastatic solid tumors (CRC, RCC, melanoma, pancreatic, lung & breast)	Toca 6 trial 2H 2017: Expect preliminary drug activity data		
	Newly diagnosed high grade glioma	Toca 7 trial Early 2018: Initiate Phase 1b		

Our Strategy

Our focus is to develop and commercialize first-in-class cancer-selective immunotherapies using our proprietary gene therapy platform. Key elements of our strategy include:

- **Advancing Toca 511 & Toca FC rapidly through clinical development and regulatory approval in recurrent HGG**. In November 2015, we initiated the Phase 2 portion of a Phase 2/3 clinical trial of Toca 511 & Toca FC in recurrent HGG. We completed enrollment of the Phase 2 portion of this clinical trial in February 2017. If we achieve our primary endpoint, overall survival, or secondary endpoints such as objective response rate, in this portion of the trial, we plan to discuss submission of a biologics license application, or BLA, based on this data with the FDA. We believe such data could serve as the basis for

regulatory approval. In February 2017, the FDA granted Toca 511 & Toca FC Breakthrough Therapy Designation for the treatment of patients with recurrent HGG.

- **Expanding the therapeutic use of Toca 511 & Toca FC into newly diagnosed HGG and other solid cancer indications**. In July 2016, we initiated a Phase 1b clinical trial in metastatic cancers including colorectal, pancreatic, breast, lung, melanoma and renal. In early 2018, we plan to initiate a Phase 1b clinical trial of Toca 511 & Toca FC in combination with surgery, radiation and chemotherapy in newly diagnosed HGG patients. We believe Toca 511 & Toca FC has potential broad applicability in the treatment of solid cancers and, because of its safety and efficacy profile in clinical trials to date, it could serve as the foundational therapy in a variety of combination treatments, if successfully developed and approved.
- **Commercializing Toca 511 & Toca FC in key markets**. If approved, we plan to build the capabilities to commercialize Toca 511 & Toca FC through medical science liaisons and a specialty sales force in key markets.
- **Pursuing strategic partnerships to expand the commercial opportunity for, and accelerate the development of, our product candidates**. We may choose to selectively partner our lead product candidate or our future product candidates in territories or therapeutic areas where a partner could bring additional resources and expertise; however, we plan to retain development and commercialization rights in key markets to maximize strategic flexibility.
- **Leveraging our RRV platform and core competencies to continue discovering and developing a broad pipeline of novel cancer-selective immunotherapies**. We believe there is a significant opportunity to develop additional immunotherapy product candidates utilizing our RRV platform. Our scientists have broad expertise in the field of gene therapy, especially cancer-selective gene therapy and immunotherapy. We intend to leverage our platform and expertise to discover and develop a broad pipeline of cancer-selective immunotherapies to help patients fight their cancers without the severe side effect profile typical of cancer treatments.

Risks Associated with Our Business

Our business and our ability to implement our business strategy are subject to numerous risks, as more fully described in the section entitled "Risk Factors" immediately following this prospectus summary. You should read these risks before you invest in our common stock. We may be unable, for many reasons, including those that are beyond our control, to implement our business strategy. In particular, risks associated with our business include:

- We have incurred significant losses since our inception, including an accumulated deficit of $128.0 million as of December 31, 2016, and anticipate that we will continue to incur significant losses for the foreseeable future. We will require substantial additional financing to achieve our goals.
- Immunotherapy, gene therapy and biopharmaceutical product development is a highly speculative undertaking and involves a substantial degree of uncertainty. Our gene therapy product candidates are based on novel technology, which makes it difficult to predict the time and cost of product candidate development. We have never generated any revenue from product sales and may never be profitable.
- The FDA regulatory approval process is lengthy and time-consuming, and we may experience significant delays in the clinical development and regulatory approval of our product candidates.
- The FDA may disagree with our regulatory plans, and we may fail to obtain regulatory approval of our product candidates.
- We rely, and expect to continue to rely, in part, on third parties to conduct, supervise and monitor our clinical trials and to manufacture our vectors, product candidates and other key materials. If these third parties perform in an unsatisfactory manner, it may harm our business.

- We face intense competition and rapid technological change and the possibility that our competitors may develop therapies that are more advanced or effective than ours, which may adversely affect our financial condition and our ability to successfully commercialize our product candidates.
- We are highly dependent on our key personnel, and if we are not successful in attracting and retaining highly qualified personnel, we may not be able to successfully implement our business strategy.
- If we are unable to protect our intellectual property rights or if our intellectual property rights are inadequate for our technology and product candidates, our competitive position could be harmed.

Corporate and Other Information

We were incorporated in Delaware in August 2007. Our principal executive offices are located at 3030 Bunker Hill Street, Suite 230, San Diego, California, 92109, and our telephone number is (858) 412-8400. Our corporate website address is www.tocagen.com. Information contained on or accessible through our website is not a part of this prospectus, and the inclusion of our website address in this prospectus is an inactive textual reference only.

This prospectus contains references to our trademarks and to trademarks belonging to other entities. Solely for convenience, trademarks and trade names referred to in this prospectus, including logos, artwork and other visual displays, may appear without the ® or TM symbols, but such references are not intended to indicate, in any way, that their respective owners will not assert, to the fullest extent under applicable law, their rights thereto. We do not intend our use or display of other companies' trade names or trademarks to imply a relationship with, or endorsement or sponsorship of us by, any other companies.

Implications of Being an Emerging Growth Company

As a company with less than $1.0 billion in revenue during our last fiscal year, we qualify as an "emerging growth company" as defined in the Jumpstart Our Business Startups Act, or JOBS Act, enacted in April 2012. An "emerging growth company" may take advantage of reduced reporting requirements that are otherwise applicable to public companies. These provisions include, but are not limited to:

- being permitted to present only two years of audited financial statements and only two years of related Management's Discussion and Analysis of Financial Condition and Results of Operations in this prospectus;
- not being required to comply with the auditor attestation requirements of Section 404 of the Sarbanes-Oxley Act of 2002, as amended, or the Sarbanes-Oxley Act;
- reduced disclosure obligations regarding executive compensation in our periodic reports, proxy statements and registration statements; and
- exemptions from the requirements of holding a nonbinding advisory vote on executive compensation and any golden parachute payments.

We may use these provisions until the last day of our fiscal year following the fifth anniversary of the completion of this offering. However, if certain events occur prior to the end of such five-year period, including if we become a "large accelerated filer," our annual gross revenues exceed $1.0 billion or we issue more than $1.0 billion of non-convertible debt in any three-year period, we will cease to be an emerging growth company prior to the end of such five-year period.

We have elected to take advantage of certain of the reduced disclosure obligations in the registration statement of which this prospectus is a part and may elect to take advantage of other reduced reporting requirements in future filings. As a result, the information that we provide to our stockholders may be different than you might receive from other public reporting companies in which you hold equity interests.

The JOBS Act provides that an emerging growth company can take advantage of an extended transition period for complying with new or revised accounting standards. We have irrevocably elected not to avail ourselves of this exemption and, therefore, we will be subject to the same new or revised accounting standards as other public companies that are not emerging growth companies.

The Offering

Common stock offered by us	8,500,000 shares
Common stock to be outstanding after this offering	18,501,763 shares
Option to purchase additional shares	The underwriters have a 30-day option to purchase up to a total of 1,275,000 additional shares of common stock.
Use of proceeds	We intend to use the net proceeds from this offering for the clinical development of Toca 511 & Toca FC, for manufacturing scale-up and validation and for working capital and other general corporate purposes, including costs and expenses associated with being a public company. See "Use of Proceeds."
Risk factors	You should read the "Risk Factors" section of this prospectus for a discussion of certain of the factors to consider carefully before deciding to purchase any shares of our common stock.
NASDAQ Global Select Market symbol	"TOCA"
Directed share program	At our request, the underwriters have reserved up to 720,292 shares of our common stock offered by this prospectus for sale, at the initial public offering price, to our directors and officers and certain other parties related to us. Shares purchased under the directed share program will be subject to the 180-day lock-up restriction described in the "Underwriting" section of this prospectus. The number of shares of common stock available for sale to the general public will be reduced to the extent these individuals purchase such reserved shares. Any reserved shares that are not so purchased will be offered by the underwriters to the general public on the same basis as the other shares offered by this prospectus.

The number of shares of our common stock to be outstanding after this offering is based on 10,001,763 shares of common stock outstanding as of December 31, 2016, after giving effect to the conversion of our outstanding shares of convertible preferred stock into 6,690,070 shares of common stock and the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017, and excludes:

- 1,385,855 shares of common stock issuable upon the exercise of outstanding stock options as of December 31, 2016, at a weighted-average exercise price of $11.35 per share;
- a maximum of 3,133,702 shares of common stock reserved for future issuance under our 2017 equity incentive plan, or the 2017 Plan, which number includes the 184,861 shares subject to stock options that were granted upon the effective date of the 2017 Plan and includes the 172,495 shares of common stock reserved for issuance under our 2009 equity incentive plan, as amended, or the 2009 Plan, as of December 31, 2016, adjusted for grants and forfeitures after year-end through March 31, 2017, including the 103,934 shares of common stock issuable upon the exercise of the stock options granted under the 2009 Plan

subsequent to December 31, 2016, for an aggregate of 69,525 shares that were added to the shares reserved under the 2017 Plan upon its effectiveness;
- 250,000 shares of common stock reserved for future issuance under our 2017 employee stock purchase plan, or the ESPP; and
- 10,660 shares of common stock issuable upon the exercise of outstanding warrants as of December 31, 2016, at a weighted-average exercise price of $34.04 per share.

Unless otherwise indicated, all information contained in this prospectus assumes or gives effect to:

- the conversion of all our outstanding shares of convertible preferred stock as of December 31, 2016, into an aggregate of 6,690,070 shares of common stock in connection with the completion of this offering;
- the adjustment of outstanding warrants to purchase shares of Series H convertible preferred stock into warrants to purchase 9,936 shares of common stock in connection with the completion of this offering;
- the issuance by us of convertible promissory notes in an aggregate principal amount of $7.5 million between January 2017 and February 2017 and the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes which will automatically convert upon the completion of this offering into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017.
- no exercise by the underwriters of their option to purchase up to a total of 1,275,000 additional shares of our common stock;
- the filing of our amended and restated certificate of incorporation and the adoption of our amended and restated bylaws immediately prior to the completion of this offering; and
- a 1-for-6.9 reverse stock split of our common stock effected on March 31, 2017.

Summary Financial Data

The following summary financial data for the years ended December 31, 2015 and 2016 and the balance sheet data as of December 31, 2016 are derived from our audited financial statements appearing elsewhere in this prospectus. The summary financial data should be read together with our financial statements and related notes appearing elsewhere in this prospectus and the information under the captions "Selected Financial Data" and "Management's Discussion and Analysis of Financial Condition and Results of Operations." Our historical results are not necessarily indicative of our future results.

	Year Ended December 31,	
	2015	2016
	(in thousands, except share and per share data)	
Statements of Operations Data:		
License revenue	$ 51	$ 49
Operating expenses:		
Research and development	19,172	27,218
General and administrative	3,833	4,522
Total operating expenses	23,005	31,740
Loss from operations	(22,954)	(31,691)
Other income (expense), net:		
Interest income	126	215
Interest expense	(339)	(2,052)
Change in fair value of preferred stock warrants	111	50
Total other income (expense), net	(102)	(1,787)
Net loss	(23,056)	(33,478)
Other comprehensive income (loss):		
Net unrealized gain (loss) on investments	(52)	58
Comprehensive loss	$ (23,108)	$ (33,420)
Net loss per common share, basic and diluted[1]	$ (10.57)	$ (15.22)
Weighted-average common shares used to compute basic and diluted net loss per share[1]	2,182,032	2,199,964
Pro forma net loss per common share, basic and diluted (unaudited)[2]		$ (3.77)
Weighted-average common shares used to compute pro forma net loss per common share, basic and diluted (unaudited)[2]		8,890,034

(1) See Note 2 to our financial statements appearing elsewhere in this prospectus for an explanation of the method used to calculate the basic and diluted net loss per common share and the number of shares used in the computation of the per share amounts.

(2) The calculations for the unaudited pro forma net loss per common share, basic and diluted, assume the conversion of all our outstanding shares of convertible preferred stock into shares of our common stock, as if the conversion had occurred at the beginning of the period presented, or the issuance date, if later, and exclude the effect of shares issuable upon the conversion of all outstanding principal and accrued interest related to convertible promissory notes upon the completion of this offering.

	As of December 31, 2016		
	Actual	Pro Forma[1]	Pro Forma as Adjusted[2]
		(unaudited) (in thousands)	
Balance Sheet Data:			
Cash, cash equivalents and marketable securities	$ 31,245	$ 38,584	$ 115,725
Working capital	18,079	25,418	102,559
Total assets	35,351	42,690	117,940
Notes payable, current portion	7,200	7,200	7,200
Notes payable, net of current portion	10,241	10,241	10,241
Convertible promissory notes payable	3,398	—	—
Convertible promissory notes subscription liability	140	—	—
Preferred stock warrant liabilities	126	—	—
Convertible preferred stock	131,413	—	—
Accumulated deficit	(128,000)	(128,000)	(128,000)
Total stockholders' equity (deficit)	(124,417)	17,999	93,249

(1) Pro forma amounts reflect (i) the conversion of all our outstanding shares of convertible preferred stock into an aggregate of 6,690,070 shares of our common stock, (ii) the issuance by us of convertible promissory notes in an aggregate principal amount of $7.5 million between January 2017 and February 2017, (iii) the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes which were issued between November 2016 and February 2017 and which will automatically convert upon the completion of this offering into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017 and (iv) the reclassification of our preferred stock warrant liabilities to additional paid-in capital, a component of stockholders' equity (deficit).

(2) Pro forma as adjusted amounts reflect the pro forma conversion adjustments described in footnote (1) above, as well as the sale of 8,500,000 shares of our common stock in this offering at the initial public offering price of $10.00 per share, and after deducting underwriting discounts and commissions and estimated offering expenses payable by us.

RISK FACTORS

An investment in shares of our common stock involves a high degree of risk. You should carefully consider the following information about these risks, together with the other information appearing elsewhere in this prospectus, including our financial statements and related notes thereto, before deciding to invest in our common stock. The occurrence of any of the following risks could have a material adverse effect on our business, financial condition, results of operations and future growth prospects. In these circumstances, the market price of our common stock could decline, and you may lose all or part of your investment.

Risks related to our business and industry

We have incurred significant losses since our inception and anticipate that we will continue to incur significant losses for the foreseeable future.

We are a clinical-stage company with a limited operating history. We are not profitable and have incurred net losses in each year since our inception in 2007, including net losses of $23.1 million and $33.5 million for the years ended December 31, 2015 and 2016, respectively. As of December 31, 2016, we had an accumulated deficit of $128.0 million.

We have devoted substantially all of our financial resources to research and development, including our clinical, preclinical and platform development activities. To date, we have financed our operations primarily through the private placement of our convertible preferred stock. We expect to continue to incur significant expenses and increasing operating losses for the foreseeable future. The amount of our future net losses will depend, in part, on the rate of our future expenditures and our ability to generate revenue. We have not completed late-stage clinical trials for any product candidate and it will be several years, if ever, before we have a product candidate ready for regulatory approval and commercialization. Even if we succeed in obtaining regulatory approval and commercializing one or more of our product candidates, we will continue to incur substantial research and development and other expenditures to develop and market additional product candidates. We may encounter unforeseen expenses, difficulties, complications, delays and other unknown factors that may adversely affect our business. The size of our future net losses will depend, in part, on the rate of future growth of our expenses and our ability to generate revenue. Our prior losses and expected future losses have had and will continue to have an adverse effect on our stockholders' equity and working capital.

We will require substantial additional financing to achieve our goals, which may not be available on acceptable terms, or at all. Failure to obtain this necessary capital when needed may force us to delay, limit or terminate our product development efforts or other operations.

We are currently advancing our lead product candidate, Toca 511 (vocimagene amiretrorepvec) & Toca FC (flucytosine extended release), through clinical development and other product candidates through preclinical development. Developing gene therapy products is expensive, and we expect our research and development expenses to increase substantially in connection with our ongoing activities, particularly as we advance our product candidates in clinical trials.

As of December 31, 2016, our cash, cash equivalents and marketable securities were $31.2 million. We estimate that the net proceeds from this offering will be approximately $75.3 million, after deducting underwriting discounts and commissions and estimated offering expenses payable by us. We expect that the net proceeds from this offering and our existing cash, cash equivalents and marketable securities will be sufficient to fund our current operations through at least the next 12 months. We intend to use the net proceeds from this offering to fund the Phase 2 portion of our Phase 2/3 clinical trial of Toca 511 & Toca FC in recurrent HGG, manufacturing scale-up and validation for our lead product candidate, the other ongoing and planned clinical development activities for Toca 511 & Toca FC and the remainder for working capital and other general

corporate purposes. However, our operating plan may change as a result of many factors currently unknown to us, and we may need to seek additional funds sooner than planned, through equity and/or debt financings. We may also consider new collaborations or selectively partner our technology or programs. In any event, we will require additional capital to obtain regulatory approval for, and to commercialize, our product candidates. Raising funds in the current economic environment may present additional challenges. Even if we believe we have sufficient funds for our current or future operating plans, we may seek additional capital if market conditions are favorable or if we have specific strategic considerations.

Any additional fundraising efforts may divert our management from their day-to-day activities, which may adversely affect our ability to develop and commercialize our product candidates. In addition, we cannot guarantee that future financing will be available in sufficient amounts or on terms acceptable to us, if at all. Moreover, the terms of any financing may adversely affect the holdings or the rights of our stockholders and the issuance of additional securities, whether equity or debt, by us, or the possibility of such issuance, may cause the market price of our shares to decline. The sale of additional equity or convertible securities would dilute all of our stockholders. The incurrence of indebtedness would result in increased fixed payment obligations and we may be required to agree to certain restrictive covenants, such as limitations on our ability to incur additional debt, limitations on our ability to acquire, sell or license intellectual property rights and other operating restrictions that could adversely impact our ability to conduct our business. We could also be required to seek funds through arrangements with collaborative partners or otherwise at an earlier stage than otherwise would be desirable and we may be required to relinquish rights to some of our technologies or product candidates or otherwise agree to terms unfavorable to us, any of which may have a material adverse effect on our business, operating results and prospects.

If we are unable to obtain funding on a timely basis, we may be required to significantly curtail, delay or discontinue one or more of our research or development programs or the commercialization of any product candidates or be unable to expand our operations or otherwise capitalize on our business opportunities, as desired, which could materially affect our business, financial condition and results of operations.

Immunotherapy, gene therapy and biopharmaceutical product development is a highly speculative undertaking and involves a substantial degree of uncertainty. We have never generated any revenue from product sales and may never be profitable.

Since our inception in August 2007, we have devoted substantially all of our efforts to developing our gene therapy platform and our lead product candidate, Toca 511 & Toca FC. We are still in the early stages of developing our product candidates, and we have not completed development of any products. Our ability to generate revenue and achieve profitability depends in large part on our ability, alone or with partners, to successfully complete the development of, obtain the necessary regulatory approvals for, and commercialize product candidates. We do not anticipate generating revenues from sales of products for the foreseeable future. Our ability to generate future revenues from product sales depends heavily on our success in:

- completing clinical trials through all phases of clinical development of our current and future product candidates;
- seeking and obtaining marketing approvals for product candidates that successfully complete clinical trials;
- launching and commercializing product candidates for which we obtain marketing approval with a partner or, if launched independently, successfully establishing a sales force, marketing and distribution infrastructure;
- identifying and developing new product candidates;
- progressing our preclinical programs into human clinical trials;
- establishing and maintaining supply and manufacturing relationships with third parties;
- maintaining, protecting, expanding and enforcing our intellectual property; and

- attracting, hiring and retaining qualified personnel.

Because of the numerous risks and uncertainties associated with gene therapy product development, we are unable to predict the timing or amount of increased expenses or when we will be able to achieve or maintain profitability, if ever. In addition, our expenses could increase beyond expectations if we are required by the FDA or foreign regulatory agencies, to perform studies and clinical trials in addition to those that we currently anticipate or if there are any delays in the development of any of our product candidates. If one or more of the product candidates that we develop is approved for commercial sale, we anticipate incurring significant costs associated with commercializing such product candidates. Even if we are able to generate revenues from the sale of any approved products, we may not become profitable and may need to obtain additional funding to continue operations, which may not be available to us on favorable terms, if at all. Even if we do achieve profitability, we may not be able to sustain or increase profitability on a quarterly or annual basis. Our failure to become and remain profitable would depress the value of our company and could impair our ability to raise capital, expand our business, maintain our research and development efforts, diversify our product offerings or even continue our operations. A decline in the value of our company could also cause you to lose all or part of your investment.

Our gene therapy product candidates are based on novel technology, which makes it difficult to predict the time and cost of product candidate development.

We have concentrated our product research and development efforts on our gene therapy platform, and our future success depends on the successful development of this therapeutic approach. There can be no assurance that any development problems we experience in the future related to our gene therapy platform will not cause significant delays or unanticipated costs, or that such development problems can be solved. We may also experience delays in developing a sustainable, reproducible and scalable manufacturing process or transferring that process to commercial partners, or developing or validating product release assays in a timely manner, which may prevent us from completing our clinical trials or commercializing our products on a timely or profitable basis, if at all.

In addition, the clinical trial requirements of the FDA, the European Medicines Agency, or EMA, and other regulatory agencies and the criteria these regulators use to determine the safety and efficacy of a product candidate vary substantially according to the type, complexity, novelty and intended use and market of the potential products. The regulatory approval process for novel product candidates such as ours can be more expensive and take longer than for other, better known or extensively studied pharmaceutical or other product candidates. In October 2015 the FDA approved Amgen Inc.'s oncolytic virus therapy, Imlygic (talimogene laherparapvec) for the local treatment of unresectable lesions in patients with melanoma recurrent after initial surgery and this product has been recommended for marketing authorization as a gene therapy in Europe by the Committee for Advanced Therapies. Currently, only two gene therapy products have been approved in Europe, uniQure NV's Glybera (alipogene tiparvovec), which received marketing authorization from the European Commission in 2012, and GlaxoSmithKline, Fondazione Telethon and Ospedale San Raffaele's Strimvelis, which was approved by the European Commission in 2016. This makes it difficult to determine how long it will take or how much it will cost to obtain regulatory approvals for our product candidates in either the United States or Europe.

Regulatory requirements governing gene therapy products have changed frequently and may continue to change in the future. For example, in January 2017, the FDA Oncology Center of Excellence, or the Center of Excellence, was created to leverage the combined skills of regulatory scientists and reviewers with expertise in drugs, biologics, and devices (including diagnostics). While the Center of Excellence is designed to help expedite the development of oncology and malignant hematology-related medical products and support an integrated approach in the clinical evaluation of drugs, biologics and devices for the treatment of cancer, the new Center of Excellence may initially create confusion within the FDA and especially in the Center of Biologics and Research that is the primary review division for our initial product candidate. Gene therapy clinical trials conducted at institutions that receive funding for recombinant DNA research from the U.S. National Institutes of Health, or the NIH, are also subject to review by the NIH Office of Biotechnology Activities' Recombinant DNA Advisory

Committee, or the RAC. We have received from time to time questions from the FDA regarding IND submissions and clinical protocols for Toca 511 & Toca FC. We believe that we have adequately addressed these questions, some of which have caused, in the past, some delays in our clinical trials. Although the FDA decides whether individual gene therapy protocols may proceed, the RAC review process can impede the initiation of a clinical trial, even if the FDA has reviewed the study and approved its initiation. Conversely, the FDA can put an IND on a partial or complete clinical hold even if the RAC has provided a favorable review. Our trials have, in the past, been put on hold for reasons including suspected serious adverse events, which resulted in delays of our trials. Also, before a clinical trial can begin at an NIH-funded institution, that institution's institutional review board, or IRB, and its Institutional Biosafety Committee will have to review the proposed clinical trial to assess the safety of the study. In addition, adverse developments in clinical trials of gene therapy products conducted by others may cause the FDA or other regulatory bodies to change the requirements for performing studies or for obtaining approval of any of our product candidates.

These regulatory review committees and advisory groups, and the new guidelines they promulgate, may lengthen the regulatory review process, require us to perform additional studies, increase our development costs, lead to changes in regulatory positions and interpretations, delay or prevent approval and commercialization of our product candidates or lead to significant post-approval limitations or restrictions. As we advance our product candidates, we will be required to consult with these regulatory and advisory groups and comply with applicable guidelines. Delay or failure to obtain, or unexpected costs in obtaining, the regulatory approval necessary to bring a potential product to market could decrease our ability to generate sufficient revenue to maintain our business.

Failure to successfully develop and obtain approval of our lead product candidate, Toca 511 & Toca FC, or our other future product candidates could adversely affect our future success.

Our business and future success is substantially dependent on our ability to obtain regulatory approval of and then successfully commercialize our lead product candidate, Toca 511 & Toca FC. Toca 511 & Toca FC is in the early stages of clinical development. All of our product candidates, including Toca 511 & Toca FC, will require additional clinical and nonclinical development, regulatory review and approval in one or more jurisdictions, substantial investment, access to sufficient commercial manufacturing capacity and significant marketing efforts before we can generate any revenue from product sales. In addition, because Toca 511 & Toca FC is our most advanced product candidate, and because all of our other future product candidates will likely be based on similar technology, if Toca 511 & Toca FC encounters safety or efficacy problems, developmental delays, regulatory issues or other problems, our development plans and business for our other product candidates would be significantly harmed.

We may have difficulty enrolling patients in our clinical trials, which could delay or prevent development of our product candidates.

Identifying and qualifying patients to participate in clinical trials of our product candidates is critical to our success. The timing of our clinical trials depends on the speed at which we can recruit patients to participate in testing our product candidates. We have experienced delays in some of our clinical trials in the past due to difficulties with enrollment and we may experience similar delays in the future. If patients are unwilling to participate in our clinical trials because of negative publicity from adverse events in the industry or in the trials for other third party product candidates, or for other reasons, including competitive clinical trials for similar patient populations, the timeline for recruiting patients, conducting studies and obtaining regulatory approval of potential products may be delayed. These delays could result in increased costs, delays in advancing our product development, delays in testing the effectiveness of our technology or termination of the clinical trials altogether.

We or our clinical trial sites may not be able to identify, recruit and enroll a sufficient number of patients, or those with the required or desired characteristics in a clinical trial, to complete our clinical trials in a timely manner. Patient enrollment is affected by factors including:

- severity of the disease under investigation;
- design of the clinical trial protocol, including the fact that certain of our clinical trials are randomized to current treatments;
- size of the patient population;
- eligibility criteria for the clinical trial in question;
- perceived risks and benefits of the product candidate under study;
- general level of excitement for the treatment approach;
- comments on social media;
- proximity and availability of clinical trial sites for prospective patients;
- availability of competing therapies and clinical trials;
- efforts to facilitate timely enrollment in clinical trials;
- patient referral practices of physicians; and
- ability to monitor patients adequately during and after treatment.

In particular, recurrent HGG, the condition for which we are initially evaluating our lead product candidate, has a limited number of patients for clinical trials. The eligibility criteria of our clinical trials will further limit the pool of available trial participants. For example, some clinical trials will be limited to patients with recurrent HGG who are scheduled for a repeat resection, for which there are fewer patients. Additionally, the process of finding and diagnosing patients may prove costly. Finally, our treatment necessitates that the patient be near one of our clinical trial sites, since periodic follow-up visits at the clinical trial site are contemplated in the protocols.

We currently plan to seek initial marketing approval in the United States and subsequently Europe and Japan. We may not be able to initiate or continue clinical trials if we cannot enroll a sufficient number of eligible patients to participate in the clinical trials required by the FDA or the EMA or other regulatory agencies. Our ability to successfully initiate, enroll and complete a clinical trial in any foreign country is subject to numerous risks unique to conducting business in foreign countries, including:

- difficulty in establishing or managing relationships with contract research organizations, or CROs, and physicians;
- different standards for the conduct of clinical trials;
- our inability to locate qualified local consultants, physicians and partners; and
- the potential burden of complying with a variety of foreign laws, medical standards and regulatory requirements, including the regulation of pharmaceutical and biotechnology products and treatments.

If we have difficulty enrolling a sufficient number of patients to conduct our clinical trials as planned, we may need to delay, limit or terminate ongoing or planned clinical trials, any of which would have an adverse effect on our business.

The FDA regulatory approval process is lengthy and time-consuming, and we may experience significant delays in the clinical development and regulatory approval of our product candidates. If we are ultimately unable to obtain regulatory approval for our product candidates, our business will be substantially harmed.

The time required to obtain approval by the FDA and comparable foreign authorities is unpredictable but typically takes many years following the commencement of clinical trials and depends upon numerous factors, including the substantial discretion of the regulatory authorities. In addition, approval policies, regulations or the type and amount of clinical data necessary to gain approval may change during the course of a product candidate's clinical development and may vary among jurisdictions. We have not obtained regulatory approval for any product candidate and it is possible that none of our existing product candidates or any product candidates we may seek to develop in the future will ever obtain regulatory approval.

We have not previously submitted a BLA to the FDA, or similar approval filings to comparable foreign authorities. A BLA must include extensive preclinical and clinical data and supporting information to establish the product candidate's safety, purity and potency for each desired indication. The BLA must also include significant information regarding the chemistry, manufacturing and controls for the product. Clinical testing is expensive, time-consuming and uncertain as to outcome. We have experienced in the past delays in the commencement and completion of our clinical trials. We cannot guarantee that any clinical trials will be conducted as planned or completed on schedule, if at all. A failure of one or more clinical trials can occur at any stage of testing. In addition to challenges related to patient enrollment, other events that may prevent successful or timely completion of clinical development include:

- the availability of financial resources to commence and complete our planned clinical trials;
- delays in reaching a consensus with clinical investigators on study design;
- delays in reaching a consensus with regulatory agencies on study design or approval from regulatory authorities to commence a trial;
- reaching agreement on acceptable terms with prospective clinical trial sites, the terms of which can be subject to extensive negotiation and may vary significantly among different clinical trial sites;
- delays in obtaining required IRB and/or biologic safety committee approval at each clinical trial site;
- imposition of a clinical hold by regulatory agencies, after an inspection of our clinical trial operations or study sites, or otherwise;
- failure by our CROs, other third parties or us to adhere to clinical trial requirements;
- failure to perform in accordance with the FDA's good clinical practices, or GCP, or applicable regulatory guidelines in other countries;
- failure to adequately acquire, preserve and quality assure clinical trial data;
- delays in the testing, validation, manufacturing and delivery of our product candidates to the clinical sites;
- inadequate shipping or storage of our products, resulting in loss of activity;
- delays in having patients complete participation in a study or return for post-treatment follow-up;
- clinical trial sites dropping out of a study;
- changes in legislation or regulatory requirements and guidance that require amending or submitting new clinical protocols; and
- technical equipment and/or operating room supply limitations at a clinical trial site.

We could also encounter delays if physicians encounter unresolved ethical issues associated with enrolling patients in clinical trials of our product candidates in lieu of prescribing existing treatments that have established safety and efficacy profiles. Further, a clinical trial may be suspended or terminated by us, the IRBs for the institutions in which such clinical trials are being conducted, the Data Safety Monitoring Committee for such clinical trial, by the FDA or other regulatory authorities due to a number of factors, including failure to conduct the clinical trial in accordance with regulatory requirements or our clinical protocols, inspection of the clinical trial operations or clinical trial site by the FDA or other regulatory authorities resulting in the imposition of a clinical hold, unforeseen safety issues or adverse side effects, failure to demonstrate a benefit from using a product candidate, changes in governmental regulations or administrative actions or lack of adequate funding to continue the clinical trial. If we experience termination of, or delays in the completion of, any clinical trial of our product candidates, the commercial prospects for our product candidates will be harmed, and our ability to generate product revenue will be delayed. In addition, any delays in completing our clinical trials will increase our costs, slow down our product development and approval process and jeopardize our ability to commence product sales and generate revenue.

Any inability to successfully complete preclinical and clinical development could result in additional costs to us or impair our ability to generate revenues from product sales, regulatory and commercialization milestones and royalties. In addition, if we make manufacturing or formulation changes to our product candidates, we may need to conduct additional studies to bridge our modified product candidates to earlier versions. Clinical trial delays could also shorten any periods during which we may have patent protection rights to commercialize our product candidates or allow our competitors to bring products to market before we do, which could impair our

ability to successfully commercialize our product candidates and may harm our business and results of operations.

Our clinical trials may fail to demonstrate safety and efficacy and any of our product candidates could be associated with undesirable side effects or other properties, which would prevent or delay regulatory approval and commercialization.

Before obtaining marketing approval from regulatory authorities for the sale of our product candidates, we must conduct extensive clinical trials to demonstrate the safety and efficacy of the product candidates in humans. Failure can occur at any time during a clinical trial process. The results of preclinical studies and early clinical trials of our product candidates may not be predictive of the results of later-stage clinical trials. There is typically an extremely high rate of attrition from the failure of product candidates proceeding through clinical trials. Product candidates in later stages of clinical trials may fail to show the desired safety and efficacy profile despite having progressed through preclinical testing and initial clinical trials. Most product candidates that commence clinical trials are never approved as products.

In addition, from time to time, we may publish interim, "top-line," initial, or preliminary data from our clinical studies. Interim data from clinical trials are subject to the risk that one or more of the clinical outcomes may materially change as patient enrollment continues and more patient data becomes available. Preliminary, initial, or "top-line" data also remain subject to audit and verification procedures that may result in the final data being materially different from the preliminary data we previously published. As a result, interim, initial, and preliminary data should be viewed with caution until the final data are available. Adverse changes between preliminary, initial, "top-line" or interim data and final data could significantly harm our business prospects. In the 126 patients who received Toca 511 in our on-going Phase 1 clinical trials, treatment-related adverse events were reported in 31.8% of patients and these events were predominantly low grade (25.4%). The most common treatment-related adverse events were fatigue (11.9%), headache (5.6%), and convulsion (4.8%). In the 118 patients who received Toca FC in our on-going Phase 1 clinical trials, treatment-related adverse events were reported in 41.5% of patients and these events were predominantly low grade (38.1%). The most common treatment-related adverse events were fatigue (21.2%), diarrhea (14.4%), and nausea (8.5%). Treatment-related serious adverse events were reported in 4.8% of patients treated with Toca 511 and 2.5% of patients treated with Toca FC. In patients that received both Toca 511 and Toca FC, hematologic toxicity was infrequent and also low grade. Patients treated with our product candidates may also be undergoing surgical, radiation and chemotherapy treatments, which can cause side effects or adverse events that are unrelated to our product candidate, but may still impact the success of our clinical trials. Additionally, our product candidates could potentially cause other adverse events that have not yet been predicted. The inclusion of critically ill patients in our clinical trials may result in deaths or other adverse medical events due to other therapies or medications that such patients may be using or due to the gravity of such patients' illnesses. Patients who will be administered Toca 511 & Toca FC in the HGG clinical trials are seriously or terminally ill and some of them may have immune impairment related to their treatment with temozolomide and dexamethasone. It is expected that some of the patients will die or experience major clinical events such as strokes, hydrocephalus, infections and pulmonary emboli either during the course of our clinical trials or after such trials, which has occurred in the past. To date, in patients with evidence of drug activity from Toca 511 & Toca FC, additional new lesions have been observed, suggesting the drug activity may be limited to locally injected lesions. We may need to retreat patients with additional courses of Toca 511 in order to control the new lesions, which additional treatment may not be successful.

Further, the design of our ongoing Phase 2/3 clinical trial of Toca 511 & Toca FC was based in part on survival data from similar patients in published trials. The prognosis, unrelated to our treatment, for our patients could be better than for patients in these prior trials, due to improvements in clinical practice, other experimental trials or underappreciated differences in entry criteria. In addition, the clinical or regulatory opinion on what constitutes the standard of care that we have used as the basis for the control arm in this clinical trial may change before we submit the BLA for Toca 511 & Toca FC, if the clinical trial is successful.

It is possible that our RRV product candidates will spread to healthy tissues and result in unknown side effects, and that any anticipated or unanticipated side effects may occur at doses required to achieve clinically relevant efficacy, which could prohibit or delay commercialization of our product candidates. Alternatively, our RRV product candidates might not spread rapidly enough through the tumor or transfer sufficient genetic material to the tumor to demonstrate efficacy sufficient for regulatory approval. In preclinical studies in rodent models, we observed that our vectors do not initially infect tumors in some locations as well as they infect tumors in other locations, which may limit treatment with our future product candidates to a limited number of cancer locations. Further, it is possible that the RRV might not spread fast enough through the brain cancer to have a beneficial effect or that the virus might not be able to reach certain parts of the tumor due to prior surgical removal of contiguous cancer tissue or from scarring resulting from surgery, chemotherapy, radiation or spontaneous tumor necrosis (cell death) or due to mechanical limitations such as the inability to insert the needle accurately into the tumor; the inability to push enough RRV volume into a tumor with a high pressure; the rapid diffusion of RRV from the injection site due to high intratumor pressure or due to the communication with the ventricular space, external cerebral spinal fluid or the entry into veins; or the inability to insert the needle into the tumor without damaging vital brain structures. It is possible that the cancers which we seek to treat with our product candidates will become resistant to infection with the virus or become resistant to the 5-FU (5-fluorouracil) produced from Toca FC, due to mutation within the cancer cells genes or due to mutation of Toca 511, including loss of the therapeutic gene, cytosine deaminase, or CD.

If the results of our clinical trials are inconclusive or if there are safety concerns or adverse events associated with our product candidates, we may:

- be delayed in obtaining marketing approval for our product candidates, if at all;
- obtain approval for indications or patient populations that are not as broad as intended or desired;
- obtain approval with labeling that includes significant use or distribution restrictions or safety warnings;
- be subject to changes with the way the product is administered;
- be required to perform additional clinical trials to support approval or be subject to additional post-marketing testing requirements;
- have regulatory authorities withdraw their approval of the product or impose restrictions on its distribution in the form of a modified Risk Evaluation and Mitigation Strategy, or REMS;
- be subject to product liability or other litigation claims; or
- experience damage to our reputation.

In third-party clinical trials involving other viral vectors for gene therapy, some patients experienced serious adverse events, including the development of leukemia due to vector-related insertional oncogenesis and death. If our vectors demonstrate a similar effect, we may be required to halt or delay clinical development of our product candidates.

Existing data on the safety and efficacy of gene therapy is very limited and sometimes include historically poor clinical efficacy of previous non-replicating gene therapy products. In addition, there have been publicized safety issues associated with previous gene therapy products in third-party clinical trials, including patient deaths. The results of preclinical and clinical trials performed for our product candidates do not definitively predict safety or efficacy in humans. Possible serious side effects of other viral vector-based gene therapy therapies in general include uncontrolled viral infections and the development of cancer, particularly lymphoma or leukemia.

A significant risk in any gene therapy product based on viral vectors is that the vector will insert near cancer-causing oncogenes leading to uncontrolled clonal proliferation of mature cancer cells in the patient. For example, in 2003, 20 patients treated for X-linked severe combined immunodeficiency in two gene therapy studies conducted by third parties using a murine gamma-retroviral vector showed correction of the disease, but the studies were terminated after five patients developed leukemia. The cause of these adverse events was believed to be related to insertional oncogenesis, which is the process whereby the corrected gene inserts near a gene that is important in a critical cellular process like growth or division, and this insertion results in the development of a cancer (often leukemia). A potential clinical concern for gene therapy using retroviral vectors

has been the possibility of insertional mutagenesis by the vectors, leading to malignant transformation of transduced cells (i.e., cancer). Because our replicating retroviruses produce viral antigens, these foreign proteins could serve as a target for immune activation against virally-infected cells, which is not a feature of non-replicating retroviral vectors. In addition, we have not, and do not plan to, treat patients with severe immunodeficiency with our product candidates. Further, with our lead product candidate, Toca FC kills the virally-infected cells and presents the antigens. We believe that we have not observed oncogenesis in the patients treated in our clinical trials to date for these reasons. Also, our future product candidates are also designed to activate the immune system against virally-infected cells.

It is possible Toca 511 may spread to non-tumor tissue. We have detected transient and low levels of viral sequences in the saliva of several patients. The risk of insertional mutagenesis or oncogenesis remains a significant concern for gene therapy, and we cannot provide any assurance that it will not occur in any of our current, planned or future clinical trials. There is also the potential risk of delayed adverse events following exposure to gene therapy products due to persistent biological activity of the genetic material or other components of products used to carry the genetic material. If any such adverse events occur, further advancement of our clinical trials could be halted or delayed, which would have a material adverse effect on our business and operations.

We may not be successful in our efforts to identify or discover additional product candidates from our gene therapy platform.

The success of our business depends primarily upon our ability to identify, develop and commercialize products based on our gene therapy platform. Although our Toca 511 & Toca FC product candidate is currently in clinical development, our research programs may fail to identify other potential product candidates for clinical development. Our research methodology may be unsuccessful in identifying potential product candidates, or our potential product candidates may be shown to have harmful side effects or may have other characteristics that may make the products unmarketable or unlikely to receive marketing approval. If any of these events occur, we may be forced to abandon our development efforts for a program or programs, which would have a material adverse effect on our business and could potentially cause us to cease operations.

We rely, and expect to continue to rely, on third parties to conduct, supervise and monitor our clinical trials, and if these third parties perform in an unsatisfactory manner, it may harm our business.

We rely on CROs and clinical trial sites to ensure our clinical trials are conducted properly and on time. While we have agreements governing their activities, we may have limited influence over their actual performance. We control only certain aspects of our CROs' activities. Nevertheless, we are responsible for ensuring that each of our clinical trials is conducted in accordance with the applicable protocol, legal, regulatory and scientific standards, and our reliance on the CROs does not relieve us of our regulatory responsibilities.

We and our CROs are required to comply with the GCPs for conducting, recording and reporting the results of clinical trials to assure that the data and reported results are credible and accurate and that the rights, integrity and confidentiality of clinical trial participants are protected. The FDA enforces these GCPs through periodic inspections of study sponsors, principal investigators and clinical trial sites. If we or our CROs fail to comply with applicable GCPs, the clinical data generated in our future clinical trials may be deemed unreliable, and the FDA may require us to perform additional clinical trials before approving any marketing applications. Upon inspection, the FDA may determine that our clinical trials did not comply with GCPs. In addition, our ongoing and future clinical trials will require a sufficient number of test subjects to evaluate the safety and effectiveness of our product candidates. Accordingly, if our CROs fail to comply with these regulations or fail to recruit a sufficient number of patients, we may be required to repeat such clinical trials, which would delay the regulatory approval process.

Our CROs are not our employees, and we are not able to directly monitor whether or not they devote sufficient time and resources to our clinical and nonclinical programs. These CROs may also have relationships with other commercial entities, including our competitors, for whom they may also be conducting clinical trials or other drug development activities that could harm our competitive position. If our CROs do not successfully carry out their contractual duties or obligations, fail to meet expected deadlines, or if the quality or accuracy of the clinical data they obtain is compromised due to their failure to adhere to our clinical protocols or regulatory requirements, or for any other reasons, our clinical trials may be extended, delayed or terminated, and we may not be able to obtain regulatory approval for or successfully commercialize our product candidates. As a result, our financial results and the commercial prospects for our product candidates would be harmed, our costs could increase and our ability to generate revenues could be delayed.

We expect to continue to rely on third parties to distribute, manufacture and perform release testing for our vectors, product candidates and other key materials and if such third parties do not carry out their contractual duties or meet expected deadlines, we may not be able to obtain regulatory approvals for our product candidates.

We intend to continue to rely on third-party contract manufacturing organizations, or CMOs, to produce our vectors, product candidates and other key materials and on third-party contract testing organizations, or CTOs, for the establishment and performance of validated product release assays, but we have not entered into binding agreements with any such CMOs or CTOs to support commercialization. Additionally, any CMO may not have experience producing our vectors and product candidates at commercial levels and may not achieve the necessary regulatory approvals or produce our vectors and products at the quality, quantities, locations and timing needed to support commercialization. We may change our manufacturing process from the current defined media process to a different defined media process, or from its current equipment to different equipment, or our cell line or vector and there can be no guarantee that the regulatory authorities will approve this new process in a timely manner or ever. Also, as a consequence of the manufacturing change, there may be a requirement to do more preclinical safety or efficacy studies, develop new manufacturing and release assays and/or repeat all or part of the ascending dose safety study in animals or humans. Regulatory requirements ultimately imposed could adversely affect our ability to test, manufacture or market products.

We have not yet secured manufacturing capabilities for commercial quantities of our viral vector. Although we intend to rely on third-party manufacturers for commercialization, we currently utilize a sole-source manufacturer to support our clinical trials. We may be unable to negotiate binding agreements with this manufacturer or additional manufacturers to support our commercialization activities at commercially reasonable terms.

No manufacturer we know of currently has the experience or ability to produce our vectors and product candidates at reasonable commercial levels or under full commercial requirements. We are currently developing a more scalable manufacturing process for Toca 511 & Toca FC, which we plan to transfer to one or more CMOs. We may run into technical or scientific issues related to manufacturing or development that we may be unable to resolve in a timely manner or with available funds. Further, we have not completed the characterization and validation activities necessary for commercial and regulatory approvals. If our manufacturing and testing partners do not obtain such regulatory approvals, our commercialization efforts may be harmed.

Even if we timely develop a manufacturing process for Toca 511 & Toca FC and successfully transfer it to third-party manufacturers, if such third-party manufacturers are unable to produce viral vectors and our product candidates in the necessary quantities, or in compliance with current Good Manufacturing Practices, or cGMP, or in compliance with pertinent regulatory requirements, and within our planned time frame and cost parameters, the development and sales of our products, if approved, may be materially harmed. The facilities used by our contract manufacturers to manufacture our product candidates must be approved by the FDA pursuant to inspections that will be conducted after we submit our BLA to the FDA. We do not control the manufacturing

process of, and are completely dependent on, our contract manufacturing partners for compliance with cGMPs for the manufacture of our product candidates. If our contract manufacturers cannot successfully manufacture material that conforms to our specifications and the strict regulatory requirements of the FDA or others, they will not be able to secure and/or maintain regulatory approval for their manufacturing facilities. In addition, we have no control over the ability of our contract manufacturers to maintain adequate quality control, quality assurance and qualified personnel. If the FDA or a comparable foreign regulatory authority does not approve these facilities for the manufacture of our product candidates or if it withdraws any such approval in the future, we may need to find alternative manufacturing facilities, which would significantly impact our ability to develop, obtain regulatory approval for or market our product candidates, if approved. In addition, any failure to achieve and maintain compliance with these laws, regulations and standards could subject us to the risk that we may have to suspend the manufacturing of our product candidates or that obtained approvals could be revoked, which would adversely affect our business and reputation.

In addition, any significant disruption in our supplier relationships could harm our business. We source key materials, devices and equipment from third parties, either directly through agreements with suppliers or indirectly through our manufacturers who have agreements with suppliers. There are a small number of suppliers for certain key materials and components that are used to manufacture our product candidates. Such suppliers may not sell these key materials to our manufacturers at the times or quantities we need them or on commercially reasonable terms. We may not have any control over the process or timing of the acquisition of these key materials by our manufacturers.

We also expect to rely on other third parties to store and distribute our vectors and products for our clinical trials. Any performance failure on the part of our distributors could delay clinical development or marketing approval of our product candidates or commercialization of our products, if approved, producing additional losses and depriving us of potential product revenue.

Our reliance on third parties may require us to share our trade secrets, which increases the possibility that a competitor will discover them or that our trade secrets will be misappropriated or disclosed.

Because we rely on third parties to manufacture our vectors and our product candidates, and because we collaborate with various organizations and academic institutions on the advancement of our gene therapy platform, we must, at times, share trade secrets with them. We seek to protect our proprietary technology in part by entering into confidentiality agreements and, if applicable, material transfer agreements, collaborative research agreements, consulting agreements or other similar agreements with our manufacturers, collaborators, advisors, employees and consultants prior to beginning research or disclosing proprietary information. These agreements typically limit the rights of the third parties to use or disclose our confidential information, such as trade secrets. Despite the contractual provisions employed when working with third parties, the need to share trade secrets and other confidential information increases the risk that such trade secrets become known by our competitors, are inadvertently incorporated into the technology of others, are used inappropriately to create new inventions or are disclosed or used in violation of these agreements. Given that our proprietary position is based, in part, on our know-how and trade secrets, a competitor's discovery of our trade secrets or other unauthorized use or disclosure would impair our competitive position and may have a material adverse effect on our business.

In addition, these agreements typically restrict the ability of our collaborators, advisors, employees and consultants to publish data potentially relating to our trade secrets. Our academic collaborators typically have rights to publish data, provided that we are notified in advance and may delay publication for a specified time in order to secure our intellectual property rights arising from the collaboration. In other cases, publication rights are controlled exclusively by us, although in some cases we may share these rights with other parties. We also conduct joint research and development programs that may require us to share trade secrets under the terms of our research and development partnerships or similar agreements. Despite our efforts to protect our trade secrets, our competitors may discover our trade secrets through breach of these agreements, independent development or

publication of information including our trade secrets in cases where we do not have proprietary or otherwise protected rights at the time of publication. A competitor's discovery of our trade secrets may impair our competitive position and have an adverse impact on our business.

We face intense competition and rapid technological change and the possibility that our competitors may develop therapies that are more advanced or effective than ours, which may adversely affect our financial condition and our ability to successfully commercialize our product candidates.

We are engaged in developing gene therapies and cancer immunotherapies, which are rapidly evolving and fiercely competitive fields. A wide variety of institutions in the United States and internationally, including major multinational pharmaceutical companies, specialty biotechnology companies, academic research departments and public and private institutions, are actively developing potentially competitive technology and products. We face substantial competition from biotechnology and pharmaceutical companies developing products in immunotherapy and our initial proposed indication. Our competitors generally fall into the following categories: companies developing checkpoint inhibitors; companies developing immunotherapies; companies aimed at stimulating immune responses; companies developing CAR and TCR T cells; companies developing oncolytic virus-based technology; and companies with a focus on HGG.

Many of our competitors have substantially greater financial, technical and other resources, such as larger research and development staff and experienced marketing and manufacturing organizations. Accordingly, our competitors may be more successful than us in obtaining approval for treatments and achieving widespread market acceptance, rendering our treatments obsolete or non-competitive. These companies also compete with us in recruiting and retaining qualified scientific and management personnel, establishing clinical trial sites and patient registration for clinical trials and acquiring technologies complementary to, or necessary for, our programs. Smaller or early-stage companies may also prove to be significant competitors, particularly through collaborative arrangements with large and established companies.

If these competitors develop and commercialize more effective, safer or less toxic products than us or if they obtain regulatory approval before us in key geographies, our commercial opportunities could be substantially limited. In addition, adverse clinical outcomes or similar events at gene therapy companies in the past have adversely affected other companies in this field and could also do so in the future at our company.

Even if we obtain regulatory approval of our product candidates, the products may not gain market acceptance among physicians, patients, hospitals, cancer treatment centers, third-party payors and others in the medical community.

Ethical, social and legal concerns about gene therapy and genetic research could result in additional regulations restricting or prohibiting the products and processes we may use. Even with the requisite approvals, the commercial success of our product candidates will depend in part on the medical community, patients, and third-party payors accepting gene therapy products in general, and our product candidates in particular, as medically useful, cost-effective and safe. Any product that we bring to the market may not gain market acceptance by physicians, patients, third-party payors and others in the medical community. If these products do not achieve an adequate level of acceptance, we may not generate significant product revenue and may not become profitable. The degree of market acceptance of these product candidates, if approved for commercial sale, will depend on a number of factors, including:

- the clinical indications for which our product candidates are approved;
- physicians, hospitals, cancer treatment centers and patients considering our product candidates as a safe and effective treatment;
- the potential and perceived advantages of our product candidates over alternative treatments;
- the prevalence and severity of any side effects;

- product labeling or product insert requirements of the FDA or other regulatory authorities;
- limitations or warnings contained in the labeling approved by the FDA;
- the timing of market introduction of our product candidates as well as competitive products;
- the cost of treatment in relation to alternative treatments;
- the availability of adequate coverage, reimbursement and pricing by third-party payors and government authorities;
- the willingness of patients to pay out-of-pocket in the absence of coverage by third-party payors, including government authorities;
- the willingness, ability and availability of healthcare providers that can comply with the transportation, handling, and temperature-controlled storage requirements associated with our product candidates;
- relative convenience and ease of administration, including as compared to alternative treatments and competitive therapies; and
- the effectiveness of our sales and marketing efforts.

Even if a potential product displays a favorable efficacy and safety profile in preclinical and clinical trials, market acceptance of the product will not be known until after it is launched. Our efforts to educate the medical community and third-party payors on the benefits of the product candidates may require significant resources and may never be successful. Such efforts to educate the marketplace may require more resources than are required by the conventional technologies marketed by our competitors and may be restricted by the allowed label.

We are highly dependent on our key personnel, and if we are not successful in attracting and retaining highly qualified personnel, we may not be able to successfully implement our business strategy.

Our ability to compete in the highly competitive biotechnology and pharmaceutical industries depends upon our ability to attract and retain highly qualified managerial, scientific and medical personnel. We are highly dependent on our management, scientific and medical personnel, including our Chief Executive Officer and our Chief Financial Officer. The loss of the services of any of our executive officers, other key employees and other scientific and medical advisors, and our inability to find suitable replacements, could result in delays in product development and harm our business.

To induce valuable employees to remain at our company, in addition to salary and cash incentives, we have provided stock options that vest over time. The value to employees of stock options that vest over time may be significantly affected by movements in our stock price that are beyond our control and may at any time be insufficient to counteract more lucrative offers from other companies. Despite our efforts to retain them, valuable employees and members of our management, scientific and development teams may terminate their employment with us at any time, with or without notice. We do not have employment agreements with any of our executive officers or other key employees other than employment agreements with Martin J. Duvall and Mark Foletta and a letter agreement with Asha Das, M.D. We do not maintain “key man” insurance policies on the lives of these individuals or the lives of any of our other employees. Our success also depends on our ability to continue to attract, retain and motivate highly skilled scientific and medical personnel.

We will need to expand our organization and we may experience difficulties in managing this growth, which could disrupt our operations.

As of December 31, 2016, we had 61 full-time employees. As our development and commercialization plans and strategies develop, and as we transition into operating as a public company, we expect to need additional managerial, operational, sales, marketing, financial and other personnel. Future growth would impose significant added responsibilities on members of management. There are a small number of individuals with experience in gene therapy and clinicians who have successfully developed drugs and the competition for such individuals is high. Our future financial performance and our ability to commercialize our product candidates will depend, in part, on our ability to effectively manage any future growth, and our management may also have

to divert a disproportionate amount of its attention away from day-to-day activities in order to devote a substantial amount of time to managing these growth activities. We currently rely, and for the foreseeable future will continue to rely on certain independent organizations, advisors and consultants to provide certain services, including substantially all aspects of regulatory approval, clinical management and manufacturing. There can be no assurance that the services of independent organizations, advisors and consultants will continue to be available to us on a timely basis when needed or that we can find qualified replacements. In addition, if we are unable to effectively manage our outsourced activities or if the quality or accuracy of the services provided by consultants is compromised for any reason, our clinical trials may be extended, delayed or terminated, and we may not be able to obtain regulatory approval of our product candidates or otherwise advance our business. There can be no assurance that we will be able to manage our existing consultants or find other competent outside contractors and consultants on economically reasonable terms, or at all.

If we are not able to effectively expand our organization by hiring new employees and expanding our groups of consultants and contractors, we may not be able to successfully implement the tasks necessary to further develop and commercialize our product candidates and, accordingly, may not achieve our research, development and commercialization goals.

We may use our financial and human resources to pursue a particular research program or product candidate and fail to capitalize on programs or product candidates that may be more profitable or for which there is a greater likelihood of success.

Because we have limited resources, we may forego or delay pursuit of opportunities with certain programs or product candidates or for indications that later prove to have greater commercial potential. Our resource allocation decisions may cause us to fail to capitalize on viable commercial products or profitable market opportunities. Our spending on current and future research and development programs for product candidates may not yield any commercially viable products. If we do not accurately evaluate the commercial potential or target market for a particular product candidate, we may relinquish valuable rights to that product candidate through strategic collaboration, licensing or other royalty arrangements in cases in which it would have been more advantageous for us to retain sole development and commercialization rights to such product candidate, or we may allocate internal resources to a product candidate in a therapeutic area in which it would have been more advantageous to enter into a partnering arrangement.

We currently have a very limited marketing and sales organization. If we are unable to expand our marketing and sales capabilities or enter into agreements with third parties to market and sell our product candidates, we may not be able to generate product revenue.

We currently have very limited sales, marketing and distribution capabilities. At the appropriate time, we plan to build a commercial infrastructure targeting oncologists, neuro-oncologists and neurosurgeons and related clinicians and health care workers in leading and regional cancer centers in the United States, which will require significant capital expenditures, management resources and time. Outside the United States, we may build our own commercial infrastructure or consider opportunities to enter into out-licensing or co-promotion agreements with other pharmaceutical or biotechnology companies to develop and/or commercialize our product candidates outside the United States. We will have to compete with other pharmaceutical and biotechnology companies to recruit, hire, train and retain marketing and sales personnel.

If we are unable or decide not to establish internal sales, marketing and distribution capabilities, we will pursue collaborative arrangements regarding the sales and marketing of our products, however, there can be no assurance that we will be able to establish or maintain such collaborative arrangements, or if we are able to do so, that they will have effective sales forces. Any revenue we receive will depend upon the efforts of such third parties, which may not be successful. We may have little or no control over the marketing and sales efforts of such third parties, and our revenue from product sales may be lower than if we had commercialized our product

candidates ourselves. We also face competition in our search for third parties to assist us with the sales and marketing efforts of our product candidates.

There can be no assurance that we will be able to develop in-house sales and distribution capabilities or establish or maintain relationships with third-party collaborators to commercialize any product in the United States or elsewhere.

A variety of risks associated with marketing our product candidates internationally could materially adversely affect our business.

We plan to seek regulatory approval of our product candidates outside of the United States and, accordingly, we expect that we will be subject to additional risks related to operating in foreign countries if we obtain the necessary approvals, including:

- differing regulatory requirements and reimbursement regimes in foreign countries;
- unexpected changes in tariffs, trade barriers, price and exchange controls and other regulatory requirements;
- economic weakness, including inflation, or political instability in particular foreign economies and markets;
- compliance with tax, employment, immigration and labor laws for employees living or traveling abroad;
- foreign taxes, including withholding of payroll taxes;
- foreign currency fluctuations, which could result in increased operating expenses and reduced revenue, and other obligations incident to doing business in another country;
- difficulties staffing and managing foreign operations;
- workforce uncertainty in countries where labor unrest is more common than in the United States;
- potential liability under the Foreign Corrupt Practices Act of 1977 or comparable foreign regulations;
- challenges enforcing our contractual and intellectual property rights, especially in those foreign countries that do not respect and protect intellectual property rights to the same extent as the United States;
- production shortages resulting from any events affecting raw material supply or manufacturing capabilities abroad; and
- business interruptions resulting from geo-political actions, including war and terrorism.

These and other risks associated with our international operations may materially adversely affect our ability to attain or maintain profitable operations.

The terms of our loan and security agreement place restrictions on our operating and financial flexibility.

In October 2015, we entered into a loan and security agreement with Oxford Finance LLC and Silicon Valley Bank that is secured by substantially all of our assets other than our intellectual property (except rights to payment from the sale, licensing or disposition of such intellectual property). We borrowed $18.0 million upon execution of the loan and security agreement.

The loan and security agreement includes affirmative and negative covenants applicable to us and any subsidiaries we create in the future. The affirmative covenants include, among others, covenants requiring us to maintain our legal existence and governmental approvals, deliver certain financial reports, maintain insurance coverage, and subject all of our deposit accounts, securities accounts, commodity accounts or any other bank accounts, to a control agreement in favor of Oxford Finance LLC. The negative covenants include, among others, restrictions on us transferring collateral, incurring additional indebtedness, engaging in mergers or acquisitions, paying dividends in cash or making other distributions, making investments, creating liens, selling assets, and suffering a change in control, in each case subject to certain exceptions.

The loan and security agreement also includes events of default, the occurrence and continuation of which provide Oxford Finance LLC, as collateral agent, with the right to exercise remedies against us and the collateral

securing the loans under the loan and security agreement, including foreclosure against our properties securing the loan and security agreement, including our cash, potentially requiring us to renegotiate our agreement on terms less favorable to us or to immediately cease operations. These events of default include, among other things, our failure to pay any amounts due under the loan and security agreement, a breach of covenants under the loan and security agreement, our insolvency, impairment in the perfection or priority of each lender's security interest in the collateral, the occurrence of any default under certain other indebtedness in an amount greater than $250,000, our failure to obtain or maintain material governmental approvals, and a final judgment against us of at least $250,000. Further, if we are liquidated, the lender's right to repayment would be senior to the rights of the holders of our common stock to receive any proceeds from the liquidation. The lenders could declare a default upon the occurrence of any event that they interpret as a material adverse change as defined under the loan and security agreement, thereby requiring us to repay the loan immediately or to attempt to reverse the declaration of default through negotiation or litigation. Any declaration by the lenders of an event of default could significantly harm our business and prospects and could cause the price of our common stock to decline.

If product liability lawsuits are brought against us, we may incur substantial liabilities and may be required to limit commercialization of our product candidates.

We face an inherent risk of product liability as a result of the clinical testing of our product candidates and will face an even greater risk if we commercialize any products. For example, we may be sued if our product candidates cause or are perceived to cause injury or are found to be otherwise unsuitable during clinical testing, manufacturing, marketing or sale. Any such product liability claims may include allegations of defects in manufacturing, defects in design, a failure to warn of dangers inherent in the product, negligence, strict liability or a breach of warranties. Claims could also be asserted under state consumer protection acts. If we cannot successfully defend ourselves against product liability claims, we may incur substantial liabilities or be required to limit commercialization of our product candidates. Even successful defense would require significant financial and management resources. Regardless of the merits or eventual outcome, liability claims may result in:

- decreased demand for our product candidates;
- injury to our reputation;
- withdrawal of clinical trial participants;
- initiation of investigations by regulators;
- costs to defend the related litigation;
- a diversion of management's time and our resources;
- substantial monetary awards to clinical trial participants or patients;
- product recalls, withdrawals or labeling, marketing or promotional restrictions;
- exhaustion of any available insurance and our capital resources;
- loss of revenue;
- the inability to commercialize any product candidate; and
- a decline in our share price.

Our inability to obtain sufficient product liability insurance at an acceptable cost to protect against potential product liability claims could prevent or inhibit the commercialization of any products we develop, alone or with corporate collaborators. We currently carry $5 million of product liability insurance covering our clinical trials. Although we maintain such insurance, our insurance policies may have various exclusions, and we may be subject to a product liability claim for which we have no coverage. We may have to pay any amounts awarded by a court or negotiated in a settlement that exceed our coverage limitations or that are not covered by our insurance, and we may not have, or be able to obtain, sufficient capital to pay such amounts. Even if our agreements with any future corporate collaborators entitle us to indemnification against losses, such indemnification may not be available or adequate should any claim arise.

Negative public opinion and increased regulatory scrutiny of gene therapy and genetic research may damage public perception of our product candidates or adversely affect our ability to conduct our business or obtain regulatory approvals for our product candidates.

Public perception may be influenced by claims that gene therapy is unsafe, and gene therapy may not gain the acceptance of the public or the medical community. In particular, our success will depend upon physicians specializing in the treatment of those diseases that our product candidates target prescribing treatments that involve the use of our product candidates in lieu of, or in addition to, existing treatments with which they are already familiar with and for which greater clinical data may be available. More restrictive government regulations or negative public opinion would have a negative effect on our business or financial condition and may delay or impair the development and commercialization of our product candidates or demand for any products we may develop. Adverse events in our clinical trials, even if not ultimately attributable to our product candidates, and the resulting publicity could lead to increased governmental regulation, unfavorable public perception, potential regulatory delays in the testing or approval of our potential product candidates, stricter labeling requirements for those product candidates that are approved and a decrease in demand for any such product candidates. Concern about environmental spread of our product, whether real or anticipated, may hinder the commercialization of our products.

Our internal computer systems, or those used by our CROs, SaaS providers, contractors or consultants, may fail or suffer security breaches.

Despite the implementation of security measures, our internal computer systems and those of our CROs, SaaS providers, contractors and consultants are vulnerable to damage from computer viruses and unauthorized access. While we have not experienced any such material system failure or security breach to date, if such an event were to occur and cause interruptions in our operations, it could result in a material disruption of our development programs and our business operations. For example, the loss of clinical trial data from completed or future clinical trials could result in delays in our regulatory approval efforts and significantly increase our costs to recover or reproduce the data. To the extent that any disruption or security breach were to result in a loss of, or damage to, our data or applications, or inappropriate disclosure of confidential or proprietary information, we could incur liability, and the further development and commercialization of our product candidates could be delayed.

Business disruptions could seriously harm our future revenue and financial condition and increase our costs and expenses.

Our operations, and those of our CROs, contractors and consultants, could be subject to power shortages, telecommunications failures, wildfires, water shortages, floods, earthquakes, hurricanes, typhoons, fires, extreme weather conditions, medical epidemics and other natural or man-made disasters or business interruptions for which we are predominantly self-insured. The occurrence of any of these business disruptions could seriously harm our operations and financial condition and increase our costs and expenses. Our ability to obtain clinical supplies of our product candidates could be disrupted if the operations of our contract manufacturers or cell line storage facilities are affected by a man-made or natural disaster or other business interruption.

Risks related to government regulation

The FDA may disagree with our regulatory plans, and we may fail to obtain regulatory approval of our product candidates.

Our ongoing Phase 2/3 clinical trial of Toca 511 & Toca FC is designed to rely on overall survival as the primary endpoint. Following the completion of the Phase 2 portion of this clinical trial, and if the results are satisfactory, we plan to meet with the FDA in a Type B meeting to discuss whether the data from the Phase 2

portion alone could support approval of a BLA for Toca 511 & Toca FC in the indication of recurrent HGG. However, the general approach for FDA approval of a new biologic or drug is to require dispositive data from two adequate and well-controlled Phase 3 clinical trials of the biologic or drug in the relevant patient population.

In addition, we believe that it is likely that there may be a regulatory requirement for one or more diagnostic assays to monitor treatment, especially for the presence of Toca 511 & Toca FC or their components or derivatives. We plan to meet with the FDA to discuss the development of such assays, and it is possible that the FDA may require a separate regulatory approval for such assays contemporaneously with the approval of Toca 511 & Toca FC.

Our clinical trials results may not support approval. In addition, Toca 511 & Toca FC and our other product candidates could fail to receive regulatory approval for many reasons, including the following:

- the FDA or comparable foreign regulatory authorities may disagree with the design or implementation of our clinical trials, including clinical endpoints;
- the results of clinical trials may not meet the level of statistical significance required by the FDA or comparable foreign regulatory authorities for approval;
- we may be unable to demonstrate that our product candidates' clinical and other benefits outweigh their safety risks or are better than recently produced safety or efficacy data for other products;
- we may encounter serious and unexpected adverse events during clinical trials that render our products unsafe for use in humans;
- the FDA or comparable foreign regulatory authorities may disagree with our interpretation of data from preclinical studies or clinical trials;
- the data collected from clinical trials of our product candidates may not be sufficient to the satisfaction of the FDA or comparable foreign regulatory authorities to support the submission of a BLA or other comparable submission in foreign jurisdictions or to obtain regulatory approval in the United States or elsewhere;
- the FDA or comparable foreign regulatory authorities may fail to approve our manufacturing processes and/or facilities of third-party manufacturers with which we contract for clinical and commercial supplies; and
- the approval policies or regulations of the FDA or comparable foreign regulatory authorities may significantly change in a manner rendering our clinical data insufficient for approval.

Obtaining and maintaining regulatory approval of our product candidates in one jurisdiction does not mean that we will be successful in obtaining regulatory approval of our product candidates in other jurisdictions.

Obtaining and maintaining regulatory approval of our product candidates in one jurisdiction does not guarantee that we will be able to obtain or maintain regulatory approval in any other jurisdiction, while a failure or delay in obtaining regulatory approval in one jurisdiction may have a negative effect on the regulatory approval process in others. For example, even if the FDA grants marketing approval of a product candidate, comparable regulatory authorities in foreign jurisdictions must also approve the manufacturing, marketing and promotion of the product candidate in those countries. Approval procedures vary among jurisdictions and can involve requirements and administrative review periods different from, and greater than, those in the United States, including additional preclinical studies or clinical trials. Studies and clinical trials conducted in one jurisdiction or study group may not be accepted by regulatory authorities in other jurisdictions. In many jurisdictions outside the United States, a product candidate must be approved for reimbursement before it can be approved for sale in that jurisdiction. In some cases, the price that we intend to charge for our products is also subject to approval.

We may also submit marketing applications in other countries. Regulatory authorities in jurisdictions outside of the United States have requirements for approval of product candidates with which we must comply prior to marketing in those jurisdictions. Obtaining approvals in one jurisdiction does not guarantee that we will

be able to obtain approval in any other jurisdiction, but the failure to obtain approval in a jurisdiction may have a negative impact on our ability to obtain approval in other jurisdictions. Obtaining foreign regulatory approvals and compliance with foreign regulatory requirements could result in significant delays, difficulties and costs for us and could delay or prevent the introduction of our products in certain countries. If we fail to comply with the regulatory requirements in international markets and/or receive applicable marketing approvals, our target market will be reduced and our ability to realize the full market potential of our product candidates will be harmed.

Additional time may be required to obtain regulatory approval for Toca 511 & Toca FC because it is a combination product.

We believe our Toca 511 & Toca FC product candidate is regulated as a drug/biologic combination product, which will require coordination within the FDA and similar foreign regulatory agencies for review of their biologic and drug components and potentially one or more diagnostic assays to monitor treatment. Although the FDA and similar foreign regulatory agencies have systems in place for the review and approval of combination products such as ours, we may experience delays in the development and commercialization of our product candidates due to regulatory timing constraints and uncertainties in the product development and approval process.

Even if we receive regulatory approval of our product candidates, we will be subject to ongoing regulatory obligations and continued regulatory review, which may result in significant additional expense, and we may be subject to penalties and/or withdrawal of product approval if we fail to comply with regulatory requirements or experience unanticipated problems with our product candidates.

Any regulatory approvals that we receive for our product candidates will require surveillance to monitor the safety and efficacy of the product candidate. Specifically, we believe that it is likely that there may be a regulatory requirement for one or more diagnostic assays to monitor treatment, especially for the presence of Toca 511 or Toca FC or their components or derivatives. We plan to meet with the FDA to discuss the development of such assays, and it is possible that the FDA may require a separate regulatory approval for such assays. Further, each vector containing a particular gene could be regulated as a separate biologic depending on its intended use and FDA policy. The FDA may also require a REMS, in order to approve our product candidates, which could entail requirements for a medication guide, physician communication plans or additional elements to ensure safe use, such as restricted distribution methods, patient registries and other risk minimization tools. In addition, if the FDA or a comparable foreign regulatory authority approves our product candidates, the manufacturing processes, labeling, packaging, distribution, adverse event reporting, storage, advertising, promotion, import, export and record keeping for our product candidates will be subject to extensive and ongoing regulatory requirements. These requirements include, among other things, submissions of safety and other post-marketing information and reports, registration, as well as continued compliance with cGMPs for manufacturing and GCPs for any clinical trials that we conduct post-approval. Later discovery of previously unknown problems with our product candidates, including adverse events of unanticipated severity or frequency, or with our third-party manufacturers or manufacturing processes, or failure to comply with regulatory requirements, may result in, among other things:

- restrictions on the marketing or manufacturing of our product candidates, withdrawal of the product from the market, or voluntary or mandatory product recalls;
- fines, warning letters or holds on clinical trials;
- refusal by the FDA to approve pending applications or supplements to approved applications filed by us or suspension or revocation of license approvals;
- suspension or termination of manufacturing at one or more manufacturing facilities;
- product seizure or detention, or refusal to permit the import or export of our product candidates; and
- injunctions or the imposition of civil or criminal penalties.

The FDA's and other regulatory authorities' policies may change and additional government regulations may be enacted that could prevent, limit or delay regulatory approval of our product candidates. For example, in

December 2016, the 21st Century Cures Act, or Cures Act, was signed into law. The Cures Act, among other things, is intended to modernize the regulation of drugs and biologics and spur innovation, and it contains provisions specific to the development and review of combination products. We cannot predict the likelihood, nature or extent of government regulation that may arise from future legislation or administrative action, either in the United States or abroad. For example, certain policies of the Trump administration may impact our business and industry. Namely, the Trump administration has taken several executive actions, including the issuance of a number of Executive Orders, that could impose significant burdens on, or otherwise materially delay, the FDA's ability to engage in routine regulatory and oversight activities such as implementing statutes through rulemaking, issuance of guidance, and review and approval of marketing applications. Notably, on January 23, 2017, President Trump ordered a hiring freeze for all executive departments and agencies, including the FDA, which prohibits the FDA from filling employee vacancies or creating new positions. Under the terms of the order, the freeze will remain in effect until implementation of a plan to be recommended by the Director for the Office of Management and Budget, or OMB, in consultation with the Director of the Office of Personnel Management, to reduce the size of the federal workforce through attrition. An under-staffed FDA could result in delays in the FDA's responsiveness or in its ability to review submissions or applications, issue regulations or guidance, or implement or enforce regulatory requirements in a timely fashion or at all. Moreover, on January 30, 2017, President Trump issued an Executive Order, applicable to all executive agencies, including the FDA, that requires that for each notice of proposed rulemaking or final regulation to be issued in fiscal year 2017, the agency shall identify at least two existing regulations to be repealed, unless prohibited by law. These requirements are referred to as the "two-for-one" provisions. This Executive Order includes a budget neutrality provision that requires the total incremental cost of all new regulations in the 2017 fiscal year, including repealed regulations, to be no greater than zero, except in limited circumstances. For fiscal years 2018 and beyond, the Executive Order requires agencies to identify regulations to offset any incremental cost of a new regulation. In interim guidance issued by the Office of Information and Regulatory Affairs within OMB on February 2, 2017, the administration indicates that the "two-for-one" provisions may apply not only to agency regulations, but also to significant agency guidance documents. It is difficult to predict how these requirements will be implemented, and the extent to which they will impact the FDA's ability to exercise its regulatory authority. If these executive actions impose constraints on the FDA's ability to engage in oversight and implementation activities in the normal course, our business may be negatively impacted. In addition, if we are slow or unable to adapt to changes in existing requirements or the adoption of new requirements or policies, or if we are not able to maintain regulatory compliance, we may lose any marketing approval that we may have obtained and we may not achieve or sustain profitability.

