IDERA PHARMACEUTICALS, INC.
Form 10-K
March 06, 2019
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UNITED STATES SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

Form 10-K

þ ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the Fiscal Year Ended December 31, 2018

OR

¨ TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

Commission File Number: 001-31918

IDERA PHARMACEUTICALS, INC.

(Exact name of Registrant as specified in its charter)

Delaware	04-3072298
(State or other jurisdiction of incorporation or organization)	(I.R.S. Employer Identification No.)

505 Eagleview Blvd., Suite 212 19341
Exton, Pennsylvania (Zip Code)
(Address of principal executive offices)

(484) 348-1600

(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act

Title of Each Class:	Name of Each Exchange on Which Registered
Common Stock, $.001 par value	Nasdaq Capital Market

Securities registered pursuant to Section 12(g) of the Act: None

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes No

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or 15(d) of the Securities Act. Yes No

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to the filing requirements for the past 90 days. Yes No

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes No

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K (§ 229.405) is not contained herein, and will not be contained, to the best of the registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K.

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of “large accelerated filer,” “accelerated filer,” “smaller reporting company,” and “emerging growth company” in Rule 12b-2 of the Exchange Act.

Large accelerated filer	Accelerated filer
Non-accelerated filer	Smaller reporting company
	Emerging growth company

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act.

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act.) Yes No

The aggregate market value of the voting and non-voting common equity held by non-affiliates of the registrant was $199.8 million based on the last sale price of the registrant’s common stock as reported on the Nasdaq Capital Market on June 29, 2018 (the last business day of the registrant’s most recently completed second fiscal quarter).

As of February 15, 2019, the registrant had 27,620,102 shares of common stock outstanding.

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IMO® and Idera® are our trademarks. All other trademarks and service marks appearing in this Annual Report on Form 10-K are the property of their respective owners.

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NOTE REGARDING FORWARD-LOOKING STATEMENTS

This Annual Report on Form 10-K (this Form 10-K) and the documents we incorporate by reference contain forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended, or the Exchange Act. All statements, other than statements of historical fact, included or incorporated in this report regarding our strategy, future operations, collaborations, intellectual property, cash resources, financial position, future revenues, projected costs, prospects, plans and objectives of management are forward-looking statements. The words “believes,” “anticipates,” “estimates,” “plans,” “expects,” “intends,” “may,” “could,” “should,” “potential,” “likely,” “projects,” “continue,” “will,” “would” and similar expre intended to identify forward-looking statements, although not all forward-looking statements contain these identifying words. We cannot guarantee that we actually will achieve the plans, intentions or expectations disclosed in our forward-looking statements and you should not place undue reliance on our forward-looking statements.

There are a number of important factors that could cause our actual results to differ materially from those indicated or implied by forward-looking statements. These important factors include those set forth below under Part I, Item 1A “Risk Factors.” These factors and the other cautionary statements made in this Annual Report on Form 10-K and the documents we incorporate by reference should be read as being applicable to all related forward-looking statements whenever they appear in this Annual Report on Form 10-K and the documents we incorporate by reference.

In addition, any forward-looking statements represent our estimates only as of the date that this Annual Report on Form 10-K is filed with the Securities and Exchange Commission and should not be relied upon as representing our estimates as of any subsequent date. We do not assume any obligation to update any forward-looking statements. We disclaim any intention or obligation to update or revise any forward-looking statement, whether as a result of new information, future events or otherwise.

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PART I.

Item 1.Business.

Overview

We are a clinical-stage biopharmaceutical company with a business strategy focused on the clinical development, and ultimately the commercialization, of drug candidates for both oncology and rare disease indications characterized by small, well-defined patient populations with serious unmet medical needs. Our current focus is on our Toll-like receptor, or TLR, agonist, tilsotolimod (IMO-2125), for oncology. We believe we can develop and commercialize targeted therapies on our own. To the extent we seek to develop drug candidates for broader disease indications, we have entered into and may explore additional collaborative alliances to support development and commercialization.

TLRs are key receptors of the immune system and play a role in innate and adaptive immunity. As a result, we believe TLRs are potential therapeutic targets for the treatment of a broad range of diseases. Using our chemistry-based platform, we have designed both TLR agonists and antagonists to act by modulating the activity of targeted TLRs. A TLR agonist is a compound that stimulates an immune response through the targeted TLR. A TLR antagonist is a compound that inhibits an immune response by blocking the targeted TLR.

Our current TLR-targeted clinical-stage drug candidate, tilsotolimod, is an agonist of TLR9. We are currently developing tilsotolimod, via intratumoral injection, for the treatment of anti-PD1 refractory metastatic melanoma in combination with ipilimumab, an anti-CTLA4 antibody marketed as Yervoy® by Bristol-Myers Squibb Company, or BMS, in a Phase 3 trial. We are also evaluating intratumoral tilsotolimod in combination with nivolumab, an anti-PD1 antibody marketed as Opdivo® by BMS, and ipilimumab for the treatment of multiple solid tumors in a Phase 2 trial.

Clinical Development

Tilsotolimod (IMO-2125)

Tilsotolimod (IMO-2125) is a synthetic phosphorothioate oligonucleotide that acts as a direct agonist of TLR9 to stimulate the innate and adaptive immune systems. We are developing tilsotolimod for administration via intratumoral injection in combination with systemically administered checkpoint inhibitors for the treatment of various solid tumors, including (i) anti-PD1 refractory metastatic melanoma in combination with ipilimumab, (ii) squamous cell

carcinoma of the head and neck in combination with nivolumab and ipilimumab, and (iii) microsatellite stable colorectal cancer in combination with nivolumab and ipilimumab. We refer to our tilsotolimod development program as the ILLUMINATE development program.

Advancements in cancer immunotherapy have included the approval and late-stage development of multiple checkpoint inhibitors, which are therapies that target mechanisms by which tumor cells evade detection by the immune system. Despite these advancements, many patients fail to respond to these therapies. For instance, approximately 50% of patients with melanoma fail to respond to therapy with approved checkpoint inhibitors. Current published data suggests that the lack of response to checkpoint inhibition is related to a non-immunogenic tumor micro environment. We also believe TLR9 agonists may be useful in other solid tumor types that are refractory to anti-PD1 treatment due, in part, to low mutation load and low dendritic cell infiltration. Because TLR9 agonists, such as tilsotolimod, stimulate the immune system, we believe there is a scientific rationale to evaluate the combination of intratumoral injection of tilsotolimod with checkpoint inhibitors. Specifically, we believe intratumoral injection of tilsotolimod activates a local immune response in the injected tumor, which may complement the effect of the systemically administered checkpoint inhibitors. Currently, there is minimal immunotherapy benefit, post chemotherapy, for patients with squamous cell carcinoma of the head and neck and no approved immunotherapy options for patients with microsatellite stable colorectal cancer.

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In studies in preclinical cancer models conducted in our laboratories, intratumoral injection of TLR9 agonists, such as tilsotolimod, has potentiated the anti-tumor activity of multiple checkpoint inhibitors in multiple tumor models. These data have been presented at several scientific and medical conferences from 2014 through the first quarter of 2019. We believe these data support evaluation of combination regimens including the combination of a TLR9 agonist, such as tilsotolimod, with one or more checkpoint inhibitors for the treatment of cancer.

Melanoma is a type of skin cancer that begins in a type of skin cell called melanocytes. Although melanoma is a rare form of skin cancer, it causes the large majority of skin cancer deaths. As is the case in many forms of cancer, melanoma becomes more difficult to treat once the disease has spread beyond the skin to other parts of the body such as the lymphatic system (metastatic disease). Additionally, despite recent advances in therapy, such as immune checkpoint inhibitors, advanced metastatic melanoma continues to present significant morbidity and mortality.

We are currently developing tilsotolimod for use in combination with checkpoint inhibitors for the treatment of patients with anti-PD1 refractory metastatic melanoma. We believe, based on internally conducted commercial research, that in the United States, by 2025, approximately 25,000 people will have advanced melanoma appropriate for systemic treatment, and over 50% will not have responded to anti-PD1 therapy.

Tilsotolimod has received Orphan Drug Designation for the treatment of melanoma Stages IIb to IV and Fast Track designation for the treatment of anti-PD1 refractory metastatic melanoma in combination with ipilimumab therapy from the U.S. Food and Drug Administration, or FDA.

ILLUMINATE-204 - Phase 1/2 Trial of Tilsotolimod (IMO-2125) in Combination with Ipilimumab or Pembrolizumab in Patients with Anti-PD1 Refractory Metastatic Melanoma

In December 2015, we initiated a Phase 1/2 clinical trial to assess the safety and efficacy of tilsotolimod, administered intratumorally, in combination with ipilimumab, in patients with metastatic melanoma (refractory to treatment with a PD1 inhibitor, also referred to as anti-PD1 refractory), which we refer to as ILLUMINATE-204. We subsequently amended the trial protocol to enable an additional arm to study the combination of tilsotolimod with pembrolizumab, an anti-PD1 antibody marketed as Keytruda® by Merck & Co., Inc., in the same patient population. In this clinical trial, tilsotolimod is administered intratumorally into a selected tumor lesion at weeks 1, 2, 3, 5, 8, 11, 17, 23 and 29 (total of 9 doses) together with the standard dosing regimen of ipilimumab or pembrolizumab, administered intravenously. For patients who lack superficially accessible disease for injection, tilsotolimod is administered via injection into deep lesions, such as liver metastases, using interventional radiology guidance.

The trial was initiated at The University of Texas, MD Anderson Cancer Center, or MD Anderson, under the strategic research alliance we entered into with MD Anderson in June 2015, and additional sites have been added through the fourth quarter of 2018. The primary objectives of the Phase 1 portion of the trial include characterizing the safety of the combinations and determining the recommended Phase 2 dose. A secondary objective of the Phase 1 portion of the trial is describing the anti-tumor activity of tilsotolimod when administered intratumorally in combination with ipilimumab or pembrolizumab. The primary objective of the Phase 2 portion of the trial is to determine the objective response rate to the combinations using immune-related response criteria (irRC) and RECIST v1.1 criteria. The secondary objectives of the Phase 2 portion of the trial include the assessment of treatment response utilizing irRC, determination of median progression free survival (PFS) and median overall survival (OS), and to continue to characterize the safety of the combinations. In the Phase 1 portion of the trial, serial biopsies are being taken of selected injected and non-injected tumor lesions pre- and post-24 hours of the first dose of tilsotolimod, as well as at 8 and 13 weeks, to assess immune changes and response assessments. In the Phase 2 portion of the trial, biopsies are optional.

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Ipilimumab Arm

In the Phase 1 portion of the ipilimumab arm of our Phase 1/2 clinical trial of tilsotolimod, escalating doses of tilsotolimod ranging from 4 mg through 32 mg were evaluated in a total of 18 patients, each of which but one had progressed on nivolumab or pembrolizumab prior to enrollment in the trial. The combination of tilsotolimod and ipilimumab had been well tolerated at all dose levels studied. In April 2017, we completed tilsotolimod dose escalation and based on the safety and efficacy data and data from translational immune parameters, selected the 8 mg dose level as the recommended dose level for the Phase 2 portion of the ipilimumab arm of the trial.

In April 2017, we initiated enrollment in the Phase 2 portion of the ipilimumab arm of our Phase 1/2 clinical trial of tilsotolimod with the 8 mg dose of intratumoral tilsotolimod. The Phase 2 portion of the trial utilizes a Simon two-stage design to evaluate the objective response rate of tilsotolimod in combination with ipilimumab, compared to historical data for ipilimumab alone in the anti-PD1 refractory metastatic melanoma population. Based on the responses observed, the trial met the pre-specified futility assessment and advanced into the second stage of the Phase 2 portion.

At the 37th Annual J.P. Morgan Healthcare Conference in January 2019, we provided an update on our Phase 1/2 trial evaluating tilsotolimod in combination with ipilimumab at the recommended 8 mg dose level, noting that as of our December 2018 data-cut, a total of 37 patients had been dosed at the 8 mg dose level and 34 patients treated at the 8 mg dose level had at least one post-baseline disease assessment. Of these 34 patients, three had a complete response and eight had a partial response, representing an overall response rate of 32.4%. One of the three patients who had a complete response has been continuing off active treatment for more than two years and has remained disease free. Additionally, fifteen other patients who were treated at the 8 mg dose level experienced stable disease. In the aggregate, 26 of the 34 patients achieved stable disease or better, representing a disease control rate of 76.5%. Additionally, as of the response data cutoff date, one patient who was treated at the 4 mg dose had an ongoing partial response and had been off active treatment for more than two years. The combination of tilsotolimod and ipilimumab continues to be well-tolerated.

In addition, other key findings include data demonstrating a clear systemic antitumor effect on distant uninjected tumors from the treatment of tilsotolimod in combination with ipilimumab. Also, data was presented showing that clinical responses were observed in patients whose tumors had low HLA-ABC expression at baseline, before treatment was started. Given that HLA-ABC expression is required for ipilimumab anti-tumor activity (Rodig, 2018), this demonstrates the contribution of tilsotolimod to overcome resistance to ipilimumab in tumors with low HLA-ABC expression, thereby enhancing the overall response rate compared to that expected with ipilimumab alone.

Pembrolizumab Arm

In the Phase 1 portion of the pembrolizumab arm of our Phase 1/2 clinical trial of tilsotolimod, we are evaluating escalating doses of tilsotolimod ranging from 8 mg through 32 mg.

We have completed enrollment of a total of six patients in the 8 mg and 16 mg dosing cohorts in the Phase 1 dose escalation portion of the pembrolizumab arm of the trial and have dosed two patients in the 32 mg dosing cohort. One patient who was treated at the 16 mg dose has experienced an ongoing complete response by RECIST v1.1 criteria.

The ILLUMINATE-204 trial was closed for enrollment in February 2019, with a total of 52 patients enrolled. Final data is expected during the fourth quarter of 2019.

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ILLUMINATE-301 - Phase 3 Trial of Tilsotolimod (IMO-2125) in Combination with Ipilimumab in Patients with Anti-PD1 Refractory Metastatic Melanoma

In the first quarter of 2018, we initiated a Phase 3 trial of the tilsotolimod–ipilimumab combination in patients with anti-PD1 refractory metastatic melanoma, which we refer to as ILLUMINATE-301. This trial will compare the results of the tilsotolimod–ipilimumab combination to those of ipilimumab alone in a 1:1 randomization, will have a sample size of approximately 300 patients and will be conducted at up to 110 sites worldwide. The primary endpoints of the trial are overall response rate (ORR) by RECIST v1.1 and median overall survival (OS). Key secondary endpoints include ORR by irRECIST, durable response rate, median time to response, median progression free survival (PFS) and patient reported outcomes using a validated scale. Enrollment is ongoing and expected to be completed by the end of 2019.

We have held discussions with and plan to continue to engage with regulatory authorities regarding the paths to registration for tilsotolimod in combination with ipilimumab in anti-PD1 refractory metastatic melanoma patients, including potentially through an accelerated approval process based on the analysis of the ORR in the Phase 3 trial with the final analysis of OS providing the confirmatory data for full approval.

As discussed below under the heading “Collaborative Alliances,” in May 2018, we entered into a clinical trial collaboration and supply agreement with BMS under which BMS has agreed to manufacture and supply YERVOY® (ipilimumab), at its cost and for no charge to us, for use in ILLUMINATE-301.

ILLUMINATE-101 - Phase 1b Trial of Intra-tumoral Tilsotolimod (IMO-2125) Monotherapy in Patients with Refractory Solid Tumors

In March 2017, we initiated a Phase 1b dose escalation trial of tilsotolimod administered intratumorally as a monotherapy in multiple tumor types, which we refer to as ILLUMINATE-101. In this trial, tilsotolimod is administered intratumorally on days 1, 8 and 15 of cycle 1 and on day 1 of each subsequent 21-day cycle, up to 17

cycles (19 total doses). We completed enrollment of a total of 38 patients in four dose-escalation cohorts at doses of 8mg (cohort 1, n=11), 16mg (cohort 2, n=8), 23mg (cohort 3, n=10) and 32mg (cohort 4, n=9). There were no dose-limiting toxicities observed and tilsotolimod appeared to be well tolerated at each of the dose levels tested. An additional purpose of this study was to obtain tumor biopsies to assess the effect of tilsotolimod on the tumor microenvironment in multiple types of solid tumors and inform the expansion of the development program beyond melanoma. Initial translational data confirms robust Type I IFN pathway activation 24 hours following a single intratumoral dose of tilsotolimod, which is similar to that observed and previously reported in the tumor biopsies from the ILLUMINATE-204 melanoma subjects.

We are also enrolling a melanoma expansion cohort to assess whether tilsotolimod as a monotherapy (8mg dose) has any clinical activity in patients with metastatic melanoma who have progressed on or after treatment with a PD-(L)1 inhibitor. We believe this is unlikely and are therefore utilizing a Simon's optimal two-stage design to test for clinically and statistically relevant clinical activity. With this method, eight patients will be treated and monitored for a RECIST v1.1 response in Stage 1. If two or more patients have a response, then the cohort will continue to Stage 2, in which 14 more patients will be treated, for a total of 22 patients. To date, 16 patients have been enrolled, however, accrual has been paused until we have evaluated the clinical outcome in the first eight patients. The melanoma expansion cohort will stop if analysis shows there is insufficient evidence of a clinically relevant response rate in those first eight patients.

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Advancements in cancer immunotherapy have included the approval and late-stage development of multiple checkpoint inhibitors, as single agents or in combination, for other solid tumors including, among others, squamous cell carcinoma of the head and neck (SCCHN) and dMMR/MSI-H colorectal cancer (CRC).

Squamous cell carcinoma is the most frequent malignant tumor of the head and neck region and develops from the mucosal linings of the upper aerodigestive tract. Although the majority of patients present with loco-regional disease, more than 50% will succumb to recurrent or metastatic disease despite aggressive therapy with surgery, radiation, and/or chemotherapy. Relapsed or metastatic SCCHN (RM SCCHN) is an incurable disease with a poor prognosis and the mortality rate of patients presenting with advanced disease remains high. Recently, the results from prospectively conducted trials employing the immune-modulating antibodies nivolumab and pembrolizumab following chemotherapy heralded a new era of treatment for RM SCCHN. Patients responding to these agents have seen durable responses and in controlled studies an overall survival benefit has been demonstrated for the anti PD-1 antibodies versus standard of care chemotherapy. The challenge remains to increase the percentage of patients responding to these treatments, which currently ranges from 13% to 23% depending on the line of therapy.

Nivolumab administered as monotherapy or in combination with ipilimumab, has demonstrated benefit and is approved for the treatment of dMMR/MSI-H mCRC. However, in a previously treated microsatellite stable (MSS) CRC patient population, nivolumab + ipilimumab combination therapy did not produce objective responses. MSS CRC has been shown to be highly immunosuppressive. Moreover, the tumor microenvironment in MSS CRC has been shown to keep dendritic cells in an immature state. Given tilsotolimod's mechanism of action of activating dendritic cells, it may serve a complementary function to nivolumab and ipilimumab, within the immunosuppressive TME of MSS CRC patients.

We believe, based on internally conducted research, that annually in the United States, approximately 140,000 people are diagnosed with CRC, of which 85% are MSS, and there are approximately 50,000 deaths attributed to CRC. Additionally, we believe that annually in the United States, approximately 64,000 people are diagnosed with SCCHN and there are approximately 14,000 deaths attributed to SCCHN.

ILLUMINATE-206 - Phase 2 Trial of Tilsotolimod (IMO-2125) in Combination with Nivolumab and Ipilimumab for the treatment of Solid Tumors

In December 2018, we submitted an IND application to the FDA to evaluate tilsotolimod administered intratumorally, in combination with nivolumab and ipilimumab in a Phase 2, multi-cohort study that anticipates the study of multiple solid tumors. We received notification from the FDA in January 2019 that the study may proceed and expect to initiate the Phase 2, multicohort study for the treatment of specific solid tumors in the second quarter of 2019. We refer to this study as ILLUMINATE-206.

Each cohort in this study is designed to be conducted in two parts. The purpose of the first part (Part 1) is for signal finding and utilizes a Simon's minimax two-stage design in a single-arm. The primary objective of Part 1 is to evaluate the efficacy (measured by ORR based on RECIST v1.1) of intratumoral tilsotolimod in combination with nivolumab and ipilimumab. The secondary objectives of Part 1 are to assess tilsotolimod in combination with nivolumab and ipilimumab by evaluating safety, tolerability, plasma concentrations and immunogenicity. Based on the data from Part 1 of each cohort, expansion of a cohort may be conducted as Part 2. Part 2 objectives will be determined after the decision is made to initiate Part 2 of a given cohort. The start and end of the study will be independent for each cohort.

The initial ILLUMINATE-206 cohorts are as follows:

· Cohort 1: RM SCCHN in immunotherapy-naïve patients treated with tilsotolimod in combination with nivolumab and ipilimumab;

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- Cohort 2: RM SCCHN in immunotherapy-refractory patients treated with tilsotolimod in combination with nivolumab and ipilimumab; and
- Cohort 3: Relapsed/refractory MSS CRC in immunotherapy-naïve patients treated with tilsotolimod in combination with nivolumab and ipilimumab.

Within Cohort 1, 41 patients are planned to be enrolled (22 patients in Stage 1 and 19 patients in Stage 2). Within Cohorts 2 and 3, 36 patients each are planned for enrollment (20 patients in Stage 1 and 16 patients in Stage 2). Each cohort is planned to be recruited for the first stage of Part 1.

We plan to initiate enrollment for cohorts 1 and 3 (immunotherapy-naïve patients) at approximately 12 total sites within the United States and Spain in the second quarter of 2019. We intend to initiate cohort 2 (immunotherapy-refractory patients) at the appropriate time.

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Suspended Programs

In July 2018, following an analysis of our gene-silencing technology platform and our research portfolio, we decided to suspend our rare disease and discovery programs as part of our overall strategy to more narrowly focus our capital resources on the development and commercialization of tilsotolimod.

IMO-8400 for Rare Diseases

We have been developing IMO-8400, an antagonist of TLR7, TLR8 and TLR9, for the treatment of rare diseases, and had selected dermatomyositis as our lead clinical target. In December 2015, we initiated a Phase 2, randomized, double-blind, placebo-controlled clinical trial designed to assess the safety, tolerability and treatment effect of IMO-8400 in adult patients with dermatomyositis. In June 2018, we reported that the trial did not meet its primary endpoint of statistically significant change from baseline in the Cutaneous Dermatomyositis Disease Area and Severity Index (CDASI) activity score versus placebo. As a result, in July 2018, we made a decision to discontinue this clinical program upon completion of final close-out activities.

IMO-9200 for Autoimmune Disease

We have developed a second novel synthetic oligonucleotide antagonist of TLR7, TLR8, and TLR9, IMO-9200, as a drug candidate for potential use in selected autoimmune disease indications. In 2015, we completed a Phase 1 clinical trial of IMO-9200 in healthy subjects as well as additional preclinical studies of IMO-9200 for autoimmune diseases. In 2015, we determined not to proceed with the development of IMO-9200 because the large autoimmune disease indications for which IMO-9200 had been developed did not fit within the strategic focus of our company. In November 2016, we entered into an exclusive license and collaboration agreement with Vivelix Pharmaceuticals, Ltd., or Vivelix, granting Vivelix worldwide rights to develop and market IMO-9200 for non-malignant gastrointestinal disorders, which agreement we refer to as the Vivelix Agreement. On November 4, 2018, Vivelix notified us that they decided to terminate ongoing development activities related to IMO-9200. Subsequently, on March 4, 2019, Vivelix and we mutually agreed to terminate the Vivelix Agreement. See Note 9 of the notes to our financial statements in this Annual Report on Form 10-K for additional information.

IDRA-008 Development

In January 2017, we announced that we had selected IDRA-008 as our first nucleic acid chemistry research program candidate that we plan to enter into clinical development and that we were planning to develop IDRA-008 for a well-established liver target. In January 2018, we announced that IDRA-008 was targeted at Apolipoprotein C-III

(APOC-III) and was being developed for the treatment of Familial Chylomicronemia Syndrome (FCS) and Familial Partial Lipodystrophy (FPL) which had available pre-clinical animal models and well-known clinical endpoints. During the first quarter of 2018, we completed our pre-clinical analysis for IDRA-008 and based upon the outcome of pre-clinical pharmacology studies, including a comparative pharmacology study with the competitive development asset Volanesorsen, and IND-enabling safety evaluation, we made a data-driven decision to not advance IDRA-008 into clinical development.

Nucleic Acid Chemistry Compound—Undisclosed Renal Target

In November 2015, we entered into a collaboration and license agreement with GlaxoSmithKline Intellectual Property Development Limited, or GSK, to license, research, develop and commercialize pharmaceutical compounds from our nucleic acid chemistry technology for the treatment of selected targets in renal disease, which agreement we refer to as the GSK Agreement. Under this collaboration, we have created multiple development candidates to address the target designated by GSK in connection with entering into the GSK Agreement. From the population of identified development candidates, GSK may designate one development candidate in its sole discretion to move forward into clinical development. If GSK designates a development candidate, GSK would be solely responsible for the development and commercialization activities for that designated development candidate.

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Corporate Consolidation and Wind-down of Discovery Operations

In July 2018, following an analysis of our gene-silencing technology platform and our research portfolio, we decided to suspend our rare disease and discovery programs, including our nucleic acid chemistry research program, as part of our overall strategy to more narrowly focus on the development and commercialization of tilsotolimod. In connection with this focused strategy, we closed our operating facility in Cambridge, Massachusetts and consolidated our operations to our Exton, Pennsylvania location.

In connection with these actions, we are eliminating a total of 18 positions, primarily in the area of discovery, representing approximately 40% of our employee base. Of the 18 positions being eliminated, 16 have been eliminated as of December 31, 2018 with the remaining two expected to be eliminated by the second quarter of 2019. We have incurred one-time termination costs in connection with the reduction in workforce, which includes severance, benefits and related costs, of approximately $2.5 million during the year ended December 31, 2018 and expect to incur an additional $0.2 million during the year ending December 31, 2019. We incurred approximately $0.5 million and $0.2 million, respectively, of non-cash impairment charges against the carrying values of equipment previously used in our Cambridge facility and prepaid expenses for facility-related contracts during the year ended December 31, 2018. Additionally, we entered into a lease termination agreement on July 27, 2018 with ARE-MA-Region No. 23 LLC which terminated our lease agreement for our Cambridge facility, effective September 30, 2018. We incurred a $0.2 million early termination fee, although the lease termination is expected to result in annual cash savings of approximately $2.0 million.

Clinical Research Support Agreement

In April 2018, we entered into a clinical development support agreement with Pillar Partners Foundation, or Pillar Partners. Under the terms of the agreement, Pillar Partners agreed to provide direct funding to support three investigator initiated clinical trials to further strategically expand the clinical research of tilsotolimod into broader melanoma populations and other solid tumors, and we agreed to provide tilsotolimod for these trials. During the third quarter of 2018, Pillar Partners sought additional consideration in order to provide their funding. As a result, in October 2018, we terminated the agreement with Pillar Partners; however, we expect to move forward with certain of the investigator initiated clinical trials of tilsotolimod originally contemplated under such agreement. We believe these trials will allow us to expand our knowledge and understanding of the various cancer types and combinations in which tilsotolimod could play a significant role in improving patient outcomes.

Collaborative Alliances

In addition to our current alliances, we may seek to enter into additional collaborative alliances to support development and commercialization of our TLR agonists and antagonists. Our current alliances include collaborations

with BMS, GSK and Abbott Molecular.