We have Orphan-Drug Designation for Toca 511 & Toca FC for the treatment of GBM, but we may be unable to maintain the benefits associated with Orphan-Drug Designation, including potential eligibility for any future market exclusivity.

Under the Orphan-Drug Act, the FDA may grant orphan designation to a drug or biologic intended to treat a rare disease or condition, which is defined as one occurring in a patient population of fewer than 200,000 in the United States, or a patient population greater than 200,000 in the United States for which there is no reasonable expectation that the cost of developing and making available in the United States a drug or biologic for a disease or condition will be recovered from sales in the United States for that drug or biologic. In the United States, Orphan-Drug Designation entitles a party to financial incentives such as opportunities for grant funding towards clinical trial costs, tax advantages and user-fee waivers. In addition, if a product that has Orphan-Drug Designation subsequently receives the first FDA approval for the disease for which it has such designation, the product is entitled to orphan product exclusivity, which means that the FDA may not approve any other applications to market the same biologic for the same indication for seven years, except in limited circumstances, such as a showing of clinical superiority to the product with orphan drug exclusivity or where the manufacturer is unable to assure sufficient product quantity.

Toca 511 & Toca FC has Orphan-Drug Designation in the United States for the treatment of GBM. However, we are currently developing this product candidate for the treatment of recurrent HGG, of which GBM

is a subset. Exclusive marketing rights in the United States may be limited if we seek approval for an indication broader than the orphan designated indication, GBM, and may be lost if the FDA later determines that the request for designation was materially defective or if the manufacturer is unable to assure sufficient quantities of the product to meet the needs of patients with the rare disease or condition. Further, even if we obtain orphan drug exclusivity for a product, that exclusivity may not effectively protect the product from competition because different products with different active moieties can be approved for the same condition. Even after an orphan product is approved, the FDA can subsequently approve the same product with the same active moiety for the same condition if the FDA concludes that the later product is safer, more effective or makes a major contribution to patient care. Orphan-Drug Designation neither shortens the development time or regulatory review time of a drug or biologic nor gives the drug or biologic any advantage in the regulatory review or approval process. In addition, while we may seek orphan designation for other product candidates, we may never receive such designations.

A Fast Track Designation or Breakthrough Therapy Designation by the FDA may not actually lead to a faster development or regulatory review or approval process.

If a product candidate is intended for the treatment of a serious or life-threatening condition and demonstrates the potential to address unmet medical needs for this condition, the drug sponsor may apply for FDA Fast Track Designation. Similarly, Breakthrough Therapy Designation may be granted by the FDA to product candidates for serious conditions that have preliminary clinical evidence indicating the product candidate may offer substantial improvement over available therapy. The FDA has broad discretion whether or not to grant these designations, and even if we believe a particular product candidate is eligible for these designations, we cannot assure you that the FDA would decide to grant them. We have been granted Fast Track Designation and Breakthrough Therapy Designation for our Toca 511 & Toca FC product candidate for the treatment of recurrent HGG, but this is no assurance we will receive these designations for any future product candidates. Further, even though we have received these designations for Toca 511 & Toca FC, we may not experience a faster development process, review or approval compared to conventional FDA procedures. The FDA may withdraw these designations if it believes that they are no longer supported by data from our clinical development program.

Our Toca 511 & Toca FC product may face competition sooner than anticipated, if approved.

The Biologics Price Competition and Innovation Act of 2009, or BPCIA, created an abbreviated approval pathway for biological products that are biosimilar to or interchangeable with an FDA-licensed reference biological product. Under the BPCIA, an application for a biosimilar product may not be submitted to the FDA until four years following the date that the reference product was first licensed by the FDA. In addition, the approval of a biosimilar product may not be made effective by the FDA until 12 years from the date on which the reference product was first licensed. During this 12-year period of exclusivity, another company may still market a competing version of the reference product if the FDA approves a full BLA for the competing product containing the sponsor's own preclinical data and data from adequate and well-controlled clinical trials to demonstrate the safety, purity and potency of its product. The law is complex and is still being interpreted and implemented by the FDA. As a result, its ultimate impact, implementation and meaning are subject to uncertainty. While it is uncertain when such processes intended to implement BPCIA may be fully adopted by the FDA, any such processes could have a material adverse effect on the future commercial prospects for our biological products.

We believe that any of our product candidates approved as a biological product under a BLA should qualify for the 12-year period of exclusivity. However, there is a risk that this exclusivity could be shortened due to congressional action or otherwise, or that the FDA will not consider our product candidates to be reference products for competing products, potentially creating the opportunity for competition sooner than anticipated. Other aspects of the BPCIA, some of which may impact the BPCIA exclusivity provisions, have also been the subject of recent litigation. Moreover, the extent to which a biosimilar, once approved, will be substituted for any one of our reference products in a way that is similar to traditional generic substitution for non-biological products is not yet clear, and will depend on a number of marketplace and regulatory factors that are still developing.

We may be subject, directly or indirectly, to federal and state healthcare fraud and abuse laws, false claims laws and other federal and state healthcare laws, and the failure to comply with such laws could result in substantial penalties. Our employees, independent contractors, consultants, principal investigators, CROs, commercial partners and vendors may engage in misconduct or other improper activities, including noncompliance with regulatory standards and requirements.

We are exposed to the risk of fraud, misconduct or other illegal activity by our employees, independent contractors, consultants, principal investigators, CROs, commercial partners and vendors. Misconduct by these parties could include intentional, reckless and/or negligent conduct that fails to: comply with the laws of the FDA and other similar foreign regulatory bodies; provide true, complete and accurate information to the FDA and other similar foreign regulatory bodies; comply with manufacturing standards we have established; comply with federal and state data privacy, security, fraud and abuse and other healthcare laws and regulations in the United States and similar foreign fraudulent misconduct laws; or report financial information or data accurately or to disclose unauthorized activities to us. If we obtain FDA approval for any of our product candidates and begin commercializing those products in the United States, our potential exposure under such laws would increase significantly, and our costs associated with compliance with such laws would likely also increase. These laws may impact, among other things, our current activities with principal investigators and research patients, as well as proposed and future sales, marketing and education programs. In particular, the promotion, sales and marketing of healthcare items and services, as well as certain business arrangements in the healthcare industry, are subject to extensive laws and regulations intended to prevent fraud, misconduct, kickbacks, self-dealing and other abusive practices. These laws and regulations may restrict or prohibit a wide range of pricing, discounting, marketing and promotion, including off-label uses of our products, structuring and commission(s), certain customer incentive programs and other business arrangements generally. Activities subject to these laws also involve the improper use or misrepresentation of information obtained in the course of patient recruitment for clinical trials, creating fraudulent data in our preclinical studies or clinical trials or illegal misappropriation of drug product, which could result in regulatory sanctions and cause serious harm to our reputation. It is not always possible to identify and deter misconduct by employees and other third parties, and the precautions we take to detect and prevent this activity may not be effective in controlling unknown or unmanaged risks or losses or in protecting us from governmental investigations or other actions or lawsuits stemming from a failure to comply with these laws or regulations. Additionally, we are subject to the risk that a person or government could allege such fraud or other misconduct, even if none occurred. If any such actions are instituted against us, and we are not successful in defending ourselves or asserting our rights, those actions could have a significant impact on our business, including the imposition of fines or other sanctions. The laws that may affect our ability to operate include, but are not limited to:

- the Federal Anti-Kickback Statute, which prohibits, among other things, individuals and entities from knowingly and willfully soliciting, receiving, offering or paying any remuneration (including any kickback, bribe, or rebate), directly or indirectly, overtly or covertly, in cash or in kind, to induce, or in return for, either the referral of an individual for, or the purchase, lease, order or recommendation of, any good, facility, item or service for which payment may be made, in whole or in part, under a federal healthcare program, such as the Medicare and Medicaid programs. A person or entity does not need to have actual knowledge of the statute or specific intent to violate it in order to have committed a violation;
- federal civil and criminal false claims laws and civil monetary penalty laws, including the civil False Claims Act, which impose criminal and civil penalties, through government, civil whistleblower or qui tam actions, on individuals and entities for, among other things, knowingly presenting, or causing to be presented, claims for payment or approval from Medicare, Medicaid, or other third-party payors that are false, fictitious or fraudulent, or knowingly making, using or causing to be made or used, a false statement to avoid, decrease or conceal an obligation to pay money to the federal government. In addition, the government may assert that a claim including items and services resulting from a violation of the federal Anti-Kickback Statute constitutes a false or fraudulent claim for purposes of the False Claims Act;
- the Federal Health Insurance Portability and Accountability Act of 1996, or HIPAA, which imposes criminal and civil liability for, among other things, knowingly and willfully executing, or attempting to

execute, a scheme to defraud or to obtain any healthcare benefit program or obtain, by means of false or fraudulent pretenses, representations, or promises, any of the money or property owned by, or under the custody or control of, any healthcare benefit program, regardless of the payor (e.g., public or private), willfully obstructing a criminal investigation of a healthcare offense, and knowingly and willfully falsifying, concealing or covering up by any trick or device a material fact or making any materially false, fictitious or fraudulent statements in connection with the delivery of, or payment for, healthcare benefits, items or services relating to healthcare matters. Similar to the federal Anti-Kickback Statute, a person or entity does not need to have actual knowledge of the statute or specific intent to violate it in order to have committed a violation;

- HIPAA, as amended by the Health Information Technology for Economic and Clinical Health Act of 2009, or HITECH, and their respective implementing regulations, which impose requirements on certain covered healthcare providers, health plans, and healthcare clearinghouses, as well as their respective business associates that perform services for them that involve the creation, use, maintenance or disclosure of, individually identifiable health information, relating to the privacy, security and transmission of individually identifiable health information without appropriate authorization;
- the federal physician payment transparency requirements, sometimes referred to as the "Physician Payments Sunshine Act," created under the Patient Protection and Affordable Care Act, as amended by the Health Care and Education Reconciliation Act, collectively the Affordable Care Act, and its implementing regulations, which require certain manufacturers of drugs, devices, biologics and medical supplies for which payment is available under Medicare, Medicaid or the Children's Health Insurance Program (with certain exceptions) to report annually to the United States Department of Health and Human Services, or HHS, information related to payments or other transfers of value made to physicians (defined to include doctors, dentists, optometrists, podiatrists and chiropractors) and teaching hospitals, as well as ownership and investment interests held by physicians and their immediate family members;
- the U.S. Federal Food, Drug and Cosmetic Act, or FDCA, which prohibits, among other things, the adulteration or misbranding of drugs and medical devices; and
- federal consumer protection and unfair competition laws, which broadly regulate marketplace activities and activities that potentially harm consumers.

Additionally, we are subject to state and foreign equivalents of each of the healthcare laws described above, among others, some of which may be broader in scope and may apply regardless of the payor.

Effective upon the completion of this offering, we will update our code of business conduct and ethics, but it is not always possible to identify and deter employee misconduct, and the precautions we take to detect and prevent inappropriate conduct may not be effective in controlling unknown or unmanaged risks or losses or in protecting us from governmental investigations or other actions or lawsuits stemming from a failure to be in compliance with such laws or regulations. Efforts to ensure that our business arrangements will comply with applicable healthcare laws and regulations will involve substantial costs. It is possible that governmental and enforcement authorities will conclude that our business practices may not comply with current or future statutes, regulations or case law interpreting applicable fraud and abuse or other healthcare laws and regulations. If any such actions are instituted against us, and we are not successful in defending ourselves or asserting our rights, those actions could have a significant impact on our business, including the imposition of civil, criminal and administrative penalties, damages, disgorgement, monetary fines, possible exclusion from participation in Medicare, Medicaid and other federal healthcare programs, contractual damages, reputational harm, diminished profits and future earnings, and curtailment or restructuring of our operations, any of which could adversely affect our ability to operate our business and our results of operations. In addition, the approval and commercialization of any of our product candidates outside the United States will also likely subject us to foreign equivalents of the healthcare laws mentioned above, among other foreign laws.

Coverage and reimbursement may be limited or unavailable in certain market segments for our product candidates, if approved, which could make it difficult for us to sell our product candidates profitably.

Successful sales of our product candidates, if approved, depend on the availability of coverage and adequate reimbursement from third-party payors. In addition, because our product candidates represent new approaches to the treatment of cancer, we cannot be sure that coverage and reimbursement will be available for, or accurately estimate the potential revenue from, our product candidates.

Patients who are provided medical treatment for their conditions generally rely on third-party payors to reimburse all or part of the costs associated with their treatment. Coverage and adequate reimbursement from governmental healthcare programs, such as Medicare and Medicaid, and commercial payors are critical to new product acceptance.

Government authorities and other third-party payors, such as private health insurers and health maintenance organizations, decide which drugs and treatments they will cover and the amount of reimbursement. Coverage and reimbursement by a third-party payor may depend upon a number of factors, including, but not limited to, the third-party payor's determination that use of a product is:

- a covered benefit under its health plan;
- safe, effective and medically necessary;
- appropriate for the specific patient;
- cost-effective; and
- neither experimental nor investigational.

In the United States, no uniform policy of coverage and reimbursement for products exists among third-party payors, and coverage and reimbursement for products can differ significantly from payor to payor. As a result, obtaining coverage and reimbursement approval of a product from a government or other third-party payor is a time-consuming and costly process that could require us to provide to each payor supporting scientific, clinical and cost-effectiveness data for the use of our products and to justify the level of coverage and reimbursement relative to other therapies, with no assurance that coverage and adequate reimbursement will be obtained. Third party payors may also have difficulty in determining the appropriate coverage of our product candidates, if approved, due to the fact that they are combination products that include a small molecule drug. To the extent there are any delays in determining such coverage or inadequate coverage and reimbursement for all aspects of our combination therapies, it would adversely affect the market acceptance, demand and use of our product candidates. Any denial in coverage or reduction in reimbursement from Medicare or other government programs may result in a similar denial or reduction in payments from private payors, which may adversely affect our future profitability.

We intend to seek approval to market our product candidates in both the United States and in selected foreign jurisdictions. If we obtain approval in one or more foreign jurisdictions for our product candidates, we will be subject to rules and regulations in those jurisdictions. In some foreign countries, particularly those in the European Union, the pricing of biologics is subject to governmental control and other market regulations which could put pressure on the pricing and usage of our product candidates. In these countries, pricing negotiations with governmental authorities can take considerable time after obtaining marketing approval of a product candidate. In addition, market acceptance and sales of our product candidates will depend significantly on the availability of coverage and adequate reimbursement from third-party payors for our product candidates and may be affected by existing and future health care reform measures.

Healthcare legislative reform measures may have a material adverse effect on our business and results of operations.

Third-party payors, whether domestic or foreign, or governmental or commercial, are developing increasingly sophisticated methods of controlling healthcare costs. In both the United States and certain foreign

jurisdictions, there have been a number of legislative and regulatory changes to the health care system that could impact our ability to sell our products profitably. In particular, in 2010, the Affordable Care Act was enacted in the United States. The Affordable Care Act and its implementing regulations, among other things, subjected biological products to potential competition by lower-cost biosimilars, revised the methodology by which rebates owed by manufacturers to the state and federal government for covered outpatient drugs and certain biologics, including our product candidates, under the Medicaid Drug Rebate Program are calculated, increased the minimum Medicaid rebates owed by most manufacturers under the Medicaid Drug Rebate Program, extended the Medicaid Drug Rebate program to utilization of prescriptions of individuals enrolled in Medicaid managed care organizations, subjected manufacturers to new annual fees and taxes for certain branded prescription drugs, and provided incentives to programs that increase the federal government's comparative effectiveness research. Since its enactment, there have been judicial and Congressional challenges to certain aspects of the Affordable Care Act, and we expect there will be additional challenges and amendments to the Affordable Care Act in the future. The new Presidential Administration and U.S. Congress will likely continue to seek to modify, repeal or otherwise invalidate all, or certain provisions of, the Affordable Care Act. It is uncertain the extent to which any such changes may impact our business or financial condition.

In addition, other legislative changes have been proposed and adopted in the United States since the Affordable Care Act was enacted. In August 2011, the Budget Control Act of 2011, among other things, created measures for spending reductions by Congress. A Joint Select Committee on Deficit Reduction, tasked with recommending a targeted deficit reduction of at least $1.2 trillion for the years 2013 through 2021, was unable to reach required goals, thereby triggering the legislation's automatic reduction to several government programs. This includes aggregate reductions of Medicare payments to providers up to 2% per fiscal year, which went into effect on April 1, 2013 and, due to the Bipartisan Budget Act of 2015, will stay in effect through 2025 unless Congressional action is taken. In January 2013, President Obama signed into law the American Taxpayer Relief Act of 2012, or the ATRA, which, among other things, reduced Medicare payments to several providers, including hospitals, imaging centers and cancer treatment centers, and increased the statute of limitations period for the government to recover overpayments to providers from three to five years. Moreover, payment methodologies including payment for any companion diagnostics may be subject to changes in healthcare legislation and regulatory initiatives. For example, the Centers for Medicare and Medicaid Services, or CMS, began bundling the Medicare payments for certain laboratory tests ordered while a patient received services in a hospital outpatient setting and, beginning in 2018, CMS will pay for clinical laboratory services based on a weighted-average of reported prices that private payors, Medicare Advantage plans and Medicaid Managed Care plans pay for laboratory services. Recently, there has been heightened governmental scrutiny over the manner in which drug manufacturers set prices for their marketed products, which has resulted in several Congressional inquiries and proposed bills designed to, among other things, bring more transparency to product pricing, review the relationship between pricing and manufacturer patient programs, and reform government program reimbursement methodologies for drug products.

There have been, and likely will continue to be, legislative and regulatory proposals at the foreign, federal and state levels directed at broadening the availability of healthcare and containing or lowering the cost of healthcare. We cannot predict the initiatives that may be adopted in the future. The continuing efforts of the government, insurance companies, managed care organizations and other payors of healthcare services to contain or reduce costs of healthcare and/or impose price controls may adversely affect:

- the demand for our product candidates, if we obtain regulatory approval;
- our ability to set a price that we believe is fair for our products;
- our ability to generate revenue and achieve or maintain profitability;
- the level of taxes that we are required to pay; and
- the availability of capital.

Due to the novel nature of our technology and the small size of our initial target patient populations, we face uncertainty related to pricing and reimbursement for these product candidates.

Our initial target patient populations are relatively small. As a result, the pricing and reimbursement of our product candidates, if approved, must be adequate to support commercial infrastructure. If we are unable to obtain adequate levels of reimbursement, our ability to successfully market and sell our product candidates will be adversely affected. The manner and level at which reimbursement is provided for services related to our product candidates (e.g., for administration of our product to patients) is also important. Inadequate reimbursement for such services may lead to physician resistance and adversely affect our ability to market or sell our products.

We and our contract manufacturers are subject to significant regulation with respect to manufacturing our products. The manufacturing facilities on which we rely may not continue to meet regulatory requirements and have limited capacity.

We currently have relationships with a limited number of suppliers for the manufacturing of our viral vectors and product candidates. Each supplier may require licenses to manufacture such components if such processes are not owned by the supplier or in the public domain and we may be unable to transfer or sublicense the intellectual property rights we may have or later obtain with respect to such activities.

All entities involved in the preparation of therapeutics for clinical trials or commercial sale, including our existing contract manufacturers for our product candidates, are subject to extensive regulation. Components of a finished therapeutic product approved for commercial sale or used in late-stage clinical trials must be manufactured in accordance with cGMP. These regulations govern manufacturing processes and procedures (including record keeping) and the implementation and operation of quality systems to control and assure the quality of investigational products and products approved for sale. Poor control of production processes can lead to the introduction of adventitious agents or other contaminants, or to inadvertent changes in the properties or stability of our product candidates that may not be detectable in final product testing. We or our contract manufacturers must supply all necessary documentation in support of a BLA on a timely basis and must adhere to the FDA's good laboratory practices, or GLP, and cGMP regulations enforced by the FDA through its facilities inspection program. Some of our contract manufacturers have not produced a commercially-approved product and therefore may have not obtained the requisite FDA approvals to do so. Our facilities and quality systems and the facilities and quality systems of some or all of our third-party contractors must pass a pre-approval inspection for compliance with the applicable regulations as a condition of regulatory approval of our product candidates or any of our other potential products. In addition, the regulatory authorities may, at any time, audit or inspect a manufacturing facility involved with the preparation of our product candidates or our other potential products or the associated quality systems for compliance with the regulations applicable to the activities being conducted. If these facilities do not pass a pre-approval plant inspection, FDA approval of the products may not be granted.

The regulatory authorities also may, at any time following approval of a product for sale, audit our manufacturing facilities or those of our third-party contractors. If any such inspection or audit identifies a failure to comply with applicable regulations or if a violation of our product specifications or applicable regulations occurs independent of such an inspection or audit, we or the relevant regulatory authority may require remedial measures that may be costly and/or time-consuming for us or a third party to implement and that may include the temporary or permanent suspension of a clinical trial or commercial sales or the temporary or permanent closure of a facility. Any such remedial measures imposed upon us or third parties with whom we contract could materially harm our business.

If we or any of our third-party manufacturers fail to maintain regulatory compliance, the FDA can impose regulatory sanctions including, among other things, refusal to approve a pending application for a new drug product or biologic product or revocation of a pre-existing approval. As a result, our business, financial condition and results of operations may be materially harmed.

Additionally, if supply from one approved manufacturer is interrupted, there could be a significant disruption in commercial supply. An alternative manufacturer would need to be qualified through a BLA supplement which could result in further delay. The regulatory agencies may also require additional studies if a new manufacturer is relied upon for commercial production. Switching manufacturers may involve substantial costs and is likely to result in a delay in our desired clinical and commercial timelines.

These factors could cause the delay of clinical trials, regulatory submissions, required approvals or commercialization of our product candidates, cause us to incur higher costs and prevent us from commercializing our products successfully. Furthermore, if our suppliers fail to meet contractual requirements, and we are unable to secure one or more replacement suppliers capable of production at a substantially equivalent cost, our clinical trials may be delayed or we could lose potential revenue.

If we fail to comply with environmental, health and safety laws and regulations, we could become subject to fines or penalties or incur costs that could have a material adverse effect on the success of our business.

Our research and development, manufacturing processes, clinical trials and products may involve the controlled use of hazardous materials, chemicals, viruses and various radioactive compounds. Specifically, if our products or product candidates spread from human or companion pet patients to other people or pets, these other individuals or pets (such as the immune suppressed or the very young), might be more sensitive to the product or product candidate than the patient and may experience an adverse reaction. We are subject to federal, state and local laws and regulations governing the use, manufacture, storage, handling and disposal of such materials and certain waste products, including numerous environmental, health and safety laws and regulations, such as those governing laboratory procedures and the handling, use, storage, treatment and disposal of hazardous materials and wastes. Our operations involve the use of hazardous and flammable materials, including chemicals and biological materials. Our operations also produce hazardous waste products. We generally contract with third parties for the disposal of these materials and wastes. We cannot eliminate the risk of contamination or injury from these materials. In the event of contamination or injury resulting from our use of hazardous materials, we could be held liable for any resulting damages, and any liability could exceed our resources. We also could incur significant costs associated with civil or criminal fines and penalties.

Although we maintain workers' compensation insurance to cover us for costs and expenses we may incur due to injuries to our employees resulting from the use of hazardous materials or other work-related injuries, this insurance may not provide adequate coverage against potential liabilities. In addition, we may incur substantial costs in order to comply with current or future environmental, health and safety laws and regulations. These current or future laws and regulations may impair our research, development or production efforts. Failure to comply with these laws and regulations also may result in substantial fines, penalties or other sanctions.

Risks related to our intellectual property

If we are unable to protect our intellectual property rights or if our intellectual property rights are inadequate for our technology and product candidates, our competitive position could be harmed.

Our commercial success will depend in part on our ability to obtain and maintain patent and other intellectual property protection in the United States and other countries with respect to our proprietary technology and products. We rely on trade secret, patent, copyright and trademark laws, and confidentiality, licensing and other agreements with employees and third parties, all of which offer only limited protection. We seek to protect our proprietary position by filing and prosecuting patent applications in the United States and abroad related to our novel technologies and products that are important to our business.

The patent positions of biotechnology and pharmaceutical companies generally are highly uncertain, involve complex legal and factual questions and have in recent years been the subject of much litigation. As a result, the

issuance, scope, validity, enforceability and commercial value of our patents, including those patent rights licensed to us by third parties, are highly uncertain. The steps we or our licensors have taken to protect our proprietary rights may not be adequate to preclude misappropriation of our proprietary information or infringement of our intellectual property rights, both inside and outside of the United States. Further, the examination process may require us or our licensors to narrow the claims for our pending patent applications, which may limit the scope of patent protection that may be obtained if these applications issue. The rights already granted under any of our currently issued patents or those licensed to us and those that may be granted under future issued patents may not provide us with the proprietary protection or competitive advantages we are seeking. If we or our licensors are unable to obtain and maintain patent protection for our technology and products, or if the scope of the patent protection obtained is not sufficient, our competitors could develop and commercialize technology and products similar or superior to ours, and our ability to successfully commercialize our technology and products may be adversely affected. It is also possible that we or our licensors will fail to identify patentable aspects of inventions made in the course of our development and commercialization activities before it is too late to obtain patent protection on them. It is also possible that as research and development progresses, the direction of our intellectual property strategy and patent portfolio will change, resulting in strategic business decisions to allow certain patents or patent applications to be abandoned or lapse.

With respect to patent rights, we do not know whether any of the pending patent applications for any of our compounds or biologic products will result in the issuance of patents that effectively protect our technology or products, or if any of our issued patents or if any of our or our licensors' issued patents will effectively prevent others from commercializing competitive technologies and products. Publications of discoveries in the scientific literature often lag behind the actual discoveries, and patent applications in the United States and other jurisdictions are typically not published until 18 months after filing or in some cases not at all, until they are issued as a patent. Therefore, we cannot be certain that we or our licensors were the first to make the inventions claimed in our owned or licensed patents or pending patent applications, or that we or our licensors were the first to file for patent protection of such inventions.

Our pending applications cannot be enforced against third parties practicing the technology claimed in such applications unless and until a patent issues from such applications. Because the issuance of a patent is not conclusive as to its inventorship, scope, validity or enforceability, issued patents that we own or have licensed from third parties may be challenged in the courts or patent offices in the United States and abroad. Such challenges may result in the loss of patent protection, the narrowing of claims in such patents or the invalidity or unenforceability of such patents, which could limit our ability to stop others from using or commercializing similar or identical technology and products, or limit the duration of the patent protection for our technology and products. Protecting against the unauthorized use of our or our licensor's patented technology, trademarks and other intellectual property rights is expensive, difficult and may in some cases not be possible. In some cases, it may be difficult or impossible to detect third-party infringement or misappropriation of our intellectual property rights, even in relation to issued patent claims, and proving any such infringement may be even more difficult.

Third-party claims of intellectual property infringement may prevent or delay our development and commercialization efforts.

Our commercial success depends in part on our avoiding infringement of the patents and proprietary rights of third parties. There is a substantial amount of litigation, both within and outside the United States, involving patent and other intellectual property rights in the biotechnology and pharmaceutical industries, including patent infringement lawsuits, interferences, oppositions and *inter partes* reexamination proceedings before the U.S. Patent and Trademark Office, or U.S. PTO, and corresponding foreign patent offices. Numerous U.S. and foreign issued patents and pending patent applications, which are owned by third parties, exist in the fields in which we are pursuing development candidates. As the biotechnology and pharmaceutical industries expand and more patents are issued, the risk increases that our product candidates may be subject to claims of infringement of the patent rights of third parties.

Third parties have asserted, and in the future may assert, that we are employing their proprietary technology without authorization. There may be third-party patents or patent applications with claims to materials, formulations, methods of manufacture or methods for treatment related to the use or manufacture of our product candidates. Because patent applications can take many years to issue, there may be currently pending patent applications which may later result in issued patents that our product candidates may infringe. In addition, third parties may obtain patents in the future and claim that use of our technologies infringes upon these patents. If any third-party patents were held by a court of competent jurisdiction to cover the manufacturing process of any of our product candidates, or any final product itself, the holders of any such patents may be able to block our ability to commercialize such product candidate unless we obtained a license under the applicable patents, or until such patents expire.

Similarly, if any third-party patents were held by a court of competent jurisdiction to cover aspects of our formulations, processes for manufacture or methods of use, including combination therapy, the holders of any such patents may be able to block our ability to develop and commercialize the applicable product candidate unless we obtained a license or until such patent expires. In either case, such a license may not be available on commercially reasonable terms or at all.

Parties making claims against us may obtain injunctive or other equitable relief, which could effectively block our ability to further develop and commercialize one or more of our product candidates. Defense of these claims, regardless of their merit, may involve substantial litigation expense and would be a substantial diversion of employee resources from our business. In the event of a successful claim of infringement against us, we may have to pay substantial damages, including treble damages and attorneys' fees for willful infringement, pay royalties, redesign our infringing products or obtain one or more licenses from third parties, which may be impossible or require substantial time and monetary expenditure.

We may not be successful in obtaining or maintaining necessary rights to gene therapy product components and processes for our development pipeline through acquisitions and in-licenses.

Presently we believe that we have rights to the intellectual property, through licenses from third parties and under patents that we own, to develop our gene therapy product candidates. Because our programs may involve additional product candidates that may require the use of proprietary rights held by third parties, the growth of our business may depend in part on our ability to acquire, in-license or use these proprietary rights. In addition, our product candidates may require specific formulations to work effectively and efficiently and these rights may be held by others. We may be unable to acquire or in-license any compositions, methods of use, processes or other third-party intellectual property rights from third parties that we identify. The licensing and acquisition of third-party intellectual property rights is a competitive area, and a number of more established companies are also pursuing strategies to license or acquire third-party intellectual property rights that we may consider attractive. These established companies may have a competitive advantage over us due to their size, cash resources and greater clinical development and commercialization capabilities.

In addition, companies that perceive us to be a competitor may be unwilling to assign or license rights to us. We also may be unable to license or acquire third-party intellectual property rights on terms that would allow us to make an appropriate return on our investment. If we are unable to successfully obtain rights to required third-party intellectual property rights, our business, financial condition and prospects for growth could suffer.

If we fail to comply with our obligations in the agreement under which we license intellectual property rights from the University of Southern California, or USC, or otherwise experience disruptions to our business relationships with USC or other future licensors, we could lose license rights that are important to our business.

In October 2007, we entered into a license agreement with USC pursuant to which we received a worldwide, exclusive license to, among other things, manufacture and market products utilizing certain inventions that are

critical to our business. We expect to enter into additional license agreements in the future. Our existing license agreement imposes, and we expect that future license agreements will impose, various diligence, milestone payment, royalty and other obligations on us. If we fail to comply with our obligations under these agreements, or we are subject to a bankruptcy, the licensor may have the right to terminate the license, in which event we would not be able to market products covered by the license. See "Business — License and Collaboration Agreements" for a description of our license agreement with USC, which includes a description of the termination provisions of this agreement.

We may need to obtain licenses from third parties to advance our research or allow commercialization of our product candidates, and we have done so from time to time. We may fail to obtain any of these licenses at a reasonable cost or on reasonable terms, if at all. In that event, we may be required to expend significant time and resources to develop or license replacement technology. If we are unable to do so, we may be unable to develop or commercialize the affected product candidates, which could harm our business significantly. We cannot provide any assurances that third-party patents do not exist which might be enforced against our current product candidates or future products, resulting in either an injunction prohibiting our sales, or, with respect to our sales, an obligation on our part to pay royalties and/or other forms of compensation to third parties.

In certain cases, patent prosecution of our licensed technology may be controlled solely by the licensor. If our licensors fail to obtain and maintain patent or other protection for the proprietary intellectual property we license from them, we could lose our rights to the intellectual property or our exclusivity with respect to those rights, and our competitors could market competing products using the intellectual property. In certain cases, we control the prosecution of patents resulting from licensed technology. In the event we breach any of our obligations related to such prosecution, we may incur significant liability to our licensing partners. Licensing of intellectual property is of critical importance to our business and involves complex legal, business and scientific issues and is complicated by the rapid pace of scientific discovery in our industry. Disputes may arise regarding intellectual property subject to a licensing agreement, including:

- the scope of rights granted under the license agreement and other interpretation-related issues;
- the extent to which our technology and processes infringe on intellectual property of the licensor that is not subject to the licensing agreement;
- the sublicensing of patent and other rights under our collaborative development relationships;
- our diligence obligations under the license agreement and what activities satisfy those diligence obligations;
- the ownership of inventions and know-how resulting from the joint creation or use of intellectual property by our licensors and us and our partners; and
- the priority of invention of patented technology.

If disputes over intellectual property that we have licensed prevent or impair our ability to maintain our current licensing arrangements on acceptable terms, we may be unable to successfully develop and commercialize the affected product candidates.

We may be involved in lawsuits to protect or enforce our patents or the patents of our licensors, which could be expensive, time-consuming and unsuccessful.

Competitors may infringe our patents or the patents of our licensors. To counter infringement or unauthorized use, we may be required to file infringement claims, which can be expensive and time-consuming. In addition, in an infringement proceeding, a court may decide that a patent of ours or our licensors is not valid, is unenforceable and/or is not infringed, or may refuse to stop the other party from using the technology at issue on the grounds that our patents do not cover the technology in question. An adverse result in any litigation or defense proceedings could put one or more of our patents at risk of being invalidated or interpreted narrowly and could put our patent applications at risk of not issuing.

Interference proceedings provoked by third parties or brought by us may be necessary to determine the priority of inventions with respect to our patents or patent applications or those of our licensors. An unfavorable outcome could require us to cease using the related technology or to attempt to license rights to it from the prevailing party. Our business could be harmed if the prevailing party does not offer us a license on commercially reasonable terms. Our defense of litigation or interference proceedings may fail and, even if successful, may result in substantial costs and distract our management and other employees. We may not be able to prevent, alone or with our licensors, misappropriation of our intellectual property rights, particularly in countries where the laws may not protect those rights as fully as in the United States.

Furthermore, because of the substantial amount of discovery required in connection with intellectual property litigation, there is a risk that some of our confidential information could be compromised by disclosure during this type of litigation. There could also be public announcements of the results of hearings, motions or other interim proceedings or developments. If securities analysts or investors perceive these results to be negative, it could have a material adverse effect on the price of our common stock.

Obtaining and maintaining our patent protection depends on compliance with various procedural, document submission, fee payment and other requirements imposed by governmental patent agencies, and our patent protection could be reduced or eliminated for non-compliance with these requirements.

Periodic maintenance fees, renewal fees, annuity fees and various other governmental fees on patents and/or applications will be due to be paid to the U.S. PTO and various governmental patent agencies outside of the United States in several stages over the lifetime of the patents and/or applications. We employ an outside firm and rely on our outside counsel to pay these fees due to non-U.S. patent agencies. The U.S. PTO and various non-U.S. governmental patent agencies require compliance with a number of procedural, documentary, fee payment and other similar provisions during the patent application process. We employ reputable law firms and other professionals to help us comply, and in many cases, an inadvertent lapse can be cured by payment of a late fee or by other means in accordance with the applicable rules. However, there are situations in which non-compliance can result in abandonment or lapse of the patent or patent application, resulting in partial or complete loss of patent rights in the relevant jurisdiction. In such an event, our competitors might be able to enter the market and this circumstance would have a material adverse effect on our business.

Issued patents covering our product candidates could be found invalid or unenforceable if challenged in court.

If we, USC or one of our future licensing partners initiated legal proceedings against a third party to enforce a patent covering one of our product candidates, the defendant could counterclaim that the patent covering our product candidate is invalid and/or unenforceable. In patent litigation in the United States, defendant counterclaims alleging invalidity and/or unenforceability are commonplace. Grounds for a validity challenge could be an alleged failure to meet any of several statutory requirements, including lack of novelty, obviousness or non-enablement. Grounds for an unenforceability assertion could be an allegation that someone connected with prosecution of the patent withheld relevant information from the U.S. PTO, or made a misleading statement, during prosecution. Third parties may also raise similar claims before administrative bodies in the United States or abroad, even outside the context of litigation. Such mechanisms include re-examination, post grant review and equivalent proceedings in foreign jurisdictions (e.g., opposition proceedings). Such proceedings could result in revocation or amendment to our patents in such a way that they no longer cover our product candidates. The outcome following legal assertions of invalidity and unenforceability is unpredictable. With respect to the validity question, for example, we cannot be certain that there is no invalidating prior art, of which we and the patent examiner were unaware during prosecution. If a defendant were to prevail on a legal assertion of invalidity and/or unenforceability, we would lose at least part, and perhaps all, of the patent protection on our product candidates. Such a loss of patent protection would have a material adverse impact on our business.

We may be subject to claims that our employees, consultants or independent contractors have wrongfully used or disclosed confidential information of third parties or that our employees have wrongfully used or disclosed alleged trade secrets of their former employers.

We employ individuals who were previously employed at universities or other biotechnology or pharmaceutical companies, including our competitors or potential competitors. Although we try to ensure that our employees, consultants and independent contractors do not use the proprietary information or know-how of others in their work for us, we may be subject to claims that we or our employees, consultants or independent contractors have inadvertently or otherwise used or disclosed intellectual property, including trade secrets or other proprietary information, of any of our employee's former employer or other third parties. Litigation may be necessary to defend against these claims. If we fail in defending any such claims, in addition to paying monetary damages, we may lose valuable intellectual property rights or personnel, which could adversely impact our business. Even if we are successful in defending against such claims, litigation could result in substantial costs and be a distraction to management and other employees.

We may be subject to claims challenging the inventorship or ownership of our patents and other intellectual property.

We may be subject to claims that former employees, collaborators or other third parties have an ownership interest in our patents or other intellectual property. We may have potential ownership disputes arising, for example, from conflicting obligations of consultants, collaborators or others who are involved in developing our product candidates. Litigation may be necessary to defend against these and other claims challenging inventorship or ownership. If we fail in defending any such claims, in addition to paying monetary damages, we may lose valuable intellectual property rights, such as exclusive ownership of, or right to use, valuable intellectual property. Such an outcome could have a material adverse effect on our business. Even if we are successful in defending against such claims, litigation could result in substantial costs and be a distraction to management and other employees.

Changes in U.S. patent law could diminish the value of patents in general, thereby impairing our ability to protect our products.

As is the case with other biotechnology companies, our success is heavily dependent on intellectual property, particularly patents. Obtaining and enforcing patents in the biotechnology industry involve both technological and legal complexity, and therefore obtaining and enforcing biotechnology patents is costly, time-consuming and inherently uncertain. In addition, the United States has recently enacted and is currently implementing wide-ranging patent reform legislation. Recent U.S. Supreme Court rulings have narrowed the scope of patent protection available in certain circumstances and weakened the rights of patent owners in certain situations. In addition to increasing uncertainty with regard to our ability to obtain patents in the future, this combination of events has created uncertainty with respect to the value of patents, once obtained. Depending on decisions by the U.S. Congress, the federal courts and the U.S. PTO, the laws and regulations governing patents could change in unpredictable ways that would weaken our ability to obtain new patents or to enforce our existing patents and patents that we might obtain in the future.

We have not yet registered trademarks for a commercial trade name for Toca 511 & Toca FC, and failure to secure such registrations could adversely affect our business.

We have not yet developed a proprietary name for our products nor registered trademarks for a commercial trade name for Toca 511 & Toca FC. During trademark registration proceedings, we may receive rejections. Although we would be given an opportunity to respond to those rejections, we may be unable to overcome such rejections. In addition, in the U.S. PTO and in comparable agencies in many foreign jurisdictions, third parties

are given an opportunity to oppose pending trademark applications and to seek to cancel registered trademarks. Opposition or cancellation proceedings may be filed against our trademarks, and our trademarks may not survive such proceedings. Moreover, any name we propose to use with our product candidates in the United States must be approved by the FDA, regardless of whether we have registered it, or applied to register it, as a trademark. The FDA typically conducts a review of proposed product names, including an evaluation of potential for confusion with other product names. If the FDA objects to any of our proposed proprietary product names, we may be required to expend significant additional resources in an effort to identify a suitable substitute name that would qualify under applicable trademark laws, not infringe the existing rights of third parties and be acceptable to the FDA.

We may not be able to protect our intellectual property rights throughout the world.

Filing, prosecuting and defending patents on product candidates in all countries throughout the world would be prohibitively expensive, and our intellectual property rights in some countries outside the United States can be less extensive than those in the United States. In addition, the laws of some foreign countries do not protect intellectual property rights to the same extent as federal and state laws in the United States. Consequently, we may not be able to prevent third parties from practicing our inventions in all countries outside the United States, or from selling or importing products made using our inventions in and into the United States or other jurisdictions. Competitors may use our technologies in jurisdictions where we have not obtained patent protection to develop their own products and further, may export otherwise infringing products to territories where we have patent protection, but enforcement is not as strong as that in the United States. These products may compete with our products and our patents or other intellectual property rights may not be effective or sufficient to prevent them from competing.

Many companies have encountered significant problems in protecting and defending intellectual property rights in foreign jurisdictions. The legal systems of certain countries, particularly certain developing countries, do not favor the enforcement of patents, trade secrets and other intellectual property protection, particularly those relating to biotechnology products, which could make it difficult for us to stop the infringement of our patents or marketing of competing products in violation of our proprietary rights generally. Proceedings to enforce our patent rights in foreign jurisdictions could result in substantial costs and divert our efforts and attention from other aspects of our business, could put our patents at risk of being invalidated or interpreted narrowly and our patent applications at risk of not issuing and could provoke third parties to assert claims against us. We may not prevail in any lawsuits that we initiate, and the damages or other remedies awarded, if any, may not be commercially meaningful. Accordingly, our efforts to enforce our intellectual property rights around the world may be inadequate to obtain a significant commercial advantage from the intellectual property that we develop or license.

Risks related to this offering and ownership of our common stock

We do not know whether an active trading market will develop for our common stock or what the market price of our common stock will be, and, as a result, it may be difficult for you to sell your shares of our common stock.

Prior to this offering, there has not been a public market for our common stock. An active trading market for our common stock may not develop following this offering. You may not be able to sell your shares quickly or at the market price if trading in our common stock is not active. The initial public offering price for the shares was determined by negotiations between us and the representative of the underwriters and may not be indicative of prices that will prevail in the trading market. As a result of these and other factors, you may be unable to resell your shares of our common stock at or above the initial public offering price. Further, an inactive market may also impair our ability to raise capital by selling shares of our common stock and may impair our ability to enter into strategic partnerships or acquire companies or products by using our shares of common stock as consideration.

The market price of our common stock may be highly volatile, and you may not be able to resell your shares at or above the initial public offering price.

The market price of our common stock is likely to be volatile. Our stock price could be subject to wide fluctuations in response to a variety of factors, including the following:

- adverse results or delays in preclinical or clinical trials;
- reports of adverse events in other gene therapy products or clinical trials of such products;
- inability to obtain additional funding;
- any delay in filing an IND or BLA for any of our product candidates and any adverse development or perceived adverse development with respect to the FDA's review of that IND or BLA;
- failure to develop successfully and commercialize our product candidates;
- failure to maintain our existing strategic collaboration or enter into new collaborations;
- failure by us or our licensors and strategic collaboration partners to prosecute, maintain or enforce our intellectual property rights;
- changes in laws or regulations applicable to future products;
- inability to obtain adequate product supply for our product candidates or the inability to do so at acceptable prices;
- adverse regulatory decisions;
- introduction of new products, services or technologies by our competitors;
- failure to meet or exceed financial projections we may provide to the public;
- failure to meet or exceed the financial projections of the investment community;
- the perception of the pharmaceutical industry by the public, legislatures, regulators and the investment community;
- announcements of significant acquisitions, strategic partnerships, joint ventures or capital commitments by us, our strategic collaboration partners or our competitors;
- disputes or other developments relating to proprietary rights, including patents, litigation matters and our ability to obtain patent protection for our technologies;
- additions or departures of key scientific or management personnel;
- significant lawsuits, including patent or stockholder litigation;
- changes in the market valuations of similar companies;
- sales of our common stock by us or our stockholders in the future; and
- trading volume of our common stock.

In addition, companies trading in the stock market in general, and The Nasdaq Global Select Market in particular, have experienced extreme price and volume fluctuations that have often been unrelated or disproportionate to the operating performance of these companies. Broad market and industry factors may negatively affect the market price of our common stock, regardless of our actual operating performance.

Unstable market and economic conditions may have serious adverse consequences on our business, financial condition and stock price.

As widely reported, global credit and financial markets have experienced extreme volatility and disruptions in the past several years, including severely diminished liquidity and credit availability, declines in consumer confidence, declines in economic growth, increases in unemployment rates and uncertainty about economic stability. We cannot assure you that further deterioration in credit and financial markets and confidence in economic conditions will not occur. Our general business strategy may be adversely affected by any such economic downturn, volatile business environment or continued unpredictable and unstable market conditions. If the current equity and credit markets deteriorate, or do not improve, it may make any necessary debt or equity financing more difficult, more costly and more dilutive. Failure to secure any necessary financing in a timely manner and on favorable terms could have a material adverse effect on our growth strategy, financial performance and stock price and could require us to delay or abandon clinical development plans. In addition,

there is a risk that one or more of our current service providers, manufacturers and other partners may not survive these difficult economic times, which could directly affect our ability to attain our operating goals on schedule and on budget.

We do not intend to pay dividends on our common stock so any returns will be limited to the value of our stock.

We have never declared or paid any cash dividends on our common stock. We currently anticipate that we will retain future earnings for the development, operation and expansion of our business and do not anticipate declaring or paying any cash dividends for the foreseeable future. Any return to stockholders will therefore be limited to the appreciation of their stock. In addition, we may enter into debt financing arrangements in the future that prohibit the payment of dividends.

If you purchase our common stock in this offering, you will incur immediate and substantial dilution in the book value of your shares.

Investors purchasing shares of common stock in this offering will pay a price per share that substantially exceeds the pro forma book value per share of our tangible assets after subtracting our liabilities. As a result, investors purchasing shares of common stock in this offering will incur immediate dilution of $4.96 per share, based on the initial public offering price of $10.00 per share and our pro forma net tangible book value as of December 31, 2016. For information on how the foregoing amount was calculated, see "Dilution." As a result of the dilution to investors purchasing shares in this offering, investors may receive significantly less than the purchase price paid in this offering, if anything, in the event of our liquidation.

We are an emerging growth company, and we cannot be certain if the reduced reporting requirements applicable to emerging growth companies will make our common stock less attractive to investors.

We are an emerging growth company, as defined in the JOBS Act. For as long as we continue to be an emerging growth company, we may take advantage of exemptions from various reporting requirements that are applicable to other public companies that are not emerging growth companies, including not being required to comply with the auditor attestation requirements of Section 404 of the Sarbanes-Oxley Act, reduced disclosure obligations regarding executive compensation in this prospectus and our periodic reports and proxy statements and exemptions from the requirements of holding nonbinding advisory votes on executive compensation and stockholder approval of any golden parachute payments not previously approved. We could be an emerging growth company for up to five years following the year in which we complete this offering, although circumstances could cause us to lose that status earlier. We will remain an emerging growth company until the earlier of (1) the last day of the fiscal year (a) following the fifth anniversary of the completion of this offering, (b) in which we have total annual gross revenue of at least $1 billion or (c) in which we are deemed to be a large accelerated filer, which requires the market value of our common stock that is held by non-affiliates to exceed $700 million as of the prior June 30th, and (2) the date on which we have issued more than $1 billion in non-convertible debt during the prior three-year period.

Even after we no longer qualify as an emerging growth company, we may still qualify as a "smaller reporting company" which would allow us to take advantage of many of the same exemptions from disclosure requirements including not being required to comply with the auditor attestation requirements of Section 404 of the Sarbanes-Oxley Act and reduced disclosure obligations regarding executive compensation in this prospectus and our periodic reports and proxy statements. We cannot predict if investors will find our common stock less attractive because we may rely on these exemptions. If some investors find our common stock less attractive as a result, there may be a less active trading market for our common stock and our stock price may be more volatile.

Under the JOBS Act, emerging growth companies can also delay adopting new or revised accounting standards until such time as those standards apply to private companies. We have irrevocably elected not to avail ourselves of this exemption from new or revised accounting standards and, therefore, will be subject to the same new or revised accounting standards as other public companies that are not emerging growth companies. As a result, changes in rules of U.S. generally accepted accounting principles or their interpretation, the adoption of new guidance or the application of existing guidance to changes in our business could significantly affect our financial position and results of operations.

We will incur significant increased costs as a result of operating as a public company, and our management will be required to devote substantial time to existing and new compliance initiatives.

As a public company, we will incur significant legal, accounting and other expenses that we did not incur as a private company. We will be subject to the reporting requirements of the Securities Exchange Act of 1934, or the Exchange Act, which will require, among other things, that we file with the Securities and Exchange Commission, or the SEC, annual, quarterly and current reports with respect to our business and financial condition. In addition, the Sarbanes-Oxley Act, as well as rules subsequently adopted by the SEC and The NASDAQ Global Select Market to implement provisions of the Sarbanes-Oxley Act, impose significant requirements on public companies, including requiring establishment and maintenance of effective disclosure and financial controls and changes in corporate governance practices. Further, in July 2010, the Dodd-Frank Wall Street Reform and Consumer Protection Act, or the Dodd-Frank Act, was enacted. There are significant corporate governance and executive compensation related provisions in the Dodd-Frank Act that require the SEC to adopt additional rules and regulations in these areas such as "say on pay" and proxy access. Recent legislation permits emerging growth companies to implement many of these requirements over a longer period and up to five years from the pricing of this offering. We intend to take advantage of this new legislation but cannot guarantee that we will not be required to implement these requirements sooner than budgeted or planned and thereby incur unexpected expenses. Stockholder activism, the current political environment and the current high level of government intervention and regulatory reform may lead to substantial new regulations and disclosure obligations, which may lead to additional compliance costs and impact the manner in which we operate our business in ways we cannot currently anticipate.

We expect the rules and regulations applicable to public companies to substantially increase our legal and financial compliance costs and to make some activities more time-consuming and costly. If these requirements divert the attention of our management and personnel from other business concerns, they could have a material adverse effect on our business, financial condition and results of operations. The increased costs will decrease our net income or increase our net loss, and may require us to reduce costs in other areas of our business or increase the prices of our products or services. For example, we expect these rules and regulations to make it more difficult and more expensive for us to obtain director and officer liability insurance and we may be required to incur substantial costs to maintain the same or similar coverage. We cannot predict or estimate the amount or timing of additional costs we may incur to respond to these requirements. The impact of these requirements could also make it more difficult for us to attract and retain qualified persons to serve on our board of directors, our board committees or as executive officers.

Sales of a substantial number of shares of our common stock in the public market could cause our stock price to fall.

If our existing stockholders sell, or indicate an intention to sell, substantial amounts of our common stock in the public market after the lock-up and other legal restrictions on resale discussed in this prospectus lapse, the market price of our common stock could decline. Based upon the number of shares of common stock, on an as-converted basis, outstanding as of December 31, 2016, upon the closing of this offering, we will have a total of 18,501,763 shares of common stock outstanding, assuming no exercise of the underwriters' option to purchase additional shares. Of these shares, as of the date of this prospectus, approximately 8,500,000 shares of our common stock, plus any shares sold upon exercise of the underwriters' option to purchase additional shares, will be freely tradable, without restriction, in the public market immediately following this offering, assuming that current

stockholders do not purchase shares in this offering. Leerink Partners LLC and Evercore Group L.L.C., however, may, in their sole discretion, permit our officers, directors and other stockholders who are subject to these lock-up agreements to sell shares prior to the expiration of the lock-up agreements.

The lock-up agreements pertaining to this offering will expire 180 days from the date of this prospectus. After the lock-up agreements expire, based upon the number of shares of common stock, on an as-converted basis, outstanding as of December 31, 2016, up to an additional 10,001,763 shares of common stock will be eligible for sale in the public market, 1,610,066 of which shares are held by directors, executive officers and other affiliates and will be subject to Rule 144 under the Securities Act of 1933, as amended, or the Securities Act.

In addition, as of December 31, 2016, 1,569,010 shares of common stock that are either subject to outstanding options, reserved for future issuance under our equity incentive plans or subject to outstanding warrants will become eligible for sale in the public market to the extent permitted by the provisions of various vesting schedules, the lock-up agreements and Rule 144 and Rule 701 under the Securities Act. If these additional shares of common stock are sold, or if it is perceived that they will be sold, in the public market, the market price of our common stock could decline.

Future sales and issuances of our common stock or rights to purchase common stock, including pursuant to our equity incentive plans, could result in additional dilution of the percentage ownership of our stockholders and could cause our stock price to fall.

Additional capital will be needed in the future to continue our planned operations. To the extent we raise additional capital by issuing equity securities, our stockholders may experience substantial dilution. We may sell common stock, convertible securities or other equity securities in one or more transactions at prices and in a manner we determine from time to time. If we sell common stock, convertible securities or other equity securities in more than one transaction, investors may be materially diluted by subsequent sales. These sales may also result in material dilution to our existing stockholders, and new investors could gain rights superior to our existing stockholders. Pursuant to our 2017 Plan, certain amendments of which became effective on the business day prior to the public trading date of our common stock, our management is authorized to grant stock options to our employees, directors and consultants.

Initially, the aggregate number of shares of our common stock that may be issued pursuant to stock awards under our 2017 Plan is up to 3,133,702 shares, which includes shares of common stock reserved for issuance under the 2009 Plan, which shares were added to the shares reserved under the 2017 Plan upon its effectiveness, and options outstanding under the 2009 Plan, to the extent such options are not exercised or otherwise terminate. Additionally, the number of shares of our common stock reserved for issuance under our 2017 Plan will automatically increase on January 1 of each year, beginning on January 1, 2018 and continuing through and including January 1, 2027, by 4% of the total number of shares of our capital stock outstanding on December 31 of the preceding calendar year, or a lesser number of shares determined by our board of directors. Unless our board of directors elects not to increase the number of shares available for future grant each year, our stockholders may experience additional dilution, which could cause our stock price to fall.

In addition, as of December 31, 2016, options to purchase 1,385,855 shares of our common stock at a weighted-average exercise price of $11.35 per share were outstanding. The exercise of any of these options would result in additional dilution.

We have broad discretion in the use of the net proceeds from this offering and may not use them effectively.

Our management will have broad discretion in the application of the net proceeds from this offering, including for any of the purposes described in the section entitled “Use of Proceeds,” and you will not have the opportunity as part of your investment decision to assess whether the net proceeds are being used appropriately. Because of the number and variability of factors that will determine our use of the net proceeds from this offering, their ultimate

use may vary substantially from their currently intended use. Our management might not apply our net proceeds in ways that ultimately increase the value of your investment. We intend to use the net proceeds from this offering to fund the Phase 2 portion of our Phase 2/3 clinical trial of Toca 511 & Toca FC in recurrent HGG, manufacturing scale-up and validation for Toca 511 & Toca FC, the other ongoing and planned clinical development activities for Toca 511 & Toca FC and the remainder for working capital and other general corporate purposes. The failure by our management to apply these funds effectively could harm our business. Pending their use, we may invest the net proceeds from this offering in short-term, investment-grade, interest-bearing securities. These investments may not yield a favorable return to our stockholders. If we do not invest or apply the net proceeds from this offering in ways that enhance stockholder value, we may fail to achieve expected financial results, which could cause our stock price to decline.

Our ability to use our net operating loss carryforwards and certain other tax attributes may be limited.

Under Sections 382 and 383 of the Internal Revenue Code of 1986, as amended, or the Code, if a corporation undergoes an "ownership change," generally defined as a cumulative change in its equity ownership by "5-percent shareholders" of greater than 50 percentage points (by value) over a three-year period, the corporation's ability to use its pre-change net operating loss carryforwards, or NOLs, and certain other pre-change tax attributes (such as research tax credits) to offset its post-change taxable income and taxes, as applicable, may be limited. We have completed multiple rounds of financing since our inception which may have resulted in an ownership change or could result in an ownership change in the future. As of December 31, 2016, we have not completed a Section 382 and 383 analysis regarding any limitations on our NOLs and research and development credit carryforwards and such limitations could be significant. We may also experience ownership changes in the future as a result of subsequent shifts in our stock ownership. As a result, our ability to use our NOLs and research and development credit carryforwards to offset our U.S. federal taxable income and taxes, as applicable, may be subject to limitations, which could potentially result in increased future tax liability to us. In addition, at the state level, similar rules may apply and there may be periods during which the use of NOLs is suspended or otherwise limited, which could accelerate or permanently increase state taxes owed.

If securities or industry analysts do not publish research or publish inaccurate or unfavorable research about our business, our stock price and trading volume could decline.

The trading market for our common stock will depend in part on the research and reports that securities or industry analysts publish about us or our business. Securities and industry analysts do not currently, and may never, publish research on our company. If no securities or industry analysts commence coverage of our company, the trading price for our stock would likely be negatively impacted. In the event securities or industry analysts initiate coverage, if one or more of the analysts who covers us downgrades our stock or publishes inaccurate or unfavorable research about our business, our stock price may decline. If one or more of these analysts ceases coverage of our company or fails to publish reports on us regularly, demand for our stock could decrease, which might cause our stock price and trading volume to decline.

Provisions in our amended and restated certificate of incorporation and amended and restated bylaws, as well as provisions of Delaware law, could make it more difficult for a third party to acquire us or increase the cost of acquiring us, even if doing so would benefit our stockholders or remove our current management.

Our amended and restated certificate of incorporation, amended and restated bylaws and Delaware law contain provisions that may have the effect of delaying or preventing a change in control of us or changes in our management. Our amended and restated certificate of incorporation and amended and restated bylaws, which will become effective upon the closing of this offering, include provisions that:

- permit our board of directors to issue up to 10,000,000 shares of preferred stock, with any rights, preferences and privileges as they may designate (including the right to approve an acquisition or other change in our control);

- provide that the authorized number of directors may be changed only by resolution of the board of directors;
- provide that the board of directors or any individual director may only be removed with cause and the affirmative vote of the holders of at least 66-2/3% of the voting power of all of our then outstanding common stock;
- provide that all vacancies, including newly created directorships, may, except as otherwise required by law, be filled by the affirmative vote of a majority of directors then in office, even if less than a quorum;
- divide our board of directors into three classes;
- require that any action to be taken by our stockholders must be effected at a duly called annual or special meeting of stockholders and not be taken by written consent;
- provide that stockholders seeking to present proposals before a meeting of stockholders or to nominate candidates for election as directors at a meeting of stockholders must provide notice in writing in a timely manner and also specify requirements as to the form and content of a stockholder's notice;
- do not provide for cumulative voting rights (therefore allowing the holders of a majority of the shares of common stock entitled to vote in any election of directors to elect all of the directors standing for election, if they should so choose);
- provide that special meetings of our stockholders may be called only by the chairman of the board, our Chief Executive Officer or by the board of directors pursuant to a resolution adopted by a majority of the total number of authorized directors; and
- provide that the Court of Chancery of the State of Delaware will be the sole and exclusive forum for (i) any derivative action or proceeding brought on our behalf, (ii) any action asserting a claim of breach of a fiduciary duty owed by any of our directors or officers to us or our stockholders, (iii) any action asserting a claim against us arising pursuant to any provision of the Delaware General Corporation Law or our certificate of incorporation or bylaws, or (iv) any action asserting a claim against us governed by the internal affairs doctrine.

These provisions, alone or together, could delay or prevent hostile takeovers and changes in control or changes in our management.

In addition, because we are incorporated in Delaware, we are governed by the provisions of Section 203 of the Delaware General Corporation Law, which limits the ability of stockholders owning in excess of 15% of our outstanding voting stock to merge or combine with us.

Any provision of our amended and restated certificate of incorporation or amended and restated bylaws or Delaware law that has the effect of delaying or deterring a change in control could limit the opportunity for our stockholders to receive a premium for their shares of our common stock, and could also affect the price that some investors are willing to pay for our common stock.

Our amended and restated certificate of incorporation and amended and restated bylaws will provide that the Court of Chancery of the State of Delaware will be the sole and exclusive forum for substantially all disputes between us and our stockholders, which could limit our stockholders' ability to obtain a favorable judicial forum for disputes with us or our directors, officers or employees.

Our amended and restated certificate of incorporation and amended and restated bylaws, which will be effective upon the closing of this offering, provide that the Court of Chancery of the State of Delaware is the sole and exclusive forum for (i) any derivative action or proceeding brought on our behalf; (ii) any action asserting a breach of fiduciary duty owed by any of our directors, officers or other employees to us or our stockholders; (iii) any action asserting a claim against us or any of our directors, officers or other employees arising pursuant to the Delaware General Corporation Law, our amended and restated certificate of incorporation or our amended and restated bylaws; or (iv) any action asserting a claim against us or any of our directors, officers or other

employees that is governed by the internal affairs doctrine. The choice of forum provision may limit a stockholder's ability to bring a claim in a judicial forum that it finds favorable for disputes with us or our directors, officers or other employees, which may discourage such lawsuits against us and our directors, officers and other employees. Alternatively, if a court were to find the choice of forum provision contained in our amended and restated certificate of incorporation and amended and restated bylaws to be inapplicable or unenforceable in an action, we may incur additional costs associated with resolving such action in other jurisdictions, which could adversely affect our business and financial condition.

Because we will have an even number of members of our board of directors, deadlocks may occur in our board of directors' decision-making process, which may delay or prevent critical decisions from being made.

Since, as of the closing of this offering, we will have an even number of directors, deadlocks may occur when such directors disagree on a particular decision or course of action. Our amended and restated certificate of incorporation and amended and restated bylaws, which will become effective upon the closing of this offering, do not contain any mechanisms for resolving potential deadlocks. While our directors are under a duty to act in the best interest of our company, any deadlocks may impede the further development of our business in that such deadlocks may delay or prevent critical decisions regarding our business.

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This prospectus contains forward-looking statements. The forward-looking statements are contained principally in the sections entitled "Prospectus Summary," "Risk Factors," "Management's Discussion and Analysis of Financial Condition and Results of Operations" and "Business." These statements relate to future events or to our future financial performance and involve known and unknown risks, uncertainties and other factors which may cause our actual results, performance or achievements to be materially different from any future results, performance or achievements expressed or implied by the forward-looking statements. Forward-looking statements include, but are not limited to, statements about:

- the success, cost, timing and potential indications of our product development activities and clinical trials, including our ongoing clinical trials of Toca 511 & Toca FC;
- our ability to obtain and maintain regulatory approval of our product candidates, including Toca 511 & Toca FC, in any of the indications for which we plan to develop them, and any related restrictions, limitations, and/or warnings in the label of an approved product candidate;
- our ability to obtain funding for our operations, including funding necessary to complete the clinical trials of any of our product candidates, including Toca 511 & Toca FC;
- our plans to research, develop and commercialize our product candidates, including Toca 511 & Toca FC;
- our ability to attract and retain collaborators with development, regulatory and commercialization expertise;
- the size of the markets for our product candidates, and our ability to serve those markets;
- our ability to successfully commercialize our product candidates, including Toca 511 & Toca FC;
- the rate and degree of market acceptance of our product candidates, including Toca 511 & Toca FC;
- our ability to develop and maintain sales and marketing capabilities, whether alone or with potential future collaborators;
- regulatory developments in the United States and foreign countries;
- the performance of our third-party suppliers and manufacturers;
- the success of competing therapies that are or become available;
- our ability to attract and retain key scientific or management personnel;
- our expectations regarding the period during which we qualify as an emerging growth company under the JOBS Act;
- our use of the proceeds from this offering;
- the accuracy of our estimates regarding expenses, future revenues, capital requirements and needs for additional financing; and
- our expectations regarding our ability to obtain and maintain intellectual property protection for our product candidates and our ability to operate our business without infringing on the intellectual property rights of others.

In some cases, you can identify these statements by terms such as "anticipate," "believe," "could," "estimate," "expects," "intend," "may," "plan," "potential," "predict," "project," "should," "will," "would" or the negative of those terms, and similar expressions that convey uncertainty of future events or outcomes. These forward-looking statements reflect our management's beliefs and views with respect to future events and are based on estimates and assumptions as of the date of this prospectus and are subject to risks and uncertainties. We discuss many of these risks in greater detail under the heading "Risk Factors." Moreover, we operate in a very competitive and rapidly changing environment. New risks emerge from time to time. It is not possible for our management to predict all risks, nor can we assess the impact of all factors on our business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements we may make. Given these uncertainties, you should not place undue reliance on these forward-looking statements.

You should carefully read this prospectus and the documents that we reference in this prospectus and have filed as exhibits to the registration statement, of which this prospectus is a part, completely and with the

understanding that our actual future results may be materially different from what we expect. We qualify all of the forward-looking statements in this prospectus by these cautionary statements.

Except as required by law, we assume no obligation to update these forward-looking statements publicly, or to update the reasons actual results could differ materially from those anticipated in any forward-looking statements, whether as a result of new information, future events or otherwise.

USE OF PROCEEDS

We estimate that we will receive net proceeds of approximately $75.3 million (or approximately $87.1 million if the underwriters' option to purchase additional shares is exercised in full) from the sale of the shares of common stock offered by us in this offering, after deducting underwriting discounts and commissions and estimated offering expenses payable by us.

The principal purposes of this offering are to obtain additional capital to support our operations, to create a public market for our common stock and to facilitate our future access to the public equity markets. We anticipate that we will use the net proceeds of this offering as follows:

- approximately $25.0 million to fund the Phase 2 portion of our Phase 2/3 clinical trial of Toca 511 & Toca FC in recurrent HGG through review of top line results from the Phase 2 portion;
- approximately $20.0 million to fund manufacturing scale-up and validation for Toca 511 & Toca FC;
- approximately $15.0 million to fund our other ongoing and planned clinical development activities for Toca 511 & Toca FC through the completion of our ongoing and planned Phase 1b clinical trials for the treatment of newly-diagnosed HGG and for the intravenous treatment of metastatic colorectal, pancreatic, breast, lung, melanoma and renal cancers; and
- the remainder for working capital and other general corporate purposes, including the additional costs associated with being a public company.

We may also use a portion of the net proceeds from this offering to in-license, acquire, or invest in complementary businesses, technologies, products or assets. However, we have no current plans, commitments or obligations to do so.

We believe that the net proceeds from this offering and our existing cash, cash equivalents and marketable securities, together with interest thereon, will be sufficient to fund our operations through at least the next 12 months.

Our expected use of net proceeds from this offering represents our current intentions based upon our present plans and business condition. As of the date of this prospectus, we cannot predict with certainty all of the particular uses for the net proceeds to be received upon the completion of this offering, or the amounts that we will actually spend on the uses set forth above. The amounts and timing of our actual use of the net proceeds will vary depending on numerous factors, including our ability to obtain additional financing, the progress, cost and results of our preclinical and clinical development programs, and whether we are able to enter into future licensing or collaboration arrangements. We may find it necessary or advisable to use the net proceeds for other purposes, and our management will have broad discretion in the application of the net proceeds, and investors will be relying on our judgment regarding the application of the net proceeds from this offering.

Pending their use, we plan to invest the net proceeds from this offering in short- and intermediate-term, interest-bearing obligations, investment-grade instruments, certificates of deposit or direct or guaranteed obligations of the U.S. government.

DIVIDEND POLICY

We have never declared or paid any cash dividends on our capital stock. We currently intend to retain all available funds and any future earnings to support our operations and finance the growth and development of our business. We do not intend to pay cash dividends on our common stock for the foreseeable future. Any future determination related to our dividend policy will be made at the discretion of our board of directors and will depend upon, among other factors, our results of operations, financial condition, capital requirements, contractual restrictions, business prospects and other factors our board of directors may deem relevant. In addition, the terms of our loan and security agreement prohibit us from paying cash dividends.

CAPITALIZATION

The following table sets forth our cash, cash equivalents and marketable securities and our capitalization as of December 31, 2016 as follows:

- on an actual basis;
- on a pro forma basis to reflect (1) the conversion of all outstanding shares of our convertible preferred stock into 6,690,070 shares of our common stock in connection with the completion of this offering, (2) the issuance by us of convertible promissory notes in an aggregate principal amount of $7.5 million between January 2017 and February 2017, (3) the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes which were issued between November 2016 and February 2017 and which will automatically convert upon the completion of this offering into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017, (4) the reclassification of our preferred stock warrant liabilities to additional paid-in capital, a component of stockholders' equity (deficit) and (5) the filing of our amended and restated certificate of incorporation immediately prior to the completion of this offering; and
- on a pro forma as adjusted basis to give further effect to our issuance and sale of 8,500,000 shares of common stock in this offering at the initial public offering price of $10.00 per share, after deducting underwriting discounts and commissions and estimated offering expenses payable by us.

You should read this information in conjunction with our financial statements and the related notes included in this prospectus and the "Management's Discussion and Analysis of Financial Condition and Results of Operations" section and other financial information contained in this prospectus.

	As of December 31, 2016		
	Actual	Pro Forma	Pro Forma As Adjusted
	(in thousands, except share and per share data)		
Cash, cash equivalents and marketable securities	$ 31,245	$ 38,584	$ 115,725
Notes payable, current portion	$ 7,200	$ 7,200	$ 7,200
Notes payable, net of current portion	10,241	10,241	10,241
Convertible promissory notes payable	3,398	—	—
Convertible promissory notes subscription liability	140	—	—
Preferred stock warrant liabilities	126	—	—
Convertible preferred stock, $0.001 par value; 51,000,000 shares authorized, 46,163,605 shares issued and outstanding, actual; 10,000,000 shares authorized and no shares issued and outstanding, pro forma and pro forma as adjusted	131,413	—	—
Stockholders' equity (deficit):			
Common stock, $0.001 par value; 77,800,000 shares authorized, 2,202,517 shares issued and outstanding, actual; 200,000,000 shares authorized, 10,001,763 shares issued and outstanding, pro forma; 200,000,000 shares authorized, 18,501,763 shares issued and outstanding, pro forma as adjusted	2	10	19
Additional paid-in capital	3,581	145,989	221,230
Accumulated deficit	(128,000)	(128,000)	(128,000)
Total stockholders' equity (deficit)	(124,417)	17,999	93,249
Total capitalization	$ 28,101	$ 35,440	$ 110,690

The number of shares of common stock shown as issued and outstanding after this offering is based on the number of shares of our common stock outstanding as of December 31, 2016, and excludes:

- 1,385,855 shares of common stock issuable upon the exercise of outstanding options as of December 31, 2016, at a weighted-average exercise price of $11.35 per share;
- a maximum of 3,133,702 shares of common stock reserved for future issuance under our 2017 Plan, which number includes the 184,861 shares subject to stock options that were granted upon the effective date of the 2017 Plan and includes the 172,495 shares of common stock reserved for issuance under our 2009 Plan as of December 31, 2016, adjusted for grants and forfeitures after year-end through March 31, 2017, including the 103,934 shares of common stock issuable upon the exercise of the stock options granted under the 2009 Plan subsequent to December 31, 2016, for an aggregate of 69,525 shares that were added to the shares reserved under the 2017 Plan upon its effectiveness;
- 250,000 shares of common stock reserved for issuance under the ESPP; and
- 10,660 shares of common stock issuable upon the exercise of outstanding warrants as of December 31, 2016, at a weighted-average exercise price of $34.04 per share.

DILUTION

If you invest in our common stock in this offering, your ownership interest will be immediately diluted to the extent of the difference between the initial public offering price per share of our common stock and the pro forma as adjusted net tangible book value per share of our common stock after this offering.

As of December 31, 2016, we had a historical net tangible book deficit of $(124.4) million, or $(56.48) per share of common stock. Our historical net tangible book deficit per share represents the amount of our total tangible assets less total liabilities, divided by the total number of shares of common stock outstanding at December 31, 2016.

After giving effect to (i) the automatic conversion of all outstanding shares of our convertible preferred stock into 6,690,070 shares of our common stock upon the completion of this offering, (ii) the issuance by us of convertible promissory notes in an aggregate principal amount of $7.5 million between January 2017 and February 2017, (iii) the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes which were issued between November 2016 and February 2017 and which will automatically convert upon the completion of this offering into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017, and (iv) the reclassification of our preferred stock warrant liabilities to additional paid-in capital, a component of stockholders' equity (deficit), our pro forma net tangible book value as of December 31, 2016 is $18.0 million, or $1.80 per share of our common stock.

After giving further effect to the sale of 8,500,000 shares of common stock that we are offering at the initial public offering price of $10.00 per share, and after deducting underwriting discounts and commissions and estimated offering expenses payable by us, our pro forma as adjusted net tangible book value as of December 31, 2016 is $93.2 million, or approximately $5.04 per share. This amount represents an immediate increase in pro forma net tangible book value of $3.24 per share to our existing stockholders and an immediate dilution in pro forma net tangible book value of approximately $4.96 per share to new investors participating in this offering.

Dilution per share to new investors is determined by subtracting pro forma as adjusted net tangible book value per share after this offering from the initial public offering price per share paid by new investors. The following table illustrates this dilution:

Initial public offering price per share		$10.00
Historical net tangible book deficit per share at December 31, 2016, before giving effect to this offering	$(56.48)	
Pro forma increase in historical net tangible book value per share attributable to conversion of all outstanding shares of convertible preferred stock and convertible notes	58.28	
Pro forma net tangible book value per share at December 31, 2016, before giving effect to this offering	$ 1.80	
Increase in pro forma net tangible book value per share attributable to investors participating in this offering	3.24	
Pro forma as adjusted net tangible book value per share after this offering		5.04
Dilution per share to new investors participating in this offering		$ 4.96

If the underwriters exercise in full their option to purchase 1,275,000 additional shares of our common stock in this offering, the pro forma as adjusted net tangible book value will increase to $5.31 per share, representing an immediate increase in pro forma as adjusted net tangible book value to existing stockholders of $3.51 per share and an immediate dilution of $4.69 per share to new investors participating in this offering.

The following table summarizes on a pro forma as adjusted basis as of December 31, 2016, the number of shares of common stock purchased or to be purchased from us, the total consideration paid or to be paid to us in cash and the average price per share paid by existing stockholders for shares issued prior to this offering and the price to be paid by new investors in this offering. The calculation below is based on the initial public offering price of $10.00 per share, before deducting underwriting discounts and commissions and estimated offering expenses payable by us.

	Shares Purchased		Total Consideration		Average Price Per Share
	Number	Percent	Amount	Percent	
Existing stockholders	8,892,587	51.1%	$131,925,368	60.8%	$14.84
Investors participating in this offering	8,500,000	48.9	85,000,000	39.2	$10.00
Total	17,392,587	100.0%	$216,925,368	100.0%	$12.47

The foregoing tables and calculations exclude:

- 1,385,855 shares of common stock issuable upon the exercise of outstanding options as of December 31, 2016, at a weighted-average exercise price of $11.35 per share;
- a maximum of 3,133,702 shares of common stock reserved for future issuance under our 2017 Plan, which number includes the 184,861 shares subject to stock options that were granted upon the effective date of the 2017 Plan and includes the 172,495 shares of common stock reserved for issuance under our 2009 Plan as of December 31, 2016, adjusted for grants and forfeitures after year-end through March 31, 2017, including the 103,934 shares of common stock issuable upon the exercise of the stock options granted under the 2009 Plan subsequent to December 31, 2016, for an aggregate of 69,525 shares that were added to the shares reserved under the 2017 Plan upon its effectiveness;
- 250,000 shares of common stock reserved for issuance under the ESPP; and
- 10,660 shares of common stock issuable upon the exercise of outstanding warrants as of December 31, 2016, at a weighted-average exercise price of $34.04 per share.

We may choose to raise additional capital through the sale of equity or convertible debt securities due to market conditions or strategic considerations even if we believe we have sufficient funds for our current or future operating plans. To the extent we issue additional shares of common stock or other equity or convertible debt securities in the future, there will be further dilution to investors participating in this offering.

SELECTED FINANCIAL DATA

The following selected financial data should be read together with our financial statements and related notes and "Management's Discussion and Analysis of Financial Condition and Results of Operations" appearing elsewhere in this prospectus. The selected financial data in this section are not intended to replace our financial statements and related notes. Our historical results are not necessarily indicative of our future results.

The following selected financial data as of and for the years ended December 31, 2015 and 2016 are derived from our audited financial statements appearing elsewhere in this prospectus.

	Year Ended December 31,	
	2015	2016
	(in thousands, except share and per share data)	
Statements of Operations Data:		
License revenue	$ 51	$ 49
Operating expenses:		
Research and development	19,172	27,218
General and administrative	3,833	4,522
Total operating expenses	23,005	31,740
Loss from operations	(22,954)	(31,691)
Other income (expense), net:		
Interest income	126	215
Interest expense	(339)	(2,052)
Change in fair value of preferred stock warrants	111	50
Total other income (expense), net	(102)	(1,787)
Net loss	(23,056)	(33,478)
Other comprehensive income (loss):		
Net unrealized gain (loss) on investments	(52)	58
Comprehensive loss	$ (23,108)	$ (33,420)
Net loss per common share, basic and diluted[(1)]	$ (10.57)	$ (15.22)
Weighted-average common shares used to compute basic and diluted net loss per share[(1)]	2,182,032	2,199,964
Pro forma net loss per common share, basic and diluted (unaudited)[(2)]		$ (3.77)
Weighted-average common shares used to compute pro forma net loss per common share, basic and diluted (unaudited)[(2)]		8,890,034

(1) See Note 2 to our financial statements appearing elsewhere in this prospectus for an explanation of the method used to calculate the basic and diluted net loss per common share and the number of shares used in the computation of the per share amounts.

(2) The calculations for the unaudited pro forma net loss per common share, basic and diluted, assume the conversion of all our outstanding shares of convertible preferred stock into shares of our common stock, as if the conversion had occurred at the beginning of the period presented, or the issuance date, if later, and exclude the effect of shares issuable upon the conversion of all outstanding principal and accrued interest related to convertible promissory notes upon completion of this offering.

	As of December 31,	
	2015	2016
	(in thousands)	
Balance Sheet Data:		
Cash, cash equivalents and marketable securities	$ 58,910	$ 31,245
Working capital	54,270	18,079
Total assets	62,175	35,351
Notes payable, current portion	600	7,200
Notes payable, net of current portion	16,873	10,241
Convertible promissory notes payable	—	3,398
Convertible promissory notes subscription liability	—	140
Preferred stock warrant liabilities	176	126
Convertible preferred stock	131,413	131,413
Accumulated deficit	(94,512)	(128,000)
Total stockholders' deficit	(92,330)	(124,417)

MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

You should read the following discussion and analysis of our financial condition and results of operations together with "Selected Financial Data" and our financial statements and related notes appearing elsewhere in this prospectus. Some of the information contained in this discussion and analysis or set forth elsewhere in this prospectus, including information with respect to our plans and strategy for our business and related financing, includes forward-looking statements that involve risks and uncertainties. As a result of many factors, including those factors set forth in the "Risk Factors" section of this prospectus, our actual results could differ materially from the results described in or implied by the forward-looking statements contained in the following discussion and analysis. You should carefully read the "Risk Factors" section of this prospectus to gain an understanding of the important factors that could cause actual results to differ materially from our forward-looking statements. Please also see the section entitled "Special Note Regarding Forward-Looking Statements."

Overview

We are a clinical-stage, cancer-selective gene therapy company focused on developing first-in-class, broadly-applicable product candidates designed to activate a patient's immune system against their own cancer from within. Our cancer-selective gene therapy platform is built on RRVs, which are designed to selectively deliver therapeutic genes into the DNA of cancer cells. Our gene therapy approach is designed to fight cancer through immunotherapeutic mechanisms of action without the autoimmune toxicities commonly experienced with other immunotherapies.

We are developing our lead product candidate, Toca 511 & Toca FC, initially for the treatment of recurrent HGG. In November 2015, we initiated the Phase 2 portion of a randomized, controlled Phase 2/3 clinical trial of Toca 511 & Toca FC in patients with recurrent HGG, which is designed to serve as a potential registrational trial. We completed enrollment of the Phase 2 portion with 187 patients in February 2017 and plan to report top line results in the first half of 2018. We also have three ongoing, ascending dose Phase 1 clinical trials in recurrent HGG with varying modes of delivery of the Toca 511 vector and a Phase 1b clinical trial for the intravenous treatment of metastatic colorectal, pancreatic, breast, lung, melanoma, and renal cancers. In addition, based on our findings in preclinical studies and clinical trials to date, we believe Toca 511 & Toca FC is a promising candidate for use in combination with surgery, radiation and chemotherapy and we plan to initiate a clinical trial in early 2018 for newly diagnosed HGG to assess safety in this setting. We are also developing other RRVs to selectively deliver genes to cancer cells against validated immunotherapy targets, such as the checkpoint protein PD-L1.

We do not have any products approved for sale and have not generated any revenue from product sales. We have funded our operations primarily through the private placement of our convertible preferred stock, from which we received net proceeds of $131.4 million through December 31, 2016. We have also received $17.7 million in net proceeds from the issuance of our notes payable, $3.4 million from the issuance of our convertible promissory notes payable, $1.6 million from private and federal grants, and a $0.5 million up-front payment from our license and collaboration agreement with Siemens Healthcare Diagnostics Inc., or Siemens.

Since our inception in August 2007, we have devoted substantially all of our efforts to developing our gene therapy platform and our lead product candidate, Toca 511 & Toca FC. We have never been profitable and have incurred significant operating losses in each year since our inception. We had an accumulated deficit of $128.0 million as of December 31, 2016. Substantially all of our net losses resulted from costs incurred in connection with our research, preclinical, clinical, product, regulatory and business development activities, as well as raising capital and building our infrastructure.

We expect to continue to incur significant expenses and increasing net operating losses for at least the next several years. We expect our expenses will increase substantially in connection with our ongoing activities as we

continue to develop and seek regulatory approval of our product candidates and operate as a public company. To fund further operations, we will need to raise additional capital.

Accordingly, we will seek to fund our operations through equity and/or debt financings. We may also consider new collaborations or selectively partnering our technology or programs. However, we may be unable to raise additional funds or enter into such other arrangements when needed on favorable terms or at all. Our failure to raise capital or enter into such other arrangements as and when needed would have a negative impact on our financial condition and our ability to develop our product candidates.

Financial Operations Overview

Revenue

We currently have no products approved for sale, and have not generated any revenues from the sale of products. We have not submitted any product candidate for regulatory approval. Our revenue has been derived from our license and collaboration arrangement we entered into with Siemens in 2011, under which we received a nonrefundable, non-creditable, lump-sum, upfront license payment of $0.5 million for our sublicense to Siemens of certain diagnostic assay technology.

In the future, we may generate revenue from a combination of product sales and royalties in connection with our Siemens agreement and any future marketing and distribution arrangements and other collaborations, strategic alliances and license arrangements, or a combination of these approaches. However, we do not expect to receive additional revenues unless and until we receive regulatory approval for product candidates or potentially enter into collaboration agreements. We do not expect any of our current product candidates to be commercially available in major markets for at least the next several years. We expect that any revenue we generate will fluctuate from quarter to quarter as a result of the timing and amount of license fees, milestone and other payments, and the amount and timing of payments that we receive upon the sale of our products, to the extent any are successfully commercialized. If we fail to complete the development of our product candidates in a timely manner or obtain regulatory approval of them, our ability to generate future revenue, and our results of operations and financial position, would be materially adversely affected.

Research and Development Expenses

Research and development expenses consist primarily of salaries and related expenses for personnel, including stock-based compensation costs, preclinical costs, clinical trial costs, costs related to acquiring and manufacturing clinical trial materials, contract services, facilities costs, overhead costs and depreciation. These activities also include research and development related to our gene therapy platform development. All research and development costs are expensed as incurred.

We cannot determine with certainty the duration and completion costs of the current or future clinical trials of our product candidates, or if, when or to what extent we will generate revenues from the commercialization and sale of any of our product candidates that obtain regulatory approval. We may never succeed in achieving regulatory approval for any of our product candidates. The duration, costs and timing of clinical trials and development of our product candidates will depend on a variety of factors, including:

- per patient trial costs;
- the number of patients that participate in the trials;
- the number of sites included in the trials;
- the countries in which the trials are conducted;
- the length of time required to enroll eligible patients;
- the drop-out or discontinuation rates of patients;

- the potential for additional safety monitoring or other clinical trials requested by regulatory agencies;
- significant and changing government regulation; and
- the timing and receipt of any regulatory approvals.

A change in the outcome of any of these variables with respect to the development of a product candidate could mean a significant change in the costs and timing associated with the development of that product candidate. For example, if the FDA or another regulatory authority were to require us to conduct clinical trials beyond those that we currently anticipate will be required for the completion of clinical development of a product candidate or if we experience significant delays in enrollment in any of our clinical trials, we could be required to expend significant additional financial resources and time on the completion of clinical development. In addition, the probability of success for each product candidate will depend on numerous factors, including competition, manufacturing capability and commercial viability. We will determine which programs to pursue and how much to fund each program in response to the scientific and clinical success of each product candidate, as well as an assessment of each product candidate's commercial potential.

The following table indicates our research and development expense by project for the years ended December 31, 2015 and 2016 (in thousands):

	Year Ended December 31,	
	2015	2016
	(unaudited)	
Toca 511 & Toca FC	$18,211	$26,490
Anti-PD-L1 and IDO-1	601	440
Vector technology and other therapeutic genes	360	288
Total	$19,172	$27,218

We expect our research and development expenses to increase for the foreseeable future as we scale up our clinical trial and manufacturing activities and seek regulatory approval of our product candidates.

General and Administrative Expenses

General and administrative expenses consist primarily of salaries and related expenses for personnel, including stock-based compensation costs and travel expenses for our employees in executive, operational, finance and business development functions. Other general and administrative expenses include facility-related costs, consulting fees for human resources and operations, capital raising and information technology, insurance, professional fees for accounting and legal services and expenses associated with obtaining and maintaining patents.

We anticipate that our general and administrative expenses will increase in the future as we increase our headcount to support our continued research and development and potential commercialization of our product candidates. We also anticipate increased expenses related to audit, legal, regulatory and tax-related services associated with maintaining compliance with exchange listing and SEC requirements, director and officer insurance premiums and investor relations costs associated with being a public company. Additionally, if we believe a regulatory approval of the lead product candidate appears likely, we anticipate an increase in payroll and related expenses as a result of our preparation for commercial operations, especially as it relates to establishing a sales force and other expenses related to the sale and marketing of our product candidates.

Interest Income

Interest income consists primarily of interest income earned on cash, cash equivalents and marketable securities.

Interest Expense

Interest expense consists of stated interest and the amortization of related debt issuance costs incurred on the outstanding principal amount of our borrowings under our notes payable and convertible promissory notes payable.

Change in Fair Value of Preferred Stock Warrants

Warrants for shares of preferred stock with conversion features are accounted for as liabilities in the accompanying balance sheets at their fair value on the date of issuance. The warrant liabilities are revalued at each balance sheet date until such instruments are exercised or expire, with changes in the fair value between reporting periods recorded as change in fair value of preferred stock warrants in the statement of operations.

Critical Accounting Policies and Significant Judgments and Estimates

Our management's discussion and analysis of our financial condition and results of operations is based on our financial statements which we have prepared in accordance with generally accepted accounting principles in the United States, or GAAP. The preparation of these financial statements requires us to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements, and the reported amounts of revenue and expenses during the reporting period. Actual results could differ from those estimates.

While our significant accounting policies are described in more detail in the notes to our financial statements appearing elsewhere in this prospectus, we believe the following accounting policies to be most critical for fully understanding and evaluating our financial condition and results of operations.

Accrued Research and Development Expenses

As part of the process of preparing our financial statements, we are required to estimate our accrued research and development expenses. This process involves reviewing open contracts and purchase orders, communicating with our personnel to identify services that have been performed on our behalf and estimating the level of service performed and the associated cost incurred for the service when we have not yet been invoiced or otherwise notified of the actual cost. The majority of our service providers invoice us monthly in arrears for services performed or when contractual milestones are met. We make estimates of our accrued expenses as of each balance sheet date in our financial statements based on facts and circumstances known to us at that time. Examples of estimated accrued research and development expenses include fees paid to: investigative sites and contract research organizations in connection with clinical trials; service providers in connection with preclinical development activities; and service providers related to product manufacturing.

We base our expenses related to clinical trials on our estimates of the services received and efforts expended pursuant to our contract arrangements. The financial terms of these agreements are subject to negotiation, vary from contract to contract and may result in uneven payment flows. There may be instances in which payments made to our service providers will exceed the level of services provided and result in a prepayment of the clinical expense. Payments under some of these contracts depend on factors such as the successful enrollment of patients, site initiation and the completion of clinical milestones. In accruing service fees, we estimate the time period over which services will be performed and the level of effort to be expended in each period. If the actual timing of the performance of services or the level of effort varies from our estimate, we adjust the accrual or prepaid expense balance accordingly.

Although we do not expect our estimates to be materially different from amounts actually incurred, if our estimates of the status and timing of services performed differ from the actual status and timing of services

performed, we may report amounts that are too high or too low in any particular period. To date, there have been no material differences from our estimates to the amount actually incurred. However, due to the nature of estimates, we cannot assure you that we will not make changes to our estimates in the future as we become aware of additional information about the status or conduct of our clinical trials and other research activities.

Stock-Based Compensation

Stock-based compensation expense represents the cost of the grant date fair value of stock options granted to employees. For awards with time-based vesting provisions, we estimate the fair value of stock options on the date of grant using the Black-Scholes option pricing model and recognize the expense over the requisite service period of the awards which is generally the vesting period, on a straight-line basis. The Black-Scholes option pricing model requires the input of highly subjective assumptions, including the risk-free interest rate, the expected volatility, the expected term of the option, the expected dividend yield of our common stock and the estimated fair value of our common stock. For awards with performance-based vesting provisions, we estimate the fair value of stock option grants on the date of grant, or the date when all of the terms of the grant have been agreed to, if later, and recognize the expense based on the probability of the occurrence of the individual milestones at each reporting period. The expense is recognized over the implicit service period that commences once management believes the performance criteria are probable of being met. Prior to January 1, 2016, we estimated forfeitures at the time of grant with stock-based compensation expense based on awards that were ultimately expected to vest. Beginning January 1, 2016, upon adoption of new accounting guidance, we account for forfeitures when they occur, and reverse any compensation cost previously recognized for awards for which the requisite service has not been completed, in the period that the award is forfeited.

We calculate the estimated fair value of each non-employee stock option award at the date of grant using Black-Scholes option pricing model with the assumptions generally consistent with those used for employee stock options, with the exception of expected term, which is over the contractual life. These options are subject to periodic revaluation over their vesting terms.

We will continue to use judgment in evaluating the assumptions related to our stock-based compensation on a prospective basis. As we continue to accumulate additional data, we may have refinements to our estimates, which could materially impact our future stock-based compensation expense. See Note 7 to our financial statements included elsewhere in this prospectus for information concerning certain of the specific assumptions we used in applying the Black-Scholes option pricing model to determine the estimated fair value of our stock options granted in the years ended December 31, 2015 and 2016.

The following table summarizes information related to stock options we granted from January 1, 2014 through the date of this prospectus:

Grant Date	Number of Common Shares Underlying Options Granted	Exercise Price Per Common Share	Reassessed Fair Value Per Common Share
February 13, 2014	1,086	$14.36	$16.08
March 10, 2014	65,643	14.36	16.42
March 18, 2014	695	14.36	16.56
August 25, 2014	38,315	16.70	11.87
November 25, 2014	72,463	11.60	11.59
February 18, 2015	37,679	11.60	18.77
March 18, 2015	34,687	11.60	18.70
April 16, 2015	3,042	11.60	17.18
April 21, 2015	18,115	11.60	16.91
May 12, 2015	38,303	11.60	15.80
June 15, 2015	14,708	19.67	16.08
September 2, 2015	19,477	14.77	22.56
October 12, 2015	6,955	14.77	20.91
November 2, 2015	507	14.77	20.08
June 10, 2016	212,807	14.98	14.63
October 17, 2016	16,809	14.43	15.80
November 16, 2016	308,706	16.56	15.32
November 16, 2016	154,353	16.56	*
March 6, 2017	103,934	15.12	*

* The reassessed fair value of these awards will be determined when we prepare our financial statements for the three months ending March 31, 2017.

The following table summarizes the stock-based compensation expense recognized in our financial statements (in thousands):

	Year Ended December 31,	
	2015	2016
Research and development	$ 456	$ 562
General and administrative	606	761
	$1,062	$1,323

Total employee stock-based compensation expense related to unvested stock option grants not yet recognized as of December 31, 2016 was $6.2 million and the weighted-average period over which these grants are expected to vest is 3.3 years.

Based on the initial public offering, or IPO, price of $10.00 per share, the intrinsic value of stock options outstanding as of December 31, 2016 would be $3.0 million, of which $3.0 million and $7,000 would have been related to stock options that were vested and unvested, respectively, at that date.

Determination of the Fair Value of Common Stock

We are required to estimate the fair value of the common stock underlying our stock-based awards when performing fair value calculations, which is the most subjective input into the Black-Scholes option pricing model. The fair value of the common stock underlying our stock-based awards was determined on each grant

date by our board of directors, taking into account input from management and our most recent independent third-party valuations. All options to purchase shares of our common stock are intended to be granted with an exercise price per share no less than the fair value per share of our common stock underlying those options on the date of grant, determined in good faith and based on the information known to us on the date of grant. Our determinations of the fair value of our common stock were made using methodologies, approaches and assumptions consistent with the American Institute of Certified Public Accountants' *Audit and Accounting Practice Aid Series: Valuation of Privately Held Company Equity Securities Issued as Compensation*, or the Practice Aid.

Our board of directors determined the fair value of our common stock by considering various objective and subjective factors, along with input from management, including:

- valuations of our common stock performed with the assistance of an independent third-party valuation specialist;
- the prices of our convertible preferred stock sold to investors in arm's length transactions, and the rights, preferences and privileges of our convertible preferred stock as compared to those of our common stock, including the liquidation preferences of our convertible preferred stock;
- our stage of development and business strategy, including the status of research and development efforts and clinical trials of our product candidates, and the material risks related to our business and industry;
- our results of operations and financial position, including our levels of available capital resources;
- the valuation of publicly traded companies in the life sciences and biotechnology sectors, as well as recently completed mergers and acquisitions of peer companies;
- the lack of marketability of our common stock as a private company;
- trends and developments in our industry;
- external market conditions affecting the life sciences and biotechnology industry sectors;
- the likelihood of achieving a liquidity event for the holders of our common stock, such as an IPO or a sale of our company, given prevailing market conditions; and
- the composition of, and changes to, our management team and board of directors.

There are significant judgments and estimates inherent in the determination of the fair value of our common stock. These judgments and estimates include assumptions regarding our future operating performance, the time to completing an IPO or other liquidity event, the selection of the appropriate comparable publicly traded companies, the determination of the appropriate valuation methods and the discount for lack of marketability of our common stock. If we had made different assumptions, our stock-based compensation expense, net loss and net loss per common share could have been significantly different.

Following the closing of this offering, our board of directors will determine the fair value of our common stock based on its closing price as reported on the date of grant on the primary stock exchange on which our common stock is traded.

Common Stock Valuation Methodologies

Our valuations were prepared in accordance with the guidelines in the Practice Aid which prescribes several valuation approaches for setting the value of an enterprise such as the cost, income and market approaches. The cost approach establishes the value of an enterprise based on the cost of reproducing or replacing the property, less depreciation and functional or economic obsolescence, if present. The income approach establishes the value of an enterprise based on the present value of future cash flows that are reasonably reflective of a company's future operations, discounting to the present value with an appropriate risk-adjusted discount rate or capitalization rate. The market approach is based on the assumption that the value of an asset is equal to the value of a substitute asset with the same characteristics. Each valuation methodology was considered in our valuations.

To determine the exercise price of stock options granted in February and March 2014, we utilized a combination of a backsolve market approach based on arm's length sales of our convertible preferred stock near the valuation date and a guideline company market approach for our September 30, 2013 valuation.

To determine the valuations used to derive the price of our stock options granted in and after August 2014, we utilized a guideline company market approach for our quarterly valuations beginning with the March 31, 2014 valuation.

Methods Used to Allocate Our Enterprise Value to Classes of Securities

In accordance with the Practice Aid, we considered the following various methods for allocating the enterprise value across our classes and series of capital stock to determine the fair value of our common stock at each valuation date:

- Current Value Method, or CVM. Under the CVM, once the fair value of the enterprise is established, the value is allocated to the various series of preferred and common stock based on their respective seniority, liquidation preferences or conversion values, whichever is greatest.
- Option Pricing Method, or OPM. Under the OPM, shares are valued by creating a series of call options with exercise prices based on the liquidation preferences and conversion terms of each equity class. The values of the preferred and common stock are inferred by analyzing these options.
- Probability-Weighted Expected Return Method, or PWERM. The PWERM is a scenario-based analysis that estimates the value per share based on the probability-weighted present value of expected future investment returns, considering each of the possible outcomes available to us, as well as the economic and control rights of each share class.
- Hybrid Method. The hybrid method employs the concepts of the OPM and PWERM merged into a single framework.

Beginning with the September 30, 2013 valuation, we utilized the OPM for each of our contemporaneous valuations of our common stock performed by an independent third-party valuation specialist. We believed that the OPM was the most appropriate given the expectation of various potential liquidity outcomes and the difficulty of selecting and supporting appropriate enterprise values given our early stage of development.

Beginning with the February 28, 2015 valuation, we transitioned to the Hybrid Method for our contemporaneous valuation of our common stock performed with the assistance of an independent third-party valuation specialist. We believed that the Hybrid Method was the most appropriate because we then had greater clarity as to our expected time to liquidity events and the nature of the expected liquidity events.

Retrospective Reassessment of Fair Value

As part of the preparation of the financial statements, we reassessed the fair value of our common stock for each stock option grant noted in the table above on a retrospective basis for financial reporting purposes. For purposes of this reassessment, we re-evaluated our original inputs and the methodologies used to determine our enterprise value and the methods we used to allocate enterprise value.

As we did not identify any significant internal or external value-generating events between the effective dates of our contemporaneous valuations of our common stock, we reassessed the fair value of our common stock for stock options granted from January 1, 2014 through the date of this prospectus. We did this reassessment using a straight-line method between the original valuation dates of our common stock as follows:

- $14.35 per share on September 30, 2013 and $16.70 per share on March 31, 2014 for the February and March 2014 stock option grants;

- $14.77 per share on June 30, 2014 and $11.59 per share on August 31, 2014 for the August 2014 stock option grants;
- $11.59 per share on August 31, 2014 and $11.59 per share on November 30, 2014 for the November 2014 stock option grants;
- $11.59 per share on November 30, 2014 and $19.67 per share on February 28, 2015 for the February 2015 stock option grants;
- $19.67 per share on February 28, 2015 and $14.77 per share on May 31, 2015 for the March through May 2015 stock option grants;
- $14.77 per share on May 31, 2015 and $22.63 per share on August 31, 2015 for the June 2015 stock option grants;
- $22.63 per share on August 31, 2015 and $18.91 per share on November 30, 2015 for the September through November 2015 stock option grants;
- $14.42 per share on May 31, 2016 and $16.56 per share on August 31, 2016 for the June 2016 stock option grants; and
- $16.56 per share on August 31, 2016 and $15.11 per share on November 30, 2016 for the October and November 2016 stock option grants.

We utilized the above reassessed fair values to determine the stock-based compensation expense which is recorded in our financial statements, and intend to also perform a reassessment to determine the stock-based compensation expense related to stock options granted in the first quarter of 2017.

Income Taxes

We account for income taxes under the asset and liability method, which requires the recognition of deferred tax assets and liabilities for the expected future tax consequences that have been included in the financial statements. Under this method, deferred tax assets and liabilities are determined on the basis of the differences between the financial statements and tax basis of assets and liabilities using enacted tax rates in effect for the year in which the differences are expected to reverse. We record a full valuation allowance against net deferred tax assets unless, based upon the available evidence, it is more likely than not that the deferred tax assets will be realized.

We record uncertain tax positions on the basis of a two-step process whereby (i) management determines whether it is more likely than not that the tax positions will be sustained on the basis of the technical merits of the position and (ii) for those tax positions that meet the more likely-than-not recognition threshold, management recognizes the largest amount of tax benefit that is more than 50 percent likely to be realized upon ultimate settlement with the related tax authority. We will recognize interest and penalties in income tax expense if and when incurred.

We have federal and California net operating loss carryforwards which may be available to offset future income tax liabilities. As of December 31, 2016, we have federal and California net operating loss carryforwards of $109.5 million and $41.5 million, respectively. The federal and state net operating losses begin to expire in 2028 unless previously utilized. Excluded from the California net operating loss carryforward are net operating losses for the years ended December 31, 2013, 2014, 2015 and 2016 that were impacted by a California Supreme Court ruling on December 31, 2015. This ruling clarified how companies are allowed to apportion income or losses in the state. We have not completed an analysis to determine the re-apportionment of our losses to California using the required single sales factor market sourcing method for 2013 through 2016 as a result of the ruling. When this analysis is finalized, we plan to update our California net operating loss carryforward accordingly.

As of December 31, 2016, we have federal and California research and development tax credit carryforwards of $15.1 million and $3.9 million, respectively. The federal research and development tax credits begin to expire in 2028 unless previously utilized. The California credits do not expire.

Pursuant to Internal Revenue Code, or the Code, Sections 382 and 383, annual use of a company's net operating loss and tax credit carryforwards may be limited if there is a cumulative change in ownership of greater

than 50% within a three-year period. The amount of the annual limitation is determined based on the value of the company immediately prior to the ownership change. Subsequent ownership changes may further affect the limitation in future years. We have completed several equity offerings since our inception which may have resulted in a change in control as defined by Sections 382 and 383 of the Code, or could result in a change in control in the future. We have not completed a Section 382 and 383 analysis regarding the limitation of net operating loss and research and development credit carryforwards. Until such an analysis has been completed, we have removed the deferred tax assets for net operating losses of $39.7 million and federal and California research and development credits of $17.7 million from our deferred tax asset schedule, and have recorded a corresponding decrease to our valuation allowance. When this analysis is finalized, we plan to update our unrecognized tax benefits accordingly. We do not expect this analysis to be completed within the next 12 months and, as a result, we do not expect that the unrecognized tax benefits will change within 12 months of this reporting date. Due to the existence of the valuation allowance, future changes in our unrecognized tax benefits will not impact our effective tax rate.

Emerging Growth Company Status

The JOBS Act permits an "emerging growth company" such as us to take advantage of an extended transition period to comply with new or revised accounting standards applicable to public companies. Thus, an emerging growth company can delay the adoption of certain accounting standards until those standards would otherwise apply to private companies. We have irrevocably elected not to avail ourselves of this extended transition period and, as a result, we will adopt new or revised accounting standards on the relevant dates on which adoption of such standards is required for other public companies.

Recently Adopted Accounting Pronouncements

In August 2014, the Financial Accounting Standards Board, or FASB, issued new guidance which addresses management's responsibility to evaluate whether there is substantial doubt about an organization's ability to continue as a going concern and to provide related footnote disclosures. Management's evaluation should be based on relevant conditions and events that are known and reasonably knowable at the date that the financial statements are issued. The new guidance was effective for our annual reporting period ending December 31, 2016. Adoption of this guidance did not have an impact on our financial position or results of operations.

In May 2015, the FASB issued an Accounting Standards Update, or ASU, that eliminates the requirement to categorize investments within the fair value hierarchy if their fair value is measured using the net asset value per share practical expedient in the FASB's fair value measurement guidance. The amendments also limit certain disclosures to investments for which the entity has elected to measure at fair value using the net asset value per share practical expedient. The amendments were adopted January 1, 2016 and were applied retrospectively by removing from the fair value hierarchy any investments for which fair value is measured using the net asset value per share practical expedient. Adoption of this guidance did not have an impact on our financial position or results of operations.

In March 2016, the FASB issued a new ASU which simplifies several aspects of the accounting for share-based payment transactions, including the income tax consequences, classification of awards as either equity or liabilities, and classification on the statement of cash flows. The update is effective for fiscal years and the interim periods within those fiscal years beginning after December 15, 2016, with early adoption permitted. Amendments related to the timing of when excess tax benefits are recognized, minimum statutory withholding requirements and forfeitures are applied using a modified retrospective transition method by means of a cumulative-effect adjustment to equity as of the beginning of the period in which the guidance is adopted. Amendments related to the presentation of employee taxes paid on the statement of cash flows when an employer withholds shares to meet the minimum statutory withholding requirement is applied retrospectively. Amendments requiring recognition of excess tax benefits and tax deficiencies in the statement of operations are

applied prospectively. We elected to early adopt this guidance effective January 1, 2016 and made a policy election to account for forfeitures of unvested share-based awards as they occur which is a change from our prior accounting whereby forfeitures were estimated at the time of grant with stock-based compensation expense based on awards that were ultimately expected to vest. We recorded a cumulative-effect adjustment on January 1, 2016 to equity to eliminate the forfeiture reserve balance at December 31, 2015 of $10,000, resulting in an increase in our accumulated deficit and additional paid-in capital by $10,000 each.

In March 2016, the FASB issued new accounting guidance intended to reduce diversity in practice of identifying embedded derivatives in debt instruments. The new guidance clarifies that the nature of an exercise contingency is not subject to the "clearly and closely" criteria for purposes of assessing whether the call or put option must be separated from the debt instrument and accounted for separately as a derivative. This new standard is effective for fiscal years beginning after December 15, 2016, and interim periods within those fiscal years. We elected to early adopt this guidance on July 1, 2016. Adoption of this guidance did not have an impact on our financial position or results of operations.

Recent Accounting Pronouncements

In May 2014, the FASB issued new revenue recognition guidance which outlines a single comprehensive revenue model for entities to use in accounting for revenue arising from contracts with customers. The guidance supersedes most current revenue recognition guidance, including industry-specific guidance. The guidance provides that an entity recognize revenue when it transfers promised goods or services to customers in an amount that reflects the consideration to which the entity expects to be entitled in exchange for those goods or services. The guidance will be effective on January 1, 2018 and earlier application is permitted only for annual reporting periods beginning after December 15, 2016 including interim reporting periods within that reporting period. The guidance allows for either a full retrospective adoption, in which the standard is applied to all of the periods presented, or a modified retrospective adoption, in which the standard is applied to the most current period presented in the financial statements. As of December 31, 2016, revenue has been generated exclusively from our license and collaboration arrangement with Siemens. We are currently evaluating the potential impact that this guidance may have on our financial position and results of operations as it relates to this single arrangement, and we expect to elect the modified retrospective adoption method.

In January 2016, the FASB issued new guidance that amends certain aspects of the recognition, measurement, presentation and disclosure of financial instruments. The amendments include the elimination of the available-for-sale classification of equity investments and requires equity investments with readily determinable fair values to be measured at fair value with changes in fair value recognized in net income (loss). The new guidance is effective for fiscal years and interim periods within those years beginning after December 15, 2017, and requires a cumulative-effect adjustment to the balance sheet as of the beginning of the fiscal year of adoption. Early adoption is not permitted. Our marketable securities are currently accounted for as available-for-sale financial instruments with changes in fair value recognized in other comprehensive income (loss). At the time of adoption, any amounts in accumulated other comprehensive income (loss) related to such financial instruments would be reclassified to non-operating income (expense) in the statement of operations. As of December 31, 2016, net unrealized gains and losses related to these investments netted to zero.

In February 2016, the FASB issued new accounting guidance that amends the existing accounting standards for leases. Under the new guidance, lessees will be required to recognize for all leases, with the exception of short-term leases, a lease liability, which is a lessee's obligation to make lease payments arising from a lease, measured on a discounted basis and a right-of-use asset, which is an asset that represents the lessee's right to use, or control the use of, a specified asset for the lease term. The new standard is effective for fiscal years beginning after December 15, 2018, including interim periods within those fiscal years. Early adoption is permitted. We are currently evaluating the impact of adopting this guidance.

Results of Operations

Comparison of the Years Ended December 31, 2015 and 2016

The following table summarizes our results of operations for the years ended December 31, 2015 and 2016, together with the changes in those items in dollars (in thousands):

	Year Ended December 31,		Increase (Decrease)
	2015	2016	
License revenue	$ 51	$ 49	$ (2)
Research and development expenses	19,172	27,218	8,046
General and administrative expenses	3,833	4,522	689
Interest income	126	215	89
Interest expense	(339)	(2,052)	(1,713)
Change in fair value of preferred stock warrants	111	50	(61)

License revenue. License revenue was $51,000 for the year ended December 31, 2015 as compared to $49,000 for the year ended December 31, 2016, a decrease of $2,000.

Research and development expenses. Research and development expenses were $19.2 million for the year ended December 31, 2015, as compared to $27.2 million for the year ended December 31, 2016. The increase of $8.0 million, or 42%, was primarily due to continued increases in clinical and manufacturing costs incurred to support our Phase 2/3 clinical trial, as well as pre-initiation costs for our Phase 1b clinical trial in solid tumors during 2016.

General and administrative expenses. General and administrative expenses were $3.8 million for the year ended December 31, 2015, as compared to $4.5 million for the year ended December 31, 2016. The increase of $0.7 million, or 18%, was primarily due to increased costs for supporting the higher level of company operations as we conduct our Phase 2/3 clinical trial.

Interest income. Interest income was $0.1 million for the year ended December 31, 2015, as compared to $0.2 million for the year ended December 31, 2016. The increase of $89,000 was primarily due to our average cash balances earning interest at higher rates during 2016 compared to 2015.

Interest Expense. Interest expense was $0.3 million for the year ended December 31, 2015 and represents $0.2 million in stated interest and $0.1 million in amortization of related debt issuance costs incurred on the outstanding principal amount of our borrowings under our notes payable issued in October 2015. Interest expense was $2.1 million for the year ended December 31, 2016 and represents $1.5 million in stated interest and $0.6 million in amortization of related debt issuance costs incurred on the outstanding principal amount of our borrowings under our notes payable, and $24,000 in interest on our convertible promissory notes payable issued in November and December 2016.

Liquidity and Capital Resources

We have incurred significant losses and cumulative negative cash flows from operations since our inception. As of December 31, 2016, we had an accumulated deficit of $128.0 million and we anticipate that we will continue to incur losses for at least the next several years. We expect that our research and development and general and administrative expenses will continue to increase and, as a result, we will need additional capital to fund our operations, which we may raise through equity and/or debt financings. We may also consider new collaborations or selectively partnering our technology or programs.

Since inception, we have funded our operations primarily through the private placement of our convertible preferred stock. Through December 31, 2016, we received net proceeds of $131.4 million from the sale of shares of our convertible preferred stock. In addition to capital received from equity offerings, we have also received $17.7 million in net proceeds from the issuance of our notes payable, $3.4 million from the issuance of our convertible promissory notes payable, $1.6 million from private grant funding and federal grants, and a $0.5 million up-front payment under the Siemens license and collaboration agreement.

The loans under our loan and security agreement, or the Loan Agreement, with two lenders, dated October 30, 2015, are secured by substantially all of our assets other than our intellectual property (except rights to payment from the sale, licensing of disposition of such intellectual property). We borrowed $18.0 million upon execution of the Loan Agreement. Balances under the Loan Agreement accrue interest at the prime rate plus 4.5%, subject to a floor of 7.75%. The loans under the Loan Agreement mature in May 2019 and were due in 12 monthly interest only payments through November 2016, and, beginning December 2016, are due in equal monthly payments of principal and interest amortized over the remaining term of the loans. The Loan Agreement contains customary conditions of borrowing, events of default and covenants, including covenants that restrict our ability to dispose of assets, merge with or acquire other entities, incur indebtedness and make distributions to holders of our capital stock. Should an event of default occur, including the occurrence of a material adverse change, we could be liable for immediate repayment of all obligations under the Loan Agreement. In connection with the Loan Agreement, we issued to each of the lenders a warrant for the purchase of shares of our Series H convertible preferred stock equal to 2% of the amount borrowed from such lender, divided by the warrant purchase price of $5.25 per share.

As of December 31, 2015 and 2016, we had $8.2 million and $5.5 million in cash and cash equivalents, respectively, and $50.8 million and $25.7 million in marketable securities, respectively. Our available cash and marketable securities are invested in accordance with our investment policy, primarily with a view to preserve principal and maintain liquidity. Currently, our funds are held in FDIC insured cash accounts, certificates of deposits, money market funds and treasury securities that are backed by the U.S. government.

Cash Flows

The following table sets forth the primary sources and uses of cash for each of the periods set forth below (in thousands):

	Year Ended December 31,	
	2015	**2016**
Net cash provided by (used in):		
Operating activities	$(21,042)	$(29,539)
Investing activities	(24,928)	24,567
Financing activities	49,916	2,332
Net increase (decrease) in cash and cash equivalents	$ 3,946	$ (2,640)

Operating Activities. The net cash used in operating activities was $21.0 million for the year ended December 31, 2015, and consisted primarily of a net loss of $23.1 million adjusted for a net increase in cash from operating assets and liabilities of $0.7 million, noncash stock-based compensation expense of $1.1 million, depreciation expense of $0.2 million, noncash interest expense of $0.1 million and a noncash reduction in the fair value of our preferred stock warrants of $0.1 million. The $0.7 million net increase in cash from operating assets and liabilities is due primarily to a $1.9 million increase in our accounts payable and accrued liabilities resulting mainly from continued increases in clinical and manufacturing costs incurred to support our clinical trials and increased accrued payroll and related liabilities, primarily offset by a $1.1 million increase in prepaid expenses related to our clinical trial costs.

The net cash used in operating activities was $29.5 million for the year ended December 31, 2016, and consisted primarily of a net loss of $33.5 million adjusted for a net increase in cash from operating assets and liabilities of $1.8 million, noncash stock-based compensation expense of $1.3 million, depreciation expense of $0.3 million and noncash interest expense of $0.6 million. The $1.8 million net increase in cash from operating assets and liabilities is due primarily to a $2.1 million increase in our accounts payable and accrued liabilities resulting mainly from continued increases in clinical and manufacturing costs incurred to support our clinical trials and increased accrued payroll and related liabilities, primarily offset by a $0.2 million increase in prepaid expenses related to our clinical trial costs.

Investing Activities. Net cash used in investing activities for the year ended December 31, 2015 was $24.9 million and consisted primarily of purchases of marketable securities of $59.9 million and purchases of property and equipment of $0.2 million, primarily offset by proceeds from the maturity of marketable securities of $35.2 million.

Net cash provided by investing activities for the year ended December 31, 2016 was $24.6 million and consisted of proceeds from the maturity of marketable securities of $48.1 million, primarily offset by purchases of marketable securities of $23.0 million and the purchase of property and equipment of $0.5 million.

Financing activities. Net cash provided by financing activities for the year ended December 31, 2015 was $49.9 million and consisted primarily of (i) the sale of 6,376,037 shares of our Series H convertible preferred stock for net proceeds of $33.4 million, of which $0.4 million was received in late December 2014 for subscription agreements that did not close until 2015, (ii) $17.7 million in net proceeds from the issuance of our notes payable in October 2015, and (iii) $0.2 million from the issuance of common stock in connection with the exercise of stock options. These proceeds were primarily offset by $1.0 million in cash paid for deferred equity issuance costs.

Cash provided by financing activities for the year ended December 31, 2016 was $2.3 million and consisted primarily of net proceeds of $3.5 million from the issuance of convertible promissory notes payable and convertible promissory note subscriptions which was offset by $0.6 million in principal payments on our notes payable and $0.6 million in cash paid for deferred equity issuance costs.

Funding Requirements

Our primary uses of capital are, and we expect will continue to be, compensation and related expenses, third-party clinical research and development services, laboratory expenses, regulatory expenses, marketing, and general and administrative expenses. Based on our research and development plans and our timing expectations related to the progress of our programs, we expect that the net proceeds from this offering, together with our existing cash, cash equivalents and marketable securities as of December 31, 2016, will enable us to fund our operations for at least the next 12 months. We have based this estimate on assumptions that may prove to be wrong, and we could use our available capital resources sooner that we currently expect. Furthermore, our operating plan may change and we may need additional funds sooner than planned.

The successful development of any product candidate is highly uncertain. As such, at this time, we cannot reasonably estimate or know the nature, timing and costs of the efforts that will be necessary to complete the development of Toca 511 & Toca FC or our other current and future product candidates. We are also unable to predict when, if ever, material net cash inflows will commence from the sale of product candidates. This is due to the numerous risks and uncertainties associated with developing immunotherapies, including the uncertainty of:

- the progress, timing, costs and results of our ongoing Phase 2/3 clinical trial for Toca 511 & Toca FC;
- the progress, timing, costs and results of our Phase 1 dose escalation clinical trials that include our intratumoral study, resection study, and intravenous study;

- the progress, timing, costs and results of development for Toca 511 & Toca FC for the treatment of metastatic solid tumors;
- the progress, timing, costs and results of development for our other future product candidates;
- the outcome, timing and cost of regulatory approvals by the FDA and comparable foreign regulatory authorities, including the potential for the FDA or comparable foreign regulatory authorities to require that we perform more studies than those that we currently expect;
- the ability of our product candidates to progress through clinical development successfully;
- the cost of filing, prosecuting, defending and enforcing any patent claims and other intellectual property rights;
- arrangements with third-party service providers and manufacturers;
- our need and ability to hire additional personnel;
- our need to implement additional infrastructure and internal systems;
- the effect of competing technological and market developments; and
- the cost of establishing sales, marketing and distribution capabilities for any products for which we may receive regulatory approval.

A change in the outcome of any of these variables with respect to the development of any of our product candidates would significantly change the costs and timing associated with the development of that product candidate.

Until we can generate a sufficient amount of revenue from our products, if ever, we expect to finance future cash needs through equity and/or debt financings. We may also consider new collaborations or selectively partnering our technology or programs. Additional capital may not be available on reasonable terms, if at all. If we are unable to raise additional capital in sufficient amounts or on terms acceptable to us, we may have to significantly delay, scale back or discontinue the development or commercialization of one or more of our product candidates. If we raise additional funds through the issuance of additional equity or debt securities, it could result in dilution to our existing stockholders and increased fixed payment obligations, and these securities may have rights senior to those of our common stock. If we incur indebtedness, we could become subject to covenants that would restrict our operations and potentially impair our competitiveness, such as limitations on our ability to incur additional debt, limitations on our ability to acquire, sell or license intellectual property rights and other operating restrictions that could adversely impact our ability to conduct our business. Any of these events could significantly harm our business, financial condition and prospects.

Contractual Obligations and Commitments

The following table summarizes our contractual obligations and commitments as of December 31, 2016 that will affect our future liquidity (in thousands):

	Total	Less than 1 Year	1-3 Years	3-5 Years	More than 5 Years
Notes payable	$18,831	$7,200	$11,631	$—	$—
Convertible promissory notes payable[1]	3,411	—	3,411	—	—
Operating lease obligation	494	429	65	—	—
Total	$22,736	$7,629	$15,107	$—	$—

(1) Subsequent to December 31, 2016, between January 1, 2017 and February 8, 2017, we issued convertible promissory notes to investors in an aggregate principal amount of $7.5 million, due in 2018 unless we elect to extend the maturity date to a date on or before November 21, 2019.

We also have obligations under license, collaboration and various grant agreements to make future payments to third parties that become due and payable on the achievement of certain commercial milestones. We have not included these commitments on our balance sheet or in the table above because the achievement and timing of these events is not fixed and determinable. These commitments are listed as follows:

- Pursuant to the technology license agreement with USC, we are obligated to pay an annual royalty to USC starting in the second full calendar year when the net sales of products using the technology covered by the agreement reach a mid-seven-digit dollar range and until such time that the last valid claim of the patents covering our products expires. We are subject to pay interest if and when we become delinquent in our royalty payments.
- Pursuant to the collaborative agreement with Siemens, we are obligated to pay Siemens a royalty amount up to the mid-nine-digit dollar range per year on our brain cancer product sales in the first five years of such commercial sales.
- Pursuant to the agreement for a grant we received from Accelerate Brain Cancer Cure, Inc., or ABC2, we are obligated to pay an amount up to a maximum of $0.2 million to ABC2 if and when the net sales of our initial product candidate reach a total of $5.0 million within 10 years of the grant date. In addition, the ABC2 grant includes a conversion option whereby the payment amount may be converted, at our option, to common stock under certain circumstances.
- Pursuant to the agreement for a grant we received from the American Brain Tumor Association, or ABTA, we are obligated to pay an amount up to a maximum of $0.2 million to ABTA if and when the net sales of our initial product candidate reach a total of $5.0 million within 10 years of the ABTA grant date.
- Pursuant to the agreement for a grant we received from Voices Against Brain Cancer, or VABC, we are obligated to pay an amount up to a maximum of $0.3 million to VABC if and when (1) the net sales of our initial product candidate reach a total of $5.0 million within five years of the VABC grant date, or (2) we enter into a definitive agreement for a favorable transaction resulting in (a) the sale of all or substantially all of our capital stock in a transaction other than an IPO, (b) a favorable merger transaction of us with another entity, or (c) the sale of all or substantially all of our assets for cash within a certain time period. In addition, the VABC Grant includes a conversion option whereby VABC can elect to receive the payment in shares of our common stock under certain circumstances.

We enter into contracts in the ordinary course of business with clinical sites for the conduct of clinical trials, service providers for product manufacture and preclinical research studies, professional consultants for expert advice and other vendors for laboratory and research supplies and services. These contracts generally provide for termination on notice, and therefore are cancelable contracts and not included in the table of contractual obligations and commitments. In addition, these contracts have indemnification clause whereby we indemnify, defend, hold harmless and agree to reimburse the indemnified party for losses suffered or incurred by third party claims arising out of the indemnified party's performance of service. The term of these indemnification clauses is perpetual any time after execution of the agreement. The maximum potential amount of future payments we could be required to make under these indemnification clauses is unlimited. We have not incurred costs to defend lawsuits or settle claims related to these indemnification clauses.

Quantitative and Qualitative Disclosures about Market Risk

The primary objective of our investment activities is to preserve our capital to fund our operations. We also seek to maximize income from our investments without assuming significant risk. To achieve our objectives, we maintain a portfolio of cash equivalents and investments in securities of high credit quality. As of December 31, 2016, we had cash, cash equivalents and marketable securities of $31.2 million consisting of certificates of deposit and money market funds in highly rated financial institutions in the United States, and treasury securities. A significant portion of our investments may be subject to interest rate risk and could fall in value if market interest rates increase. However, because our investments are primarily short-term in duration, we believe that our exposure to interest rate risk is not significant and a 1% movement in market interest rates would not have a significant impact on the total value of our portfolio. We actively monitor changes in interest rates.

Off-Balance Sheet Arrangements

We did not have during the periods presented, and we do not currently have, any off-balance sheet arrangements, as defined in the rules and regulations of the SEC.

BUSINESS

Overview

We are a clinical-stage, cancer-selective gene therapy company focused on developing first-in-class, broadly-applicable product candidates designed to activate a patient's immune system against their own cancer from within. Our cancer-selective gene therapy platform is built on retroviral replicating vectors, or RRVs, which are designed to selectively deliver therapeutic genes into the DNA of cancer cells. Our gene therapy approach is designed to fight cancer through immunotherapeutic mechanisms of action without the autoimmune toxicities commonly experienced with other immunotherapies. Our founding vision is "No One Should Die Of Cancer" because we believe the immune system can be safely activated to fight the patient's cancer.

We are developing our lead product candidate, Toca 511 & Toca FC, initially for the treatment of recurrent high grade glioma, or HGG, a brain cancer with limited treatment options, low survival rates and, therefore, a significant unmet medical need. In November 2015, we initiated the Phase 2 portion of a randomized, controlled Phase 2/3 clinical trial of Toca 511 & Toca FC in patients with recurrent HGG, which is designed to serve as a potential registrational trial. We completed enrollment of the Phase 2 portion with 187 patients in February 2017 and plan to report top line results in the first half of 2018. In February 2017, the U.S. Food and Drug Administration, or FDA, granted Toca 511 & Toca FC Breakthrough Therapy Designation for the treatment of patients with recurrent HGG. Breakthrough Therapy Designation indicates that preliminary clinical evidence demonstrates the drug may have substantial improvement on one or more clinically significant endpoints over available therapy.

As of May 31, 2016, we have treated 126 recurrent HGG patients with Toca 511 & Toca FC in three ongoing ascending dose Phase 1 clinical trials with three modes of delivery: injection into the cavity wall after surgical resection of the recurred tumor, direct intratumoral injection without resection, and intravenous administration followed, approximately one to two weeks later, by resection with further local vector delivery at the time of resection. In these trials, we observed potential benefits, including durable objective responses, extended overall survival and a favorable safety profile. To date, we have not reached a dose-limiting toxicity. Based on these Phase 1 clinical trial results, in November 2015 we initiated the Phase 2 portion of a Phase 2/3 clinical trial, which is designed to serve as a potential registrational trial in patients with first or second recurrent HGG undergoing resection.

The median overall survival of patients in the Phase 1 resection injection study (in which an ascending range of doses of Toca 511 were injected into the wall of the resection cavity after resection of the tumor) exceeds historical controls across a variety of previously reported clinical trials. As of the data cutoff of May 31, 2016, 43 patients in the resection injection trial had a median overall survival of 12.4 months that was approximately four months longer relative to results from clinical trials of drugs used as standard of care for recurrent HGG. Data from our Phase 1 trial was reported in Science Translational Medicine (Cloughesy et al. 2016). As of the data cutoff of May 31, 2016, the subset of 24 patients in our Phase 1 resection injection trial that mirrors the entry criteria, clinical setting and dosing for patients in our Phase 2/3 clinical trial had median survival of 14.3 months, with an approximately six-month improvement in median overall survival relative to results from clinical trials of drugs used as standard of care for recurrent HGG.

Furthermore, an independent radiology review of magnetic resonance imaging, or MRI, brain scans from our Phase 1 clinical trials identified tumor shrinkage in some patients, including several complete and partial responses. All patients in the resection injection trial with objective responses remain with durable response as of October 2016, for a median of 26.7 months, which compares favorably to a range of durable responses of 2.79 to 9.62 months in a clinical trial of a drug used as standard of care for recurrent HGG. We also documented, for patients in the resection injection trial in some cohorts, changes in immunologic activity including elevations of replicating CD4 (often referred to as "helper" T cells) and CD8 (often referred to as "killer" T cells) T cells in blood, comparing pre- and post-Toca 511 & Toca FC treatment.

We obtained Fast Track Designation (which may lead to expedited regulatory review of new products that treat serious diseases or conditions and demonstrate the potential to address an unmet medical need) from the FDA for Toca 511 & Toca FC for the treatment of recurrent HGG and Orphan-Drug Designation (a designation for a product that treats a rare disease or condition and which, if the product receives the first FDA approval for that disease or condition, may result in a period of regulatory exclusivity, subject to some exceptions) for the treatment of glioblastoma, or GBM, which is a subset of HGG. We plan to seek Orphan-Drug Designation from the FDA for the treatment of HGG.

Based on preclinical data, we believe Toca 511 & Toca FC may have therapeutic benefit in multiple other solid tumor cancers, and we initiated a Phase 1b clinical trial in July 2016 for the intravenous treatment of metastatic colorectal, pancreatic, breast, lung, melanoma and renal cancers, all of which can spread to the brain and other organs. In our ongoing intravenous clinical trial of Toca 511 for the treatment of recurrent HGG, Toca 511 crossed the blood brain barrier and was detected selectively in brain tumors. In our metastatic cancer trial we plan to continue to evaluate safety, presence of Toca 511 genes in tumors of patients with widely-disseminated disease, immunologic activity in blood and tumor such as changes in CD4 and CD8 T cells and clinical activity such as objective tumor response and clinical benefit. We also plan, in this clinical trial, to evaluate Toca 511 & Toca FC in combination with one or more checkpoint inhibitors.

Based on our findings in preclinical studies and clinical trials to date, we believe Toca 511 & Toca FC is a promising candidate for use in combination with surgery, radiation and chemotherapy and we plan to initiate a clinical trial in early 2018 for newly diagnosed HGG to evaluate safety and preliminary efficacy in this setting when Toca 511 & Toca FC is delivered in conjunction with radiation and temozolomide.

Our RRV platform is versatile and we believe it has the potential to deliver a wide variety of genes selectively to cancer cells. Our first RRV-based immunotherapy product candidate, Toca 511 & Toca FC, is designed to directly kill tumor cells and activate the immune system against cancer through a combination of mechanisms. In addition, we are developing other RRVs to selectively deliver genes to cancer cells against validated immunotherapy targets, such as the checkpoint protein PD-L1. We generated preclinical data supporting the potential anti-cancer benefits of an RRV delivering a gene against PD-L1. In 2018, we plan to select an anti-PD-L1 RRV product candidate for further development.

Cancer is the second leading cause of mortality in the United States and accounts for nearly one in four deaths. Early cancer treatments relied on relatively non-specific and highly toxic small molecule chemotherapies. Over the last 20 years, a new paradigm of cancer research and treatment has emerged that is focused on more targeted therapies. Most recently this has included the emergence of immunotherapies that can stimulate a patient's immune system to slow the growth and the spread of, and ideally, eliminate, cancer cells. These therapies have shown the potential to provide dramatic efficacy and to extend survival for cancer patients even in cases in which conventional therapies, such as surgery, chemotherapy and radiotherapy, have already been used. In 2013, *Science* magazine named cancer immunotherapy as the biggest breakthrough of the year. With this breakthrough, global pharmaceutical companies as well as a large number of emerging companies are researching and developing new cancer immunotherapy treatments.

Despite these advancements, many current immunotherapies, such as checkpoint inhibitors, CAR and TCR T cells, are limited by their autoimmune and other side effects. Combination treatments are common in cancer, but combinations of immune mediated treatments with systemic cytotoxic chemotherapy may be challenging as chemotherapy is often damaging to the immune system. Thus, immunotherapies effective enough to be able to displace systemic chemotherapy are needed. Also, achieving efficacious results using oncolytic viruses alone as immunotherapies has been difficult to date because they typically may cause injury to healthy tissues, are not designed to inactivate specific brakes on the immune system, and are effectively cleared, limiting the potential to create long-term benefit. Consequently, there remains a significant need for immunotherapies that are effective as well as safe and tolerable.

In contrast to current immunotherapies, we believe our RRV platform and lead product candidate have the potential to selectively infect cancer cells to stimulate robust and durable anti-cancer immune responses with

minimal toxicity. Our RRVs are designed to selectively integrate into the DNA of cancer cells which then serve as factories to produce more of these RRVs by budding. The progeny RRV infect neighboring cancer cells, providing long-term presence of the therapeutic gene or genes. Our novel therapies are designed to break immune tolerance in the tumor microenvironment.

Toca 511 & Toca FC is designed to break immune tolerance through a combination of mechanisms triggered by the conversion of Toca FC into high levels of 5-FU (5-fluorouracil), an anti-cancer agent, by the therapeutic gene delivered by Toca 511 into the cancer cell. Toca 511 & Toca FC treatment is designed for cycles of sustained production of high levels of 5-FU directly in tumors, which we believe is important for robust and durable anti-cancer immune activation. Cancer cell death releases damage-associated molecular patterns, or DAMPs, pathogen-associated molecular patterns, or PAMPs, and cancer neo-antigens, resulting in antigen presentation and activation of T cells. 5-FU is known to kill cancer cells and immune cells when used systemically. When 5-FU is present locally, it kills immune-suppressive myeloid cells in the tumor micro-environment while leaving systemic immune activity clinically intact. The local immune-suppressive myeloid cells include myeloid-derived suppressor cells, or MDSCs, as well as tumor associated macrophages, or TAMs, which are white blood cells recruited and retained by the tumor that contribute to the suppression of normal immune activity against cancer cells. TAMs and MDSCs suppress the number and activity of CD4 and CD8 T cells and work with the lymphocyte-derived suppressor T cells called regulatory T cells, or Tregs. MDSC and TAM destruction by 5-FU is designed to contribute to immune activation against the cancer neo-antigens. We believe the persistence of the therapeutic gene in the cancer cells has allowed for multiple cycles of Toca FC treatment in our trials, which may result in additional killing of cancer cells and immunosuppressive myeloid cells, leading to enhancement of the strength and durability of the immune response with each successive cycle of Toca FC treatment. Also, in a trial with multiple Toca 511 intravenous infusions followed by resection, we observed increased Toca 511 in the tumor compared to single day infusion. We plan to assess whether additional treatment with RRVs provides further anti-cancer activity.

Our management team members possess significant experience in the field of gene therapy, especially cancer-selective gene therapy and immunotherapy, as well as clinical development and commercialization experience with oncology drugs, including those for the treatment of HGG. We were co-founded by some of the founders, key inventors and scientists of Viagene Inc., which we believe was the first U.S. gene therapy company and which was conducting human clinical trials in cancer immunotherapy as early as 1993.

We have retained worldwide rights to the development and commercialization of therapeutic product candidates derived from our RRV platform in all indications. We have licensed rights to, and collaborate with, Siemens Healthcare Diagnostics Inc., or Siemens, to develop diagnostics related to the clinical development and future commercialization of Toca 511 & Toca FC. We have intellectual property protection in major markets worldwide, including 58 issued and granted patents and 75 patent applications (foreign and domestic) on our technology platform and novel product candidates, which we believe will maintain coverage until approximately 2030. Since inception in 2007 and through December 2016, we have raised a total of $131.9 million in gross proceeds from sales of our equity securities.

Our Proprietary Technology Platform: Harnessing Cancer Immunotherapy and Gene Therapy Together to Fight Cancer

Cancer immunotherapy, also termed immuno-oncology, has recently emerged as an exciting field of cancer therapy with the approval of drugs that aim to enhance anti-cancer immune responses by, for example, overcoming the suppressive mechanisms that cancer cells have developed to evade the immune system. Despite recent advances, current cancer immunotherapies have limitations. They often lead to unwanted and unanticipated autoimmune toxicities. Also, treatment effectiveness may be limited by previous or co-treatment with systemic cytotoxic chemotherapies, which damage the immune system. In addition, knocking out a particular brake on the immune system may not be relevant to a particular clinical setting or the tumor may simply not be immunogenic enough to become a target for immune clearance.

Early promising cancer gene therapies designed to provoke antitumor immune responses predominantly focused on enhancing the activation of the immune system by delivering genes for cytokines. Most of the first generation non-replicating cancer gene therapy viral vectors, however, were limited in their ability to enter and persist in a sufficient number of cancer cells to generate robust and durable anti-cancer immune responses consistently. Second generation cancer gene therapy vectors are replicating and, in the case of immunotherapies, have primarily consisted of oncolytic viruses, which lyse infected cells and activate the immune system against the virus, leading to its rapid clearance.

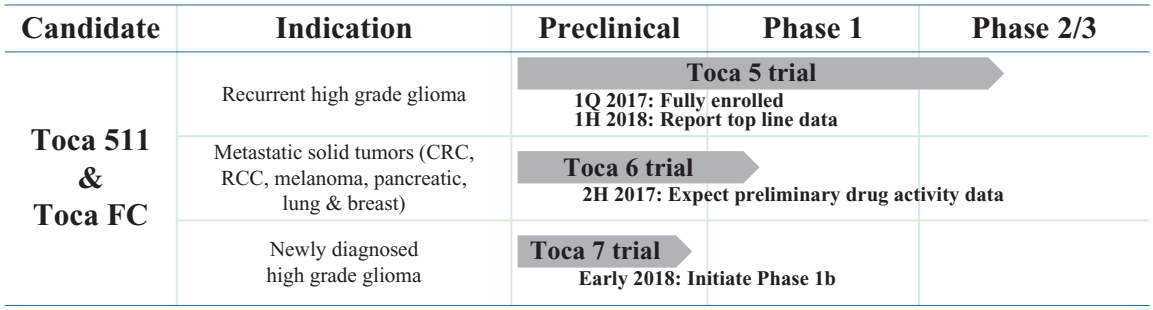
We believe our investigational gene therapy platform and therapeutic genes represent innovative approaches in cancer-selective immunotherapy which have the potential to drive a safe, powerful and durable immune response against cancer, without triggering autoimmunity. We chose to utilize RRVs as the basis of our gene therapy platform for cancer-selective immunotherapy because they exhibit several characteristics that we believe allow us to optimize the safety, delivery and persistence of our therapeutic genes in cancer cells. These characteristics include that they:

- replicate readily and persist in the immune-defective environment of cancer;
- are controlled in healthy tissue by normal immune mechanisms;
- only infect dividing cells such as cancer cells;
- bud from, rather than lyse, infected cancer cells, reducing anti-RRV immune activation;
- infect most cancer types; and
- can cross the blood brain barrier.

For our lead product candidate, Toca 511 & Toca FC, we believe cytosine deaminase, or CD, as our therapeutic gene paired with 5-FC (5-fluorocytosine) is a promising choice for the following reasons:

- CD is able to convert the anti-fungal drug, 5-FC, into the broadly applicable anti-cancer drug, 5-FU, in the cancer microenvironment;
- CD provides additional anti-cancer selectivity, as humans do not have this gene;
- the short half-life of 5-FU limits its direct killing to the localized area of the tumor micro-environment;
- local 5-FU has powerful effects on increasing survival in immune competent animals after only a few cycles of 5-FC; and
- MDSCs and TAMs are very sensitive to 5-FU-mediated killing, which may reduce immune tolerance to the cancer.

Our Pipeline



Our Strategy

Our focus is to develop and commercialize first-in-class cancer-selective immunotherapies using our proprietary gene therapy platform. Key elements of our strategy include:

- **Advancing Toca 511 & Toca FC rapidly through clinical development and regulatory approval in recurrent HGG**. In November 2015, we initiated the Phase 2 portion of a Phase 2/3 clinical trial of

Toca 511 & Toca FC in recurrent HGG. We completed enrollment of the Phase 2 portion of this clinical trial in February 2017. If we achieve our primary endpoint, overall survival, or secondary endpoints, such as objective response rate, in this portion of the trial, we plan to discuss submission of a biologics license application, or BLA, based on this data with the FDA. We believe such data could serve as the basis for regulatory approval. In February 2017, the FDA granted Toca 511 & Toca FC Breakthrough Therapy Designation for the treatment of patients with recurrent HGG.

- **Expanding the therapeutic use of Toca 511 & Toca FC into newly diagnosed HGG and other solid cancer indications**. In July 2016, we initiated a Phase 1b clinical trial in metastatic cancers including colorectal, pancreatic, breast, lung, melanoma and renal. In early 2018, we plan to initiate a Phase 1b clinical trial of Toca 511 & Toca FC in combination with surgery, radiation and chemotherapy in newly diagnosed HGG patients. We believe Toca 511 & Toca FC has potential broad applicability in the treatment of solid cancers and, because of its safety and efficacy profile in clinical trials to date, it could serve as the foundational therapy in a variety of combination treatments, if successfully developed and approved.
- **Commercializing Toca 511 & Toca FC in key markets**. If approved, we plan to build the capabilities to commercialize Toca 511 & Toca FC through medical science liaisons and a specialty sales force in key markets.
- **Pursuing strategic partnerships to expand the commercial opportunity for, and accelerate the development of, our product candidates**. We may choose to selectively partner our lead product candidate or our future product candidates in territories or therapeutic areas where a partner could bring additional resources and expertise; however, we plan to retain development and commercialization rights in key markets to maximize strategic flexibility.
- **Leveraging our RRV platform and core competencies to continue discovering and developing a broad pipeline of novel cancer-selective immunotherapies**. We believe there is a significant opportunity to develop additional immunotherapy product candidates utilizing our RRV platform. Our scientists have broad expertise in the field of gene therapy, especially cancer-selective gene therapy and immunotherapy. We intend to leverage our platform and expertise to discover and develop a broad pipeline of cancer-selective immunotherapies to help patients fight their cancers without the severe side effect profile typical of cancer treatments.

Immunotherapy and the Emergence of Cancer-Selective Immunotherapy

Background on Cancer and Immunotherapy

Cancer results from damage to the genes of the cell, sometimes exacerbated by underlying genetic defects such as those in oncogene regulation, DNA repair and immune competence. When cancerous cells acquire novel proteins, called neo-antigens, the immune system is believed to act as a surveillance system that can seek and destroy these mutated cells. However, over time, the cancer cell mutation process results in the activation of certain genes and/or the inactivation of others, leading to the ability of the cancer cells to hide from the immune system and grow, eventually becoming malignant and having the ability to invade and destroy healthy tissue. The process of cancer becoming able to hide from the immune system is referred to as developing immune tolerance to the cancer antigens.

To achieve immune tolerance, cancer tissue modifies the immune system by dampening or inactivating key immune mechanisms to thereby allow the cancer to hide from or diminish the immune system. An important example of the mechanism of local immune suppression is the attraction, retention and expansion of immune-suppressive myeloid cells such as MDSCs and TAMs, which are suppressors of immune cell killing both directly and through their support of Tregs. Also, in HGG and other tumors, the cancer cells and infiltrating immune cells often deploy proteins on their cell surface such as PD-L1 to activate the programmed death-1, or PD-1, proteins on the surface of lymphocytes creating a brake on the immune system. The tumor can also produce increased amounts of IDO-1 proteins, which both metabolize and drastically reduce tryptophan, an

amino acid important in immune activation, and produce catabolites that are immune-suppressive. The cancer cells may also release cytokines such as TGF-beta which lead to local immune suppression.

In order for a patient to conquer his or her advanced cancer, the patient typically needs treatment that can overcome most or all of these immune tolerance mechanisms. Once tolerance is broken and the patient's immune system can attack and destroy the cancer, it precipitates a prolonged process of immune activation and the development of a robust and durable immune response.

Immunotherapy is an emerging field of cancer treatment that aims to activate the immune system, as well as to overcome the immuno-suppressive mechanisms that cancer cells and their resulting tumors have developed. Approaches in immunotherapy generally have one of two desired effects on the immune system: "putting the foot on the gas," which stimulates the immune system by therapies including vaccine-, cytokine-, antibody-, cellular- and adjuvant-based approaches; and "removing the brakes," which removes the inhibition of the immune system, and currently mainly consists of monoclonal antibodies targeted against ligands and receptors that tumor cells use to suppress the immune system, such as PD-1, PD-L1 and CTLA-4. Small molecule inhibitors of IDO-1 and arginase are also being evaluated to "remove the brakes." To date, these approaches have been demonstrated to activate the immune system to varying degrees, leading to anti-cancer benefits, but have often caused moderate to severe autoimmunity against healthy tissue, in many cases leading to discontinuation of treatment, persistent toxicity or even death.

Our Approach to Immunotherapy

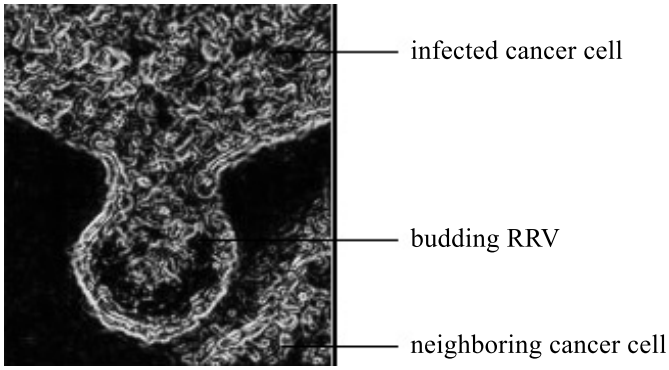
Due to the novel mechanisms of action and favorable safety profile in clinical studies to date, we believe our RRVs represent an important advancement in the field of immunotherapy. Our approach is designed to enhance immune responses against cancer cells and, in the case of our lead product candidate, Toca 511 & Toca FC, reduce immune-suppressive myeloid cell inhibition of the immune system. Also, we believe our RRV platform has the potential to be safely combined with conventional therapies and complement emerging checkpoint inhibitors and other approaches to cancer immunotherapy.

Our RRV Platform

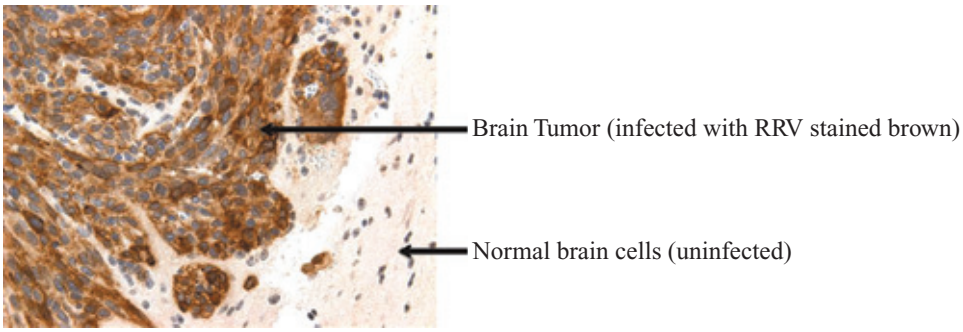
We have developed a first-in-class gene therapy platform, based on a genus of retroviruses called gamma retroviruses, designed to selectively deliver therapeutic genes to cancer cells. Native gamma retroviruses, which were originally isolated from cancer cells, possess three useful properties as a gene therapy vector for human cancers: they have been demonstrated to be reasonably benign in primates; they only infect dividing cells and selectively infect cancer cells *in vivo*; and they have a small, simple genome structure that allows straightforward manipulation.

Our RRVs are not known human pathogens as they only exhibit minimal virulence gene activity. Virulence genes ordinarily result in widespread infection of healthy cells. Gamma retroviruses have evolved in a way that makes infection, replication and spread in immune deficient cancer cells more permissive than infection of healthy cells and tissues. Specifically, RRVs and their progeny do not directly kill the cells they infect during spread. Instead they bud, which is less likely to stimulate an immune response to the virus. In contrast, oncolytic viral infection and cell lysis typically cause marked inflammation, leading to rapid viral clearance.

RRV budding from an infected cell



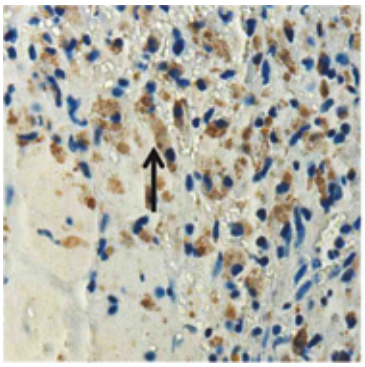
Although RRVs can spread in tumors, they usually cannot replicate and spread in healthy tissues in the body due to antiviral immune system activity. In healthy cells, gamma retroviruses are typically controlled by powerful cellular resistance factors whose production can be driven by Type 1 interferons, a large subgroup of interferon proteins that help regulate the activity of the immune system to kill cancer cells and virally-infected cells. In contrast, cancer cells usually have defective Type 1 interferon signaling pathways, possibly from selective pressure from Type 1 interferons in the cancer microenvironment, potentially leading to lower levels of antiretroviral resistance factors. RRVs can infect and replicate readily in such an environment. RRVs carry, at most, subtle offense genes to modulate the antiviral immune system. This is in contrast to pathogenic viruses and vectors derived from them, including vaccinia, lenti, adeno, polio and herpes viruses. Replication competent versions of these viruses are known to normally replicate vigorously in otherwise healthy tissues because they carry virulence genes that inactivate the host viral resistance genes. Our RRV platform predominantly relies on immune deficiencies of cancer cells and tumors, combined with its non-inflammatory nature, to replicate and spread throughout the tumor and we believe has a good balance between attenuation and replication efficiency. In another mechanism of specificity, RRVs do not encode nuclear localization signals which, in certain viruses such as lentiviruses, facilitate virus entry into the nucleus of non-dividing cells to allow productive infection. Without nuclear localization signals, RRVs only enter the nuclei of dividing cells, such as cancer cells, during the time the nuclear membrane opens to create two daughter cells. Hence, RRVs have inherent selectivity to cancer and we have demonstrated this selectivity *in vivo* as shown below in a glioma growing in a mouse brain.



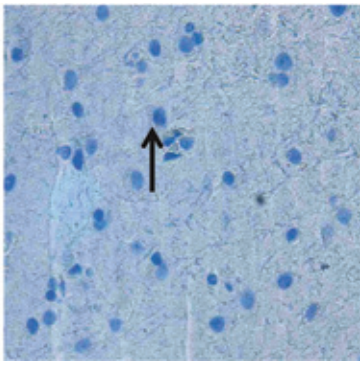
Further, in humans, as shown in the images below, in patients with HGG treated with Toca 511 and then Toca FC, in subsequently re-resected tumors, we confirmed the presence of CD protein (stained brown in left image) in tumor cells but not in nearby normal brain cells (stained blue in right image). Although the RRV may enter normal dividing cells, its DNA may not enter the nucleus and integrate into cellular DNA or, if it does, the infected cell may be killed by the immune system or subsequent treatment with Toca FC. Although Toca 511 may bud from the tumor cells and be transiently present weeks or months later in blood, infection is likely cleared due to the innate and adaptive immunity present in healthy cells as well as from Toca FC treatment. Yet,

even after Toca 511 clears from blood, its presence in re-resected brain cancer tissues has been documented in several patients.