Collaboration with Bristol-Meyers Squibb

Effective May 18, 2018, we entered into a clinical trial collaboration and supply agreement with BMS to clinically evaluate the combination of our TLR-9 agonist, tilsotolimod (IMO-2125), with BMS's therapy YERVOY® (ipilimumab), which agreement we refer to as the BMS Collaboration and Supply Agreement.

Under the BMS Collaboration and Supply Agreement, we will sponsor, fund and conduct our ongoing global, open-label, multi-center Phase 3 clinical trial of tilsotolimod in combination with YERVOY® entitled "A Randomized Phase 3 Comparison of IMO-2125 with Ipilimumab versus Ipilimumab Alone in Patients with Anti-PD-1 Refractory Melanoma" in accordance with an agreed-upon protocol, which we refer to as ILLUMINATE-301. Under the BMS Collaboration and Supply Agreement, BMS has granted us a non-exclusive, non-transferrable, royalty-free license (with a right to sublicense) under its intellectual property to use YERVOY® in ILLUMINATE-301 and has agreed to manufacture and supply YERVOY®, at its cost and for no charge to us, for use in ILLUMINATE-301.

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Collaboration with Vivelix Pharmaceuticals, Ltd.

In November 2016, we entered into the Vivelix Agreement, granting Vivelix worldwide rights to develop and market IMO-9200, an antagonist of TLR 7, 8 and 9, for non-malignant gastrointestinal disorders (the GI Field or Field as defined in the Vivelix Agreement) and certain back-up compounds to IMO-9200. In connection with the Vivelix Agreement, we transferred certain drug material to Vivelix for Vivelix's use in its development activities. Vivelix is solely responsible for the development and commercialization of IMO-9200 and any designated back-up compounds to IMO-9200.

In accordance with the Vivelix Agreement, a Joint Research Committee, or JRC, was formed with equal representation from us and Vivelix. The responsibilities of the JRC, include, but are not limited to monitoring the progress of the research program, advising on the designation of back-up compounds, sharing information between the parties and dealing with disputes that may arise between the parties. If a dispute cannot be resolved by the JRC, Vivelix has final decision-making authority.

Pursuant to the Vivelix Agreement, Vivelix could request that we create, characterize and perform research on back-up compounds. Such activity was to be mutually agreed upon and moderated by the JRC. The research period commenced with the execution of the agreement and may last for up to three years. As a result of our decision to wind-down our discovery operations as further described in under the heading "Corporate Consolidation and Wind-down of Discovery Operations," in July 2018, we informed Vivelix that no additional research projects will be undertaken by the Company.

Vivelix has certain rights under the agreement whereby it may (i) exercise the right of first refusal, (ii) the right of first negotiation to obtain an exclusive license for any compound controlled by us that has activity in the field of inflammatory bowel disease and (iii) the right to request an expanded Field beyond the GI Field.

Under the terms of the Vivelix Agreement, we received an upfront, non-refundable fee of $15 million. In addition, we will be eligible for future IMO-9200 related development, regulatory and sales milestone payments totaling up to $140 million, including development and regulatory milestones totaling up to $65 million and sales milestones totaling up to $75 million, and escalating royalties ranging from the mid single-digits to low double-digits of global net sales, which percentages are subject to reduction under agreed upon circumstances. As it relates to back-up compounds, including certain compounds controlled by us as of the effective date of the Vivelix Agreement and/or those created at Vivelix's request under the research program, we will be eligible for related designation payments and development, regulatory and sales milestone payments totaling up to $52.5 million, including development and regulatory milestones totaling up to $35 million and sales milestones totaling up to $17.5 million and escalating royalties ranging from the mid single-digits to low double-digits of global net sales, which percentages are subject to reduction under agreed upon circumstances. Under the terms of the Vivelix Agreement, we have performed research services, as requested by Vivelix and at Vivelix's expense. To date, Vivelix has not designated any back-up compounds subject to the research program.

Pursuant to the Vivelix Agreement, Vivelix conducted two clinical studies on IMO-9200 in the field of inflammatory bowel diseases. While there were no apparent safety signals identified in either study, there was no apparent benefit associated with IMO-9200 at the doses studied compared with placebo. As a result, Vivelix has decided to terminate ongoing development activities related to IMO-9200. Additionally, on March 4, 2019, Vivelix and we mutually agreed to terminate the Vivelix Agreement. Accordingly, we are no longer eligible to receive any future milestone or royalty-based payments and all rights previously granted to Vivelix with respect to IMO-9200 and certain back-up compounds to IMO-9200 revert back to us.

Collaboration with GlaxoSmithKline Intellectual Property Development Limited

In November 2015, we entered into the GSK Agreement to license, research, develop and commercialize pharmaceutical compounds from our nucleic acid chemistry technology for the treatment of selected targets in renal disease. The initial collaboration term is currently anticipated to last between two and four years from signing. In connection with the GSK Agreement, GSK identified an initial target for us to attempt to identify a potential population of development candidates to address such target under a mutually agreed upon research plan, currently estimated to take 36 months to complete. From the population of identified development candidates, GSK may designate one development candidate in its sole discretion to move forward into clinical

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development. Once GSK designates a development candidate, GSK would be solely responsible for the development and commercialization activities for that designated development candidate.

The GSK Agreement also provided GSK with the option to select up to two additional targets at any time during the first two years of the agreement, for further research under mutually agreed upon research plans. Upon selecting additional targets, GSK then had the option to designate one development candidate for each additional target, at which time GSK would have sole responsibility to develop and commercialize each such designated development candidate. GSK did not select any additional targets for research through the expiry of the option period.

In accordance with the GSK Agreement, a Joint Steering Committee, or JSC, was formed with equal representation from us and GSK. The responsibilities of the JSC, include, but are not limited to monitoring the progress of the collaboration, reviewing research plans and dealing with disputes that may arise between the parties. If a dispute cannot be resolved by the JSC, GSK has final decision-making authority.

Under the terms of the GSK Agreement, we received a $2.5 million upfront, non-refundable, non-creditable cash payment upon the execution of the GSK Agreement. Additionally, we were eligible to receive a total of up to approximately $100 million in license, research, clinical development and commercialization milestone payments, of which $9 million of these milestone payments would have been payable by GSK upon the identification of the additional targets, the completion of current and future research plans and the designation of development candidates and $89 million would have been payable by GSK upon the achievement of clinical milestones and commercial milestones. As a result of GSK not selecting additional targets during the two-year option period, we are now only eligible to receive a total of up to approximately $20 million in license, research, clinical development and commercialization milestone payments, of which $1 million of these milestone payments would be payable by GSK upon the designation of a development candidate from the initial target and $17 million would be payable by GSK upon the achievement of clinical milestones and commercial milestones. In addition, we are eligible to receive royalty payments based on net sales of licensed products following commercialization at varying rates of up to five percent on annual net sales, as defined in the GSK Agreement.

Collaboration with Abbott Molecular

In May 2014, we entered into a development and commercialization agreement with Abbott Molecular for the development of an in vitro companion diagnostic for use in our clinical development programs to treat certain genetically defined forms of B-cell lymphoma with IMO-8400. The agreement provides for the development and subsequent commercialization by Abbott Molecular of a companion diagnostic test utilizing polymerase chain reaction technology to identify with high sensitivity and specificity the presence in tumor biopsy samples of the oncogenic mutation referred to scientifically as MYD88 L265P. Under the agreement, Abbott Molecular is primarily responsible for developing and obtaining regulatory approvals for the companion diagnostic in accordance with an agreed development plan and regulatory plan and for making the companion diagnostic test commercially available in accordance with an agreed commercialization plan. Abbott Molecular will retain all proceeds from commercialization

of the companion diagnostic test. Subject to the terms of the agreement, we are required to pay Abbott Molecular fees and fund Abbott Molecular's development of the companion diagnostic test in an approximate aggregate amount of $6.7 million over an approximately five year development period, which includes clinical trial site costs and Abbott Molecular's costs of preparation and filing fees for regulatory submissions for the companion diagnostic with the FDA. This amount is subject to increase if Abbott Molecular incurs additional expenses in order to meet unexpected material requirements or obligations not included in the agreement or if we are required to conduct additional or different clinical trials which result in Abbott Molecular incurring additional costs.

The parties' activities pursuant to the agreed development, regulatory and commercialization plans are governed by a joint steering committee, with Abbott Molecular retaining final decision-making authority, subject to its obligations under the agreement, for development, manufacture and marketing of the companion diagnostic and our retaining final decision-making authority, subject to our obligations under the agreement, for the development, manufacture and marketing of IMO-8400.

Under the agreement, each party grants the other party specified intellectual property licenses to enable the other party to perform its obligations and exercise its rights under the agreement, including license grants enabling Abbott Molecular to develop and commercialize the companion diagnostic test for use with IMO-8400 and enabling

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us to develop and commercialize IMO-8400 with Abbott Molecular's companion diagnostic test. The licenses granted by the parties to one another generally survive termination of the agreement. Abbott Molecular remains free to develop its companion diagnostic test for use with third party therapeutic products, and we remain free to engage third party diagnostics companies to develop other companion diagnostic tests for use with IMO-8400.

We are permitted to terminate the agreement upon 90 days written notice to Abbott Molecular and, under circumstances specified in the agreement, payment of a termination fee and wind-down costs. The parties also may terminate the agreement based on uncured material breaches by or the bankruptcy or insolvency of the other party, and each party has the right to terminate the agreement in the event of specified permanent injunctions based on infringement of third party intellectual property rights. In September 2016, we suspended clinical development of IMO-8400 for B-cell lymphomas. However, we have maintained our relationship with Abbott under the agreement as we may explore potential collaborative alliances to support the development of IMO-8400 for B-cell lymphomas.

Academic and Research Collaborations

We have entered into research collaborations with scientists at leading academic research institutions. These research collaborations allow us to augment our internal research capabilities and obtain access to specialized knowledge and expertise. In general, our research collaborations may require us to supply compounds and pay various amounts to support the research. Under these research agreements, if a collaborator, solely or jointly with us, creates any invention, we may own exclusively such invention, have an automatic paid-up, royalty-free non-exclusive license or have an option to negotiate an exclusive, worldwide, royalty-bearing license to such invention. Inventions developed solely by our scientists in connection with research collaborations are owned exclusively by us. These collaborative agreements are non-exclusive and may be terminated with limited notice.

Research and Development Expenses

We are committed to redefining the treatment of certain cancers and rare diseases and have historically dedicated a significant portion of our resources to our efforts on the discovery and development of our drug candidates. For the years ended December 31, 2018, 2017 and 2016, we spent approximately $41.8 million, $50.7 million, and $39.8 million, respectively, on research and development activities. We plan to continue to invest in research and development, primarily with respect to our clinical trials of tilsotolimod. Accordingly, we anticipate that a significant portion of our operating expenses will continue to be related to clinical development in 2019 and beyond.

Termination of Merger Agreement

On January 21, 2018, we entered into an Agreement and Plan of Merger, or the Merger Agreement, with BioCryst Pharmaceuticals, Inc., or BioCryst, Nautilus Holdco, Inc., a direct, wholly owned subsidiary of BioCryst, or Holdco, Island Merger Sub, Inc., a direct, wholly owned subsidiary of Holdco, and Boat Merger Sub, Inc., a direct, wholly owned subsidiary of Holdco. The board of directors of each of Idera and BioCryst unanimously approved the Merger Agreement and the transactions contemplated thereby and the required regulatory approvals were received. However, the proposed merger was subject to approval by the stockholders of Idera and BioCryst, and satisfaction of other customary closing conditions, as specified in the Merger Agreement.

At a special meeting of BioCryst stockholders held on July 10, 2018, BioCryst's stockholders voted against the adoption of the Merger Agreement. Following such vote and in accordance with the terms of the Merger Agreement, BioCryst terminated the Merger Agreement on July 10, 2018.

In accordance with the Merger Agreement, BioCryst paid us a fixed expense reimbursement amount of $6 million in connection with the termination of the Merger Agreement.

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Patents, Proprietary Rights and Trade Secrets

Our success depends in part on our ability to obtain and maintain proprietary protection for our drug candidates, technology and know-how, to operate without infringing the proprietary rights of others and to prevent others from infringing our proprietary rights. We use a variety of methods to seek to protect our proprietary position, including filing U.S. and foreign patent applications related to our proprietary technology, inventions and improvements that are important to the development of our business. We also rely on trade secrets, know-how, continuing technological innovation, and in-licensing opportunities to develop and maintain our proprietary position.

We have devoted and continue to devote a substantial amount of our resources into establishing intellectual property protection for:

- Novel chemical entities that function as agonists of TLR3, TLR7, TLR8 or TLR9;
- Novel chemical entities that function as antagonists of TLR7, TLR8 or TLR9; and
- Composition and use of our nucleic acid chemistry compounds to treat and prevent a variety of diseases.

As of February 15, 2019, we owned approximately 51 U.S. patents and patent applications and about 139 patents and patent applications throughout the rest of the world for our TLR-targeted immune modulation technologies. These patents and patent applications include claims covering the chemical compositions of matter and methods of use of our IMO compounds, such as IMO-8400, IMO-9200 and tilsotolimod (IMO-2125), as well as other compounds. These patents expire at various dates ranging from 2023 to 2037. With respect to IMO-8400, we have six issued U.S. patents that cover the chemical composition of matter of IMO-8400 and certain methods of its use that provide exclusivity for IMO-8400 until at least 2031. With respect to IMO-9200, we have nine issued U.S. patents that cover the chemical composition for IMO-9200 and methods of its use that provide exclusivity for IMO-9200 until at least 2034. With respect to tilsotolimod, we have an issued U.S. patent that covers the chemical composition of matter of tilsotolimod and methods of its use that will expire in 2025. We have pending applications in the United States and outside of the United States that cover methods of treatment or use with tilsotolimod with expiration dates of 2035 and 2037.

As of February 15, 2019, we owned three issued U.S. patents, approximately 38 issued foreign patents, one pending U.S. patent application and four foreign patent applications (including pending applications under the Patent Cooperation Treaty, or PCT) related to our nucleic acid chemistry compounds and methods of their use. The issued patents covering our nucleic acid chemistry technologies have an earliest statutory expiration date in 2030.

Because patent applications in the United States and many foreign jurisdictions are typically not published until 18 months after filing, or in some cases not at all, and because publications of discoveries in the scientific literature often lag behind actual discoveries, neither we nor our licensors can be certain that we or they were the first to make the inventions claimed in issued patents or pending patent applications, or that we or they were the first to file for protection of the inventions set forth in these patent applications.

Litigation may be necessary to defend against or assert claims of infringement, to enforce patents issued to us, to protect trade secrets or know-how owned by us, or to determine the scope and validity of the proprietary rights of others or to determine the appropriate term for an issued patent. In addition, the United States Patent and Trademark Office, or USPTO, may declare interference proceedings to determine the priority of inventions with respect to our patent applications or reexamination or reissue proceedings to determine if the scope of a patent should be narrowed. Litigation or any of these other proceedings could result in substantial costs to and diversion of effort by us, even if the eventual outcome is favorable to us, and could have a material adverse effect on our business, financial condition and results of operations. These efforts by us may not be successful.

The term of individual patents depends upon the legal term for patents in the countries in which they are obtained. In most countries, including the United States, the patent term is 20 years from the earliest filing date of a non-provisional patent application. In the United States, a patent's term may be lengthened by patent term adjustment, which compensates a patentee for administrative delays by the USPTO in examining and granting a patent, or may be shortened if a patent is terminally disclaimed over an earlier filed patent. The term of a patent that covers a drug, biological product or medical device approved pursuant to a pre-market approval may also be eligible for patent term extension when FDA approval is granted, provided statutory and regulatory requirements

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are met. The length of the patent term extension is related to the length of time the drug is under regulatory review while the patent is in force. The Drug Price Competition and Patent Term Restoration Act of 1984, or the Hatch-Waxman Act, permits a patent term extension of up to five years beyond the expiration date set for the patent. Patent extension cannot extend the remaining term of a patent beyond a total of 14 years from the date of product approval, only one patent applicable to each regulatory review period may be granted an extension and only those claims reading on the approved drug are extended. Similar provisions are available in Europe and other foreign jurisdictions to extend the term of a patent that covers an approved drug.

We may rely, in some circumstances, on trade secrets and confidentiality agreements to protect our technology. Although trade secrets are difficult to protect, wherever possible, we use confidential disclosure agreements to protect the proprietary nature of our technology. We regularly implement confidentiality agreements with our employees, consultants, scientific advisors, and other contractors and collaborators. However, there can be no assurance that these agreements will not be breached, that we will have adequate remedies for any breach, or that our trade secrets and/or proprietary information will not otherwise become known or be independently discovered by competitors. To the extent that our employees, consultants or contractors use intellectual property owned by others in their work for us, disputes may also arise as to the rights in related or resulting know-how and inventions.

Manufacturing

We do not currently own or operate manufacturing facilities for the production of clinical or commercial quantities of any of our drug candidates. We currently rely and expect to continue to rely on other companies for the manufacture of our drug candidates for preclinical and clinical development. We currently source our bulk drug manufacturing requirements from a limited number of contract manufacturers through the issuance of work orders on an as-needed basis. We depend and will continue to depend on our contract manufacturers to manufacture our drug candidates in accordance with current Good Manufacturing Practices, or cGMP, regulations for use in clinical trials. We will ultimately depend on contract manufacturers for the manufacture of our products for commercial sale, if and when our drug candidates are approved. Contract manufacturers are subject to extensive governmental regulation.

Under our collaborative agreement with GSK, GSK is responsible for manufacturing clinical drug candidates.

Competition

The biotechnology and pharmaceutical industries are characterized by rapidly advancing technologies, intense competition and a strong emphasis on proprietary products. We are currently developing tilsotolimod (IMO-2125), our TLR agonist drug candidate, for the treatment by intra-tumoral injection of multiple oncology indications in combination with checkpoint inhibitors. There are many other companies, public and private, that are actively engaged in discovery, development, and commercializing products and technologies that may compete with our drug

candidate, tilsotolimod, including TLR-targeted compounds as well as non-TLR-targeted therapeutics.

Immuno-oncology, which utilizes a patient's own immune system to combat cancer, is currently an active area of research for biotechnology and pharmaceutical companies. Interest in immuno-oncology is driven by efficacy data in cancers with historically bleak outcomes and the potential to achieve a cure or functional cure for some patients. As such, we expect that our efforts in this field will be competitive with a wide variety of different approaches. Any one of these competitive approaches may result in the development of novel technologies that are more effective, safer or less costly than any that we are developing.

We are aware of other companies developing TLR agonists as well as other mechanisms of action that are focused on stimulating the immune response. These companies include, but are not limited to, Aduro Biotech, Inc., BioLineRx Ltd., Checkmate Pharmaceuticals, Inc., Dynavax Technologies Corporation, Exicure, Inc., Gilead Sciences Inc., GlaxoSmithKline plc, Hoffmann-La Roche Ltd., Innate Immunotherapeutics Ltd., Mologen AG VentiRx Pharmaceuticals Inc., Nektar Therapeutics, and Telormedix S.A.

Some of these potentially competitive products have been in development or commercialized for years, in some cases by large, well established pharmaceutical companies. Many of the marketed products have been accepted by the medical community, patients, and third-party payors. Our ability to compete may be affected by the previous adoption of such products by the medical community, patients, and third-party payors. Additionally, in

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some instances, insurers and other third-party payors seek to encourage the use of generic products, which makes branded products, such as is planned for our drug candidates upon commercialization, potentially less attractive, from a cost perspective, to buyers.

We recognize that other companies, including large pharmaceutical companies, may be developing or have plans to develop products and technologies that may compete with ours. Many of our competitors have substantially greater financial, technical, and human resources than we have. In addition, many of our competitors have significantly greater experience than we have in undertaking preclinical studies and human clinical trials of new pharmaceutical products, obtaining FDA and other regulatory approvals of products for use in health care and manufacturing, and marketing and selling approved products. Our competitors may discover, develop or commercialize products or other novel technologies that are more effective, safer or less costly than any that we are developing. Our competitors may also obtain FDA or other regulatory approval for their products more rapidly than we may obtain approval for ours.

We anticipate that the competition with our drug candidate, tilsotolimod, and technologies will be based on a number of factors including product efficacy, safety, availability, and price. The timing of market introduction of tilsotolimod and competitive products will also affect competition among products. We expect the relative speed with which we can develop tilsotolimod, complete the clinical trials and approval processes, and supply commercial quantities of the products to the market to be important competitive factors. Our competitive position will also depend upon our ability to attract and retain qualified personnel, to obtain patent protection or otherwise develop proprietary products or processes, protect our intellectual property, and to secure sufficient capital resources for the period between technological conception and commercial sales.

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Government Regulation

Government authorities in the United States, at the federal, state and local level, and in other countries and jurisdictions, including the European Union, extensively regulate, among other things, the research, development, testing, manufacture, quality control, approval, packaging, storage, recordkeeping, labeling, advertising, promotion, distribution, marketing, pricing, post-approval monitoring and reporting, and import and export of pharmaceutical products. The processes for obtaining regulatory approvals in the United States and in foreign countries and jurisdictions, along with subsequent compliance with applicable statutes and regulations and other regulatory authorities, require the expenditure of substantial time and financial resources.

Review and Approval of Drugs in the United States

In the United States, the FDA regulates drugs under the Federal Food, Drug, and Cosmetic Act, or FDCA, and associated implementing regulations. The failure to comply with the FDCA and other applicable U.S. requirements at any time during the product development process, approval process or after approval may subject an applicant and/or sponsor to a variety of administrative or judicial sanctions, including refusal by the FDA to approve pending applications, withdrawal of an approval, imposition of a clinical hold, issuance of warning letters and other types of letters, product recalls, product seizures, total or partial suspension of production or distribution, injunctions, fines, refusals of government contracts, restitution, disgorgement of profits, or civil or criminal investigations and penalties brought by the FDA and the Department of Justice, or DOJ, or other governmental entities, including state agencies.

An applicant seeking approval to market and distribute a new drug product in the United States must typically undertake the following:

- completion of preclinical laboratory tests, animal studies and formulation studies in compliance with the FDA's good laboratory practice, or GLP, regulations;

- submission to the FDA of an IND, which must take effect before human clinical trials may begin in the United States;

- approval by an independent institutional review board, or IRB, representing each clinical site before each clinical trial may be initiated;

- performance of adequate and well-controlled human clinical trials in accordance with good clinical practices, or GCP, to establish the safety and efficacy of the proposed drug product for each indication;

- preparation and submission to the FDA of a new drug application, or NDA;

- review of the product candidate by an FDA advisory committee, where appropriate or if applicable;

- satisfactory completion of one or more FDA inspections of the manufacturing facility or facilities at which the product, or components thereof, are produced to assess compliance with cGMP requirements and to assure that the facilities, methods and controls are adequate to preserve the product's identity, strength, quality and purity;

- satisfactory completion of FDA audits of clinical trial sites to assure compliance with GCPs and the integrity of the clinical data;

- payment of user fees and securing FDA approval of the NDA; and

- compliance with any post-approval requirements, including Risk Evaluation and Mitigation Strategies, or REMS, where applicable, and post-approval studies required by the FDA.

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Preclinical Studies

Before an applicant begins testing a product candidate with potential therapeutic value in humans, the product candidate enters the preclinical testing stage. Preclinical studies include laboratory evaluation of the purity and stability of the manufactured drug substance or active pharmaceutical ingredient and the formulated drug or drug product, as well as in vitro and animal studies to assess the safety and activity of the drug for initial testing in humans and to establish a rationale for therapeutic use. The conduct of preclinical studies is subject to federal regulations and requirements, including GLP regulations. The results of the preclinical tests, together with manufacturing information, analytical data, any available clinical data or literature and plans for clinical studies, among other things, are submitted to the FDA as part of an IND. Additional preclinical testing, such as animal tests of reproductive adverse events and carcinogenicity, may continue after the IND is submitted.

Human Clinical Studies in Support of an NDA

Clinical trials involve the administration of the investigational product to human subjects under the supervision of qualified investigators in accordance with GCP requirements, which include, among other things, the requirement that all research subjects provide their informed consent in writing before their participation in any clinical trial. Clinical trials are conducted under written study protocols detailing, among other things, the objectives of the study, inclusion and exclusion criteria, the parameters to be used in monitoring safety and the effectiveness criteria to be evaluated. A protocol for each clinical trial and any subsequent protocol amendments must be submitted to the FDA as part of the IND. An IND is an exemption from the FDCA that allows an unapproved product candidate to be shipped in interstate commerce for use in an investigational clinical trial and a request for FDA authorization to administer such investigational product to humans. An IND automatically becomes effective 30 days after receipt by the FDA, unless before that time the FDA raises concerns or questions related to a proposed clinical trial and places the trial on clinical hold or partial clinical hold. In such a case, the IND sponsor and the FDA must resolve any outstanding concerns before the clinical trial can begin.

Typically, the FDA will require one IND for early development studies where the sponsor is uncertain of the indication or dosage form of the proposed product, where the drug is being developed for closely related indications within a single review division at FDA, or where there are multiple closely-related routes of administration using the same dosage formulation. On the other hand, multiple INDs may be required where there are two or more unrelated conditions being developed or where multiple dosage forms are being extensively investigated or where multiple routes of administration are being evaluated.

In addition to the foregoing IND requirements, an IRB representing each institution participating in the clinical trial must review and approve the plan for any clinical trial before it commences at that institution, and the IRB must conduct continuing review and reapprove the study at least annually. The IRB must review and approve, among other things, the study protocol and informed consent information to be provided to study subjects. An IRB must operate in compliance with FDA regulations. Information about certain clinical trials must be submitted within specific

timeframes to the National Institutes of Health for public dissemination on their ClinicalTrials.gov website.

Additionally, some trials are overseen by an independent group of qualified experts organized by the trial sponsor, known as a data monitoring committee, or DMC. This group provides recommendations as to whether a trial should move forward at designated check points based on access that only the group maintains to available data from the study. Suspension or termination of development during any phase of clinical trials can occur if it is determined that the participants or patients are being exposed to an unacceptable health risk. Other reasons for suspension or termination may be made by us based on evolving business objectives and/or competitive climate.

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

Phase 1: The drug is initially introduced into healthy human subjects or patients with the target disease (e.g. cancer) or condition and tested for safety, dosage tolerance, absorption, metabolism, distribution, excretion and, if possible, to gain an early indication of its effectiveness and to determine optimal dosage.

Phase 2: The drug is administered to a limited patient population to identify possible adverse effects and safety risks, to preliminarily evaluate the efficacy of the product for specific targeted diseases and to determine dosage tolerance and optimal dosage.

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Phase 3: The drug is administered to an expanded patient population, generally at geographically dispersed clinical trial sites, in well-controlled clinical trials to generate enough data to statistically evaluate the efficacy and safety of the product for approval, to establish the overall risk-benefit profile of the product, and to provide adequate information for the labeling of the product.

Progress reports detailing the results of the clinical trials must be submitted at least annually to the FDA and more frequently if serious adverse events occur. In addition, IND safety reports must be submitted to the FDA for any of the following: serious and unexpected suspected adverse reactions; findings from other studies or animal or in vitro testing that suggest a significant risk in humans exposed to the drug; and any clinically important increase in the case of a serious suspected adverse reaction over that listed in the protocol or investigator brochure. Phase 1, Phase 2 and Phase 3 clinical trials may not be completed successfully within any specified period, or at all. Furthermore, the FDA, the sponsor or the data monitoring committee for a clinical trial may suspend or terminate the clinical trial at any time on various grounds, including a finding that the research subjects are being exposed to an unacceptable health risk. Similarly, an IRB can suspend or terminate approval of a clinical trial at its institution, or an institution it represents, if the clinical trial is not being conducted in accordance with the IRB's requirements or if the drug has been associated with unexpected serious harm to patients. The FDA will typically inspect one or more clinical sites to assure compliance with GCP and the integrity of the clinical data submitted.

Section 505(b)(2) NDAs

NDAs for most new drug products are based on two full clinical studies which must contain substantial evidence of the safety and efficacy of the proposed new product. These applications are submitted under Section 505(b)(1) of the FDCA. The FDA is, however, authorized to approve an alternative type of NDA under Section 505(b)(2) of the FDCA. This type of application allows the applicant to rely, in part, on the FDA's previous findings of safety and efficacy for a similar product, or published literature. Specifically, Section 505(b)(2) applies to NDAs for a drug for which the investigations made to show whether or not the drug is safe for use and effective in use and relied upon by the applicant for approval of the application "were not conducted by or for the applicant and for which the applicant has not obtained a right of reference or use from the person by or for whom the investigations were conducted."

Thus, Section 505(b)(2) authorizes the FDA to approve an NDA based on safety and effectiveness data that were not developed by the applicant. NDAs filed under Section 505(b)(2) may provide an alternate and potentially more expeditious pathway to FDA approval for new or improved formulations or new uses of previously approved products. If the Section 505(b)(2) applicant can establish that reliance on the FDA's previous approval is scientifically appropriate, the applicant may eliminate the need to conduct certain preclinical or clinical studies of the new product. The FDA may also require companies to perform additional studies or measurements to support the change from the approved product. The FDA may then approve the new drug candidate for all or some of the label indications for which the referenced product has been approved, as well as for any new indication sought by the Section 505(b)(2) applicant.

Submission of an NDA to the FDA

Assuming successful completion of required clinical testing and other requirements, the results of the preclinical and clinical studies, together with detailed information relating to the product's chemistry, manufacture, controls and proposed labeling, among other things, are submitted to the FDA as part of an NDA requesting approval to market the drug product for one or more indications. Under federal law, the submission of most NDAs is subject to an application user fee, which for federal fiscal year 2018 is $2,421,495 for an application requiring clinical data. The sponsor of an approved NDA is also subject to an annual program fee, which for fiscal year 2018 is $304,162. Exceptions or waivers for these fees exist for a small company (fewer than 500 employees, including employees and affiliates) satisfying certain requirements and products with orphan drug designation for a particular indication are not subject to a fee provided there are no other intended uses in the NDA.

The FDA conducts a preliminary review of an NDA within 60 calendar days of its receipt and strives to inform the sponsor by the 74th day after the FDA's receipt of the submission to determine whether the application is sufficiently complete to permit substantive review. The FDA may request additional information rather than accept an NDA for filing. In this event, the application must be resubmitted with the additional information. The resubmitted application is also subject to review before the FDA accepts it for filing. Once the submission is accepted for filing, the FDA begins an in-depth substantive review.

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The FDA has agreed to specified performance goals in the review process of NDAs. Under the agreement, 90% of applications seeking approval of New Molecular Entities, or NMEs, are meant to be reviewed within ten months from the date on which the FDA accepts the NDA for filing, and 90% of applications for NMEs that have been designated for "priority review" are meant to be reviewed within six months of the filing date. For applications seeking approval of drugs that are not NMEs, the ten-month and six-month review periods run from the date that the FDA receives the application. The review process may be extended by the FDA for three additional months to consider new information or clarification provided by the applicant to address an outstanding deficiency identified by the FDA following the original submission.

Before approving an NDA, the FDA typically will inspect the facility or facilities where the product is or will be manufactured. These pre-approval inspections cover all facilities associated with an NDA submission, including drug component manufacturing (such as active pharmaceutical ingredients), finished drug product manufacturing, and control testing laboratories. The FDA will not approve an application unless it determines that the manufacturing processes and facilities are in compliance with cGMP requirements and adequate to assure consistent production of the product within required specifications. Additionally, before approving an NDA, the FDA will typically inspect one or more clinical sites to assure compliance with GCP.

In addition, as a condition of approval, the FDA may require an applicant to develop a REMS. REMS use risk minimization strategies beyond the professional labeling to ensure that the benefits of the product outweigh the potential risks. To determine whether a REMS is needed, the FDA will consider the size of the population likely to use the product, seriousness of the disease, expected benefit of the product, expected duration of treatment, seriousness of known or potential adverse events, and whether the product is a new molecular entity. REMS can include medication guides, physician communication plans for healthcare professionals, and elements to assure safe use, or ETASU. ETASU may include, but are not limited to, special training or certification for prescribing or dispensing, dispensing only under certain circumstances, special monitoring, and the use of patient registries. The FDA may require a REMS before approval or post-approval if it becomes aware of a serious risk associated with use of the product. The requirement for a REMS can materially affect the potential market and profitability of a product.

The FDA is required to refer an application for a novel drug to an advisory committee or explain why such referral was not made. Typically, an advisory committee is a panel of independent experts, including clinicians and other scientific experts, that reviews, evaluates and provides 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.

Fast Track, Breakthrough Therapy and Priority Review Designations

The FDA is authorized to designate certain products for expedited review if they are intended to address an unmet medical need in the treatment of a serious or life-threatening disease or condition. These programs are fast track designation, breakthrough therapy designation and priority review designation.

Specifically, the FDA may designate a product for fast track review if it is intended, whether alone or in combination with one or more other drugs, 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. For fast track products, sponsors may have greater interactions with the FDA and the FDA may initiate review of sections of a fast track product's NDA before the application is complete. This rolling review may be available if the FDA determines, after preliminary evaluation of clinical data submitted by the sponsor, that a fast track product may be effective. The sponsor must also provide, and the FDA must approve, a schedule for the submission of the remaining information and the sponsor must pay applicable user fees. However, the FDA's time period goal for reviewing a fast track application does not begin until the last section of the NDA is submitted. In addition, the fast track designation may be withdrawn by the FDA if the FDA believes that the designation is no longer supported by data emerging in the clinical trial process.

Second, in 2012, Congress enacted the Food and Drug Administration Safety and Innovation Act, or FDASIA. This law established a new regulatory scheme allowing for expedited review of products designated as "breakthrough therapies." A product may be designated as a breakthrough therapy if it is intended, either 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 the product may demonstrate substantial improvement over existing

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therapies on one or more clinically significant endpoints, such as substantial treatment effects observed early in clinical development. The FDA may take certain actions with respect to breakthrough therapies, including holding meetings with the sponsor throughout the development process; providing timely advice to the product sponsor regarding development and approval; involving more senior staff in the review process; assigning a cross-disciplinary project lead for the review team; and taking other steps to design the clinical trials in an efficient manner.

Third, the FDA may designate a product for priority review if it is a drug that treats a serious condition and, if approved, would provide a significant improvement in safety or effectiveness. The FDA determines, on a case-by-case basis, whether the proposed drug represents a significant improvement when compared with other available therapies. Significant improvement may be illustrated by evidence of increased effectiveness in the treatment of a condition, elimination or substantial reduction of a treatment-limiting drug reaction, documented enhancement of patient compliance that may lead to improvement in serious outcomes, and evidence of safety and effectiveness in a new subpopulation. A priority designation is intended to direct overall attention and resources to the evaluation of such applications, and to shorten the FDA's goal for taking action on a marketing application from ten months to six months.

Accelerated Approval Pathway

The FDA may grant accelerated approval to a drug for a serious or life-threatening condition that provides meaningful therapeutic advantage to patients over existing treatments based upon a determination that the drug has an effect on a surrogate endpoint that is reasonably likely to predict clinical benefit. The FDA may also grant accelerated approval for such a condition when the product has an effect on an intermediate clinical endpoint that can be measured earlier than an effect on irreversible morbidity or mortality, or IMM, and 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. Drugs granted accelerated approval must meet the same statutory standards for safety and effectiveness as those granted traditional approval.

For the purposes of accelerated approval, a surrogate endpoint is a marker, such as a laboratory measurement, radiographic image, physical sign, or other measure that is thought to predict clinical benefit, but is not itself a measure of clinical benefit. Surrogate endpoints can often be measured more easily or more rapidly than clinical endpoints. An intermediate clinical endpoint is a measurement of a therapeutic effect that is considered reasonably likely to predict the clinical benefit of a drug, such as an effect on IMM. The FDA has limited experience with accelerated approvals based on intermediate clinical endpoints, but has indicated that such endpoints generally may support accelerated approval where the therapeutic effect measured by the endpoint is not itself a clinical benefit and basis for traditional approval, if there is a basis for concluding that the therapeutic effect is reasonably likely to predict the ultimate clinical benefit of a drug.

The accelerated approval pathway is most often used in settings in which the course of a disease is long and an extended period of time is required to measure the intended clinical benefit of a drug, even if the effect on the

surrogate or intermediate clinical endpoint occurs rapidly. Thus, accelerated approval has been used extensively in the development and approval of drugs for treatment of a variety of cancers in which the goal of therapy is generally to improve survival or decrease morbidity and the duration of the typical disease course requires lengthy and sometimes large trials to demonstrate a clinical or survival benefit.

The accelerated approval pathway is usually contingent on a sponsor's agreement to conduct, in a diligent manner, additional post-approval confirmatory studies to verify and describe the drug's clinical benefit. As a result, a drug candidate approved on this basis is subject to rigorous post-marketing compliance requirements, including the completion of Phase 4 or post-approval clinical trials to confirm the effect on the clinical endpoint. Failure to conduct required post-approval studies, or confirm a clinical benefit during post-marketing studies, would allow the FDA to withdraw the drug from the market on an expedited basis. All promotional materials for drug candidates approved under accelerated regulations are subject to prior review by the FDA.

The FDA's Decision on an NDA

On the basis of the FDA's evaluation of the NDA and accompanying information, including the results of the inspection of the manufacturing facilities, the FDA may issue an approval letter or a complete response letter. An

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approval letter authorizes commercial marketing of the product with specific prescribing information for specific indications. A complete response letter generally outlines the deficiencies in the submission and may require substantial additional testing or information in order for the FDA to reconsider the application. If and when those deficiencies have been addressed to the FDA's satisfaction in a resubmission of the NDA, the FDA will issue an approval letter. The FDA has committed to reviewing such resubmissions in two or six months depending on the type of information included. Even with submission of this additional information, the FDA ultimately may decide that the application does not satisfy the regulatory criteria for approval.

If the FDA approves a product, it may limit the approved indications for use for the product, require that contraindications, warnings or precautions be included in the product labeling, require that post-approval studies, including Phase 4 clinical trials, be conducted to further assess the drug's safety after approval, require testing and surveillance programs to monitor the product after commercialization, or impose other conditions, including distribution restrictions or other risk management mechanisms, including REMS, which can materially affect the potential market and profitability of the product. The FDA may prevent or limit further marketing of a product based on the results of post-market studies or surveillance programs. After approval, many types of changes to the approved product, such as adding new indications, manufacturing changes and additional labeling claims, are subject to further testing requirements and FDA review and approval.

Post-Approval Requirements

Drugs manufactured or distributed pursuant to FDA approvals are subject to pervasive and continuing regulation by the FDA, including, among other things, requirements relating to recordkeeping, periodic reporting, product sampling and distribution, advertising and promotion and reporting of adverse experiences with the product. After approval, most changes to the approved product, such as adding new indications or other labeling claims, are subject to prior FDA review and approval. There also are continuing, annual user fee requirements for any marketed products and the establishments at which such products are manufactured, as well as new application fees for supplemental applications with clinical data.

In addition, drug manufacturers and other entities involved in the manufacture and distribution of approved drugs are required to register their establishments with the FDA and state agencies, and are subject to periodic unannounced inspections by the FDA and these state agencies for compliance with cGMP requirements. Changes to the manufacturing process are strictly regulated and often require prior FDA approval before being implemented. FDA regulations also require investigation and correction of any deviations from cGMP and impose reporting and documentation requirements upon the sponsor and any third-party manufacturers that the sponsor may decide to use. Accordingly, manufacturers must continue to expend time, money, and effort in the area of production and quality control to maintain cGMP compliance.

Once an approval is granted, the FDA may withdraw the approval if compliance with regulatory requirements and standards is not maintained or if problems occur after the product reaches the market. Later discovery of previously

unknown problems with a product, including adverse events of unanticipated severity or frequency, or with manufacturing processes, or failure to comply with regulatory requirements, may result in revisions to the approved labeling to add new safety information; imposition of post-market studies or clinical trials to assess new safety risks; or imposition of distribution or other restrictions under a REMS program. Other potential consequences include, among other things:

- restrictions on the marketing or manufacturing of the product, suspension of the approval, complete withdrawal of the product from the market or product recalls;

- fines, warning letters or holds on post-approval clinical trials;

- refusal of the FDA to approve pending NDAs or supplements to approved NDAs, or suspension or revocation of product license approvals;

- product seizure or detention, or refusal to permit the import or export of products; or

- injunctions or the imposition of civil or criminal penalties.

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The FDA strictly regulates the marketing, labeling, advertising and promotion of prescription drug products placed on the market. This regulation includes, among other things, standards and regulations for direct-to-consumer advertising, communications regarding unapproved uses, industry-sponsored scientific and educational activities, and promotional activities involving the Internet and social media. Promotional claims about a drug's safety or effectiveness are prohibited before the drug is approved. After approval, a drug product generally may not be promoted for uses that are not approved by the FDA, as reflected in the product's prescribing information. In the United States, health care professionals are generally permitted to prescribe drugs for such uses not described in the drug's labeling, known as off-label uses, because the FDA does not regulate the practice of medicine. However, FDA regulations impose rigorous restrictions on manufacturers' communications, prohibiting the promotion of off-label uses. It may be permissible, under very specific, narrow conditions, for a manufacturer to engage in nonpromotional, non-misleading communication regarding off-label information, such as distributing scientific or medical journal information.

If a company is found to have promoted off-label uses, it may become subject to adverse public relations and administrative and judicial enforcement by the FDA, the Department of Justice, or the Office of the Inspector General of the Department of Health and Human Services, as well as state authorities. This could subject a company to a range of penalties that could have a significant commercial impact, including civil and criminal fines and agreements that materially restrict the manner in which a company promotes or distributes drug products. The federal government has levied large civil and criminal fines against companies for alleged improper promotion, and has also requested that companies enter into consent decrees or permanent injunctions under which specified promotional conduct is changed or curtailed.

In addition, the distribution of prescription pharmaceutical products is subject to the Prescription Drug Marketing Act, or PDMA, and its implementing regulations, as well as the Drug Supply Chain Security Act, or DSCA, which regulate the distribution and tracing of prescription drug samples at the federal level, and set minimum standards for the regulation of drug distributors by the states. The PDMA, its implementing regulations and state laws limit the distribution of prescription pharmaceutical product samples and the DSCA imposes requirements to ensure accountability in distribution and to identify and remove counterfeit and other illegitimate products from the market.

Abbreviated New Drug Applications for Generic Drugs

In 1984, with passage of the Hatch-Waxman Amendments to the FDCA, Congress authorized the FDA to approve generic drugs that are the same as drugs previously approved by the FDA under the NDA provisions of the statute. To obtain approval of a generic drug, an applicant must submit an abbreviated new drug application, or ANDA, to the agency. In support of such applications, a generic manufacturer may rely on the preclinical and clinical testing previously conducted for a drug product previously approved under an NDA, known as the reference listed drug, or RLD.

Specifically, in order for an ANDA to be approved, the FDA must find that the generic version is identical to the RLD with respect to the active ingredients, the route of administration, the dosage form, and the strength of the drug. At the

same time, the FDA must also determine that the generic drug is “bioequivalent” to the innovator drug. Under the statute, a generic drug is bioequivalent to a RLD if “the rate and extent of absorption of the drug do not show a significant difference from the rate and extent of absorption of the listed drug.”

Upon approval of an ANDA, the FDA indicates whether the generic product is “therapeutically equivalent” to the RLD in its publication “Approved Drug Products with Therapeutic Equivalence Evaluations,” also referred to as the “Orange Book.” Physicians and pharmacists consider a therapeutic equivalent generic drug to be fully substitutable for the RLD. In addition, by operation of certain state laws and numerous health insurance programs, the FDA’s designation of therapeutic equivalence often results in substitution of the generic drug without the knowledge or consent of either the prescribing physician or patient.

Under the Hatch-Waxman Amendments, the FDA may not approve an ANDA until any applicable period of non-patent exclusivity for the RLD has expired. The FDCA provides a period of five years of non-patent data exclusivity for a new drug containing a new chemical entity. For the purposes of this provision, a new chemical entity, or NCE, is a drug that contains no active moiety that has previously been approved by the FDA in any other NDA. An active moiety is the molecule or ion responsible for the physiological or pharmacological action of the drug substance. In cases where such exclusivity has been granted, an ANDA may not be filed with the FDA until the

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expiration of five years unless the submission is accompanied by a Paragraph IV certification, in which case the applicant may submit its application four years following the original product approval. The FDCA also provides for a period of three years of exclusivity if the NDA includes reports of one or more new clinical investigations, other than bioavailability or bioequivalence studies, that were conducted by or for the applicant and are essential to the approval of the application. This three-year exclusivity period often protects changes to a previously approved drug product, such as a new dosage form, route of administration, combination or indication.

The FDA must establish a priority review track for certain generic drugs, requiring the FDA to review a drug application within eight (8) months for a drug that has three (3) or fewer approved drugs listed in the Orange Book and is no longer protected by any patent or regulatory exclusivities, or is on the FDA's drug shortage list. The new legislation also authorizes FDA to expedite review of ''competitor generic therapies'' or drugs with inadequate generic competition, including holding meetings with or providing advice to the drug sponsor prior to submission of the application.

Hatch-Waxman Patent Certification and the 30-Month Stay

Upon approval of an NDA or a supplement thereto, NDA sponsors are required to list with the FDA each patent with claims that cover the applicant's product or an approved method of using the product. Each of the patents listed by the NDA sponsor is published in the Orange Book. When an Abbreviated New Drug Application, or ANDA, or 505(b)(2) applicant files its application with the FDA, the applicant is required to certify to the FDA concerning any patents listed for the reference product in the Orange Book, except for patents covering methods of use for which the ANDA applicant is not seeking approval.

Specifically, the applicant must certify with respect to each patent that:

- the required patent information has not been filed;
- the listed patent has expired;
- the listed patent has not expired, but will expire on a particular date and approval is sought after patent expiration; or
- the listed patent is invalid, unenforceable or will not be infringed by the new product.

A certification that the new product will not infringe the already approved product's listed patents or that such patents are invalid or unenforceable is called a Paragraph IV certification. If the applicant does not challenge the listed patents or indicates that it is not seeking approval of a patented method of use, the application will not be approved until all the listed patents claiming the referenced product have expired (other than method of use patents involving indications for which the ANDA applicant is not seeking approval).

If the ANDA or 505(b)(2) applicant has provided a Paragraph IV certification to the FDA, the applicant must also send notice of the Paragraph IV certification to the NDA and patent holders once the ANDA or 505(b)(2) application has been accepted for filing by the FDA. The NDA and patent holders may then initiate a patent infringement lawsuit in response to the notice of the Paragraph IV certification. The filing of a patent infringement lawsuit within 45 days after the receipt of a Paragraph IV certification automatically prevents the FDA from approving the ANDA or 505(b)(2) application until the earlier of 30 months after the receipt of the Paragraph IV notice, expiration of the patent, or a decision in the infringement case that is favorable to the ANDA applicant.

Pediatric Studies and Exclusivity

Under the Pediatric Research Equity Act of 2003, an NDA or supplement thereto must contain data that are adequate to assess the safety and effectiveness of the drug 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. With enactment of the FDASIA in 2012, sponsors must also submit pediatric study plans prior to the assessment data. Those plans must contain an outline of the proposed pediatric study or studies the applicant plans to conduct, including study objectives and design, any deferral or waiver requests, and other information required by regulation. The applicant, the FDA, and the FDA's internal review committee must then

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review the information submitted, consult with each other, and agree upon a final plan. The FDA or the applicant may request an amendment to the plan at any time.

For drugs intended to treat a serious or life-threatening disease or condition, the FDA must, upon the request of an applicant, meet to discuss preparation of the initial pediatric study plan or to discuss deferral or waiver of pediatric assessments. In addition, FDA will meet early in the development process to discuss pediatric study plans with sponsors and FDA must meet with sponsors by no later than the end-of-phase 1 meeting for serious or life-threatening diseases and by no later than ninety (90) days after FDA's receipt of the study plan.

The FDA may, on its own initiative or at the request of the applicant, grant deferrals for submission of some or all pediatric data until after approval of the product for use in adults, or full or partial waivers from the pediatric data requirements. Additional requirements and procedures relating to deferral requests and requests for extension of deferrals are contained in the FDASIA. Unless otherwise required by regulation, the pediatric data requirements do not apply to products with orphan designation.

Pediatric exclusivity is another type of non-patent marketing exclusivity in the United States and, if granted, provides for the attachment of an additional six months of marketing protection to the term of any existing regulatory exclusivity, including the non-patent and orphan exclusivity. This six-month exclusivity may be granted if an NDA sponsor submits pediatric data that fairly respond to a written request from the FDA for such data. The data do not need to show the product to be effective in the pediatric population studied; rather, if the clinical trial is deemed to fairly respond to the FDA's request, the additional protection is granted. If reports of requested pediatric studies are submitted to and accepted by the FDA within the statutory time limits, whatever statutory or regulatory periods of exclusivity or patent protection cover the product are extended by six months. This is not a patent term extension, but it effectively extends the regulatory period during which the FDA cannot approve another application.

Orphan Drug Designation and Exclusivity

Under the Orphan Drug Act, the FDA may designate a drug product as an "orphan drug" if it is intended to treat a rare disease or condition (generally meaning that it affects fewer than 200,000 individuals in the United States, or more in cases in which there is no reasonable expectation that the cost of developing and making a drug product available in the United States for treatment of the disease or condition will be recovered from sales of the product). A company must request orphan product designation before submitting an NDA. If the request is granted, the FDA will disclose the identity of the therapeutic agent and its potential use. Orphan product designation does not convey any advantage in or shorten the duration of the regulatory review and approval process, although it does convey certain advantages such as tax benefits and exemption from PDUFA fees.

If a product with orphan status receives the first FDA approval for the disease or condition for which it has such designation or for a select indication or use within the rare disease or condition for which it was designated, the product generally will receive orphan product exclusivity. Orphan product exclusivity means that the FDA may not approve any other applications for the same product for the same indication for seven years, except in certain limited circumstances. Competitors may receive approval of different products for the indication for which the orphan product has exclusivity and may obtain approval for the same product but for a different indication. If a drug or drug product designated as an orphan product ultimately receives marketing approval for an indication broader than what was designated in its orphan product application, it may not be entitled to exclusivity.

Orphan drug exclusivity will not bar approval of another product under certain circumstances, including if a subsequent product with the same drug for the same condition is shown to be clinically superior to the approved product on the basis of greater efficacy or safety, or providing a major contribution to patient care, or if the company with orphan drug exclusivity is not able to meet market demand. This is the case despite an earlier court opinion holding that the Orphan Drug Act unambiguously required the FDA to recognize orphan exclusivity regardless of a showing of clinical superiority.

Patent Term Restoration and Extension

A patent claiming a new drug product may be eligible for a limited patent term extension under the Drug Price Competition and Patent Term Restoration Act of 1984, which permits a patent restoration of up to five years for patent term lost during product development and the FDA regulatory review. The restoration period granted is typically one-half the time between the effective date of an IND and the submission date of an NDA, plus the time

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between the submission date of an NDA and the ultimate approval date. Patent term restoration cannot be used to extend the remaining term of a patent past a total of 14 years from the product's approval date. Only one patent applicable to an approved drug product is eligible for the extension, and the application for the extension must be submitted prior to the expiration of the patent in question. A patent that covers multiple drugs for which approval is sought can only be extended in connection with one of the approvals. The USPTO reviews and approves the application for any patent term extension or restoration in consultation with the FDA.

The 21st Century Cures Act

On December 13, 2016, President Obama signed the 21st Century Cures Act, or the Cures Act, into law. The Cures Act is designed to modernize and personalize healthcare, spur innovation and research, and streamline the discovery and development of new therapies through increased federal funding of particular programs. It authorizes increasing funding for FDA to spend on innovation projects. The new law also amends the Public Health Service Act to reauthorize and expand funding for the National Institutes of Health. The Act establishes the NIH Innovation Fund to pay for the cost of development and implementation of a strategic plan, early stage investigators and research. It also charges NIH with leading and coordinating expanded pediatric research. Further, the Cures Act directs the Centers for Disease Control and Prevention to expand surveillance of neurological diseases.

With amendments to the FDCA and the Public Health Service Act, Title III of the Cures Act seeks to accelerate the discovery, development, and delivery of new medicines and medical technologies. To that end, and among other provisions, the Cures Act reauthorizes the priority review voucher program for certain drugs intended to treat rare pediatric diseases; creates a new priority review voucher program for drug applications determined to be material threat medical countermeasure applications; revises the FDCA to streamline review of combination product applications; requires FDA to evaluate the potential use of "real world evidence" to help support approval of new indications for approved drugs; provides a new "limited population" approval pathway for antibiotic and antifungal drugs intended to treat serious or life-threatening infections; and authorizes FDA to designate a drug as a "regenerative advanced therapy," thereby making it eligible for certain expedited review and approval designations.

Review and Approval of Drug Products in the European Union

In order to market any product outside of the United States, a company must also comply with numerous and varying regulatory requirements of other countries and jurisdictions regarding quality, safety and efficacy and governing, among other things, clinical trials, marketing authorization, commercial sales and distribution of drug products. Whether or not it obtains FDA approval for a product, the company would need to obtain the necessary approvals by the comparable foreign regulatory authorities before it can commence clinical trials or marketing of the product in those countries or jurisdictions. The approval process ultimately varies between countries and jurisdictions and can involve additional product testing and additional administrative review periods. The time required to obtain approval in other countries and jurisdictions might differ from and be longer than that required to obtain FDA approval. Regulatory approval in one country or jurisdiction does not ensure regulatory approval in another, but a failure or

delay in obtaining regulatory approval in one country or jurisdiction may negatively impact the regulatory process in others.

Clinical Trial Approval in the EU

Pursuant to the European Clinical Trials Directive, a system for the approval of clinical trials in the European Union has been implemented through national legislation of the member states. Under this system, an applicant must obtain approval from the competent national authority of a European Union member state in which the clinical trial is to be conducted. Furthermore, the applicant may only start a clinical trial after a competent ethics committee has issued a favorable opinion. Clinical trial application must be accompanied by an investigational medicinal product dossier with supporting information prescribed by the European Clinical Trials Directive and corresponding national laws of the member states and further detailed in applicable guidance documents. In April 2014, the EU adopted a new Clinical Trials Regulation, which will be directly applicable to and binding without the need for any national implementing legislation. Under the new coordinated procedure for the approval of clinical trials, the sponsor of a clinical trial will be required to submit a single application for approval of a clinical trial to a reporting EU Member State (RMS) through an EU Portal. The submission procedure will be the same irrespective of whether the clinical trial is to be conducted in a single EU Member State or in more than one EU Member State.

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The Clinical Trials Regulation also aims to streamline and simplify the rules on safety reporting for clinical trials. The Regulation was published on June 16, 2014 but is not expected to apply until 2019.