Analysis of re-resected brain tumor tissue



CD Protein in Brain Tumor



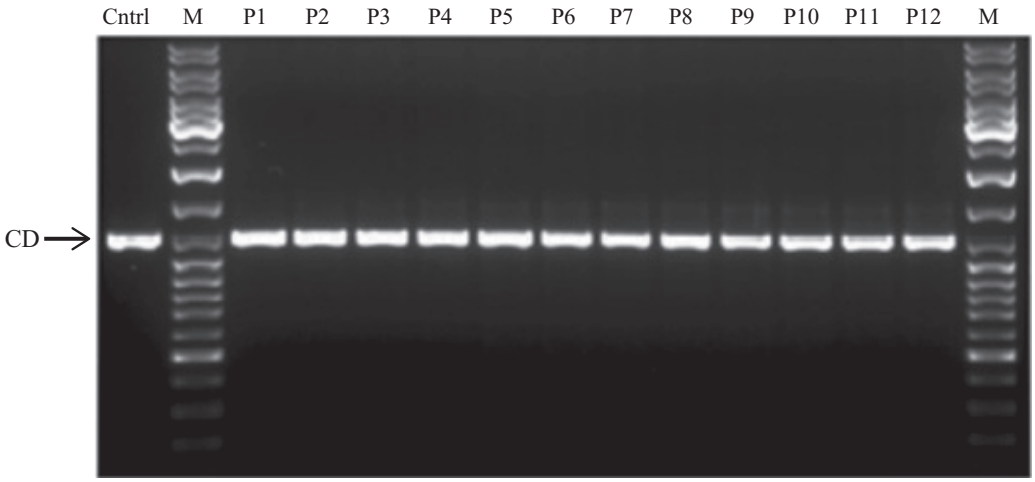
No CD Protein in Normal Brain

Our novel RRV platform is designed to be versatile. In preclinical testing, we have stably delivered several different therapeutic genes, and we can create new vectors using a well-defined process to insert one or more therapeutic genes into our RRVs. We have also engineered RRVs to enhance their suitability for therapeutic purposes. For example, we converted therapeutic genes of viral or fungal origin to use mammalian codons resulting in enhanced genomic stability as the RRV replicates and increased protein production in infected cells. We also modified the native vector by replacing the highly restrictive native envelope structural gene with a more permissive envelope gene which allows for entry of our RRV into most cancer cells through the widely available phosphate transport channel. Our most frequently used vector construction approach is shown below, including the regulatory, structural and therapeutic genes.

Our RRV Structure

When developing a new RRV, a key focus is to develop a gene therapy vector which stably carries and expresses the therapeutic gene as it is serially passaged in cell culture to mimic replication in tumors over extended time-periods. We believe our RRVs have the ability to carry a therapeutic gene stably as they replicate and spread to neighboring cells as shown below.

Toca 511 construct optimized for genomic stability



M is marker; P is passage

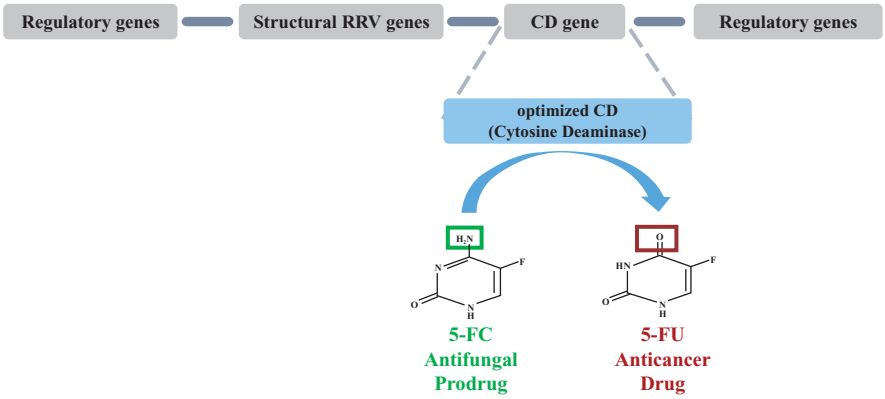
Toca 511 has a stable genome, shown in the gel above by the stable size of the segment of the genome encoding a CD containing sequence, as it is serially passaged through 12 cycles in cell culture.

In addition to developing our lead product candidate, Toca 511 & Toca FC, we are employing strategies to deliver genes which can reduce the production of specific proteins. For example, we built RRVs designed to inhibit the "brakes" on the immune system, from PD-1 and PD-L1 interaction, by inhibiting PD-L1 gene expression in the cancer cells. We have built RRVs designed to inhibit the IDO-1 gene, another immune checkpoint mechanism demonstrated in humans to likely be a good target to create an immunotherapeutic benefit. Future development candidate targets include RRVs to deliver immune-activating cytokines or single chain monoclonal antibodies against immune checkpoint proteins which are validated in humans and could potentially be less toxic and more potent when delivered locally to the tumor. Specifically, we have built RRVs with genes for anti-PD-L1 single chain antibodies and are evaluating them in our anti-PD-L1 preclinical program, currently focused on our RRV T5.13(v).

Our safety data with gamma retroviruses, preclinically and in humans, suggest that our RRV technology may be an attractive partner for combination with many conventional and newly developed cancer treatments. We have generated data in preclinical models of glioma that demonstrated an additive or synergistic effect when combining Toca 511 & Toca FC treatment with current treatments for HGG, including lomustine (marketed as CeeNU in the United States by Bristol-Myers Squibb Company), temozolomide (marketed as Temodar by Merck & Co., Inc.), radiation and bevacizumab (marketed as Avastin by Genentech, Inc.). We also have preclinical data to support additive effects with Toca 511 & Toca FC in adoptive cell transfer animal models. Finally, we plan on exploring the possibility of using combinations of our own therapies to enhance the immune response against cancer, for example, using Toca 511 & Toca FC to initiate a broad immune response against cancer cells, and adding our RRVs against immune checkpoint proteins to further stimulate the immune response in the cancer microenvironment.

Our Lead Product Candidate: Toca 511 & Toca FC

Our lead product candidate is a combination of an investigational biologic, Toca 511, and an investigational small molecule drug, Toca FC, designed to be used together. Toca 511 is a proprietary injectable RRV that encodes a prodrug activator enzyme, CD. CD is derived from yeast, and humans do not naturally have this gene. Its selective delivery to cancer cells means that the infected cancer cells selectively carry the CD gene and produce CD protein. Toca FC is an orally administered, proprietary extended-release version of 5-FC, a prodrug that is inactive as an anti-cancer drug. In humans, the orally administered Toca FC is absorbed and carried through the bloodstream, crosses the blood brain barrier and diffuses into the cancer cells. In animal models, we have shown that 5-FC is converted into the active anti-cancer drug, 5-FU, at high concentrations in Toca 511-infected cancer cells that are producing CD protein. 5-FU is a well-established anti-cancer agent used in many conventional chemotherapy settings.



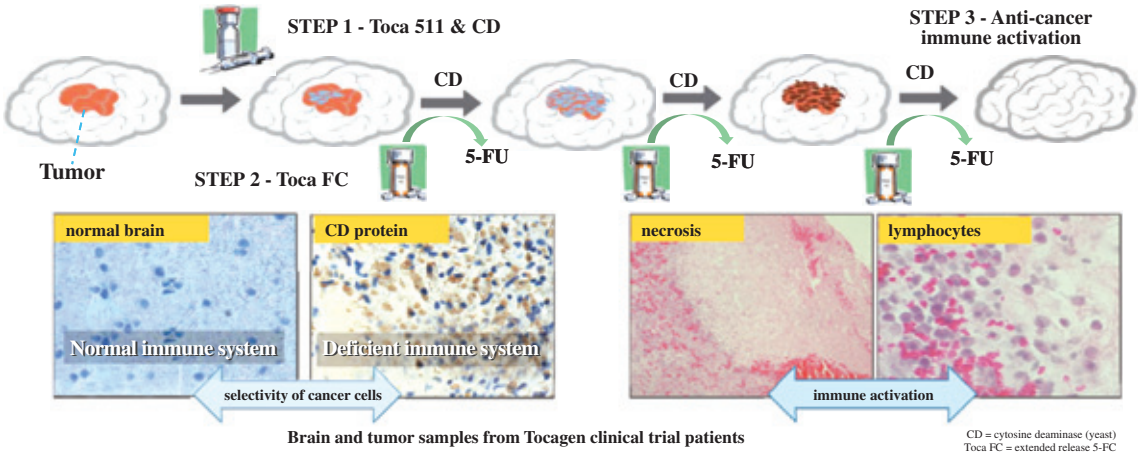
Toca 511 contains an optimized yeast-derived CD gene downstream of structural RRV genes which code viral proteins (gag, pol, env). Regulatory genes flank the coding genes on either side.

In addition to the direct killing of Toca 511-infected cancer cells, 5-FU can kill neighboring uninfected cancer cells and immune-suppressive myeloid cells in the tumor. In our preclinical studies, following direct killing of these cells, our therapy activated the immune system against tumors. Toca 511 & Toca FC treatment is designed for cycles of sustained production of high levels of 5-FU directly in tumors, which we believe is important for robust and durable anti-cancer immune activation.

Toca 511 & Toca FC has a dual mechanism of action, as depicted below. Our treatment regimen is designed to transform tumors into chemotherapy factories of 5-FU, which kills infected cancer cells and neighboring dividing tumor cells, triggering activation of the immune system against cancer neo-antigens with systemic benefits. In humans, Toca 511 is administered by one of several routes and is allowed to selectively spread through the cancer cells for up to two months. After Toca 511 spreads, Toca FC is administered cyclically, for approximately one week of every four to eight weeks. In re-resected tumors from some patients in our trials, we observed CD protein in the tumor (by immunohistochemistry) but not in contiguous normal brain tissue. We also documented Toca 511 RNA and DNA, including the CD gene, selectively in the tumors. The CD protein produced in the tumor is designed to convert the 5-FC into 5-FU and achieve high intratumoral concentrations.

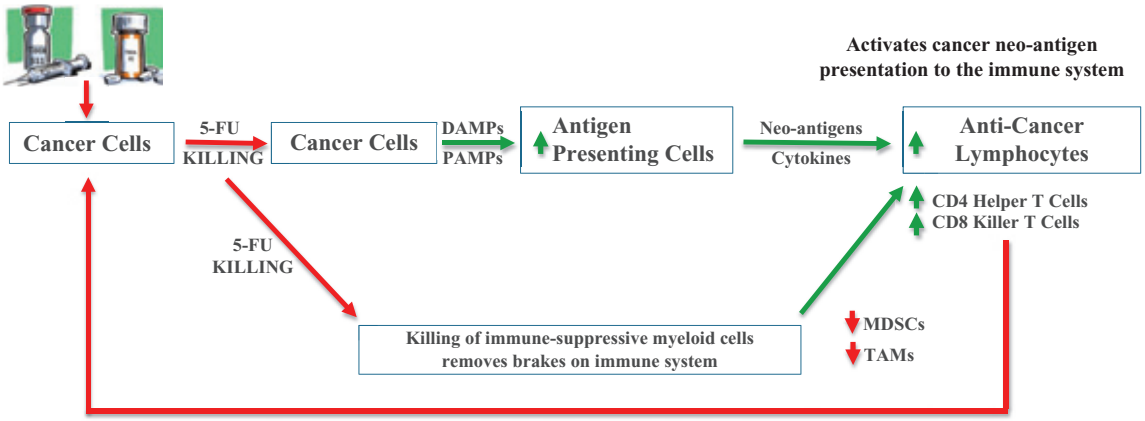
Some patients, whose tumors appeared larger during serial MRI brain scans, opted for resection. In some of these cases, the re-resected tumor had large areas of necrosis, or tumor death, and dense lymphocytic infiltrates in some remaining areas of cancer, under higher magnification, as seen below. Enlargement of tumors during an inflammatory response as part of the killing process is called pseudo-progression.

Toca 511 & Toca FC is designed to selectively transform cancer cells into chemotherapy factories of 5-FU and activate the immune system against the tumor



Cancer cell killing caused by Toca 511 & Toca FC is designed to first occur directly through the local generation of 5-FU, which is diffusible and kills both infected and neighboring dividing cancer cells and immune-suppressive myeloid cells, such as MDSCs and TAMs. Such cancer cell killing leads to the release of neo-antigens and local inflammatory DAMPs and PAMPs, which stimulate the antigen-presenting cells in the tumor micro-environment to present the neo-antigens to the CD4 (helper) and CD8 (killer) T cells of the immune system. This results in further induction and harnessing of these cells against the neo-antigens to kill more cancer cells and provide durable control of the cancer, a process called acquired immunity. Through a combination of mechanisms and multiple cycles of tumor antigen presentation during Toca FC treatment cycles, tolerance to current and evolving cancer neo-antigens is designed to be broken, leading to lymphocyte infiltration, immune activation, gradual killing and gradual shrinkage of the tumor, sometimes completely, over many months.

Continued immune activation against cancer is designed to be triggered by cycles of 5-FU-mediated tumor cell killing as depicted below. Serial cancer cell killing vaccinates against many of the patient's cancer neo-antigens by releasing these proteins as well as immune stimulatory molecules from the dying cancer cells. Following cancer cell killing, denatured RRV protein may serve as an adjuvant to enhance immune activation. Also, local reduction of immune checkpoint proteins, such as PD-L1 and IDO-1, may contribute to immune activation. In addition, MDSCs and TAMs are known to be particularly sensitive to 5-FU. MDSCs and TAMs made in the tumor are killed, while helper T lymphocytes and cytotoxic T lymphocytes, or killer T cells, which fight the cancer, can continuously enter the tumor from the blood as they are systemically present in blood and lymphatic tissues where there is very limited 5-FU-mediated killing. We have shown in preclinical cancer models that robust immune responses provide durable control of the tumor using killer T cells and helper T cells to kill cancer cells. Supporting data was obtained in a Phase 1 clinical trial as described below.



In our preclinical studies, Toca 511 and 5-FC led to high levels of 5-FU in and around cancer cells. 5-FU is known to have a very short half-life, mainly due to an enzyme present throughout the body which quickly detoxifies 5-FU, allowing for its local production with no clinically significant 5-FU exposure to remote healthy dividing cells. 5-FU administered intravenously has a narrow therapeutic index resulting in marked toxicity to many patients. When administered systemically, 5-FU, like most anti-cancer drugs, preferentially kills dividing cells, causing collateral damage to rapidly dividing cells such as those of the bone marrow and gastrointestinal tract which may limit the dose or duration of treatment. Systemic 5-FU is known to kill immune cells, so it may also limit anti-cancer immune activity.

In summary, the CD gene we are delivering in our lead product candidate is designed to produce a unique protein which, in combination with oral Toca FC, generates high concentrations of an anti-cancer drug in the tumor, leading to killing of cancer and immune suppressor cells and thereby activating the immune system against the cancer cells.

Clinical Development of Toca 511 & Toca FC

Toca 511 & Toca FC in Recurrent High Grade Glioma

Our initial proposed indication, recurrent HGG, also referred to as malignant glioma, is the most common and aggressive primary brain cancer and often strikes in the prime of life. The two most common forms of HGG are GBM and anaplastic astrocytoma or AA, which are grade 4 and grade 3, respectively. The total number of new diagnoses of HGG expected in 2017 is about 160,000 worldwide and about 14,000 in the United States, with new diagnoses of GBM estimated to be approximately 12,000 in 2017 in the United States. Recurrent HGG represents a major unmet medical need. HGG recurs in most patients, even after maximal treatment.

Historical survival data for HGG trials is limited, though there are many published studies for GBM. Patients with newly diagnosed GBM who receive maximal therapy had a median survival of 14.6, 16.1 or

16.8 months according to three Phase 3 clinical trials published in the *New England Journal of Medicine*. Current standard of care therapy for patients with newly diagnosed GBM includes surgery, radiation therapy and chemotherapy, and is similar in all major markets. The Central Brain Tumor Registry of the United States reports the one-, five-, and 10-year survival rates for patients with GBM as 37.2%, 5.1%, and 2.6% from diagnosis respectively, making it one of the most lethal among all cancers.

Recurrent HGG is typically treated with oral chemotherapy drugs, such as lomustine or temozolomide, bevacizumab, radiation or further surgery with or without carmustine wafer (marketed as Gliadel wafer by Arbor Pharmaceuticals, LLC). Survival in our initial proposed indication, recurrent HGG, is shorter than newly diagnosed GBM with reported median overall survival approximately half of that in newly diagnosed patients. There are relatively few trials which report on recurrent HGG (inclusive of both grade 4 and 3). One trial published by Brem in *The Lancet* reported median overall survival of a carmustine wafer cohort to be 7.2 months. Reported median survival for patients in multicenter clinical trials with recurrent GBM ranges from 7.6 months, from a summary analysis of Phase 2 clinical trials conducted by the North American Brain Tumor Consortium, to 8.4 months, based on a weighted-average from recent lomustine trials. Clinical trials evaluating the anti-angiogenesis agent bevacizumab have shown median overall survival of 8.0 to 9.2 months in what we believe are particularly favorable patient groups because of the number of first recurrent patients and restrictions on tumor size. Surgery has not been reported to prolong survival of patients with recurrent GBM. Partial response, or PR, (tumor shrinkage by 50%) rates for chemotherapy for recurrent HGG are low, typically ranging from 0% to 8.9%. Complete responses, or CR, (disappearance of the tumor) to chemotherapy are extremely rare, typically occurring in less than 1% of patients treated. We chose recurrent HGG as our initial proposed indication because of the significant unmet medical need, together with our goal to minimize time to regulatory approval.

Our ongoing Phase 1 clinical trials and Phase 2/3 clinical trial are being conducted pursuant to an IND we submitted to the FDA in September 2009. This IND currently covers the indications of recurrent HGG, newly-diagnosed HGG and metastatic solid tumors. In the future, we may also focus on hematological malignancies.

Ongoing Phase 1 Clinical Trials

Three ascending dose Phase 1 clinical trials in recurrent HGG are ongoing with varying modes of delivery of the Toca 511 vector: injection into the cavity wall after surgical resection of the recurred tumor, direct intratumoral injection without resection, and intravenous administration followed, approximately one to two weeks later, by resection with further local vector delivery at the time of resection. These clinical trials of Toca 511 & Toca FC are in patients whose tumors have recurred following surgery, radiation therapy and chemotherapy. As of May 31, 2016, we had treated 126 recurrent HGG patients with Toca 511 & Toca FC in these clinical trials in which we observed potential benefits, including extended overall survival and a favorable safety profile. The median overall survival of patients in the resection injection study exceeds historical controls across a variety of previously reported clinical trials and shows a trend towards a dose response. Furthermore, an independent radiology review, or IRR, identified tumor shrinkage in some patients, including several complete and partial responses. Based on these Phase 1 clinical trial results, in November 2015 we initiated the Phase 2 portion of a Phase 2/3 clinical trial, which is designed to serve as a potential registrational trial in patients with first or second recurrent HGG undergoing resection. We chose the resection setting for our Phase 2/3 clinical trial because we believe that resection of the bulk of the tumor and then injection into the residual tumor left behind in the cavity wall provides a longer opportunity for the treatment to activate the immune system against the growing tumor.

The primary goal of these three Phase 1 clinical trials was to evaluate the safety and tolerability of Toca 511 & Toca FC. Although all trials were designed to identify the highest safe and well-tolerated dose of Toca 511 & Toca FC, called the maximum tolerated dose, criteria for dose-limiting toxicities were never reached. The maximum feasible dose of Toca 511 & Toca FC was determined, allowing us to move forward to our Phase 2/3 clinical trial. The maximum feasible dose of Toca 511 was chosen to be 4 mL delivered by forty 0.1 mL injections with a blunt tip, narrow bore needle and a side port for infusion, which is the highest practical number of injections which can be

administered at the time of resection. The secondary goal of each of these three Phase 1 clinical trials is to evaluate the efficacy of Toca 511 & Toca FC, including tumor response observed by MRI and patient survival. These clinical trials also allow us to evaluate the presence of Toca 511 in tumors and tumor pathology at subsequent resection and to measure CD4 and CD8 T cell levels before and following treatment. In addition, we are conducting a continuation trial to follow long term safety and survival in patients from all three of these clinical trials.

Ongoing Resection Injection Trial

In February 2012, we initiated a Phase 1 multicenter ascending dose clinical trial of Toca 511 & Toca FC in patients with recurrent HGG who are suitable for resection. The 43 patients in the resection injection trial treated with Toca 511 & Toca FC (excluding the combination cohorts with lomustine or bevacizumab) predominantly had GBM (81%) with other histologies including AA (12%) and other gliomas (7.0%). The trial included patients with multiple prior recurrences, with 23% at second recurrence and 26% at third or greater recurrence, and 51% at first recurrence. Patients were treated in seven ascending dose cohorts of Toca 511 and three ascending dose cohorts of Toca FC.

In this trial, following tumor resection, Toca 511 was administered by multiple small injections directly into the mixture of brain and cancer tissue surrounding the resection cavity. These injections target the tumor which has been left behind after surgery since the infiltrative nature of the disease into functional brain regions precludes complete resection. Pursuant to the protocol, the patient begins a seven- to 14-day course of oral Toca FC five to eight weeks following the administration of Toca 511 and repeats this Toca FC cycle every four to eight weeks thereafter. When the recommended Phase 2 dose was determined, cohorts with lomustine or bevacizumab combined with Toca 511 & Toca FC were enrolled to provide safety data for the combination with standard HGG treatment to allow the option of combination therapy to patients who appeared to be progressing in the ongoing trials. To date, no safety issues have been observed in these expansion cohorts. This clinical trial has completed enrollment, with 56 patients. Efficacy evaluable patients are those who received both Toca 511 and Toca FC. We excluded the combination cohorts with lomustine or bevacizumab from our composite efficacy analyses. Based upon a data cutoff of September 18, 2015, a manuscript was published in Science Translational Medicine (Cloughesy et al. 2016). Median survival of patients with GBM, the worst grade of HGG, with first and second recurrence, was 13.6 months, similar to the reported survival for newly diagnosed GBM (14.6 to 16.8 months). A summary of the data is shown in the table below, suggesting strong evidence of efficacy:

Endpoint	Result
Overall survival efficacy evaluable recurrent HGG (N=43)	Median 12.4 months (95% CI 10.8, 15.7)
Overall survival in all cohorts at 6 months (OS6)	88.4%
Overall survival in all cohorts at 9 months (OS9)	72.1%
Overall survival in all cohorts at 12 months (OS12)	50.5%
Overall survival in all cohorts at 24 months (OS24)	26.2%
Overall survival efficacy evaluable recurrent GBM or AA subgroup for higher doses (cohorts 4-7a) and 1st and 2nd recurrence, no prior bevacizumab in rHGG, tumor not > 5 cm (N=24)	Median 14.3 months (95% CI 11.1, 28.1)
Overall survival (N=24)	
(OS6)	100.0%
(OS12)	62.5%

Endpoint	Result
(OS24)	33.3%
(OS30)	27.8%
(OS36)	27.8%
Overall response in all cohorts, IRR + clinical data (N=43)	Complete response 7.0% Partial response 4.7% Stable disease 16.3% Progressive disease 72.0% Clinical benefit rate 28.0%
Overall response in recurrent GBM or AA subgroup for higher doses (cohorts 4-7a) and 1st and 2nd recurrence, no prior bevacizumab in rHGG, tumor not > 5 cm (N=24)	Complete response 12.5% Partial response 8.3% Stable disease 20.8% Progressive disease 58.3% Clinical benefit rate 41.7%

95% CI stands for a 95% confidence interval, which is a range of values in which we can be 95% certain the true population mean lies.

Stable disease means that the patient is clinically stable and the cancer is not decreasing or increasing in extent or severity. Patients reported as progressive disease may include patients with pseudoprogression or the appearance of a tumor getting worse at the time of imaging but where the tumor eventually stabilizes or shrinks without additional new treatment.

Total clinical benefit includes CRs, PRs and stable disease.

Overall survival results are based upon a data cutoff of May 31, 2016; overall response results are based upon a data cutoff of November 18, 2016.

As shown in the table below, in the 24 patients with HGG first or second recurrence treated in the Higher Dose Cohort (as defined below), when compared with baseline MRIs taken just prior to the start of Toca FC dosing (four to eight weeks after surgery), three CRs and two PRs were identified by an IRR, providing further support for Toca 511 & Toca FC efficacy. All of these patients were continuing to respond as of their last MRI review as of a data cutoff in October 2016. The CR and PRs were determined based on the Macdonald criteria, including, for CR, complete disappearance of all enhancing measurable and non-measurable tumor, and for PR, at least 50% tumor shrinkage. Total clinical benefit includes CRs, PRs and stable disease, or SD. As shown in the table below, five of five responses occurred in patients treated in the Higher Dose Cohort, suggesting a potential dose-response effect. Specifically, in this Phase 1 dose escalation resection trial, across all cohorts, including combination cohorts, no responses were seen in the lowest three Toca 511 doses (1.4×10^7, 3.8×10^8 and 1.5×10^8 Therapeutic Units, or TU). The next four dose increments, referred to as the Higher Dose Cohort, all had durable objective responses (4.8×10^8 TU with one CR and one PR; 1.2 or 1.5×10^9 TU with three CRs; and 4.8×10^9 TU with one PR). We selected to use the Toca 511 dose of ~1×10^9 TU for the Toca 5 Phase 2/3 clinical trial.

Resection Study: All Responses are in the Higher Dose Cohort

Response Category[1]	Higher Doses & Phase2/3 Entry Criteria Subset [2] N=24 n (%)	All Patients N=43 n (%)
Overall response	**5 (20.8) 3CR + 2PR**	**5 (11.6)**
Stable disease (SD)	5 (20.8)	7 (16.3)
Progressive disease	14 (58.3)	31 (72.1)
Clinical Benefit Rate (CR, PR, and SD at 8 wks)	10 (41.7)	12 (27.9)

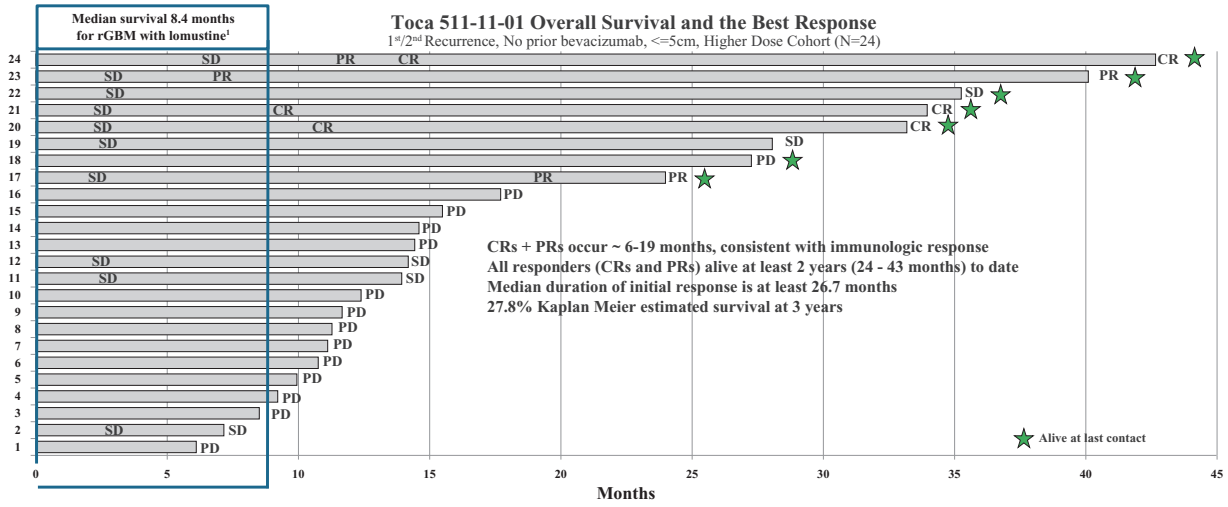
1 Includes MRI by independent radiology review and clinical data; patients categorized by best response achieved during MRI screenings.

2 Higher doses (cohorts 4-7a) and meet Phase 2/3 entry criteria of 1st and 2nd recurrence, no prior Avastin in rHGG, tumor not > 5cm Data cutoff date November 18, 2016; adapted from Cloughesy et al. June 2016.

Seven medical centers participated in the resection study, five of which had a patient with an objective response identified by an IRR. Sites included large regional hospitals and academic centers.

The responses, which occur approximately six to 19 months after Toca 511 administration, are consistent with immunologic response, all responses are ongoing, and all responders are alive at least two years (24 to 43 months) to date as shown in the chart below.

Resection Study: Long-Term Survival in Higher Dose Cohort



1 Lomustine. Weighted average from Batchelor 2013, Taal 2014, Wick 2010, EORTC 26101.

The median overall survival of patients in this resection injection study (in which an ascending range of doses of Toca 511 were injected into the wall of the resection cavity after resection of the tumor) exceeds historical controls across a variety of previously reported clinical trials. Forty-three patients had a median overall survival of 12.4 months that was approximately four months longer relative to a weighted-average of results from clinical trials of drugs used as standard of care for recurrent HGG, including 7.2 months in the active arm of a randomized surgical recurrent HGG trial for the carmustine wafer. In a subset of 30 patients in our resection injection trial who received higher doses of Toca 511, median overall survival was higher, 14.4 months. Furthermore, in the subset of 24 patients in this trial that mirror the entry criteria, clinical setting and dosing for patients in our Phase 2/3 clinical trial, median overall survival was 14.3 months, an approximate six-month improvement in median overall survival relative to a weighted average of clinical trials of drugs used as standard of care (lomustine or bevacizumab) for recurrent HGG. Finally, in our patients with recurrent GBM at first or second recurrence in our resection injection trial (27 patients), median overall survival was 13.6 months, comparing favorably to the median survival of 7.1 months in the external control study of recurrent GBM patients treated with lomustine. We saw a plateau of survival in the Higher Dose Cohort, with a 40% survival probability at two years (data cutoff of September 18, 2015). Data from our resection injection study was reported in Science Translational Medicine (Cloughesy et al. 2016).

Population	Toca 511 and Toca FC Resection Study Median Overall Survival Months[1]	Other Trials in Recurrent Disease
Recurrent High Grade Glioma	12.4 (n=43)	7.2 (n=110)[2]
Recurrent High Grade Glioma and higher doses	14.4 (n=30)	7.2 (n=110)[2]
Higher doses and Phase 2/3 entry criteria[3]	14.3 (n=24)	8.5 (n=437)[4]
Glioblastoma at 1st or 2nd recurrence	13.6 (n=27)	7.1 (n=84)[5]

1 Data cutoff date September 1, 2016.

2 Carmustine wafer. Brem et. al., Lancet 345: 1008-1012, 1995.

3 Higher doses (cohorts 4-7a) and 1st and 2nd recurrence, no prior bevacizumab in rHGG, tumor not > 5cm.

[4] Estimate based on weighted average of lomustine (Batchelor 2013, Taal 2014, Wick 2010, EORTC 26101: n=352) and bevacizumab historical controls (n=85) and assumed percentage of enrollment.

[5] Wick 2010.

Adapted from Cloughesy TF et al. with data cutoff September 1, 2016.

Furthermore, an independent radiology review of MRI brain scans from our Phase 1 clinical trials identified tumor shrinkage in some patients, including several CRs and PRs. All patients in the resection injection trial with objective responses remain with durable response as of October 2016, for a median of 26.7 months, which represents approximately four times longer duration of response relative to responses from a clinical trial of lomustine which showed an estimated median duration of response of approximately six months (range of response duration was 2.79 to 9.62 months).

	Lomustine[1]	**Toca 511 & Toca FC[2]**
Overall response rate CRs & PRs	4.3%	20.8%
Duration of response (months)	~6.2	>26.7l (median not reached)
Median Survival (months)	7.1	14.3

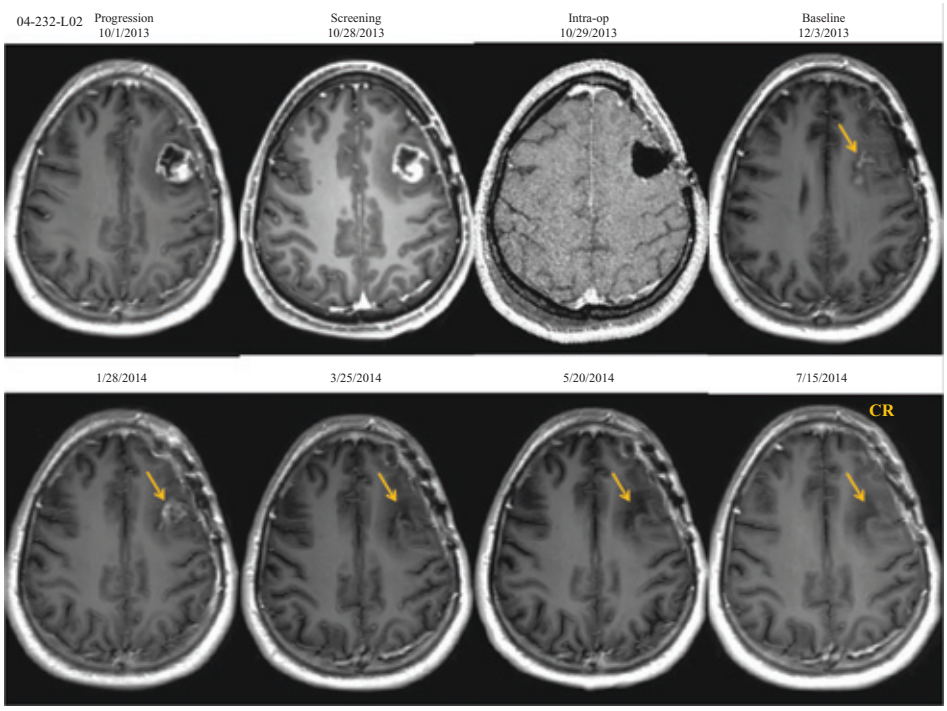
[1] Adapted from Wick, JCO 2010.

[2] Higher doses (cohorts 4-7a) and 1st and 2nd recurrence, no prior Avastin in rHGG, tumor not > 5cm.

This survival data, evidence of tumor response, as well as a reported safety profile of mild and moderate toxicity, encouraged us to plan our Phase 2/3 clinical trial of Toca 511 & Toca FC in this same setting, enrolling patients with recurrent HGG who were planning for further resection of their tumor. Also, we chose the resection setting for our Phase 2/3 clinical trial because we believe that resection of the bulk of the tumor and then injection into the residual tumor left behind in the cavity wall provides a longer opportunity for the treatment to activate the immune system against the growing tumor.

We also tested for changes in CD4 and CD8 T cells during the study, allowing us to evaluate both the safety and activity of our treatment on the immune system. Average increases of 34.0% in total CD4 (p=0.019) and 12.4% in total CD8 (p=0.277) were observed between the visit prior to Toca FC administration and the end of study, suggesting immune activation after Toca 511 & Toca FC treatment (n=43). The p value is the probability that the difference between two data sets was due to chance. The smaller the p value, the more likely the differences are not due to chance alone. In general, if the p value is less than or equal to 0.05, the outcome is statistically significant. The FDA's evidentiary standard of efficacy generally relies on a p value of less than or equal to 0.05. Supporting data was obtained from a subsequent cohort in this trial, and in this case, there were significant increases in activated CD8+ T cells (p=0.015) within the CD8 population from patients (n=6 patients, 39 samples) showing clinical benefit (SD, CR) between pre- and post-treatment measurements, but not from patients with progressive disease (n=7 patients, 48 samples). A sustained increase in activated CD4+ T cells (p=0.16) was also observed within the CD4 population from patients showing clinical benefit. In these examples, immune cell testing occurred at baseline and at time points after one or more cycles of Toca FC.

To provide further details, a case of CR at eight months in a patient with progressive AA who is alive more than 34 months is shown below.



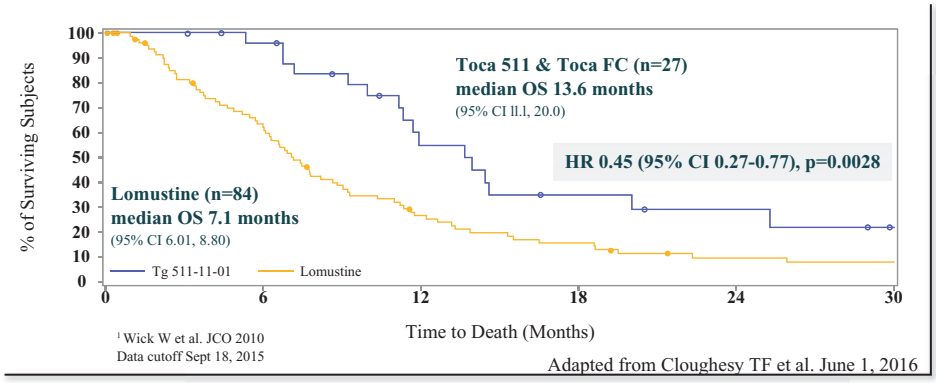
Resection injection trial, Independent Radiology Review, Macdonald criteria

Shown above are MRI scans from a 24 year old patient with AA who received standard of care in the newly diagnosed setting. At the time of first recurrence, the patient underwent resection of tumor and injection of Toca 511 into the wall of the resection cavity on October 29, 2013 followed by Toca FC. The patient's MRI scan prior to entry into the trial on October 1, 2013 shows tumor progression that increased on the screening MRI (October 28, 2013). Based on IRR, the patient had two evaluable lesions in the left frontal lobe on the patient's baseline MRI on December 3, 2013 (prior to initiation of Toca FC) that decreased and resolved completely by July 15, 2014. The patient was considered to have achieved a CR on July 15, 2014 (approximately 8 months after the baseline MRI), with a persistent response as of the last available MRI on October 4, 2016. The patient was continuing on Toca FC and was alive as of October 4, 2016, more than 34 months after initiation of treatment with Toca 511, without evidence of disease progression on last neurological examination. The lesion shown above (yellow arrow) and another lesion, which was similar in size but at a different level in the brain, had Complete Responses at the same time.

Ongoing Resection Injection Trial Compared to Lomustine External Control

Patients with GBM at first and second recurrence in our resection injection trial were compared to an external control of lomustine-treated patients from a previously-conducted non-surgical Phase 3 clinical trial (database for control arm obtained from the trial sponsor). Surgery is not known to prolong survival in recurrent GBM. Both our resection injection trial and the external control lomustine trial were reasonably contemporaneous (our trial: 2012-2015; lomustine trial: 2006-2010). The characteristics of the patients in these trials were comparable: the external control had a slightly younger population, more patients in first recurrence and a lower percentage of patients requiring corticosteroids at baseline; and our resection injection trial had a higher percentage of patients with a Karnofsky performance status score of 90-100. The Karnofsky score is a 0-100 scale generally used by physicians to quantify a cancer patient's general well-being and activities of daily life; 100 is "perfect" health and 0 is death. The median overall survival for patients with first or second recurrent GBM in our resection injection trial was 13.6 months (95% CI 11.1, 20) compared to 7.1 months (95% CI 6.01,

8.80) for patients in the external control lomustine trial. The hazard ratio for overall survival was 0.45 (95% CI 0.27, 0.77; p=0.0028), meaning that with Toca 511 & Toca FC the risk of death was reduced by 55% compared to lomustine. Although the data is not generated from a single randomized trial, use of statistical analysis of the external comparison is only for the purpose of providing context to some of the data collected in our Phase 1 resection injection trial. In the overall survival setting, the hazard ratio is the ratio of the hazard rate (probability of dying during a certain unit time) between two groups. The separation of the survival curves occurred initially and continued through 30 months with overall survival at six months of 96.0% vs. 61.8% (p<0.001). Lomustine is one of the active control treatments for our ongoing Phase 2/3 clinical trial.

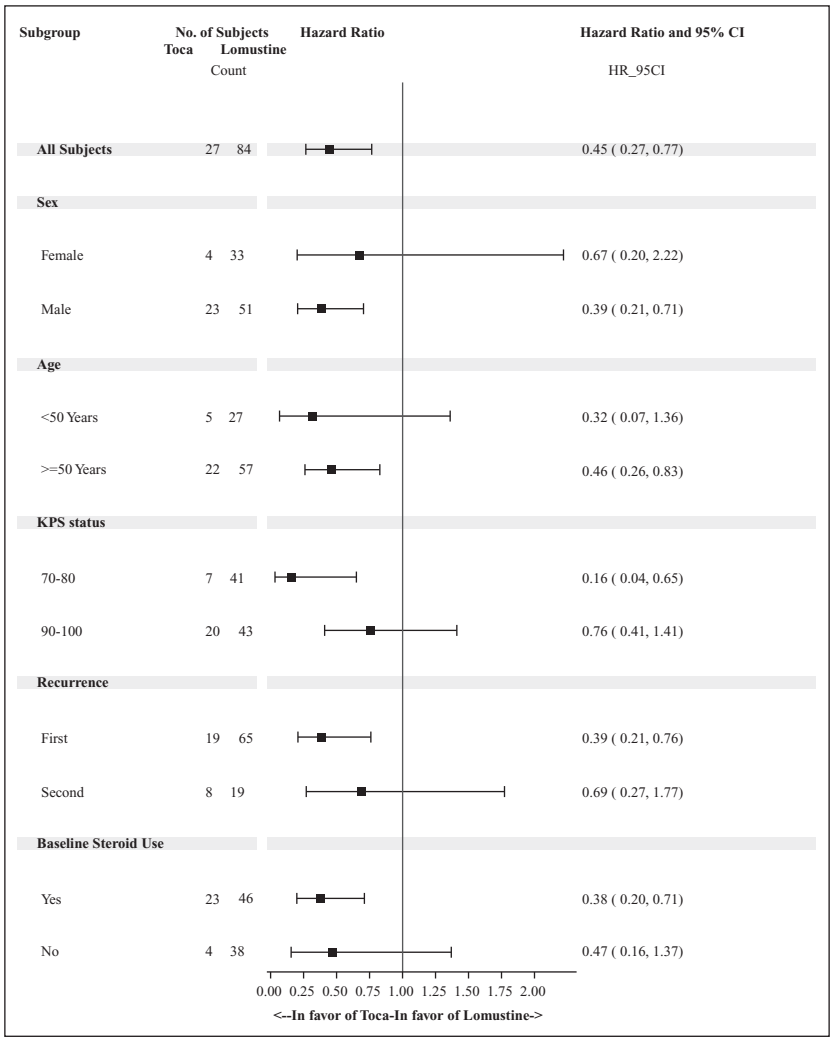


A circle denotes a censored survival event, meaning that the survival is counted up to this timepoint.

Patients treated with Toca 511 & Toca FC had far fewer grade ≥3 adverse events and a virtual absence of hematologic toxicity for study subjects relative to the lomustine external control, where grade ≥3 thrombocytopenia occurred in 23.8% and neutropenia occurred in 13.1% of lomustine patients.

	Toca 511 & Toca FC N = 27 n(%)		Lomustine N = 84 n(%)	
Nonhematologic toxicity	**Grade 2**	**Grade 3 to 4**	**Grade 2**	**Grade 3 to 4**
Fatigue	2 (7.4%)	0	4 (4.8%)	0
Nausea	1 (3.7%)	0	2 (2.4%)	0
Edema peripheral	0	0	2 (2.4%)	0
Alanine aminotransferase increased	0	0	1 (1.2%)	1 (1.2%)
Hematologic toxicity				
Thrombocytopenia	0	0	9 (10.7%)	20 (23.8%)
Platelet count decreased	0	0	0	1 (1.2%)
Neutropenia	0	0	4 (4.8%)	11 (13.1%)
Neutrophil count decreased	0	0	0	6 (7.1%)
Leukopenia	0	0	3 (3.6%)	4 (4.8%)
White blood cell count decreased	0	0	1 (1.2%)	2 (2.4%)
Anemia	0	0	1 (1.2%)	2 (2.4%)
Hemoglobin decreased	0	0	2 (2.4%)	0
Lymphopenia	0	0	2 (2.4%)	0

A subgroup analysis showed a trend to improved survival for our resection injection study of glioblastoma at first or second recurrence patients in all subgroups versus the lomustine control, as depicted below.



Ongoing Intratumoral Injection Trial

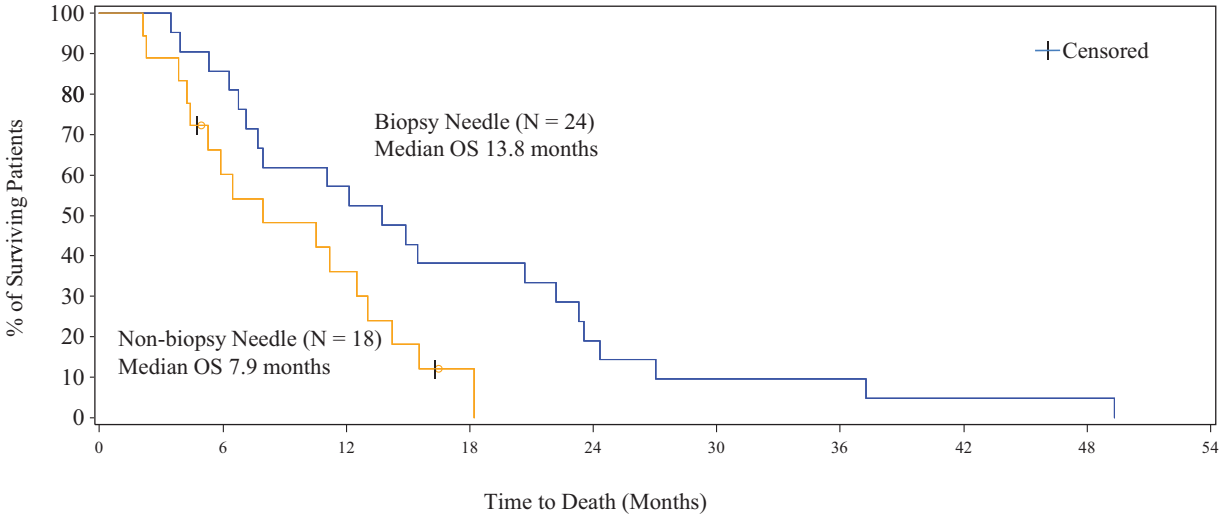
In August 2010, we initiated a Phase 1 multicenter ascending dose clinical trial of Toca 511 & Toca FC to be administered via intratumoral injection in patients with recurrent HGG. As of September 25, 2015, 47 patients had been enrolled and treated.

Patients were treated in ascending dose cohorts using two different intratumoral delivery methods. The first method utilized a biopsy needle under stereotactic guidance to concentrate Toca 511 delivery to one location at the advancing edge of the tumor. The second method utilized intraoperative MRI, delivering Toca 511 spread mostly throughout the center of the tumor using convection enhanced delivery over several hours, referred to as non-biopsy needle. Pursuant to the protocol, the patient begins a seven-day course of oral Toca FC four weeks following Toca 511 injection and repeats the cycle of Toca FC every five to seven weeks thereafter.

Delivery of Toca 511 with a biopsy needle in this trial showed a median overall survival of 13.8 months, while delivery via non-biopsy needle showed 7.9 months. Delivery with biopsy needle exceeded the range of

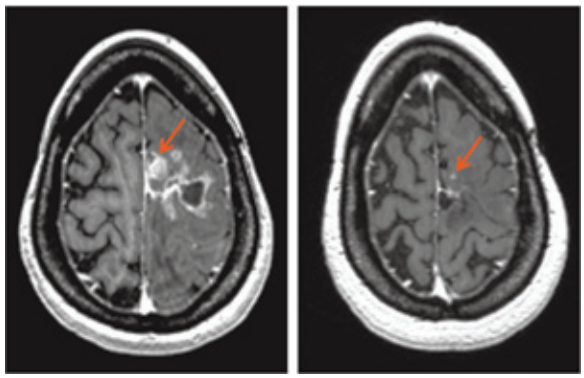
7.1 to 8.5 months, the survival data for currently-approved therapies discussed above. The benefit of biopsy needle delivery compared to non-biopsy needle delivery is statistically significant (p value = 0.0249; indicating that there is a 97.5% probability that the observations are not due to chance alone) as shown below. In a multivariate analysis controlling for other prognostic factors such as number of recurrences and tumor grade, the delivery method remains statistically significant.

Survival By Delivery—Univariate Analysis



The IRR results as of our data transfer on September 2016 revealed a clinical benefit rate of 38.3%, with 17 of 47 patients (36.2%) showing stable disease. Two patients with stable disease were shown to have an unconfirmed PR (50% tumor shrinkage without subsequent confirmation by MRI). As shown in the MRI below, one patient had a confirmed PR, with duration of 7.8 months.

Independent Radiology Review Confirms Tumor Shrinkage



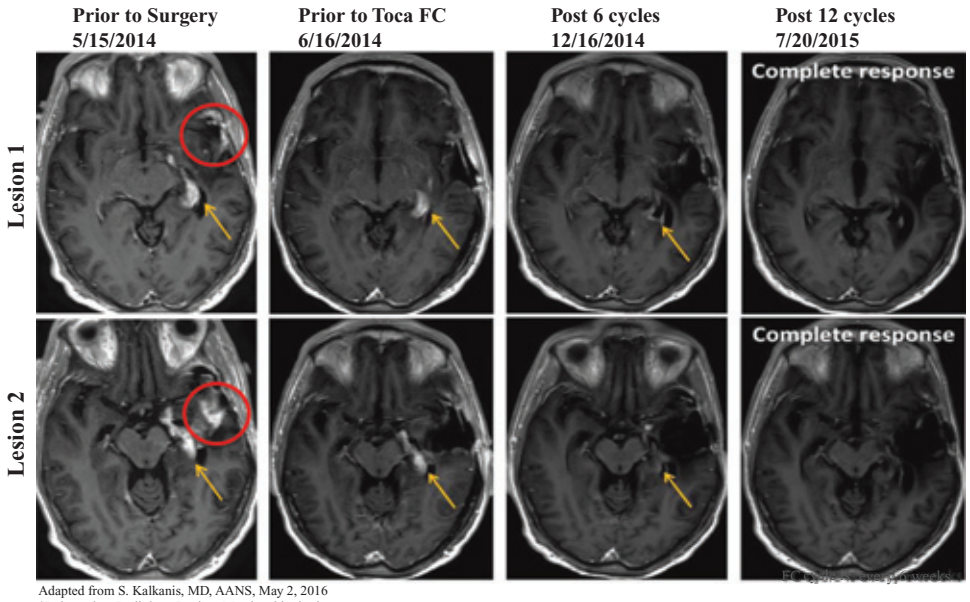
Baseline **4.7 Months; 87% Shrinkage**

Ongoing Intravenous Administration Followed by Resection Injection Trial in 17 Patients

In February 2014, we initiated a Phase 1 multicenter ascending dose clinical trial in patients with recurrent HGG who are scheduled for resection. Toca 511 is administered initially intravenously on one, three or five

consecutive days followed by resection of the tumor with further Toca 511 administration using multiple small injections directly into the mixture of brain and cancer tissue surrounding the resection cavity. Samples of the resected tumor are evaluated for evidence of the presence of Toca 511. Pursuant to the protocol, the patient begins a seven day course of oral Toca FC five to seven weeks following the administration of Toca 511 at resection and repeats the cycle of Toca FC every three to five weeks thereafter.

For this intravenous study, median survival was 13.6 months as of November 2016. An independent radiology review showed one patient with complete radiologic disappearance of all lesions.



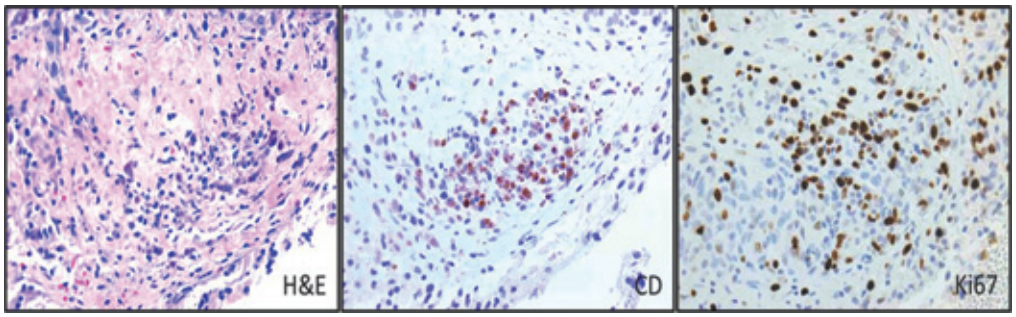
Adapted from S. Kalkanis, MD, AANS, May 2, 2016
*Independent Radiology Review, Macdonald criteria

Shown above are MRI scans from a 52 year old patient with GBM who received standard of care in the newly diagnosed setting. At the time of first recurrence, the patient received a single intravenous injection of Toca 511 on May 7, 2014, followed on May 16, 2014 by resection of a left temporal lobe tumor (circled in red) and injection of Toca 511 into the walls of the resection cavity, and treatment with Toca FC on June 16, 2014. Based on IRR, two evaluable (non-measurable) lesions (yellow arrows) were detected in the left temporal lobe on the patient's baseline MRI on June 16, 2014 (prior to initiation of Toca FC). On July 8, 2014, the patient suffered a stroke, which resolved with sequelae on July 17, 2014, that was considered unrelated to Toca 511 or Toca FC. Based on an MRI on July 20, 2015, the patient achieved a radiologic CR; this response was persistent as of the last available MRI on April 4, 2016. The patient was continuing on Toca FC and was alive as of November 27, 2016, more than 30 months after initiation of treatment with Toca 511.

There is a clear dose response to vector transduction with higher detectable and quantifiable viral DNA and RNA when the intravenous injections were administered daily for three days compared to the single day infusion cohorts. A monoclonal antibody staining for CD protein detected the presence of CD in resected tumor samples, indicating that intravenous delivery results in integration and expression of the vector in the tumor and providing further evidence that the vector can pass through the blood brain barrier.

Glioma cells divide at a low rate overall; however, we see clusters of dividing cells manifested by staining for Ki67 (image on right below). Within these clusters, dividing cells represent 29% of the total cells. CD positive cells represent 14% of the total cells (image in center below) in these samples taken from a closely adjoining area of the tumor. This strongly supports that CD is incorporated into dividing cells as shown by similar localization and confirms that Toca 511 delivered this transgene and resultant CD protein to these cells by

intravenous administration. Based on this finding, we believe there is potential for treating other tumor types with systemic infusions.



Percent of total cells

100% (all cells) **14% (CD-positive cells)** **29% (dividing cells)**

Histochemical analysis of serial sections of tumor from a patient stained to show tissue architecture (H&E Stains), expression of vector encoded cytosine deaminase (CD, red stain), and dividing cells (Ki67, brown stain) (40X).

Biomarkers

As part of our exploration of mutation profiles that may serve as a biomarker for patients with a higher likelihood of long-term benefit, we observed that objective responses occurred in patients with IDH1 mutant (mt) and IDH1 wild type (wt) tumors. Approximately 15% of the population with HGG is believed to have the IDH1 mutation. Across the Phase 1 clinical trial program, and as of October 6, 2016, the three patients with known IDH1 mutations at first recurrence had CRs (two in the resection study and one patient in the intravenous study with a radiologic CR) and all these IDH1 mutation patients are alive (range of survival 12.2 to 35.3 months), suggesting a potential association of IDH1 mutation to survival.

Pooled Safety Data

Toca 511 & Toca FC has been well tolerated in clinical trials to date. There has been little difference in adverse events among the three ongoing Phase 1 clinical trials in recurrent HGG other than a few adverse events unrelated to Toca 511 in the post-operative period of the resection clinical trial. For this reason we chose to pool safety data across the three ongoing trials and the continuation trial. As shown in the table below, in 126 patients who received Toca 511, treatment-related adverse events were reported in 31.8% of patients and these events were predominantly low grade (25.4%). The most common treatment-related adverse events were fatigue (11.9%), headache (5.6%) and convulsion (4.8%). Also shown below, in 118 patients who received Toca FC, treatment-related adverse events were reported in 41.5% of patients and these events were predominantly low grade (38.1%). The most common treatment-related adverse events were fatigue (21.2%), diarrhea (14.4%), and nausea (8.5%). Treatment-related serious adverse events were reported in 4.8% of patients treated with Toca 511 (which included asthenia, pyrexia, subdural hygroma, cerebral cyst, vasogenic edema, convulsions and pulmonary embolism) and 2.5% of patients treated with Toca FC (which included pulmonary embolism, diarrhea and intracranial hemorrhage). Hematologic toxicity was infrequent and also low grade. We monitored blood samples for viral RNA and DNA and found that quantitative levels were cleared within two weeks to four months of administration. Also, we analyzed tumor and blood samples for viral insertion sites and demonstrated an absence of clonality, supporting viral safety. We also monitor Toca FC blood levels for the first treatment cycle and whenever the dose is increased. This helps us to adjust dosing upwards in patients with Toca FC blood levels below the target range. The favorable toxicity profile of Toca 511 & Toca FC suggests that combination with other modalities such as chemotherapy or radiation should yield little incremental toxicity.

Adverse Events Related to Toca 511 – Pooled Across Studies

	Toca 511[1] N = 126			Toca FC[1] N = 118	
	Grade 1, 2 n (%)	**Grade ≥ 3[2] n (%)**		**Grade 1, 2 n (%)**	**Grade ≥ 3[3] n (%)**
Any treatment-related AE	**32 (25.4)**	**8 (6.4)**	**Any treatment-related AE**	**45 (38.1)**	**4 (3.4)**
Treatment-related AE in ≥ 3 patients			Treatment-related AE in ≥ 3 subjects		
Fatigue	14 (11.1)	1 (0.8)	Fatigue	25 (21.2)	0
Headache	6 (4.8)	1 (0.8)	Diarrhea	16 (13.6)	1 (0.8)
Convulsion	6 (4.8)	0	Nausea	10 (8.5)	0
Confusional state	5 (4.0)	0	Decreased appetite	5 (4.2)	0
Nausea	5 (4.0)	0	Rash	3 (2.5)	0
Pyrexia	5 (4.0)	0			
Vasogenic cerebral edema	1 (0.8)	2 (1.6)			
Any treatment-related SAE[4]	1 (0.8)	5 (4.0)	**Any treatment-related SAE[5]**	1 (0.8)	2 (1.7)
			AEs leading to discontinuation[6]	1 (0.8)	6 (5.1)

(1) Preliminary data – cutoff May 31, 2016.

(2) No deaths considered related to Toca 511.

(3) No deaths considered related to Toca FC.

(4) Toca 511 SAEs in six patients included asthenia (one), pyrexia (one), subdural hygroma (one), cerebral cyst (one), vasogenic edema (one), convulsions (two) and pulmonary embolism (one).

(5) Toca FC SAEs in three patients included pulmonary embolism (one), diarrhea (one) and intracranial hemorrhage (one).

(6) Events leading to study discontinuation or withdrawal of study drug, regardless of attribution. AEs of highest severity counted in patients with multiple events. In the continuation study, one patient was discontinued after > one year of treatment due to Grade 1 skin rash and Grade 2 oral ulcers that recurred with each cycle of Toca FC.

Ongoing Phase 2/3 Clinical Trial

In November 2015, we initiated the Phase 2 portion of a randomized, controlled Phase 2/3 clinical trial of Toca 511 & Toca FC against the current standard of care in recurrent HGG. In this clinical trial we are using doses of Toca 511 and Toca FC of 4 mL and 220 mg/kg/day, respectively, equivalent to the doses used in the Higher Dose Cohort of our Phase 1 resection injection trial. Enrollment criteria for patients in this clinical trial includes first or second recurrence of HGG, no prior treatment with bevacizumab for recurrent HGG, and a tumor size of less than or equal to five centimeters. We completed enrollment with 187 patients in the Phase 2 portion of this trial as of February 2017. Investigators may choose chemotherapy (lomustine or temozolomide) or antiangiogenic therapy (bevacizumab) for the control arm. We expect that the arms of the trial will be comparable through stratification at the time of 1:1 randomization based on performance status, geographic region and IDH1 mutation status. The primary endpoint for the trial is overall survival. The expected median overall survival for the control arm is 8.5 months based on the assumption that approximately 25% of patients will receive bevacizumab and the remainder will receive chemotherapy in the control arm. In this trial we are evaluating evidence for immunologic mechanisms of disease control and we will perform a detailed molecular analysis of RNA expression, IDH phenotypes and MGMT methylation status in resected tumors. We will continue to monitor blood for viral RNA, DNA and for Toca FC levels. This clinical trial is being conducted in the United States, Canada, Israel and South Korea. The principal investigator in the United States is Timothy Cloughesy, M.D., director of the neuro-oncology program at the University of California, Los Angeles.

Because overall survival is the primary endpoint, we did not request a Special Protocol Assessment from the FDA. At our Type B meeting with the FDA, we and the FDA discussed the design of the trial and we

subsequently finalized the protocol based upon the FDA's feedback. We also discussed the possibility of providing the data from the Phase 2 portion of this clinical trial to the FDA prior to initiation of the Phase 3 portion of the trial. The FDA indicated that they would be willing to meet with us in an end of Phase 2 meeting to review the data if the results appear compelling. Based upon our discussions with the FDA, we believe such data could serve as the basis for regulatory approval depending on the results we see in the Phase 2 portion.

In February 2017, the FDA granted Toca 511 & Toca FC Breakthrough Therapy Designation for the treatment of recurrent HGG. Our Breakthrough Therapy Designation application was based on data from three Phase 1 ascending-dose clinical trials involving 126 patients with recurrent brain cancer. The clinical data included results published in Science Translational Medicine, including safety data, patient survival data and data regarding durable, complete or partial tumor shrinkage as determined by independent radiology review. In addition, preclinical information was provided to the FDA supporting a novel immunological mechanism of action involving the depletion of immune-suppressive myeloid cells in the tumor microenvironment.

Breakthrough Therapy Designation indicates that preliminary clinical evidence demonstrates the drug may have substantial improvement on one or more clinically significant endpoints over available therapy. Breakthrough Therapy Designation intensifies FDA involvement to ensure an efficient drug development program and is an organizational commitment from the FDA to involve its senior managers.

Ongoing Intravenous Clinical Trial

In July 2016, we initiated a Phase 1b clinical trial in various types of metastatic solid cancer, including colorectal, pancreatic, breast, lung, melanoma and renal to confirm the selective tumor transduction with the CD gene and CD protein expression following Toca 511 delivery already documented in HGG with intravenous delivery. New diagnoses of these cancers are estimated to exceed 700,000 per year in the United States and 5.4 million per year worldwide. In our metastatic cancer trial we plan to evaluate safety, presence of Toca 511 genes in tumors of patients with widely-disseminated disease, immunologic activity in blood and tumor such as changes in CD4, CD8 and immune-suppressive myeloid cells, and clinical activity such as tumor response and clinical benefit. We also plan, in this clinical trial, to evaluate Toca 511 & Toca FC in combination with one or more checkpoint inhibitors.

Planned Clinical Trials

In early 2018, we plan to initiate a Phase 1b clinical trial evaluating Toca 511 & Toca FC in patients with newly diagnosed HGG. The primary goals of this study will be to evaluate the safety and preliminary efficacy of Toca 511 delivered at the time of resection and Toca FC subsequently delivered in conjunction with radiation and temozolomide.

Preclinical Studies of Toca 511 and 5-FC

We believe our preclinical studies support the clinical development of Toca 511 & Toca FC in brain cancers both as a stand-alone regimen and in combination with current treatments. During preclinical testing of Toca 511 we observed that treatment with Toca 511 and 5-FC had two powerful mechanisms of action: direct killing of cancer cells and activation of the immune system against the cancer cells. 5-FC, which we use in our preclinical studies, is the active component of the Toca FC tablets we use in humans.

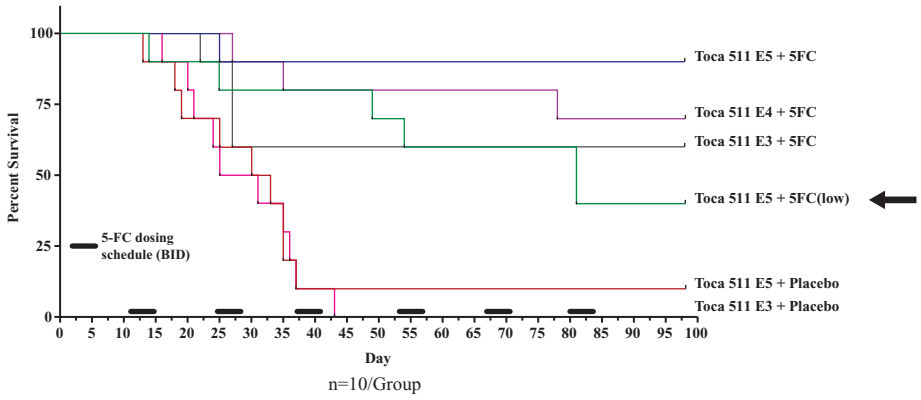
We have observed in *in vitro* viral-spreading studies that increasing the ratio of Toca 511 virus particles to tumor cells, referred to as multiplicity of infection, or MOI, increases the initial infection rate and the subsequent rate of spread.

In a mouse glioma (Tu 2449 glioma cell line) growing intracranially (within the cranium) in mice with a normal immune system, treatment with Toca 511 and 5-FC resulted in increased median survival compared to

control even at either relatively low Toca 511 (10^3 transducing units, TU) or low 5-FC doses (100 mg/kg/day). The treatment effect was observed to be dose dependent with maximum improvement in median survival achieved with higher doses of Toca 511 (10^5 or 10^6 TU) and higher doses of 5-FC (500-1000 mg/kg/day). When 5-FC was administered to one group of mice at one tenth the 5-FC dose (100 mg/kg/day) compared to the typical 5-FC dose (1000 mg/kg/day) in combination with the same dose of Toca 511 (E5), the survival was approximately 40% rather than the approximately 90% observed at the higher 5-FC dose (black arrow shown below).

The minimum effective dose of Toca 511 in mouse models (10^5 TU/g brain) is similar, on a species adjusted basis, to the dose chosen for use in our ongoing Phase 2/3 clinical trial and the doses showing tumor response and increased median survival in our Phase 1 resection injection trial.

Ascending Doses of Toca 511 and 5-FC Increases Survival



Tu-2449 glioma cells in mice

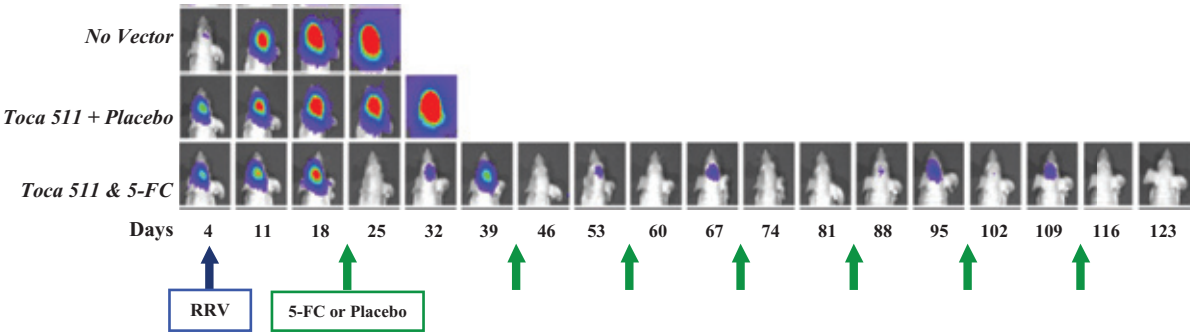
E3, E4, E5 = 10^3, 10^4, 10^5 TU/ gm brain, respectively.

Additionally, cell viability assays in human and mouse glioma Toca 511 infected cell lines show dose-dependent killing with 5-FC. Toca 511 infected human cells showed marked killing at clinically achievable concentrations of 5-FC (approximately 100 µg/mL) and control cells transduced with a vector that does not contain CD showed no loss of viability at the same 5-FC concentration (100 µg/mL).

Preclinically, durable remissions are produced in immune competent mice even after stopping 5-FC, but immune deficient rodent models do not have durable benefits after stopping 5-FC, supporting an immune mechanism for long-term survival. Also, mice with long-term remission develop anti-cancer immunity evidenced by rejection of the identical tumor implanted in a new location. Preclinical models showed that this rejection was T cell-mediated.

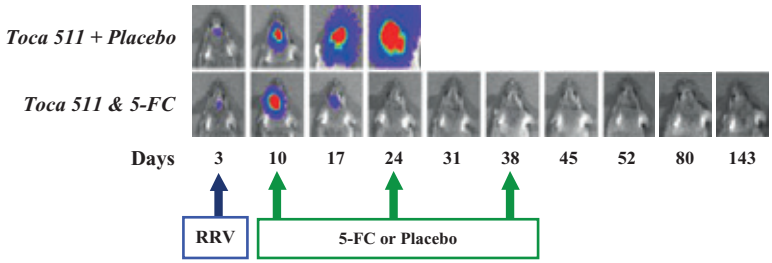
When human glioma tumors growing in immune deficient (nude) mice are treated with Toca 511 followed by 5-FC, the tumors shrink dramatically on each 5-FC cycle but grow back immediately upon stopping the treatment with 5-FC. The tumors can be controlled, but rarely eliminated. This is illustrated in the figure below where the tumor implant is monitored in the same animals over time by external imaging, showing that the tumor continues to be present and regrow after each cycle of 5-FC.

In immune deficient mice Toca 511 and 5-FC controlled but did not eliminate human brain cancer cells



In contrast, when syngeneic glioma cell line tumors growing in animals with a normal immune system were treated with Toca 511 and only a few cycles of 5-FC, the tumors cleared permanently even if 5-FC cycles were stopped. This suggests the immune cells activated against the implanted tumors were generated. Subsequent experiments using adoptive cell transfer, or ACT, of immune cell subsets confirmed that this effect was T cell mediated.

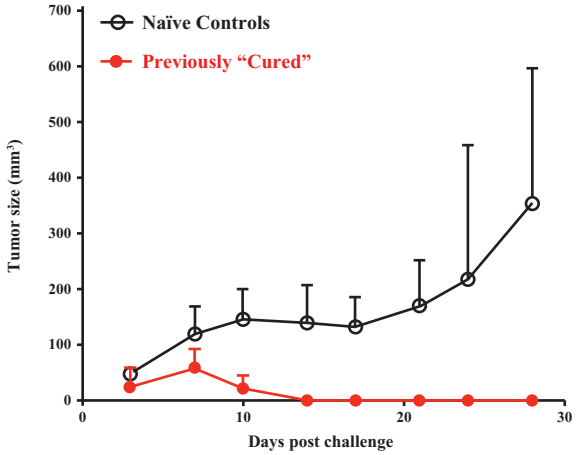
In mice with a normal immune system and syngeneic glioma, Toca 511 and 5-FC activated anti-cancer immunity through several cycles of 5-FU-mediated cell killing



Tumor remains cleared, despite stopping FC treatment

In the experiment shown below, animals survived, apparently tumor-free, for approximately one year and were then re-challenged with the same tumor in the flank. These re-implanted tumors were rejected by the mice. Rejection of rechallenged tumors involved CD8 and CD4 anti-tumor T cells. Tumors in naïve animals grew unchecked. Rejection of the re-implanted tumor was attenuated by the treatment of mice with antibodies against CD4 alone and more so with CD4 and CD8. We believe the rejection of tumors at a remote site (flank not brain) implanted after almost one year, is evidence for the induction of durable systemic immunity against the cancer induced by prior Toca 511 and 5-FC treatment.

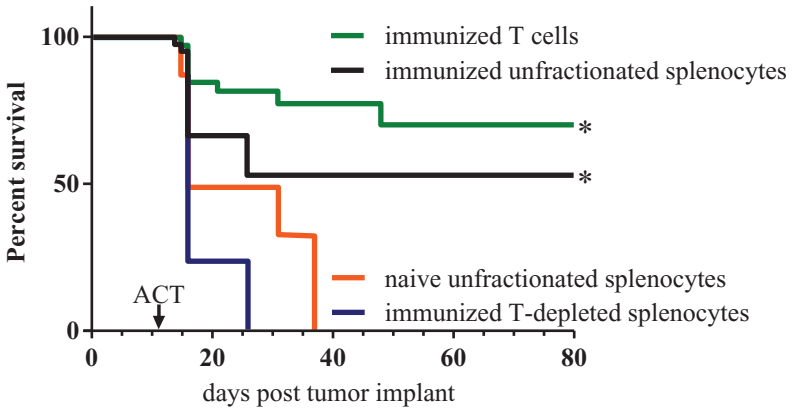
Rejection of re-challenge with same tumor in mouse model



"Cured" mice developed systemic immunity against the rechallenged cancer as shown by rejection of tumor implanted in the flank.

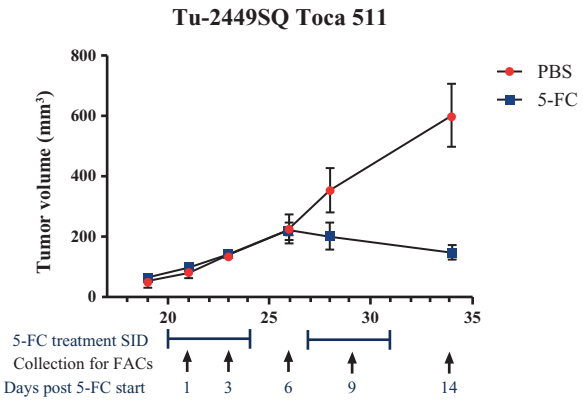
Animals which had previously cleared Tu-2449 intracranial tumors through treatment with Toca 511 and 5-FC (termed "immunized") were used for ACT into recipient mice bearing intracranial Tu-2449 tumors, shown below. Before transfer, immunized splenocytes were separated or fractionated. Animals received one of the following: unfractionated splenocytes from immunized (black) or naïve (orange) mice, purified T cells from immunized spleens (green) or immunized splenocytes depleted of T cells (blue).

Kaplan Meier survival curves in mice carrying intracranial tumors and infused with cells from "cured" mice show the anti-tumor effect is T cell mediated



In a subcutaneous glioma model treated with Toca 511 & 5-FC, tumor size decreased, shown below. In this model, MDSCs were depressed while CD4 (helper) and CD8 (killer) T cells were increased, conducive for an anti-cancer immune activation.

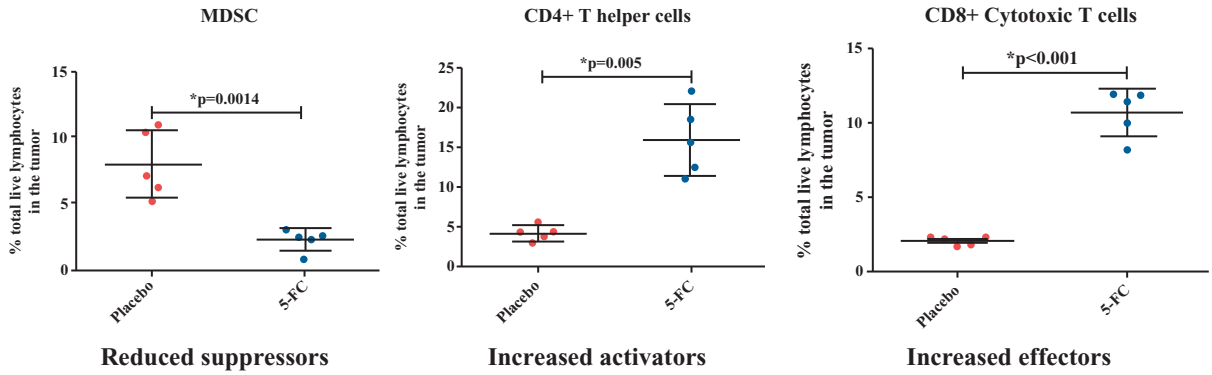
Toca 511 and 5-FC reduces tumor burden in mouse glioma

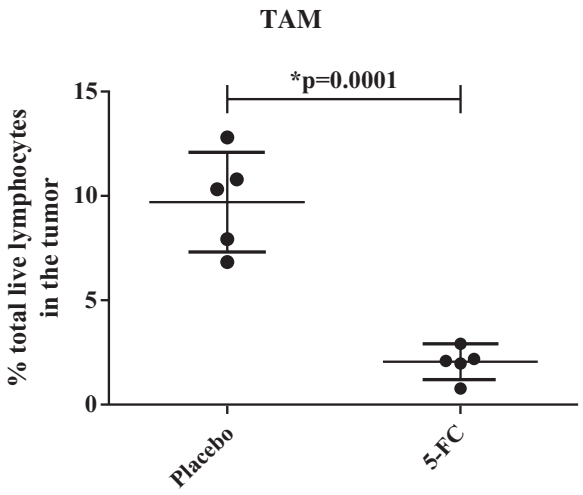


Tumor burden expressed as tumor volume (mm^3) over time (days post tumor implant).

5-FC treatment cycles are shown below the graph and collection dates are indicated by black arrows and labeled as days post 5-FC start (n=5).

Toca 511 & 5-FC activate Immune System in Tumor Micro-Environment

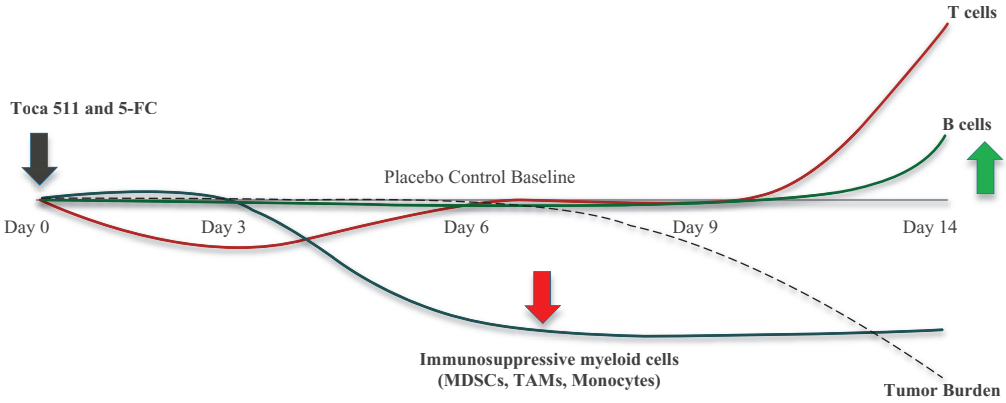




Tumor tissue obtained on day 14 in subcutaneous glioma model.

Toca 511 and 5-FC treatment reduces immune-suppressive myeloid cells six days following treatment initiation which we believe results in, or permits, the increase in T cells in the tumor 14 days following treatment initiation as shown below.

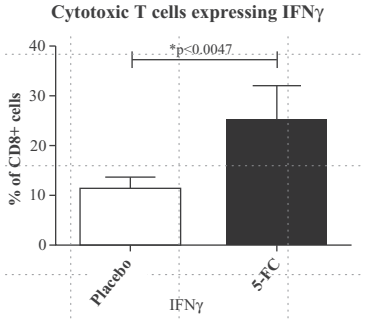
Toca 511 and 5-FC activate Immune System in Tumor Micro-Environment



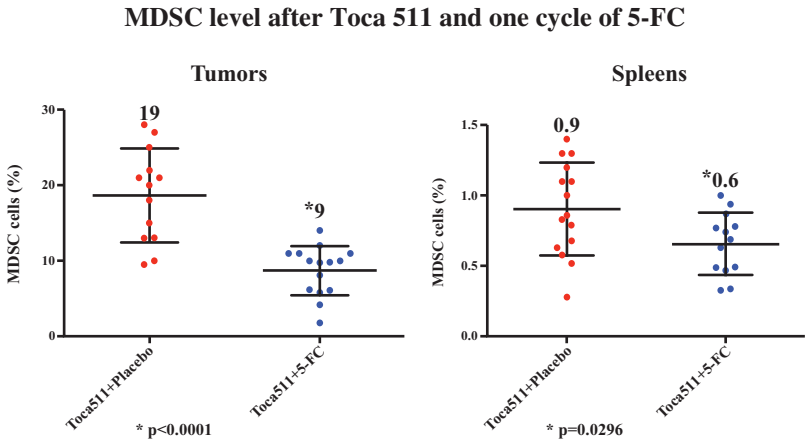
T-regs not significantly impacted (no autoimmunity expected)

In a separate experiment, interferon gamma (IFNγ, a cytokine with known immune cell effector function and a marker for activated CD8 T cells) expression was analyzed in CD8 cytotoxic T cells which were collected from animals bearing Toca 511-pretransduced Tu-2449 tumors. Those animals that were treated with 5-FC had significantly greater numbers (approximately two-fold) of CD8 T cells that expressed IFNγ compared to animals that received placebo.

Cytokine profiles support T cell function enhancement after Toca 511 and 5-FC

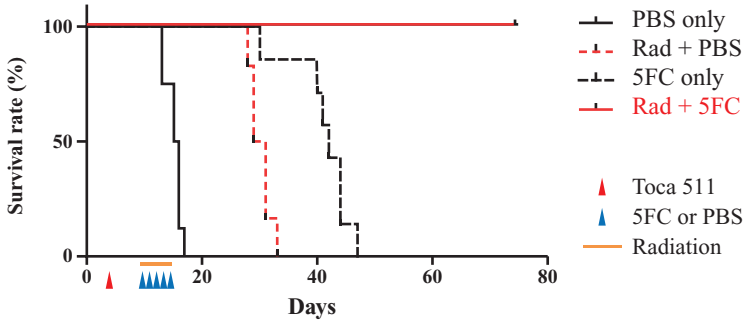


The effect of Toca 511 and 5-FC on MDSCs was also investigated in a colorectal brain metastases model. When immune competent animals with metastatic colorectal cancer transduced with Toca 511 in the brain were treated with one cycle of 5-FC, the animals experienced a dramatic reduction in MDSCs in both brain tumors and spleen as shown below. We believe MDSCs originate in the cancer microenvironment; some of these can escape the tumor through the blood stream and end up in the spleen.



Preclinical Combination Studies with Existing Treatments in HGG

Because Toca 511 & Toca FC has been well tolerated in clinical trials to date, we believe it could be added to established treatment combinations without additional toxicity. Standard of care for newly diagnosed HGG is surgery followed by radiation therapy and an alkylating drug, temozolomide. We believe preclinical data support the thesis that Toca 511 & Toca FC has the potential to work in combinations with standard therapies for brain cancer giving added benefit. We believe this likely happens because 5-FU starves the cell of one of the building blocks of DNA, and treatments that result in DNA breaks such as alkylating agents and radiation are especially effective when combined with 5-FU. For example, an additive long-term survival advantage was observed when submaximal temozolomide in combination with submaximal Toca 511 and 5-FC was administered to mice bearing an intracranial, temozolomide-sensitive glioma tumor (U-87 model). Similarly, combination treatment of Toca 511 and 5-FC plus radiation in pre-established tumors in mice showed markedly improved survival compared to a single cycle of either treatment alone in a radio-resistant human U-87 malignant glioma subline (U87EGFRvIII), as shown below. We believe our data support the further development of Toca 511 & Toca FC in first line therapy where patients routinely receive temozolomide and radiation after surgery.



Rad in the chart means radiation; PBS means phosphate-buffered saline, or placebo.

Recurrent HGG is typically treated with oral chemotherapy drugs, such as lomustine or temozolomide, bevacizumab, radiation or further surgery. In preclinical models, we have demonstrated the compatibility and additive and/or synergistic effects of Toca 511 and 5-FC with these therapies. This combination of preclinical studies supports the use of Toca 511 & Toca FC in combination with existing treatments in clinical trials in HGG.

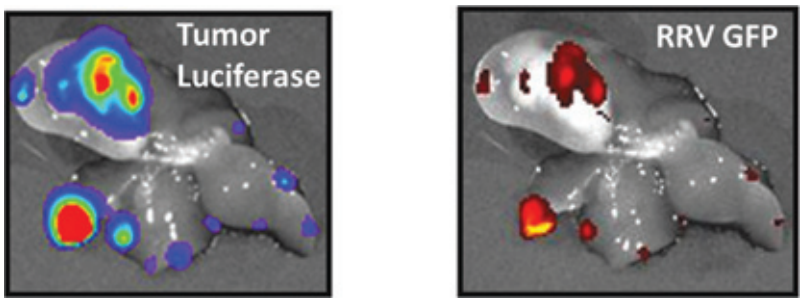
The cooperative therapeutic activity between radiation treatment and 5-FU is commonly employed in the treatment of radiation-sensitive tumors, for example in many gastrointestinal tumors, supporting the use of Toca 511 & Toca FC in other radiation settings.

Preliminary preclinical data supports that there may be therapeutic advantages in using Toca 511 & Toca FC in combination with some checkpoint inhibitors.

Preclinical Studies in Other Cancer Types

Our pipeline of proprietary programs has the potential to be applicable to a wide variety of cancers. For example, we have demonstrated biodistribution, tumor shrinkage, and long-term survival in colorectal, breast and bladder cancers in preclinical studies, in addition to our brain cancer models with an RRV containing CD and 5-FC.

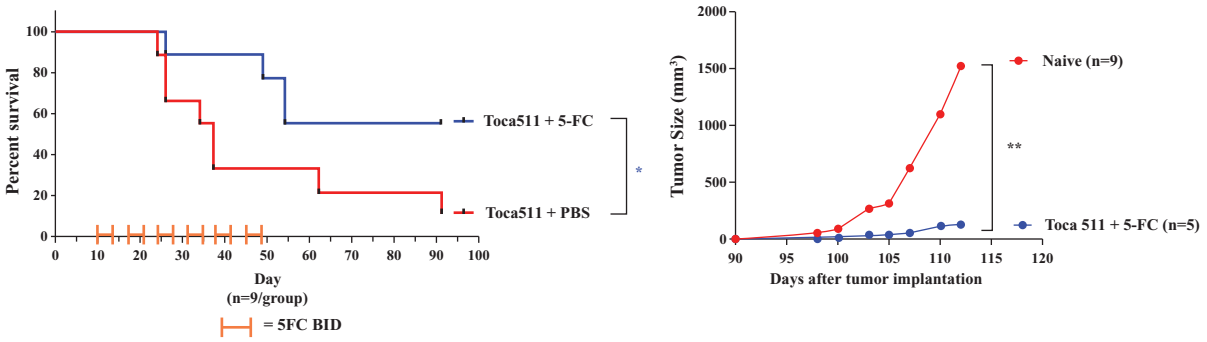
Based on preclinical data, we believe Toca 511 & Toca FC has the potential to be effective in treating most cancer types. First, most human cancer cell lines that have been tested are permissive for Toca 511 and sensitive to Toca 511 and 5-FC at clinically relevant concentrations of 5-FC. Also, we have conducted *in vivo* studies in numerous cancer types, and the studies show that Toca 511 spreads through tumors, including after intravenous infusions into animals with highly-metastatic cancers. For example, in a metastatic colorectal cancer model with numerous lesions in the liver (below left), an RRV containing the GFP gene shows that intravenous administration of RRV is selectively present in the tumor tissue and leaves normal liver uninfected. Tumor metastases are identified by luciferase-based bioluminescence which closely overlays with the location of RRV expressing GFP (below right).



Images of same liver in colorectal cancer metastases model after intravenous RRV delivery

In this animal model, as in animals with the same colorectal cancer metastases (above) in the brain, Toca 511 and 5-FC caused tumor shrinkage, long-term survival and the generation of anti-tumor immunity sufficient to prevent re-challenge (as shown below). The treated mice had an apparent 56% cure rate and such animals showed a dramatic decrease in the number of MDSCs in the tumor microenvironment and, overall, generated an anti-tumor immune response based on their ability to reject reimplanted tumors. We believe these cell culture and additional animal studies support the view that Toca 511 & Toca FC is generally active against cancer and drives our decision to evaluate this treatment against various types of cancers in clinical trials.

Survival, cure rates and anti-tumor responses in colorectal cancer model



CT26-luciferase liver metastases model treated with Toca 511 (intravenous) and 5-FC (500 mg/kg administered twice a day, or BID, for five consecutive days out of every seven days)

Comparison of peak 5-FU levels in tumors and plasma after systemic administration or treatment with either 5-FU or Toca 511 and 5-FC

Toca 511 and 5-FC creates high concentrations of 5-FU in the tumor especially compared to the low levels in the blood stream in several models leading to drug activity with minimal side effects. Systemic 5-FU treatment of humans generates low levels of 5-FU in the tumor and high levels in the blood stream leading to systemic toxicity and limited anti-cancer activity. In contrast, in the rat glioma model with Toca 511 and 5-FC (800 mg/kg/day, human equivalent dose 129 mg/kg/day), the peak 5-FU levels in brain tumor and plasma were 69 µg/g and 0.4 µg/mL respectively (tumor to plasma ratio = 189).

Toca 511 & 5-FC yields sustained high levels of 5-FU directly in tumors - minimizing systemic exposure

Setting	Treatment	Tumor 5-FU (µg/g)	Plasma 5-FU (µg/g)
Rat F98 glioma[1]	Toca 511 and 5-FC	69	0.4
Human Colon[2]	5-FU	0.1-2.8	52

1 Data on file.

2 Peters GJ., et al. Cancer Chemother. Pharmacol., 1993, 31(4):269-276.

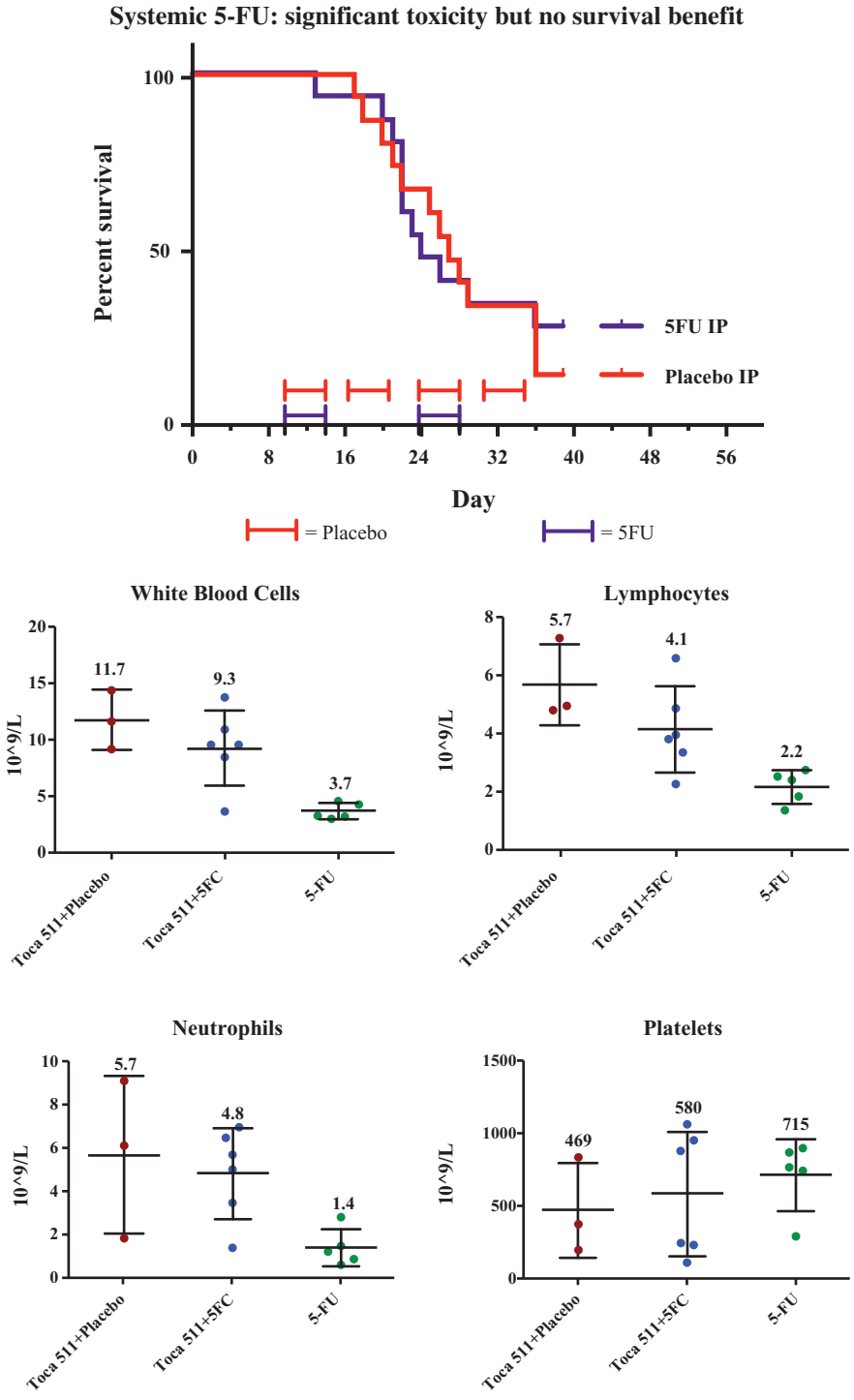
Comparison of peak 5-FU levels in tumor and plasma after systemic administration of 5-FU or treatment with Toca 511 and 5-FC.

In a mouse colon cancer CT26 liver metastasis model with Toca 511 and 5-FC at maximum 5-FC doses, the peak 5-FU levels in tumor and plasma were 74 µg/g and 10 µg/mL respectively (ratio = 7.4). Treatment with Toca 511 and 5-FC at this dose resulted in significantly improved median survival compared to control, a 56% cure rate, induction of anti-tumor immune response, as described above, and no gastrointestinal, or GI, toxicity. Also, as described below, no hematologic toxicity was observed with this treatment. Both of these models support the excellent therapeutic index observed for Toca 511 and 5-FC.

Thus, we expect treatment with Toca 511 & Toca FC to yield high levels of intratumoral 5-FU in metastatic tumor as well as primary tumors compared to systemic 5-FU. Based on this data, in the metastatic setting, we expect these high levels of 5-FU to overcome potential resistance to prior 5-FU-based treatment.

In the same CT26 model described above, treatment with intravenous 5-FU (20 mg/kg) did not improve overall median survival compared to control and resulted in significant hematologic toxicity including lymphopenia ($p<0.05$), as shown below, and gastrointestinal toxicity (diarrhea and weight loss). The effects of

systemic 5-FU on lymphocytes may reduce potential benefits of 5-FU effects on MDSCs. Also displayed are the values for hematologic cells (white blood cells, neutrophils and platelets) including immunologic cells (lymphocytes) with Toca 511 and 5-FC treatment, all within normal limits.



CT26-luciferase liver metastases model treated with systemic 5-FU (20 mg/kg administered BID for five consecutive days out of every 14 days)

Manufacturing

Our lead product candidate, Toca 511 & Toca FC, consists of a biological component and a drug component, which are separately manufactured and are both covered by our proprietary intellectual property. The process for Toca 511 manufacturing and testing has been developed internally and we believe that the process itself and the expertise to design and implement this process as well as the testing are significant assets. The process and the vector composition are covered by patents, patent applications and trade secrets. The process for Toca FC (extended release 5-FC) was also designed internally. We rely on third-party contract manufacturing organizations, or CMOs, for both of these manufacturing processes to produce our final product for clinical use, as currently we do not own or operate manufacturing facilities. In addition we utilize contract testing organizations, or CTOs, for the establishment and performance of validated product release assays for Toca 511 & Toca FC material. For Toca FC and Toca 511, we require that our CMOs produce bulk drug substances and finished drug products compliant with current Good Manufacturing Practices, or cGMP, requirements and all other applicable laws and regulations. We plan to release material with appropriately qualified assays by our CTOs, who we require to operate under cGMP. We will retain final responsibility for product release and maintain an appropriate quality assurance capability to meet this need. We will continue to rely on CMOs and CTOs to manufacture and perform release testing, respectively, of our products for commercial sale. We maintain agreements with manufacturers and testing laboratories that include confidentiality and intellectual property provisions to protect our proprietary rights related to our product candidates and testing methods.

We use a viral producer cell line to create Toca 511 and currently rely on a sole-source CMO to manufacture Toca 511. We believe that our current manufacturing capacity for Toca 511 will be sufficient to support our ongoing and planned clinical trials.

Manufacturing for the Toca FC component generally encompasses both the chemical synthesis of the active pharmaceutical ingredient, or API, and its formulation and fill/finish of the final product. We currently utilize two CMOs for the production of the API and a CMO for the manufacture of the final drug product tablets. One API site is in the United States and the other is in Europe. Our final drug product tablets are manufactured in Canada. We expect these preparations to supply sufficient Toca FC drug substance to complete the planned clinical trials. We believe we have the manufacturing capacity to supply the drug product tablets for our ongoing and planned clinical trials.

We currently have no plans to build our own manufacturing capacity to manufacture Toca 511 or Toca FC.

License and Collaboration Agreements

Laboratory Services and License Agreement with Siemens

In November 2011, we entered into a laboratory services and license agreement with Siemens, which we amended in June 2015, pursuant to which we agreed to engage Siemens (i) to develop and perform certain *in vitro* diagnostic assays in connection with the cancer therapy trials of Toca 511 & Toca FC, (ii) concurrently and/or thereafter, to further develop, obtain FDA approval for, and perform one or more of such *in vitro* diagnostic assays as drug monitoring diagnostics for Toca 511 & Toca FC as Toca 511 & Toca FC receives marketing approval from the FDA, and (iii) following FDA approval of such in vitro diagnostic assay as a monitoring diagnostic, to perform such *in vitro* diagnostic monitoring assays as necessary in connection with post-marketing clinical trials of Toca 511 & Toca FC and, if appropriate, as commercial diagnostic tests. We granted Siemens the licensed intellectual property covered by the agreement on an exclusive and non-exclusive basis, depending on Siemens' use of such intellectual property.

Under the terms of the agreement, Siemens paid us an initial upfront payment of $0.5 million. Additionally, beginning with the first commercial sale of a product that has received approval for clinical use under the

agreement, Siemens will pay us a royalty in the 10-20 percent range of net assay revenue with respect to approved designated assay products and net sales revenue with respect to approved *in vitro* diagnostic products, until the fifth anniversary of such commercial sale, subject to certain reductions. Beginning with the first commercial sale of Toca 511 or Toca FC, we will pay a royalty to Siemens in the low single-digit percentage range on net product sales of Toca 511 & Toca FC for sales up to the mid-nine-digit dollar range per year, until the fifth anniversary of such commercial sale.

The term of this agreement will continue until the expiration of all payment obligations. The agreement provides that it may be terminated by either party upon written notice to the other party in the event of the other party's material breach of the agreement if such breach remains uncured for 45 days, or in the event the other party files a voluntary petition in bankruptcy, is adjudicated as bankrupt or insolvent after all appeals are exhausted, makes a general assignment for the benefit of creditors or fails to discharge or have dismissed within 60 days an involuntary petition in bankruptcy filed against it. If market approval is rejected by the FDA, Siemens must provide us with prompt written notice. Should the parties be unable to reach mutual agreement regarding regulatory strategy within 20 business days of such notice, then either party may terminate the agreement upon written notice to the other party. Siemens may terminate the agreement for any reason upon 90 days prior written notice to us, provided that, notwithstanding such termination, Siemens must continue to provide the laboratory services for any of our trials the protocol for which has been submitted to FDA until the conclusion of such pre-approval trial. Siemens may also terminate the agreement if, after using commercially reasonable efforts, certain assay specifications are not achieved. If Siemens terminates the agreement for breach of contract by us, the licenses granted to Siemens will survive such termination and will become non-exclusive, perpetual and irrevocable, provided that Siemens will have the right to terminate any such license at any time upon written notice to us. If the agreement expires, or if the agreement is terminated by us for breach of contract by Siemens or for failure to reach an agreement on regulatory strategy, the restriction in the license granted to activities outside of the territory will terminate, and we will have the right to pursue development and commercialization of companion diagnostics for products with one or more other partners in the territory, and to grant to such other partners sublicenses of our rights under the agreement. If the agreement is terminated by either party for failure to reach an agreement on regulatory strategy, or by Siemens by 90 days written notice, for a minimum of 45 days after the later of (i) the termination date or (ii) completion of any required post-termination laboratory services and delivery to us of all results thereof, Siemens must retain any stocks of qualified reagents for the assays that remain as of Siemens' completion of such laboratory services, and, upon our request made at any time during such 45-day period, Siemens must deliver such remaining stocks to us, provided that we shall have executed documentation reasonably satisfactory to Siemens acknowledging that the use of such reagents is restricted to investigational use pursuant to our IND, and any other use permitted by, and in compliance with, applicable laws, regulatory guidelines and regulatory approvals.

License Agreement with USC

In October 2007, we entered into a license agreement with the University of Southern California, or USC, pursuant to which we received a worldwide, exclusive license to, among other things, manufacture and market products utilizing inventions related to our RRV platform and other key technology.

Under the terms of the agreement, we paid an initial license fee to USC in the low six-digit dollar range and issued to USC shares of our common stock in an amount equal to the low single-digit percent range of all the number of shares of common stock issued at the time shares were issued to our six founders prior to the date of the agreement. Pursuant to the agreement, we owe USC a royalty in the low single-digit percent range of our and our sub-licensee's net sales of products covered by the agreement. In addition, we owe USC an additional royalty in the low single-digit percent range of revenue from our sub-licensees. Once our and our sub-licensees net sales reach an amount in the mid-seven digit dollar range, the minimum annual royalty payment due to USC will be in the low six-digit dollar range. Our royalty obligations continue on a licensed product-by-licensed product and country-by-country basis until the expiration of the last valid claim in the licensed patent covering a licensed product in such country.

The term of this agreement will continue until all of our royalty payment obligations have expired unless terminated earlier. The agreement provides that it may be terminated by either party upon written notice to the other party in the event of the other party's material breach of the agreement if such breach remains uncured for 45 days. We may terminate the agreement without cause upon 45 days' advance written notice to USC. USC may also terminate the agreement upon notice to us upon (i) the declaration by a court of competent jurisdiction that we are bankrupt and our assets are to be liquidated pursuant to the U.S. Bankruptcy Code; (ii) upon the filing or institution by us of bankruptcy, liquidation or receivership proceedings under Chapter 7 of the U.S. Bankruptcy Code; (iii) upon an assignment of a substantial portion of our assets for the benefit of creditors; or (iv) in the event a receiver or custodian is appointed in bankruptcy for all or substantially all of our business; provided, however, that in the case of any involuntary proceeding, such right to terminate shall only become effective if the proceeding is not dismissed within 120 days after the filing thereof. Upon termination of the agreement, all rights granted to or provided by each party to the other shall automatically and irrevocably revert to the granting party.

Grants

We have received grants from the following entities: National Institutes of Health, Voices Against Brain Cancer, Musella Foundation, Accelerate Brain Cancer Cure, Inc., National Brain Tumor Society, American Brain Tumor Association, Adenoid Cystic Carcinoma Research Foundation, and Internal Revenue Service — Qualifying Therapeutic Discovery Project Program.

Sales and Marketing

We currently own exclusive worldwide development and commercial rights to our therapeutic product candidates and underlying viral technology platforms. We plan to build at the appropriate time a commercial infrastructure targeting oncologists, neuro-oncologists and neurosurgeons and related clinicians and health care workers in leading and regional cancer centers in the United States.

We anticipate that our commercial infrastructure will be built around a "high-touch" model to maximize patient access to our products. In addition to an internal team of dedicated medical sales, marketing, medical affairs, reimbursement, and commercial operations personnel we anticipate leveraging external capabilities such as contract pharmacy services. It is possible that a Risk Evaluation Mitigation Strategy program, or REMS, will be required for our products.

For our lead product candidate, Toca 511 & Toca FC for HGG, we have established a base of scientific familiarity with leading physicians in the United States, EU, Canada, South Korea, Israel and Japan. If we obtain regulatory approval, we expect that the base of familiarity we have built with leading international brain cancer centers during the conduct of our clinical trials, including the Toca 5 trial, will help drive market acceptance of our product. We believe that the majority of patients undergoing treatment for HGG in the United States are treated at approximately 60 brain cancer centers in the United States, many of which have participated in our clinical trials. Therefore, we believe a highly specialized, relatively small, medically-focused sales force, in addition to medical science liasons, will be sufficient to support the commercialization of our product.

Outside the United States, we may build our own commercial infrastructure or consider opportunities to enter into out-licensing or co-promotion agreements with other pharmaceutical or biotechnology companies to develop and/or commercialize our product candidates outside the United States.

We currently have very limited sales and marketing or distribution capabilities or in-house personnel specializing in these functions.

Intellectual Property

Intellectual property is of vital importance in our field and in biotechnology generally. We seek to protect and enhance proprietary technology, inventions, and improvements that are commercially important to the

development of our business by seeking, maintaining, and defending patent rights, whether developed internally or licensed from third parties.

We will also seek to rely on regulatory protection afforded through Orphan-Drug Designations, data exclusivity, market exclusivity and patent term extensions where available.

We have obtained Orphan-Drug Designation for Toca 511 & Toca FC for the treatment of GBM, which makes the product eligible for a period of orphan drug exclusivity, if approved in this indication, under certain conditions. We believe that approval under a biologics license application, or BLA, will be eligible for 12 years of market exclusivity in the United States, 10 years of market exclusivity in Europe and significant durations in other markets, which would be complementary to any relevant patent exclusivity.

Through licensing and developing our own portfolio, and as of March 2017, we have rights to eight issued patents in the United States, two of which are assigned to us and six of which are exclusively licensed to us, and 50 issued and granted patents in foreign countries, 32 of which are assigned to us and 18 of which are exclusively licensed to us, 16 patent applications in the United States, of which 15 are assigned to us and one is exclusively licensed to us, and 59 patent applications in foreign countries, all of which are assigned to us, which we believe will provide coverage on our technology platform and product candidates until approximately 2030. The Company files intellectual property it believes to be key to its business at a minimum in jurisdictions including the United States, Europe and Japan. Our original core technology was licensed from the University of Southern California, or USC, and The Regents of the University of California. Families within the portfolio are directed to our RRV technology platform, the modified CD gene that we use in Toca 511, various other therapeutic modalities and genes for use with RRV, manufacturing methods for RRV, the extended release Toca FC formulation, various combination therapies with Toca 511 & Toca FC and other agents, intravenous administration of RRV and diagnostic assays for detection of RRV.

We possess significant knowledge relating to the construction, manufacture, development and protection of gene therapy products. Certain intellectual property we aim to protect through a trade secret strategy.

Competition

The biotechnology and pharmaceutical industries, and the immunotherapy subsector, are characterized by rapid evolution of technologies, fierce competition and strong defense of intellectual property. A wide variety of institutions, including large pharmaceutical companies, specialty biotechnology companies, academic research departments and public and private research institutions, are actively developing potentially competitive products and technologies. We face substantial competition from biotechnology and pharmaceutical companies developing products in immunotherapy and in our lead indication.

Companies developing other immunotherapy products generally fall within the following categories:

- diversified pharmaceutical companies developing immunotherapies, including checkpoint inhibitors: AstraZeneca plc, Bristol-Myers Squibb Co., Celgene Corporation, F. Hoffman-La Roche AG, GlaxoSmithKline plc, Merck & Co., Inc., Novartis AG, Pfizer Inc. and Sanofi SA;
- companies aimed at stimulating immune responses: Argos Therapeutics, Inc., Aduro Biotech, Inc., Advaxis, Inc., Idera Pharmaceuticals, Inc., Immune Design Corp., Incyte Corporation, NantKwest, Inc, New Link Genetic Corporation, Northwest Biotherapeutics, Inc., Stemline Therapeutics Inc., and Trillium Therapeutics Inc.;
- companies developing CAR and TCR T cells: Adaptimmune Therapeutics plc, Bellicum Pharmaceuticals, Inc., Cellectis S.A., Juno Therapeutics, Inc., Kite Pharma, Inc. and Novartis AG; and
- companies developing virus-based technology: Amgen, Inc. (Imlygic (talimogene laherparepvec) approved by the FDA in 2015), Vascular Biogenics Ltd, DNAtrix, Inc., Ziopharm Oncology, Inc., and Duke University.

Approved treatments for HGG or GBM, a subset of HGG, include surgery, radiation and chemotherapy, the most widely used being temozolomide. Other approved treatments include the carmustine implant (marketed as Gliadel wafer by Arbor Pharmaceuticals, LLC), bevacizumab (marketed as Avastin by Genentech, Inc.), and NovoCure Limited's personal electric field device, marketed as Optune (approved for the treatment of GBM). In addition to approved therapies, we expect that Toca 511 & Toca FC will compete with product candidates that we are aware of in clinical development by third parties, including nivolumab and ipilimumab (being developed as monocolonal antibodies targeting immune checkpoints, PD-1 and CTLA-4, for the treatment of GBM by Bristol-Myers Squibb Co.; currently in Phase 3 clinical trials), pembrolizumab (being developed as a monocolonal antibody targeting PD-1 for the treatment of GBM by Merck & Co., Inc.; currently in Phase 2 clinical trials), ABT414 (being developed as a monocolonal antibody targeting EGFR for the treatment of GBM by AbbVie Biotherapeutics Corporation; currently in Phase 2 clinical trials), VB-111 (being developed as an antiangiogenic agent delivered with adenovirus for recurrent GBM by Vascular Biogenics Ltd.; currently in Phase 3 clinical trials under a special protocol assessment), VAL-083 (a bi-functional alkylating agent in development for recurrent GBM by DelMar Pharmaceuticals Inc.; currently in Phase 1/2 clinical trials), TPI-207 (a 3rd generation taxane in combination with bevacizumab in development for recurrent GBM by Cortice Biosciences; currently in Phase 1/2 clinical trials), martizomib (an alkylating proteasome inhibitor in development for GBM by Celgene Corporation in collaboration with Triphase Accelerator Corporation; currently in Phase 1 clinical trials), Ad-RTS-HIL-12 with veledimex in development for recurrent GBM by Ziopharm Oncology Inc.; currently in Phase 1 clinical trials, SL-701 (a GBM vaccine in development by Stemline Therapeutics Inc.; currently in Phase 2 clinical trials), PVSRIPO (being studied by Duke University as a modified oncolytic polio virus), and a CAR T cells (being studied in Phase 1 clinical trials by University of Pennsylvania and City of Hope against EGFRvIII and interleukin-13 receptor alpha 2, respectively).

Any product candidates that we successfully develop and commercialize may compete with existing and new therapies that may become available in the future. The availability of reimbursement from government and other third-party payers will also significantly affect the pricing and competitiveness of our products.

Many of our competitors, either alone or with strategic partners, have substantially greater financial, technical and human resources than we do. Accordingly, our competitors may be more successful than we are in obtaining approval for treatments and achieving widespread market acceptance, rendering our treatments obsolete or non-competitive. Accelerated mergers and acquisitions activity in the biotechnology and pharmaceutical industries may result in even more resources being concentrated among a smaller number of our competitors. These companies also compete with us in recruiting and retaining qualified scientific and management personnel, establishing clinical trial sites and patient registration for clinical trials and acquiring technologies complementary to, or necessary for, our programs. Smaller or early-stage companies may also prove to be significant competitors, particularly through collaborative arrangements with large and established companies.

Our commercial opportunity could be substantially limited in the event that our competitors develop and commercialize products that are more effective, safer, less toxic, more convenient or cheaper than our comparable products. In geographies that are critical to our commercial success, competitors may also obtain regulatory approvals before us, resulting in our competitors building a strong market position in advance of our product's entry. We believe the competitive factors that will determine the success of our programs will be the efficacy, safety, pricing and reimbursement, and convenience of our product candidates.

Government Regulation

Our most advanced product candidate, Toca 511 & Toca FC, is subject to regulation as a combination product in the U.S., which means that it is comprised of both a drug product and a biologic product. If marketed individually, each component would be subject to different regulatory pathways and reviewed by different Centers within the FDA. A combination product, however, is assigned to a Center that will have primary

jurisdiction over its regulation based on a determination of the combination product's primary mode of action, which is the single mode of action that provides the most important therapeutic action. In the case of our Toca 511 & Toca FC product candidate, we believe that the primary mode of action is attributable to the biologic component of the product, which means that the Food and Drug Administration's Center for Biologics Evaluation and Research, or CBER, has primary jurisdiction over premarket development. We have had formal communication with the Center for Drug Evaluation and Research, or CDER, acknowledging that CBER will be the lead review agency while CDER will be a consulting agency for the Toca FC product component. Accordingly, we are investigating Toca 511 & Toca FC pursuant to a single IND and we plan to seek approval of the combination product through a single BLA. Based on our discussions with the FDA to date, we do not anticipate that the FDA will require a separate marketing authorization for Toca FC, the small molecule drug component of the combination.

Combination products comprised of biological products, such as gene therapy products, and small molecule drugs, are subject to regulation under the Federal Food, Drug, and Cosmetic Act, or FD&C Act, and the Public Health Service Act, or PHS Act, and other federal, state, local, and foreign statutes and regulations. Both the FD&C Act and the PHS Act and their corresponding regulations govern, among other things, the testing, manufacturing, safety, efficacy, labeling, packaging, storage, record keeping, distribution, reporting, advertising, and other promotional practices involving combination products. In the United States, before clinical testing of such combination products, we must submit an IND to the FDA, which reviews the clinical protocol, and the IND must become effective before clinical studies may begin. In some instances, we must also submit our protocols to the U.S. National Institutes of Health, or NIH, through its Recombinant DNA Advisory Committee, or RAC, before initiating clinical testing of gene therapy products. FDA approval also must be obtained before marketing of combination products. The process of obtaining regulatory approvals and the subsequent compliance with appropriate federal, state, local, and foreign statutes and regulations require the expenditure of substantial time and financial resources.

Within the FDA, CBER regulates gene therapy products. CBER works closely with the NIH and its RAC, which makes recommendations to the NIH on gene therapy issues and engages in a public discussion of scientific, safety, ethical and societal issues related to proposed and ongoing gene therapy protocols. The FDA and the NIH have published guidance documents with respect to the development and submission of gene therapy protocols, including informed consent documents. The FDA also has published guidance documents related to, among other things, gene therapy products in general, their preclinical assessment, observing patients involved in gene therapy studies for delayed adverse events, potency testing, and chemistry, manufacturing and control information in gene therapy INDs.

Ethical, social, and legal concerns about gene therapy, genetic testing, and genetic research could result in additional regulations restricting or prohibiting the processes we may use. Federal and state agencies, congressional committees and foreign governments have expressed interest in further regulating biotechnology. More restrictive regulations or claims that our products are unsafe or pose a hazard could prevent us from commercializing any products. New government requirements may be established that could delay or prevent regulatory approval of our product candidates under development. It is impossible to predict whether legislative changes will be enacted, regulations, policies, or guidance changed, or interpretations by agencies or courts changed, or what the impact of such changes, if any, may be.

U.S. Combination Products Development Process

The process required by the FDA before a biological product, including our Toca 511 & Toca FC combination product candidate, may be marketed in the United States generally involves the following:

- completion of nonclinical laboratory tests and animal studies according to good laboratory practices, or GLPs, and applicable requirements for the humane use of laboratory animals or other applicable regulations;

- submission to the FDA of an application for an IND, which must become effective before human clinical trials may begin;
- performance of adequate and well-controlled human clinical trials according to the FDA's regulations commonly referred to as good clinical practices, or GCPs, and any additional requirements for the protection of human research patients and their health information, to establish the safety, purity, and potency of the proposed biological product for its intended use;
- submission to the FDA of a BLA for marketing approval that includes substantive evidence of safety, purity, and potency from results of nonclinical testing and clinical trials;
- satisfactory completion of an FDA inspection of the manufacturing facility or facilities where the components of the combination product are produced and tested to assess compliance with cGMP requirements to assure that the facilities, methods and controls are adequate to preserve the product's identity, strength, quality and purity;
- potential FDA audit of the nonclinical and clinical trial sites that generated the data in support of the BLA; and
- FDA review and approval, or licensure, of the BLA.

Before testing any product candidate, including a gene therapy product, in humans, the product candidate enters the preclinical testing stage. Preclinical tests, also referred to as nonclinical studies, include laboratory evaluations of product chemistry, toxicity and formulation, as well as animal studies to assess the potential safety and activity of the product candidate. The conduct of certain preclinical tests must comply with federal regulations and requirements including GLPs.

Where a gene therapy study is conducted at, or sponsored by, institutions receiving NIH funding for recombinant DNA research, a protocol and related documentation has to be submitted to and the clinical trial registered with the NIH Office of Biotechnology Activities, or OBA, pursuant to the NIH Guidelines for Research Involving Recombinant DNA Molecules, or NIH Guidelines. Compliance with the NIH Guidelines is mandatory for investigators at institutions receiving NIH funds for research involving recombinant DNA, however many companies and other institutions not otherwise subject to the NIH Guidelines voluntarily follow them. The NIH is responsible for convening the RAC, a federal advisory committee, which discusses protocols that raise novel or particularly important scientific, safety or ethical considerations at one of its quarterly public meetings. Current NIH guidelines specify that RAC review of human gene transfer protocols should be limited to cases in which an oversight body, such as an Institutional Biosafety Committee or an Institutional Review Board, or IRB, determines that a protocol would significantly benefit from RAC review, and has been determined to meet certain additional criteria. The OBA will notify the FDA and the sponsor of the RAC's decision regarding the necessity for full public review of a gene therapy protocol. RAC proceedings and reports are posted to the OBA web site and may be accessed by the public.

The clinical trial sponsor must submit the results of the preclinical tests, together with manufacturing information, analytical data, any available clinical data or literature and a proposed clinical protocol, to the FDA as part of the IND. Some preclinical testing may continue even after the IND is submitted. The IND automatically becomes effective 30 days after receipt by the FDA, unless the FDA places the clinical trial on a clinical hold within that 30-day time period. In such a case, the IND sponsor and the FDA must resolve any outstanding concerns before the clinical trial can begin. With gene therapy protocols, if the FDA allows the IND to proceed, but the RAC decides that full public review of the protocol is warranted, the FDA will request at the completion of its IND review that sponsors delay initiation of the protocol until after completion of the RAC review process. The FDA may also impose clinical holds on a product candidate at any time before or during clinical trials due to safety concerns or non-compliance. If the FDA imposes a clinical hold, trials may not recommence without FDA authorization and then only under terms authorized by the FDA. Accordingly, we cannot be sure that submission of an IND will result in the FDA allowing clinical trials to begin, or that, once begun, issues will not arise that suspend or terminate such trials.

Clinical trials involve the administration of the product candidate to healthy volunteers or patients under the supervision of qualified investigators, generally physicians not employed by or under the clinical trial sponsor's

control. Clinical trials are conducted under protocols detailing, among other things, the objectives of the clinical trial, dosing procedures, patient selection and exclusion criteria, and the parameters to be used to monitor patient safety, including stopping rules that assure a clinical trial will be stopped if certain adverse events should occur. Each protocol and any amendments to the protocol must be submitted to the FDA as part of the IND. Clinical trials must be conducted and monitored in accordance with the FDA's regulations comprising the GCP requirements, including the requirement that all patients provide informed consent. Further, each clinical trial must be reviewed and approved by an independent IRB at or servicing each institution at which the clinical trial will be conducted. An IRB is charged with protecting the welfare and rights of clinical trial participants and considers such items as whether the risks to individuals participating in the clinical trials are minimized and are reasonable in relation to anticipated benefits. The IRB also approves the form and content of the informed consent, which must be signed by each clinical trial patient or his or her legal representative, and must monitor the clinical trial until completed. Clinical trials involving biological product candidates also must be reviewed by an institutional biosafety committee, or IBC, a local institutional committee that reviews and oversees basic and clinical research conducted at that institution. The IBC assesses the safety of the research and identifies any potential risk to public health or the environment.

Human clinical trials are typically conducted in three sequential phases that may overlap or be combined:

- *Phase 1*. The investigational product candidate is initially introduced into healthy human patients and tested for safety. In the case of some products for severe or life-threatening diseases, especially when the product candidate may be inherently too toxic to be ethically administered to healthy volunteers, the initial human testing is often conducted in patients; gene therapy is usually administered to patients in Phase 1 trials. This is also true in situations where toxicity can only be judged in patients with disease. An evaluation for preliminary evidence of efficacy can be performed at this time.
- *Phase 2*. The investigational product candidate is evaluated in a limited patient population to identify possible adverse effects and safety risks, to evaluate preliminarily the efficacy of the product candidate for specific targeted diseases, and to generate hypotheses for the dosage tolerance, optimal dosage, and dosing schedule.
- *Phase 3*. Clinical trials are undertaken to evaluate further dosage, clinical efficacy, potency, and safety in an expanded patient population at geographically dispersed clinical trial sites. These clinical trials are intended to establish the overall risk/benefit ratio of the product candidate and provide an adequate basis for product labeling.

Post-approval clinical trials, sometimes referred to as Phase 4 clinical trials, may be conducted after initial marketing approval. These clinical trials are used to gain additional experience from the treatment of patients in the intended therapeutic indication, particularly for long-term safety follow-up. The FDA recommends that sponsors observe patients for potential gene therapy-related delayed adverse events with agents such as those we are developing for a period of up to 15 years, including a minimum of five years of annual examinations followed by ten years of annual queries, either in person or by questionnaire, of clinical trial patients.

During all phases of clinical development, regulatory agencies require extensive monitoring and auditing of all clinical activities, clinical data, and clinical trial investigators. Annual progress reports detailing the results of the clinical trials must be submitted to the FDA. Written IND safety reports must be promptly submitted to the FDA, the NIH and the investigators for serious and unexpected adverse events, any findings from other trials, tests in laboratory animals or *in vitro* testing that suggest a significant risk for human patients, or any clinically important increase in the rate of a serious suspected adverse reaction over that listed in the protocol or investigator brochure. The sponsor must submit an IND safety report within 15 calendar days after the sponsor determines that the information qualifies for expedited reporting. The sponsor also must notify the FDA of any unexpected fatal or life-threatening suspected adverse reaction within seven calendar days after the sponsor's initial receipt of the information. Phase 1, Phase 2, and Phase 3 clinical trials may not be completed successfully within any specified period, if at all. The FDA, the sponsor, or its data safety monitoring board may suspend a clinical trial at any time on various grounds, including a finding that the patients are being exposed to an

unacceptable health risk. Similarly, an IRB can suspend or terminate approval of a clinical trial at its institution if the clinical trial is not being conducted in accordance with the IRB's requirements or if the investigational product candidate has been associated with unexpected serious harm to patients.

There are also requirements governing the reporting of ongoing clinical trials and completed clinical trial results to public registries. Sponsors of clinical trials of FDA-regulated products, including biologics, are required to register and disclose certain clinical trial information, which is publicly available at www.clinicaltrials.gov. Information related to the product, patient population, phase of investigation, study sites and investigators, and other aspects of the clinical trial is then made public as part of the registration. Sponsors are also obligated to discuss the results of their clinical trials after completion. Disclosure of the results of these trials can be delayed until the new product or new indication being studied has been approved. The NIH and the FDA have a publicly accessible database, the Genetic Modification Clinical Research Information System, which includes information on gene therapy trials and serves as an electronic tool to facilitate the reporting and analysis of adverse events on these trials.

Concurrent with clinical trials, companies usually complete additional animal studies and also develop additional information about the physical characteristics of the components of a combination product as well as finalize processes for manufacturing the components in commercial quantities in accordance with cGMP requirements. To help reduce the risk of the introduction of adventitious agents with use of biological products, the PHS Act emphasizes the importance of manufacturing control for products whose attributes cannot be precisely defined. The manufacturing process must be capable of consistently producing quality batches of the product candidate and, among other things, the sponsor must develop methods for testing the identity, strength, quality, potency and purity of the final product. Additionally, appropriate packaging must be selected and tested and stability studies must be conducted to demonstrate that the components of a combination product candidate do not undergo unacceptable deterioration over their shelf life.

U.S. Review and Approval Processes

After the completion of clinical trials of an investigational biologic product, FDA approval of a BLA must be obtained before commercial marketing of the product. The BLA must include results of product development, laboratory, and animal studies, human trials, information on the manufacture and composition of the product, proposed labeling and other relevant information. In addition, under the Pediatric Research Equity Act, or PREA, a BLA or supplement to a BLA must contain data to assess the safety and effectiveness of the combination product for the claimed indications in all relevant pediatric subpopulations and to support dosing and administration for each pediatric subpopulation for which the product is safe and effective. The FDA may grant deferrals for submission of data or full or partial waivers. Unless otherwise required by regulation, PREA does not apply to any product for an indication for which orphan Designation has been granted. Currently we have Orphan-Drug Designation for Toca 511 & Toca FC for the treatment of GBM. The testing and approval processes require substantial time and effort and there can be no assurance that the FDA will accept the BLA for filing and, even if filed, that any approval will be granted on a timely basis, if at all.

Under the Prescription Drug User Fee Act, or PDUFA, as amended, each BLA must be accompanied by a significant user fee. The FDA adjusts the PDUFA user fees on an annual basis. PDUFA also imposes annual product fees and annual establishment fees on facilities used to manufacture prescription drugs or biologics. Fee waivers or reductions are available in certain circumstances, including a waiver of the application fee for the first application filed by a small business. Additionally, no user fees are assessed on BLAs for products designated as orphan drugs, unless the application also includes a non-orphan indication.

Within 60 days following submission of the application, the FDA reviews a BLA submitted to determine if it is substantially complete before the agency accepts it for filing. The FDA may refuse to file any BLA that it deems incomplete or not properly reviewable at the time of submission and may request additional information.

In this event, the BLA must be resubmitted with the additional information. The resubmitted application also is subject to an initial filing review before the FDA accepts it for filing. Once the submission is accepted for filing, the FDA begins an in-depth substantive review of the BLA. The FDA reviews the BLA to determine, among other things, whether the proposed product is safe and potent, or effective, for its intended use, and has an acceptable purity profile, and whether the product is being manufactured in accordance with cGMP to assure and preserve the product's identity, safety, strength, quality, potency and purity. The FDA may refer applications for novel products or products that present difficult questions of safety or efficacy to an advisory committee, typically a panel that includes clinicians and other experts, for review, evaluation and a recommendation as to whether the application should be approved and under what conditions. The FDA is not bound by the recommendations of an advisory committee, but it considers such recommendations carefully when making decisions. During the product approval process, the FDA also will determine whether a Risk Evaluation and Mitigation Strategy, or REMS, is necessary to assure the safe use of the product. If the FDA concludes that a REMS is needed, the sponsor of the BLA must submit a proposed REMS; the FDA will not approve the BLA without a REMS, if required.

Before approving a BLA, the FDA will inspect the facilities at which the product is manufactured. The FDA will not approve the product unless it determines that the manufacturing processes and facilities are in substantial compliance with cGMP requirements and adequate to assure consistent production of the product within required specifications. Additionally, before approving a BLA, the FDA will typically inspect one or more clinical sites, to assure that the clinical trials were conducted in compliance with GCP requirements. To assure cGMP, GLP and GCP compliance, an applicant must incur significant expenditure of time, money, and effort in the areas of training, record keeping, production, and quality control.

Notwithstanding the submission of relevant data and information, the FDA may ultimately decide that the BLA does not satisfy its regulatory criteria for approval and deny approval. Data obtained from clinical trials are not always conclusive and the FDA may interpret data differently from how we interpret the same data. If the agency decides not to approve the BLA in its present form, the FDA will issue a complete response letter that usually describes all of the specific deficiencies in the BLA identified by the FDA. The deficiencies identified may be minor, for example, requiring labeling changes, or major, for example, requiring additional clinical trials. Additionally, the complete response letter may include recommended actions that the applicant might take to place the application in a condition for approval. If a complete response letter is issued, the applicant may either resubmit the BLA, addressing all of the deficiencies identified in the letter, or withdraw the application.

If a product candidate receives regulatory approval, the approval may be significantly limited to specific diseases and dosages or the indications for use may otherwise be limited, which could restrict the commercial value of the product. Further, the FDA may require that certain contraindications, warnings, or precautions be included in the product labeling. The FDA may impose restrictions and conditions on product distribution, prescribing, or dispensing in the form of a risk management plan, or otherwise limit the scope of any approval. In addition, the FDA may require post marketing clinical trials, sometimes referred to as Phase 4 clinical trials, designed to assess further a biological product's safety and effectiveness, and testing and surveillance programs to monitor the safety of approved products that have been commercialized.

One of the performance goals agreed to by the FDA under the PDUFA is to review 90% of original standard BLAs within 10 months of the 60 day filing date and 90% of original priority BLAs within six months of the 60 day filing date, whereupon a review decision is to be made. The FDA does not always meet its PDUFA goal dates for standard and priority BLAs and its review goals are subject to change from time to time. The review process and the PDUFA goal date may be extended by three months if the FDA requests or the BLA sponsor otherwise provides additional information or clarification regarding information already provided in the submission within the last three months before the PDUFA goal date.

Orphan-Drug Designation

Under the Orphan-Drug Act, the FDA may grant orphan designation to a drug or biological product intended to treat a rare disease or condition, which is generally a disease or condition that affects fewer than 200,000 individuals in the United States, or more than 200,000 individuals in the United States for which there is no reasonable expectation that the cost of developing and making a drug or biological product available in the United States for this type of disease or condition will be recovered from sales of the product. Orphan product designation must be requested before submitting a BLA. After the FDA grants orphan product designation, the identity of the therapeutic agent and its potential orphan use are disclosed publicly by the FDA. We have been granted Orphan-Drug Designation by the FDA for Toca 511 & Toca FC for the treatment of GBM, which is a subset of HGG, the indication that we are initially pursuing. Orphan product designation does not convey any advantage in or shorten the duration of the regulatory review and approval process. There can be no assurance that we will receive Orphan-Drug Designation for additional indications or for any additional product candidates.

If a product candidate that has orphan designation subsequently receives the first FDA approval for the disease or condition for which it has such designation, the product is entitled to orphan product exclusivity, which means that the FDA may not approve any other applications to market the same drug or biological product for the same indication for seven years, except in limited circumstances, such as a showing of clinical superiority to the product with orphan exclusivity. Competitors, however, may receive approval of different products for the indication for which the orphan product has exclusivity or obtain approval for the same product but for a different indication for which the orphan product has exclusivity. Orphan product exclusivity also could block the approval of one of our products for seven years if a competitor obtains approval of the same biological product as defined by the FDA or if our product candidate is determined to be contained within the competitor's product for the same indication or disease. If a drug or biological product designated as an orphan product receives marketing approval for an indication broader than what is designated, it may not be entitled to orphan product exclusivity.

Expedited Development and Review Programs

The FDA has four programs in place intended to facilitate and expedite development and review of new drugs and biologics intended to address unmet medical needs in the treatment of serious or life-threatening conditions: Fast Track Designation, Breakthrough Therapy Designation, accelerated approval, and priority review designation.

The Fast Track program is intended to expedite or facilitate the process for reviewing a new product if it is intended for the treatment of a serious or life-threatening disease or condition, and it demonstrates the potential to address unmet medical needs for such a disease or condition. Fast Track Designation applies to the combination of the product and the specific indication for which it is being studied. The sponsor of a new drug or biologic may request the FDA to designate the drug or biologic as a Fast Track product at any time during the clinical development of the product. Unique to a Fast Track product, the FDA may consider for review sections of the marketing application on a rolling basis before the complete application is submitted, if the sponsor provides a schedule for the submission of the sections of the application, the FDA agrees to accept sections of the application and determines that the schedule is acceptable, and the sponsor pays any required user fees upon submission of the first section of the application. We have received Fast Track Designation of Toca 511 & Toca FC for the treatment of patients with recurrent HGG, to improve their overall survival.

A new product can receive Breakthrough Therapy Designation if it is intended, alone or in combination with one or more other drugs, to treat a serious or life-threatening disease or condition and preliminary clinical evidence indicates that it may demonstrate substantial improvement over existing therapies on one or more clinically significant endpoints, such as substantial treatment effects observed early in clinical development. A Breakthrough Therapy Designation conveys all of the features of Fast Track Designation in addition to more

intensive FDA guidance on an efficient development program, organizational commitment involving senior managers, and eligibility for priority review. Specifically, FDA intends to expedite the development and review of a Breakthrough Therapy by, where appropriate, intensively involving senior managers and experienced review staff in a proactive collaborative, cross-disciplinary review. Where appropriate, FDA also intends to assign a cross-disciplinary project lead for the review team to facilitate an efficient review of the development program. The FDA notes that a compressed drug development program still must generate adequate data to demonstrate that the drug or biologic meets the statutory standard for approval. Omitting components of the development program that are necessary for such a determination can significantly delay, or even preclude, marketing approval.

The FDA has granted Toca 511 & Toca FC Breakthrough Therapy Designation for the treatment of recurrent HGG. Our Breakthrough Therapy Designation application was based on data from three Phase 1 ascending-dose clinical trials involving 126 patients with recurrent brain cancer. The clinical data included results published in Science Translational Medicine, including safety data, patient survival data and data regarding durable, complete or partial tumor shrinkage as determined by independent radiology review. In addition, preclinical information was provided to the FDA supporting a novel immunological mechanism of action involving the depletion of immune-suppressive myeloid cells in the tumor microenvironment.

Breakthrough Therapy Designation indicates that preliminary clinical evidence demonstrates the drug may have substantial improvement on one or more clinically significant endpoints over available therapy. Breakthrough Therapy Designation intensifies FDA involvement to ensure an efficient drug development program and is an organizational commitment from the FDA to involve its senior managers. We have up to six months after receiving the Breakthrough Therapy Designation to request an Initial Comprehensive Multidisciplinary meeting to discuss the drug development program. This initial meeting is a Type B meeting, used to discuss the overarching, high-level plan for drug development. The discussion will include topics such as planned clinical trials and endpoints, any resizing or adaptations to the trials, plans for expediting the manufacturing development strategy and studies that potentially could be completed after approval. When Breakthrough Therapy Designation has been granted, the FDA is encouraged to meet regularly with the sponsor and subsequent meetings are considered Type B meetings and are established based on the needs of the program.

The FDA may grant Accelerated Approval to a product candidate for a serious or life-threatening condition upon a determination that the product candidate has an effect on a surrogate endpoint that is reasonably likely to predict clinical benefit, or an effect on a clinical endpoint that can be measured earlier than an effect on irreversible morbidity or mortality, that is reasonably likely to predict an effect on irreversible morbidity or mortality or other clinical benefit, taking into account the severity, rarity, or prevalence of the condition and the availability or lack of alternative treatments. Accelerated approval is usually contingent on a sponsor's agreement to conduct adequate and well-controlled additional post-approval trials to verify and describe the product's clinical benefit. In addition, the FDA currently requires as a condition for accelerated approval pre-approval of promotional materials, which could adversely impact the timing of the commercial launch of the product.

Fast Track Designation, Breakthrough Therapy Designation, and accelerated approval do not change the standards for approval but may expedite the development process.

An application for a product candidate may be eligible to obtain Priority Review Designation if it is intended to treat a serious condition and, if approved, would provide a significant improvement in safety or effectiveness. The FDA will attempt to direct additional resources to the evaluation of an application for a new product designated for priority review in an effort to facilitate the review. A Priority Review Designation means FDA's goal is to take action on the marketing application within six months (compared to 10 months under standard review) of the 60-day filing date. Priority Review Designation does not change the standards for approval but may expedite the review process.

Post-Approval Requirements

Maintaining post-approval compliance with applicable federal, state, and local statutes and regulations requires the expenditure of substantial time and financial resources. Rigorous and extensive FDA regulation of combination products continues after approval, particularly with respect to cGMP. We rely, and expect to continue to rely, on third parties for the production and distribution of clinical and commercial quantities of any products that we may commercialize. Manufacturers of our products are required to comply with applicable requirements in the cGMP regulations, including quality control and quality assurance and maintenance of records and documentation. Other post-approval requirements applicable to combination products include reporting of cGMP deviations that may affect the identity, potency, purity and overall safety of a distributed product, record-keeping requirements, reporting of adverse effects, reporting updated safety and efficacy information, and complying with electronic record and signature requirements. After a BLA is approved, the product also may be subject to official lot release. As part of the manufacturing process, the manufacturer is required to perform certain tests on each lot of the product before it is released for distribution. If the product is subject to official release by the FDA, the manufacturer submits samples of each lot of product to the FDA together with a release protocol showing a summary of the history of manufacture of the lot and the results of all of the manufacturer's tests performed on the lot. The FDA also may perform certain confirmatory tests on lots of some products, such as viral vaccines, before releasing the lots for distribution by the manufacturer. In addition, the FDA conducts laboratory research related to the regulatory standards on the safety, purity, potency, and effectiveness of combination products.

We also must comply with the FDA's advertising and promotion requirements, such as those related to direct-to-consumer advertising, the prohibition on promoting products for uses or in patient populations that are not described in the product's approved labeling (known as "off-label use"), industry-sponsored scientific and educational activities, and promotional activities involving the internet. Discovery of previously unknown problems or the failure to comply with the applicable regulatory requirements may result in restrictions on the marketing of a product or withdrawal of the product from the market as well as possible civil or criminal sanctions. Failure to comply with the applicable U.S. requirements at any time during the product development process, approval process or after approval, may subject an applicant or manufacturer to administrative or judicial civil or criminal sanctions and adverse publicity. FDA sanctions could include refusal to approve pending applications, withdrawal of an approval, clinical hold, warning or untitled letters, product recalls, product seizures, total or partial suspension of production or distribution, injunctions, fines, refusals of government contracts, mandated corrective advertising or communications with doctors, debarment, restitution, disgorgement of profits, or civil or criminal penalties. Any agency or judicial enforcement action could have a material adverse effect on us.

Manufacturers and other entities involved in the manufacture and distribution of approved products are required to register the establishments where the approved products are made with the FDA and certain state agencies, and are subject to periodic unannounced inspections by the FDA and certain state agencies for compliance with cGMPs and other laws. Accordingly, manufacturers must continue to expend time, money, and effort in the area of production and quality control to maintain cGMP compliance. Discovery of problems with a product after approval may result in restrictions on a product, manufacturer, or holder of an approved BLA, including withdrawal of the product from the market. In addition, changes to the manufacturing process or facility generally require prior FDA approval before being implemented. Other types of changes to the approved product, such as adding new indications and additional labeling claims, are also subject to further FDA review and approval.

U.S. Patent Term Restoration

Depending upon the timing, duration, and specifics of the FDA approval of the use of our product candidates, some of our U.S. patents may be eligible for limited patent term extension under the Drug Price Competition and Patent Term Restoration Act of 1984, commonly referred to as the Hatch-Waxman

Amendments. The Hatch-Waxman Amendments permit a patent restoration term of up to five years as compensation for patent term lost during product development and the FDA regulatory review process. However, patent term restoration cannot extend the remaining term of a patent beyond a total of 14 years from the product's approval date. The patent term restoration period is generally one-half the time between the effective date of an IND and the submission date of a BLA plus the time between the submission date of a BLA and the approval of that application. Only one patent applicable to an approved biological product is eligible for the extension and the application for the extension must be submitted prior to the expiration of the patent. The U.S. Patent and Trademark Office, in consultation with the FDA, reviews and approves the application for any patent term extension or restoration. In the future, we may intend to apply for restoration of patent term for one of our currently owned or licensed patents to add patent life beyond its current expiration date, depending on the expected length of the clinical trials and other factors involved in the filing of the relevant BLA.

Biosimilars and Exclusivity

The Biologics Price Competition and Innovation Act of 2009, or BPCIA, created an abbreviated approval pathway for biological products shown to be highly similar to, or interchangeable with, an FDA-licensed reference biological product. The FDA has issued several guidance documents outlining an approach to review and approval of biosimilars.

Biosimilarity, which requires that there be no clinically meaningful differences between the biological product and the reference product in terms of safety, purity, and potency, can be shown through analytical studies, animal studies, and a clinical study or studies. Interchangeability requires that a product is biosimilar to the reference product and the product must demonstrate that it can be expected to produce the same clinical results as the reference product in any given patient and, for products that are administered multiple times to an individual, the biologic and the reference biologic may be alternated or switched after one has been previously administered without increasing safety risks or risks of diminished efficacy relative to exclusive use of the reference biologic. However, complexities associated with the larger, and often more complex, structures of biological products, as well as the processes by which such products are manufactured, pose significant hurdles to implementation of the abbreviated approval pathway that are still being worked out by the FDA.

The BPCIA includes, among other provisions:

- A 12-year exclusivity period from the date of first licensure of the reference product, during which approval of a 351(k) application referencing that product may not be made effective;
- A four-year exclusivity period from the date of first licensure of the reference product, during which a 351(k) application referencing that product may not be submitted; and
- An exclusivity period for certain biological products that have been approved through the 351(k) pathway as interchangeable biosimilars;

The BPCIA also establishes procedures for identifying and resolving patent disputes involving applications submitted under section 351(k) of the PHS Act.

A biological product can also obtain pediatric market exclusivity in the United States. Pediatric exclusivity, if granted, adds six months to existing exclusivity periods and patent terms. This six-month exclusivity, which runs from the end of other exclusivity protection or patent term, may be granted based on the voluntary completion of a pediatric clinical trial in accordance with an FDA-issued "Written Request" for such a clinical trial.

The BPCIA is complex and only beginning to be interpreted and implemented by the FDA. In addition, recent government proposals have sought to reduce the 12-year reference product exclusivity period. Other aspects of the BPCIA, some of which may impact the BPCIA exclusivity provisions, have also been the subject of recent litigation. As a result, the ultimate impact, implementation, and meaning of the BPCIA is subject to uncertainty.

Additional U.S. Regulation

In the United States, our activities are potentially subject to regulation by various federal, state and local authorities in addition to the FDA, including but not limited to, the Centers for Medicare and Medicaid Services, or CMS, other divisions of the U.S. Department of Health and Human Services, for instance the Office of Inspector General, the U.S. Department of Justice, or DOJ, and individual U.S. Attorney offices within the DOJ, and state and local governments. For example, sales, marketing and scientific/educational grant programs must comply with the anti-fraud and abuse provisions of the Social Security Act, the false claims laws, the physician payment transparency laws, the privacy and security provisions of the Health Insurance Portability and Accountability Act, or HIPAA, as amended by the Health Information Technology for Economic and Clinical Health Act, or HITECH, and similar state laws, each as amended.

In addition to the foregoing, state and federal laws regarding environmental protection and hazardous substances, including the Occupational Safety and Health Act, the Resource Conservancy and Recovery Act and the Toxic Substances Control Act, may affect our business. These and other laws govern our use, handling and disposal of various biological, chemical, and radioactive substances used in, and wastes generated by, our operations. If our operations result in contamination of the environment or expose individuals to hazardous substances, we could be liable for damages and governmental fines. We believe that we are in material compliance with applicable environmental laws and that continued compliance therewith is unlikely to have a material adverse effect on our business. We cannot predict, however, how changes in these laws may affect our future operations.

Federal and State Fraud and Abuse Laws

In the United States, our activities are potentially subject to regulation by various federal, state and local authorities in addition to the FDA, including but not limited to, CMS, other divisions of the U.S. Department of Health and Human Services, for instance, the Office of Inspector General, DOJ, and individual U.S. Attorney offices within the DOJ, and state and local governments. These federal and state laws, which generally will not be applicable to us or our product candidates unless and until we obtain FDA marketing approval for any of our product candidates, include, among others, anti-kickback statutes, false claims statutes, transparency laws, privacy and regulation regarding providing drug samples, sales and marketing activities and our relationships with customers and payors as follows.

The federal Anti-Kickback Statute prohibits, among other things, individuals and entities from knowingly and willfully offering, paying, soliciting, or receiving any remuneration, directly or indirectly, overtly or covertly, to induce or in return for purchasing, leasing, recommending, ordering, or arranging for the purchase, lease, recommendation or order of any health care item or service reimbursable, in whole or in part, under Medicare, Medicaid, or other federally financed healthcare programs. This statute has been interpreted to apply to arrangements between pharmaceutical manufacturers on one hand and prescribers, purchasers, and formulary managers on the other. Although there are a number of statutory exemptions and regulatory safe harbors protecting certain common activities from prosecution, the exemptions and safe harbors are drawn narrowly, and practices that involve remuneration that may be alleged to be intended to induce prescribing, purchases, or recommendations may be subject to scrutiny if they do not qualify for an exemption or safe harbor. Additionally, the intent standard under the Anti-Kickback Statute was amended by the Affordable Care Act to a stricter standard such that a person or entity does not need to have actual knowledge of the statute or specific intent to violate it in order to have committed a violation. Further, the Affordable Care Act codified case law that a claim including items or services resulting from a violation of the federal Anti-Kickback Statute constitutes a false or fraudulent claim for purposes of the federal civil False Claims Act.

HIPAA created additional federal criminal statutes that prohibit, among other actions, knowingly and willfully executing, or attempting to execute, a scheme to defraud or to obtain, by means of false or fraudulent

pretenses, representations or promises, any money or property owned by, or under the control or custody of, any healthcare benefit program, including private third-party payers, willfully obstructing a criminal investigation of a healthcare offense, and knowingly and willfully falsifying, concealing or covering up by trick, scheme or device, a material fact or making any materially false, fictitious or fraudulent statement in connection with the delivery of or payment for healthcare benefits, items or services. Similar to the federal Anti-Kickback Statute, a person or entity does not need to have actual knowledge of the statute or specific intent to violate it in order to have committed a violation.

Federal false claims and civil monetary penalties laws, including the federal civil False Claims Act, prohibit, among other things, any person or entity from knowingly presenting, or causing to be presented, a false, fictitious or fraudulent claim for payment to, or approval by, the federal government, or knowingly making, using, or causing to be made or used, a false statement to get a false claim paid. Several pharmaceutical and other health care companies have been prosecuted under these laws for allegedly providing free product to customers with the expectation that the customers would bill federal programs for the product. Other companies have been prosecuted for causing false claims to be submitted because of the company's marketing of the product for unapproved, and thus non-reimbursable, uses.

The majority of states also have statutes or regulations similar to the federal Anti-Kickback Statute and false claims laws, which apply to items and services, reimbursed under Medicaid and other state programs, or, in several states, apply regardless of the payer.

We may also be subject to data privacy and security regulations by both the federal government and the states in which we conduct our business. HIPAA, as amended by HITECH, and their respective implementing regulations, including the final Omnibus Rule published on January 25, 2013, imposes requirements on certain types of entities, including mandatory contractual terms, relating to the privacy, security, and transmission of individually identifiable health information. Among other things, HITECH makes HIPAA's security standards and certain privacy standards directly applicable to business associates, which are independent contractors or agents of covered entities that create, receive, maintain or transmit protected health information in connection with providing a service for or on behalf of a covered entity. HITECH also created four new tiers of civil monetary penalties, amended HIPAA to make civil and criminal penalties directly applicable to business associates, and gave state attorneys general new authority to file civil actions for damages or injunctions in federal courts to enforce the federal HIPAA laws and seek attorneys' fees and costs associated with pursuing federal civil actions. In addition, many state laws govern the privacy and security of health information in specified circumstances, many of which differ from each other and from HIPAA in significant ways and may not have the same requirements, thus complicating compliance efforts.

Additionally, the federal Physician Payments Sunshine Act under the Affordable Care Act, and its implementing regulations, require that certain manufacturers of drugs, devices, biological and medical supplies for which payment is available under Medicare, Medicaid or the Children's Health Insurance Program, with certain exceptions, annually report to CMS information related to certain payments or other transfers of value made or distributed to physicians and teaching hospitals, or to entities or individuals at the request of, or designated on behalf of, the physicians and teaching hospitals and to report annually certain ownership and investment interests held by physicians and their immediate family members. Failure to submit timely, accurately, and completely the required information may result in civil monetary penalties of up to an aggregate of $150,000 per year and up to an aggregate of $1 million per year for "knowing failures". Certain states also mandate implementation of compliance programs, impose restrictions on pharmaceutical manufacturer marketing practices, and/or require the tracking and reporting of gifts, compensation, and other remuneration to healthcare providers and entities.

Because of the breadth of these laws and the narrowness of the exceptions and safe harbors, it is possible that some of our business activities could be subject to challenge under one or more of such laws. Such a challenge could have a material adverse effect on our business, financial condition, and results of operations. If

our operations are found to be in violation of any of these or any other health regulatory laws that may apply to us, we may be subject to, without limitation, significant penalties, including the imposition of significant civil, criminal and administrative penalties, damages, monetary fines, disgorgement, individual imprisonment, possible exclusion from participation in Medicare, Medicaid and other federal healthcare programs, contractual damages, reputational harm, diminished profits and future earnings, and curtailment or restructuring of our operations, any of which could adversely affect our ability to operate our business and our results of operations.