Orphan Drug Designation and Exclusivity

Regulation 141/2000 provides that a drug shall be designated as an orphan drug if its sponsor can establish: that the product is intended for the diagnosis, prevention or treatment of a life-threatening or chronically debilitating condition affecting not more than five in ten thousand persons in the European Community when the application is made, or that the product is intended for the diagnosis, prevention or treatment of a life-threatening, seriously debilitating or serious and chronic condition in the European Community and that without incentives it is unlikely that the marketing of the drug in the European Community would generate sufficient return to justify the necessary investment. For either of these conditions, the applicant must demonstrate that there exists no satisfactory method of diagnosis, prevention or treatment of the condition in question that has been authorized in the European Community or, if such method exists, the drug will be of significant benefit to those affected by that condition.

Regulation 847/2000 sets out criteria and procedures governing designation of orphan drugs in the EU. Specifically, an application for designation as an orphan product can be made any time prior to the filing of an application for approval to market the product. Marketing authorization for an orphan drug leads to a ten-year period of market exclusivity. This period may, however, be reduced to six years if, at the end of the fifth year, it is established that the product no longer meets the criteria for orphan drug designation, for example because the product is sufficiently profitable not to justify market exclusivity. Market exclusivity can be revoked only in very selected cases, such as consent from the marketing authorization holder, inability to supply sufficient quantities of the product, demonstration of “clinically relevant superiority” by a similar medicinal product, or, after a review by the Committee for Orphan Medicinal Products, requested by a member state in the fifth year of the marketing exclusivity period (if the designation criteria are believed to no longer apply). Medicinal products designated as orphan drugs pursuant to Regulation 141/2000 shall be eligible for incentives made available by the European Community and by the member states to support research into, and the development and availability of, orphan drugs.

Pharmaceutical Coverage, Pricing and Reimbursement

Significant uncertainty exists as to the coverage and reimbursement status of products approved by the FDA and other government authorities. Sales of products will depend, in part, on the extent to which the costs of the products will be covered by third-party payors, including government health programs in the United States such as Medicare and Medicaid, commercial health insurers and managed care organizations. The process for determining whether a payor will provide coverage for a product may be separate from the process for setting the price or reimbursement rate that the payor will pay for the product once coverage is approved. Third-party payors are increasingly challenging the prices charged, examining the medical necessity, and reviewing the cost-effectiveness of medical products and services and imposing controls to manage costs. Third-party payors may also limit coverage to specific products on an approved list, or formulary, which might not include all of the approved products for a particular indication.

In order to secure coverage and reimbursement for any product that might be approved for sale, a company may need to conduct expensive pharmacoeconomic studies in order to demonstrate the medical necessity and cost-effectiveness of the product, in addition to the costs required to obtain FDA or other comparable regulatory approvals. A payor's decision to provide coverage for a drug product does not imply that an adequate reimbursement rate will be approved. Third-party reimbursement may not be sufficient to maintain price levels high enough to realize an appropriate return on investment in product development.

The containment of healthcare costs also has become a priority of federal, state and foreign governments and the prices of drugs have been a focus in this effort. Governments have shown significant interest in implementing cost-containment programs, including price controls, restrictions on reimbursement and requirements for substitution of generic products. Adoption of price controls and cost-containment measures, and adoption of more restrictive policies in jurisdictions with existing controls and measures, could further limit a company's revenue generated from the sale of any approved products. 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 a company or its collaborators receive marketing approval, less favorable coverage

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policies and reimbursement rates may be implemented in the future. In the European Union, pricing and reimbursement schemes vary widely from country to country. Some countries provide that drug products may be marketed only after a reimbursement price has been agreed. Some countries may require the completion of additional studies that compare the cost-effectiveness of a particular drug candidate to currently available therapies, or so-called health technology assessments, in order to obtain reimbursement or pricing approval. For example, the European Union provides options for its member states to restrict the range of drug products for which their national health insurance systems provide reimbursement and to control the prices of medicinal products for human use. European Union member states may approve a specific price for a drug product or may instead adopt a system of direct or indirect controls on the profitability of the company placing the drug product on the market. Other member states allow companies to fix their own prices for drug products, but monitor and control company profits. The downward pressure on health care costs in general, particularly prescription drugs, has become intense. As a result, increasingly high barriers are being erected to the entry of new products. In addition, in some countries, cross-border imports from low-priced markets exert competitive pressure that may reduce pricing within a country. Any country that has price controls or reimbursement limitations for drug products may not allow favorable reimbursement and pricing arrangements.

Healthcare Law and Regulation

Healthcare providers, physicians and third-party payors play a primary role in the recommendation and prescription of drug products that are granted marketing approval. Arrangements with providers, consultants, third-party payors and customers are subject to broadly applicable fraud and abuse and other healthcare laws and regulations. Such restrictions under applicable federal and state healthcare laws and regulations, include the following:

- the federal Anti-Kickback Statute prohibits, among other things, persons from knowingly and willfully soliciting, offering, receiving or providing remuneration, directly or indirectly, in cash or in kind, to induce or reward either the referral of an individual for, or the purchase, order or recommendation of, any good or service, for which payment may be made, in whole or in part, under a federal healthcare program such as Medicare and Medicaid;

- the federal False Claims Act imposes civil penalties, and provides for civil whistleblower or qui tam actions, against individuals or entities for knowingly presenting, or causing to be presented, to the federal government, claims for payment that are false or fraudulent or making a false statement to avoid, decrease or conceal an obligation to pay money to the federal government, with potential liability including mandatory treble damages and significant per-claim penalties, currently set at $5,500 to $11,000 per false claim;

- the federal Health Insurance Portability and Accountability Act of 1996, or HIPAA, imposes criminal and civil liability for executing a scheme to defraud any healthcare benefit program or making false statements relating to healthcare matters;

- HIPAA, as amended by the Health Information Technology for Economic and Clinical Health Act and their respective implementing regulations, including the Final Omnibus Rule published in January 2013, also imposes

obligations, including mandatory contractual terms, with respect to safeguarding the privacy, security and transmission of individually identifiable health information;

- the federal false statements statute prohibits knowingly and willfully falsifying, concealing or covering up a material fact or making any materially false statement in connection with the delivery of or payment for healthcare benefits, items or services;

- the federal transparency requirements under the Health Care Reform Law, known as the federal Physician Payments Sunshine Act, require manufacturers of drugs, devices, biologics and medical supplies to report to the Centers for Medicare & Medicaid Services, or CMS, within the Department of Health and Human Services information related to payments and other transfers of value to physicians and teaching hospitals and physician ownership and investment interests held by physicians and their immediate family members; and

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- analogous state and foreign laws and regulations, such as state anti-kickback and false claims laws, may apply to sales or marketing arrangements and claims involving healthcare items or services reimbursed by non-governmental third-party payors, including private insurers.

Some state laws require pharmaceutical companies to comply with the pharmaceutical industry's voluntary compliance guidelines and the relevant compliance guidance promulgated by the federal government in addition to requiring drug manufacturers to report information related to payments to physicians and other health care providers or marketing expenditures. State and foreign laws also govern the privacy and security of health information in some circumstances, many of which differ from each other in significant ways and often are not preempted by HIPAA, thus complicating compliance efforts.

Healthcare Reform in the United States

A primary trend in the United States healthcare industry and elsewhere is cost containment. There have been a number of federal and state proposals during the last several years regarding the pricing of pharmaceutical and biopharmaceutical products, limiting coverage and reimbursement for drugs and other medical products, government control and other changes to the healthcare system in the United States.

By way of example, the United States and state governments continue to propose and pass legislation designed to reduce the cost of healthcare. In March 2010, the United States Congress enacted the Patient Protection and Affordable Care Act, or the PPACA, which, among other things, includes changes to the coverage and payment for products under government health care programs. Among the provisions of the PPACA of importance to potential drug candidates are:

- an annual, nondeductible fee on any entity that manufactures or imports specified branded prescription drugs and biologic agents, apportioned among these entities according to their market share in certain government healthcare programs, although this fee would not apply to sales of certain products approved exclusively for orphan indications;
- expansion of eligibility criteria for Medicaid programs by, among other things, allowing states to offer Medicaid coverage to certain individuals with income at or below 133% of the federal poverty level, thereby potentially increasing a manufacturer's Medicaid rebate liability;
- expanded manufacturers' rebate liability under the Medicaid Drug Rebate Program by increasing the minimum rebate for both branded and generic drugs and revising the definition of "average manufacturer price," or AMP, for calculating and reporting Medicaid drug rebates on outpatient prescription drug prices and extending rebate liability to prescriptions for individuals enrolled in Medicare Advantage plans;
- addressed a new methodology by which rebates owed by manufacturers under the Medicaid Drug Rebate Program are calculated for drugs that are inhaled, infused, instilled, implanted or injected;
- expanded the types of entities eligible for the 340B drug discount program;
- established the Medicare Part D coverage gap discount program by requiring manufacturers to provide a 50% (increasing to 70% in 2019) point of sale discount off the negotiated price of applicable brand drugs to eligible beneficiaries during their coverage gap period as a condition for the manufacturers' outpatient drugs to be covered under Medicare Part D;
-

established a new Patient Centered Outcomes Research Institute to oversee, identify priorities in, and conduct comparative clinical effectiveness research, along with funding for such research;

- established the Independent Payment Advisory Board, or IPAB, which has authority to recommend certain changes to the Medicare program to reduce expenditures by the program that could result in reduced payments for prescription drugs. However, the IPAB implementation has been not been clearly defined. The PPACA provided that under certain circumstances, IPAB recommendations will become law unless Congress enacts legislation that will achieve the same or greater Medicare cost savings; and

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- established the Center for Medicare and Medicaid Innovation within CMS to test innovative payment and service delivery models to lower Medicare and Medicaid spending, potentially including prescription drug spending. Funding has been allocated to support the mission of the Center for Medicare and Medicaid Innovation from 2011 to 2019. Other legislative changes have been proposed and adopted since the PPACA was enacted. These changes include the Budget Control Act of 2011, which, among other things, led to aggregate reductions to Medicare payments to providers of up to 2% per fiscal year that started in 2013 and will stay in effect through 2024 unless additional Congressional action is taken, and the American Taxpayer Relief Act of 2012, which, among other things, reduced Medicare payments to several types of providers and increased the statute of limitations period for the government to recover overpayments to providers from three to five years. These new laws may result in additional reductions in Medicare and other healthcare funding and otherwise affect the prices we may obtain for any of our product candidates for which we may obtain regulatory approval or the frequency with which any such product candidate is prescribed or used. Further, there have been several recent U.S. congressional inquiries and proposed state and federal legislation designed to, among other things, bring more transparency to drug pricing, review the relationship between pricing and manufacturer patient programs, reduce the costs of drugs under Medicare and reform government program reimbursement methodologies for drug products.

These healthcare reforms, as well as other healthcare reform measures that may be adopted in the future, may result in additional reductions in Medicare and other healthcare funding, more rigorous coverage criteria, new payment methodologies and additional downward pressure on the price for any approved product and/or the level of reimbursement physicians receive for administering any approved product. Reductions in reimbursement levels may negatively impact the prices or the frequency with which products are prescribed or administered. Any reduction in reimbursement from Medicare or other government programs may result in a similar reduction in payments from private payors. Since enactment of the PPACA, there have been numerous legal challenges and Congressional actions to repeal and replace provisions of the law. In May 2017, the U.S. House of Representatives passed legislation known as the American Health Care Act of 2017. Thereafter, the Senate Republicans introduced and then updated a bill to replace the PPACA known as the Better Care Reconciliation Act of 2017. The Senate Republicans also introduced legislation to repeal the PPACA without companion legislation to replace it, and a “skinny” version of the Better Care Reconciliation Act of 2017. In addition, the Senate considered proposed healthcare reform legislation known as the Graham-Cassidy bill. None of these measures was passed by the U.S. Senate.

The Trump Administration has also taken executive actions to repeal or delay implementation of the PPACA. In January 2017, President Trump signed an Executive Order directing federal agencies with authorities and responsibilities under the PPACA to waive, defer, grant exemptions from, or delay the implementation of any provision of the PPACA that would impose a fiscal or regulatory burden on states, individuals, healthcare providers, health insurers, or manufacturers of pharmaceuticals or medical devices. In October 2017, the President signed a second Executive Order allowing for the use of association health plans and short-term health insurance, which may provide fewer health benefits than the plans sold through the PPACA exchanges. At the same time, the Administration announced that it will discontinue the payment of cost-sharing reduction, or CSR, payments to insurance companies until Congress approves the appropriation of funds for such CSR payments. The loss of the CSR payments is expected to increase premiums on certain policies issued by qualified health plans under the PPACA. A bipartisan bill to appropriate funds for CSR payments was introduced in the Senate, but the future of that bill is uncertain.

More recently, with enactment of the Tax Cuts and Jobs Act of 2017, which was signed by the President on December 22, 2017, Congress repealed the "individual mandate." The repeal of this provision, which requires most Americans to carry a minimal level of health insurance, will become effective in 2019. According to the Congressional Budget Office, the repeal of the individual mandate will cause 13 million fewer Americans to be insured in 2027 and premiums in insurance markets may rise. Additionally, on January 22, 2018, President Trump signed a continuing resolution on appropriations for fiscal year 2018 that delayed the implementation of certain PPACA-mandated fees, including the so-called "Cadillac" tax on certain high cost employer-sponsored insurance plans, the annual fee imposed on certain health insurance providers based on market share, and the medical device excise tax on non-exempt medical devices. The Congress will likely consider other legislation to replace elements of the PPACA, during the next Congressional session.

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Further, there have been several recent U.S. congressional inquiries and proposed federal and proposed and enacted state legislation designed to, among other things, bring more transparency to drug pricing, review the relationship between pricing and manufacturer patient programs, reduce the costs of drugs under Medicare and reform government program reimbursement methodologies for drug products. At the federal level, Congress and the Trump administration have each indicated that it will continue to seek new legislative and/or administrative measures to control drug costs. At the state level, individual states are increasingly aggressive in passing legislation and implementing regulations designed to control pharmaceutical and biological product pricing, including price or patient reimbursement constraints, discounts, restrictions on certain product access and marketing cost disclosure and transparency measures, and, in some cases, designed to encourage importation from other countries and bulk purchasing. In addition, regional health care authorities and individual hospitals are increasingly using bidding procedures to determine what pharmaceutical products and which suppliers will be included in their prescription drug and other health care programs. These measures could reduce the ultimate demand for our products, once approved, or put pressure on our product pricing.

Segment and Geographical Information

We operate in a single operating segment. For segment and geographical financial information, see Note 2 to the financial statements appearing elsewhere in this Annual Report on Form 10-K, which are incorporated herein by reference.

Employees

As of February 15, 2019, we employed 36 individuals, 21 of whom are engaged in research and development activities and seven of whom hold a Ph.D., M.D., or equivalent degree. None of our employees are covered by a collective bargaining agreement, and we consider relations with our employees to be good.

Corporate Information

We were incorporated in Delaware in 1989 and our office headquarters is located at 505 Eagleview Boulevard, Suite 212, Exton, Pennsylvania 19341.

Information Available on the Internet

Our internet address is www.iderapharma.com. The contents of our website are not part of this Annual Report on Form 10-K and our internet address is included in this document as an inactive textual reference. We make available free of charge through our web site our Annual Reports on Form 10-K, Quarterly Reports on Form 10-Q, Current Reports on Form 8-K and amendments to these reports filed or furnished pursuant to Section 13(a) or 15(d) of the Securities Exchange Act of 1934, as amended, or the Exchange Act, as soon as reasonably practicable after we electronically file or furnish such materials to the Securities and Exchange Commission, or the SEC. The SEC maintains an internet site at www.sec.gov containing reports, proxies and information statements and other information regarding issuers that file electronically with the SEC.

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Item 1A. RISK FACTORS.

RISK FACTORS

Investing in our securities involves a high degree of risk. You should carefully consider the risks and uncertainties described below in addition to the other information included or incorporated by reference in this Annual Report on Form 10-K before purchasing our common stock. Our business, financial condition and results of operations could be materially and adversely affected by any of these and currently unknown risks or uncertainties. In that case, the market price of our common stock could decline, and you may lose all or part of your investment in our securities.

Risks Relating to Our Financial Results and Need for Financing

We will need additional financing, which may be difficult to obtain on terms attractive to us or at all. Our failure to obtain necessary financing or doing so on unattractive terms could result in the termination of our operations and the sale and license of our assets or otherwise adversely affect our research and development programs and other operations.

We had cash, cash equivalents and investments of approximately $71.4 million at December 31, 2018. We believe that, based on our current operating plan, our existing cash and cash equivalents will enable us to fund our operations through the one-year period subsequent to the filing date of this Annual Report on Form 10-K. Specifically, we believe that our available funds will be sufficient to enable us to perform the following during this one-year period:

(i) complete enrollment and continue to execute on:
  a) the Phase 1 portion of our ongoing Phase 1/2 clinical trial of tilsotolimod in combination with pembrolizumab in anti-PD1 refractory melanoma (ILLUMINATE-204);
b) the Phase 2 portion of our ongoing Phase 1/2 clinical trial of tilsotolimod in combination with ipilimumab in anti-PD1 refractory melanoma (ILLUMINATE-204);
c) the Phase 3 clinical trial of tilsotolimod in combination with ipilimumab for the treatment of anti-PD1 refractory metastatic melanoma (ILLUMINATE-301); and
d) the Phase 1b monotherapy clinical trial of tilsotolimod in multiple refractory tumor types (ILLUMINATE-101);
(ii) initiate our Phase 2 study of tilsotolimod in combination with nivolumab and ipilimumab for the treatment of certain solid tumors (ILLUMINATE-206);
(iii) fund certain investigator initiated clinical trials of tilsotolimod; and
(iv) maintain our current level of general and administrative expenses in order to support the business.

We expect that we will need to raise additional funds in order to complete our ongoing clinical trials of tilsotolimod and to continue to fund our operations. We are seeking and expect to continue to seek additional funding through collaborations, the sale or license of assets or financings of equity or debt securities. We believe that the key factors that will affect our ability to obtain funding are:

- the results of our clinical development activities in our tilsotolimod program or any other drug candidates we develop on the timelines anticipated;
- the cost, timing and outcome of regulatory reviews;
- competitive and potentially competitive products and technologies and investors' receptivity to tilsotolimod or any other drug candidates we develop and the technology underlying them in light of competitive products and technologies;
- the receptivity of the capital markets to financings by biotechnology companies generally and companies with drug candidates and technologies similar to ours specifically;

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- the receptivity of the capital markets to any in-licensing, product acquisition or other transaction we may enter into; and
- our ability to enter into additional collaborations with biotechnology and pharmaceutical companies and the success of such collaborations.

In addition, increases in expenses or delays in clinical development may adversely impact our cash position and require additional funds or cost reductions.

Financing may not be available to us when we need it or may not be available to us on favorable or acceptable terms or at all. We could be required to seek funds through collaborative alliances or through other means that may require us to relinquish rights to some of our technologies, drug candidates or drugs that we would otherwise pursue on our own. In addition, if we raise additional funds by issuing equity securities, our then existing stockholders may experience dilution. The terms of any financing may adversely affect the holdings or the rights of existing stockholders. An equity financing that involves existing stockholders may cause a concentration of ownership. Debt financing, if available, may involve agreements that include covenants limiting or restricting our ability to take specific actions, such as incurring additional debt, making capital expenditures or declaring dividends, and are likely to include rights that are senior to the holders of our common stock. Any additional debt or equity financing may contain terms which are not favorable to us or to our stockholders, such as liquidation and other preferences, or liens or other restrictions on our assets. As discussed in Note 13 to the financial statements appearing elsewhere in this Annual Report on Form 10-K, additional equity financings may also result in cumulative changes in ownership over a three-year period in excess of 50% which would limit the amount of net operating loss and tax credit carryforwards that we may utilize in any one year.

If we are unable to obtain adequate funding on a timely basis or at all, we will be required to terminate, modify or delay clinical trials of tilsotolimod, or relinquish rights to portions of our technology, drug candidates and/or products.

We have incurred substantial losses and expect to continue to incur losses. We will not be successful unless we reverse this trend.

We have incurred losses in every year since our inception, except for 2002, 2008, and 2009 when our recognition of revenues under license and collaboration agreements resulted in our reporting net income for those years. As of December 31, 2018, we had an accumulated deficit of $664.4 million. Since January 1, 2001, we have primarily been involved in the development of our TLR pipeline. From January 1, 2001 to December 31, 2017, we incurred losses of $404.1 million. We incurred losses of $260.2 million prior to December 31, 2000, during which time we were primarily involved in the development of earlier generation antisense technology. These losses, among other things, have had and will continue to have an adverse effect on our stockholders' equity, total assets and working capital.

We have never had any products of our own available for commercial sale and have received no revenues from the sale of drugs. As of December 31, 2018, substantially all of our revenues have been from collaborative and license agreements. We have devoted substantially all of our efforts to research and development, including clinical trials, and

have not completed development of any drug candidates. Because of the numerous risks and uncertainties associated with developing drugs, we are unable to predict the extent of any future losses, whether or when any of our drug candidates will become commercially available, or when we will become profitable, if at all. We expect to incur substantial operating losses in future periods.

Risks Relating to Our Business, Strategy and Industry

We are depending heavily on the development of our lead TLR-targeted drug candidate, tilsotolimod, in our immuno-oncology program. If we terminate the development of this program or are unable to successfully develop and commercialize tilsotolimod or any other drug candidate, or experience significant delays in doing so, our business may be materially harmed.

We have invested a significant portion of our time and financial resources in the development of TLR-targeted clinical-stage drug candidates as part of our immuno-oncology and rare disease programs. In the future, we intend to invest a significant portion of our time and financial resources in the development of our lead TLR-targeted

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candidate, tilsotolimod, in our immuno-oncology program. For instance, we are conducting (i) a Phase 1/2 clinical trial of tilsotolimod, administered intra-tumorally, in combination with ipilimumab or pembrolizumab in patients with anti-PD1 refractory metastatic melanoma, (ii) a Phase 3 clinical trial of tilsotolimod, administered intra-tumorally, in combination with ipilimumab in patients with anti-PD1 refractory metastatic melanoma, and (iii) a Phase 1b trial of tilsotolimod, administered intra-tumorally, as a monotherapy in patients with refractory solid tumors. We also plan to initiate a Phase 2 clinical trial of tilsotolimod in combination with checkpoint inhibitors for the treatment of multiple tumor types in 2019.

We anticipate that our ability to generate product revenues will depend heavily on the successful development and commercialization of our TLR drug candidate, tilsotolimod.

Our ability to generate future milestone and royalty revenues under our current collaboration with GSK, and under any other collaboration that we enter into with respect to our other programs, will depend on the development and commercialization of the drug candidates being developed under the collaborations.

We have entered into and may in the future continue to seek to enter into collaborative alliances with pharmaceutical companies to advance our TLR agonists and antagonist candidates and with respect to additional applications of our nucleic acid chemistry technology program, which we suspended internally in 2018. Should we in the future seek to do so, we may not be able to enter into such agreements on attractive terms or at all.

Our ability to successfully develop and commercialize potential drug candidates will depend on our ability to overcome these recent challenges and on several factors, including the following:

- the drug candidates demonstrating activity in clinical trials;
- the drug candidates demonstrating an acceptable safety profile in nonclinical toxicology studies and during clinical trials;
- timely enrollment in clinical trials of drug candidates, which may be slower than anticipated, potentially resulting in significant delays;
- satisfying conditions imposed on us and/or our collaborators by the FDA or equivalent foreign regulatory authorities regarding the scope or design of clinical trials;
- the ability to demonstrate to the satisfaction of the FDA, or equivalent foreign regulatory authorities, the safety and efficacy of the drug candidates through current and future clinical trials;
- timely receipt of necessary marketing approvals from the FDA and equivalent foreign regulatory authorities;
- the ability to combine our drug candidates and the drug candidates being developed by our collaborators and any other collaborators safely and successfully with other therapeutic agents;
- achieving and maintaining compliance with all regulatory requirements applicable to the products;
- establishment of commercial manufacturing arrangements with third-party manufacturers;
- the ability to secure orphan drug exclusivity for our drug candidates either alone or in combination with other products;
- the successful commercial launch of the drug candidates, assuming FDA approval is obtained, whether alone or in combination with other products;

- acceptance of the products as safe and effective by patients, the medical community, and third-party payors;
- competition from other companies and their therapies;
- changes in treatment regimens;
- favorable market conditions in which to raise additional capital;
- the strength of our intellectual property portfolio in the United States and abroad; and
- a continued acceptable safety and efficacy profile of the drug candidates following marketing approval.

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We are in the early stages of developing our TLR9 agonists in combination with checkpoint inhibitors, which is a novel technology, and our efforts may not be successful or result in any approved and marketable products.

In June 2015, we entered into a strategic clinical research alliance with MD Anderson to advance clinical development of TLR9 agonists in combination with checkpoint inhibitors. We initiated the first trial from the research alliance, a Phase 1/2 clinical trial to assess the safety and efficacy of tilsotolimod, administered intra-tumorally in combination with ipilimumab, a CTLA4 antibody, in patients with metastatic melanoma (anti-PD1 refractory) in the fourth quarter of 2015. While we have evaluated the safety profile of tilsotolimod in previous trials, in those trials we evaluated the safety profile of tilsotolimod by subcutaneous injection and not by intra-tumoral injection. In addition, while, as a marketed product, the safety profile of ipilimumab is known, the safety profile of the combination of tilsotolimod and ipilimumab has not been evaluated in previous trials. These factors may result in participating subjects experiencing serious adverse events or undesirable side effects or exposure to unacceptable health risks requiring us to suspend or terminate any clinical trials that we may conduct of tilsotolimod in combination with ipilimumab, or any other checkpoint inhibitor. Furthermore, we have expanded the Phase 1/2 clinical trial to include the assessment of safety and efficacy of tilsotolimod, administered intra-tumorally in combination with pembrolizumab, an anti-PD1 antibody in patients with metastatic melanoma (anti-PD1 refractory). While, as a marketed product, the safety profile of pembrolizumab is known, the safety profile of the combination of tilsotolimod and pembrolizumab has not been evaluated in previous trials and may result in participating subjects experiencing serious adverse events or undesirable side effects or exposure to unacceptable health risks requiring us to suspend or terminate any clinical trials that we may conduct of tilsotolimod in combination with pembrolizumab, or any other checkpoint inhibitor. Additionally, we are planning to initiate a Phase 2 clinical trial of tilsotolimod in combination with nivolumab, an anti-PD1 antibody, and ipilimumab, in patients with various solid tumors. Similar to ipilimumab, as discussed above, while as a marketed product the safety profile of nivolumab is known, the safety profile of the combination of tilsotolimod and nivolumab has not been evaluated in previous trials. These factors may result in participating subjects experiencing serious adverse events or undesirable side effects or exposure to unacceptable health risks requiring us to suspend or terminate any clinical trials that we may conduct of tilsotolimod in combination with nivolumab and ipilimumab, or any other checkpoint inhibitor.

If we experience delays or difficulties in the enrollment of patients in clinical trials, our receipt of necessary regulatory approvals could be delayed or prevented.

We may not be able to initiate or continue clinical trials for our drug candidates if we are unable to locate and enroll a sufficient number of eligible patients to participate in these trials as required by the FDA or similar regulatory authorities outside the United States. Additionally, because there are a limited number of patients with dermatomyositis, or other rare diseases having indications for which we may determine to develop our TLR antagonists, our ability to enroll eligible patients in any clinical trials for these indications may be limited or may result in slower enrollment than we anticipated. In addition, some of our competitors have ongoing clinical trials for drug candidates that treat the same indications as our drug candidates, and patients who would otherwise be eligible for our clinical trials may instead enroll in clinical trials of our competitors' drug candidates.