In addition, as part of the sales and marketing process, pharmaceutical companies frequently provide samples of approved products to physicians. This practice is regulated by the FDA and other governmental authorities, including, in particular, requirements concerning record keeping and control procedures. Any failure to comply with the regulations may result in significant criminal and civil penalties as well as damage to our credibility in the marketplace.

Coverage and Reimbursement

In many of the markets where we may do business in the future, the prices of pharmaceutical products are subject to direct price controls (by law) and to reimbursement programs with varying price control mechanisms. In the United States, significant uncertainty exists as to the coverage and reimbursement status of any product candidates for which we obtain product approval. Often private payers follow the coverage and reimbursement decisions of the Medicare program, and it is difficult to predict how CMS may decide to cover and reimburse approved products, especially novel products, and those determinations are subject to change.

Moreover, the process for determining whether a third-party payer will provide coverage for a drug product may be separate from the process for setting the price of a drug product or for establishing the reimbursement rate that such a payer will pay for the drug product. Third-party payers may limit coverage to specific products on an approved list, also known as a formulary, which might not include all of the FDA-approved drugs for a particular indication. A decision by a third-party payer not to cover our product candidates could reduce physician utilization of our products once approved. A payer's decision to provide coverage for a drug product does not imply that an adequate reimbursement rate will be approved. Further, one payer's determination to provide coverage for a drug product does not assure that other payers will also provide coverage for the drug product. Coverage and reimbursement for new products can differ significantly from payer to payer. As a result, the coverage determination process will require us to provide scientific and clinical support for the use of our products to each payer separately and will be a time-consuming process. Additionally, third-party reimbursement may not be available or may not be adequate to enable us to maintain price levels sufficient to realize an appropriate return on our investment in product development.

The marketability of any product candidates for which we or our collaborators receive regulatory approval for commercial sale may suffer if the government and third-party payers fail to provide adequate coverage and reimbursement. In addition, an emphasis on cost containment measures in the United States has increased and we expect will continue to increase the pressure on pharmaceutical pricing. Third-party payers are increasingly challenging the prices charged for medical products and services, examining the medical necessity and reviewing the cost-effectiveness of drugs, medical devices and medical services, in addition to questioning safety and efficacy. If these third-party payers do not consider our products to be cost-effective compared to other available therapies, they may not cover our products after FDA approval or, if they do, the level of payment may not be sufficient to allow us to sell our products at a profit. Coverage policies and third-party reimbursement rates may change at any time. Even if favorable coverage and reimbursement status is attained for one or more products for which we or our collaborators receive regulatory approval, less favorable coverage policies and reimbursement rates may be implemented in the future.

Healthcare Reform

In March 2010, President Obama enacted the Affordable Care Act, which has the potential to substantially change healthcare financing and delivery by both governmental and private insurers, and significantly impact the

pharmaceutical and biotechnology industry. The Affordable Care Act will impact existing government healthcare programs and may result in the development of new programs.

Among the Affordable Care Act's provisions of importance to the pharmaceutical and biotechnology industries, in addition to those otherwise described above, are the following:

- an annual, nondeductible fee on any entity that manufactures or imports certain specified branded prescription drugs and biologic agents apportioned among these entities according to their market share in some government healthcare programs;
- an increase in the statutory minimum rebates a manufacturer must pay under the Medicaid Drug Rebate Program, to 23.1% and 13% of the average manufacturer price for most branded and generic drugs, respectively and capped the total rebate amount for innovator drugs at 100% of the Average Manufacturer Price, or AMP;
- a new methodology by which rebates owed by manufacturers under the Medicaid Drug Rebate Program are calculated for certain drugs and biologics, including our product candidates, that are inhaled, infused, instilled, implanted or injected;
- extension of manufacturers' Medicaid rebate liability to covered drugs dispensed to individuals who are enrolled in Medicaid managed care organizations;
- expansion of eligibility criteria for Medicaid programs by, among other things, allowing states to offer Medicaid coverage to additional individuals and by adding new mandatory eligibility categories for individuals with income at or below 133% of the federal poverty level, thereby potentially increasing manufacturers' Medicaid rebate liability;
- a new Medicare Part D coverage gap discount program, in which manufacturers must agree to offer 50% point-of-sale discounts off negotiated prices of applicable brand drugs to eligible beneficiaries during their coverage gap period, as a condition for the manufacturer's outpatient drugs to be covered under Medicare Part D;
- expansion of the entities eligible for discounts under the Public Health Service pharmaceutical pricing program;
- a new Patient-Centered Outcomes Research Institute to oversee, identify priorities in, and conduct comparative clinical effectiveness research, along with funding for such research;
- establishment of a Center for Medicare Innovation at CMS to test innovative payment and service delivery models to lower Medicare and Medicaid spending, potentially including prescription drug spending that began on January 1, 2011; and
- a licensure framework for follow on biologic products.

Since its enactment, there have been judicial and Congressional challenges to certain aspects of the Affordable Care Act, and we expect there will be additional challenges and amendments to the Affordable Care Act in the future. The new Presidential Administration and U.S. Congress will likely continue to seek to modify, repeal or otherwise invalidate all, or certain provisions of, the Affordable Care Act. It is uncertain the extent to which any such changes may impact our business or financial condition.

Other legislative changes have been proposed and adopted in the United States since the Affordable Care Act was enacted. For example, in August 2011, the Budget Control Act of 2011, among other things, created measures for spending reductions by Congress. A Joint Select Committee on Deficit Reduction, tasked with recommending a targeted deficit reduction of at least $1.2 trillion for the fiscal year 2012 through 2021, was unable to reach required goals, thereby triggering the legislation's automatic reduction to several government programs. This includes aggregate reductions of Medicare payments to providers of up to 2% per fiscal year, which went into effect in April 2013 and, due to the Bipartisan Budget Act of 2015, will remain in effect through 2025 unless additional Congressional action is taken. Further, in January 2013, President Obama signed into law the American Taxpayer Relief Act of 2012, which, among other things, further reduced Medicare payments to several providers, including hospitals, imaging centers and cancer treatment centers, and increased the statute of limitations period for the government to recover overpayments to providers from three to five years.

We anticipate that the Affordable Care Act and other legislative reforms will result in additional downward pressure on the price that we receive for any approved product, if covered, and could seriously harm our business. Any reduction in reimbursement from Medicare and other government programs may result in a similar reduction in payments from private payers. The implementation of cost containment measures or other healthcare reforms may prevent us from being able to generate revenue, attain profitability, or commercialize our products. In addition, it is possible that there will be further legislation or regulation that could harm our business, financial condition, and results of operations.

Environmental Regulation

In addition to the foregoing, state and federal laws regarding environmental protection and hazardous substances, including the Occupational Safety and Health Act, the Resource Conservancy and Recovery Act and the Toxic Substances Control Act, may affect our business. These and other laws govern our use, handling and disposal of various biological, chemical, and radioactive substances used in, and wastes generated by, our operations. If our operations result in contamination of the environment or expose individuals to hazardous substances, we could be liable for damages and governmental fines. We believe that we are in material compliance with applicable environmental laws and that continued compliance therewith is unlikely to have a material adverse effect on our business. We cannot predict, however, how changes in these laws may affect our future operations.

U.S. Foreign Corrupt Practices Act

The U.S. Foreign Corrupt Practices Act, to which we are subject, prohibits corporations and individuals from engaging in certain activities to obtain or retain business or to influence a person working in an official capacity. It is illegal to pay, offer to pay or authorize the payment of anything of value to any foreign government official, government staff member, political party, or political candidate in an attempt to obtain or retain business or to influence otherwise a person working in an official capacity.

Government Regulation Outside of the United States

In addition to regulations in the United States, we will be subject to a variety of regulations in other jurisdictions governing, among other things, clinical trials and any commercial sales and distribution of our products. Because biologically sourced raw materials are subject to unique contamination risks, their use may be subjected to different types of restrictions in different countries.

Whether or not we obtain FDA approval for a product, we must obtain the required approvals from regulatory authorities in foreign countries prior to the commencement of clinical trials or marketing of the product in those countries. Certain countries outside of the United States have a similar process that requires the submission of a clinical trial application equivalent to an IND prior to the commencement of human clinical trials. In the European Union, for example, a clinical trial authorization, or CTA, must be submitted to each country's national health authority and an independent ethics committee, much like the FDA and the IRB, respectively. Once the CTA is approved in accordance with a country's requirements, clinical trials may start.

The requirements and process governing the conduct of clinical trials, product licensing, pricing, and reimbursement vary from country to country. In all cases, the clinical trials are to be conducted in accordance with GCP, applicable regulatory requirements, and the ethical principles that have their origin in the Declaration of Helsinki.

If we fail to comply with applicable foreign regulatory requirements, we may be subject to, among other things, fines, suspension, or withdrawal of regulatory approvals, product recalls, seizure of products, operating restrictions and criminal prosecution in those countries.

Legal Proceedings

From time to time, we are subject to various legal proceedings and claims that arise in the ordinary course of our business activities. Although the results of litigation and claims cannot be predicted with certainty, as of the date of this prospectus, we do not believe we are party to any claim or litigation the outcome of which, if determined adversely to us, would individually or in the aggregate be reasonably expected to have a material adverse effect on our business. Regardless of the outcome, litigation can have an adverse impact on us because of defense and settlement costs, diversion of management resources and other factors.

Facilities

Our corporate headquarters are located in San Diego, California. Our current leased facility encompasses approximately 17,000 square feet of laboratory and office space. The lease for this facility expires in February 2018. We believe that our existing facilities are adequate to meet our current needs and that this facilities lease can be renewed, or that suitable additional alternative spaces will be available in the future, on commercially reasonable terms.

Research and Development

Our research and development expenses were $19.2 million and $27.2 million for the years ended December 31, 2015 and 2016, respectively.

Employees

As of December 31, 2016, we had 61 full-time employees, 18 of whom have Ph.D. or M.D. degrees. Of these full-time employees, 49 employees are engaged in research and development activities and 12 employees are engaged in finance and general management activities including accounting, contracts, human resources, information technology, investor relations, marketing and business development. We have no collective bargaining agreements with our employees and we have not experienced any work stoppages. We consider our relations with our employees to be good.

MANAGEMENT

The following table sets forth information about our executive officers and directors as of March 1, 2017.

Name	Age	Position(s)
Executive Officers		
Martin J. Duvall	54	Chief Executive Officer and Director
Harry E. Gruber, M.D.	64	President, Research and Development and Director
Dennis N. Berman	66	Executive Vice President, Corporate Development and Director
Thomas E. Darcy	66	Executive Vice President and Director
Asha Das, M.D.	52	Senior Vice President and Chief Medical Officer
Mark Foletta	56	Executive Vice President and Chief Financial Officer
Douglas Jolly, Ph.D.	69	Executive Vice President, Research and Pharmaceutical Development
Non-Employee Directors		
Faheem Hasnain(1) (2) (3)	58	Director and Chairman of the Board of Directors
Franklin M. Berger(1) (3)	67	Director
Lori Kunkel, M.D. (2)	59	Director
David Parkinson, M.D. (1)	66	Director
Paul Schimmel, Ph.D. (2)	76	Director

(1) Member of the audit committee.

(2) Member of the compensation committee.

(3) Member of the nominating and corporate governance committee.

Executive Officers

Martin J. Duvall has served as our Chief Executive Officer and as a member of our board of directors since November 2016. Prior to joining us, Mr. Duvall served as Executive Vice President, Chief Commercial Officer of ARIAD Pharmaceuticals, Inc., a publicly-held biotechnology company, from September 2011 to June 2016. From December 2010 to September 2011, he served as Senior Vice President and General Manager for the oncology franchise at Merck & Co., Inc., a publicly-held healthcare company. Prior to that, he served in similar capacities at Abraxis Bioscience, Inc., a publicly-held biotechnology company, and MGI Pharma, Inc., a publicly-held biopharmaceutical company, and in positions of increasing responsibility at Sanofi US, a publicly-held biotechnology company. Mr. Duvall received his B.S. degree in chemistry from Muhlenberg College, his M.A. degree in chemistry from Johns Hopkins University and his M.B.A. from the University of Kansas. We believe that Mr. Duvall's experience in managing and building biotechnology companies qualifies him to serve as a member of our board of directors.

Harry E. Gruber, M.D. has served as our President, Research and Development since November 2016 and as a member of our board of directors since August 2007. Dr. Gruber served as our Chief Executive Officer from August 2007 to November 2016 and served as Chairman of our board of directors from August 2007 to October 2014. Dr. Gruber is a co-founder of Tocagen and has been the co-founder and/or co-inventor of key technology for the following publicly-held companies: Gensia Inc., a biopharmaceutical company, Viagene Inc., a gene therapy company, Aramed, Inc., a biopharmaceutical company, INTERVU Inc., a technology company, and Kintera, Inc., a technology company. Dr. Gruber holds a B.A. and an M.D. from the University of Pennsylvania and trained in Internal Medicine, Biochemical Genetics and Rheumatology/Immunology at the University of California, San Diego, where he subsequently joined the medical school faculty until founding Gensia Inc. We believe that Dr. Gruber's experience in founding, managing and building biotechnology and high tech companies qualifies him to serve on our board of directors.

Dennis N. Berman has served as our Executive Vice President, Corporate Development and as a member of our board of directors since December 2007. Mr. Berman is a co-founder of Tocagen. Prior to joining us, he was an Executive Vice President, Director and co-founder of Kintera, Inc., a technology company, where he served for seven years. Prior to co-founding Kintera, Inc., Mr. Berman was Vice President of Corporate Development of INTERVU Inc., a technology company, where he oversaw strategic alliances and financings. Prior to INTERVU Inc., Mr. Berman was a partner in large law firms. Mr. Berman received his Bachelor of Arts degree from the University of Pennsylvania and his Bachelor of Science degree from The Wharton School at the University of Pennsylvania. Mr. Berman also holds a General Course Certificate from the London School of Economics and received his Juris Doctor from Harvard Law School. We believe that Mr. Berman's experience in founding and managing companies and his legal expertise qualify him to serve as a member of our board of directors. Mr. Berman has tendered his resignation as an executive officer and member of our board of directors effective as of April 15, 2017.

Thomas E. Darcy has served as our Executive Vice President and as a member of our board of directors since August 2007 and served as our Chief Financial Officer from August 2007 to February 2017. Mr. Darcy is a co-founder of Tocagen. Prior to joining us, Mr. Darcy served for over five years as Executive Vice President and Chief Financial Officer of Science Applications International Corporation, or SAIC, a publicly-held science and technology company. Mr. Darcy also served as a director and chairman of the audit committee of McAfee, Inc., a publicly-held technology company, for over three years until its sale to Intel Corporation in February 2011. Mr. Darcy also currently serves as a director and chairman of the audit committee of Lytx, Inc., a privately-held technology company, and the San Diego County YMCA. Prior to SAIC, he was a Partner in the accounting firm of PricewaterhouseCoopers LLP, where he served as the Managing Partner of both the West and Southwest Region Audit and Business Advisory Service Technology practices, as well as the Managing Partner of the San Diego office. Mr. Darcy is a Certified Public Accountant (inactive) in the state of California and graduated from San Diego State University with a B.S. in Accounting. We believe that Mr. Darcy's board, financial and management expertise qualifies him to serve as a member of our board of directors. Mr. Darcy has notified us that he intends to resign as our Executive Vice President shortly following the closing of this offering but he will remain a member of our board of directors.

Asha Das, M.D. has served as our Senior Vice President and Chief Medical Officer since March 2017 and served as our acting Chief Medical Officer from May 2016 to March 2017 and as our Vice President, Clinical Development and Medical Affairs from April 2015 to March 2017. From April 2008 to April 2015, Dr. Das served in positions of increasing responsibility at Genentech Inc., a biotechnology company and member of the Roche Group, initially as Associate Medical Director and ultimately as Group Medical Director. From 2005 to 2008, Dr. Das served as Associate Medical Director at Eisai Inc., a pharmaceutical company. Prior to that, Dr. Das was head of the neuro-oncology program at Cedars-Sinai Medical Center. Dr. Das is certified in neurology by the American Board of Psychiatry and Neurology and in the sub-specialty of neuro-oncology by the United Council for Neurologic Subspecialties and previously served as a clinical fellow in neuro-oncology at Massachusetts General Hospital. Dr. Das has completed a residency in neurology at Cornell Medical Center and has held academic appointments at the University of California, Los Angeles; University of California, San Francisco; and National University of Singapore. Dr. Das obtained her M.D. and bachelor's degree from Cornell University.

Mark Foletta has served as our Executive Vice President and Chief Financial Officer since February 2017. Prior to joining us, Mr. Foletta served as the Interim Chief Financial Officer of Biocept, Inc., a publicly-held diagnostics company, from August 2015 to July 2016, as an employee of Biocept, Inc. assisting with the Chief Financial Officer transition in August 2016 and as a consultant to Biocept, Inc. on a part-time basis from September 2016 to October 2016. Mr. Foletta served as Senior Vice President, Finance and Chief Financial Officer of Amylin Pharmaceuticals, Inc., or Amylin, a publicly-held biopharmaceutical company, from March 2006 until October 2012 and as Vice President, Finance and Chief Financial Officer of Amylin from March 2000 until March 2006. Mr. Foletta serves as a member of the board of directors, chairman of the audit committee and member of the nominating and governance committee of Regulus Therapeutics, Inc., a publicly-held

biopharmaceutical company, as lead director of the board of directors and chairman of the audit committee of DexCom, Inc., a publicly-held medical device company and as a member of the board of directors and chairman of the audit committee of AMN Healthcare Services, Inc., a publicly-held healthcare workforce and staffing company, and Viacyte, Inc., a privately-held biotechnology company. Mr. Foletta previously served as a member of the board of directors of Ambit Biosciences Corporation and Anadys Pharmaceuticals, Inc., each a publicly-held biopharmaceutical company. Mr. Foletta received a B.A. from the University of California, Santa Barbara. He is a Certified Public Accountant (inactive) and a member of the Corporate Directors Forum.

Douglas Jolly, Ph.D. has served as our Executive Vice President, Research and Pharmaceutical Development since December 2007. Dr. Jolly is a co-founder of Tocagen and an internationally recognized expert in the field of gene therapy and its pharmaceutical application. Over the last 25 years he has been a senior biotechnology executive involved in translating gene-based products from research through clinical development at the following companies: Viagene, Inc., where he was also a co-founder, Chiron Corporation, Oxford BioMedica plc, where he ran the U.S. subsidiary, BioMedica Inc., and Advantagene, Inc. Before entering the biopharmaceutical industry, Dr. Jolly pursued his academic career in biophysics and molecular biology at the Weizmann Institute, Harvard Medical School, Scripps Clinic, the University of California, San Diego and The French National Institute for Health and Medical Research, INSERM, in Paris, France. Dr. Jolly holds a Ph.D. in Biochemistry from the University of Glasgow. Dr. Jolly is a board member, chairman of the Industrial Liaison Committee, and also currently serves as a member of the Translational Medicine Committee, of the American Society of Gene & Cell Therapy.

Non-Employee Directors

Faheem Hasnain has served as the Chairman of our board of directors since October 2014. Mr. Hasnain served as President, Chief Executive Officer and as a member of the board of directors of Receptos, Inc., or, Receptos, a publicly-held biopharmaceutical company, from November 2010 until the company's acquisition by Celgene Corporation in August 2015. Prior to joining Receptos, Mr. Hasnain was the President and Chief Executive Officer and a director of Facet Biotech Corporation, or Facet Biotech, a publicly-held biology driven antibody company with a focus in multiple sclerosis and oncology. He held that position from December 2008 until the company's acquisition by Abbott Laboratories in April 2010. Prior to joining Facet Biotech, Mr. Hasnain was President, Chief Executive Officer and a director of PDL BioPharma, Inc. from October 2008 until Facet Biotech was spun off from PDL BioPharma, Inc. in December 2008. From October 2004 to September 2008, Mr. Hasnain served at Biogen Idec Inc., a publicly-held biotechnology company specializing in neurological disorders, autoimmune disorders and cancer, most recently as Executive Vice President in charge of the oncology/rheumatology strategic business unit. Prior to Biogen Idec Inc., Mr. Hasnain held roles with Bristol Myers Squibb, where he was President of the Oncology Therapeutics Network, and for 14 years at GlaxoSmithKline and its predecessor organizations. Mr. Hasnain serves on the board of directors of Kura Oncology, Inc. and Vital Therapies, Inc. and previously served as a member of the board of directors of Ambit Biosciences Corporation, Seragon Pharmaceuticals, Inc., Tercica, Inc., Aragon Pharmaceuticals, Inc., Pernix Sleep, Inc. and Somaxon Pharmaceuticals, Inc. Mr. Hasnain received a B.H.K. and B.Ed. from the University of Windsor Ontario in Canada. We believe that Mr. Hasnain is qualified to serve on our board of directors due to his years of experience with drug discovery and development and his experience as a biotechnology executive.

Franklin M. Berger has served as a member of our board of directors since October 2014. Since 2008, Mr. Berger has served as an independent consultant to biopharmaceutical companies rendering strategic and financial advice as the Managing Director of FMB Research. Mr. Berger worked at Sectoral Asset Management as a founder of the small-cap focused NEMO Fund from January 2007 through June 2008. From May 1998 to March 2003, he served at J.P. Morgan Securities Inc., most recently as Managing Director, Equity Research and Senior Biotechnology Analyst. Previously, Mr. Berger served in similar capacities at Salomon Smith Barney and Josephthal & Co. Mr. Berger also serves on the boards of directors of Immune Design Corp., BELLUS Health, Inc., ESSA Pharma Inc., Proteostasis Therapeutics, Inc. and Five Prime Therapeutics, Inc., each of which is a

publicly-held biotechnology company. Mr. Berger previously served as a member of the board of directors of Seattle Genetics, Inc., Asterias Biotherapeutics, Inc. and Aurinia Pharmaceuticals, Inc., publicly-held biopharmaceutical companies, as well as Emisphere Technologies, Inc., BioTime, Inc. and VaxGen, Inc., each of which were publicly-held biopharmaceutical companies during Mr. Berger's service as a director. Mr. Berger received his B.A. in International Relations and his M.A. in International Economics from Johns Hopkins University and received his M.B.A. from the Harvard Business School. We believe that Mr. Berger is qualified to serve on our board of directors due to his financial background and experience as an equity analyst in the biotechnology industry.

Paul Schimmel, Ph.D. has served as a member of our board of directors since February 2015. Dr. Schimmel is the Hahn Professor of Molecular Biology and Chemistry at The Scripps Research Institute, a position he has held since 2001. Dr. Schimmel co-founded Alnylam Pharmaceuticals, a publicly-held biopharmaceutical company, and currently serves as a member of the company's board of directors. He also serves as a member of the board of directors of aTyr Pharma, Inc., a publicly-held biopharmaceutical company. In addition, Dr. Schimmel co-founded and served as a founding director of Cubist Pharmaceuticals, a publicly-held biopharmaceutical company, acquired by Merck and Co. He previously served as a member of the board of directors of Alkermes plc, Sirtris Pharmaceuticals, acquired by GlaxoSmithKline, RepliGen Corporation and Momenta Pharmaceuticals, Inc., which are all publicly-held biopharmaceutical companies. Prior to joining The Scripps Research Institute, Dr. Schimmel was the MacArthur professor of biophysics and biochemistry at the Massachusetts Institute of Technology. He also served as chairman for the division of biological chemistry at the American Chemical Society and is an elected member of the American Academy of Arts and Sciences, the National Academy of Sciences, the American Philosophical Society and the Institute of Medicine. Dr. Schimmel received his Ph.D. from the Massachusetts Institute of Technology and his bachelor's degree from Ohio Wesleyan University. He conducted his post-doctoral work at Stanford University. We believe that Dr. Schimmel is qualified to serve on our board of directors due to his years of experience with biotechnology enterprises and with cellular mechanisms.

David Parkinson, M.D. has served as a member of our board of directors since April 2015. Since January 2016, Dr. Parkinson has served as the President and Chief Executive Officer of ESSA Pharma, Inc., a publicly-held biopharmaceutical company. Dr. Parkinson is also a venture advisor at New Enterprise Associates, a venture capital fund, a company he has been with since June 2012. Dr. Parkinson has more than twenty years of experience in oncology clinical development, including leading clinical activities at Amgen and Novartis for the cancer therapeutics Gleevec, Femara, Zometa, Kepivance and Vectibix. Dr. Parkinson presently serves on the board of directors of Threshold Pharmaceuticals, Cerulean Pharma Inc., ESSA Pharma Inc. and 3S Bio, each a biopharmaceutical company, and previously served on the board of directors of Facet Biotech and Ambit Biosciences Corporation, a biopharmaceutical company acquired by Daiichi Sankyo. Among other prior roles, Dr. Parkinson was Vice President of Oncology Development at Amgen, Vice President of Global Clinical Oncology Development at Novartis and Senior Vice President at Biogen Idec, leading oncology research and development. Previously, Dr. Parkinson worked at the National Cancer Institute for almost a decade, including serving as chief of the Investigational Drug Branch. He has also served as the chairman of the FDA Biologics Advisory Committee. Dr. Parkinson received his M.D. from University of Toronto Faculty of Medicine. We believe that Dr. Parkinson is qualified to serve on our board of directors due to his years of experience with drug development.

Lori Kunkel, M.D. has served as a member of our board of directors since September 2015. From October 2013 to October 2014 she was the acting Chief Medical Officer of Loxo Oncology, Inc. Prior to that role she was the Chief Medical Officer of Pharmacyclics LLC, the Chief Medical Officer of Proteolix, Inc., and the Vice President of Clinical Development at Xencor, Inc., each a biopharmaceutical company. Prior to these positions she was a clinical scientist at Genentech, a biopharmaceutical company, where she worked on the development of RITUXAN. Additionally, as a clinical drug development specialist, Dr. Kunkel has advised multiple clients including Chiron, Genentech/Roche, Salmedics, and currently is an advisor to Stemcentrx, Inc. and Amphivena Therapeutics, each a biopharmaceutical company. Prior to joining the biotechnology industry, Dr. Kunkel spent

ten years in academic medicine and served as a faculty member at the Bone Marrow Transplant Unit in the Division of Hematology/Oncology at University of California, Los Angeles. Dr. Kunkel serves on the board of directors of Loxo Oncology, Inc., a publicly-held biotechnology company, Curis, Inc., a publicly-held biotechnology company, and Harpoon Therapeutics, Inc., a privately-held biotechnology company. Dr. Kunkel received her medical degree from University of Southern California and her bachelor's degree in biology from University of California, San Diego. She is board certified in internal medicine and held board certifications in hematology and oncology. We believe that Dr. Kunkel is qualified to serve on our board of directors due to her years of experience with clinical drug development.

Board Composition

Our business and affairs are organized under the direction of our board of directors, which currently consists of nine members and, effective as of April 15, 2017, will consist of eight directors. The primary responsibilities of our board of directors are to provide oversight, strategic guidance, counseling and direction to our management. Our board of directors meets on a regular basis and on an ad hoc basis as required.

Our board of directors has determined that all of our directors other than Mr. Duvall, Dr. Gruber, Mr. Berman and Mr. Darcy are independent directors, as defined by Rule 5605(a)(2) of The NASDAQ Listing Rules.

In accordance with the terms of our amended and restated certificate of incorporation and amended and restated bylaws, which will become effective immediately prior to and upon the completion of this offering, respectively, we will divide our board of directors into three classes, as follows:

- Class I, which will consist of Mr. Darcy, Dr. Gruber and Dr. Schimmel, whose terms will expire at our annual meeting of stockholders to be held in 2018;
- Class II, which will consist of Mr. Berger, Dr. Kunkel and Dr. Parkinson, whose terms will expire at our annual meeting of stockholders to be held in 2019; and
- Class III, which will consist of Mr. Duvall and Mr. Hasnain, whose terms will expire at our annual meeting of stockholders to be held in 2020.

At each annual meeting of stockholders to be held after the initial classification, the successors to directors whose terms then expire will serve until the third annual meeting following their election and until their successors are duly elected and qualified. The authorized size of our board of directors is currently nine members and, effective as of April 15, 2017, will be decreased to eight members. The authorized number of directors may be changed only by resolution of our board of directors. Any additional directorships resulting from an increase in the number of directors will be distributed between the three classes so that, as nearly as possible, each class will consist of one-third of the directors. This classification of our board of directors may have the effect of delaying or preventing changes in our control or management. Our directors may be removed for cause by the affirmative vote of the holders of at least 66-2/3% of our voting stock.

Board Leadership Structure

Our board of directors is currently chaired by Mr. Hasnain who has authority, among other things, to call and preside over board of directors meetings, to set meeting agendas and to determine materials to be distributed to the board of directors. Accordingly, the Chairman has substantial ability to shape the work of the board of directors. We believe that separation of the positions of Chairman and Chief Executive Officer reinforces the independence of the board of directors in its oversight of our business and affairs. In addition, we have a separate chair for each committee of our board of directors. The chair of each committee is expected to report annually to our board of directors on the activities of their committee in fulfilling their responsibilities as detailed in their respective charters or specify any shortcomings should that be the case.

Role of the Board in Risk Oversight

The audit committee of our board of directors is primarily responsible for overseeing our risk management processes on behalf of our board of directors. Going forward, we expect that the audit committee will receive reports from management at least quarterly regarding our assessment of risks. In addition, the audit committee reports regularly to our board of directors, which also considers our risk profile. The audit committee and our board of directors focus on the most significant risks we face and our general risk management strategies. While our board of directors oversees our risk management, management is responsible for day-to-day risk management processes. Our board of directors expects management to consider risk and risk management in each business decision, to proactively develop and monitor risk management strategies and processes for day-to-day activities and to effectively implement risk management strategies adopted by the audit committee and our board of directors. We believe this division of responsibilities is the most effective approach for addressing the risks we face and that our board of directors' leadership structure, which also emphasizes the independence of our board of directors in its oversight of its business and affairs, supports this approach.

Board Committees

Our board of directors has established an audit committee, a compensation committee and a nominating and corporate governance committee.

Audit Committee

Our audit committee consists of Mr. Berger, Mr. Hasnain and Dr. Parkinson. Our board of directors has determined that each of the members of our audit committee satisfies The NASDAQ Stock Market and SEC independence requirements. Mr. Berger serves as the chair of our audit committee. The functions of this committee include, among other things:

- evaluating the performance, independence and qualifications of our independent auditors and determining whether to retain our existing independent auditors or engage new independent auditors;
- reviewing and approving the engagement of our independent auditors to perform audit services and any permissible non-audit services;
- monitoring the rotation of partners of our independent auditors on our engagement team as required by law;
- prior to engagement of any independent auditor, and at least annually thereafter, reviewing relationships that may reasonably be thought to bear on their independence, and assessing and otherwise taking the appropriate action to oversee the independence of our independent auditor;
- reviewing our annual and quarterly financial statements and reports, including the disclosures contained under the caption "Management's Discussion and Analysis of Financial Condition and Results of Operations," and discussing the statements and reports with our independent auditors and management;
- reviewing, with our independent auditors and management, significant issues that arise regarding accounting principles and financial statement presentation and matters concerning the scope, adequacy and effectiveness of our financial controls;
- reviewing with management and our independent auditors any earnings announcements and other public announcements regarding material developments;
- establishing procedures for the receipt, retention and treatment of complaints received by us regarding financial controls, accounting or auditing matters and other matters;
- preparing the report that the SEC requires in our annual proxy statement;
- reviewing and providing oversight of any related-person transactions in accordance with our related person transaction policy and reviewing and monitoring compliance with legal and regulatory responsibilities, including our code of business conduct and ethics;
- reviewing our major financial risk exposures, including the guidelines and policies to govern the process by which risk assessment and risk management are implemented;

- reviewing on a periodic basis our investment policy; and
- reviewing and evaluating on an annual basis the performance of the audit committee and the audit committee charter.

Our board of directors has determined that Mr. Berger qualifies as an audit committee financial expert within the meaning of SEC regulations and meets the financial sophistication requirements of the NASDAQ Listing Rules. In making this determination, our board has considered Mr. Berger's prior experience, business acumen and independence. Both our independent registered public accounting firm and management periodically meet privately with our audit committee.

We believe that the composition and functioning of our audit committee complies with all applicable requirements of the Sarbanes-Oxley Act, and all applicable SEC and NASDAQ rules and regulations. We intend to comply with future requirements to the extent they become applicable to us.

Compensation Committee

Our compensation committee consists of Dr. Schimmel, Dr. Kunkel and Mr. Hasnain. Dr. Schimmel serves as the chair of our compensation committee. Our board of directors has determined that each of the members of our compensation committee is a non-employee director, as defined in Rule 16b-3 promulgated under the Exchange Act, is an outside director, as defined pursuant to Section 162(m) of the Code, and satisfies The NASDAQ Stock Market independence requirements. The functions of this committee include, among other things:

- reviewing, modifying and approving (or if it deems appropriate, making recommendations to the full board of directors regarding) our overall compensation strategy and policies;
- reviewing and making recommendations to the full board of directors regarding the compensation and other terms of employment of our executive officers;
- reviewing and approving (or if it deems it appropriate, making recommendations to the full board of directors regarding) performance goals and objectives relevant to the compensation of our executive officers and assessing their performance against these goals and objectives;
- reviewing and approving (or if it deems it appropriate, making recommendations to the full board of directors regarding) the equity incentive plans, compensation plans and similar programs advisable for us, as well as modifying, amending or terminating existing plans and programs;
- evaluating risks associated with our compensation policies and practices and assessing whether risks arising from our compensation policies and practices for our employees are reasonably likely to have a material adverse effect on us;
- reviewing and making recommendations to the full board of directors regarding the type and amount of compensation to be paid or awarded to our non-employee board members;
- establishing policies with respect to votes by our stockholders to approve executive compensation as required by Section 14A of the Exchange Act and determining our recommendations regarding the frequency of advisory votes on executive compensation, to the extent required by law;
- reviewing and assessing the independence of compensation consultants, legal counsel and other advisors as required by Section 10C of the Exchange Act;
- administering our equity incentive plans;
- establishing policies with respect to equity compensation arrangements;
- reviewing the competitiveness of our executive compensation programs and evaluating the effectiveness of our compensation policy and strategy in achieving expected benefits to us;
- reviewing and making recommendations to the full board of directors regarding the terms of any employment agreements, severance arrangements, change in control protections and any other compensatory arrangements for our executive officers;
- reviewing with management and approving our disclosures under the caption "Compensation Discussion and Analysis" in our periodic reports or proxy statements to be filed with the SEC, to the extent such caption is included in any such report or proxy statement;

- preparing the report that the SEC requires in our annual proxy statement; and
- reviewing and assessing on an annual basis the performance of the compensation committee and the compensation committee charter.

We believe that the composition and functioning of our compensation committee complies with all applicable requirements of the Sarbanes-Oxley Act, and all applicable SEC and NASDAQ rules and regulations. We intend to comply with future requirements to the extent they become applicable to us.

Nominating and Corporate Governance Committee

Our nominating and corporate governance committee consists of Mr. Hasnain and Mr. Berger. Our board of directors has determined that each of the members of this committee satisfies the NASDAQ Stock Market independence requirements. Mr. Hasnain serves as the chair of our nominating and corporate governance committee. The functions of this committee include, among other things:

- identifying, reviewing and evaluating candidates to serve on our board of directors consistent with criteria approved by our board of directors;
- determining the minimum qualifications for service on our board of directors;
- evaluating director performance on the board and applicable committees of the board and determining whether continued service on our board is appropriate;
- evaluating, nominating and recommending individuals for membership on our board of directors;
- evaluating nominations by stockholders of candidates for election to our board of directors;
- considering and assessing the independence of members of our board of directors;
- developing a set of corporate governance policies and principles, including a code of business conduct and ethics, periodically reviewing and assessing these policies and principles and their application and recommending to our board of directors any changes to such policies and principles;
- considering questions of possible conflicts of interest of directors as such questions arise; and
- reviewing and assessing on an annual basis the performance of the nominating and corporate governance committee and the nominating and corporate governance committee charter.

We believe that the composition and functioning of our nominating and corporate governance committee complies with all applicable requirements of the Sarbanes-Oxley Act, and all applicable SEC and NASDAQ rules and regulations. We intend to comply with future requirements to the extent they become applicable to us.

Compensation Committee Interlocks and Insider Participation

None of our current or former executive officers serves as a member of the compensation committee. None of our officers serves, or has served during the last completed fiscal year on the board of directors or compensation committee, or other committee serving an equivalent function, of any other entity that has one or more of its executive officers serving as a member of our board of directors or our compensation committee. Prior to establishing the compensation committee, our full board of directors made decisions relating to compensation of our officers. For a description of transactions between us and members of our compensation committee and affiliates of such members, please see “Certain Relationships and Related Party Transactions.”

Code of Business Conduct and Ethics

We have adopted a written code of business conduct and ethics that applies to our directors, officers and employees, including our principal executive officer, principal financial officer, principal accounting officer or controller, or person performing similar functions. Following this offering, a current copy of the code will be available on the Corporate Governance section of our website, www.tocagen.com.

Limitation of Liability and Indemnification

Our amended and restated certificate of incorporation, which will become effective immediately prior to the completion of this offering, limits the liability of directors to the maximum extent permitted by Delaware law. Delaware law allows a corporation to eliminate the personal liability of directors of a corporation to the corporation and its stockholders for monetary damages for breach of their fiduciary duties as directors, except for liability for any:

- breach of his or her duty of loyalty to the corporation or its stockholders;
- act or omission not in good faith or that involves intentional misconduct or a knowing violation of law;
- unlawful payments of dividends or unlawful stock repurchases or redemptions as provided in Section 174 of the Delaware General Corporation Law; or
- transaction from which the director derived an improper personal benefit.

Our amended and restated certificate of incorporation, which will become effective immediately prior to the completion of this offering, does not eliminate a director's duty of care and, in appropriate circumstances, equitable remedies, such as injunctive or other forms of non-monetary relief, will remain available under Delaware law. These limitations also do not affect a director's responsibilities under any other laws, such as the federal securities laws or other state or federal laws. Our amended and restated bylaws, which will become effective upon the completion of this offering, provide that we will indemnify our directors and executive officers and may indemnify other officers, employees and other agents, to the fullest extent permitted by law. Our amended and restated bylaws, which will become effective upon the completion of this offering, also provide that we are obligated to advance expenses incurred by a director or officer in advance of the final disposition of any action or proceeding and also permit us to secure insurance on behalf of any officer, director, employee or other agent for any liability arising out of his or her actions in connection with their services to us, regardless of whether our amended and restated bylaws permit such indemnification. We have obtained a policy of directors' and officers' liability insurance.

We have entered, and intend to continue to enter, into separate indemnification agreements with our directors and executive officers, in addition to the indemnification provided for in our amended and restated bylaws. These agreements, among other things, will require us to indemnify our directors and executive officers for certain expenses, including attorneys' fees, judgments, fines and settlement amounts incurred by a director or executive officer in any action or proceeding arising out of their services as one of our directors or executive officers or any other company or enterprise to which the person provides services at our request. We believe that these bylaw provisions and indemnification agreements are necessary to attract and retain qualified persons as directors and officers.

The limitation of liability and indemnification provisions in our amended and restated certificate of incorporation and amended and restated bylaws may discourage stockholders from bringing a lawsuit against directors for breach of their fiduciary duties. They may also reduce the likelihood of derivative litigation against directors and officers, even though an action, if successful, might benefit us and our stockholders. A stockholder's investment may be harmed to the extent we pay the costs of settlement and damage awards against directors and officers pursuant to these indemnification provisions.

We believe that these provisions in our amended and restated certificate of incorporation and amended and restated bylaws and these indemnification agreements are necessary to attract and retain qualified persons as directors and officers.

Except as otherwise disclosed under the heading "Legal Proceedings" in the "Business" section of this prospectus, at present, there is no pending litigation or proceeding involving any of our directors or executive officers as to which indemnification is required or permitted, and we are not aware of any threatened litigation or proceeding that may result in a claim for indemnification.

EXECUTIVE AND DIRECTOR COMPENSATION

Our named executive officers for the year ended December 31, 2016, which consist of our principal executive officer, our former principal executive officer and our two other most highly compensated executive officers, are:

- Martin J. Duvall, our Chief Executive Officer;
- Harry E. Gruber, M.D., our President, Research and Development;
- Thomas E. Darcy, our Executive Vice President and former Chief Financial Officer; and
- Asha Das, M.D., our Senior Vice President and Chief Medical Officer.

In February 2017, Mark Foletta commenced employment with us as our Executive Vice President and Chief Financial Officer. Although Mr. Foletta is not one of our named executive officers for the year ended December 31, 2016, we have included information regarding Mr. Foletta's compensation in this section where it may be material to an understanding of our executive compensation program.

Summary Compensation Table

Name and principal position	Year	Salary ($)	Bonus ($)[1]	Option awards ($)[2]	All other compensation ($)[3]	Total ($)
Martin J. Duvall *Chief Executive Officer*	2016	67,692	24,000	3,033,440	18,468	3,143,600
Harry E. Gruber, M.D.[4] *President, Research and Development*	2016	355,796	25,000	259,274	750	640,820
Thomas E. Darcy[5] *Executive Vice President and former Chief Financial Officer*	2016	303,495	25,000	156,929	17,301	502,725
Asha Das, M.D.[6] *Senior Vice President and Chief Medical Officer*	2016	313,712	50,000	20,469	7,360	391,541

(1) This column reflects the amount of discretionary cash bonuses earned by our named executive officers for 2016. We expect to pay such bonuses on or before April 30, 2017. For more information, see below under "—Bonus Compensation."

(2) In accordance with SEC rules, this column reflects the aggregate grant date fair value of the stock option awards granted during 2016. These amounts have been computed in accordance with FASB ASC Topic 718. Assumptions used in the calculation of these amounts are described in Note 7 to our financial statements included elsewhere in this prospectus. These amounts do not reflect the actual economic value that will be realized by the named executive officer upon the vesting of the stock options, the exercise of the stock options, or the sale of the common stock underlying such stock options.

(3) This column reflects term life insurance premiums paid by us on behalf of each of the named executive officers. For Mr. Darcy, this column reflects $489 for such life insurance premiums and $16,812 paid by us to Mr. Darcy to be used for the cost of his medical insurance maintained through PricewaterhouseCoopers LLP as a retired partner of that firm. In addition, this column includes $6,610 and $18,468 for reimbursed relocation expenses for Dr. Das and Mr. Duvall, respectively. The insurance benefits, except for those to Mr. Darcy, are provided to the named executive officers on the same terms as provided to all of our regular full-time employees. For more information regarding these benefits, see below under "— Perquisites, Health, Welfare and Retirement Benefits."

(4) Dr. Gruber served as our principal executive officer until November 2016.

(5) Mr. Darcy served as our Chief Financial Officer until February 2017.

(6) Dr. Das served as our Vice President, Clinical Development and Medical Affairs and acting Chief Medical Officer until March 2017.

Annual Base Salary

The base salary of our named executive officers is generally determined and approved at the end of each March or in connection with the commencement of employment of the executive, by our board of directors. As of December 31, 2016, base salaries for our named executive officers, which became effective as of April 1, 2016, except for Mr. Duvall, whose base salary became effective upon his commencement of employment with us on November 1, 2016, are provided below.

Name	2016 Base Salary ($)
Martin J. Duvall	400,000
Harry E. Gruber, M.D.	356,500(1)
Thomas E. Darcy	304,100(1)
Asha Das, M.D.	315,000(1)

(1) From January 1, 2016 to March 31, 2016, Dr. Gruber's annual base salary rate was $348,200, Mr. Darcy's annual base salary rate was $297,000 and Dr. Das' annual base salary rate was $305,000.

Bonus Compensation

From time to time our board of directors or compensation committee may approve bonuses for our named executive officers based on individual performance, company performance or as otherwise determined appropriate. In 2016, our executive officers, other than Mr. Duvall, were not entitled to any target or minimum bonus and no specific performance goals or bonus program were established for our named executive officers.

Pursuant to Mr. Duvall's employment agreement, he is entitled to an annual bonus of up to 40% of his annual base salary based on achievement of individual and/or corporate performance targets, metrics and/or objectives to be determined and approved by the board of directors or the compensation committee thereof.

In March 2017, our board of directors awarded bonuses to our named executive officers based on our 2016 company performance achievements with respect to our goals. Mr. Duvall was awarded a $24,000 bonus, Dr. Gruber and Mr. Darcy were each awarded a $25,000 bonus and Dr. Das was awarded a $50,000 bonus, in each case in recognition of such achievement.

Equity-Based Incentive Awards

Our equity-based incentive awards are designed to align our interests and those of our stockholders with those of our employees and consultants, including our named executive officers. The board of directors is responsible for approving equity grants. As of the date of this prospectus, stock option awards were the only form of equity awards we granted to our named executive officers.

We have historically used stock options as an incentive for long-term compensation to our named executive officers because they are able to profit from stock options only if our stock price increases relative to the stock option's exercise price, which exercise price is set at the fair market value of our common stock on the date of grant. We may grant equity awards at such times as our board of directors determines appropriate. Our executives generally are awarded an initial grant in the form of a stock option in connection with their commencement of employment with us. Additional grants may occur periodically in order to specifically incentivize executives with respect to achieving certain corporate goals or to reward executives for exceptional performance.

Prior to this offering, we have granted all stock options pursuant to our 2009 Plan. Upon and following this offering, we will grant equity incentive awards under the terms of our 2017 Plan. The terms of our equity plans are described below under "— Equity Benefit Plans."

All options are granted with an exercise price per share that is no less than the fair market value of our common stock on the date of grant of such award. Our stock option awards generally vest over a four-year period

and may be subject to acceleration of vesting and exercisability under certain termination and change in control events. See "— Outstanding Equity Awards at Fiscal Year-End."

In June 2016, the board of directors granted an option to purchase 27,536 shares of common stock to Dr. Gruber, an option to purchase 16,666 shares of common stock to Mr. Darcy and an option to purchase 2,173 shares of common stock to Dr. Das. Each of these options has an exercise price of $14.98 per share and is subject to a four-year vesting schedule, with 25% vesting as of April 1, 2017 and the balance vesting monthly over the remaining 36 months, subject to the respective optionholder's continued service with us. The options for Dr. Gruber and Mr. Darcy provide for full acceleration of all of the shares subject to the option in the event of a change in control. The option for Dr. Das provides for vesting acceleration of up to 25% of the shares subject to the option in the event of a change in control and for the acceleration of up to 25% of the shares subject to the option in the event of Dr. Das' death or disability.

In November 2016, the board of directors granted an option to purchase 308,706 shares of common stock to Mr. Duvall, in connection with the commencement of his employment. This option has an exercise price of $16.56 per share and is subject to a four-year vesting schedule, with 25% vesting on November 1, 2017 and the balance vesting monthly over the remaining 36 months, subject to Mr. Duvall's continued service with us. This option provides for full acceleration of all of the shares in the event of a change of control and the acceleration of 25% of the shares in the event of Mr. Duvall's death or disability.

In November 2016, the board of directors also granted an option to purchase an additional 154,353 shares of common stock to Mr. Duvall, in connection with the commencement of his employment. This option also has an exercise price of $16.56 per share and shall vest upon the achievement of development and regulatory milestones, subject to Mr. Duvall's continued service with us. In the event of a change of control that occurs prior to the vesting of the shares subject to this option, the board of directors shall have discretion to accelerate vesting, in whole or in part, based on progress towards the milestones.

In March 2017, the board of directors granted an option to purchase 69,636 shares of common stock to Mr. Foletta, in connection with the commencement of his employment. This option has an exercise price of $15.12 per share and is subject to a four-year vesting schedule, with 25% vesting on February 27, 2018 and the balance vesting monthly over the remaining 36 months, subject to Mr. Foletta's continued service with us. This option provides for full acceleration of all of the shares in the event of a change of control and the acceleration of 25% of the shares in the event of Mr. Foletta's death or disability.

In March 2017, the board of directors also granted an option to purchase an additional 34,298 shares of common stock to Mr. Foletta, in connection with the commencement of his employment. This option also has an exercise price of $15.12 per share and shall vest upon the achievement of development and regulatory milestones, subject to Mr. Foletta's continued service with us. In the event of a change of control that occurs prior to the vesting of the shares subject to this option, the board of directors shall have discretion to accelerate vesting, in whole or in part, based on progress towards the milestones.

In March 2017, the board of directors also approved the grant of options to purchase 46,739 shares, 27,536 shares, 4,528 shares and 7,246 shares of common stock, respectively, to Mr. Duvall, Dr. Gruber, Mr. Darcy and Dr. Das. These options were granted under our 2017 Plan effective as of the execution and delivery of the underwriting agreement relating to this offering and have a per share exercise price equal to $10.00, the initial public offering price. Each option is subject to a four-year vesting schedule, with 25% vesting one year after the vesting commencement date and the balance vesting monthly over the remaining 36 months, subject to the respective optionholder's continued service with us. The options for Mr. Duvall, Dr. Gruber and Mr. Darcy provide for full acceleration of all of the shares subject to the option in the event of a change in control. The option for Mr. Das provides for vesting acceleration of up to 25% of the shares subject to the option in the event of a change in control. The options for Mr. Duvall, Dr. Gruber and Dr. Das provide for the acceleration of up to 25% of the shares subject to the option in the event of the optionholder's death or disability.

Agreements with Named Executive Officers

In March 2015, we entered into an offer letter agreement with Dr. Das, our Senior Vice President and Chief Medical Officer. Dr. Das' employment under the agreement is at will and may be terminated at any time by us or by her. Under the terms of the agreement, Dr. Das was initially entitled to receive an annual base salary of $305,000 and an option to purchase 36,231 shares of our common stock under our 2009 Plan, which was granted on May 12, 2015. Twenty-five percent of the shares subject to the option vested on April 29, 2016 (the first anniversary of Dr. Das' commencement of employment) and the remaining shares vest in 36 equal monthly installments thereafter, subject to Dr. Das' continued service, as defined in the 2009 Plan. The option provides for vesting acceleration of up to 25% of the shares subject to the option in the event of a change in control and for vesting acceleration of up to 25% of the shares subject to the option in the event of Dr. Das' death or disability.

In October 2016, we entered into an employment agreement with Mr. Duvall, our Chief Executive Officer. Mr. Duvall's employment under the agreement is at will and may be terminated at any time by us or by him. Under the terms of the agreement, Mr. Duvall is entitled to receive an annual base salary of $400,000. The agreement provides for a target bonus of up to 40% of Mr. Duvall's annual base salary, as described above under "— Bonus Compensation" and provides for the options to purchase shares of common stock described above under "— Equity-Based Incentive Awards." In addition, the agreement provided for reimbursement of up to $100,000 for Mr. Duvall's relocation expenses which he will have to repay if he resigns from the Company at any time prior to November 1, 2017. If we terminate Mr. Duvall's employment without cause (other than due to his death or disability) or if Mr. Duvall resigns for good reason at any time, we are obligated to pay Mr. Duvall, subject to receiving an effective release and waiver of claims from him, (1) severance payments in the form of continuation of his base salary then in effect (ignoring any decrease that forms the basis for his resignation for good reason, if applicable) for 18 months, and (2) continued health insurance coverage under the Company's group health plans under the Consolidated Omnibus Budget Reconciliation Act of 1985 or the state equivalent until the earliest of (i) the end of the 18 month severance period, (ii) the expiration of his eligibility for the continuation coverage, or (iii) the date when he becomes eligible for substantially equivalent health insurance coverage in connection with new employment or self-employment. In addition, if we terminate Mr. Duvall's employment without cause (other than due to his death or disability) or if Mr. Duvall resigns for good reason at any time, Mr. Duvall shall receive an extension of the period of time following which he may exercise vested shares subject to outstanding equity awards until the date that is the earlier of (i) the original expiration date of such award and (ii) 18 months following such termination or resignation.

For the purposes of Mr. Duvall's employment agreement, "cause" means the occurrence of any of the following events: (i) his commission of any felony or any crime involving fraud, dishonesty or moral turpitude under the laws of the United States or any state thereof; (ii) his attempted commission of, or participation in, a fraud or act of dishonesty against the Company; (iii) his intentional, material violation of any contract or agreement between him and the Company or of any statutory duty owed to the Company that has not been cured, if curable, within fifteen (15) days after written notice from the board of directors of such violation; (iv) his unauthorized use or disclosure of the Company's confidential information or trade secrets; or (v) his gross misconduct that has not been cured, if curable, within fifteen (15) days after written notice from the board of directors requesting that the he cure such misconduct. For purposes of Mr. Duvall's employment agreement, "good reason" means voluntary resignation of employment with us within 30 days of the occurrence of one or more of the following undertaken by us without Mr. Duvall's consent, after we fail to remedy the condition within a 30 day cure period: (1) a material reduction in his base salary (i.e. a reduction of at least 10% of base salary (unless pursuant to a salary reduction program applicable generally to the Company's similarly situated employees)); (2) a material reduction in his authority, duties or responsibilities; (3) a material reduction in the authority, duties, or responsibilities of the supervisor to whom he is required to report, including a requirement that he reports to a corporate officer or employee instead of reporting directly to the board of directors; (4) from and after the earlier to occur of (x) the one year anniversary of the commencement of his employment and (y) the date on which he relocates his primary residence to San Diego county, California, a relocation of his principal place of employment to a place that

increases his one-way commute by more than 50 miles as compared to his then-current principal place of employment immediately prior to such relocation (excluding regular travel in the ordinary course of business); and (5) a breach of a material provision of the employment agreement by the Company.

We entered into an employment agreement with Mr. Foletta in February 2017 in connection with his commencement of employment, a description of which is provided below under "Certain Relationships and Related Party Transactions — Employment and Consulting Agreements."

We have not entered into employment agreements with any of our other named executive officers and each of our named executive officers' employment is at will and may be terminated by us at any time. Any potential payments and benefits due upon a qualifying termination of employment or a change in control are further described below under "— Potential Payments and Benefits upon Termination or Change in Control."

Potential Payments and Benefits upon Termination or Change in Control

Regardless of the manner in which a named executive officer's service terminates, each named executive officer is entitled to receive amounts earned during his or her term of service, including unpaid salary and unused vacation, as applicable. In addition, Mr. Duvall is entitled to receive certain benefits upon our termination of his employment without cause or his resignation for good reason, as provided above under "— Agreements with Named Executive Officers."

Each of our named executive officers holds stock options that were granted subject to the general terms of our 2009 Plan. A description of the termination and change in control provisions in our 2009 Plan and applicable to the stock options granted to our named executive officers is provided below under "— Equity Benefit Plans" and "—Outstanding Equity Awards at Fiscal Year-End" and above under "—Equity-Based Incentive Awards."

Outstanding Equity Awards at Fiscal Year-End

The following table sets forth certain information regarding equity awards granted to our named executive officers that remain outstanding as of December 31, 2016.

		Option Awards[1]				
	Grant Date	Number of Securities Underlying Unexercised Options Exercisable (#)	Number of Securities Underlying Unexercised Options Unexercisable (#)	Equity Incentive Plan Awards: Number of Securities Underlying Unexercised Unearned Options (#)	Option Exercise Price ($)[2]	Option Expiration Date
Martin J. Duvall	11/16/2016	—	308,706[3]	—	$16.56	11/15/2026
	11/16/2016	—	—	154,353[4]	$16.56	11/15/2026
Harry E. Gruber, M.D.	3/14/2013	110,144	—	—	$ 3.94	3/13/2023
	06/10/2016	—	27,536[5]	—	$14.98	06/09/2026
Thomas E. Darcy	3/14/2013	66,666	—	—	$ 3.94	3/13/2023
	06/10/2016	—	16,666[6]	—	$14.98	06/09/2026
Asha Das, M.D.	05/12/2015	15,095[7]	21,136[7]	—	$11.60	05/11/2025
	06/10/2016	—	2,173[8]	—	$14.98	06/09/2026

(1) All of the outstanding stock option awards were granted under and subject to the terms of the 2009 Plan, described below under "— Equity Benefit Plans." As of December 31, 2016, each option award becomes exercisable as it becomes vested and all vesting is subject to the executive's continuous service with us through the vesting dates and the potential vesting acceleration described above under "— Potential Payments and Benefits upon Termination or Change in Control."

(2) All of the stock option awards were granted with a per share exercise price equal to the fair market value of one share of our common stock on the date of grant, as determined in good faith by our board of directors.

(3) 77,176 shares will vest on November 1, 2017 and 6,431.39 shares will vest on the 1st day of each month commencing thereafter and ending on November 1, 2020.

(4) The shares shall vest upon the achievement of three separate development and regulatory milestones (with one-third of the shares vesting upon the achievement of each milestone).

(5) 6,884 shares will vest on April 1, 2017 and 573.67 shares will vest on the 1st day of each month commencing thereafter and ending on April 1, 2020.

(6) 4,166 shares will vest on April 1, 2017 and 347.22 shares will vest on the 1st day of each month commencing thereafter and ending on April 1, 2020.

(7) 9,057 shares vested on April 29, 2016 and 754.83 shares vest on the 29th day of each month commencing thereafter and ending on April 29, 2019.

(8) 543 shares will vest on April 1, 2017 and 45.28 shares will vest on the 1st day of each month commencing thereafter and ending on April 1, 2020.

Option Repricings

We did not engage in any repricings or other modifications or cancellations to any of our named executive officers' outstanding equity awards during the fiscal year ended December 31, 2016.

Perquisites, Health, Welfare and Retirement Benefits

Our named executive officers, during their employment with us, are eligible to participate in our employee benefit plans, including our medical, dental, group term life, disability and accidental death and dismemberment insurance plans, in each case on the same basis as all of our other employees. In addition, we provide a medical cash subsidy to Mr. Darcy who does not participate in our medical benefit plan due to his preexisting participation in the PricewaterhouseCoopers LLP medical plan as described above. We provide a 401(k) plan to our employees, including our named executive officers, as discussed in the section below entitled "— 401(k) Plan."

We generally do not provide perquisites or personal benefits to our named executive officers, except in limited circumstances. We do, however, pay the premiums for medical, dental, group term life, disability and accidental death and dismemberment insurance for all of our employees, including our named executive officers. Our board of directors may elect to adopt qualified or nonqualified benefit plans in the future if it determines that doing so is in our best interests.

401(k) Plan

We maintain a defined contribution employee retirement plan, or 401(k) plan, for our employees. Our named executive officers are eligible to participate in the 401(k) plan on the same basis as our other employees. The 401(k) plan is intended to qualify as a tax-qualified plan under Section 401(k) of the Code. The 401(k) plan provides that each participant may contribute up to the lesser of 100% of his or her compensation or the statutory limit, which is $18,000 for calendar years 2016 and 2017. Participants that are 50 years or older can also make "catch-up" contributions, which in calendar years 2016 and 2017 may be up to an additional $6,000 above the statutory limit. We currently do not make matching contributions into the 401(k) plan on behalf of participants. Participant contributions are held and invested, pursuant to the participant's instructions, by the plan's trustee.

Nonqualified Deferred Compensation

We do not maintain nonqualified defined contribution plans or other nonqualified deferred compensation plans. Our board of directors may elect to provide our officers and other employees with nonqualified defined contribution or other nonqualified deferred compensation benefits in the future if it determines that doing so is in our best interests.

Equity Benefit Plans

2017 Equity Incentive Plan

Our board of directors and stockholders approved and adopted the 2017 Plan in March 2017. No awards may be granted under the 2017 Plan prior to the date of the underwriting agreement for this offering. On and after such date, no further grants will be made under the 2009 Plan. The 2017 Plan became effective in connection with the execution and delivery of the underwriting agreement related to this offering.

Awards. The 2017 Plan provides for the grant of incentive stock options, or ISOs, nonstatutory stock options, or NSOs, stock appreciation rights, restricted stock awards, restricted stock unit awards, performance-based stock awards, and other forms of equity compensation, which we refer to collectively as stock awards. Additionally, the 2017 Plan provides for the grant of performance cash awards. ISOs may be granted only to employees. All other awards may be granted to employees, including officers, and to non-employee directors and consultants of us and our affiliates.

Share Reserve. Initially, the aggregate number of shares of our common stock that may be issued pursuant to stock awards under the 2017 Plan after the 2017 Plan becomes effective is 3,133,702 shares, which is the sum of (1) 1,600,000 new shares, plus (2) the number of shares reserved for issuance under our 2009 Plan at the time our 2017 Plan becomes effective, plus (3) any shares subject to outstanding stock options or other stock awards that would have otherwise returned to our 2009 Plan (such as upon the expiration or termination of a stock award prior to exercise). Additionally, the number of shares of our common stock reserved for issuance under our 2017 Plan will automatically increase on January 1 of each year, beginning on January 1, 2018 (assuming the 2017 Plan becomes effective before such date) and continuing through and including January 1, 2027, by 4% of the total number of shares of our capital stock outstanding on December 31 of the preceding calendar year, or a lesser number of shares determined by our board of directors. The maximum number of shares that may be issued upon the exercise of ISOs under our 2017 Plan is 6,267,404 shares. On March 31, 2017, our board of directors approved the grant of stock options to our employees and directors to purchase an aggregate of 184,861 shares of common stock under the 2017 Plan. These awards were granted effective as of the execution and delivery of the underwriting agreement relating to this offering, and have a per share exercise price equal to $10.00, the initial public offering price.

No person may be granted stock awards covering more than 1,000,000 shares of our common stock under our 2017 Plan during any calendar year pursuant to stock options, stock appreciation rights and other stock awards whose value is determined by reference to an increase over an exercise or strike price of at least 100% of the fair market value on the date the stock award is granted. Additionally, no person may be granted in a calendar year a performance stock award covering more than 1,000,000 shares or a performance cash award having a maximum value in excess of $3,000,000. Such limitations are designed to help assure that any deductions to which we would otherwise be entitled with respect to such awards will not be subject to the $1,000,000 limitation on the income tax deductibility of compensation paid to any covered executive officer imposed by Section 162(m) of the Code. In addition, the maximum number of shares of our common stock subject to stock awards granted under the 2017 Plan with respect to any period commencing on the date of the Company's Annual Meeting of Stockholders for a particular year and ending on the day immediately prior to the date of the Company's Annual Meeting of Stockholders for the next subsequent year to any non-employee director, taken together with any cash fees paid by us to such non-employee director during such period for service on our board of directors, will not exceed $400,000 in total value, or, with respect to such period in which a non-employee director is first appointed or elected to our board of directors, $500,000. Our board of directors may make exceptions to this limit in extraordinary circumstances.

If a stock award granted under the 2017 Plan (i) expires or otherwise terminates without all of the shares covered by such stock award having been issued or (ii) is settled in cash, the shares of our common stock not acquired pursuant to the stock award again will become available for subsequent issuance under the 2017 Plan. In

addition, the following types of shares under the 2017 Plan may become available for the grant of new stock awards under the 2017 Plan: (1) shares that are forfeited to or repurchased by us prior to becoming fully vested; (2) shares withheld to satisfy income or employment withholding taxes; or (3) shares used to pay the exercise or purchase price of a stock award. Shares issued under the 2017 Plan will be authorized but unissued shares or reacquired shares bought by us on the open market. As of the date hereof, no awards have been granted and no shares of our common stock have been issued under the 2017 Plan.

Administration. Our board of directors, or a duly authorized committee thereof, has the authority to administer the 2017 Plan. Our board of directors may also delegate to one or more of our officers the authority to (1) designate employees (other than other officers) to be recipients of certain stock awards, and (2) determine the number of shares of common stock to be subject to such stock awards. Subject to the terms of the 2017 Plan, our board of directors or the authorized committee, referred to herein as the plan administrator, determines recipients, dates of grant, the numbers and types of stock awards to be granted and the terms and conditions of the stock awards, including the period of their exercisability and vesting schedule applicable to a stock award. Subject to the limitations set forth below, the plan administrator will also determine the exercise price, strike price or purchase price of awards granted and the types of consideration to be paid for the award.

The plan administrator has the authority to modify outstanding awards under our 2017 Plan. Subject to the terms of our 2017 Plan, the plan administrator has the authority to reduce the exercise, purchase or strike price of any outstanding stock award, cancel any outstanding stock award in exchange for new stock awards, cash or other consideration, or take any other action that is treated as a repricing under generally accepted accounting principles, with the consent of any adversely affected participant.

Stock Options. ISOs and NSOs are granted pursuant to stock option agreements adopted by the plan administrator. The plan administrator determines the exercise price for a stock option, within the terms and conditions of the 2017 Plan, provided that the exercise price of a stock option generally cannot be less than 100% of the fair market value of our common stock on the date of grant. Options granted under the 2017 Plan vest at the rate specified by the plan administrator.

The plan administrator determines the term of stock options granted under the 2017 Plan, up to a maximum of 10 years. Unless the terms of an optionholder's stock option agreement provide otherwise, if an optionholder's service relationship with us, or any of our affiliates, ceases for any reason other than disability, death or cause, the optionholder may generally exercise any vested options for a period of three months following the cessation of service. The option term may be extended in the event that exercise of the option following such a termination of service is prohibited by applicable securities laws or our insider trading policy. If an optionholder's service relationship with us or any of our affiliates ceases due to disability or death, or an optionholder dies within a certain period following cessation of service, the optionholder or a beneficiary may generally exercise any vested options for a period of 12 months in the event of disability and 18 months in the event of death. In the event of a termination for cause, options generally terminate immediately upon the termination of the individual for cause. In no event may an option be exercised beyond the expiration of its term.

Acceptable consideration for the purchase of common stock issued upon the exercise of a stock option will be determined by the plan administrator and may include (1) cash, check, bank draft or money order, (2) a broker-assisted cashless exercise, (3) the tender of shares of our common stock previously owned by the optionholder, (4) a net exercise of the option if it is an NSO, and (5) other legal consideration approved by the plan administrator.

Unless the plan administrator provides otherwise, options generally are not transferable except by will, the laws of descent and distribution, or (subject to the approval of the plan administrator or an authorized officer) pursuant to a domestic relations order. Subject to the approval of the plan administrator or an authorized officer, an optionholder may designate a beneficiary, however, who may exercise the option following the optionholder's death.

Tax Limitations On Incentive Stock Options. The aggregate fair market value, determined at the time of grant, of our common stock with respect to ISOs that are exercisable for the first time by an optionholder during any calendar year under all of our stock plans and the stock plans of any of our affiliates may not exceed $100,000. Options or portions thereof that exceed such limit will generally be treated as NSOs. No ISO may be granted to any person who, at the time of the grant, owns or is deemed to own stock possessing more than 10% of our total combined voting power or that of any of our affiliates unless (1) the option exercise price is at least 110% of the fair market value of the stock subject to the option on the date of grant, and (2) the term of the ISO does not exceed five years from the date of grant.

Restricted Stock Awards. Restricted stock awards are granted pursuant to restricted stock award agreements adopted by the plan administrator. Restricted stock awards may be granted in consideration for (1) cash, check, bank draft or money order, (2) services rendered to us or our affiliates, or (3) any other form of legal consideration acceptable to the plan administrator. Common stock acquired under a restricted stock award may, but need not, be subject to a share repurchase option in our favor in accordance with a vesting schedule to be determined by the plan administrator. A restricted stock award may be transferred only upon such terms and conditions as set by the plan administrator. Except as otherwise provided in the applicable award agreement, restricted stock that has not vested will be forfeited or repurchased by us upon the participant's cessation of continuous service for any reason.

Restricted Stock Unit Awards. Restricted stock unit awards are granted pursuant to restricted stock unit award agreements adopted by the plan administrator. Restricted stock unit awards may be granted in consideration for any form of legal consideration acceptable to the plan administrator. A restricted stock unit award may be settled by cash, delivery of stock, a combination of cash and stock as deemed appropriate by the plan administrator, or in any other form of consideration set forth in the restricted stock unit award agreement. Additionally, dividend equivalents may be credited in respect of shares covered by a restricted stock unit award. Except as otherwise provided in the applicable award agreement, restricted stock units that have not vested will be forfeited upon the participant's cessation of continuous service for any reason.

Stock Appreciation Rights. Stock appreciation rights are granted pursuant to stock appreciation grant agreements adopted by the plan administrator. The plan administrator determines the strike price for a stock appreciation right, which generally cannot be less than 100% of the fair market value of our common stock on the date of grant. Upon the exercise of a stock appreciation right, we will pay the participant an amount equal to the product of (1) the excess of the per share fair market value of our common stock on the date of exercise over the strike price, multiplied by (2) the number of shares of common stock with respect to which the stock appreciation right is exercised. A stock appreciation right granted under the 2017 Plan vests at the rate specified in the stock appreciation right agreement as determined by the plan administrator.

The plan administrator determines the term of stock appreciation rights granted under the 2017 Plan, up to a maximum of 10 years. Unless the terms of a participant's stock appreciation right agreement provides otherwise, if a participant's service relationship with us or any of our affiliates ceases for any reason other than cause, disability or death, the participant may generally exercise any vested stock appreciation right for a period of three months following the cessation of service. The stock appreciation right term may be further extended in the event that exercise of the stock appreciation right following such a termination of service is prohibited by applicable securities laws. If a participant's service relationship with us, or any of our affiliates, ceases due to disability or death, or a participant dies within a certain period following cessation of service, the participant or a beneficiary may generally exercise any vested stock appreciation right for a period of 12 months in the event of disability and 18 months in the event of death. In the event of a termination for cause, stock appreciation rights generally terminate immediately upon the occurrence of the event giving rise to the termination of the individual for cause. In no event may a stock appreciation right be exercised beyond the expiration of its term.

Performance Awards. The 2017 Plan permits the grant of performance-based stock and cash awards that may qualify as performance-based compensation that is not subject to the $1,000,000 limitation on the income

tax deductibility of compensation paid to a covered executive officer imposed by Section 162(m) of the Code. To help assure that the compensation attributable to performance-based awards will so qualify, our compensation committee can structure such awards so that stock or cash will be issued or paid pursuant to such award only after the achievement of certain pre-established performance goals during a designated performance period.

The performance goals that may be selected include one or more of the following: (1) earnings (including earnings per share and net earnings); (2) earnings before interest, taxes and depreciation; (3) earnings before interest, taxes, depreciation and amortization; (4) earnings before interest, taxes, depreciation, amortization and legal settlements; (5) earnings before interest, taxes, depreciation, amortization, legal settlements and other income (expense); (6) earnings before interest, taxes, depreciation, amortization, legal settlements, other income (expense) and stock-based compensation; (7) earnings before interest, taxes, depreciation, amortization, legal settlements, other income (expense), stock-based compensation and changes in deferred revenue; (8) earnings before interest, taxes, depreciation, amortization, legal settlements, other income (expense), stock-based compensation, other non-cash expenses and changes in deferred revenue; (9) total stockholder return; (10) return on equity or average stockholder's equity; (11) return on assets, investment, or capital employed; (12) stock price; (13) margin (including gross margin); (14) income (before or after taxes); (15) operating income; (16) operating income after taxes; (17) pre-tax profit; (18) operating cash flow; (19) sales or revenue targets; (20) increases in revenue or product revenue; (21) expenses and cost reduction goals; (22) improvement in or attainment of working capital levels; (23) economic value added (or an equivalent metric); (24) market share; (25) cash flow; (26) cash flow per share; (27) cash balance; (28) cash burn; (29) cash collections; (30) share price performance; (31) debt reduction; (32) implementation or completion of projects or processes (including, without limitation, discovery of a preclinical drug candidate, recommendation of a drug candidate to enter a clinical trial, clinical trial initiation, clinical trial enrollment and dates, clinical trial results, regulatory filing submissions (such as IND, BLA and NDA), regulatory filing acceptances, regulatory or advisory committee interactions, regulatory approvals, and product supply); (33) stockholders' equity; (34) capital expenditures; (35) financings; (36) operating profit or net operating profit; (37) workforce diversity; (38) growth of net income or operating income; (39) employee retention; (40) initiation of studies by specific dates; (41) budget management; (42) submission to, or approval by, a regulatory body (including, but not limited to the FDA) of an applicable filing or a product; (43) regulatory milestones; (44) progress of internal research or development programs; (45) progress of partnered programs; (46) partner satisfaction; (47) timely completion of clinical trials; (48) milestones related to research development (including, but not limited to, preclinical and clinical studies), product development and manufacturing; (49) expansion of sales in additional geographies or markets; (50) research progress, including the development of programs; (51) strategic partnerships or transactions (including in-licensing and out-licensing of intellectual property; (52) filing of patent applications and granting of patents; and (53) and to the extent that an award is not intended to comply with Section 162(m) of the Code, other measures of performance selected by our board of directors.

The performance goals may be based on a company-wide basis, with respect to one or more business units, divisions, affiliates, or business segments, and in either absolute terms or relative to the performance of one or more comparable companies or the performance of one or more relevant indices. Unless specified otherwise (1) in the award agreement at the time the award is granted or (2) in such other document setting forth the performance goals at the time the goals are established, we will appropriately make adjustments in the method of calculating the attainment of performance goals as follows: (a) to exclude restructuring and/or other nonrecurring charges; (b) to exclude exchange rate effects; (c) to exclude the effects of changes to generally accepted accounting principles; (d) to exclude the effects of any statutory adjustments to corporate tax rates; (e) to exclude the effects of items that are "unusual" in nature or occur "infrequently" as determined under generally accepted accounting principles; (f) to exclude the dilutive effects of acquisitions or joint ventures; (g) to assume that any business divested by us achieved performance objectives at targeted levels during the balance of a performance period following such divestiture; (h) to exclude the effect of any change in the outstanding shares of our common stock by reason of any stock dividend or split, stock repurchase, reorganization, recapitalization, merger, consolidation, spin-off, combination or exchange of shares or other similar corporate change, or any distributions to common stockholders other than regular cash dividends; (i) to exclude the effects of stock based compensation and the award of bonuses under our bonus plans; (j) to exclude costs incurred in connection with

potential acquisitions or divestitures that are required to be expensed under generally accepted accounting principles; (k) to exclude the goodwill and intangible asset impairment charges that are required to be recorded under generally accepted accounting principles; and (l) to exclude the effects of the timing of acceptance for review and/or approval of submissions to the FDA or any other regulatory body. In addition, we retain the discretion to reduce or eliminate the compensation or economic benefit due upon attainment of the goals. The performance goals may differ from participant to participant and from award to award.

Other Stock Awards. The plan administrator may grant other awards based in whole or in part by reference to our common stock. The plan administrator will set the number of shares under the stock award and all other terms and conditions of such awards.

Changes to Capital Structure. In the event that there is a specified type of change in our capital structure, such as a stock split or recapitalization, appropriate adjustments will be made to (1) the class and maximum number of shares reserved for issuance under the 2017 Plan, (2) the class and maximum number of shares by which the share reserve may increase automatically each year, (3) the class and maximum number of shares that may be issued upon the exercise of ISOs, (4) the class and maximum number of shares subject to stock awards that can be granted to any person in a calendar year (as established under the 2017 Plan pursuant to Section 162(m) of the Code), and (5) the class and number of shares and exercise price, strike price, or purchase price, if applicable, of all outstanding stock awards.

Corporate Transactions. In the event of certain specified significant corporate transactions (or a change in control, as described below), the plan administrator has the discretion to take any of the following actions with respect to stock awards:

- arrange for the assumption, continuation or substitution of a stock award by a surviving or acquiring entity or parent company;
- arrange for the assignment of any reacquisition or repurchase rights held by us to the surviving or acquiring entity or parent company;
- accelerate the vesting of the stock award and provide for its termination prior to the effective time of the transaction;
- arrange for the lapse of any reacquisition or repurchase right held by us;
- cancel or arrange for the cancellation of the stock award in exchange for such cash consideration, if any, as our board of directors may deem appropriate; and
- make a payment equal to the excess of (a) the value of the property the participant would have received upon exercise of the stock award immediately prior to the effective time of the transaction, over (b) the exercise price otherwise payable by the participant in connection with such exercise.

Our plan administrator is not obligated to treat all stock awards, even those that are of the same type, in the same manner.

Under the 2017 Plan, a corporate transaction is generally the consummation of (1) a sale or other disposition of all or substantially all of our assets, (2) a sale or other disposition of more than 50% of our outstanding securities, (3) a merger, consolidation or similar transaction following which we are not the surviving corporation, or (4) a merger, consolidation or similar transaction following which we are the surviving corporation but the shares of our common stock outstanding immediately prior to such transaction are converted or exchanged into other property by virtue of the transaction.

Change in Control. In addition to the above, the plan administrator may provide, in an individual award agreement or in any other written agreement between a participant and us that the stock award will be subject to additional acceleration of vesting and exercisability in the event of a change in control. Under the 2017 Plan, a change in control is generally (1) the acquisition by a person or entity of more than 50% of our combined voting power other than by merger, consolidation or similar transaction; (2) a consummated merger, consolidation or

similar transaction immediately after which our stockholders cease to own more than 50% of the combined voting power of the surviving entity (or its parent); (3) a consummated sale, lease, exclusive license or other disposition of all or substantially all of our assets; (4) a complete dissolution or liquidation of the Company, except for a liquidation into a parent corporation; or (5) when a majority of our board of directors becomes comprised of individuals who were not serving on our board of directors on the date of adoption of the 2017 Plan, or the incumbent board, or whose nomination, appointment, or election was not approved by a majority of the incumbent board then still in office.

Amendment and Termination. Our board of directors has the authority to amend, suspend, or terminate our 2017 Plan, provided that such action does not materially impair the existing rights of any participant without such participant's written consent. No ISOs may be granted after the 10th anniversary of the date our board of directors adopted our 2017 Plan.

2009 Equity Incentive Plan

Our board of directors and our stockholders approved our 2009 Plan in March 2009. The 2009 Plan was subsequently amended by our board of directors and stockholders, most recently in November 2016. As of December 31, 2016, there were 172,495 shares remaining available for the grant of stock awards under our 2009 Plan and there were outstanding stock options covering a total of 1,385,855 shares that were granted under our 2009 Plan.

No additional awards will be granted under the 2009 Plan, and all outstanding awards granted under the 2009 Plan that are repurchased, forfeited, expire or are canceled will become available for grant under the 2017 Plan in accordance with its terms.

Stock awards. The 2009 Plan provides for the grant of ISOs, NSOs, stock appreciation rights, restricted stock awards, restricted stock unit awards, performance stock awards and other stock awards, or collectively, stock awards. With the exception of ISOs, all stock awards may be granted to employees, including officers, and to non-employee directors and consultants of us and our affiliates. ISOs may be granted only to employees. We have only granted stock options under the 2009 Plan.

Share Reserve. As of the date of this prospectus, the aggregate number of shares of our common stock reserved for issuance pursuant to stock awards under the 2009 Plan is 1,617,289 and the maximum number of shares that may be issued upon the exercise of ISOs under our 2009 Plan is 3,234,578 shares.

If a stock award granted under the 2009 Plan is forfeited to us because of the failure to meet a contingency or condition required for vesting, such shares will become available for subsequent issuance under the 2009 Plan or the 2017 Plan, after its effective date. In addition, shares withheld to satisfy income or employment withholding taxes and shares used to pay the exercise price of a stock option will become available for the grant of new stock awards under the 2009 Plan. Shares issued under the 2009 Plan may be authorized but unissued or reacquired common stock, including shares repurchased by us on the open market.

Administration. Our board of directors, or a duly authorized committee thereof, has the authority to administer the 2009 Plan. Subject to the terms of the 2009 Plan, our board of directors or the authorized committee, referred to herein as the plan administrator, determines recipients, dates of grant, the numbers and types of stock awards to be granted and the terms and conditions of the stock awards, including the period of their exercisability and vesting schedule applicable to a stock award. Subject to the limitations set forth below, the plan administrator will also determine the exercise price, strike price or purchase price of awards granted and the types of consideration to be paid for the award.

The plan administrator has the authority to modify outstanding awards under our 2009 Plan. Subject to the terms of our 2009 Plan, the plan administrator has the authority to reduce the exercise price of any outstanding

stock option, cancel any outstanding stock option in exchange for new stock awards, cash or other consideration, or take any other action that is treated as a repricing under generally accepted accounting principles, with the consent of any adversely affected participant.

Stock Options. ISOs and NSOs are granted pursuant to stock option agreements adopted by the plan administrator. The plan administrator determines the exercise price for a stock option, within the terms and conditions of the 2009 Plan, provided that the exercise price of a stock option generally cannot be less than 100% of the fair market value of our common stock on the date of grant. Options granted under the 2009 Plan vest at the rate specified by the plan administrator.

The plan administrator determines the term of stock options granted under the 2009 Plan, up to a maximum of 10 years. Unless the terms of an optionholder's stock option agreement provide otherwise, if an optionholder's service relationship with us, or any of our affiliates, ceases for any reason other than disability, death or cause, the optionholder may generally exercise any vested options for a period of three months following the cessation of service, with respect to employee optionholders. The option term may be extended in the event that exercise of the option following such a termination of service is prohibited by applicable securities laws. If an optionholder's service relationship with us or any of our affiliates ceases due to death, or an optionholder dies within a certain period following cessation of service, the optionholder or a beneficiary may generally exercise any vested options for a period of 18 months following the date of death. If an optionholder's service relationship with us or any of our affiliates ceases due to disability, the optionholder may generally exercise any vested options for a period of 12 months following the cessation of service. In the event of a termination for cause, options generally terminate upon the termination date. In no event may an option be exercised beyond the expiration of its term.

Acceptable consideration for the purchase of common stock issued upon the exercise of a stock option will be determined by the plan administrator and may include (1) cash, check, bank draft or money order, (2) a broker-assisted cashless exercise, (3) the tender of shares of our common stock previously owned by the optionholder, (4) a net exercise of the option if it is an NSO, and (5) other legal consideration approved by the plan administrator.

Unless the plan administrator provides otherwise, options generally are not transferable except by will, the laws of descent and distribution, or pursuant to a domestic relations order. An optionholder may designate a beneficiary, however, who may exercise the option following the optionholder's death.

Tax Limitations On Incentive Stock Options. The aggregate fair market value, determined at the time of grant, of our common stock with respect to ISOs that are exercisable for the first time by an optionholder during any calendar year under all of our stock plans may not exceed $100,000. Options or portions thereof that exceed such limit will generally be treated as NSOs. No ISO may be granted to any person who, at the time of the grant, owns or is deemed to own stock possessing more than 10% of our total combined voting power or that of any of our affiliates unless (1) the option exercise price is at least 110% of the fair market value of the stock subject to the option on the date of grant, and (2) the option is not exercisable after the expiration of five years from the date of grant.

Changes to Capital Structure. In the event that there is a specified type of change in our capital structure, such as a stock split or recapitalization, appropriate adjustments will be made to (a) the class and maximum number of shares reserved for issuance under the 2009 Plan, (b) the class and maximum number of shares that may be issued upon the exercise of ISOs, and (c) the class and number of shares and price per share of stock subject to all outstanding stock awards.

Corporate Transactions. In the event of certain specified significant corporate transactions, unless otherwise provided in a stock award or other written agreement between us and the holder of a stock award, the plan administrator has the discretion to take any of the following actions with respect to stock awards:

- arrange for the assumption, continuation or substitution of a stock award by a surviving or acquiring entity or its parent company;

- arrange for the assignment of any reacquisition or repurchase rights held by us with respect to the shares covered by the stock award to the surviving or acquiring entity or its parent company;
- accelerate the vesting and exercisability, if applicable, of the stock award and provide for its termination at or prior to the effective time of the corporate transaction;
- arrange for the lapse of any reacquisition or repurchase right held by us with respect to the shares covered by the stock award; or
- make a payment in such form determined by our board of directors equal to the excess, if any, of (a) the value of the property the holder of the stock award would have received upon exercise of the stock award over (b) any exercise price otherwise payable by such holder in connection with such exercise.

Our plan administrator is not obligated to treat all stock awards or portions thereof or all holders of stock awards, even those that are of the same type, in the same manner.

Under the 2009 Plan, a corporate transaction is generally the occurrence of (1) any consolidation or merger with or into any other corporation or other entity or person, or any other corporate reorganization; (2) any transaction or series of related transactions to which we are a party in which in excess of 50% of our voting power is transferred; or (3) a sale, lease, exclusive license or other disposition of all or substantially all of our assets.

Change in Control. The plan administrator may provide, in an individual award agreement or in any other written agreement between a participant and us that the stock award will be subject to additional acceleration of vesting and exercisability in the event of a change in control. Our form of award agreement for employees who are not founders provides for the acceleration of up to 25% of the shares subject to the option in the event of a change in control, as defined in the 2009 Plan, and for the acceleration of up to 25% of the shares subject to the option in the event of the holder's death or disability, as defined in the 2009 Plan. Our form of award agreement for founders and non-employee directors provides for the acceleration of up to 100% of the shares subject to the option in the event of a change in control.

Under the 2009 Plan, a change in control is generally (1) a sale of all or substantially all of our assets; (2) a merger or consolidation in which we are not the surviving corporation (other than a merger or consolidation in which stockholders immediately before the merger or consolidation have, immediately after the merger or consolidation, a majority of the voting power of the surviving corporation); (3) a reverse merger in which we are the surviving corporation but the shares of our common stock outstanding immediately preceding the merger are converted by virtue of the merger into other property, whether in the form of securities, cash or otherwise (other than a reverse merger in which stockholders immediately before the merger have, immediately after the merger, a majority of the voting power of the surviving corporation); or (4) any transaction or series of related transactions in which in excess of 50% of our voting power is transferred, other than the sale by us of stock in transactions the primary purpose of which is to raise capital for our operations and activities.

Amendment and Termination. The 2009 Plan will terminate on March 22, 2019. However, our board of directors has the authority to amend, suspend, or terminate our 2009 Plan, provided that such action does not impair the existing rights of any participant without such participant's written consent.

2017 Employee Stock Purchase Plan

Our board of directors and stockholders adopted the ESPP in March 2017. The ESPP became effective immediately prior to and contingent upon the date of the underwriting agreement for this offering. The purpose of the ESPP is to retain the services of new employees and secure the services of new and existing employees while providing incentives for such individuals to exert maximum efforts toward our success and that of our affiliates.

Share Reserve. Following this offering, the ESPP authorizes the issuance of 250,000 shares of our common stock pursuant to purchase rights granted to our employees or to employees of any of our designated

affiliates. The number of shares of our common stock reserved for issuance will automatically increase on January 1 of each calendar year, from January 1, 2018 (assuming the ESPP becomes effective before such date) through January 1, 2027 by the least of (a) 1% of the total number of shares of our common stock outstanding on December 31 of the preceding calendar year, (b) 300,000 shares, or (c) a number determined by our board of directors that is less than (a) and (b). The ESPP is intended to qualify as an "employee stock purchase plan" within the meaning of Section 423 of the Code. As of the date hereof, no shares of our common stock have been purchased under the ESPP.

Administration. Our board of directors has delegated its authority to administer the ESPP to our compensation committee. The ESPP is implemented through a series of offerings of purchase rights to eligible employees. Under the ESPP, we may specify offerings with durations of not more than 27 months, and may specify shorter purchase periods within each offering. Each offering will have one or more purchase dates on which shares of our common stock will be purchased for employees participating in the offering. An offering may be terminated under certain circumstances.

Payroll Deductions. Generally, all regular employees, including executive officers, employed by us or by any of our designated affiliates, may participate in the ESPP and may contribute, normally through payroll deductions, up to 15% of their earnings for the purchase of our common stock under the ESPP. Unless otherwise determined by our board of directors, common stock will be purchased for accounts of employees participating in the ESPP at a price per share equal to the lower of (a) 85% of the fair market value of a share of our common stock on the first date of an offering or (b) 85% of the fair market value of a share of our common stock on the date of purchase.

Limitations. Employees may have to satisfy one or more of the following service requirements before participating in the ESPP, as determined by our board of directors: (a) customarily employed for more than 20 hours per week, (b) customarily employed for more than five months per calendar year or (c) continuous employment with us or one of our affiliates for a period of time (not to exceed two years). No employee may purchase shares under the ESPP at a rate in excess of $25,000 worth of our common stock based on the fair market value per share of our common stock at the beginning of an offering for each year such a purchase right is outstanding. Finally, no employee will be eligible for the grant of any purchase rights under the ESPP if immediately after such rights are granted, such employee has voting power over 5% or more of our outstanding capital stock measured by vote or value pursuant to Section 424(d) of the Code.

Changes to Capital Structure. In the event that there occurs a change in our capital structure through such actions as a stock split, merger, consolidation, reorganization, recapitalization, reincorporation, stock dividend, dividend in property other than cash, large nonrecurring cash dividend, liquidating dividend, combination of shares, exchange of shares, change in corporate structure or similar transaction, the board of directors will make appropriate adjustments to (a) the class and number of shares reserved under the ESPP, (b) the class and maximum number of shares by which the share reserve may increase automatically each year, (c) the class and number of shares and purchase price of all outstanding offerings and purchase rights and (d) the class and number of shares that are the subject of the purchase limits under each ongoing offering.

Corporate Transactions. In the event of certain significant corporate transactions, including the consummation of: (1) a sale or other disposition of all or substantially all of our assets, (2) the sale or other disposition of more than 50% of our outstanding securities, (3) a merger, consolidation or similar transaction where we do not survive the transaction, and (4) a merger, consolidation or similar transaction where we do survive the transaction but the shares of our common stock outstanding immediately prior to such transaction are converted or exchanged into other property by virtue of the transaction, any then-outstanding rights to purchase our stock under the ESPP may be assumed, continued or substituted for by any surviving or acquiring entity (or its parent company). If the surviving or acquiring entity (or its parent company) elects not to assume, continue or substitute for such purchase rights, then the participants' accumulated payroll contributions will be used to purchase shares of our common stock within 10 business days prior to such corporate transaction, and such purchase rights will terminate immediately after such purchase.

Plan Amendments, Termination. Our board of directors has the authority to amend or terminate our ESPP, provided that except in certain circumstances any such amendment or termination may not materially impair any outstanding purchase rights without the holder's consent. We will obtain stockholder approval of any amendment to our ESPP as required by applicable law or listing requirements.

Director Compensation

Historically, we have not paid cash compensation to any of our non-employee directors for service on our board of directors. As set forth below, we did pay equity compensation to our non-employee directors in 2016 for service on our board of directors.

In June 2016, we granted Faheem Hasnain an option to purchase 15,398 shares of common stock, Franklin M. Berger an option to purchase 10,268 shares of common stock, Paul Schimmel, Ph.D. an option to purchase 5,289 shares of common stock, David Parkinson, M.D. an option to purchase 4,152 shares of common stock and Lori Kunkel, M.D. an option to purchase 2,644 shares of common stock, each at an exercise price of $14.98 per share. Each option is subject to a four-year vesting schedule, with 25% vesting after the first year and the balance vesting monthly over the remaining 36 months, subject to the respective optionholder's continued service with us. Each option provides for full acceleration of all of the shares subject to the option in the event of a change in control.

In March 2017, the board of directors approved the grant of an option to purchase 10,869 shares of common stock to Mr. Hasnain, an option to purchase 7,246 shares of common stock to Mr. Berger, an option to purchase 4,528 shares of common stock to Dr. Schimmel, an option to purchase 4,528 shares of common stock to Dr. Parkinson and an option to purchase 4,528 shares of common stock to Dr. Kunkel in connection with their service on the board of directors. The options were granted under the 2017 Plan effective as of the execution and delivery of the underwriting agreement for this offering and at a per share exercise price equal to $10.00, the initial public offering price. Each option is subject to a four-year vesting schedule, with 25% vesting one year after the vesting commencement date and the balance vesting monthly over the remaining 36 months, subject to the respective optionholder's continued service with us. The options provide for full acceleration of all of the shares subject to the option in the event of a change in control. The post-termination exercise period for the options will be up to 12 months from the date of termination, if such termination is other than for death, disability or cause.

We have reimbursed and will continue to reimburse all of our non-employee directors for their travel, lodging and other reasonable expenses incurred in attending meetings of our board of directors and committees of our board of directors.

The following table sets forth in summary form information concerning the compensation that we paid or awarded during the year ended December 31, 2016 to each of our non-employee directors. None of our non-employee directors earned or were paid any cash during the year ended December 31, 2016.

NAME	Option Awards ($)[1][2]	Total ($)
Faheem Hasnain	144,989	144,989
Franklin M. Berger	96,682	96,682
Paul Schimmel, Ph.D.	49,808	49,808
David Parkinson, M.D.	39,096	39,096
Lori Kunkel, M.D.	24,904	24,904

(1) In accordance with SEC rules, this column reflects the aggregate grant date fair value of the stock option awards granted in 2016 computed in accordance with FASB ASC Topic 718. Assumptions used in the calculation of these amounts are described in Note 7 to our financial statements included elsewhere in this prospectus. These amounts do not reflect the actual economic value that will be realized by the non-employee director upon the vesting of the stock option awards, the exercise of the stock option awards or the sale of the common stock underlying such stock option awards.

(2) As of December 31, 2016, the aggregate number of shares outstanding under all options to purchase our common stock held by our non-employee directors were: Mr. Hasnain: 58,876; Mr. Berger: 39,253; Dr. Schimmel: 23,404; Dr. Parkinson: 22,267; and Dr. Kunkel: 20,759.

Our board of directors adopted a new compensation policy in March 2017 that became effective upon the execution and delivery of the underwriting agreement for this offering and is applicable to all of our non-employee directors. This compensation policy provides that each such non-employee director will receive the following compensation for service on our board of directors:

- an annual cash retainer of $35,000;
- an additional cash retainer of $30,000 to the chairman of the board of directors;
- an additional cash retainer of $20,000 to the lead independent director of the board of directors;
- an additional annual cash retainer of $7,500, $5,000 and $4,000 for service as a member of the audit committee, compensation committee and the nominating and corporate governance committee, respectively;
- an additional annual cash retainer of $15,000, $10,000 and $7,500 for service as chairman of the audit committee, compensation committee and the nominating and corporate governance committee, respectively;
- an initial option grant to purchase 25,000 shares of our common stock for each non-employee director who first joins our board of directors, on the date of commencement of service on the board, vesting over a three year period following the grant date; and
- an annual option grant to purchase 15,000 shares of our common stock for each non-employee director serving on the board of directors on the date of our annual stockholder meeting, vesting one year following the grant date.

Each of the option grants described above will vest and become exercisable subject to the director's continuous service to us, provided that each option will vest in full upon a change in control (as defined under our 2017 Plan). The term of each option will be 10 years, subject to earlier termination as provided in the 2017 Plan, except that the post-termination exercise period will be for up to 12 months from the date of termination, if such termination is other than for death, disability or cause. The options will be granted under our 2017 Plan, the terms of which are described in more detail above under "— Equity Benefit Plans — 2017 Equity Incentive Plan."

CERTAIN RELATIONSHIPS AND RELATED PARTY TRANSACTIONS

The following includes a summary of transactions since January 1, 2014 to which we have been a party, in which the amount involved in the transaction exceeded $120,000, and in which any of our directors, executive officers or, to our knowledge, beneficial owners of more than 5% of our capital stock or any member of the immediate family of any of the foregoing persons had or will have a direct or indirect material interest, other than equity and other compensation, termination, change in control and other arrangements, which are described under "Executive And Director Compensation."

Preferred Stock Financings

Series H Convertible Preferred Stock

From January 2014 through September 2015, we entered into a series of subscription agreements with various investors, pursuant to which we issued and sold to such investors an aggregate of 8,041,275 shares of our Series H convertible preferred stock at a purchase price of $5.25 per share, and received gross proceeds of approximately $42.2 million.

The subscription agreements in these convertible preferred stock financings contained, among other things, certain transfer restrictions and a voting agreement pursuant to which each investor granted to our former chief executive officer, Harry E. Gruber, M.D., Dr. Gruber's designee or our current chief executive officer, Martin J. Duvall, the right to vote all of the shares of our capital stock held by such investor in the same manner as the majority of the holders of shares of our outstanding common stock. Such voting rights will terminate upon the completion of this offering.

The participants in these convertible preferred stock financings included the following members of our board of directors and holders of more than 5% of our capital stock or entities affiliated with them. The following table sets forth the aggregate number of shares of convertible preferred stock issued to these related parties in these convertible preferred stock financings:

Participants	Shares of Series H Convertible Preferred Stock
Directors	
Paul Schimmel, Ph.D.	161,906
Greater than 5% stockholders	
Irwin Mark Jacobs and Joan Klein Jacobs Family Trust UA dated 6/2/80	571,428

Convertible Note Financing

From November 2016 through February 2017 we issued and sold to investors, convertible promissory notes in the aggregate principal amount of $10.9 million. The convertible promissory notes carry an interest rate of 7% per annum.

The participants in this convertible note financing included the following executive officers and members of our board of directors, or entities affiliated with them:

Participants	Aggregate Principal Amount of Notes
Executive Officers and Directors	
Franklin M. Berger	$ 250,000
Martin J. Duvall	$ 35,000
Faheem Hasnain[1]	$1,000,000

(1) Note held by Faheem Hasnain and Marie Hasnain Co-Trustees of the Hasnain Revocable Trust, dated February 19, 2010.

Employment and Consulting Arrangements

In March 2015, we entered into an offer letter agreement with Dr. Das, our Senior Vice President and Chief Medical Officer, and in October 2016, we entered into an employment agreement with Mr. Duvall, our Chief Executive Officer. These agreements are described in the section titled "Executive and Director Compensation."

In May 2016, we entered into a consulting agreement with Dr. Skillings, our former Senior Vice President and Chief Medical Officer, pursuant to which she provides clinical development and medical affairs consulting services to us. Pursuant to her consulting agreement, Dr. Skillings is compensated for services rendered as requested from time to time. In connection with Dr. Skillings' transition from an employee to a consultant to the company, 50% of the unvested shares subject to outstanding options held by Dr. Skillings were canceled, effective May 20, 2016.

In February 2017, we entered into a separation agreement with Mr. Berman in connection with his resignation as our Executive Vice President, Corporate Development, which resignation will be effective as of April 15, 2017. Pursuant to the separation agreement, Mr. Berman agreed to a release of claims against the company and is entitled to receive (1) a lump sum payment equal to his base salary from the period that begins on the effective date of his resignation and ends on December 31, 2017 plus any discretionary bonus awarded to him by our board of directors for 2016, less standard payroll deductions and withholdings, (2) health insurance premiums through December 31, 2017, (3) acceleration of the vesting of a portion of his stock options and (4) an extension of the post-termination exercise period of his vested stock options until March 31, 2019.

In February 2017, we entered into an employment agreement with Mark Foletta, our Executive Vice President and Chief Financial Officer. Mr. Foletta's employment under the agreement is at will and may be terminated at any time by us or by him. Under the terms of the agreement, Mr. Foletta is entitled to receive an annual base salary of $350,000 and the agreement provides for a target bonus of up to 40% of his base salary, based on achievement of individual and/or corporate performance targets, metrics and/or objectives to be determined and approved by the board of directors or compensation committee thereof. The agreement provides for the grant to Mr. Foletta of an option to purchase up to 69,636 shares of our common stock, of which 25% of the shares will vest on February 27, 2018 and the balance will vest over the remaining 36 months, subject to Mr. Foletta's continued service with us, and subject to full acceleration of all of the shares in the event of a change of control and the acceleration of 25% of the shares in the event of Mr. Foletta's death or disability. The agreement also provides for the grant to Mr. Foletta of an option to purchase up to 34,298 additional shares of our common stock, which shall vest upon the achievement of development and regulatory milestones, subject to his continued service with us and subject to the acceleration of vesting in the event that a change of control occurs prior to the vesting of the shares, at the discretion of the board of directors and based on progress towards the milestones. Both options have exercise prices of $15.12 per share. The agreement also provides that, if we terminate Mr. Foletta's employment without cause (other than due to his death or disability) or if Mr. Foletta

resigns for good reason at any time, we are obligated to pay Mr.Foletta, subject to receiving an effective release and waiver of claims from him, (1) severance payments in the form of continuation of his base salary then in effect (ignoring any decrease that forms the basis for his resignation for good reason, if applicable) for 12 months, and (2) continued health insurance coverage under the Company's group health plans under the Consolidated Omnibus Budget Reconciliation Act of 1985 or the state equivalent until the earliest of (i) the end of the 12 month severance period, (ii) the expiration of his eligibility for the continuation coverage, or (iii) the date when he becomes eligible for substantially equivalent health insurance coverage in connection with new employment or self-employment. In addition, if we terminate Mr. Foletta's employment without cause (other than due to his death or disability) or if Mr. Foletta resigns for good reason at any time, Mr. Foletta shall receive an extension of the period of time following which he may exercise vested shares subject to outstanding equity awards until the date that is the earlier of (i) the original expiration date of such award and (ii) 12 months following such termination or resignation. For the purposes of Mr. Foletta's employment agreement, "cause" means the occurrence of any of the following events: (i) his commission of any felony or any crime involving fraud, dishonesty or moral turpitude under the laws of the United States or any state thereof; (ii) his attempted commission of, or participation in, a fraud or act of dishonesty against the Company; (iii) his intentional, material violation of any contract or agreement between him and the Company or of any statutory duty owed to the Company that has not been cured, if curable, within fifteen (15) days after written notice from the board of directors of such violation; (iv) his unauthorized use or disclosure of the Company's confidential information or trade secrets; or (v) his gross misconduct that has not been cured, if curable, within fifteen (15) days after written notice from the board of directors requesting that the he cure such misconduct. For purposes of Mr. Foletta's employment agreement, "good reason" means voluntary resignation of employment with us within 30 days of the occurrence of one or more of the following undertaken by us without Mr. Foletta's consent, after we fail to remedy the condition within a 30 day cure period: (1) a material reduction in his base salary (i.e. a reduction of at least 10% of base salary (unless pursuant to a salary reduction program applicable generally to the Company's similarly situated employees)); (2) a material reduction in his authority, duties or responsibilities; (3) a material reduction in the authority, duties, or responsibilities of the supervisor to whom he is required to report, including a requirement that he reports to a corporate officer or employee other than the chief executive officer; (4) a relocation of his principal place of employment to a place that increases his one-way commute by more than 50 miles as compared to his then-current principal place of employment immediately prior to such relocation (excluding regular travel in the ordinary course of business); and (5) a breach of a material provision of the employment agreement by the Company.

Stock Options Granted to Executive Officers and Directors

We have granted stock options to our executive officers and directors, as more fully described in the section titled "Executive and Director Compensation."

Indemnification Agreements

We have entered, and intend to continue to enter, into separate indemnification agreements with each of our directors and executive officers, as described in "Management — Limitation of Liability and Indemnification."

Policies and Procedures for Transactions with Related Persons

We have adopted a written related-person transactions policy that sets forth our policies and procedures regarding the identification, review, consideration and oversight of "related-person transactions." For purposes of our policy only, a "related-person transaction" is a transaction, arrangement or relationship (or any series of similar transactions, arrangements or relationships) in which we and any "related person" are participants involving an amount that exceeds $120,000.

Transactions involving compensation for services provided to us as an employee, consultant or director are not considered related-person transactions under this policy. A related person is any executive officer, director,

nominee to become a director or a holder of more than five percent of our common stock, including any of their immediate family members and affiliates, including entities owned or controlled by such persons.

Under the policy, where a transaction has been identified as a related-person transaction, management must present information regarding the proposed related-person transaction to our audit committee (or, where review by our audit committee would be inappropriate, to another independent body of our board of directors) for review. The presentation must include a description of, among other things, all of the parties thereto, the direct and indirect interests of the related persons, the purpose of the transaction, the material facts, the benefits of the transaction to us and whether any alternative transactions are available, an assessment of whether the terms are comparable to the terms available from unrelated third parties and management's recommendation. To identify related-person transactions in advance, we rely on information supplied by our executive officers, directors and certain significant stockholders. In considering related-person transactions, our audit committee or another independent body of our board of directors takes into account the relevant available facts and circumstances including, but not limited to:

- the risks, costs and benefits to us;
- the impact on a director's independence in the event the related person is a director, immediate family member of a director or an entity with which a director is affiliated;
- the terms of the transaction;
- the availability of other sources for comparable services or products; and
- the terms available to or from, as the case may be, unrelated third parties.

In the event a director has an interest in the proposed transaction, the director must recuse himself or herself from the deliberations and approval.

PRINCIPAL STOCKHOLDERS

The following table sets forth information regarding beneficial ownership of our capital stock by:

- each person, or group of affiliated persons, known by us to beneficially own more than 5% of our common stock;
- each of our directors;
- each of our named executive officers; and
- all of our current executive officers and directors as a group.

The percentage ownership information under the column entitled "Before Offering" is based on 8,893,132 shares of common stock outstanding as of January 31, 2017, assuming conversion of all outstanding shares of our convertible preferred stock into 6,690,070 shares of common stock, which will occur in connection with the completion of this offering. The percentage ownership information under the column entitled "After Offering" is based on the sale of 8,500,000 shares of common stock in this offering and takes into account the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes that we issued between November 2016 and February 2017, which will automatically convert upon the completion of this offering into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017. The following table does not reflect any potential purchases pursuant to the directed share program or otherwise in this offering, which purchases, if any, will increase the percentage of shares owned after the offering.

Information with respect to beneficial ownership has been furnished by each director, officer or beneficial owner of more than 5% of our common stock. We have determined beneficial ownership in accordance with the rules of the SEC. These rules generally attribute beneficial ownership of securities to persons who possess sole or shared voting power or investment power with respect to those securities. In addition, the rules include shares of common stock issuable pursuant to the exercise of stock options or warrants that are either immediately exercisable or exercisable on or before April 1, 2017, which is 60 days after January 31, 2017. These shares are deemed to be outstanding and beneficially owned by the person holding those options or warrants for the purpose of computing the percentage ownership of that person, but they are not treated as outstanding for the purpose of computing the percentage ownership of any other person. Unless otherwise indicated, the persons or entities identified in this table have sole voting and investment power with respect to all shares shown as beneficially owned by them, subject to applicable community property laws.

Except as otherwise noted below, the address for each person or entity listed in the table is c/o Tocagen Inc., 3030 Bunker Hill Street, Suite 230, San Diego, California 92109.

Name and Address of Beneficial Owner	Number of Shares Beneficially Owned		Percentage of Shares Beneficially Owned	
	Before Offering	After Offering	Before Offering	After Offering
5% or Greater Stockholders				
Irwin Mark Jacobs and Joan Klein Jacobs Family Trust UA dated 6/2/80	552,380	552,380	6.2%	3.0%
Harry E. Gruber, M.D.(1)	509,781	509,781	5.7%	2.7%
Douglas Jolly, Ph.D.(2)	496,376	496,376	5.5%	2.7%
Directors and Named Executive Officers				
Martin J. Duvall(3)	—	3,571	*	*
Harry E. Gruber, M.D.(1)	509,781	509,781	5.7%	2.7%
Thomas E. Darcy(4)	440,397	440,397	4.9%	2.4%
Asha Das, M.D.(5)	17,903	17,903	*	*
Dennis N. Berman(6)	304,890	304,890	3.4%	1.6%
Faheem Hasnain(7)	30,116	132,973	*	*
Franklin M. Berger(8)	20,077	45,412	*	*
Paul Schimmel, Ph.D.(9)	45,583	45,583	*	*
David Parkinson, M.D.(10)	9,716	9,716	*	*
Lori Kunkel, M.D.(11)	7,452	7,452	*	*
All current executive officers and directors as a group (12 persons)(12)	1,882,291	2,014,054	20.2%	10.7%

* Represents beneficial ownership of less than 1%.

(1) Consists of (a) 392,753 shares of common stock owned by The Harry Edward Gruber and Joan Diane Cunningham Trust, dated 7/12/1988 and (b) 117,028 shares of common stock that Dr. Gruber has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options. Pursuant to (i) that certain Voting Agreement, dated December 20, 2007, by and among us, Dr. Gruber and certain other holders of our capital stock, and (ii) the subscription agreements entered into between us and the purchasers of shares of our convertible preferred stock in connection with our convertible preferred stock financings, Dr. Gruber has voting control and may be deemed to have beneficial ownership over all of the shares of our capital stock (except in certain circumstances, the shares of capital stock held by Mr. Darcy). However, such voting rights will terminate upon the completion of this offering so shares that he has voting control over pursuant to such agreements prior to the completion of this offering are not included.

(2) Consists of (a) 391,304 shares of common stock owned by Dr. Jolly, (b) 21,739 shares of common stock owned by his son, Alexander Jolly, (c) 21,739 shares of common stock owned by his daughter, Marianna Jolly, and (d) 61,594 shares of common stock that Dr. Jolly has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options. Dr. Jolly disclaims beneficial ownership of the shares held by Alexander Jolly and Marianna Jolly.

(3) The number of shares beneficially owned after the offering includes 3,571 shares of common stock issuable upon the conversion of convertible promissory notes in the principal amount of $35,000 plus accrued interest upon the completion of this offering at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017. Pursuant to the subscription agreements entered into between us and the purchasers of shares of our convertible preferred stock in connection with our convertible preferred stock financings, Mr. Duvall has voting control and may be deemed to have beneficial ownership over all of the shares of our capital stock held by holders of our convertible preferred stock. However, such voting rights will terminate upon the completion of this offering so shares that he has voting control over pursuant to such agreement prior to the completion of this offering are not included.

(4) Consists of (a) 369,565 shares of common stock owned by Thomas Eric Darcy and Janet E. Darcy, Trustees of the Darcy Family Trust dated September 21, 2005 and (b) 70,832 shares of common stock that Mr. Darcy has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options.

(5) Consists of 17,903 shares of common stock that Dr. Das has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options.

(6) Consists of (a) 246,376 shares of common stock owned by The Berman Family Trust dated August 8, 2000 and (b) 58,514 shares of common stock that Mr. Berman has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options.

(7) Consists of 30,116 shares of common stock that Mr. Hasnain has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options. The number of shares beneficially owned after the offering includes 102,857 shares of common stock issuable upon the conversion of a convertible promissory note in the principal amount of $1,000,000 plus accrued interest held by Faheem Hasnain and Marie Hasnain Co-Trustees of the Hasnain Revocable Trust, Dated February 19, 2010 upon the completion of this offering at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017.

(8) Consists of 20,077 shares of common stock that Mr. Berger has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options. The number of shares beneficially owned after the offering includes 25,335 shares of common stock issuable upon the conversion of a convertible promissory note in the principal amount of $250,000 plus accrued interest upon the completion of this offering at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017.

(9) Consists of (a) 4,117 shares of common stock issuable upon conversion of Series F convertible preferred stock owned by NFS/FMTC FBO Paul Schimmel Rollover IRA, (b) 3,623 shares of common stock issuable upon conversion of Series G convertible preferred stock owned by Paul Schimmel Prototype PSP Paul R. Schimmel, TTEE U/A dtd 01/01/1999 FBO Paul Schimmel, (c) 3,623 shares of common stock issuable upon conversion of Series G convertible preferred stock owned by Schimmel Revocable Trust Paul R. Schimmel, Trustee Cleo Schimmel, Trustee U/A dtd 9/6/2000, (d) 23,464 shares of common stock issuable upon conversion of Series H convertible preferred stock owned by Dr. Schimmel and (e) 10,756 shares of common stock that Dr. Schimmel has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options.

(10) Consists of 9,716 shares of common stock that Dr. Parkinson has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options.

(11) Consists of 7,452 shares of common stock that Dr. Kunkel has the right to acquire from us within 60 days of January 31, 2017 pursuant to the exercise of stock options.

(12) Consists of the shares described in footnotes (1) through (11).

DESCRIPTION OF CAPITAL STOCK

Upon filing of our amended and restated certificate of incorporation and the completion of this offering, our authorized capital stock will consist of 200,000,000 shares of common stock, par value $0.001 per share, and 10,000,000 shares of preferred stock, par value $0.001 per share. All of our authorized preferred stock upon the completion of this offering will be undesignated. The following is a summary of the rights of our common and preferred stockholders and some of the provisions of our amended and restated certificate of incorporation and amended and restated bylaws, which will become effective immediately prior to and upon the completion of this offering, respectively, and of the Delaware General Corporation Law. This summary is not complete. For more detailed information, please see our amended and restated certificate of incorporation and amended and restated bylaws, which are filed as exhibits to the registration statement of which this prospectus is a part, as well as the relevant provisions of the Delaware General Corporation Law.

Common Stock

Outstanding Shares

As of December 31, 2016, there were 2,202,517 shares of common stock issued and outstanding held of record by 76 stockholders. This amount excludes our outstanding shares of convertible preferred stock, which will convert into 6,690,070 shares of common stock in connection with the completion of this offering. Based on the number of shares of common stock outstanding as of December 31, 2016, and assuming (1) the conversion of all outstanding shares of our convertible preferred stock, (2) the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes which were issued between November 2016 and February 2017 and which will automatically convert upon the completion of this offering into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017 and (3) the issuance by us of 8,500,000 shares of common stock in this offering, there will be 18,501,763 shares of common stock outstanding upon the completion of this offering.

As of December 31, 2016, there were 1,385,855 shares of common stock subject to outstanding options under our equity incentive plan. In addition, as discussed below, as of December 31, 2016, there were 724 shares of common stock issuable upon the exercise of an outstanding warrant and 68,572 shares of our Series H convertible preferred stock issuable upon the exercise of outstanding warrants, which will become exercisable for 9,936 shares of common stock upon the completion of this offering, as described below.

Voting

Our common stock is entitled to one vote for each share held of record on all matters submitted to a vote of the stockholders, including the election of directors, and does not have cumulative voting rights. Accordingly, the holders of a majority of the shares of our common stock entitled to vote in any election of directors can elect all of the directors standing for election.

Dividends

Subject to preferences that may be applicable to any then-outstanding preferred stock, the holders of common stock are entitled to receive dividends, if any, as may be declared from time to time by our board of directors out of legally available funds.

Liquidation

In the event of our liquidation, dissolution or winding-up, holders of our common stock will be entitled to share ratably in the net assets legally available for distribution to stockholders after the payment of all of our

debts and other liabilities, subject to the satisfaction of any liquidation preference granted to the holders of any outstanding shares of preferred stock.

Rights and Preferences

Holders of our common stock have no preemptive, conversion or subscription rights, and there are no redemption or sinking fund provisions applicable to our common stock. The rights, preferences and privileges of the holders of our common stock are subject to, and may be adversely affected by, the rights of the holders of shares of any series of our preferred stock that we may designate and issue in the future.

Fully Paid and Nonassessable

All of our outstanding shares of common stock are, and the shares of common stock to be issued in this offering will be, fully paid and nonassessable.

Convertible Preferred Stock

As of December 31, 2016, there were 46,163,605 shares of convertible preferred stock outstanding, held of record by 670 stockholders. In connection with the completion of this offering, all outstanding shares of convertible preferred stock will be converted into 6,690,070 shares of our common stock. Immediately prior to the completion of this offering, our certificate of incorporation will be amended and restated to delete all references to such shares of convertible preferred stock. Under the amended and restated certificate of incorporation, our board of directors will have the authority, without further action by the stockholders, to issue up to 10,000,000 shares of convertible preferred stock in one or more series, to establish from time to time the number of shares to be included in each such series, to fix the rights, preferences and privileges of the shares of each wholly unissued series and any qualifications, limitations or restrictions thereon and to increase or decrease the number of shares of any such series, but not below the number of shares of such series then outstanding.

Our board of directors may authorize the issuance of preferred stock with voting or conversion rights that could adversely affect the voting power or other rights of the holders of the common stock. The issuance of preferred stock, while providing flexibility in connection with possible acquisitions and other corporate purposes, could, among other things, have the effect of delaying, deferring or preventing a change in our control that may otherwise benefit holders of our common stock and may adversely affect the market price of the common stock and the voting and other rights of the holders of common stock. We have no current plans to issue any shares of preferred stock.

Warrants

In June 2013, we issued a warrant to purchase 724 shares of our common stock at an exercise price of $3.94 per share to Voices Against Brain Cancer, or VABC, in connection with our consulting agreement with VABC. The warrant is subject to vesting such that 1/4th of the total shares subject to the warrant vested on June 5, 2014 and 1/48th of the total shares subject to the warrant vest monthly thereafter, provided that VABC continues to provide services to us through each such vesting date. As of December 31, 2016, 634 shares of our common stock were vested and issuable upon exercise of the warrant. The warrant provides for cashless exercise at the option of the holder, and also contains provisions for the adjustment of the number of shares issuable upon the exercise of the warrant and of the exercise price in the event of stock dividends, splits, recapitalizations, reclassifications, combinations or exchanges of shares, separations, reorganizations, liquidations or the like. The warrant terminates upon the earlier of (i) June 5, 2023, (ii) immediately prior to the effective time of a change in control, as defined in the warrant, and (iii) 90 days after the date of the expiration or termination of our consulting agreement with VABC.

In October 2015, we issued warrants to purchase shares of our Series H convertible preferred stock to Oxford and SVB, in connection with the Loan Agreement. As of the date of this prospectus, the warrants are exercisable for up to 68,572 shares of Series H convertible preferred stock at an exercise price of $5.25 per share. In connection with the completion of this offering, the warrants become exercisable for up to 9,936 shares of common stock, at an exercise price of $36.23 per share. These warrants expire on October 30, 2025 and, upon such date, they will be automatically exercised pursuant to the net exercise provision, if the fair market value of the exercise shares is greater than the exercise price. In addition, these warrants terminate if not exercised in connection with certain acquisitions of our company. These warrants contain provisions for the adjustment of the exercise price and the aggregate number of shares issuable upon exercise in the event of stock dividends, stock splits, reclassifications, exchanges, substitutions, consolidations, diluting issuances or certain acquisitions where an acquiring entity refuses to assume the warrants.

Grants

In June 2013, we received a grant pursuant to a research and development grant agreement with VABC. Pursuant to that grant agreement, we may be required to pay back the amount of the grant to VABC if we reach certain milestones for sales of therapies covered by the grant agreement. Under the grant agreement, after our initial public offering, if the milestones are met, instead of being paid in cash, VABC has the option to be paid back the grant amount in full or in part by receiving shares of our common stock, at a price per share equal to the closing stock price for our common stock on the first business day prior to such conversion date. After our initial public offering, we also have the right to elect to pay back the grant amount in full by issuing shares of our common stock.

Registration Rights

The holders of our capital stock do not have the right to require us to register with the SEC any such shares of capital stock.

Anti-Takeover Effects of Provisions of Our Amended and Restated Certificate of Incorporation, Our Amended and Restated Bylaws and Delaware Law

Delaware Anti-Takeover Law

We are subject to Section 203 of the Delaware General Corporation Law, or Section 203. Section 203 generally prohibits a public Delaware corporation from engaging in a "business combination" with an "interested stockholder" for a period of three years following the time that such stockholder became an interested stockholder, unless:

- prior to such time the board of directors of the corporation approved either the business combination or the transaction which resulted in the stockholder becoming an interested stockholder;
- upon consummation of the transaction which resulted in the stockholder becoming an interested stockholder, the interested stockholder owned at least 85% of the voting stock of the corporation outstanding at the time the transaction commenced, excluding for purposes of determining the voting stock outstanding (but not the outstanding voting stock owned by the interested stockholder) those shares owned (1) by persons who are directors and also officers and (2) employee stock plans in which employee participants do not have the right to determine confidentially whether shares held subject to the plan will be tendered in a tender or exchange offer; or
- at or subsequent to such time, the business combination is approved by the board of directors and authorized at an annual or special meeting of stockholders, and not by written consent, by the affirmative vote of at least 66-2/3% of the outstanding voting stock which is not owned by the interested stockholder.

Section 203 defines a business combination to include:

- any merger or consolidation involving the corporation and the interested stockholder;
- any sale, transfer, pledge or other disposition involving the interested stockholder of 10% or more of the assets of the corporation;
- subject to exceptions, any transaction that results in the issuance or transfer by the corporation of any stock of the corporation to the interested stockholder;
- subject to exceptions, any transaction involving the corporation that has the effect of increasing the proportionate share of the stock of any class or series of the corporation beneficially owned by the interested stockholder; and
- the receipt by the interested stockholder of the benefit of any loans, advances, guarantees, pledges or other financial benefits provided by or through the corporation.

In general, Section 203 defines an interested stockholder as any entity or person beneficially owning 15% or more of the outstanding voting stock of the corporation and any entity or person affiliated with or controlling or controlled by the entity or person.

Amended and Restated Certificate of Incorporation and Amended and Restated Bylaws

Provisions of our amended and restated certificate of incorporation and amended and restated bylaws, which will become effective immediately prior to and upon the completion of this offering, respectively, may delay or discourage transactions involving an actual or potential change in our control or change in our management, including transactions in which stockholders might otherwise receive a premium for their shares or transactions that our stockholders might otherwise deem to be in their best interests. Therefore, these provisions could adversely affect the price of our common stock. Among other things, our amended and restated certificate of incorporation and amended and restated bylaws:

- permit our board of directors to issue up to 10,000,000 shares of preferred stock, with any rights, preferences and privileges as they may designate (including the right to approve an acquisition or other change in our control);
- provide that the authorized number of directors may be changed only by resolution of the board of directors;
- provide that the board of directors or any individual director may only be removed with cause and the affirmative vote of the holders of at least 66-2/3% of the voting power of all of our then outstanding common stock;
- provide that all vacancies, including newly created directorships, may, except as otherwise required by law, be filled by the affirmative vote of a majority of directors then in office, even if less than a quorum;
- divide our board of directors into three classes;
- require that any action to be taken by our stockholders must be effected at a duly called annual or special meeting of stockholders and not be taken by written consent;
- provide that stockholders seeking to present proposals before a meeting of stockholders or to nominate candidates for election as directors at a meeting of stockholders must provide notice in writing in a timely manner and also specify requirements as to the form and content of a stockholder's notice;
- do not provide for cumulative voting rights (therefore allowing the holders of a majority of the shares of common stock entitled to vote in any election of directors to elect all of the directors standing for election, if they should so choose);
- provide that special meetings of our stockholders may be called only by the chairman of the board, our Chief Executive Officer or by the board of directors pursuant to a resolution adopted by a majority of the total number of authorized directors; and
- provide that the Court of Chancery of the State of Delaware will be the sole and exclusive forum for (i) any derivative action or proceeding brought on our behalf, (ii) any action asserting a claim of breach

of a fiduciary duty owed by any of our directors or officers to us or our stockholders, (iii) any action asserting a claim against us arising pursuant to any provision of the Delaware General Corporation Law or our certificate of incorporation or bylaws, or (iv) any action asserting a claim against us governed by the internal affairs doctrine.

The amendment of any of these provisions, with the exception of the ability of our board of directors to issue shares of preferred stock and designate any rights, preferences and privileges thereto, would require approval by the holders of at least 66-2/3% of our then-outstanding common stock.

NASDAQ Global Select Market Listing

Our common stock has been approved for listing on The NASDAQ Global Select Market under the symbol "TOCA."

Transfer Agent and Registrar

The transfer agent and registrar for our common stock is Computershare Trust Company, N.A. The transfer agent and registrar's address is 250 Royall Street, Canton, Massachusetts 02021.

SHARES ELIGIBLE FOR FUTURE SALE

Immediately prior to this offering, there has been no public market for our common stock. Future sales of substantial amounts of common stock in the public market could adversely affect prevailing market prices. Furthermore, since only a limited number of shares will be available for sale shortly after this offering because of contractual and legal restrictions on resale described below, sales of substantial amounts of common stock in the public market after the restrictions lapse could adversely affect the prevailing market price for our common stock as well as our ability to raise equity capital in the future.

Based on the number of shares of common stock outstanding as of December 31, 2016, upon the completion of this offering and assuming (1) the 1-for-6.9 reverse stock split of all outstanding shares of our capital stock, (2) the conversion of all of our outstanding shares of convertible preferred stock into an aggregate of 6,690,070 shares of common stock, (3) the conversion of $11.1 million of aggregate principal amount plus accrued interest underlying convertible promissory notes which were issued between November 2016 and February 2017 and which will automatically convert upon the completion of this offering into an aggregate of 1,109,176 shares of our common stock at the initial public offering price of $10.00 per share, and assuming the occurrence of the conversion on April 19, 2017, (4) no exercise of the underwriters' option to purchase additional shares of common stock and (5) no exercise of outstanding options or warrants, an aggregate of 18,501,763 shares of common stock will be outstanding. All of the shares sold in this offering will be freely tradable in the public market without restriction or further registration under the Securities Act, unless held by an affiliate of ours. Except as set forth below, the remaining 10,001,763 shares of common stock outstanding after this offering will be restricted as a result of securities laws or lock-up agreements. In addition, any shares sold in this offering to entities affiliated with our existing stockholders and directors will be subject to lock-up agreements. These remaining shares will generally become available for sale in the public market as follows:

- no restricted shares will be eligible for immediate sale upon the completion of this offering; and
- up to 10,001,763 restricted shares will be eligible for sale under Rule 144 or Rule 701 upon expiration of lock-up agreements 180 days after the date of this offering.

Rule 144

In general, under Rule 144 as currently in effect, beginning 90 days after the effective date of the registration statement of which this prospectus is a part, any person who is not an affiliate of ours and has held their shares for at least six months, including the holding period of any prior owner other than one of our affiliates, may sell shares without restriction, provided current public information about us is available. In addition, under Rule 144, any person who is not an affiliate of ours and has held their shares for at least one year, including the holding period of any prior owner other than one of our affiliates, would be entitled to sell an unlimited number of shares immediately upon the completion of this offering without regard to whether current public information about us is available. Beginning 90 days after the effective date of the registration statement of which this prospectus is a part, a person who is an affiliate of ours and who has beneficially owned restricted securities for at least six months, including the holding period of any prior owner other than one of our affiliates, is entitled to sell a number of restricted shares within any three-month period that does not exceed the greater of:

- 1% of the number of shares of our common stock then outstanding, which will equal approximately 185,018 shares immediately after this offering; or
- the average weekly trading volume of our common stock on The NASDAQ Global Select Market during the four calendar weeks preceding the filing of a notice on Form 144 with respect to the sale.

Sales of restricted shares under Rule 144 held by our affiliates are also subject to requirements regarding the manner of sale, notice and the availability of current public information about us. Rule 144 also provides that affiliates relying on Rule 144 to sell shares of our common stock that are not restricted shares must nonetheless comply with the same restrictions applicable to restricted shares, other than the holding period requirement.

Notwithstanding the availability of Rule 144, the holders of substantially all of our restricted shares have entered into lock-up agreements as described below and their restricted shares will become eligible for sale at the expiration of the restrictions set forth in those agreements.

Rule 701

Under Rule 701, shares of our common stock acquired upon the exercise of currently outstanding options or pursuant to other rights granted under our stock plans may be resold by:

- persons other than affiliates, beginning 90 days after the effective date of the registration statement of which this prospectus is a part, subject only to the manner-of-sale provisions of Rule 144; and
- our affiliates, beginning 90 days after the effective date of the registration statement of which this prospectus is a part, subject to the manner-of-sale and volume limitations, current public information and filing requirements of Rule 144, in each case, without compliance with the six-month holding period requirement of Rule 144.

As of December 31, 2016, options to purchase a total of 1,385,855 shares of common stock were outstanding, of which 566,085 were vested. Of the total number of shares of our common stock issuable under these options, substantially all are subject to contractual lock-up agreements with us or the underwriters described below under “Underwriting” and will become eligible for sale at the expiration of those agreements unless held by an affiliate of ours.

Lock-Up Agreements

We, along with our directors, executive officers and substantially all of our other stockholders, optionholders and warrantholders, have agreed that for a period of 180 days, after the date of this prospectus, except with the prior written consent of Leerink Partners LLC and Evercore Group L.L.C. and subject to specified exceptions, we or they will not offer, pledge, sell, contract to sell, sell any option or contract to purchase, purchase any option or contract to sell, grant any option, right or warrant for the sale of, or otherwise dispose of or transfer, any shares of common stock or any securities convertible into or exercisable or exchangeable for shares of common stock, or enter into any swap or other arrangement that transfers to another, in whole or in part, directly or indirectly, any of the economic consequences of ownership of the common stock. Leerink Partners LLC and Evercore Group L.L.C. have advised us that they have no current intent or arrangement to release any of the shares subject to the lock-up agreements prior to the expiration of the lock-up agreements.

After this offering, certain of our employees, including our executive officers and/or directors, may enter into written trading plans that are intended to comply with Rule 10b5-1 under the Exchange Act. Sales under these trading plans would not be permitted until the expiration of the lock-up agreements relating to the offering described above.

Registration Rights

The holders of our capital stock do not have any rights with respect to the registration of their shares under the Securities Act.

Equity Incentive Plans

We intend to file with the SEC a registration statement on Form S-8 under the Securities Act covering the shares of common stock reserved for issuance under the 2009 Plan, the 2017 Plan and the ESPP. The registration statement is expected to be filed and become effective as soon as practicable after the completion of this offering. Accordingly, shares registered under the registration statement will be available for sale in the open market following its effective date, subject to Rule 144 volume limitations and the lock-up agreements described above, if applicable.

MATERIAL U.S. FEDERAL INCOME TAX CONSEQUENCES TO NON-U.S. HOLDERS OF OUR COMMON STOCK

The following discussion describes the material U.S. federal income tax consequences of the acquisition, ownership and disposition of our common stock acquired in this offering by Non-U.S. Holders (as defined below). This discussion does not address all aspects of U.S. federal income taxes that may be relevant to Non-U.S. Holders in light of their particular circumstances, nor does it address any state, local or non-U.S. tax consequences or U.S. federal tax consequences other than income taxes (such as U.S. federal estate or gift tax consequences). Rules different from those described below may apply to certain Non-U.S. Holders that are subject to special treatment under the Code such as financial institutions, insurance companies, tax-exempt organizations, tax-qualified retirement plans, broker-dealers and traders in securities, commodities or currencies, U.S. expatriates, "controlled foreign corporations," "passive foreign investment companies," corporations that accumulate earnings to avoid U.S. federal income tax, persons that hold our common stock as part of a "straddle," "conversion transaction," or other risk reduction strategy, holders deemed to sell our common stock under the constructive sale provisions of the Code, holders who hold or receive our common stock pursuant to the exercise of employee stock options or otherwise as compensation, holders who are subject to the alternative minimum tax or the Medicare contribution tax, partnerships and other pass-through entities, and investors in such pass-through entities or entities that are treated as disregarded entities for U.S. federal income tax purposes (regardless of their places of organization or formation). Such Non-U.S. Holders are urged to consult their own tax advisors to determine the U.S. federal, state, local and other tax consequences that may be relevant to them. Furthermore, the discussion below is based upon the provisions of the Code, and Treasury regulations, published administrative pronouncements, rulings and judicial decisions thereunder as of the date hereof. Such authorities may be repealed, revoked or modified, perhaps retroactively, so as to result in U.S. federal income tax consequences different from those discussed below. We have not requested a ruling from the U.S. Internal Revenue Service, or IRS, with respect to the statements made and the conclusions reached in the following summary. This discussion assumes that the Non-U.S. Holder holds our common stock as a "capital asset" within the meaning of Section 1221 of the Code (generally, property held for investment).

The following discussion is for general information only and is not tax advice for any Non-U.S. Holders under their particular circumstances. Persons considering the purchase of our common stock pursuant to this offering should consult their own tax advisors concerning the U.S. federal income tax consequences of acquiring, owning and disposing of our common stock in light of their particular situations as well as any consequences arising under the laws of any other taxing jurisdiction, including any state, local and non-U.S. tax consequences and any U.S. federal non-income tax consequences.

For the purposes of this discussion, a "Non-U.S. Holder" is, for U.S. federal income tax purposes, a beneficial owner of common stock that is not a U.S. Holder. A "U.S. Holder" means a beneficial owner of our common stock that is for U.S. federal income tax purposes (a) an individual who is a citizen or resident of the United States, (b) a corporation or other entity treated as a corporation that is created or organized in or under the laws of the United States, any state thereof or the District of Columbia, (c) an estate the income of which is subject to U.S. federal income taxation regardless of its source or (d) a trust if it (1) is subject to the primary supervision of a court within the United States and one or more U.S. persons have the authority to control all substantial decisions of the trust or (2) has a valid election in effect under applicable U.S. Treasury regulations to be treated as a U.S. person. Also, partnerships and their partners, or other entities that are treated as partnerships for U.S. federal income tax purposes and their equity holders (regardless of their place of organization or formation) and entities that are treated as disregarded entities for U.S. federal income tax purposes (regardless of their place of organization or formation) are not addressed by this discussion and are, therefore, not considered to be Non-U.S. Holders for the purposes of this discussion.

Distributions on Our Common Stock

Subject to the discussion below regarding backup withholding and foreign accounts, distributions, if any, made on our common stock to a Non-U.S. Holder generally will constitute dividends for U.S. tax purposes to the extent made out of our current or accumulated earnings and profits (as determined under U.S. federal income tax principles) and will be subject to withholding tax at a 30% rate or such lower rate as may be specified by an applicable income tax treaty. To obtain a reduced rate of withholding under a treaty, a Non-U.S. Holder generally will be required to provide us with a properly executed IRS Form W-8BEN or Form W-8BEN-E, or other appropriate form, certifying the Non-U.S. Holder's entitlement to benefits under that treaty. In the case of a Non-U.S. Holder that is an entity, Treasury regulations and the relevant tax treaty provide rules to determine whether, for purposes of determining the applicability of a tax treaty, dividends will be treated as paid to the entity or to those holding an interest in that entity. If a Non-U.S. Holder holds stock through a financial institution or other agent acting on the holder's behalf, the holder will be required to provide appropriate documentation to such agent. The holder's agent will then be required to provide such certification to us, either directly or through other intermediaries. If you are eligible for a reduced rate of U.S. federal withholding tax under an income tax treaty, you should consult with your own tax advisor to determine if you are able to obtain a refund or credit if any excess amount is withheld by timely filing an appropriate claim for a refund with the IRS.

We generally are not required to withhold tax on dividends paid to a Non-U.S. Holder that are effectively connected with the Non-U.S. Holder's conduct of a trade or business within the United States (and, if required by an applicable income tax treaty, are attributable to a permanent establishment that such holder maintains in the United States) if a properly executed IRS Form W-8ECI, certifying that the dividends are so connected, is furnished to us (or, if stock is held through a financial institution or other agent, to such agent). In general, such effectively connected dividends will be subject to U.S. federal income tax, on a net income basis at the regular graduated rates, unless a specific treaty exemption applies. A corporate Non-U.S. Holder receiving effectively connected dividends may also be subject to an additional "branch profits tax," which is imposed, under certain circumstances, at a rate of 30% (or such lower rate as may be specified by an applicable treaty) on the corporate Non-U.S. Holder's effectively connected earnings and profits, subject to certain adjustments.

To the extent distributions on our common stock, if any, exceed our current and accumulated earnings and profits, they will first reduce your adjusted basis in our common stock as a non-taxable return of capital, but not below zero, and then any excess will be treated as gain and taxed in the same manner as gain realized from a sale or other disposition of common stock as described in the next section.

Gain on Disposition of Our Common Stock

Subject to the discussion below regarding backup withholding and foreign accounts, a Non-U.S. Holder generally will not be subject to U.S. federal income tax with respect to gain realized on a sale or other disposition of our common stock unless (a) the gain is effectively connected with a trade or business of such holder in the United States (and, if required by an applicable income tax treaty, is attributable to a permanent establishment that such holder maintains in the United States), (b) the Non-U.S. Holder is a nonresident alien individual and is present in the United States for 183 or more days in the taxable year of the disposition and certain other conditions are met, or (c) we are or have been a "United States real property holding corporation," or a USRPHC, within the meaning of Code Section 897(c)(2) at any time within the shorter of the five-year period preceding such disposition or such holder's holding period.

If you are a Non-U.S. Holder described in (a) above, you will be required to pay tax on the net gain derived from the sale at regular graduated U.S. federal income tax rates, unless a specific treaty exemption applies, and corporate Non-U.S. Holders described in (a) above may be subject to the additional branch profits tax at a 30% rate or such lower rate as may be specified by an applicable income tax treaty. If you are an individual Non-U.S. Holder described in (b) above, you will be required to pay a flat 30% tax on the gain derived from the sale, which

gain may be offset by U.S. source capital losses (even though you are not considered a resident of the United States), provided you have timely filed U.S. federal income tax returns with respect to such losses. With respect to (c) above, in general, we would be a USRPHC if interests in U.S. real estate constituted (by fair market value) at least half of our assets. We believe that we are not, and do not anticipate becoming, a USRPHC. However, there can be no assurance that we will not become a USRPHC in the future. Even if we are treated as a USRPHC, gain realized by a Non-U.S. Holder on a disposition of our common stock will not be subject to U.S. federal income tax so long as (1) the Non-U.S. Holder owned, directly, indirectly and constructively, no more than 5% of our common stock at all times within the shorter of (a) the five-year period preceding the disposition or (b) the holder's holding period and (2) our common stock is regularly traded on an established securities market within the meaning of applicable Treasury regulations. There can be no assurance that our common stock will continue to qualify as regularly traded on an established securities market.

Information Reporting Requirements and Backup Withholding

Generally, we or certain financial middlemen must report information to the IRS with respect to any dividends we pay on our common stock including the amount of any such dividends, the name and address of the recipient, and the amount, if any, of tax withheld. A similar report is sent to the holder to whom any such dividends are paid. Pursuant to tax treaties or certain other agreements, the IRS may make its reports available to tax authorities in the recipient's country of residence.

Dividends paid by us (or our paying agents) to a Non-U.S. Holder may also be subject to U.S. backup withholding. U.S. backup withholding generally will not apply to a Non-U.S. Holder who provides a properly executed IRS Form W-8BEN, Form W-8BEN-E or Form W-8ECI, or otherwise establishes an exemption.

Under current U.S. federal income tax law, U.S. information reporting and backup withholding requirements generally will apply to the proceeds of a disposition of our common stock effected within the United States or through certain U.S.-related brokers, unless the holder provides a properly executed IRS Form W-8BEN, Form W-8BEN-E or Form W-8ECI, or otherwise establishes an exemption. Generally, U.S. information reporting and backup withholding requirements will not apply to a payment of disposition proceeds to a Non-U.S. Holder where the transaction is effected outside the United States through a non-U.S. office of a non-U.S. broker. For information reporting purposes, certain brokers with substantial U.S. ownership or operations will generally be treated in a manner similar to U.S. brokers.

Backup withholding is not an additional tax. Any amounts withheld under the backup withholding rules may be allowed as a refund or credit against a Non-U.S. Holder's U.S. federal income tax liability, provided the required information is timely furnished to the IRS. If backup withholding is applied to you, you should consult with your own tax advisor to determine if you are able to obtain a tax refund or credit with respect to the amount withheld.

Foreign Accounts

A U.S. federal withholding tax of 30% may apply to dividends and the gross proceeds of a disposition of our common stock paid to a foreign financial institution (as specifically defined by applicable rules), including when the foreign financial institution holds our common stock on behalf of a Non-U.S. Holder, unless such institution enters into an agreement with the U.S. government to withhold on certain payments and to collect and provide to the U.S. tax authorities substantial information regarding U.S. account holders of such institution (which may include certain equity holders of such institution, as well as certain account holders that are foreign entities with U.S. owners). Foreign financial institutions located in jurisdictions that have an intergovernmental agreement with the United States governing these withholding and reporting requirements may be subject to different rules. This U.S. federal withholding tax of 30% will also apply to dividends and the gross proceeds of a disposition of our common stock paid to a non-financial foreign entity unless such entity provides the withholding agent with

either a certification that it does not have any substantial direct or indirect U.S. owners or provides information regarding direct and indirect U.S. owners of the entity. The withholding tax described above will not apply if the foreign financial institution or non-financial foreign entity otherwise qualifies for an exemption from these rules. Under certain circumstances, a Non-U.S. Holder might be eligible for refunds or credits of such taxes. Holders are encouraged to consult with their own tax advisors regarding the possible implications of these rules on their investment in our common stock.

The withholding provisions described above generally apply to payments of dividends, and will apply to payments of gross proceeds from a sale or other disposition of common stock after December 31, 2018.

EACH PROSPECTIVE INVESTOR SHOULD CONSULT ITS OWN TAX ADVISOR REGARDING THE TAX CONSEQUENCES OF PURCHASING, HOLDING AND DISPOSING OF OUR COMMON STOCK, INCLUDING THE CONSEQUENCES OF ANY PROPOSED CHANGE IN APPLICABLE LAW, AS WELL AS TAX CONSEQUENCES ARISING UNDER ANY STATE, LOCAL, NON-U.S. OR U.S. FEDERAL NON-INCOME TAX LAWS.

UNDERWRITING

Leerink Partners LLC and Evercore Group L.L.C. are acting as representatives of each of the underwriters named below and as joint bookrunning managers for this offering. Subject to the terms and conditions set forth in the underwriting agreement among us and the underwriters, we have agreed to sell to the underwriters, and each of the underwriters has agreed, severally and not jointly, to purchase from us, the number of shares of common stock set forth opposite its name below.

Underwriter	Number of Shares
Leerink Partners LLC	3,400,000
Evercore Group L.L.C.	2,975,000
Stifel, Nicolaus & Company, Incorporated	2,125,000
Total	8,500,000

Subject to the terms and conditions set forth in the underwriting agreement, the underwriters have agreed, severally and not jointly, to purchase all of the shares sold under the underwriting agreement if any of the shares are purchased. If an underwriter defaults, the underwriting agreement provides that the purchase commitments of the non-defaulting underwriters may be increased or the underwriting agreement may be terminated.

We have agreed to indemnify the underwriters against certain liabilities, including liabilities under the Securities Act, or to contribute to payments the underwriters may be required to make in respect of those liabilities.

The underwriters are offering the shares, subject to prior sale, when, as and if issued to and accepted by them, subject to approval of legal matters by their counsel, including the validity of the shares, and other conditions contained in the underwriting agreement, such as the receipt by the underwriters of officers' certificates and legal opinions. The underwriters reserve the right to withdraw, cancel or modify offers to the public and to reject orders in whole or in part.

Commissions and Discounts

The representatives have advised us that the underwriters propose initially to offer the shares to the public at the public offering price set forth on the cover page of this prospectus and to dealers at that price less a concession not in excess of $0.42 per share. After the initial offering of the shares, the public offering price, concession or any other term of the offering may be changed by the representatives.

The following table shows the public offering price, underwriting discounts and commissions and proceeds before expenses to us. The information assumes either no exercise or full exercise by the underwriters of their option to purchase additional shares of our common stock.

		Total	
	Per Share	Without Option	With Option
Public offering price	$10.00	$85,000,000	$97,750,000
Underwriting discounts and commissions	$ 0.70	$ 5,950,000	$ 6,842,500
Proceeds, before expenses, to us	$ 9.30	$79,050,000	$90,907,500

We estimate expenses payable by us in connection with this offering, other than the underwriting discounts and commissions referred to above, will be approximately $3.8 million. We also have agreed to reimburse the underwriters for up to $30,000 for their FINRA counsel fee. In accordance with FINRA Rule 5110, this reimbursed fee is deemed underwriting compensation for this offering.

Option to Purchase Additional Shares

We have granted an option to the underwriters, exercisable for 30 days after the date of this prospectus, to purchase up to 1,275,000 additional shares at the public offering price, less the underwriting discounts and commissions. If the underwriters exercise this option, each underwriter will be obligated, subject to conditions contained in the underwriting agreement, to purchase a number of additional shares proportionate to that underwriter's initial amount reflected in the above table.

No Sales of Similar Securities

We, our executive officers and directors and all of our other existing security holders have agreed not to sell or transfer any common stock or securities convertible into or exchangeable or exercisable for common stock, for 180 days after the date of this prospectus, subject to certain exceptions, without first obtaining the written consent of Leerink Partners LLC and Evercore Group L.L.C. on behalf of the underwriters. Specifically, we and these other persons have agreed, with certain limited exceptions, not to directly or indirectly:

- offer, pledge, sell or contract to sell any common stock;
- sell any option or contract to purchase any common stock;
- purchase any option or contract to sell any common stock;
- grant any option, right or warrant for the sale of any common stock;
- otherwise dispose of or transfer any common stock;
- request or demand that we file a registration statement related to the common stock; or
- enter into any swap or other agreement or any transaction that transfers, in whole or in part, the economic consequence of ownership of any common stock, whether any such swap, agreement or transaction is to be settled by delivery of shares or other securities, in cash or otherwise.

This lock-up provision applies to common stock and to securities convertible into or exchangeable or exercisable for common stock. It also applies to common stock owned now or acquired later by the person executing the agreement or for which the person executing the agreement later acquires the power of disposition.

NASDAQ Global Select Market Listing

Our common stock has been approved for listing on The NASDAQ Global Select Market under the symbol "TOCA."

Determination of Offering Price

Before this offering, there has been no public market for our common stock. The initial public offering price will be determined through negotiations between us and the representatives. In addition to prevailing market conditions, the factors to be considered in determining the initial public offering price are:

- the valuation multiples of publicly traded companies that the representatives believe to be comparable to us;
- our financial information;
- the history of, and the prospects for, our company and the industry in which we compete;
- an assessment of our management, its past and present operations, and the prospects for, and timing of, our future revenues;
- the present state of our development; and
- the above factors in relation to market values and various valuation measures of other companies engaged in activities similar to ours.

An active trading market for the shares may not develop. It is also possible that after the offering the shares will not trade in the public market at or above the initial public offering price.

The underwriters do not expect to sell more than 5% of the shares in the aggregate to accounts over which they exercise discretionary authority.

Price Stabilization, Short Positions and Penalty Bids

Until the distribution of the shares is completed, SEC rules may limit underwriters and selling group members from bidding for and purchasing our common stock. However, the representatives may engage in transactions that stabilize the price of the common stock, such as bids or purchases to peg, fix or maintain that price.

In connection with the offering, the underwriters may purchase and sell our common stock in the open market. These transactions may include short sales, purchases on the open market to cover positions created by short sales and stabilizing transactions. Short sales involve the sale by the underwriters of a greater number of shares than they are required to purchase in the offering. "Covered" short sales are sales made in an amount not greater than the underwriters' option described above. The underwriters may close out any covered short position by either exercising their option or purchasing shares in the open market. In determining the source of shares to close out the covered short position, the underwriters will consider, among other things, the price of shares available for purchase in the open market as compared to the price at which they may purchase shares through the option granted to them. "Naked" short sales are sales in excess of such option. The underwriters must close out any naked short position by purchasing shares in the open market. A naked short position is more likely to be created if the underwriters are concerned that there may be downward pressure on the price of our common stock in the open market after pricing that could adversely affect investors who purchase in the offering. Stabilizing transactions consist of various bids for or purchases of shares of common stock made by the underwriters in the open market prior to the closing of the offering.

The underwriters may also impose a penalty bid. This occurs when a particular underwriter repays to the underwriters a portion of the underwriting discount received by it because the representatives have repurchased shares sold by or for the account of such underwriter in stabilizing or short covering transactions.

Similar to other purchase transactions, the underwriters' purchases to cover the syndicate short sales may have the effect of raising or maintaining the market price of our common stock or preventing or retarding a decline in the market price of our common stock. As a result, the price of our common stock may be higher than the price that might otherwise exist in the open market. The underwriters may conduct these transactions on The NASDAQ Global Select Market, in the over-the-counter market or otherwise.

Neither we nor any of the underwriters make any representation or prediction as to the direction or magnitude of any effect that the transactions described above may have on the price of our common stock. In addition, neither we nor any of the underwriters make any representation that the representatives will engage in these transactions or that these transactions, once commenced, will not be discontinued without notice.

Electronic Distribution

In connection with the offering, certain of the underwriters or securities dealers may distribute prospectuses by electronic means, such as e-mail.

Directed Share Program

At our request, the underwriters have reserved for sale, at the initial public offering price, up to 720,292 shares, or the reserved shares, offered by this prospectus for sale to some of our executive officers,

directors, employees, existing stockholders and other individuals associated with us and members of their families through a directed share program. If these persons purchase reserved shares, this will reduce the number of shares available for sale to the general public. Any reserved shares that are not purchased through the directed share program will be offered by the underwriters to the general public on the same terms as the other shares offered by this prospectus.

Other Relationships

The underwriters and certain of their affiliates are full service financial institutions engaged in various activities, which may include securities trading, commercial and investment banking, financial advisory, investment management, investment research, principal investment, hedging, financing and brokerage activities. Some of the underwriters and certain of their affiliates may in the future engage in investment banking and other commercial dealings in the ordinary course of business with us and our affiliates, for which they may in the future receive customary fees, commissions and expenses.

In addition, in the ordinary course of their business activities, the underwriters and their affiliates may make or hold a broad array of investments and actively trade debt and equity securities (or related derivative securities) and financial instruments (including bank loans) for their own account and for the accounts of their customers. Such investments and securities activities may involve securities and/or instruments of ours or our affiliates. The underwriters and their affiliates may also make investment recommendations and/or publish or express independent research views in respect of such securities or financial instruments and may hold, or recommend to clients that they acquire, long and/or short positions in such securities and instruments.