Patient enrollment can be affected by other factors, including the:

- severity of the disease under investigation;
- eligibility criteria for the trial in question;
- perceived risks and benefits of the TLR-targeted drug candidates under study;
- efforts to facilitate timely enrollment in clinical trials;
- availability of competing clinical trials or other therapies;
- patient referral practices of physicians;
- ability to monitor patients adequately during and after treatment; and
- proximity and availability of clinical trial sites for prospective patients.

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Our inability to enroll a sufficient number of patients for our clinical trials would result in significant delays and could require us to abandon one or more clinical trials altogether. Enrollment delays in our clinical trials may result in increased development costs for our drug candidates, which would cause the value of our company to decline and limit our ability to obtain additional financing.

If our clinical trials are unsuccessful, or if they are delayed or terminated, we may not be able to develop and commercialize our drug candidates.

In order to obtain regulatory approvals for the commercial sale of our drug candidates, we are required to complete extensive clinical trials in humans to demonstrate the safety and efficacy of our drug candidates. Clinical trials are lengthy, complex, and expensive processes with uncertain results. We may not be able to complete any clinical trial of a potential product within any specified time period. Moreover, clinical trials may not show our potential products to be both safe and efficacious. The FDA or other equivalent foreign regulatory agencies may not allow us to complete these trials or commence and complete any other clinical trials.

The results from preclinical testing of a drug candidate that is under development may not be predictive of results that will be obtained in human clinical trials. In addition, the results of early human clinical trials may not be predictive of results that will be obtained in larger scale, advanced stage clinical trials.

Furthermore, interim results of a clinical trial do not necessarily predict final results, and failure of any of our clinical trials can occur at any stage of testing. Companies in the biotechnology and pharmaceutical industries, including companies with greater experience in preclinical testing and clinical trials than we have, have suffered significant setbacks in clinical trials, even after demonstrating promising results in earlier trials. Moreover, effects seen in nonclinical studies, even if not observed in clinical trials, may result in limitations or restrictions on clinical trials. Numerous unforeseen events may occur during, or as a result of, preclinical testing, nonclinical testing or the clinical trial process that could delay or inhibit the ability to receive regulatory approval or to commercialize drug products.

Other companies developing drugs targeted to TLRs have experienced setbacks in clinical trials. These setbacks may result in enhanced scrutiny by regulators or institutional review boards, or IRBs, of clinical trials of our drug candidates, including our TLR-targeted drug candidates, which could result in regulators or IRBs prohibiting the commencement of clinical trials, requiring additional nonclinical studies as a precondition to commencing clinical trials or imposing restrictions on the design or scope of clinical trials that could slow enrollment of trials, increase the costs of trials or limit the significance of the results of trials. Such setbacks could also adversely impact the desire of investigators to enroll patients in, and the desire of patients to enroll in, clinical trials of our drug candidates.

Other events that could delay or inhibit conduct of our clinical trials include:

- regulators or IRBs may not authorize us to commence a clinical trial or conduct a clinical trial at a prospective trial site;
- nonclinical or clinical data may not be readily interpreted, which may lead to delays and/or misinterpretation;
- our nonclinical tests, including toxicology studies, or clinical trials may produce negative or inconclusive results, and we may decide, or regulators may require us, to conduct additional nonclinical testing or clinical trials or we may abandon projects that we expect may not be promising;
- the rate of enrollment or retention of patients in our clinical trials may be lower than we expect;
- we might have to suspend or terminate our clinical trials if the participating subjects experience serious adverse events or undesirable side effects or are exposed to unacceptable health risks;
- regulators or IRBs may hold, suspend or terminate clinical research for various reasons, including noncompliance with regulatory requirements, issues identified through inspections of manufacturing or clinical trial operations or clinical trial sites, or if, in their opinion, the participating subjects are being exposed to unacceptable health risks;

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- regulators may hold or suspend our clinical trials while collecting supplemental information on, or clarification of, our clinical trials or other clinical trials, including trials conducted in other countries or trials conducted by other companies;
- we, along with our collaborators and subcontractors, may not employ, in any capacity, persons who have been debarred under the FDA's Application Integrity Policy, or similar policy under foreign regulatory authorities. Employment of such debarred persons, even if inadvertent, may result in delays in the FDA's or foreign equivalent's review or approval of our drug candidates, or the rejection of data developed with the involvement of such person(s);
- we or our contract manufacturers may be unable to manufacture sufficient quantities of our drug candidates for use in clinical trials;
- the cost of our clinical trials may be greater than we currently anticipate making continuation and/or completion improbable; and
- our drug candidates may not cause the desired effects or may cause undesirable side effects or our drug candidates may have other unexpected characteristics.

We do not know whether clinical trials will begin as planned, will need to be restructured or will be completed on schedule, if at all. Significant clinical trial delays also could allow our competitors to bring products to market before we do and impair our ability to commercialize our drug candidates.

Delays in commencing clinical trials of potential products could increase our costs, delay any potential revenues, and reduce the probability that a potential product will receive regulatory approval.

Our drug candidates and our collaborators' drug candidates will require preclinical and other nonclinical testing and extensive clinical trials prior to submission of any regulatory application for commercial sales. In conducting clinical trials, we cannot be certain that any planned clinical trial will begin on time, if at all. Delays in commencing clinical trials of potential products could increase our drug candidate development costs, delay any potential revenues, reduce the potential length of patent exclusivity and reduce the probability that a potential product will receive regulatory approval.

Commencing clinical trials may be delayed for a number of reasons, including delays in:

- manufacturing sufficient quantities of drug candidate that satisfy the required quality standards for use in clinical trials;
- demonstrating sufficient safety to obtain regulatory approval for conducting a clinical trial;
- reaching an agreement with any collaborators on all aspects of the clinical trial;
- reaching agreement with contract research organizations, if any, and clinical trial sites on all aspects of the clinical trial;
- resolving any objections from the FDA or any regulatory authority on an IND or proposed clinical trial design;
- obtaining additional financing;
- obtaining IRB approval for conducting a clinical trial at a prospective site; and
- enrolling patients in order to commence the clinical trial.

The technologies on which we rely are unproven and may not result in any approved and marketable products.

Our technologies or therapeutic approaches are relatively new and unproven. We have focused our efforts on the research and development of RNA- and DNA-based compounds, or oligonucleotides, targeted to TLRs. Neither we nor any other company have obtained regulatory approval to market such TLR-targeted drug candidates as therapeutic drugs, and no such products currently are being marketed. The results of preclinical studies with TLR-targeted compounds may not be indicative of results that may be obtained in clinical trials, and results we have obtained in the clinical trials we have conducted to date may not be predictive of results in subsequent large-scale clinical trials. Further, the chemical and pharmacological properties of RNA- and DNA-based compounds targeted

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to TLRs may not be fully recognized in preclinical studies and small-scale clinical trials, and such compounds may interact with human biological systems in unforeseen, ineffective or harmful ways that we have not yet identified.

Moreover, only five nucleic acid-based therapeutics have been approved by the FDA for marketing in the United States since 1998 and are currently being marketed. As such, oligonucleotides as a chemical class of drug candidates have limited precedence for successful late-stage development and regulatory approval. As we progress our oligonucleotide drug candidate and conduct long-term nonclinical toxicology studies, we expect to encounter an increased risk of generating clinical adverse events and nonclinical toxicology study results that will require careful interpretation. In animal toxicology studies, we have observed adverse treatment-related effects on serum complement as well as evidence of adverse kidney, vascular, and heart pathology in longer term dosing of animals with our oligonucleotide compounds, which we believe are consistent with data previously generated with other third party oligonucleotides. Given the limited experience in assessing the relevance of oligonucleotide-related adverse animal toxicology findings to humans, the clinical and regulatory context for interpreting the significance of such events and results is not well established.

As a result of these factors, we may never succeed in obtaining regulatory approval to market any product. Furthermore, the commercial success of any of our drug candidates for which we may obtain marketing approval from the FDA or other regulatory authorities will depend upon their acceptance by patients, the medical community, and third-party payors as clinically useful, safe, and cost-effective. In addition, if products being developed by our competitors have negative clinical trial results or otherwise are viewed negatively, the perception of our technologies and market acceptance of our drug candidates could be impacted negatively.

Our setbacks with respect to our TLR-targeted compounds, together with the setbacks experienced by other companies developing oligonucleotides-based compounds and TLR-targeted compounds, may result in a negative perception of our technology and our TLR-targeted compounds, impact our ability to obtain marketing approval of these drug candidates and adversely affect acceptance of our technology and our TLR-targeted compounds by patients, the medical community and third-party payors.

Our efforts to educate the medical community on our potentially unique approaches may require greater resources than would be typically required for products based on conventional technologies or therapeutic approaches. The safety, efficacy, convenience, and cost-effectiveness of our drug candidates as compared to competitive products will also affect market acceptance.

We face substantial competition, which may result in others discovering, developing or commercializing drugs before or more successfully than us.

We are developing our TLR-targeted drug candidate, tilsotolimod, for use in our immuno-oncology program. We are conducting a Phase 1/2 clinical trial of tilsotolimod in combination with ipilimumab, a CTLA4 antibody, or pembrolizumab in patients with anti-PD1 refractory metastatic melanoma; a Phase 3 Trial of tilsotolimod in combination with ipilimumab in patients with anti-PD1 refractory metastatic melanoma; a Phase 1b trial of tilsotolimod monotherapy in patients with refractory solid tumors; a Phase 2 clinical trial of tilsotolimod in combination with nivolumab and ipilimumab for the treatment of solid tumors and may initiate additional clinical trials of tilsotolimod in our immuno-oncology program in combination with checkpoint inhibitors for the treatment of multiple tumor types. In the immune-oncology environment, there are many other companies, public and private, that are actively engaged in discovery, development, and commercializing products and technologies that may compete with our drug candidate and program, including TLR-targeted compounds as well as non-TLR-targeted therapeutics.

Immuno-oncology, which utilizes a patient's own immune system to combat cancer, is currently an active area of research for biotechnology and pharmaceutical companies. Interest in immuno-oncology is driven by efficacy data in cancers with historically bleak outcomes and the potential to achieve a cure or functional cure for some patients. As such, we expect that our efforts in this field will be competitive with a wide variety of different approaches. Any one of these competitive approaches may result in the development of novel technologies that are more effective, safer or less costly than any that we are developing.

We are aware of other companies developing TLR agonists as well as other mechanisms of action that are focused on stimulating the immune response. These companies include, but are not limited to, Aduro Biotech, Inc., BioLineRx Ltd., Checkmate Pharmaceuticals, Inc., Dynavax Technologies Corporation, Exicure, Inc., Gilead Sciences

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Inc., GlaxoSmithKline plc, Hoffmann-La Roche Ltd., Innate Immunotherapeutics Ltd., Mologen AG VentiRx Pharmaceuticals Inc., Nektar Therapeutics, and Telormedix S.A.

Some potentially competitive products have been in development or commercialized for years, in some cases by large, well established pharmaceutical companies. Many of the marketed products have been accepted by the medical community, patients, and third-party payors. Our ability to compete may be affected by the previous adoption of such products by the medical community, patients, and third-party payors. Additionally, in some instances, insurers and other third-party payors seek to encourage the use of generic products, which makes branded products, such as is planned for our drug candidates upon commercialization, potentially less attractive, from a cost perspective, to buyers.

We recognize that other companies, including large pharmaceutical companies, may be developing or have plans to develop products and technologies that may compete with ours. Many of our competitors have substantially greater financial, technical, and human resources than we have. In addition, many of our competitors have significantly greater experience than we have in undertaking preclinical studies and human clinical trials of new pharmaceutical products, obtaining FDA and other regulatory approvals of products for use in health care and manufacturing, and marketing and selling approved products. Our competitors may discover, develop or commercialize products or other novel technologies that are more effective, safer or less costly than any that we are developing. Our competitors may also obtain FDA or other regulatory approval for their products more rapidly than we may obtain approval for ours.

We anticipate that the competition with our drug candidates and technologies will be based on a number of factors including product efficacy, safety, availability, and price. The timing of market introduction of our drug candidates and competitive products will also affect competition among products. We expect the relative speed with which we can develop products, complete the clinical trials and approval processes, and supply commercial quantities of the products to the market to be important competitive factors. Our competitive position will also depend upon our ability to attract and retain qualified personnel, to obtain patent protection or otherwise develop proprietary products or processes, protect our intellectual property, and to secure sufficient capital resources for the period between technological conception and commercial sales.

Competition for technical and management personnel is intense in our industry, and we may not be able to sustain our operations or grow if we are unable to attract and retain key personnel.

Our success is highly dependent on the retention of principal members of our technical and management staff, including our President and Chief Executive Officer, Mr. Vincent Milano.

We are a party to an employment agreement with Mr. Milano, which is terminable upon 15 days prior written notice at the election of either party and immediately in the event of a termination for cause (as defined therein). We do not carry key man life insurance for Mr. Milano.

Furthermore, our future growth will require hiring a number of qualified technical and management personnel. Accordingly, recruiting and retaining such personnel in the future will be critical to our success. There is intense competition from other companies and research and academic institutions for qualified personnel in the areas of our activities. If we are not able to continue to attract and retain, on acceptable terms, the qualified personnel necessary for the continued development of our business, we may not be able to sustain our operations or growth.

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Risks Related to Regulatory Approval and Marketing of Our Drug Candidates and Other

Legal Compliance Matters

Even if we complete the necessary preclinical studies and clinical trials, the marketing approval process is expensive, time-consuming and uncertain and may prevent us from obtaining approvals for the commercialization of some or all of our drug candidates. As a result, we cannot predict when or if we, or any future collaborators, will obtain marketing approval to commercialize a drug candidate.

Our drug candidates and the activities associated with their development and commercialization, including their design, testing, manufacture, safety, efficacy, recordkeeping, labeling, storage, approval, marketing, promotion, sale and distribution, export and import are subject to extensive regulation by the FDA and comparable foreign regulatory authorities, whose laws and regulations may differ from country to country. We are not permitted to market our drug candidates in the United States or in other countries until we, or any future collaborators, receive approval of an NDA from the FDA or marketing approval from applicable regulatory authorities outside of the United States.

All of the drug candidates that we are developing, or may develop in the future, will require additional research and development, extensive preclinical studies, nonclinical testing, clinical trials, and regulatory approval prior to any commercial sales. This process is lengthy, often taking a number of years, is uncertain, and is expensive. Securing marketing approval requires the submission of extensive preclinical and clinical data and supporting information to regulatory authorities for each therapeutic indication to establish the drug candidate's safety and purity. Securing marketing approval also requires the submission of information about the product manufacturing process to, and inspection of manufacturing facilities by, the regulatory authorities.

Since our inception, we have conducted clinical trials of a number of compounds and are planning to initiate clinical trials for a number of additional disease indications. Specifically:

- we are conducting a Phase 1/2 clinical trial of tilsotolimod, administered intra-tumorally, in combination with ipilimumab or pembrolizumab in patients with anti-PD1 refractory metastatic melanoma, a Phase 3 clinical trial of tilsotolimod, administered intra-tumorally, in combination with ipilimumab in patients with anti-PD1 refractory metastatic melanoma, and a Phase 1b trial of tilsotolimod administered intra-tumorally, as a monotherapy in patients with refractory solid tumors;
- we plan to conduct a Phase 2 trial of tilsotolimod, administered intra-tumorally, in combination with ipilimumab and nivolumab in patients with squamous cell carcinoma of the head and neck and MSS-colorectal cancer; and
- we may conduct additional clinical trials of tilsotolimod in our immuno-oncology program and in combination with checkpoint inhibitors for the treatment of multiple tumor types.

The FDA and other regulatory authorities may not approve any of our potential products for any indication.

We may need to address a number of technological challenges in order to complete development of our drug candidates. Moreover, these products may not be effective in treating any disease or may prove to have undesirable or unintended side effects, unintended alteration of the immune system over time, toxicities or other characteristics that may preclude our obtaining regulatory approval or prevent or limit commercial use. In addition, changes in marketing approval policies during the development period, changes in or the enactment of additional statutes or regulations, or changes in regulatory review for each submitted product application, may cause delays in the approval or rejection of an application. The FDA and comparable authorities in other countries have substantial discretion in the approval process and may refuse to accept any application or may decide that our data is insufficient for approval and require additional preclinical, clinical or other studies. In addition, varying interpretations of the data obtained from preclinical and clinical testing could delay, limit or prevent marketing approval of a drug candidate.

Any delay in obtaining or failure to obtain required approvals could materially adversely affect our ability or that of any collaborators we may have to generate revenue from the particular drug candidate, which likely would result in significant harm to our financial position and adversely impact our stock price.

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Our failure to obtain marketing approval in foreign jurisdictions would prevent our drug candidates from being marketed abroad, and any approval we are granted for our drug candidates in the United States would not assure approval of drug candidates in foreign jurisdictions.

In order to market and sell our drugs in the European Union and many other jurisdictions, we, and any future collaborators, must obtain separate marketing approvals and comply with numerous and varying regulatory requirements. The approval procedure varies among countries and can involve additional testing. The time required to obtain approval may differ substantially from that required to obtain FDA approval. The marketing approval process outside of the United States generally includes all of the risks associated with obtaining FDA approval. In addition, in many countries outside of the United States, it is required that the drug be approved for reimbursement before the drug can be approved for sale in that country. We, and any future collaborators, may not obtain approvals from regulatory authorities outside of the United States on a timely basis, if at all. Approval by the FDA does not ensure approval by regulatory authorities in other countries or jurisdictions, and approval by one regulatory authority outside of the United States does not ensure approval by regulatory authorities in other countries or jurisdictions or by the FDA.

Additionally, on June 23, 2016, the electorate in the United Kingdom voted in favor of leaving the European Union, commonly referred to as Brexit. On March 29, 2017, the country formally notified the European Union of its intention to withdraw pursuant to Article 50 of the Lisbon Treaty. Since a significant proportion of the regulatory framework in the United Kingdom is derived from European Union directives and regulations, the referendum could materially impact the regulatory regime with respect to the approval of our drug candidates in the United Kingdom or the European Union. Any delay in obtaining, or an inability to obtain, any marketing approvals, as a result of Brexit or otherwise, would prevent us from commercializing our drug candidates in the United Kingdom and/or the European Union and restrict our ability to generate revenue and achieve and sustain profitability. If any of these outcomes occur, we may be forced to restrict or delay efforts to develop or seek regulatory approval in the United Kingdom and/or European Union for our drug candidates, which could significantly and materially harm our business.

Even if we, or any future collaborators, obtain marketing approvals for our drug candidates, the terms of approvals and ongoing regulation of our drugs may limit how we, or they, manufacture and market our drugs, which could materially impair our ability to generate revenue.

Once marketing approval has been granted, an approved drug and its manufacturer and marketer are subject to ongoing review and extensive regulation. We, and any future collaborators, must therefore comply with requirements concerning advertising and promotion for any of our drug candidates for which we or they obtain marketing approval. Promotional communications with respect to prescription drugs are subject to a variety of legal and regulatory restrictions and must be consistent with the information in the drug's approved labeling. Thus, we, and any future collaborators, may not be able to promote any drugs we develop for indications or uses for which they are not approved.

In addition, manufacturers of approved drugs and those manufacturers' facilities are required to comply with extensive FDA requirements, including ensuring that quality control and manufacturing procedures conform to cGMPs, which include requirements relating to quality control and quality assurance as well as the corresponding maintenance of

records and documentation and reporting requirements. We, our contract manufacturers, our future collaborators and their contract manufacturers could be subject to periodic unannounced inspections by the FDA to monitor and ensure compliance with cGMPs.

Accordingly, assuming we, or our future collaborators, receive marketing approval for one or more of our drug candidates, we, and our future collaborators, and our and their contract manufacturers will continue to expend time, money and effort in all areas of regulatory compliance, including manufacturing, production, product surveillance and quality control.

If we, and our future collaborators, are not able to comply with post-approval regulatory requirements, we, and our future collaborators, could have the marketing approvals for our drugs withdrawn by regulatory authorities and our, or our future collaborators', ability to market any future drugs could be limited, which could adversely affect our ability to achieve or sustain profitability. Further, the cost of compliance with post-approval regulations may have a negative effect on our operating results and financial condition.

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Moreover, legislative and regulatory proposals have been made to expand post-approval requirements and restrict sales and promotional activities for pharmaceutical products. We cannot be sure whether additional legislative changes will be enacted, or whether the FDA regulations, guidance or interpretations will be changed, or what the impact of such changes on the marketing approvals of our drug candidates, if any, may be. In addition, increased scrutiny by the United States Congress of the FDA's approval process may significantly delay or prevent marketing approval, as well as subject us and any collaborators to more stringent product labeling and post-marketing testing and other requirements.

Any of our drug candidates for which we, or our future collaborators, obtain marketing approval in the future could be subject to post-marketing restrictions or withdrawal from the market and we, and our future collaborators, may be subject to substantial penalties if we, or they, fail to comply with regulatory requirements or if we, or they, experience unanticipated problems with our drugs following approval.

Any of our drug candidates for which we, or our future collaborators, obtain marketing approval in the future, as well as the manufacturing processes, post-approval studies and measures, labeling, advertising and promotional activities for such drug, among other things, will be subject to continual requirements of and review by the FDA and other regulatory authorities. These requirements include submissions of safety and other post-marketing information and reports, registration and listing requirements, requirements relating to manufacturing, quality control, quality assurance and corresponding maintenance of records and documents, requirements regarding the distribution of samples to physicians and recordkeeping. Even if marketing approval of a drug candidate is granted, the approval may be subject to limitations on the indicated uses for which the drug may be marketed or to the conditions of approval, including the requirement to implement a Risk Evaluation and Mitigation Strategy, which could include requirements for a restricted distribution system.

The FDA may also impose requirements for costly post-marketing studies or clinical trials and surveillance to monitor the safety or efficacy of a drug. The FDA and other agencies, including the Department of Justice, or the DOJ, closely regulate and monitor the post-approval marketing and promotion of drugs to ensure that they are manufactured, marketed and distributed only for the approved indications and in accordance with the provisions of the approved labeling. The FDA imposes stringent restrictions on manufacturers' communications regarding off-label use and if we, or our future collaborators, do not market any of our drug candidates for which we, or they, receive marketing approval for only their approved indications, we, or they, may be subject to warnings or enforcement action for off-label marketing. Violation of the FDCA and other statutes, including the False Claims Act, relating to the promotion and advertising of prescription drugs may lead to investigations or allegations of violations of federal and state health care fraud and abuse laws and state consumer protection laws.

In addition, later discovery of previously unknown adverse events or other problems with our drugs or their manufacturers or manufacturing processes, or failure to comply with regulatory requirements, may yield various results, including:

•litigation involving patients taking our drug;

• restrictions on such drugs, manufacturers or manufacturing processes;

• restrictions on the labeling or marketing of a drug;

•restrictions on drug distribution or use;

- requirements to conduct post-marketing studies or clinical trials;
- warning letters or untitled letters;
- withdrawal of the drugs from the market;
- refusal to approve pending applications or supplements to approved applications that we submit;
- recall of drugs;
- fines, restitution or disgorgement of profits or revenues;
- suspension or withdrawal of marketing approvals;
- damage to relationships with any potential collaborators;
- unfavorable press coverage and damage to our reputation;

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•refusal to permit the import or export of drugs;

• drug seizure; or

•injunctions or the imposition of civil or criminal penalties.

Under the CURES Act and the Trump Administration's regulatory reform initiatives, the FDA's policies, regulations and guidance may be revised or revoked and that could prevent, limit or delay regulatory approval of our drug candidates, which would impact our ability to generate revenue.

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 spur innovation, but its ultimate implementation is unclear. 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, which would adversely affect our business, prospects, financial condition and results of operations.

We also cannot predict the likelihood, nature or extent of government regulation that may arise from future legislation or administrative or executive 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. 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, which 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 and approximate the total costs or savings associated with each new regulation or repealed 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. In addition, on February 24, 2017, President Trump issued an executive order directing each affected agency to designate an agency official as a "Regulatory Reform Officer" and establish a "Regulatory Reform Task Force" to implement the two-for-one provisions and other previously issued executive orders relating to the review of federal regulations, however 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.

We may not be able to obtain orphan drug exclusivity for applications of our TLR drug candidates.

Regulatory authorities in some jurisdictions, including the United States and Europe, may designate drugs for relatively small patient populations as orphan drugs. Under the Orphan Drug Act, the FDA may designate a product as an orphan drug if it is a drug intended to treat a rare disease or condition, which is generally defined as a patient population of fewer than 200,000 individuals in the United States.

Generally, if a product with an orphan drug designation subsequently receives the first marketing approval for the indication for which it has such designation, the product is entitled to a period of marketing exclusivity, which precludes the European Medicines Agency, or EMA, or the FDA from approving another marketing application for the same drug for the same indication for that exclusivity period. The applicable period is seven years in the United States and ten years in Europe. The European exclusivity period can be reduced to six years if a drug no longer meets the criteria for orphan drug designation or if the drug is sufficiently profitable such that market exclusivity is no longer justified. Orphan drug exclusivity may be lost if the FDA or EMA determines that the request for designation was materially defective or if the manufacturer is unable to assure sufficient quantity of the drug to meet the needs of patients with the rare disease or condition.

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In June 2017, the FDA granted us orphan drug designation for tilsotolimod for the treatment of melanoma Stages IIb to IV. However, there can be no assurance that we will obtain orphan drug designation or exclusivity for any other disease indications for which we develop tilsotolimod, or for our other drug candidates. Even if we obtain orphan drug exclusivity for a product, that exclusivity may not effectively protect the product from competition because different drugs can be approved for the same condition. Even after an orphan drug is approved, the FDA can subsequently approve the same drug for the same condition if the FDA concludes that the later drug is clinically superior in that it is shown to be safer, more effective or makes a major contribution to patient care.

On August 3, 2017, Congress passed the FDA Reauthorization Act of 2017, or FDARA. FDARA, among other things, codified the FDA's pre-existing regulatory interpretation, to require that a drug sponsor demonstrate the clinical superiority of an orphan drug that is otherwise the same as a previously approved drug for the same rare disease in order to receive orphan drug exclusivity. The new legislation reverses prior precedent holding that the Orphan Drug Act unambiguously requires that the FDA recognize the orphan exclusivity period regardless of a showing of clinical superiority. The FDA may further reevaluate the Orphan Drug Act and its regulations and policies. We do not know if, when, or how the FDA may change the orphan drug regulations and policies in the future, and it is uncertain how any changes might affect our business. Depending on what changes the FDA may make to its orphan drug regulations and policies, our business could be adversely impacted.

A fast track designation by the FDA may not actually lead to a faster development or regulatory review or approval process, and does not increase the likelihood that drug candidates will receive marketing approval.

We intend to seek fast track designation for some applications of our drug candidates. If a drug is intended for the treatment of a serious or life-threatening condition and the drug demonstrates the potential to address unmet medical needs for this condition, the drug sponsor may apply for FDA fast track designation. The FDA has broad discretion whether or not to grant this designation, so even if we believe a particular drug candidate is eligible for this designation, we cannot assure you that the FDA would decide to grant it.

In November 2017, the FDA granted us fast track designation for tilsotolimod for the treatment of anti-PD1 refractory metastatic melanoma in combination with ipilimumab therapy. However, even with fast track designation, we may not experience a faster development process, review or approval compared to conventional FDA procedures. The FDA may withdraw fast track designation if it believes that the designation is no longer supported by data from our clinical development program.

A breakthrough therapy designation by the FDA for any application of our drug candidates may not lead to a faster development or regulatory review or approval process, and it does not increase the likelihood that those drug candidates will receive marketing approval.

We may seek a breakthrough therapy designation for some applications of our drug candidates. A breakthrough therapy is defined as a drug that 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 the drug may demonstrate substantial improvement over existing therapies on one or more clinically significant endpoints, such as substantial treatment effects observed early in clinical development. For drugs and biologics that have been designated as breakthrough therapies, interaction and communication between the FDA and the sponsor of the trial can help to identify the most efficient path for clinical development while minimizing the number of patients placed in ineffective control regimens. Drugs designated as breakthrough therapies by the FDA are also eligible for accelerated approval.

Designation as a breakthrough therapy is within the discretion of the FDA. Accordingly, even if we believe an application of one of our drug candidates meets the criteria for designation as a breakthrough therapy, the FDA may disagree and instead determine not to make such designation. In any event, the receipt of a breakthrough therapy designation for a drug candidate may not result in a faster development process, review or approval compared to drugs considered for approval under conventional FDA procedures and does not assure ultimate approval by the FDA. In addition, even if one or more of our drug candidates qualify as breakthrough therapies, the FDA may later decide that the products no longer meet the conditions for qualification or decide that the time period for FDA review or approval will not be shortened.

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If we are required by the FDA to obtain approval of a companion diagnostic in connection with and as a condition to approval of a drug candidate, and we do not obtain or we experience delays in obtaining FDA approval of a diagnostic device, we will not be able to commercialize the drug candidate and our ability to generate revenue will be materially impaired.

According to FDA guidance, if the FDA determines that a companion diagnostic device is essential to the safe and effective use of a novel therapeutic product or indication, the FDA generally will not approve the therapeutic product or new therapeutic product indication if the companion diagnostic is not also approved or cleared for that indication. Under the Federal Food, Drug, and Cosmetic Act, companion diagnostics are regulated as medical devices and the FDA has generally required companion diagnostics intended to select the patients who will respond to cancer treatment to obtain Premarket Approval, or a PMA. The PMA process, including the gathering of clinical and preclinical data and the submission to and review by the FDA, involves a rigorous premarket review during which the applicant must prepare and provide the FDA with reasonable assurance of the device's safety and effectiveness and information about the device and its components regarding, among other things, device design, manufacturing and labeling. PMA approval is not guaranteed and may take considerable time, and the FDA may ultimately respond to a PMA submission with a not approvable determination based on deficiencies in the application and require additional clinical trial or other data that may be expensive and time-consuming to generate and that can substantially delay approval.

We do not have experience or capabilities in developing or commercializing diagnostics and plan to rely on third parties or collaborators to perform these functions. Companion diagnostics are subject to regulation by the FDA and similar regulatory authorities outside the United States as medical devices and require separate regulatory approval prior to commercialization.

If we, or any third parties that we engage to assist us or any of our collaborators, are unable to successfully develop companion diagnostics for our TLR antagonist drug candidates that require a companion diagnostic, or experience delays in doing so:

- the development of such TLR antagonist drug candidates may be adversely affected if we are unable to appropriately select patients for enrollment in our clinical trials;
- such TLR antagonist drug candidates may not receive marketing approval if their safe and effective use depends on a companion diagnostic; and
- we may not realize the full commercial potential of any TLR antagonist drug candidate that receives marketing approval if, among other reasons, we are unable to appropriately identify patients with the specific oncogenic mutation targeted by such TLR antagonist drug candidate.

If any of these events were to occur, our business would be harmed, possibly materially.

We have only limited experience in regulatory affairs and our drug candidates are based on new technologies; these factors may affect our ability or the time we require to obtain necessary regulatory approvals.

We have only limited experience in filing the applications necessary to obtain regulatory approvals. Moreover, the products that result from our research and development programs will likely be based on new technologies and new therapeutic approaches that have not been extensively tested in humans. The regulatory requirements governing these types of products may be more rigorous than for conventional drugs. As a result, we may experience a longer regulatory process in connection with obtaining regulatory approvals of any product that we develop.

Our relationships with healthcare providers and physicians and third-party payors will be subject to applicable anti-kickback, fraud and abuse and other healthcare laws and regulations, which could expose us to criminal sanctions, civil penalties, contractual damages, reputational harm and diminished profits and future earnings.

Healthcare providers, physicians and third party payors will play a primary role in the recommendation and prescription of any drugs for which we obtain marketing approval. Our future arrangements with third party payors, healthcare providers and physicians may expose us to broadly applicable fraud and abuse and other healthcare

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laws and regulations that may constrain the business or financial arrangements and relationships through which we market, sell and distribute any drugs for which we obtain marketing approval. These include the following:

- Anti-Kickback Statute—the federal healthcare anti-kickback statute prohibits, among other things, persons from knowingly and willfully soliciting, offering, receiving or providing remuneration, directly or indirectly, in cash or in kind, to induce or reward, or in return for, either the referral of an individual for, or the purchase, order or recommendation or arranging of, any good or service, for which payment may be made under a federal healthcare program such as Medicare and Medicaid;
- False Claims Act—the federal False Claims Act imposes criminal and civil penalties, including through civil whistleblower or qui tam actions, against individuals or entities for, among other things, knowingly presenting, or causing to be presented false or fraudulent claims for payment by a federal healthcare program or making a false statement or record material to payment of a false claim or avoiding, decreasing or concealing an obligation to pay money to the federal government, with potential liability including mandatory treble damages and significant per-claim penalties, currently set at $5,500 to $11,000 per false claim;
- HIPAA—the federal Health Insurance Portability and Accountability Act of 1996, or HIPAA, imposes criminal and civil liability for executing a scheme to defraud any healthcare benefit program or making false statements relating to healthcare matters, and, as amended by the Health Information Technology for Economic and Clinical Health Act and its implementing regulations, also imposes obligations, including mandatory contractual terms and technical safeguards, with respect to maintaining the privacy, security and transmission of individually identifiable health information;
- Transparency Requirements—federal laws require applicable manufacturers of covered drugs to report payments and other transfers of value to physicians and teaching hospitals; and
- Analogous State and Foreign Laws—analogous state and foreign fraud and abuse laws and regulations, such as state anti-kickback and false claims laws, can apply to sales or marketing arrangements and claims involving healthcare items or services and are generally broad and are enforced by many different federal and state agencies as well as through private actions.

Some state laws require pharmaceutical companies to comply with the pharmaceutical industry's voluntary compliance guidelines and the relevant compliance guidance promulgated by the federal government and require drug manufacturers to report information related to payments and other transfers of value to physicians and other healthcare providers or marketing expenditures. State and foreign laws also govern the privacy and security of health information in some circumstances, many of which differ from each other in significant ways and often are not pre-empted by HIPAA, thus complicating compliance efforts.

Efforts to ensure that our business arrangements with third parties will comply with applicable healthcare laws and regulations will involve substantial costs. It is possible that governmental authorities will conclude that our business practices may not comply with current or future statutes, regulations or case law involving applicable fraud and abuse or other healthcare laws and regulations. If our operations are found to be in violation of any of these laws or any other governmental regulations that may apply to us, we may be subject to significant civil, criminal and administrative penalties, damages, fines, imprisonment, exclusion of products from government funded healthcare programs, such as Medicare and Medicaid, and the curtailment or restructuring of our operations. If any of the physicians or other healthcare providers or entities with whom we expect to do business is found to be not in compliance with applicable laws, they may be subject to criminal, civil or administrative sanctions, including exclusions from government funded healthcare programs.

Current and future legislation may increase the difficulty and cost for us and any collaborators to obtain marketing approval of our drug candidates and may affect the prices we, or they, may obtain.

In the United States and some foreign jurisdictions, there have been a number of legislative and regulatory changes and proposed changes regarding the healthcare system that could, among other things, prevent or delay marketing approval of our drug candidates, restrict or regulate post-approval activities and affect our ability, or the ability of any collaborators, to profitably sell any products for which we, or they, obtain marketing approval. We expect that current laws, as well as other healthcare reform measures that may be adopted in the future, may

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result in more rigorous coverage criteria and in additional downward pressure on the price that we, or any collaborators, may receive for any approved products.

For example, in March 2010, President Obama signed into law the Patient Protection and Affordable Care Act, as amended by the Health Care and Education Reconciliation Act, or collectively the PPACA. Among the provisions of the PPACA of potential importance to our business and our drug candidates are the following:

- an annual, non-deductible fee on any entity that manufactures or imports specified branded prescription drugs and biologic agents;
- an increase in the statutory minimum rebates a manufacturer must pay under the Medicaid Drug Rebate Program;
- expansion of healthcare fraud and abuse laws, including the civil False Claims Act and the federal Anti-Kickback Statute, new government investigative powers and enhanced penalties for noncompliance;
- a new Medicare Part D coverage gap discount program, in which manufacturers must agree to offer 50% point-of-sale discounts off negotiated prices;
- extension of manufacturers' Medicaid rebate liability;
- expansion of eligibility criteria for Medicaid programs;
- expansion of the entities eligible for discounts under the Public Health Service pharmaceutical pricing program;
- new requirements to report certain financial arrangements with physicians and teaching hospitals;
- a new requirement to annually report drug samples that manufacturers and distributors provide to physicians; and
- a new Patient-Centered Outcomes Research Institute to oversee, identify priorities in, and conduct comparative clinical effectiveness research, along with funding for such research.

In addition, other legislative changes have been proposed and adopted since the PPACA was enacted. These changes include the Budget Control Act of 2011, which, among other things, led to aggregate reductions to Medicare payments to providers of up to 2% per fiscal year that started in 2013 and, due to subsequent legislative amendments to the statute, will stay in effect through 2025 unless additional congressional action is taken, and the American Taxpayer Relief Act of 2012, which, among other things, reduced Medicare payments to several types of providers and increased the statute of limitations period for the government to recover overpayments to providers from three to five years. These new laws may result in additional reductions in Medicare and other healthcare funding and otherwise affect the prices we may obtain for any of our drug candidates for which we may obtain regulatory approval or the frequency with which any such drug candidate is prescribed or used. Further, there have been several recent U.S. congressional inquiries and proposed state and federal legislation designed to, among other things, bring more transparency to drug pricing, review the relationship between pricing and manufacturer patient programs, reduce the costs of drugs under Medicare and reform government program reimbursement methodologies for drug products.

We expect that these healthcare reforms, as well as other healthcare reform measures that may be adopted in the future, may result in additional reductions in Medicare and other healthcare funding, more rigorous coverage criteria, new payment methodologies and additional downward pressure on the price that we receive for any approved product and/or the level of reimbursement physicians receive for administering any approved product we might bring to market. Reductions in reimbursement levels may negatively impact the prices we receive or the frequency with which our products are prescribed or administered. Any reduction in reimbursement from Medicare or other government programs may result in a similar reduction in payments from private payors.

The Trump Administration has also taken a number of executive actions to repeal or delay implementation of the PPACA. Most recently, the Tax Cuts and Jobs Act of 2017 repealed the “individual mandate.” The repeal of this provision, which requires most Americans to carry a minimal level of health insurance, became effective in 2019. According to the Congressional Budget Office, the repeal of the individual mandate will cause 13 million fewer Americans to be insured in 2027 and premiums in insurance markets may rise.

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We will continue to evaluate the effect that the PPACA and its possible repeal and replacement could have on our business. It is possible that repeal and replacement initiatives, if enacted into law, could ultimately result in fewer individuals having health insurance coverage or in individuals having insurance coverage with less generous benefits. While the timing and scope of any potential future legislation to repeal and replace PPACA provisions is highly uncertain in many respects, it is also possible that some of the PPACA provisions that generally are not favorable for the research-based pharmaceutical industry could also be repealed along with PPACA coverage expansion provisions Accordingly, such reforms, if enacted, could have an adverse effect on anticipated revenue from drug candidates that we may successfully develop and for which we may obtain marketing approval and may affect our overall financial condition and ability to develop commercialize drug candidates.

The costs of prescription pharmaceuticals in the United States has also been the subject of considerable discussion in the United States, and members of Congress and the Administration have stated that they will address such costs through new legislative and administrative measures. The pricing of prescription pharmaceuticals is also subject to governmental control outside the United States. In these countries, pricing negotiations with governmental authorities can take considerable time after the receipt of marketing approval for a product. To obtain reimbursement or pricing approval in some countries, we may be required to conduct a clinical trial that compares the cost effectiveness of our drug candidates to other available therapies. If reimbursement of our products is unavailable or limited in scope or amount, or if pricing is set at unsatisfactory levels, our ability to generate revenues and become profitable could be impaired. In the European Union, similar political, economic and regulatory developments may affect our ability to profitably commercialize our products. In addition to continuing pressure on prices and cost containment measures, legislative developments at the European Union or member state level may result in significant additional requirements or obstacles that may increase our operating costs.

Moreover, legislative and regulatory proposals have also been made to expand post-approval requirements and restrict sales and promotional activities for pharmaceutical drugs. We cannot be sure whether additional legislative changes will be enacted, or whether the FDA regulations, guidance or interpretations will be changed, or what the impact of such changes on the marketing approvals of our drug candidates, if any, may be. In addition, increased scrutiny by Congress of the FDA’s approval process may significantly delay or prevent marketing approval, as well as subject us and any future collaborators to more stringent drug labeling and post-marketing testing and other requirements.

Laws and regulations governing any international operations we may have in the future may preclude us from developing, manufacturing and selling certain drug candidates outside of the United States and require us to develop and implement costly compliance programs.

We are subject to numerous laws and regulations in each jurisdiction outside the United States in which we operate. The creation, implementation and maintenance of international business practices compliance programs is costly and such programs are difficult to enforce, particularly where reliance on third parties is required.

The FCPA prohibits any U.S. individual or business from paying, offering, authorizing payment or offering of anything of value, directly or indirectly, to any foreign official, political party or candidate for the purpose of influencing any act or decision of the foreign entity in order to assist the individual or business in obtaining or retaining business. The FCPA also obligates companies whose securities are listed in the United States to comply with certain accounting provisions requiring the company to maintain books and records that accurately and fairly reflect all transactions of the corporation, including international subsidiaries, and to devise and maintain an adequate system of internal accounting controls for international operations. The anti-bribery provisions of the FCPA are enforced primarily by the DOJ. The Securities and Exchange Commission, or SEC, is involved with enforcement of the books and records provisions of the FCPA.

Compliance with the FCPA and other anti-bribery laws is expensive and difficult, particularly in countries in which corruption is a recognized problem. In addition, the FCPA presents particular challenges in the pharmaceutical industry, because, in many countries, hospitals are operated by the government, and doctors and other hospital employees are considered foreign officials. Certain payments to hospitals in connection with clinical trials and other work have been deemed to be improper payments to government officials and have led to FCPA enforcement actions.

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Various laws, regulations and executive orders also restrict the use and dissemination outside of the United States, or the sharing with certain non-U.S. nationals, of information classified for national security purposes, as well as certain products and technical data relating to those products. Our expansion outside of the United States, has required, and will continue to require, us to dedicate additional resources to comply with these laws, and these laws may preclude us from developing, manufacturing, or selling certain drugs and drug candidates outside of the United States, which could limit our growth potential and increase our development costs. The failure to comply with laws governing international business practices may result in substantial penalties, including suspension or debarment from government contracting. Violation of the FCPA and other anti-bribery laws can result in significant civil and criminal penalties. Indictment alone under the FCPA can lead to suspension of the right to do business with the U.S. government until the pending claims are resolved. Conviction of a violation of the FCPA can result in long-term disqualification as a government contractor. The termination of a government contract or relationship as a result of our failure to satisfy any of our obligations under laws governing international business practices would have a negative impact on our operations and harm our reputation and ability to procure government contracts. The SEC also may suspend or bar issuers from trading securities on U.S. exchanges for violations of the FCPA's accounting provisions.

Governments outside of the United States tend to impose strict price controls, which may adversely affect our revenues from the sales of drugs, if any.

In some countries, particularly the countries of the European Union, the pricing of prescription pharmaceuticals is subject to governmental control. In these countries, pricing negotiations with governmental authorities can take considerable time after the receipt of marketing approval for a drug. To obtain reimbursement or pricing approval in some countries, we, or our future collaborators, may be required to conduct a clinical trial that compares the cost-effectiveness of our drug to other available therapies. If reimbursement of our drugs is unavailable or limited in scope or amount, or if pricing is set at unsatisfactory levels, our business could be materially harmed.

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 our business.

We are subject to numerous environmental, health and safety laws and regulations, including 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 and radioactive 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, this insurance may not provide adequate

coverage against potential liabilities. We do not maintain insurance for environmental liability or toxic tort claims that may be asserted against us in connection with our storage or disposal of biological, hazardous or radioactive materials.

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 commercialization efforts. Failure to comply with these laws and regulations also may result in substantial fines, penalties or other sanctions.

Our employees may engage in misconduct or other improper activities, including non-compliance with regulatory standards and requirements, which could cause significant liability for us and harm our reputation.

We are exposed to the risk of employee fraud or other misconduct, including intentional failures to comply with FDA regulations or similar regulations of comparable foreign regulatory authorities, provide accurate information to the FDA or comparable foreign regulatory authorities, comply with manufacturing standards we have established, comply with federal and state healthcare fraud and abuse laws and regulations and similar laws and regulations established and enforced by comparable foreign regulatory authorities, report financial information or

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data accurately or disclose unauthorized activities to us. Employee misconduct could also involve the improper use of information obtained in the course of clinical trials, which could result in regulatory sanctions and serious harm to our reputation. It is not always possible to identify and deter employee misconduct, 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 be in compliance with such laws, standards or 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 and results of operations, including the imposition of significant fines or other sanctions.

We depend on information technology, infrastructure and data to conduct our business. Any significant disruption could have a material adverse effect on our business.

We are dependent upon information technology, infrastructure and data. Computer systems, including ours and those of our suppliers, partners and service providers, contain sensitive confidential information or intellectual property. Computer systems are vulnerable to service interruption or destruction, cyber-attacks (both malicious and random) and other natural or man-made incidents or disasters, which may be prolonged or go undetected. Such events and attacks are increasing in their frequency, sophistication and intensity, and have become increasingly difficult to detect. A significant or large-scale interruption of our information technology could adversely affect our ability to manage and keep our operations running efficiently and effectively. An incident that results in a wider or sustained disruption to our business or products could have a material adverse effect on our business, financial condition and results of operations.

Likewise, data privacy or security breaches by employees or others may pose a risk that sensitive data, including our intellectual property, trade secrets or personal information of our employees, patients or other business partners may be exposed to unauthorized persons or to the public. There can be no assurance that our efforts, or the efforts of our partners and vendors, will prevent service interruptions, or identify breaches in our systems, that could adversely affect our business and operations and/or result in the loss of critical or sensitive information, which could result in financial, legal, business or reputational harm to us. In addition, our liability insurance may not be sufficient in type or amount to cover us against claims related to security breaches, cyberattacks and other related breaches.

Risks Relating to Collaborators

Our existing collaborations and any collaborations we enter into in the future may not be successful.

Historically, an important element of our business strategy has included entering into collaborative alliances with corporate collaborators, primarily large pharmaceutical companies, for the development, commercialization, marketing, and distribution of some of our drug candidates. We are currently a party to a collaboration and license

agreement with GSK for the development of our nucleic acid chemistry technology for certain renal indications, which we entered into in November 2015.

Our current collaboration, or any collaborations we may enter into in the future, may not be successful. The success of our collaborative alliances, if any, will depend heavily on the efforts and activities of our collaborators. Our existing collaborations and any potential future collaborations have risks, including the following:

- our collaborators may control the development of the drug candidates being developed with our technologies and compounds including the timing of development;
- our collaborators may control the development of the companion diagnostic to be developed for use in conjunction with our drug candidates including the timing of development;
- our collaborators may control the public release of information regarding the developments, and we may not be able to make announcements or data presentations on a schedule favorable to us;
- disputes may arise in the future with respect to the ownership of or right to use technology and intellectual property developed with our collaborators;
- disagreements with our collaborators could delay or terminate the research, development or commercialization of products, or result in litigation or arbitration;

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- we may have difficulty enforcing the contracts if any of our collaborators fail to perform;
- our collaborators may terminate their collaborations with us, which could make it difficult for us to attract new collaborators or adversely affect the perception of us in the business or financial communities;
- our collaboration agreements are likely to be for fixed terms and subject to termination by our collaborators in the event of a material breach or lack of scientific progress by us;
- our collaborators may have the first right to maintain or defend our intellectual property rights and, although we would likely have the right to assume the maintenance and defense of our intellectual property rights if our collaborators do not, our ability to do so may be compromised by our collaborators' acts or omissions;
- our collaborators may challenge our intellectual property rights or utilize our intellectual property rights in such a way as to invite litigation that could jeopardize or invalidate our intellectual property rights or expose us to potential liability;
- our collaborators may not comply with all applicable regulatory requirements, or may fail to report safety data in accordance with all applicable regulatory requirements;
- our collaborators may change the focus of their development and commercialization efforts. Pharmaceutical and biotechnology companies historically have re-evaluated their priorities following mergers and consolidations, which have been common in recent years in these industries. The ability of our drug candidates to reach their potential could be limited if our collaborators decrease or fail to increase spending relating to such drug candidates;
- our collaborators may under fund or not commit sufficient resources to the testing, marketing, distribution or development of our drug candidates; and
- our collaborators may develop alternative products either on their own or in collaboration with others, or encounter conflicts of interest or changes in business strategy or other business issues, which could adversely affect their willingness or ability to fulfill their obligations to us.

Given these risks, it is possible that any collaborative alliance into which we enter may not be successful. Collaborations with pharmaceutical companies and other third parties often are terminated or allowed to expire by the other party. For example, in March 2019, Vivelix and we mutually agreed to terminate the Vivelix Agreement. The termination or expiration of our current collaboration agreement or any other collaboration agreement that we enter into in the future may adversely affect us financially and could harm our business reputation.

If we are unable to establish additional collaborative alliances, our business may be materially harmed.

Collaborators provide the necessary resources and drug development experience to advance our compounds in their programs. We have entered into and expect to continue to seek to enter into collaborative alliances with pharmaceutical companies to advance our TLR agonist and antagonist candidates and with respect to additional applications of our nucleic acid chemistry technology research program. Upfront payments and milestone payments received from collaborations help to provide us with the financial resources for our internal research and development programs. Our internal programs are focused on developing TLR-targeted drug candidates for the potential treatment of certain rare diseases and in our immuno-oncology program and on nucleic acid chemistry drug candidates. We believe that additional resources will be required to advance compounds in all of these areas. If we do not reach agreements with additional collaborators in the future, we may not be able to obtain the expertise and resources necessary to achieve our business objectives, our ability to advance our compounds will be jeopardized and we may fail to meet our business objectives.

We may have difficulty establishing additional collaborative alliances, particularly with respect to our TLR-targeted drug candidates and technology. For example, potential collaborators may note that our prior TLR collaborations with Vivelix, Novartis and with Merck KGaA have been terminated. Potential collaborators may also be reluctant to establish collaborations with respect to tilsotolimod (IMO-2125), IMO-8400 or IMO-9200, given our prior setbacks with respect to these drug candidates. We also face, and expect to continue to face, significant competition in seeking appropriate collaborators.

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Even if a potential partner were willing to enter into a collaborative alliance with respect to our TLR-targeted compounds or technology or our nucleic acid chemistry technology, the terms of such a collaborative alliance may not be on terms that are favorable to us. Moreover, collaborations are complex and time consuming to negotiate, document, and implement. We may not be successful in our efforts to establish and implement collaborations on a timely basis.

Risks Relating to Intellectual Property

If we are unable to obtain and maintain patent protection for our discoveries, the value of our technology and products will be adversely affected.

Our patent positions, and those of other drug discovery companies, are generally uncertain and involve complex legal, scientific, and factual questions. Our ability to develop and commercialize drugs depends in significant part on our ability to:

- obtain and maintain valid and enforceable patents;
- obtain licenses to the proprietary rights of others on commercially reasonable terms;
- operate without infringing upon the proprietary rights of others;
- prevent others from infringing on our proprietary rights; and
- protect our trade secrets.

We do not know whether any of our currently pending patent applications or those patent applications that we license will result in the issuance of any patents. Our issued patents and those that may be issued in the future, or those licensed to us, may be challenged, invalidated, held unenforceable, narrowed in the course of a post-issuance proceeding or circumvented, and the rights granted thereunder may not provide us proprietary protection or competitive advantages against competitors with similar technology. Moreover, intellectual property laws may change and negatively impact our ability to obtain issued patents covering our technologies or to enforce any patents that issue. Because of the extensive time required for development, testing, and regulatory review of a potential product, it is possible that, before any of our products can be commercialized, any related patent may expire or remain in force for only a short period following commercialization, thus reducing any advantage provided by the patent.

Because patent applications in the United States and many foreign jurisdictions are typically not published until 18 months after filing, or in some cases not at all, and because publications of discoveries in the scientific literature often lag behind actual discoveries, neither we nor our licensors can be certain that we or they were the first to make the inventions claimed in issued patents or pending patent applications, or that we or they were the first to file for protection of the inventions set forth in these patent applications.

As of February 15, 2019, we owned approximately 51 U.S. patents and patent applications and approximately 139 patents and patent applications throughout the rest of the world for our TLR-targeted immune modulation technologies. These patents and patent applications include claims covering the chemical compositions of matter and methods of use of our IMO compounds, such as IMO-8400, IMO-9200 and tilsotolimod (IMO-2125), as well as other compounds. These patents expire at various dates ranging from 2023 to 2037. With respect to IMO-8400, we have six issued U.S. patents that cover the chemical composition of matter of IMO-8400 and certain methods of its use that provide exclusivity for IMO-8400 until at least 2031. With respect to IMO-9200, we have nine issued U.S. patents that cover the chemical composition for IMO-9200 and methods of its use that provide exclusivity for IMO-9200 until at least 2034. With respect to tilsotolimod, we have an issued U.S. patent that covers the chemical composition of matter of tilsotolimod and methods of its use that will expire in 2025. We have pending applications in the United States and outside of the United States that cover methods of treatment or use with tilsotolimod with expiration dates of 2035 and 2037.

As of February 15, 2019, we owned three issued U.S. patents, approximately 38 issued foreign patents, one pending U.S. patent application, and four foreign patent applications (including pending applications under the Patent Cooperation Treaty, or PCT) related to our nucleic acid chemistry compounds and methods of their use. The issued patents covering our nucleic acid chemistry technologies have an earliest statutory expiration date in 2030.

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Third parties may own or control patents or patent applications and require us to seek licenses, which could increase our development and commercialization costs, or prevent us from developing or marketing products.

Although we have many issued patents and pending patent applications in the United States and other countries, we may not have rights under certain third-party patents or patent applications related to our compounds under development. Third parties may own or control these patents and patent applications in the United States and abroad. In particular, we are aware of certain third-party U.S. patents that contain claims related to immunostimulatory polynucleotides and their use to stimulate an immune response, as well as to antisense technology. Although we do not believe any of our TLR or antisense compounds under development infringe any valid claim of these patents, we cannot be assured that the holder of such patents would not seek to assert such patents against us or, if the holder did, that the courts would not interpret the claims of such patents more broadly than we believe appropriate and determine that we are in infringement of such patents. In addition, there may be other patents and patent applications related to our current or future drug candidates of which we are not aware. Therefore, in some cases, in order to develop, manufacture, sell or import some of our drug candidates, we or our collaborators may choose to seek, or be required to seek, licenses under third-party patents issued in the United States and abroad or under third-party patents that might issue from U.S. and foreign patent applications. In such an event, we would be required to pay license fees or royalties or both to the licensor. If licenses are not available to us on acceptable terms, we or our collaborators may not be able to develop, manufacture, sell or import these products, or may be delayed in doing so. Either of these results could have a material adverse effect on our business.

We may become involved in expensive patent litigation or other proceedings, which could result in our incurring substantial costs and expenses or substantial liability for damages, require us to stop our development and commercialization efforts or result in our patents being invalidated, interpreted narrowly or limited.