Selling Restrictions

Notice to Prospective Investors in the European Economic Area

In relation to each Member State of the European Economic Area (each, a "Relevant Member State"), no offer of shares may be made to the public in that Relevant Member State other than:

A. to any legal entity which is a qualified investor as defined in the Prospectus Directive;

B. to fewer than 100 or, if the Relevant Member State has implemented the relevant provision of the 2010 PD Amending Directive, 150, natural or legal persons (other than qualified investors as defined in the Prospectus Directive), as permitted under the Prospectus Directive, subject to obtaining the prior consent of the representatives; or

C. in any other circumstances falling within Article 3(2) of the Prospectus Directive,

provided that no such offer of shares shall require the Company or the representatives to publish a prospectus pursuant to Article 3 of the Prospectus Directive or supplement a prospectus pursuant to Article 16 of the Prospectus Directive.

Each person in a Relevant Member State who initially acquires any shares or to whom any offer is made will be deemed to have represented, acknowledged and agreed that it is a "qualified investor" within the meaning of the law in that Relevant Member State implementing Article 2(1)(e) of the Prospectus Directive. In the case of any shares being offered to a financial intermediary as that term is used in Article 3(2) of the Prospectus Directive, each such financial intermediary will be deemed to have represented, acknowledged and agreed that the shares acquired by it in the offer have not been acquired on a non-discretionary basis on behalf of, nor have they been acquired with a view to their offer or resale to, persons in circumstances which may give rise to an offer of any shares to the public other than their offer or resale in a Relevant Member State to qualified investors as so defined or in circumstances in which the prior consent of the representatives has been obtained to each such proposed offer or resale.

We, the representatives and each of our and the representatives' and their affiliates will rely upon the truth and accuracy of the foregoing representations, acknowledgements and agreements.

This prospectus has been prepared on the basis that any offer of shares in any Relevant Member State will be made pursuant to an exemption under the Prospectus Directive from the requirement to publish a prospectus for offers of shares. Accordingly, any person making or intending to make an offer in that Relevant Member State of shares which are the subject of the offering contemplated in this prospectus may only do so in circumstances in which no obligation arises for the company or any of the underwriters to publish a prospectus pursuant to Article 3 of the Prospectus Directive in relation to such offer. Neither the company nor the underwriters have authorized, nor do they authorize, the making of any offer of shares in circumstances in which an obligation arises for the company or the underwriters to publish a prospectus for such offer.

For the purpose of the above provisions, the expression "an offer to the public" in relation to any shares in any Relevant Member State means the communication in any form and by any means of sufficient information on the terms of the offer and the shares to be offered so as to enable an investor to decide to purchase or subscribe the shares, as the same may be varied in the Relevant Member State by any measure implementing the Prospectus Directive in the Relevant Member State and the expression "Prospectus Directive" means Directive 2003/71/EC (including the 2010 PD Amending Directive, to the extent implemented in the Relevant Member States) and includes any relevant implementing measure in the Relevant Member State and the expression "2010 PD Amending Directive" means Directive 2010/73/EU.

LEGAL MATTERS

The validity of the shares of common stock being offered by this prospectus will be passed upon for us by Cooley LLP, San Diego, California. The underwriters are being represented by Latham & Watkins LLP, San Diego, California.

EXPERTS

Ernst & Young LLP, independent registered public accounting firm, has audited our financial statements at December 31, 2015 and 2016 and for the years then ended, as set forth in their report. We have included our financial statements in the prospectus and elsewhere in the registration statement in reliance on Ernst & Young LLP's report, given on their authority as experts in accounting and auditing.

WHERE YOU CAN FIND ADDITIONAL INFORMATION

We have filed with the SEC a registration statement on Form S-1 under the Securities Act, with respect to the shares of common stock being offered by this prospectus. This prospectus does not contain all of the information in the registration statement and its exhibits. For further information with respect to us and the common stock offered by this prospectus, we refer you to the registration statement and its exhibits. Statements contained in this prospectus as to the contents of any contract or any other document referred to are not necessarily complete, and in each instance, we refer you to the copy of the contract or other document filed as an exhibit to the registration statement. Each of these statements is qualified in all respects by this reference.

You can read our SEC filings, including the registration statement, over the Internet at the SEC's website at www.sec.gov. You may also read and copy any document we file with the SEC at its public reference facilities at 100 F Street NE, Washington, D.C. 20549. You may also obtain copies of these documents at prescribed rates by writing to the Public Reference Section of the SEC at 100 F Street N.E., Washington, D.C. 20549. Please call the SEC at 1-800-SEC-0330 for further information on the operation of the public reference facilities. You may also request a copy of these filings, at no cost, by writing us at 3030 Bunker Hill Street, Suite 230, San Diego, California 92109 or telephoning us at (858) 412-8400.

Upon the completion of this offering, we will be subject to the information reporting requirements of the Exchange Act, and we will file reports, proxy statements and other information with the SEC. These reports, proxy statements and other information will be available for inspection and copying at the public reference room and website of the SEC referred to above. We also maintain a website at www.tocagen.com, at which, following the completion of this offering, you may access these materials free of charge as soon as reasonably practicable after they are electronically filed with, or furnished to, the SEC. The information contained in, or that can be accessed through, our website is not incorporated by reference in, and is not part of, this prospectus.

Tocagen Inc.

Index to Financial Statements

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

Board of Directors and Stockholders of
Tocagen Inc.

We have audited the accompanying balance sheets of Tocagen Inc. as of December 31, 2015 and 2016, and the related statements of operations and comprehensive loss, changes in convertible preferred stock and stockholders' deficit and cash flows for the years then ended. These financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on these financial statements based on our audits.

We conducted our audits in accordance with the Standards of the Public Company Accounting Oversight Board (United States). Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. We were not engaged to perform an audit of the Company's internal control over financial reporting. Our audits included consideration of internal control over financial reporting as a basis for designing audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Company's internal control over financial reporting. Accordingly, we express no such opinion. An audit also includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements, assessing the accounting principles used and significant estimates made by management, and evaluating the overall financial statement presentation. We believe that our audits provide a reasonable basis for our opinion.

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of Tocagen Inc. at December 31, 2015 and 2016, and the results of its operations and its cash flows for the years then ended, in conformity with U.S. generally accepted accounting principles.

/s/ Ernst & Young LLP

San Diego, California
March 9, 2017
except for paragraphs 3 through 7 in Note 14, as to which the date is
March 31, 2017

Tocagen Inc.

Balance Sheets
(In Thousands, Except Share and Per Share Data)

	December 31,		Pro Forma Stockholders' Equity December 31,
	2015	2016	2016
			(unaudited)
Assets			
Current assets:			
Cash and cash equivalents	$ 8,150	$ 5,510	
Marketable securities	50,760	25,735	
Prepaid expenses and other current assets	1,295	1,216	
Total current assets	60,205	32,461	
Property and equipment, net	445	743	
Other assets	1,525	2,147	
Total assets	$ 62,175	$ 35,351	
Liabilities, convertible preferred stock and stockholders' equity (deficit)			
Current liabilities:			
Accounts payable	$ 1,300	$ 1,666	
Accrued liabilities	3,890	5,437	
Notes payable, current portion	600	7,200	
Deferred license revenue	54	45	
Deferred grant funding	91	34	
Total current liabilities	5,935	14,382	
Notes payable, net of current portion	16,873	10,241	
Convertible promissory notes payable (due to related parties of $0 and $1,025 at December 31, 2015 and 2016, respectively)	—	3,398	
Convertible promissory notes subscription liability	—	140	
Long-term portion of deferred license revenue	108	68	
Preferred stock warrant liabilities	176	126	
Total liabilities	23,092	28,355	
Commitments and contingencies *(Note 12)*			
Convertible preferred stock, $0.001 par value; authorized shares — 48,600,000 and 51,000,000 at December 31, 2015 and 2016, respectively; issued and outstanding shares — 46,163,605 at December 31, 2015 and 2016; aggregate liquidation preferences of $131,720 at December 31, 2015 and 2016; no shares authorized, issued or outstanding pro forma at December 31, 2016 (unaudited)	131,413	131,413	$ —
Stockholders' equity (deficit):			
Common stock, $0.001 par value; authorized shares — 70,100,000 and 77,800,000 at December 31, 2015 and 2016, respectively; issued and outstanding shares — 2,197,852 and 2,202,517 at December 31, 2015 and 2016, respectively; 8,892,587 shares issued and outstanding pro forma at December 31, 2016 (unaudited)	2	2	9
Additional paid-in capital	2,238	3,581	134,987
Accumulated deficit	(94,512)	(128,000)	(128,000)
Accumulated other comprehensive loss	(58)	—	—
Total stockholders' equity (deficit)	(92,330)	(124,417)	$ 6,996
Total liabilities, convertible preferred stock and stockholders' equity (deficit)	$ 62,175	$ 35,351	

See accompanying notes.

Tocagen Inc.

Statements of Operations and Comprehensive Loss
(In Thousands, Except Share and Per Share Data)

	Year Ended December 31,	
	2015	2016
License revenue	$ 51	$ 49
Operating expenses:		
Research and development	19,172	27,218
General and administrative	3,833	4,522
Total operating expenses	23,005	31,740
Loss from operations	(22,954)	(31,691)
Other income (expense), net:		
Interest income	126	215
Interest expense (related party interest expense of $0 and $15 at December 31, 2015 and 2016, respectively)	(339)	(2,052)
Change in fair value of preferred stock warrants	111	50
Total other income (expense), net	(102)	(1,787)
Net loss	(23,056)	(33,478)
Other comprehensive income (loss):		
Net unrealized gain (loss) on investments	(52)	58
Comprehensive loss	$ (23,108)	$ (33,420)
Net loss per common share, basic and diluted	$ (10.57)	$ (15.22)
Weighted-average common shares outstanding, basic and diluted	2,182,032	2,199,964
Pro forma net loss per common share, basic and diluted (unaudited)		$ (3.77)
Pro forma weighted-average common shares outstanding, basic and diluted (unaudited)		8,890,034

See accompanying notes.

Tocagen Inc.

Statements of Changes in Convertible Preferred Stock and Stockholders' Deficit
(In Thousands, Except Share and Per Share Data)

	Convertible Preferred Stock		Common Stock		Additional Paid-In Capital	Accumulated Deficit	Accumulated Other Comprehensive Income (Loss)	Total Stockholders' Deficit
	Shares	Amount	Shares	Amount				
Balance at December 31, 2014	39,787,568	$ 97,973	2,175,687	$ 2	$1,019	$ (71,456)	$ (6)	$ (70,441)
Issuance of Series H convertible preferred stock, net of issuance costs	6,376,037	33,440	—	—	—	—	—	—
Exercise of stock options	—	—	22,165	—	157	—	—	157
Stock-based compensation	—	—	—	—	1,062	—	—	1,062
Other comprehensive loss	—	—	—	—	—	—	(52)	(52)
Net loss	—	—	—	—	—	(23,056)	—	(23,056)
Balance at December 31, 2015	46,163,605	131,413	2,197,852	2	2,238	(94,512)	(58)	(92,330)
Cumulative effect of accounting change	—	—	—	—	10	(10)	—	—
Balance at January 1, 2016	46,163,605	131,413	2,197,852	2	2,248	(94,522)	(58)	(92,330)
Exercise of stock options	—	—	4,665	—	10	—	—	10
Stock-based compensation	—	—	—	—	1,323	—	—	1,323
Other comprehensive income	—	—	—	—	—	—	58	58
Net loss	—	—	—	—	—	(33,478)	—	(33,478)
Balance at December 31, 2016	46,163,605	$131,413	2,202,517	$ 2	$3,581	$(128,000)	$ —	$(124,417)

See accompanying notes.

Tocagen Inc.

Statements of Cash Flows
(In Thousands)

	Year Ended December 31,	
	2015	**2016**
Operating activities		
Net loss	$(23,056)	$(33,478)
Adjustments to reconcile net loss to net cash used in operating activities:		
Stock-based compensation	1,062	1,323
Depreciation	232	255
Noncash interest expense	94	570
Change in fair value of preferred stock warrants	(111)	(50)
Amortization of premium (discount) on investments, net	5	(9)
Gain on disposal of property and equipment	(15)	(20)
Changes in operating assets and liabilities:		
Prepaid expenses and other assets	(1,072)	(157)
Accounts payable	571	586
Accrued liabilities	1,301	1,547
Deferred license revenue	(51)	(49)
Deferred grant funding	(2)	(57)
Net cash used in operating activities	(21,042)	(29,539)
Investing activities		
Proceeds from the sale/maturity of marketable securities	35,158	48,095
Purchase of marketable securities	(59,870)	(23,003)
Purchase of property and equipment	(231)	(525)
Proceeds from the sale of property and equipment	15	—
Net cash provided by (used in) investing activities	(24,928)	24,567
Financing activities		
Proceeds from issuance of convertible promissory notes payable, net of issuance costs	—	3,374
Proceeds from convertible promissory note subscriptions	—	140
Proceeds from issuance of notes payable, net of issuance costs	17,666	—
Proceeds from issuance of convertible preferred stock for cash, net of issuance costs	33,075	—
Principal payments on notes payable	—	(600)
Proceeds from issuance of common stock	157	10
Cash paid for deferred debt and equity issuance costs	(982)	(592)
Net cash provided by financing activities	49,916	2,332
Net increase (decrease) in cash and cash equivalents	3,946	(2,640)
Cash and cash equivalents at beginning of year	4,204	8,150
Cash and cash equivalents at end of year	$ 8,150	$ 5,510
Supplemental disclosure of cash flow information		
Cash paid for interest	$ 124	$ 1,460
Noncash investing and financing activities:		
Deferred equity issuance costs in accounts payable and accrued liabilities	543	226
Fair value of preferred stock warrants issued in connection with notes payable	287	—
Property and equipment purchases included in accounts payable and accrued liabilities	—	28

See accompanying notes.

Tocagen Inc.

Notes to Financial Statements

1. Organization and Basis of Presentation

Tocagen Inc. (Tocagen or the Company) is a clinical-stage, cancer-selective gene therapy company focused on developing first-in-class, broadly-applicable product candidates designed to activate a patient's immune system against their own cancer from within. The Company's cancer-selective gene therapy platform is built on retroviral replicating vectors (RRVs) which are designed to selectively deliver therapeutic genes into the DNA of cancer cells. Tocagen's gene therapy approach is designed to fight cancer through immunotherapeutic mechanisms of action without the autoimmune toxicities commonly experienced with other immunotherapies.

From inception through December 31, 2016, the Company has devoted substantially all of its efforts to developing its gene therapy platform and its lead product candidate, Toca 511 & Toca FC, as well as raising capital and building its infrastructure. The Company has not generated revenues from its principal operations.

Liquidity and Adoption of FASB Accounting Standards Codification Topic 205-40

For the year ended December 31, 2016, the Company has adopted as required the Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) Topic 205-40, Presentation of Financial Statements - Going Concern, which requires that management evaluate whether there are relevant conditions and events that in aggregate raise substantial doubt about the entity's ability to continue as a going concern and to meet its obligations as they become due within one year after the date that the financial statements are issued. Under this standard, management's assessment shall not take into consideration the potential mitigating effects of management's plans that have not been fully implemented as of the date the financial statements are issued.

The Company has a limited operating history and the sales and income potential of the Company's business and patient markets are unproven. The Company has experienced net losses and negative cash flows from operating activities since its inception. As of December 31, 2016 the Company had an accumulated deficit of $128.0 million and working capital of $18.1 million available to fund future operations. As the Company continues to incur net losses, its transition to profitability is dependent upon the successful development, approval, and commercialization of its product candidates and achieving a level of revenues adequate to support the Company's cost structure. The Company may never achieve profitability, and unless and until it does, the Company will continue to need to raise additional capital.

In performing the first step of the assessment under ASC Topic 205-40, the Company considered that its future operations anticipate an initial public offering or alternative form of equity or debt financing. The Company also considered that new collaborations or selectively partnering its technology or programs may provide other sources of capital. However, there can be no assurances that additional funding or other sources of capital will be available on terms acceptable to the Company, or at all. Without the financing or capital described above, and without consideration of management's other plans to control costs, continued net losses as anticipated raise substantial doubt about the Company's ability to continue as a going concern under the first step of the assessment.

In performing the second step of this assessment, the Company is required to evaluate whether it has other plans to mitigate the conditions to alleviate the substantial doubt about its ability to meet its obligations as they become due. In performing this step, due to inherent uncertainty, management did not consider its planned sources of funding. Management has also developed a plan to implement cost cutting measures commencing in the second quarter of 2017 to reduce its working capital requirements assuming no additional planned financing. The plan includes a delay in hiring and additional reductions in personnel-related costs, the curtailment of certain of the Company's development activities and other discretionary expenditures that are within the Company's

control. Any of the actions contemplated by the implementation of this plan, if required, could have an adverse impact on the Company's ability to achieve certain of its planned objectives during 2017, and thus, materially harm the Company's business.

Management has evaluated that if required, it is probable that the cost cutting measures described above can be effectively implemented during the second quarter of 2017, and that when implemented will allow the Company to meet its obligations as they become due within one year after the date that the financial statements are issued.

Use of Estimates

The Company's financial statements are prepared in accordance with accounting principles generally accepted in the United States (GAAP), which requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at the date of the financial statements, and expenses and related disclosures during the reporting period. Significant estimates in the Company's financial statements relate to clinical trial accruals, the valuation of equity awards, and the development period used for license revenue recognition. Estimates are periodically reviewed in light of changes in circumstances, facts and experience. Actual results may differ from these estimates under different assumptions or conditions.

Unaudited Pro Forma Information

The unaudited pro forma stockholders' equity as of December 31, 2016 assumes the automatic conversion of all the outstanding convertible preferred stock into shares of common stock upon the completion of this proposed offering. The pro forma stockholders' equity was prepared as though the completion of the proposed offering had occurred on December 31, 2016. Shares issued in the proposed offering, any related net proceeds and shares issued upon the conversion of all outstanding principal plus accrued interest related to convertible promissory notes payable upon completion of this proposed offering are excluded from the pro forma information.

Unaudited pro forma net loss per common share is computed using the weighted-average number of common shares outstanding after giving effect to the conversion of all the outstanding convertible preferred stock into shares of common stock as if such conversion had occurred at the beginning of the period presented, or the date of original issuance, if later, and excludes the effect of the conversion of all outstanding principal plus accrued interest related to convertible promissory notes.

Segment Reporting

Operating segments are identified as components of an enterprise about which separate discrete financial information is available for evaluation by the chief operating decision maker, or decision making group, in making decisions on how to allocate resources and assess performance. The Company views its operations and manages its business in one operating segment. No product revenue has been generated since inception and all assets are held in the United States.

2. Summary of Significant Accounting Policies

Cash, Cash Equivalents and Marketable Securities

Cash consists of the balance in a readily available checking account. Cash equivalents consist of certificates of deposit and money market funds with remaining maturities of three months or less at the time of purchase, and are considered highly liquid investments.

Marketable securities consist of certificates of deposit and U.S. Treasury securities that have original maturities greater than three months at the time of purchase. The Company classifies its investments as available-for-sale and records such assets at fair value in the balance sheet, with unrealized gains and losses, if any, reported in stockholders' deficit. Realized gains and losses are calculated on the specific identification method and recorded to interest income.

A decline in the market value of any marketable security below cost that is determined to be other-than-temporary results in a revaluation of its carrying amount to fair value and a new cost basis for the security. Impairment losses are recognized in other expense in the statement of operations.

Concentration of Credit Risk and Off-Balance Sheet Risk

Financial instruments that potentially subject the Company to significant concentration of credit risk consist primarily of cash equivalents and marketable securities. The Company's investment policy includes guidelines for the quality of the related institutions and financial instruments, and defines allowable investments that the Company may invest in, which the Company believes minimizes the exposure to concentration of credit risk.

The Company has no financial instruments with off-balance sheet risk of loss.

Prepaid Expenses and Other Current Assets

Prepaid expenses and other current assets primarily represent amounts related to insurance, clinical trial and manufacturing agreements, and investment interest receivable.

Property and Equipment

Property and equipment consists of furniture, fixtures, computers and software, laboratory and office equipment, and leasehold improvements. Property and equipment is stated at cost and depreciated over the estimated useful lives of the assets (three to five years) using the straight-line method. Leasehold improvements are depreciated using the straight-line method over the lesser of the remaining lease term or an estimated useful life of five years.

Costs of major additions and betterments are capitalized and depreciated on a straight-line basis over their useful lives. Repairs and maintenance costs are expensed as incurred. Upon retirement or sale, the cost of assets disposed of and the related accumulated depreciation are removed from the accounts, and any resulting gain or loss is credited or charged to expense.

Deferred Equity Issuance Costs

Specific incremental costs directly attributable to a proposed or actual offering of securities are deferred and charged against the gross proceeds of the offering through additional paid-in capital. In the event the offering is discontinued, the deferred costs will be expensed in the period the offering is discontinued.

Impairment of Long-Lived Assets

Long-lived assets consist of property and equipment. An impairment loss is recorded if and when events and circumstances indicate that assets might be impaired and the undiscounted cash flows estimated to be generated by those assets are less than the carrying amount of those assets.

Fair Value of Financial Instruments

The Company's financial instruments consist principally of cash, cash equivalents, marketable securities, accounts payable, notes payable, convertible promissory notes payable and preferred stock warrant liabilities.

The authoritative accounting guidance defines fair value, establishes a consistent framework for measuring fair value and expands disclosure for each major asset and liability category measured at fair value on either a recurring or nonrecurring basis. Fair value is defined as an exit price, representing the amount that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants. As such, fair value is a market-based measurement that should be determined based on assumptions that market participants would use in pricing an asset or liability. As a basis for considering such assumptions, the authoritative accounting guidance establishes a three-tier fair value hierarchy that prioritizes the inputs used in measuring fair value as follows:

Level 1: Observable inputs such as quoted prices in active markets;

Level 2: Inputs, other than the quoted prices in active markets, that are observable either directly or indirectly such as quoted prices for similar assets or liabilities, quoted prices in markets that are not active, or other inputs that are observable or can be corroborated by observable market data for substantially the full term of the assets or liabilities; and

Level 3: Unobservable inputs that are supported by little or no market activity and that are significant to the fair value of the assets or liabilities.

Clinical Trial Accruals

Expenses related to clinical studies are based on estimates of the services received and efforts expended pursuant to the Company's contract arrangements. The financial terms of these agreements are subject to negotiation, vary from contract to contract and may result in uneven payment flows. There may be instances in which payments made to the Company's service providers will temporarily exceed the level of services provided and result in a prepayment of the clinical expense. Payments under some of these contracts depend on factors such as the successful enrollment of patients, site initiation and the completion of clinical milestones. The Company makes estimates of its accrued expenses as of each balance sheet date in its financial statements based on facts and circumstances known at that time. In accruing service fees, the Company estimates the time period over which services will be performed and the level of effort to be expended in each period. If the actual timing of the performance of services or the level of effort varies from its estimate, the Company adjusts the accrual or prepaid expense balance accordingly.

Revenue Recognition

Revenue is comprised of license revenue from the up-front payment that the Company received under its license and collaboration arrangement with Siemens (Note 8).

Revenue is recognized for each unit of accounting when all of the following criteria are met:

- Persuasive evidence of an arrangement exists
- Delivery of the Company's obligations under the arrangement has occurred
- The seller's price to the buyer is fixed or determinable
- Collectability is reasonably assured

Amounts received prior to satisfying the revenue recognition criteria are recorded as deferred revenue in the Company's balance sheets. Amounts expected to be recognized as revenue within the 12 months following the balance sheet date are classified as deferred revenue. Amounts not expected to be recognized as revenue within the 12 months following the balance sheet date are classified as long-term deferred revenue.

The Company analyzes multiple-element arrangements based on the relevant authoritative guidance. Pursuant to the guidance, the Company evaluates multiple-element arrangements to determine (1) the deliverables included in the arrangement and (2) whether the individual deliverables represent separate units of accounting, or whether they must be accounted for as a combined unit of accounting. This evaluation involves subjective determinations and requires the Company to make judgments about the individual deliverables and whether such deliverables are separable from the other aspects of the contractual relationship. Deliverables are considered separate units of accounting provided that: (i) the delivered item(s) has value to the customer (a collaboration partner to date) on a standalone basis and (ii) if the arrangement includes a general right of return relative to the delivered item(s), delivery or performance of the undelivered item(s) is considered probable and substantially in its control. In assessing whether an item has standalone value, the Company considers factors such as the research, manufacturing and commercialization capabilities of the collaboration partner and the availability of the associated expertise in the general marketplace. In addition, the Company considers whether the collaboration partner can use the other deliverable(s) for their intended purpose without the receipt of the remaining element(s), whether the value of the deliverable is dependent on the undelivered item(s) and whether there are other vendors that can provide the undelivered element(s).

Arrangement consideration that is fixed or determinable is allocated among the separate units of accounting using the relative selling price method. The Company determines the estimated selling price for units of accounting within each arrangement using vendor-specific objective evidence (VSOE) of selling price, if available, third-party evidence (TPE) of selling price if VSOE is not available, or best estimate of selling price (BESP) if neither VSOE nor TPE is available. The Company uses BESP to estimate the selling price, since it generally does not have VSOE or TPE of selling price for its units of accounting. Determining the BESP for a unit of accounting requires significant judgment. In developing the BESP for a unit of accounting, the Company considers applicable market conditions and relevant entity-specific factors, including factors that were contemplated in negotiating the agreement with the collaboration partner and estimated costs. The Company validates the BESP for units of accounting by evaluating whether changes in the key assumptions used to determine the BESP will have a significant effect on the allocation of arrangement consideration between multiple units of accounting.

The Company then applies the applicable revenue recognition criteria to each of the separate units of accounting in determining the appropriate period and pattern of recognition. If there is no discernible pattern of performance and/or objectively measurable performance measures do not exist, then the Company recognizes revenue under the arrangement on a straight-line basis over the period it expects to complete its performance obligations.

Research and Development Costs

Research and development expenses consist primarily of salaries and benefits, clinical trial costs, costs related to acquiring and manufacturing clinical trial materials, contract services, facilities costs, overhead costs, and depreciation. All research and development costs are expensed as incurred.

Patent Costs

Costs related to filing and pursuing patent applications are recorded as general and administrative expense and expensed as incurred because recoverability of such expenditures is uncertain.

Grant Funding

The Company receives certain research and development funding through grants from nonprofit organizations that serve the brain cancer community. The Company evaluates the terms of each grant to assess the Company's obligations, and such funding is recognized in the statement of operations as a reduction to research and development expense as the related costs are incurred to meet those obligations over the grant period. Certain grants contain repayment provisions contingent on future events, such as future revenue milestones related to the Company's lead product candidate under development. For each repayment provision, the Company assesses if it is obligated to repay the funds provided by the other parties regardless of the outcome of the funded research and development. For each arrangement, the Company also reviews the repayment provisions to determine the likelihood of repayment at the execution of each grant and on an ongoing basis. If the likelihood of repayment of a grant is determined to be remote and the Company is not obligated to repay the funds regardless of the outcome of the funded research and development, the grant is recognized as a reduction to research and development expense as related costs are incurred over the grant period. The Company subsequently reviews the repayment provisions of each grant at each reporting date and will record a related grant repayment liability if and when such repayment obligation is determined to be probable. If, at the execution of a grant with repayment provisions, the probability of repayment is probable, the Company will record the grant as a liability until such time as the grant requirements have been satisfied and the repayment provisions have lapsed.

Debt Issuance Costs

Debt issuance costs incurred to obtain debt financing are deferred and are amortized over the term of the debt using the effective interest method. The costs are recorded as a reduction to the carrying value of the debt and the amortization expense is included in interest expense in the statement of operations.

Warrants for Shares of Preferred Stock

The Company accounts for warrants for shares of preferred stock with conversion features as liabilities in the accompanying balance sheets at their fair value on the date of issuance. The warrant liabilities are revalued at each balance sheet date until such instruments are exercised or expire, with changes in the fair value between reporting periods recorded as other income or expense in the statement of operations.

Income Taxes

The Company accounts for income taxes under the asset and liability method, which requires the recognition of deferred tax assets and liabilities for the expected future tax consequences that have been included in the financial statements. Under this method, deferred tax assets and liabilities are determined on the basis of the differences between the financial statements and tax basis of assets and liabilities using enacted tax rates in

effect for the year in which the differences are expected to reverse. The Company provides a valuation allowance against net deferred tax assets unless, based upon the available evidence, it is more likely than not that the deferred tax assets will be realized.

The Company records uncertain tax positions on the basis of a two-step process whereby (i) management determines whether it is more likely than not that the tax positions will be sustained on the basis of the technical merits of the position and (ii) for those tax positions that meet the more likely-than-not recognition threshold, management recognizes the largest amount of tax benefit that is more than 50 percent likely to be realized upon ultimate settlement with the related tax authority. The Company will recognize interest and penalties in income tax expense if and when incurred.

Comprehensive Income (Loss)

All components of comprehensive income (loss) are reported in the financial statements in the period in which they are recognized. Other comprehensive income (loss) is defined as the change in equity during a period from transactions and other events and circumstances from non-owner sources, including unrealized gains and losses on investments. The Company's only component of other comprehensive loss is unrealized gains (losses) on investments. Comprehensive gains (losses) have been reflected in the statements of operations and comprehensive loss for all periods presented.

Stock-Based Compensation

Stock-based compensation expense represents the cost of the grant date fair value of stock options granted to employees. For awards with time-based vesting provisions, the Company estimates the fair value of stock options on the date of grant using the Black-Scholes option pricing model and recognizes the expense over the requisite service period of the awards, which is generally the vesting period, on a straight-line basis. For awards with performance-based vesting provisions, the Company estimates the fair value of stock option grants on the date of grant, or the date when all of the terms of the grant have been agreed to, if later, and recognizes the expense based on the probability of the occurrence of the individual milestones at each reporting period. The expense is recognized over the implicit service period that commences once management believes the performance criteria are probable of being met. The Company accounts for forfeitures when they occur, and reverses any compensation cost previously recognized for awards for which the requisite service has not been completed, in the period that the award is forfeited.

The Company accounts for stock options and stock warrants granted to non-employees using the fair value approach. These option and warrant grants are subject to periodic revaluation over their vesting terms.

Net Loss Per Share

Basic and diluted net loss per common share for the periods presented is computed by dividing net loss by the weighted-average number of common shares outstanding during the respective periods, without consideration of common stock equivalents as they are antidilutive. Common stock equivalents that could potentially dilute earnings in the future are comprised of shares issuable upon the conversion of all outstanding principal and accrued interest related to convertible promissory notes payable upon the completion of this proposed offering, shares issuable upon the conversion of convertible preferred stock, options to purchase shares of common stock outstanding under the Company's equity incentive plan and warrants for the purchase of shares of common and preferred stock. For all periods presented, there is no difference in the number of shares used to calculate basic and diluted shares outstanding due to the Company's net loss position.

Recently Adopted Accounting Pronouncements

In May 2015, the FASB issued an Accounting Standards Update (ASU) that eliminates the requirement to categorize investments within the fair value hierarchy if their fair value is measured using the net asset value per share practical expedient in the FASB's fair value measurement guidance. The amendments also limit certain disclosures to investments for which the entity has elected to measure at fair value using the net asset value per share practical expedient. The amendments were adopted January 1, 2016 and were applied retrospectively by removing from the fair value hierarchy any investments for which fair value is measured using the net asset value per share practical expedient. Adoption of this guidance did not have an impact on the Company's financial position or results of operations.

In March 2016, the FASB issued a new ASU which simplifies several aspects of the accounting for share-based payment transactions, including the income tax consequences, classification of awards as either equity or liabilities, and classification on the statement of cash flows. The update is effective for fiscal years and the interim periods within those fiscal years beginning after December 15, 2016, with early adoption permitted. Amendments related to the timing of when excess tax benefits are recognized, minimum statutory withholding requirements and forfeitures are applied using a modified retrospective transition method by means of a cumulative-effect adjustment to equity as of the beginning of the period in which the guidance is adopted. Amendments related to the presentation of employee taxes paid on the statement of cash flows when an employer withholds shares to meet the minimum statutory withholding requirement is applied retrospectively. Amendments requiring recognition of excess tax benefits and tax deficiencies in the statement of operations are applied prospectively. The Company elected to early adopt this guidance effective January 1, 2016 and made a policy election to account for forfeitures of unvested share-based awards as they occur which is a change from its prior accounting whereby forfeitures were estimated at the time of grant with stock-based compensation expense based on awards that were ultimately expected to vest. The Company recorded a cumulative-effect adjustment on January 1, 2016 to equity to eliminate the forfeiture reserve balance at December 31, 2015 of $10,000, resulting in an increase in its accumulated deficit and additional paid-in capital by $10,000 each.

In March 2016, the FASB issued new accounting guidance intended to reduce diversity in practice of identifying embedded derivatives in debt instruments. The new guidance clarifies that the nature of an exercise contingency is not subject to the "clearly and closely" criteria for purposes of assessing whether the call or put option must be separated from the debt instrument and accounted for separately as a derivative. This new standard is effective for fiscal years beginning after December 15, 2016, and interim periods within those fiscal years. The Company elected to early adopt this guidance on July 1, 2016. Adoption of this guidance did not have an impact on the Company's financial position or results of operations.

Recent Accounting Pronouncements

In May 2014, the FASB issued new revenue recognition guidance which outlines a single comprehensive revenue model for entities to use in accounting for revenue arising from contracts with customers. The guidance supersedes most current revenue recognition guidance, including industry-specific guidance. The guidance provides that an entity recognize revenue when it transfers promised goods or services to customers in an amount that reflects the consideration to which the entity expects to be entitled in exchange for those goods or services. The guidance will be effective on January 1, 2018 and earlier application is permitted only for annual reporting periods beginning after December 15, 2016 including interim reporting periods within that reporting period. The guidance allows for either a full retrospective adoption, in which the standard is applied to all of the periods presented, or a modified retrospective adoption, in which the standard is applied to the most current period presented in the financial statements. As of December 31, 2016, revenue has been generated exclusively from the

Company's license and collaboration arrangement with Siemens. The Company is currently evaluating the potential impact that this guidance may have on its financial position and results of operations as it relates to this single arrangement, and expects to elect the modified retrospective adoption method.

In January 2016, the FASB issued new guidance that amends certain aspects of the recognition, measurement, presentation and disclosure of financial instruments. The amendments include the elimination of the available-for-sale classification of equity investments and requires equity investments with readily determinable fair values to be measured at fair value with changes in fair value recognized in net income (loss). The new guidance is effective for fiscal years and interim periods within those years beginning after December 15, 2017, and requires a cumulative-effect adjustment to the balance sheet as of the beginning of the fiscal year of adoption. Early adoption is not permitted. The Company's marketable securities are currently accounted for as available-for-sale financial instruments with changes in fair value recognized in other comprehensive income (loss). At the time of adoption, any amounts in accumulated other comprehensive income (loss) related to such financial instruments would be reclassified to non-operating income (expense) in the statement of operations. As of December 31, 2016, unrealized gains and losses related to these investments netted to zero.

In February 2016, the FASB issued new accounting guidance that amends the existing accounting standards for leases. Under the new guidance, lessees will be required to recognize for all leases, with the exception of short-term leases, a lease liability, which is a lessee's obligation to make lease payments arising from a lease, measured on a discounted basis and a right-of-use asset, which is an asset that represents the lessee's right to use, or control the use of, a specified asset for the lease term. The new standard is effective for fiscal years beginning after December 15, 2018, including interim periods within those fiscal years. Early adoption is permitted. The Company is currently evaluating the impact of adopting this guidance.

3. Fair Value of Financial Instruments

Fair Values of Assets and Liabilities Measured on a Recurring Basis

The following tables summarize the Company's assets and liabilities that require fair value measurements on a recurring basis and their respective input levels based on the fair value hierarchy (in thousands):

		Fair Value Measurements at End of Period Using:		
December 31, 2015	**Total**	**Quoted Market Prices for Identical Assets (Level 1)**	**Significant Other Observable Inputs (Level 2)**	**Significant Unobservable Inputs (Level 3)**
Cash equivalents:				
Certificates of deposit	$ 2,880	$ —	$ 2,880	$ —
Marketable securities:				
Certificates of deposit	$38,779	$ —	$38,779	$ —
U.S. Treasury securities	11,981	11,981	—	—
	$50,760	$11,981	$38,779	$ —
Preferred stock warrant liabilities	$ 176	$ —	$ —	$176

		Fair Value Measurements at End of Period Using:		
December 31, 2016	**Total**	**Quoted Market Prices for Identical Assets (Level 1)**	**Significant Other Observable Inputs (Level 2)**	**Significant Unobservable Inputs (Level 3)**
Cash equivalents:				
Certificates of deposit	$ 240	$ —	$ 240	$ —
Marketable securities:				
Certificates of deposit	$22,777	$ —	$22,777	$ —
U.S. Treasury securities	2,958	2,958	—	—
	$25,735	$ 2,958	$22,777	$ —
Preferred stock warrant liabilities	$ 126	$ —	$ —	$126

Marketable Securities. For fair values determined by Level 1 inputs, which utilize quoted prices in active markets for identical assets, the level of judgment required to estimate fair value is relatively low. The fair values of investments in U.S. treasury securities were determined using Level 1 inputs.

Fair values determined by Level 2 inputs, which utilize data points that are observable such as quoted prices, interest rates and yield curves, require the exercise of judgment and use of estimates, that if changed, could significantly affect the Company's financial position and results of operations. Investments in certificates of deposit are valued using Level 2 inputs. Level 2 securities are initially valued at the transaction price and subsequently valued and reported utilizing inputs other than quoted prices that are observable either directly or indirectly, such as quotes from third-party pricing vendors.

There were no transfers in or out of Level 1 or Level 2 investments during the years ended December 31, 2015 or 2016.

At December 31, 2015 and December 31, 2016, the Company had investments in money market funds of $3.1 million and $2.2 million, respectively, that were measured at fair value using the net asset value per share (or its equivalent) that have not been classified in the fair value hierarchy. The funds invest primarily in U.S. government securities.

Warrant Liabilities. The Company's preferred stock warrants are accounted for as liabilities and measured at fair value on a recurring basis as they are convertible into preferred stock which is contingently redeemable under conditions that are not in the control of the Company. The Company estimates fair values of these warrant liabilities utilizing the Black-Scholes option pricing model, which requires Level 3 inputs.

Estimating fair values of derivative financial instruments, including Level 3 instruments, requires the use of significant and subjective inputs that may, and are likely to, change over the duration of the instrument with related changes in internal and external market factors, including changes in the estimated fair value of the Company's equity securities.

The following assumptions were employed in estimating the value of the liabilities for Series H preferred stock warrants using the Black-Scholes option pricing model as of the following dates:

	October 30, 2015 (Issuance Date)	December 31, 2015	December 31, 2016
Risk-free interest rate	2.16%	2.27%	2.38%
Volatility	85.7%	90.0%	77.8%
Dividend Yield	—	—	—
Contractual term (in years)	10.0	9.8	8.8

A 10% increase in the fair value of preferred stock at December 31, 2016 would result in an aggregate increase in the estimated fair value of the preferred stock warrant liabilities of $15,000.

The following table summarizes the activity in liabilities measured at fair value on a recurring basis using significant unobservable inputs (Level 3 inputs) (in thousands):

	Preferred Stock Warrant Liabilities
Issuances	$ 287
Decrease in fair value	(111)
Balance at December 31, 2015	176
Decrease in fair value	(50)
Balance at December 31, 2016	$ 126

Fair Values of Other Financial Instruments

The carrying amounts of certain of the Company's financial instruments, including cash and accounts payable, approximate their respective fair values due to their short-term nature. The carrying amount of the Company's notes payable of $17.4 million at December 31, 2016 approximated their fair value as the terms of

the notes are consistent with the market terms of transactions with similar profiles of one of the lenders as of those dates (Level 3 inputs). The carrying amount of the Company's convertible promissory notes payable of $3.4 million at December 31, 2016 approximated their fair value due to their recent issuance during November and December 2016 (Level 3 inputs).

4. Certain Financial Statement Caption Information

Marketable Securities

The following is a summary of the Company's marketable securities (in thousands):

December 31, 2015	Maturity (in years)	Amortized Cost	Unrealized Gain	Unrealized Loss	Fair Value
Certificates of deposit	1 or less	$21,013	$—	$ (9)	$21,004
Certificates of deposit	>1 and <5	17,800	—	(25)	17,775
U.S. Treasury securities	1 or less	7,011	—	(4)	7,007
U.S. Treasury securities	>1 and <5	4,994	—	(20)	4,974
		$50,818	$—	$(58)	$50,760

December 31, 2016	Maturity (in years)	Amortized Cost	Unrealized Gain	Unrealized Loss	Fair Value
Certificates of deposit	1 or less	$19,299	$ 1	$ (2)	$19,298
Certificates of deposit	>1 and <5	3,478	1	—	3,479
U.S. Treasury securities	1 or less	1,678	—	—	1,678
U.S. Treasury securities	>1 and <5	1,280	4	(4)	1,280
		$25,735	$ 6	$ (6)	$25,735

The Company has classified all of its available-for-sale investment securities, including those with maturity greater than one year, as current assets on the balance sheet based on the highly liquid nature of these investment securities and because these investment securities are considered available for use in current operations.

There were no impairments considered other-than-temporary during the periods presented, as it is management's intention and ability to hold the securities until a recovery of the cost basis or recovery of fair value. Gross realized gains and losses on sales of marketable securities were immaterial for all periods presented.

Property and Equipment

Property and equipment is comprised of (in thousands):

	December 31,	
	2015	2016
Laboratory equipment	$ 2,410	$ 2,841
Computers, software and office equipment	172	187
Furniture and fixtures	8	21
Leasehold improvements	108	108
	2,698	3,157
Less accumulated depreciation	(2,253)	(2,414)
	$ 445	$ 743

Depreciation expense was $0.2 million and $0.3 million during the years ended December 31, 2015 and 2016, respectively.

Accrued Liabilities

Accrued liabilities are comprised of (in thousands):

	December 31,	
	2015	2016
Clinical trial expenses	$1,584	$2,114
Contract manufacturing services	664	1,508
Payroll and other employee-related expenses	524	728
Professional fees	485	459
Contract research services	152	114
Interest payable	120	120
Other	361	394
	$3,890	$5,437

5. Notes Payable

Loan Agreement

On October 30, 2015, the Company entered into a Loan and Security Agreement (the Loan Agreement) with two lenders whereby it borrowed $18.0 million (the Loans) on October 30, 2015. Balances under the Loan Agreement bear a floating rate of interest equal to the greater of 7.75% or the monthly prime rate plus 4.50% (7.75% and 8.00% at December 31, 2015 and 2016, respectively), and were due in 12 monthly interest-only payments through November 2016, followed by 30 equal monthly principal payments, together with applicable interest payments, with final maturity of the Loans in May 2019. Each Loan bears a final payment fee of 7.95% of the original principal amount due upon maturity.

The costs incurred to issue the Loans of $0.6 million were deferred and are included in the discount to the carrying value of the Loans in the accompanying balance sheets. The Loans also include a final payment fee of $1.4 million due at the earlier of prepayment or the maturity date of the Loans. The deferred costs and the final payment fee are amortized to interest expense over the expected term of the Loans using the effective interest method. The effective interest rates on the Loans at December 31, 2015 and 2016 are 10.94% and 11.19%, respectively.

The aggregate carrying amounts of the Loans are comprised of the following (in thousands):

	December 31,	
	2015	2016
Principal	$18,000	$17,400
Add: accreted liability for final payment fee	66	462
Less: unamortized discount	(593)	(421)
	$17,473	$17,441

The Loans are secured by substantially all of the Company's assets other than its intellectual property, except rights to payment from the sale, licensing or disposition of such intellectual property. The Company is also required to maintain its primary operating accounts at all times with one of the lenders. The Loan Agreement contains customary conditions of borrowing, events of default and covenants, including covenants that restrict the Company's ability to dispose of assets, merge with or acquire other entities, incur indebtedness and make distributions to holders of its capital stock. Should an event of default occur, including the occurrence of a material adverse change, the Company could be liable for immediate repayment of all obligations under the Loan Agreement. The Company does not believe it is likely that a material adverse change will occur. At December 31, 2016, the Company was in compliance with the covenants contained in the Loan Agreement.

In connection with the issuance of the Loans in October 2015, the Company issued detachable, fully vested warrants to purchase an aggregate of 68,572 shares of Series H Preferred Stock at an exercise price of $5.25 per share to the lenders. The warrants are exercisable at any time through October 2025. The grant-date fair value of the warrants of $0.3 million was recorded as a liability, with a reduction to the carrying value of the Loans, and which is being recognized as additional interest expense over the remaining term of the Loans.

Convertible Promissory Notes Payable and Subscription Liability

During the year ended December 31, 2016, the Company issued convertible promissory notes payable (the Convertible Notes) to investors aggregating $3.4 million. The Convertible Notes include $1.0 million issued to members of the Company's board of directors and $25,000 issued to the Company's chief executive officer. The Convertible Notes, which bear interest at 7% per annum, are unsecured and are subordinated to the Company's Loans. Principal and interest are due on November 21, 2018, unless the Company elects to extend the maturity date of the Convertible Notes to a date on or before November 21, 2019.

At December 31, 2016, the aggregate carrying amount of the Convertible Notes is $3.4 million, which is net of an unamortized discount of $34,000. The effective interest rate on the Convertible Notes at December 31, 2016 is 7.54%.

At December 31, 2016, the Company had $140,000 in subscriptions for Convertible Notes from investors for which the notes had not yet been issued. This amount is recorded as a convertible promissory note subscription liability in the balance sheet as of that date.

Subsequent to December 31, 2016, between January 1, 2017 and February 8, 2017, the Company issued Convertible Notes to investors in an aggregate principal amount of $7.5 million, of which $250,000 was issued to a member of the Company's board of directors and $10,000 was issued to the Company's chief executive officer.

The Convertible Notes provide for mandatory share-settlement of all outstanding principal plus accrued and unpaid interest as follows: (1) upon a qualifying financing event whereby the Company issues shares of its preferred stock to investors, the Convertible Notes automatically convert into shares of the same class of preferred stock at an amount equal to the price per share at which the preferred stock was issued to the investors; (2) upon the closing of a qualifying initial public offering (IPO), the Convertible Notes automatically convert into shares of common stock at an amount equal to the per share purchase price paid by the public in the IPO; (3) immediately prior to the closing of a qualifying change of control transaction, the Convertible Notes automatically convert into shares of the latest-issue preferred stock determined by dividing (i) the sum of (x) 110% of the outstanding principal plus (y) accrued and unpaid interest by (ii) the last price paid by the investors of such series of preferred stock; or (4) upon the maturity date, the Convertible Notes automatically convert into shares of the latest-issue preferred stock determined by dividing the outstanding principal and interest by the last price paid by investors for the purchase of such series of preferred stock.

Future maturities of the Company's Loans, including the final payment fee, and the Convertible Notes are as follows (in thousands):

Year ended December 31,	
2017	$ 7,200
2018	10,611
2019	4,431
	22,242
Unaccreted balance for final payment fee on Loans	(969)
Unamortized discounts	(455)
Accrued interest on Convertible Notes	21
	20,839
Less current portion	(7,200)
Noncurrent portion	$13,639

6. Convertible Preferred Stock and Common Stock

In February 2015, the Company increased its authorized common and preferred stock to 68,100,000 and 46,600,000 shares, respectively. In September 2015, the Company increased its authorized common and preferred stock to 70,100,000 and 48,600,000 shares, respectively. In June 2016, the Company increased its authorized common stock to 72,900,000 shares. In July 2016, the Company increased its authorized common and preferred stock to 75,300,000 and 51,000,000, respectively. In November 2016, the Company increased its authorized common stock to 77,800,000 shares, and the authorized preferred stock remained at 51,000,000 shares.

Convertible Preferred Stock

The authorized, issued and outstanding shares, and liquidation preference of convertible preferred stock by series as of December 31, 2015 are as follows (in thousands, except share amounts):

	Shares Authorized	Shares Issued and Outstanding	Liquidation Preference
Series A	6,700,000	6,700,000	$ 6,700
Series B	8,676,800	8,676,800	10,846
Series C	5,697,601	5,697,601	9,116
Series C-1	1,578,948	1,578,948	3,000
Series D	3,888,375	3,888,375	7,777
Series E	2,485,250	2,485,250	9,941
Series F	5,904,501	5,904,501	25,980
Series G	2,432,068	2,432,068	12,160
Series H	9,600,000	8,800,062	46,200
Undesignated	1,636,457	—	—
	48,600,000	46,163,605	$131,720

During the year ended December 31, 2015, the Company issued 6,376,037 shares of its Series H convertible preferred stock at a purchase price of $5.25 per share for net proceeds of $33.4 million, which is net of $34,000 in issuance costs.

The authorized, issued and outstanding shares, and liquidation preference of convertible preferred stock by series as of December 31, 2016 are as follows (in thousands, except share amounts):

	Shares Authorized	Shares Issued and Outstanding	Liquidation Preference
Series A	6,700,000	6,700,000	$ 6,700
Series B	8,676,800	8,676,800	10,846
Series C	5,697,601	5,697,601	9,116
Series C-1	1,578,948	1,578,948	3,000
Series D	3,888,375	3,888,375	7,777
Series E	2,485,250	2,485,250	9,941
Series F	5,904,501	5,904,501	25,980
Series G	2,432,068	2,432,068	12,160
Series H	12,000,000	8,800,062	46,200
Undesignated	1,636,457	—	—
	51,000,000	46,163,605	$131,720

The Company records each series of convertible preferred stock based upon gross proceeds on the respective dates of issuance, net of issuance costs. A right to receive payment will only occur upon the liquidation or winding up of the Company, a greater than 50% change of control or sale of substantially all of the assets of the Company. As this right to receive payment is considered a deemed liquidation outside the control of the Company, all shares of convertible preferred stock have been presented outside of permanent equity in accordance with accounting guidance for redeemable securities. Further, the Company is not adjusting the carrying values of the convertible preferred stock as it is uncertain whether or when a redemption event will occur. Adjustments to increase the carrying values will be made if it becomes probable that such redemption will occur.

Dividends

The holders of the convertible preferred stock are entitled to receive, in preference to the holders of common stock, noncumulative dividends at a rate of 5% per annum, when, as and if declared by the Board of Directors. As of December 31, 2016, the Company's Board of Directors has not declared any dividends.

Liquidation Preferences

The holders of the convertible preferred stock are entitled to receive a liquidation payment, before any distribution or payment to the holders of common stock, *pari passu* on a pro rata basis per share until the holders have received an amount equal to the applicable original purchase price per share of convertible preferred stock.

Conversion

The convertible preferred stock is convertible into common stock on a one-for-6.9 basis at any time, subject to customary anti-dilution adjustments, and automatically converts into common stock upon the consent of a majority of the holders of outstanding convertible preferred stock or, for any series of convertible preferred stock, a majority of the holders of such series, or upon a public offering with aggregate proceeds to the Company of at least $10 million. The convertible preferred stock also includes anti-dilution provisions making it subject to adjustment for stock splits, stock dividends, recapitalizations and similar events.

Shares of the Series G and H convertible preferred stock are also subject to transfer restrictions until the earlier of a registration under the Securities Act covering the proposed disposition, the closing date of the Company's first firm commitment underwritten public offering of its common stock registered under the Securities Act, and the closing date of an acquisition or asset transfer.

Voting

All series of the Company's convertible preferred stock vote together with the common stock on an as-converted basis and all holders of convertible preferred stock have granted the Company's President of Research and Development (R&D) and former CEO, Harry E. Gruber, Dr. Gruber's designee or the Company's current CEO, Martin J. Duvall, their proxy for voting on their behalf in the same manner as the majority of the holders of shares of the Company's outstanding common stock for so long as the Company is privately held.

Common Stock

The Company had 2,197,852 and 2,202,517 shares of common stock outstanding as of December 31, 2015 and 2016, respectively. All of the holders of common stock have granted the Company's President of R&D and former CEO, Harry E. Gruber, their proxy for voting on their behalf while the Company is privately held, and all shares of common stock include a 180-day lock-up provision upon a public offering of the common stock of the Company.

Common Stock Reserved for Future Issuance

Common stock reserved for future issuance at December 31, 2015 and 2016 is as follows and excludes shares issuable upon the conversion of all outstanding principal and accrued interest related to convertible promissory notes payable upon the completion of this proposed offering:

	December 31,	
	2015	2016
Conversion of all outstanding convertible preferred stock	6,690,070	6,690,070
Common stock options issued and outstanding	738,809	1,385,855
Common stock authorized for future stock based awards	55,933	172,495
Common stock warrant issued and outstanding	724	724
Conversion of preferred stock warrants issued and outstanding	9,936	9,936
	7,495,472	8,259,080

7. Equity Incentive Plan and Stock-Based Compensation

Equity Incentive Plan

The Company's 2009 Equity Incentive Plan, as amended (the 2009 Plan), provides for the issuance of stock options, restricted stock awards and other equity based awards to employees, directors and consultants of the Company. In June 2016, the Company increased its authorized common stock reserved for issuance under the 2009 Plan by 405,797 shares. In November 2016, the Company increased its authorized common stock reserved for issuance under the 2009 Plan by 362,318 shares. As of December 31, 2016, awards for up to 1,558,350 shares of common stock are reserved under the 2009 Plan, of which 1,385,855 shares are reserved for issuance upon exercise of granted and outstanding stock options and 172,495 shares are available for future grants.

All grants of common stock options under the 2009 Plan expire in 10 years. Grants with time-based vesting provisions are subject to a four-year vesting schedule with 25% vesting after the first year, and the balance vesting monthly over the remaining 36 months. At December 31, 2016, the Company had 154,353 options outstanding that were identified as performance-based options with performance milestones to be mutually agreed upon at a later date.

All option holders have granted the Company's President of R&D and former CEO, Harry E. Gruber, their proxy for voting common stock received upon exercise of options while the Company is privately held, and all such shares of common stock will include a customary 180-day lock-up provision upon a public offering of the common stock of the Company.

The following table summarizes stock option activity under the 2009 Plan:

	Shares Subject to Options	Weighted-Average Exercise Price per Share	Weighted-Average Remaining Contractual Term (in years)	Aggregate Intrinsic Value (in thousands)
Balance outstanding at December 31, 2015	738,809	$ 7.08		
Granted	692,675	$16.02		
Exercised	(4,665)	$ 2.23		
Canceled or forfeited	(40,964)	$14.49		
Balance outstanding at December 31, 2016	1,385,855	$11.35	7.9	$5,957
Time-Based Options at December 31, 2016:				
Outstanding	1,231,502	$10.69	7.7	$5,957
Vested and expected to vest	1,231,502	$10.69	7.7	$5,957
Exercisable	566,085	$ 5.33	5.7	$5,569
Performance-Based Options at December 31, 2016:				
Outstanding	154,353	$16.56	9.9	$ —
Vested and expected to vest	—	$ —	—	$ —
Exercisable	—	$ —	—	$ —

The weighted-average fair value of options granted during the years ended December 31, 2015 and 2016, was $13.59 and $9.66, respectively. The total fair value of options vested during the years ended December 31, 2015 and 2016, was $0.9 million and $1.1 million, respectively.

The aggregate intrinsic value of options is calculated as the difference between the exercise price of the options and the fair value of the Company's common stock for those options that had exercise prices lower than the fair value of the Company's common stock. The aggregate intrinsic value of stock options exercised during the years ended December 31, 2015 and 2016, was $160,000 and $62,000, respectively.

Stock-Based Compensation Expense

Time-Based Stock Options

The assumptions used in the Black-Scholes option pricing model to determine the fair value of the employee stock option grants with time-based vesting provisions were as follows:

	Year Ended December 31,	
	2015	2016
Assumptions:		
Risk-free interest rate	1.61%	1.63%
Expected volatility	73.5% to 86.8%	73.3% to 73.5%
Expected term (in years)	6.1	6.1
Expected dividend yield	—	—

Risk-free interest rate. The Company bases the risk-free interest rate assumption on U.S. Treasury constant maturities with maturities similar to those of the expected term of the award being valued.

Expected volatility. Due to the Company's lack of a public market for the trading of its common stock and lack of company-specific historical or implied volatility data, the Company has based its estimate of expected volatility on the historical volatility of a group of similar companies in the life sciences industry whose shares are publicly traded. The Company selects the peer group based on comparable characteristics, including development stage, product pipeline, and enterprise value. The Company computes historical volatility data using the daily closing prices for the selected companies' shares during the equivalent period of the calculated expected term of the stock-based awards. The Company will continue to apply this process until sufficient amount of historical information regarding the volatility of its own stock price become available.

Expected term. As a nonpublic entity, the Company has elected to estimate the expected term of its employee stock options as the midpoint between the requisite service period and the contractual term of the option.

Expected dividend yield. The Company bases the expected dividend yield assumption on the fact that it has never paid, and does not expect to pay, dividends in the foreseeable future.

The Company calculates the estimated fair value of each non-employee stock option award at the date of grant using Black-Scholes option pricing model with the assumptions generally consistent with those used for employee stock options, with the exception of expected term, which is over the contractual life.

Performance-Based Options

As of December 31, 2016, the Company had 154,353 options outstanding that were identified as performance-based options with the performance milestones to be mutually agreed upon at a later date. The measurement date for the determination of fair value is not deemed to have occurred until all of the terms of the award are agreed to, therefore, no expense for these options was recognized during the year ended December 31, 2016.

On February 8, 2017, the vesting terms were mutually agreed to and provide for vesting upon the achievement of three separate development and regulatory milestones, with one-third of the options vesting upon the achievement of each milestone.

During the year ended December 31, 2015, the Company recorded share-based compensation expense only for awards that were expected to vest and recorded cumulative adjustments for actual forfeitures that differed from those estimates in the period that the estimates were revised. Beginning January 1, 2016, upon adoption of new accounting guidance, the Company recorded share-based compensation expense, net of forfeitures recognized as they occurred. Total share-based compensation expense of $1.1 million and $1.3 million was recorded for the years ended December 31, 2015 and 2016, respectively. Unrecognized compensation expense at December 31, 2016 for time-based stock options was $6.2 million which is expected to be recognized over a weighted-average period of 3.3 years.

Common Stock Warrant

In June 2013, the Company issued a warrant to purchase 724 shares of common stock. The award was granted in exchange for consulting services provided by a non-employee pursuant to standalone award agreement that is independent of the 2009 Plan. The stock warrant expires in 10 years, has an exercise price of $3.94 per share, and is subject to a four-year vesting schedule with 25% vesting after the first year, and the balance vesting monthly over the remaining 36 months. The Company has calculated the estimated fair value of the non-employee stock warrant award at the date of grant using Black-Scholes option pricing model with the assumptions generally consistent with those used for employee stock options, with the exception of expected term, which is over the contractual life. The stock warrant is subject to periodic revaluation over its vesting term. As of December 31, 2016, the expense recognized for the stock warrant issued was immaterial.

The warrant holder has granted the Company's President of R&D and former CEO, Harry E. Gruber, its proxy for voting common stock to be received upon exercise of the warrant while the Company is privately held, and all such shares of common stock will include a customary 180-day lock-up provision upon a public offering of the common stock of the Company.

8. License and Collaboration Agreements

Siemens License and Collaboration

In November 2011, the Company entered into a laboratory services and license agreement with Siemens, which was amended in June 2015, pursuant to which the Company agreed to engage Siemens (i) to develop and perform certain in vitro diagnostic assays in connection with the cancer therapy trials of Toca 511 & Toca FC, (ii) concurrently and/or thereafter, to further develop, obtain FDA approval for, and perform one or more of such in vitro diagnostic assays as companion diagnostics for Toca 511 & Toca FC after Toca 511 & Toca FC have received marketing approval from the FDA, and (iii) following FDA approval of such in vitro diagnostic assay as a companion diagnostic, to perform such in vitro diagnostic monitoring assays as necessary in connection with post-marketing clinical trials of Toca 511 & Toca FC. The Company granted Siemens the licensed intellectual property covered by the agreement on an exclusive and non-exclusive basis, depending on Siemens' use of such intellectual property.

Under the terms of the agreement, Siemens paid the Company an initial upfront payment of $0.5 million in December 2011. Under the terms of the June 2015 amendment, the Company is required to reimburse Siemens for 50% of future costs of the new assay development. Additionally, beginning with the first commercial sale of a product that has received approval for clinical use under the agreement, Siemens will pay the Company a royalty in the 10-20 percent range of net assay revenue with respect to approved designated assay products and net sales revenue with respect to approved in vitro diagnostic products, until the fifth anniversary of such commercial sale, subject to certain reductions. Beginning with the first commercial sale of Toca 511 or Toca FC, the Company will pay a royalty to Siemens in the low single-digit percentage range on net product sales of Toca 511 & Toca FC for sales up to the mid nine-digit dollar range per year, until the fifth anniversary of such commercial sale.

In order to account for multiple-element arrangements, the Company identified the deliverables within the agreement and evaluated which deliverables represent units of accounting. The deliverables under the agreement included (i) a license under the Company's licensed intellectual property, (ii) transfer of existing assays, (iii) training, and (iv) collaboration (i.e., the Company's technical/regulatory support) with Siemens for its development of clinical assays to be used as companion diagnostics for the Company's brain cancer product candidate. The collaboration arrangement does not contain a general right of return relative to the delivered item(s).

Based on the terms of the agreement, the Company identified one single unit of accounting for the deliverables and the up-front payment was allocated to it. The up-front payment is being recognized as license revenue on a straight-line basis over the estimated development period, and royalty revenue and royalty expenses will thereafter be recorded as earned and incurred, respectively.

USC Technology License

In October 2007, the Company entered into a license agreement with the University of Southern California (USC) pursuant to which the Company received a worldwide, exclusive license to, among other things, manufacture and market products utilizing the inventions claimed and described in the patents as described in the agreement.

Under the terms of the agreement, the Company paid an initial license fee to USC and issued to USC shares of the Company's common stock. Pursuant to the agreement, the Company owes USC a royalty in the low single-digit percent range of the Company's and the Company's sub-licensees' net sales of products covered by the agreement. In addition, the Company owes USC an additional royalty in the low single-digit percent range of revenue from its sub-licensees. Once the Company's and its sub-licensees' net sales reach an amount in the mid seven-digit dollar range, the minimum annual royalty payment due to USC will be in the low six-digit dollar range. The Company's royalty obligations continue on a licensed product-by-licensed product and country-by-country basis until the expiration of the last valid claim in the licensed patent covering a licensed product in such country. In October 2010, the Company exercised its option under the agreement to reduce the royalty rate to a lower single-digit percent range.

9. Grant Agreements

As of December 31, 2016, the Company was awarded grants from nonprofit organizations and the U.S. federal government to fund its research and development as follows (in thousands):

Award Date	Awarded by	Funds Received
July 15, 2009	Accelerate Brain Cancer Cure, Inc. (ABC2)	$ 150
June 1, 2010	National Brain Tumor Society	200
April 21, 2011	American Brain Tumor Association (ABTA)	200
June 6, 2012	Musella Foundation	50
September 26, 2012	National Institutes of Health	261
May 10, 2013	Adenoid Cystic Carcinoma Research Foundation	25
June 5, 2013	Voices Against Brain Cancer (VABC)	300
November 6, 2014	Adenoid Cystic Carcinoma Research Foundation	102
May 31, 2015	Musella Foundation	80
		$1,368

The grants listed below contain repayment provisions contingent on future events which the Company reviewed at the execution of each grant and continues to review on an ongoing basis to determine the likelihood of repayment.

ABC2 Grant

Terms of the ABC2 Grant include a revenue share clause whereby an amount up to a maximum of $0.2 million is payable to ABC2 if and when net sales of the Company's initial product candidate reach a total of $5.0 million within 10 years of the ABC2 Grant date. In addition, the ABC2 Grant includes a conversion option whereby the payment amount may be converted to common stock under certain circumstances. As the Company has not recognized any such revenues, no repayment liability has been recorded as of December 31, 2016.

ABTA Grant

Terms of the ABTA Grant include a revenue share clause whereby an amount up to a maximum of $0.2 million is payable to ABTA if and when net sales of the Company's initial product candidate reach a total of $5.0 million within 10 years of the ABTA Grant date. As the Company has not recognized any such revenues, no repayment liability has been recorded as of December 31, 2016.

VABC Grant

Terms of the VABC Grant include a recovery clause whereby an amount up to a maximum of $0.3 million is payable to VABC if and when (1) net sales of the Company's initial product candidate reach a total of $5.0 million within five years of the VABC Grant date, or (2) the Company enters into a definitive agreement for a favorable transaction resulting in (a) the sale of all or substantially all of the Company's capital stock in a transaction other than an initial public offering, (b) a favorable merger transaction of the Company with another entity, or (c) the sale of all or substantially all of the Company's assets for cash within a certain time period. In addition, the VABC Grant includes a conversion option whereby the payment may be converted to common stock under certain circumstances. As none of the recovery payment events were considered probable to occur as of December 31, 2016, no repayment liability has been recorded.

10. Income Taxes

The Company has not recorded a current or deferred tax expense or benefit for the years ended December 31, 2015 or 2016.

The (benefit) provision for income taxes differs from the amount of income tax determined by applying the applicable U.S. statutory federal income tax rate to pretax income as a result of the following differences:

	Year Ended December 31,	
	2015	2016
Federal statutory rate	34.0%	34.0%
Adjustments for tax effects of:		
State taxes, net	5.6%	5.6%
Permanent adjustments	(4.8)%	(5.4)%
Net operating loss carryovers not recognized	(33.3)%	(32.8)%
Valuation allowance	(1.7)%	(1.1)%
Other	0.2%	(0.3)%
Effective income tax rate	—%	—%

Deferred taxes are recognized for temporary differences between the basis of assets and liabilities for financial statement and income tax purposes. Significant components of the Company's deferred taxes are as follows (in thousands):

	December 31,	
	2015	2016
Deferred tax assets:		
Depreciation and amortization	$ 97	$ 52
Deferred license revenue	55	38
Share-based compensation	635	1,062
Accrued liabilities and other	810	796
Total deferred tax assets	1,597	1,948
Less valuation allowance	(1,597)	(1,948)
Net deferred tax assets	$ —	$ —

The Company has evaluated the positive and negative evidence bearing upon the realizability of its deferred tax assets. Based upon the Company's history of operating losses, the Company has concluded that it is more likely than not that the benefit of its deferred tax assets will not be realized. Accordingly, the Company has provided a full valuation allowance for deferred tax assets as of December 31, 2015 and 2016. During each of the years ended December 31, 2015 and 2016, the valuation allowance increased by $0.4 million.

The Company has federal and California net operating loss carryforwards which may be available to offset future income tax liabilities. As of December 31, 2016, the Company has federal and California net operating loss carryforwards of $109.5 million and $41.5 million, respectively. The federal and state net operating losses begin to expire in 2028 unless previously utilized. Excluded from the California net operating loss carryforward are net operating losses for the years ended December 31, 2013, 2014, 2015 and 2016 that were impacted by a California Supreme Court ruling on December 31, 2015. This ruling clarified how companies are allowed to apportion income or losses in the state. The Company has not completed an analysis to determine the re-apportionment of its losses to California using the required single sales factor market sourcing method for 2013 through 2016 as a result of the ruling. When this analysis is finalized, the Company plans to update its California net operating loss carryforward accordingly.

As of December 31, 2016, the Company has federal and California research and development tax credit carryforwards of $15.1 million and $3.9 million, respectively. The federal research and development tax credits begin to expire in 2028 unless previously utilized. The California credits do not expire.

Pursuant to Internal Revenue Code (the Code) Sections 382 and 383, annual use of a company's net operating loss and tax credit carryforwards may be limited if there is a cumulative change in ownership of greater than 50% within a three-year period. The amount of the annual limitation is determined based on the value of the Company immediately prior to the ownership change. Subsequent ownership changes may further affect the limitation in future years. The Company has completed several equity offerings since its inception which may have resulted in a change in control as defined by Sections 382 and 383 of the Code, or could result in a change in control in the future. The Company has not completed a Section 382 and 383 analysis regarding the limitation of net operating loss and research and development credit carryforwards. Until such an analysis has been completed, the Company has removed the deferred tax assets for net operating losses of $39.7 million and federal and California research and development credits of $17.7 million from its deferred tax asset schedule, and has recorded a corresponding decrease to its valuation allowance. When this analysis is finalized, the Company plans to update its unrecognized tax benefits accordingly. The Company does not expect this analysis to be completed within the next 12 months and, as a result, the Company does not expect that the unrecognized tax benefits will change within 12 months of this reporting date. Due to the existence of the valuation allowance, future changes in the Company's unrecognized tax benefits will not impact the Company's effective tax rate.

The Company's policy is to record interest and penalties relating to uncertain tax positions as a component of income tax expense. As of December 31, 2015 and 2016, there were no accruals for interest or penalties for uncertain tax positions.

The Company is subject to taxation in the U.S. and state jurisdictions. As of December 31, 2016, the Company's tax years beginning 2007 to date are subject to examination by federal and California taxing authorities due to the carry forward of unutilized net operating losses and R&D tax credits. To the extent the Company has tax attribute carryforwards, the tax years in which the attribute was generated may still be adjusted upon examination by the Internal Revenue Service or state tax authorities to the extent utilized in a future period.

11. Retirement Plan

The Company sponsors an employee savings plan that qualifies as a deferred salary arrangement under Section 401(k) of the IRC. Participating employees may defer up to the Internal Revenue Service annual contribution limit. Additionally, the Company may elect to make contributions into the savings plan at its sole discretion. The Company has not made any contributions for the years ended December 31, 2015 or 2016.

12. Commitments and Contingencies

The Company leases its laboratory and office space under an operating lease that expires in February 2018. Rent expense under the lease was $0.3 million and $0.4 million during the years ended December 31, 2015 and 2016, respectively. Future minimum obligations under all non-cancelable operating lease commitments at December 31, 2016 are $0.4 million and $65,000 during 2017 and 2018, respectively.

The Company enters into service agreements with an indemnification clause in the ordinary course of business. Pursuant to the clause, the Company indemnifies, defends, holds harmless, and agrees to reimburse the indemnified party for losses suffered or incurred by third party claims arising out of the indemnified party's

performance of service. The term of these indemnification clauses is perpetual any time after execution of the agreement. The maximum potential amount of future payments the Company could be required to make under these indemnification clauses is unlimited. The Company has not incurred costs to defend lawsuits pursuant to these indemnification clauses.

13. Net Loss Per Share

Potentially dilutive securities not included in the calculation of diluted net loss per share, because to do so would be anti-dilutive, are as follows (in common stock equivalent shares) and excludes shares issuable upon the conversion of all outstanding principal and accrued interest related to the convertible promissory notes:

	Year Ended December 31,	
	2015	2016
Convertible preferred stock (as-converted)	6,690,070	6,690,070
Common stock options	738,809	1,385,855
Common stock warrant	724	724
Convertible preferred stock warrants (as-converted)	9,936	9,936
	7,439,539	8,086,585

The following table summarizes the pro forma net loss per common share (in thousands, except share and per share data) and excludes the effect of shares issuable upon the conversion of all outstanding principal and accrued interest related to convertible promissory notes payable upon the completion of this proposed offering:

	Year Ended December 31, 2016
Numerator	
Net loss	$ (33,478)
Denominator	
Weighted-average common shares outstanding, basic and diluted	2,199,964
Pro forma adjustments to reflect assumed weighted-average effect of conversion of convertible preferred stock	6,690,070
Pro forma weighted-average common shares outstanding, basic and diluted	8,890,034
Pro forma net loss per common share, basic and diluted	$ (3.77)

14. Subsequent Events

For purposes of the financial statements as of December 31, 2016 and the year then ended, the Company evaluated subsequent events for recognition and measurement purposes through March 9, 2017, the date the financial statements were issued. The Company has evaluated subsequent events for purposes of disclosure through March 31, 2017. Except as described below or elsewhere in these financial statements, the Company has concluded that no events or transactions have occurred subsequent to December 31, 2016 that require disclosure.

Stock Option Grants

On March 6, 2017, the Company granted 103,934 options to purchase common stock under the 2009 Plan, each with an exercise price of $15.12.

2017 Equity Incentive Plan

In March 2017, the Company's board of directors and stockholders approved and adopted the 2017 Equity Incentive Plan (the 2017 Plan). The 2017 Plan will become effective upon the execution and delivery of the underwriting agreement for this offering. The 2017 Plan provides for the grant of incentive stock options (ISOs), nonstatutory stock options, stock appreciation rights, restricted stock awards, restricted stock unit awards, performance based stock awards, other forms of equity compensation and performance cash awards. ISOs may be granted only to employees. All other awards may be granted to employees, including officers, and to the Company's non-employee directors and consultants, and affiliates.

Initially, 1,600,000 in new shares of common stock were approved for issuance under the 2017 Plan. The initial shares reserved exclude shares of common stock reserved for issuance under the 2009 Plan. The number of shares reserved that are remaining under the 2009 plan will be added to the shares initially reserved under the 2017 Plan upon its effectiveness.

In addition, the number of shares of common stock reserved for issuance under the 2017 Plan will automatically increase on January 1 of each year, beginning on January 1, 2018 and continuing through and including January 1, 2027, by 4% of the total number of shares of the Company's capital stock outstanding on December 31 of the preceding calendar year, or a lesser number of shares determined by the Company's board of directors.

2017 Employee Stock Purchase Plan

In March 2017, the Company's board of directors and stockholders approved and adopted the 2017 Employee Stock Purchase Plan (the ESPP). The ESPP will become effective upon the date of the underwriting agreement for this offering. The ESPP authorizes the issuance of 250,000 shares of the Company's common stock pursuant to purchase rights granted to our employees or to employees of any of the Company's designated affiliates. The number of shares of common stock reserved for issuance will automatically increase on January 1 of each calendar year, from January 1, 2018 through January 1, 2027 by the lesser of (a) 1% of the total number of shares of our common stock outstanding on December 31 of the preceding calendar year, (b) 300,000 shares, or (c) a number determined by our board of directors that is less than (a) and (b).

Reverse Stock Split

In March 2017, the Company's board of directors and stockholders approved a 1-for-6.9 reverse stock split of its outstanding common stock. The accompanying financial statements and notes to the financial statements give retroactive effect to the reverse stock split for all periods presented.

8,500,000 Shares

Common Stock

PROSPECTUS

April 12, 2017

Leerink Partners

Evercore ISI

Stifel

Through and including May 7, 2017 (25 days after the commencement of this offering), all dealers that buy, sell or trade shares of our common stock, whether or not participating in this offering, may be required to deliver a prospectus. This delivery requirement is in addition to the dealers' obligation to deliver a prospectus when acting as underwriters and with respect to their unsold allotments or subscriptions.