There has been substantial litigation and other proceedings regarding patent and other intellectual property rights in the biotechnology industry. We may become a party to various types of patent litigation or other proceedings regarding intellectual property rights from time to time even under circumstances where we are not practicing and do not intend to practice any of the intellectual property involved in the proceedings.

In addition to litigation, we may become involved in patent office proceedings, including oppositions, reexaminations, supplemental examinations and inter partes reviews involving our patents or the patents of third parties. We may initiate such proceedings or have such proceedings brought against us. An adverse determination in any such proceeding, or in litigation, could reduce the scope of, or invalidate, our patent rights, allow third parties to commercialize our technology or products and compete directly with us, without payment to us, or result in our inability to manufacture or commercialize products without infringing third-party patent rights. In addition, if the breadth or strength of protection provided by our patents and patent applications is threatened, it could dissuade companies from collaborating with us to license, develop or commercialize current or future drug candidates. An adverse determination in a proceeding involving a patent in our portfolio could result in the loss of protection or a narrowing in the scope of protection provided by that patent.

The cost to us of any patent litigation or other proceeding, even if resolved in our favor, could be substantial. Some of our competitors may be able to sustain the cost of such litigation or proceedings more effectively than we can because of their substantially greater financial resources. If any patent litigation or other proceeding is resolved against us, we or our collaborators may be enjoined from developing, manufacturing, selling or importing our drugs without a license from the other party and we may be held liable for significant damages. We may not be able to obtain any required license on commercially acceptable terms or at all. In a patent office proceeding, such as an opposition, reexamination or inter partes review, our patents may be narrowed or invalidated.

Uncertainties resulting from the initiation and continuation of patent litigation or other proceedings could have a material adverse effect on our ability to compete in the marketplace. Patent litigation and other proceedings may also absorb significant management time.

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Risks Relating to Product Manufacturing, Marketing and Sales, and Reliance on Third Parties

Because we have limited manufacturing experience, and no manufacturing facilities or infrastructure, we are dependent on third-party manufacturers to manufacture drug candidates for us. If we cannot rely on third-party manufacturers, we will be required to incur significant costs and devote significant efforts to establish our own manufacturing facilities and capabilities.

We have limited manufacturing experience and no manufacturing facilities, infrastructure or clinical or commercial scale manufacturing capabilities. In order to continue to develop our drug candidates, apply for regulatory approvals, and ultimately commercialize products, we need to develop, contract for or otherwise arrange for the necessary manufacturing capabilities.

We currently rely upon third parties to produce material for nonclinical and clinical testing purposes and expect to continue to do so in the future. We also expect to rely upon third parties to produce materials that may be required for the commercial production of our drug candidates, if approved. Our current and anticipated future dependence upon others for the manufacture of our drug candidates may adversely affect our future profit margins and our ability to develop drug candidates and commercialize any drug candidates on a timely and competitive basis. We currently do not have any long term supply contracts.

There are a limited number of manufacturers that operate under the FDA's cGMP regulations capable of manufacturing our drug candidates. As a result, we may have difficulty finding manufacturers for our drug candidates with adequate capacity for our needs. If we are unable to arrange for third-party manufacturing of our drug candidates on a timely basis, or to do so on commercially reasonable terms, we may not be able to complete development of our drug candidates or market them.

Reliance on third-party manufacturers entails risks to which we would not be subject if we manufactured drug candidates ourselves, including:

- reliance on the third party for regulatory compliance and quality assurance;
- the possibility of breach of the manufacturing agreement by the third party because of factors beyond our control;
- the possibility of termination or nonrenewal of the agreement by the third party, based on its own business priorities or otherwise, at a time that is costly or inconvenient for us;
- the potential that third-party manufacturers will develop know-how owned by such third party in connection with the production of our drug candidates that becomes necessary for the manufacture of our drug candidates; and
- reliance upon third-party manufacturers to assist us in preventing inadvertent disclosure or theft of our proprietary knowledge.

Any contract manufacturers with which we enter into manufacturing arrangements will be subject to ongoing periodic, unannounced inspections by the FDA, or foreign equivalent, and corresponding state and foreign agencies or their designees to ensure compliance with cGMP requirements and other governmental regulations and corresponding foreign standards. Any failure by our third-party manufacturers to comply with such requirements, regulations or standards could lead to a delay in the conduct of our clinical trials, or a delay in, or failure to obtain, regulatory approval of any of our drug candidates. Such failure could also result in sanctions being imposed, including fines, injunctions, civil penalties, delays, suspension or withdrawal of approvals, product seizures or recalls, imposition of operating restrictions, total or partial suspension of production or distribution, or criminal prosecution.

Additionally, contract manufacturers may not be able to manufacture our drug candidates at a cost or in quantities necessary to make them commercially viable. As of February 15, 2018, our third-party manufacturers have met our manufacturing requirements, but we cannot be assured that they will continue to do so. Furthermore, changes in the manufacturing process or procedure, including a change in the location where the drug substance or drug product is manufactured or a change of a third-party manufacturer, may require prior FDA review and approval in accordance with the FDA's cGMP and New Drug Application/biologics license application regulations. Contract manufacturers may also be subject to comparable foreign requirements. This review may be costly and

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time-consuming and could delay or prevent the launch of a drug candidate. The FDA or similar foreign regulatory agencies at any time may also implement new standards, or change their interpretation and enforcement of existing standards for manufacture, packaging or testing of products. If we or our contract manufacturers are unable to comply, we or they may be subject to regulatory action, civil actions or penalties.

We have no experience selling, marketing or distributing products and no internal capability to do so.

If we receive regulatory approval to commence commercial sales of any of our drug candidates, we will face competition with respect to commercial sales, marketing, and distribution. These are areas in which we have no experience. To market any of our drug candidates directly, we would need to develop a marketing and sales force with technical expertise and with supporting distribution capability. In particular, we would need to recruit experienced marketing and sales personnel. Alternatively, we could engage a pharmaceutical or other healthcare company with an existing distribution system and direct sales force to assist us. However, to the extent we entered into such arrangements, we would be dependent on the efforts of third parties. If we are unable to establish sales and distribution capabilities, whether internally or in reliance on third parties, our business would suffer materially.

If third parties on whom we rely for clinical trials do not perform as contractually required or as we expect, we may not be able to obtain regulatory approval for or commercialize our drug candidates and our business may suffer.

We do not have the ability to independently conduct the clinical trials required to obtain regulatory approval for our drug candidates. We depend on independent clinical investigators, contract research organizations, and other third-party service providers in the conduct of the clinical trials of our drug candidates and expect to continue to do so. We expect to contract with contract research organizations for future clinical trials. We rely heavily on these parties for successful execution of our clinical trials, but do not control many aspects of their activities. We are responsible for ensuring that each of our clinical trials is conducted in accordance with the general investigational plan and protocols for the trial. Moreover, the FDA and foreign regulatory agencies require us to comply with certain standards, commonly referred to as good clinical practices, and applicable regulatory requirements, for conducting, recording, and reporting the results of clinical trials to assure that data and reported results are credible and accurate and that the rights, integrity, and confidentiality of clinical trial participants are protected. Our reliance on third parties that we do not control does not relieve us of these responsibilities and requirements. Third parties may not complete activities on schedule, or at all, or may not conduct our clinical trials in accordance with regulatory requirements or our stated protocols. If these third parties fail to carry out their obligations, we may need to enter into new arrangements with alternative third parties. This could be difficult, costly or impossible, and our preclinical studies or clinical trials may need to be extended, delayed, terminated or repeated, and we may not be able to obtain regulatory approval in a timely fashion, or at all, for the applicable drug candidate, or to commercialize such drug candidate being tested in such studies or trials. If we seek to conduct any of these activities ourselves in the future, we will need to recruit appropriately trained personnel and add to our research, clinical, quality and corporate infrastructure.

The commercial success of any drug candidates that we may develop will depend upon the degree of market acceptance by physicians, patients, third-party payors, and others in the medical community.

Any products that we ultimately bring to the market, if they receive marketing approval, may not gain market acceptance by physicians, patients, third-party payors or others in the medical community. For example, current cancer treatments like chemotherapy and radiation therapy are well established in the medical community, and doctors may continue to rely on these treatments. If our products do not achieve an adequate level of acceptance, we may not generate product revenue and we may not become profitable. The degree of market acceptance of our products, if approved for commercial sale, will depend on a number of factors, including:

- the prevalence and severity of any side effects, including any limitations or warnings contained in the product's approved labeling;
- the efficacy and potential advantages over alternative treatments;
    - the ability to offer our drug candidates for sale at competitive prices;
- relative convenience and ease of administration;
- the willingness of the target patient population to try new therapies and of physicians to prescribe these therapies;

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- the strength of marketing and distribution support and the timing of market introduction of competitive products; and
- publicity concerning our products or competing products and treatments.

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

If we are unable to obtain adequate reimbursement from third-party payors for any products that we may develop or acceptable prices for those products, our revenues and prospects for profitability will suffer.

Most patients rely on Medicare, Medicaid, private health insurers, and other third-party payors to pay for their medical needs, including any drugs we may market. If third-party payors do not provide adequate coverage or reimbursement for any products that we may develop, our revenues and prospects for profitability will suffer. Congress enacted a limited prescription drug benefit for Medicare recipients in the Medicare Prescription Drug, Improvement, and Modernization Act of 2003. While the program established by this statute may increase demand for our products if we were to participate in this program, our prices will be negotiated with drug procurement organizations for Medicare beneficiaries and are likely to be lower than we might otherwise obtain. Non-Medicare third-party drug procurement organizations may also base the price they are willing to pay on the rate paid by drug procurement organizations for Medicare beneficiaries or may otherwise negotiate the price they are willing to pay.

A primary trend in the United States healthcare industry is toward cost containment. In addition, in some foreign countries, particularly the countries of the European Union, the pricing of prescription pharmaceuticals is subject to governmental control. In these countries, pricing negotiations with governmental authorities can take six months or longer after the receipt of regulatory marketing approval for a product. To obtain reimbursement or pricing approval in some countries, we may be required to conduct a clinical trial that compares the cost effectiveness of our drug candidates or products to other available therapies. The conduct of such a clinical trial could be expensive and result in delays in commercialization of our drug candidates. These further clinical trials would require additional time, resources, and expenses. If reimbursement of our products is unavailable or limited in scope or amount, or if pricing is set at unsatisfactory levels, our prospects for generating revenue, if any, could be adversely affected and our business may suffer.

In March 2010, the Patient Protection and Affordable Care Act and the Health Care and Education Reconciliation Act became law. These health care reform laws are intended to broaden access to health insurance; reduce or constrain the growth of health care spending, especially Medicare spending; enhance remedies against fraud and abuse; add new transparency requirements for health care and health insurance industries; impose new taxes and fees on certain sectors of the health industry; and impose additional health policy reforms. Among the new fees is an annual assessment on makers of branded pharmaceuticals and biologics, under which a company's assessment is based

primarily on its share of branded drug sales to federal health care programs. Such fees could affect our future prospects for profitability. Although it is too early to determine the effect of the health care legislation on our future prospects for profitability and financial condition, the law appears likely to continue the pressure on pharmaceutical pricing, especially under the Medicare program, and may also increase our regulatory burdens and operating costs.

Third-party payors are challenging the prices charged for medical products and services, and many third-party payors limit reimbursement for newly-approved health care products. These third-party payors may base their coverage and reimbursement on the coverage and reimbursement rate paid by carriers for Medicare beneficiaries. Furthermore, many such payors are investigating or implementing methods for reducing health care costs, such as the establishment of capitated or prospective payment systems. Cost containment pressures have led to an increased emphasis on the use of cost-effective products by health care providers. In particular, third-party payors may limit the indications for which they will reimburse patients who use any products that we may develop. Cost control initiatives could limit the price we might establish for products that we or our current or future collaborators may develop or sell, which would result in lower product revenues or royalties payable to us.

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We face a risk of product liability claims and may not be able to obtain insurance.

Our business exposes us to the risk of product liability claims that is inherent in the manufacturing, testing, and marketing of human therapeutic drugs. We face an inherent risk of product liability exposure related to the testing of our drug candidates in human clinical trials and will face an even greater risk if we commercially sell any products. Regardless of merit or eventual outcome, liability claims and product recalls may result in:

- decreased demand for our drug candidates and products;
- damage to our reputation;
- regulatory investigations that could require costly recalls or product modifications;
- withdrawal of clinical trial participants;
- costs to defend related litigation;
- substantial monetary awards to clinical trial participants or patients, including awards that substantially exceed our product liability insurance, which we would then have to pay using other sources, if available, and would damage our ability to obtain liability insurance at reasonable costs, or at all, in the future;
- loss of revenue;
- the diversion of management's attention away from managing our business; and
- the inability to commercialize any products that we may develop.

Although we have product liability and clinical trial liability insurance that we believe is adequate, this insurance is subject to deductibles and coverage limitations. We may not be able to obtain or maintain adequate protection against potential liabilities. If we are unable to obtain insurance at acceptable cost or otherwise protect against potential product liability claims, we will be exposed to significant liabilities, which may materially and adversely affect our business and financial position. These liabilities could prevent or interfere with our commercialization efforts.

Risks Relating to Ownership of Our Common Stock

Our corporate governance structure, including provisions in our certificate of incorporation and by-laws and Delaware law, may prevent a change in control or management that stockholders may consider desirable.

Section 203 of the Delaware General Corporation Law and our certificate of incorporation and by-laws contain provisions that might enable our management to resist a takeover of our company or discourage a third party from attempting to take over our company. These provisions include:

- a classified board of directors;
- limitations on the removal of directors;
- limitations on stockholder proposals at meetings of stockholders;
- the inability of stockholders to act by written consent or to call special meetings; and
- the ability of our board of directors to designate the terms of and issue new series of preferred stock without stockholder approval.

In addition, Section 203 of the Delaware General Corporation Law imposes restrictions on our ability to engage in business combinations and other specified transactions with significant stockholders. These provisions could have the effect of delaying, deferring or preventing a change in control of us or a change in our management that stockholders may consider favorable or beneficial. These provisions could also discourage proxy contests and make it more difficult for you and other stockholders to elect directors and take other corporate actions. These provisions could also limit the price that investors might be willing to pay in the future for shares of our common stock.

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We have three significant securityholders. If these securityholders choose to act together, they could exert substantial influence over our business. In addition, in connection with any merger, consolidation or sale of all or substantially all of our assets, they would be entitled to receive consideration in excess of their reported beneficial ownership of our common stock.

As of February 15, 2019, Baker Bros. Advisors LP, and certain of its affiliated funds, which we refer to collectively as Baker Brothers, held 4,839,895 shares of our common stock and pre-funded warrants to purchase up to 2,768,882 shares of our common stock at an exercise price of $0.08 per share. As of February 15, 2019, Baker Brothers beneficially owned 17.7% of our outstanding common stock. In addition, one member of our board of directors is an affiliate of Baker Brothers. Under the terms of the pre-funded warrants issued to Baker Brothers, Baker Brothers is not permitted to exercise such warrants to the extent that such exercise would result in Baker Brothers (and its affiliates) beneficially owning more than 4.999% of the number of shares of our common stock outstanding immediately after giving effect to the issuance of shares of common stock issuable upon exercise of such warrants. Baker Brothers has the right to increase this beneficial ownership limitation in its discretion on 61 days' prior written notice to us, provided that in no event is Baker Brothers permitted to exercise such warrants to the extent that such exercise would result in Baker Brothers (and its affiliates) beneficially owning more than 19.99% of the number of shares of our common stock outstanding or the combined voting power of our securities outstanding immediately after giving effect to the issuance of shares of common stock issuable upon exercise of such warrants. The information in this paragraph is based on a Schedule 13D/A filed with the SEC on September 20, 2018; Form 4s filed with the SEC on October 3, 2018 and January 4, 2019; and on information provided to us by Baker Brothers. On February 9, 2015, we entered into a registration rights agreement with Baker Brothers, pursuant to which we agreed to file registration statements to register for resale the shares of our common stock, including shares issuable upon the exercise of warrants, held by Baker Brothers

As of February 15, 2019, entities affiliated with Pillar Invest Corporation, which we refer to collectively as the Pillar Investment Entities, held 2,447,407 shares of our common stock. As of February 15, 2019, the Pillar Investment Entities beneficially owned 9.0% of our outstanding common stock. The Pillar Investment Entities are subject to contractual limitations that limit their ability to exercise any securities held by them that are exercisable into shares of our common stock to the extent that such exercise would result in the Pillar Investment Entities and their affiliates beneficially owning more than 19.99% of the number of shares of our common stock outstanding or the combined voting power of our securities outstanding immediately after giving effect to the issuance of shares of common stock issuable upon exercise of such securities. The information in this paragraph is based on a Schedule 13D/A filed with the SEC on October 17, 2016; Form 4s filed with the SEC on October 17, 2017 and August 17, 2018; and on information provided to us by Pillar Invest Corporation.

Although there are contractual limitations on the beneficial ownership of Baker Brothers and the Pillar Investment Entities, which we refer to collectively as our significant securityholders, if our significant securityholders were to exercise their warrants for common stock and were to choose to act together, they could be able to exert substantial influence over our business. This concentration of voting power could delay, defer or prevent a change of control, entrench our management and the board of directors or delay or prevent a merger, consolidation, takeover or other business combination involving us on terms that other stockholders may desire. In addition, conflicts of interest could arise in the future between us, on the one hand, and either or both of our significant securityholders on the other hand, concerning potential competitive business activities, business opportunities, the issuance of additional securities and

other matters. Furthermore in the event of a sale of our company, whether by merger, sale of all or substantially all of our assets or otherwise, our significant securityholders would be entitled to receive, with respect to each share of common stock issuable upon exercise of the warrants then held by them and without regard to the beneficial ownership limitations imposed on the conversion or exercise of such securities, the same amount and kind of securities, cash or property as they would have been entitled to receive if such securities had been converted into or exercised for shares of our common stock immediately prior to such sale of our company. Because the significant securityholders would receive this sale consideration with respect to warrants not included in their reported beneficial ownership of our common stock, in the event of a sale of our company, they would be entitled to receive a significantly larger portion of the total proceeds distributable to the holders of our securities than is represented by their reported beneficial ownership of our common stock.

As of February 15, 2019, Castellina Ventures Ltd., or Castellina, held 2,137,638 shares of our common stock, constituting 7.7% of our outstanding common stock. The information in this paragraph is based on a Schedule 13G filed with the SEC on September 4, 2018.

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Our stock price has been and may in the future be extremely volatile. In addition, because our common stock has historically been traded at low volume levels, our investors' ability to trade our common stock may be limited. As a result, investors may lose all or a significant portion of their investment.

Our stock price has been and may in the future be volatile. During the period from January 1, 2018 to February 15, 2019, the closing sales price of our common stock ranged from a high of $20.40 per share to a low of $2.25 per share. The stock market has also experienced periods of significant price and volume fluctuations and the market prices of biotechnology companies in particular have been highly volatile, often for reasons that have been unrelated to the operating performance of particular companies. The market price for our common stock may be influenced by many factors, including:

- our cash resources;
- timing and results of nonclinical studies and clinical trials of our drug candidates or those of our competitors;
- the regulatory status of our drug candidates;
- failure of any of our drug candidates, if approved, to achieve commercial success;
- the success of competitive products or technologies;
- regulatory developments in the United States and foreign countries;
- our success in entering into collaborative agreements;
- developments or disputes concerning patents or other proprietary rights;
- the departure of key personnel;
- our ability to maintain the listing of our common stock on The Nasdaq Capital Market or an alternative national securities exchange;
- variations in our financial results or those of companies that are perceived to be similar to us;
- the terms of any financing consummated by us;
- changes in the structure of healthcare payment systems;
- market conditions in the pharmaceutical and biotechnology sectors and issuance of new or changed securities analysts' reports or recommendations; and
- general economic, industry, and market conditions.

In addition, our common stock has historically been traded at low volume levels and may continue to trade at low volume levels. As a result, any large purchase or sale of our common stock could have a significant impact on the price of our common stock and it may be difficult for investors to sell our common stock in the market without depressing the market price for the common stock or at all.

As a result of the foregoing, investors may not be able to resell their shares at or above the price they paid for such shares. Investors in our common stock must be willing to bear the risk of fluctuations in the price of our common stock and the risk that the value of their investment in our stock could decline.

Because we do not intend to pay dividends on our common stock, investor returns will be limited to any increase in the value of our stock.

We have never declared or paid any cash dividends on our common 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 and do not anticipate declaring or paying any cash dividends on our common stock for the foreseeable future. Any return to stockholders will therefore be limited to the appreciation of their stock, if any.

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Item 1B. Unresolved Staff Comments.

None.

Item 2. Properties.

We lease approximately 11,000 square feet of office space located in Exton, Pennsylvania. The lease expires on May 31, 2020 subject to a three-year renewal option exercisable by us. We have specified rights to sublease this facility.

Item 3. Legal Proceedings.

None.

Item 4. Mine Safety Disclosures.

Not applicable.

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PART II.

Item 5.Market for Registrant’s Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities.

Market Information

Our common stock is listed under the symbol “IDRA” on the Nasdaq Capital Market.

Holders of Record

As of February 15, 2019, we had approximately 76 common stockholders of record registered on our books, excluding shares held through banks and brokers.

Dividends

We have never declared or paid cash dividends on our common stock, and we do not expect to pay any cash dividends on our common stock in the foreseeable future.

Recent Sales of Unregistered Securities

We did not issue any unregistered equity securities during the quarter ended December 31, 2018.

Issuer Purchases of Equity Securities

We did not repurchase any of our equity securities during the year ended December 31, 2018.

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Item 6.Selected Financial Data.

The following selected financial data are derived from our financial statements. The data should be read in conjunction with Management's Discussion and Analysis of Financial Condition and Results of Operations and the financial statements, related notes, and other financial information included elsewhere in this Annual Report on Form 10-K.

	Year Ended December 31,				
	2018	2017	2016	2015	2014
	(In thousands, except per share data)				
Statement of Operations and Comprehensive (Loss) Income Data:					
Alliance revenue	$ 662	$ 902	$ 16,199	$ 249	$ 73
Operating expenses:					
Research and development	41,841	50,653	39,824	33,699	27,493
General and administrative	15,420	15,588	15,132	15,396	11,332
Merger-related costs, net	1,245	1,128	—	—	—
Restructuring costs	3,112	—	—	—	—
Total operating expenses	61,618	67,369	54,956	49,095	38,825
Loss from operations	(60,956)	(66,467)	(38,757)	(48,846)	(38,752)
Other income (expense):					
Interest income	1,089	574	415	357	66
Interest expense	(11)	(50)	(80)	(105)	(27)
Foreign currency exchange (loss) gain	(3)	(41)	33	39	71
Net loss	$ (59,881)	$ (65,984)	$ (38,389)	$ (48,555)	$ (38,642)
Loss on extinguishment of convertible preferred stock, and preferred stock accretion and dividends	—	—	—	—	519
Net loss applicable to common stockholders	$ (59,881)	$ (65,984)	$ (38,389)	$ (48,555)	$ (39,161)
Net loss per share applicable to common stockholders - basic and diluted	$ (2.25)	$ (3.35)	$ (2.41)	$ (0.42)	$ (0.47)
Weighted-average number of common shares used in computing net loss per common share applicable to common stockholders - basic and diluted (1)	26,601	19,675	15,950	14,387	10,353

Comprehensive loss:					
Net loss	(59,881)	(65,984)	(38,389)	(48,555)	(38,642)
Other comprehensive income (loss):					
Unrealized income (loss) on available-for-sale securities	—	17	117	(117)	(10)
Total other comprehensive income (loss)	—	17	117	(117)	(10)
Comprehensive loss	$ (59,881)	$ (65,967)	$ (38,272)	$ (48,672)	$ (38,652)
Balance Sheet Data:					
Cash, cash equivalents and investments	$ 71,431	$ 112,629	$ 109,014	$ 87,157	$ 48,571
Working capital	63,789	106,512	101,691	56,427	35,384
Total assets	73,023	118,417	113,231	92,276	51,426
Note payable	—	209	501	762	870
Accumulated deficit	(664,375)	(604,494)	(538,470)	(500,081)	(451,526)
Total stockholders' equity	63,994	107,695	103,349	83,582	43,402

(1) Computed on the basis described in Note 16 to the financial statements appearing elsewhere in this Annual Report on Form 10-K.

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Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations.

The following discussion and analysis of our financial condition and results of operations should be read in conjunction with our audited financial statements and the related notes appearing elsewhere in this Annual Report on Form 10-K.

Overview

We are a clinical-stage biopharmaceutical company with a business strategy focused on the clinical development, and ultimately the commercialization, of drug candidates for both oncology and rare disease indications characterized by small, well-defined patient populations with serious unmet medical needs. Our current focus is on our Toll-like receptor, or TLR, agonist, tilsotolimod (IMO-2125), for oncology. We believe we can develop and commercialize targeted therapies on our own. To the extent we seek to develop drug candidates for broader disease indications, we have entered into and may explore additional collaborative alliances to support development and commercialization.

TLRs are key receptors of the immune system and play a role in innate and adaptive immunity. As a result, we believe TLRs are potential therapeutic targets for the treatment of a broad range of diseases. Using our chemistry-based platform, we have designed both TLR agonists and antagonists to act by modulating the activity of targeted TLRs. A TLR agonist is a compound that stimulates an immune response through the targeted TLR. A TLR antagonist is a compound that inhibits an immune response by blocking the targeted TLR.

Our current TLR-targeted clinical-stage drug candidate, tilsotolimod, is an agonist of TLR9. We are currently developing tilsotolimod, via intratumoral injection, for the treatment of anti-PD1 refractory metastatic melanoma in combination with ipilimumab, an anti-CTLA4 antibody marketed as Yervoy® by Bristol-Myers Squibb Company, or BMS, in a Phase 3 trial. We are also evaluating intratumoral tilsotolimod in combination with nivolumab, an anti-PD1 antibody marketed as Opdivo® by BMS, and ipilimumab for the treatment of multiple solid tumors in a Phase 2 trial.

Termination of Merger Agreement

On January 21, 2018, we entered into an Agreement and Plan of Merger, or the Merger Agreement, with BioCryst Pharmaceuticals, Inc., or BioCryst, Nautilus Holdco, Inc., a direct, wholly owned subsidiary of BioCryst, or Holdco, Island Merger Sub, Inc., a direct, wholly owned subsidiary of Holdco, and Boat Merger Sub, Inc., a direct, wholly owned subsidiary of Holdco. The board of directors of each of Idera and BioCryst unanimously approved the Merger Agreement and the transactions contemplated thereby and the required regulatory approvals were received. However, the proposed merger was subject to approval by the stockholders of Idera and BioCryst, and satisfaction of other customary closing conditions, as specified in the Merger Agreement.

At a special meeting of BioCryst stockholders held on July 10, 2018, BioCryst's stockholders voted against the adoption of the Merger Agreement. Following such vote and in accordance with the terms of the Merger Agreement, BioCryst terminated the Merger Agreement on July 10, 2018.

In accordance with the Merger Agreement, BioCryst paid us a fixed expense reimbursement amount of $6 million in connection with the termination of the Merger Agreement.

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Critical Accounting Policies and Estimates

This management's discussion and analysis of financial condition and results of operations is based on our financial statements, which have been prepared in accordance with accounting principles generally accepted in the United States. The preparation of these financial statements requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. On an ongoing basis, management evaluates its estimates and judgments, including those related to revenue recognition, stock-based compensation and research and development prepayments, accruals and related expenses. Management bases its estimates and judgments on historical experience and on various other factors that are believed to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions.

We regard an accounting estimate or assumption underlying our financial statements as a "critical accounting estimate" where:

- the nature of the estimate or assumption is material due to the level of subjectivity and judgment necessary to account for highly uncertain matters or the susceptibility of such matters to change; and

- the impact of the estimates and assumptions on financial condition or operating performance is material.

While our significant accounting policies are described in more detail in Note 2 to our financial statements appearing elsewhere in this Annual Report on Form 10-K, we believe the following accounting policies to be most critical to the judgments and estimates used in the preparation of our financial statements.

Revenue Recognition

We recognize revenue in accordance with the Financial Accounting Standards Board's, or FASB, Accounting Standards Codification, or ASC, Topic 606, Revenue from Contracts with Customers. Accordingly, revenue is recognized when the customer obtains control of promised goods or services, in an amount that reflects the consideration which we expect to receive in exchange for those goods or services. To determine revenue recognition for arrangements that we determine are within the scope of ASC Topic 606, we perform the following five steps:

(i) identify the contracts(s) with a customer;
(ii) identify the performance obligations in the contract;
(iii) determine the transaction price;

(iv) allocate the transaction price to the performance obligations in the contract; and
(v) recognize revenue when (or as) performance obligations are satisfied.

We only apply the five-step model to contracts when we determine that it is probable we will collect the consideration to which we are entitled in exchange for the goods or services we transfer to the customer. At contract inception, once the contract is determined to be within the scope of ASC Topic 606, we assess the goods or services promised within each contract and determine those that are performance obligations, and assess whether each promised good or service is distinct. We then recognize as revenue the amount of the transaction price that is allocated to the respective performance obligation when (or as) the performance obligation is satisfied.

Amounts received prior to satisfying the revenue recognition criteria are recognized as deferred revenue in our balance sheet. Amounts expected to be recognized as revenue within the 12 months following the balance sheet date are classified as current portion of deferred revenue. Amounts not expected to be recognized as revenue within the 12 months following the balance sheet date are classified as deferred revenue, net of current portion.

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Our revenues have primarily been generated through collaborative research, development and/or commercialization agreements. The terms of these agreements typically may include payment to us of one or more of the following: nonrefundable, up-front license fees, research, development and commercial milestone payments; and other contingent payments due based on the activities of the counterparty or the reimbursement by licensees of costs associated with patent maintenance. Each of these types of revenue are recorded as Alliance revenues in our statement of operations.

In determining the appropriate amount of revenue to be recognized as we fulfill our obligations under each arrangement, we perform the following steps:

(i) identify the promised goods and services in the contract;
(ii) determine whether the promised goods or services are performance obligations, including whether they are distinct within the context of the contract;
(iii) measure the transaction price, including the constraint on variable consideration;
(iv) allocate the transaction price to the performance obligations; and
(v) recognize revenue when (or as) performance obligations are satisfied.

See Note 9, “Collaboration and License Agreements” for additional details regarding the our collaboration arrangements.

As part of the accounting for these arrangements, we allocate the transaction price to each performance obligation on a relative stand-alone selling price basis. The stand-alone selling price may be, but is not presumed to be, the contract price. In determining the allocation, we maximize the use of observable inputs. When the stand-alone selling price of a good or service is not directly observable, we estimate the stand-alone selling price for each performance obligation using assumptions that require judgment. Acceptable estimation methods include, but are not limited to: (i) the adjusted market assessment approach, (ii) the expected cost plus margin approach, and (iii) the residual approach (when the stand-alone selling price is not directly observable and is either highly variable or uncertain). In order for the residual approach to be used, we must demonstrate that (a) there are observable stand-alone selling prices for one or more of the performance obligations and (b) one of the two criteria in ASC 606-10- 32-34(c)(1) and (2) is met. The residual approach cannot be used if it would result in a stand-alone selling price of zero for a performance obligation as a performance obligation, by definition, has value on a stand-alone basis.

An option in a contract to acquire additional goods or services gives rise to a performance obligation only if the option provides a material right to the customer that it would not receive without entering into that contract. Factors that we consider in evaluating whether an option represents a material right include, but are not limited to: (i) the overall objective of the arrangement, (ii) the benefit the collaborator might obtain from the arrangement without exercising the option, (iii) the cost to exercise the option (e.g. priced at a significant and incremental discount) and (iv) the likelihood that the option will be exercised. With respect to options determined to be performance obligations, we recognize revenue when those future goods or services are transferred or when the options expire.

Our revenue arrangements may include the following:

Up-front License Fees: If a license is determined to be distinct from the other performance obligations identified in the arrangement, we recognize revenues from nonrefundable, up-front fees allocated to the license when the license is transferred to the licensee and the licensee is able to use and benefit from the license. For licenses that are bundled with other promises, we utilize judgment to assess the nature of the combined performance obligation to determine whether the combined performance obligation is satisfied over time or at a point in time and, if over time, the appropriate method of measuring progress for purposes of recognizing revenue from non-refundable, up-front fees. We evaluate the measure of progress each reporting period and, if necessary, adjusts the measure of performance and related revenue recognition.

Milestone Payments: At the inception of an agreement that includes research and development milestone payments, we evaluate whether each milestone is considered probable of being achieved and estimate the amount to be included in the transaction price using the most likely amount method. If it is probable that a significant revenue reversal would not occur, the associated milestone value is included in the transaction price. Milestone

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payments that are not within our control or the licensee, such as regulatory approvals, are not considered probable of being achieved until those approvals are received. The transaction price is then allocated to each performance obligation on a relative stand-alone selling price basis, for which we recognize revenue as or when the performance obligations under the contract are satisfied. At the end of each subsequent reporting period, we re-evaluate the probability of achievement of such milestones and any related constraint, and if necessary, adjust our estimate of the overall transaction price. Any such adjustments are recorded on a cumulative catch-up basis, which would affect Alliance revenues and earnings in the period of adjustment.

Research and Development Activities: If we are entitled to reimbursement from our collaborators for specified research and development activities or the reimbursement of costs associated with patent maintenance, we determine whether such funding would result in Alliance revenues or an offset to research and development expenses. Reimbursement of patent maintenance costs are recognized during the period in which the related expenses are incurred as Alliance revenues in our statements of operations.

Royalties: If we are entitled to receive sales-based royalties from our collaborator, including milestone payments based on the level of sales, and the license is deemed to be the predominant item to which the royalties relate, we recognize revenue at the later of (i) when the related sales occur, provided the reported sales are reliably measurable, or (ii) when the performance obligation to which some or all of the royalty has been allocated has been satisfied (or partially satisfied). To date, we have not recognized any royalty revenue resulting from any of our collaboration and license arrangements.

Manufacturing Supply and Research Services: Arrangements that include a promise for future supply of drug substance, drug product or research services at the licensee’s discretion are generally considered as options. We assess if these options provide a material right to the licensee and if so, they are accounted for as separate performance obligations. If we are entitled to additional payments when the licensee exercises these options, any additional payments are recorded in Alliance revenues when the licensee obtains control of the goods, which is upon delivery, or as the services are performed.

We receive payments from our licensees based on schedules established in each contract. Upfront payments and fees are recorded as deferred revenue upon receipt, and may require deferral of revenue recognition to a future period until we perform our obligations under these arrangements. Amounts are recorded as accounts receivable when our right to consideration is unconditional. We do not assess whether a contract has a significant financing component if the expectation at contract inception is such that the period between payment by the licensees and the transfer of the promised goods or services to the licensees will be one year or less.

Stock-Based Compensation

We recognize all share-based payments to employees and directors as expense in our statements of operations and comprehensive loss based on their fair values. We record compensation expense over an award's requisite service period, or vesting period, based on the award's fair value at the date of grant. Our policy is to charge the fair value of stock options as an expense, adjusted for forfeitures, on a straight-line basis over the vesting period, which is generally four years for employees and one year for directors.

We use the Black-Scholes option pricing model to estimate the fair value of stock option grants. The Black-Scholes option pricing model relies on a number of key assumptions to calculate estimated fair values, including assumptions as to average risk-free interest rate, expected dividend yield, expected life and expected volatility. For the assumed risk-free interest rate, we use the U.S. Treasury security rate with a term equal to the expected life of the option. Our assumed dividend yield of zero is based on the fact that we have never paid cash dividends to common stockholders and have no present intention to pay cash dividends. We use an expected option life based on actual experience. Our assumption for expected volatility is based on the actual stock-price volatility over a period equal to the expected life of the option.

If factors change and we employ different assumptions for estimating stock-based compensation expense in future periods, or if we decide to use a different valuation model, the stock-based compensation expense we recognize in future periods may differ significantly from what we have recorded in the current period and could materially affect our operating income (loss), net income (loss) and earnings (loss) per share. It may also result in a lack of comparability with other companies that use different models, methods and assumptions. The Black-Scholes option pricing model was developed for use in estimating the fair value of traded options that have no

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vesting restrictions and are fully transferable. These characteristics are not present in our option grants. Although the Black-Scholes option pricing model is widely used, existing valuation models, including the Black-Scholes option pricing model, may not provide reliable measures of the fair values of our stock-based compensation.

Research and Development Prepayments, Accruals and Related Expenses

As part of the process of preparing our financial statements, we are required to estimate our accrued and prepaid expenses for research and development activities performed by third parties, including Clinical Research Organizations, or CROs, and clinical investigators. These estimates are made as of the reporting date of the work completed over the life of the individual study in accordance with agreements established with CROs and clinical trial sites. Some CROs invoice us on a monthly basis, while others invoice upon achievement of milestones and the expense is recorded as services are rendered. We determine the estimates of research and development activities incurred at the end of each reporting period through discussion with internal personnel and outside service providers as to the progress or stage of completion of trials or services, as of the end of each reporting period, pursuant to contracts with clinical trial centers and CROs and the agreed upon fee to be paid for such services. We periodically confirm the accuracy of our estimates with the service providers and make adjustments if necessary. Clinical trial site costs related to patient enrollments are recorded as patients are entered into the trial.

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Results of Operations

Years ended December 31, 2018, 2017 and 2016

Alliance Revenue

Alliance revenue for the years ended December 31, 2018, 2017 and 2016 was comprised of the following:

	Year Ended December 31, (in thousands)			% Change		
($ in thousands)	2018	2017	2016	2018 vs 2017	2017 vs 2016	
GSK collaboration	$ 517	$ 863	$ 1,111	-40%	-22%	(1)
Vivelix collaboration	56	14	15,000	300%	-100%	(2)
Other	89	25	88	256%	-72%	(3)
Total Alliance revenue	$ 662	$ 902	$ 16,199	-27%	-94%	

(1) GSK collaboration revenues for each of the years ended December 31, 2018, 2017 and 2016 primarily relate to the recognition of a $2.5 million upfront payment received in connection with the execution of the GSK Agreement in November 2015, which was initially recorded as deferred revenue. We have recognized this deferred revenue as revenue on a straight line basis over the anticipated performance period under the GSK Agreement. The decrease in GSK collaboration revenues during 2018 and 2017 as compared to the corresponding prior year was primarily due to a change that we made during the second quarter of 2017 with respect to our anticipated performance period under our collaboration with GSK from the original estimate of 27 months to an updated estimate of 36 months, which we accounted for on a prospective basis. See Part I, Item 1, "Business —Collaborative Alliances" of this Form 10-K for additional details regarding our collaboration with GSK and Note 9 to the financial statements appearing elsewhere in this Annual Report on Form 10-K for information on the related accounting treatment.

(2) Vivelix collaboration revenues for the year ended December 31, 2016 reflects the recognition of an upfront, non-refundable fee of $15 million received in connection with the execution of the Vivelix Agreement in November 2016. Vivelix collaboration revenues for each of the years ended December 31, 2017 and 2018 reflects reimbursement of certain research activities we have performed under the Vivelix Agreement. See Part I, Item 1, "Business —Collaborative Alliances" of this Form 10-K for additional details regarding our collaboration with Vivelix and Note 9 to the financial statements appearing elsewhere in this Annual Report on Form 10-K for information on the related accounting treatment.

(3) Other revenues are comprised of amounts earned in connection with collaborations which are not material to our current operations nor expected to be material in the future, including reimbursements by licensees of costs associated with patent maintenance.

Research and Development Expenses

For each of our research and development programs, we incur both direct and indirect expenses. We track direct research and development expenses by program, which include third party costs such as contract research, consulting and clinical trial and manufacturing costs. We do not allocate indirect research and development expenses, which may include regulatory, laboratory (equipment and supplies), personnel, facility and other overhead costs (including depreciation and amortization), to specific programs.

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In the table below, research and development expenses are set forth in the following categories which are discussed beneath the table:

	Year Ended December 31, (in thousands)			% Change		
($ in thousands)	2018	2017	2016	2018 vs 2017	2017 vs 2016	
IMO-2125 external development expense	$ 23,388	$ 10,930	$ 4,187	114%	161%	(1)
IMO-8400 external development expense	2,647	8,484	11,150	-69%	-24%	(2)
IMO-9200 external development expense	—	7	392	-100%	-98%	(3)
Other drug development expense	10,732	16,675	14,221	-36%	17%	(4)
Basic discovery expense	5,074	8,980	9,874	-43%	-9%	(5)
Severance and option modification expense	—	5,577	—	-100%	100%	(6)
Total research and development expenses	$ 41,841	$ 50,653	$ 39,824	-17%	27%	

(1) IMO-2125 External Development Expenses. These expenses include external expenses that we have incurred in connection with the development of tilsotolimod as part of our immuno-oncology program. These external expenses include payments to independent contractors and vendors for drug development activities conducted after the initiation of tilsotolimod clinical development in immuno-oncology, but exclude internal costs such as payroll and overhead expenses. We commenced clinical development of tilsotolimod as part of our immuno-oncology program in July 2015 and from July 2015 through December 31, 2018 we incurred approximately $39.7 million in tilsotolimod external development expenses as part of our immuno-oncology program, including costs associated with the preparation for and conduct of the ongoing Phase 1/2 clinical trial to assess the safety and efficacy of tilsotolimod in combination with ipilimumab and with pembrolizumab in patients with metastatic melanoma (ILLUMINATE-204), the preparation and conduct of our ongoing Phase 1b clinical trial of tilsotolimod monotherapy in patients with refractory solid tumors (ILLUMINATE-101), the preparation for, initiation and conduct of our ongoing Phase 3 clinical trial of tilsotolimod in combination with ipilimumab in patients with metastatic melanoma (ILLUMINATE-301), and the manufacture of additional drug substance for use in our clinical trials and additional nonclinical studies.

The increases in our IMO-2125 external development expenses in 2018 as compared to 2017 was primarily due to increases in costs incurred with contract research organizations to support (i) our ongoing ILLUMINATE-301 trial, which we initiated in the first quarter of 2018, (ii) our ongoing ILLUMINATE-101 trial, which we initiated in March 2017, and (iii) our ongoing ILLUMINATE-204 trial, which we initiated in December 2015.

The increases in our IMO-2125 external development expenses in 2017 as compared to 2016 were primarily due to increases in costs associated with the design and planning for additional clinical trials of IMO-2125 and increased clinical activity under our ongoing ILLUMINATE-204 trial, which we initiated in December 2015, including costs incurred with contract research organizations and drug manufacturing costs. In addition, expenses incurred during the 2017 period included costs associated with our ongoing ILLUMINATE-101 trial, which was initiated in March 2017, and costs associated with the design and planning of our ongoing ILLUMINATE-301, which was initiated in the first quarter of 2018.

Going forward, we expect ongoing IMO-2125 external development expenses to be significant as our focus in 2019 continues to be on the clinical development of tilsotolimod (IMO-2125). See additional information under the heading “Financial Condition, Liquidity and Capital Resources” regarding our future funding requirements.

(2) IMO-8400 External Development Expenses. These expenses include external expenses that we have incurred in connection with IMO-8400 since October 2012, when we commenced clinical development of IMO-8400. These external expenses include payments to independent contractors and vendors for drug development activities conducted after the initiation of IMO-8400 clinical development but exclude internal costs such as payroll and overhead expenses. Since October 2012, we incurred approximately $45.4 million in IMO-8400 external development expenses through December 31, 2018, including costs associated with our Phase 1 clinical trial in healthy subjects; our Phase 2 clinical trial in patients with psoriasis, our Phase 1/2 clinical trial in patients with Waldenström’s macroglobulinemia and our Phase

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1/2 clinical trial in patients with diffuse large B-cell lymphoma, or DLBCL, harboring the MYD88 L265P oncogenic mutation, which we discontinued in September 2016; our Phase 2 clinical trial in patients with dermatomyositis, which we determined in July 2018 to discontinue upon completion of final close-out activities; the manufacture of drug substance for use in our clinical trials; and expenses associated with our collaboration with Abbott Molecular for the development of a companion diagnostic for identification of patients with DLBCL harboring the MYD88 L265P oncogenic mutation. In July 2018, we terminated further development of IMO-8400. As a result, we expect IMO-8400 external development expenses to be insignificant in future periods.

The decrease in our IMO-8400 external development expenses in 2018, as compared to 2017, was primarily due to costs incurred during the 2017 period on clinical development of IMO-8400 for B-cell lymphomas, including our trials in Waldenström's macroglobulinemia and DLBCL harboring the MYD88 L265P oncogenic mutation, which we did not incur in 2018 as a result of our decision in September 2016 to discontinue development of IMO-8400 for treatment of B-cell lymphomas and focus on the development of IMO-8400 for the treatment of dermatomyositis.

The decrease in our IMO-8400 external development expenses in 2017, as compared to 2016, was primarily due to lower costs incurred on clinical development of IMO-8400 for B-cell lymphomas, including our trials in Waldenström's macroglobulinemia and DLBCL harboring the MYD88 L265P oncogenic mutation which we discontinued in 2016, partially offset by increased spending on our ongoing Phase 2 clinical trial of IMO-8400 in patients with dermatomyositis.

(3) IMO-9200 External Development Expenses. These expenses include external expenses that we have incurred in connection with IMO-9200 since October 2014, when we commenced clinical development of IMO-9200. These external expenses include payments to independent contractors and vendors for drug development activities conducted after the initiation of IMO-9200 clinical development but exclude internal costs such as payroll and overhead expenses. In September 2016, we determined not to proceed with the development of IMO-9200 and, in November 2016, we entered into the Vivelix Agreement, granting Vivelix worldwide rights to develop and market IMO-9200 for nonmalignant gastrointestinal disorders. Prior to entering the Vivelix Agreement, we incurred approximately $4.6 million in IMO-9200 external development expenses including costs associated with our Phase 1 clinical trial in healthy subjects, the manufacture of additional drug substance for use in our clinical and nonclinical trials and additional nonclinical studies.

The decrease in our IMO-9200 external development expenses in 2017, as compared to 2016, primarily reflects lower spending on manufacturing and nonclinical toxicology as a result of our decision to not proceed with the development of IMO-9200 in September 2016. Accordingly, we did not incur any external development expenses with respect to IMO-9200 subsequent to 2017.

(4) Other Drug Development Expenses. These expenses include external expenses associated with preclinical development of identified compounds in anticipation of advancing these compounds into clinical development, including IDRA-008. In addition, these expenses include internal costs, such as payroll and overhead expenses, associated with preclinical development and products in clinical development. The external expenses associated with preclinical compounds include payments to contract vendors for manufacturing and the related stability

studies, preclinical studies, including animal toxicology and pharmacology studies, and professional fees. Other drug development expenses also include costs associated with compounds that were previously being developed but are not currently being developed. In July 2018, we suspended further preclinical research. As a result, we expect other drug development expenses to be lower in future periods.

The decrease in other drug development expenses in 2018, as compared to 2017, was primarily due to a decrease in internal employee and facility overhead related costs and external costs of preclinical programs, including related toxicology studies, bulk drug manufacturing and awareness and education programs, as we suspended preclinical research activities in July 2018 and focused on the development of our clinical drug candidates.

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The increase in other drug development expenses in 2017, as compared to 2016, was primarily due to an increase in external costs of preclinical programs, including toxicology/pharmacology and bioanalytical studies, storage fees and awareness and education programs, in addition to higher payroll and overhead costs.

(5) Basic Discovery Expenses. These expenses include our internal and external expenses relating to our discovery efforts with respect to our TLR-targeted programs, including agonists and antagonists of TLR3, TLR7, TLR8 and TLR9, and our nucleic acid chemistry research programs. These expenses reflect charges for laboratory supplies, external research, and professional fees, as well as payroll and overhead expenses. In July 2018, we suspended all internal discovery programs. As a result, we expect basic discovery expenses to be insignificant in future periods

The decrease in basic discovery expenses in 2018, as compared to 2017, was primarily due to decreases in employee-related costs, lab supplies and facility overhead expenses as a result of our restructuring initiatives, including the suspension of all internal discovery programs and closing of our Cambridge, Massachusetts facility.

The decrease in basic discovery expenses in 2017, as compared to 2016, was primarily due to lower compensation related expenses, including salaries and non-cash stock-based compensation resulting from the resignation of our President of Research in May 2017 (see discussion of Severance and Option Modification Expenses below) as well as lower facility related charges, including overhead expenses.

(6) Severance and Option Modification Expenses. The expenses incurred during 2017 relate to charges for severance benefits provided pursuant to a separation agreement entered into in April 2017 in connection with the resignation of our former President of Research, effective May 31, 2017. Of the $5.6 million incurred, $1.3 million relates to severance pay in the form of salary continuation payments which will be paid over a two-year period through May 31, 2019 and a pro-rated 2017 bonus payment, and $4.3 million relates to non-cash stock-based compensation expense resulting from modifications to previously issued stock option awards. No such expenses were incurred in 2018 or 2016.

We do not know if we will be successful in developing and commercializing any drug candidate. At this time, and without knowing the results from our ongoing clinical trial of tilsotolimod, we cannot reasonably estimate or know the nature, timing, and costs of the efforts that will be necessary to complete the remainder of the development of, or the period, if any, in which material net cash inflows may commence from, any drug candidate. Moreover, the clinical development of tilsotolimod is subject to numerous risks and uncertainties associated with the duration and cost of clinical trials, which vary significantly over the life of a project as a result of unanticipated events arising during clinical development.

General and Administrative Expenses

General and administrative expenses consist primarily of payroll, stock-based compensation expense, consulting fees and professional legal fees associated with our patent applications and maintenance, our corporate regulatory filing requirements, our corporate legal matters, and our business development initiatives. For the years ended December 31, 2018, 2017 and 2016, general and administrative expenses totaled $15.4 million, $15.6 million and $15.1 million, respectively.

General and administrative expenses decreased by approximately $0.2 million, or 1.1%, in 2018, as compared to 2017, primarily due to lower employee related costs, partially offset by facility related costs incurred at our Cambridge, Massachusetts facility post-restructuring in July 2018.

General and administrative expenses increased by approximately $0.5 million, or 3.3%, in 2017, as compared to 2016, primarily due to increases in corporate legal fees, investor relations and information technology expenses.

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Merger-related Costs, net

Merger-related costs, net consists of charges and, where applicable, credits for transaction and integration-related professional fees, employee retention, and other incremental costs directly related to these activities, which are offset by merger termination fees.

Merger-related costs, net for the years ended December 31, 2018 and 2017 amounted to a net charge of $1.2 million and $1.1 million, respectively. The 2018 period was comprised of $7.2 million of expenses incurred in connection with the transactions contemplated by the Merger Agreement, including legal and professional fees, partially offset by a $6.0 million fixed expense reimbursement received in connection with the termination of the Merger Agreement. No such costs were incurred during 2016.

Restructuring Costs

Restructuring costs consist primarily of severance and related benefit costs related to workforce reductions, contract termination and wind-down costs and asset impairments.

Restructuring costs for the year ended December 31, 2018 totaled $3.1 million and resulted from our decision in July 2018 to wind-down our discovery operations, reduce the workforce in Cambridge, Massachusetts that supported such operations, and close our Cambridge facility. No such costs were incurred during 2017 or 2016.

Interest Income

For the years ended December 31, 2018, 2017 and 2016, interest income totaled $1.1 million, $0.6 million and $0.4 million, respectively.

Interest income increased by approximately $0.5 million, or 89.7%, in 2018, as compared to 2017, primarily due to an increase in average investment balances, including money market funds classified as cash equivalents, during 2018 as a result of our decision to invest more cash in interest earning money market accounts.

Interest income increased by approximately $0.2 million, or 38.3%, in 2017, as compared to 2016, primarily due to an increase in average investment balances, including money market funds classified as cash equivalents, during 2017 resulting from our follow-on underwritten public offerings in October 2016 and October 2017.

Amounts may fluctuate from period to period due to changes in average investment balances, including money market funds classified as cash equivalents, and composition of investments.

Interest Expense

For each of the years ended December 31, 2018, 2017 and 2016, interest expense totaled less than $0.1 million.

Interest expense decreased in both 2018 and 2017, as compared to the corresponding prior periods, primarily due to decreases in the outstanding principal amount of our note payable, which was paid off in June 2018.

Net Loss Applicable to Common Stockholders

As a result of the factors discussed above, our net loss applicable to common stockholders was $59.9 million, $66.0 million and $38.4 million for the years ended December 31, 2018, 2017 and 2016, respectively.

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Net Operating Loss Carryforwards

In December 2017, the Tax Cuts and Jobs Act, or the TCJA, was signed into law. Among other things, the TCJA permanently lowered the corporate federal income tax rate to 21% from the existing maximum rate of 35%, effective for tax years including or commencing January 1, 2018. Certain provisions from the Tax Reform Act of 1986 were not impacted by TCJA, such as those limiting the amount of net operating loss carryforwards, or NOLs, and tax credit carryforwards that companies may utilize in any one year in the event of cumulative changes in ownership over a three-year period in excess of 50%.

We have completed several financings since the effective date of the Tax Reform Act of 1986, which as of December 31, 2018, have resulted in ownership changes in excess of 50% that will significantly limit our ability to utilize our NOL and tax credit carryforwards. In December 2017, we completed a study which determined that a cumulative three-year ownership change in excess of 50% had occurred in February 2015. The 2018 and 2017 federal and state NOLs, tax credit carryforwards and related deferred tax assets shown below and included in Note 13 to the financial statements appearing elsewhere in this Annual Report on Form 10-K have been adjusted to reflect the ownership change limitations that resulted from this study. As no study has been completed subsequent to 2017, additional ownership change limitations may result from ownership changes that occurred after February 2015, or may occur in the future.

As of December 31, 2018, we had cumulative federal and state NOLs of approximately $253.8 million and $263.5 million available to reduce federal and state taxable income, respectively. As a result of TCJA, federal net operating losses incurred for taxable years beginning after January 1, 2018 have an unlimited carryforward period, but can only be utilized to offset 80% of taxable income in future taxable periods. Of the $253.8 million of federal NOLs, $56.4 million have an unlimited carryforward and the remaining NOLs are still subject to expiration through 2037. During the current year, $3.0 million of federal NOLs expired unused and 2032 will be the next year in which federal NOLs will expire should they remain unused. State NOLs are still subject to expiration according to the laws of each respective jurisdiction. We file state tax returns in Massachusetts and Pennsylvania whereby both jurisdictions impose a 20-year carryforward period. All $263.5 million of state NOLs expire through 2038, with the first year of expiration being 2032 for $21.0 million of Massachusetts NOLs. In addition, at December 31, 2018, we had cumulative federal and state tax credit carryforwards of $17.0 million and $1.9 million, respectively, available to reduce federal and state income taxes, respectively, which expire through 2038 and 2033, respectively, for federal and state purposes.

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Financial Condition, Liquidity and Capital Resources

Financial Condition

We have incurred operating losses in all fiscal years since our inception except 2002, 2008 and 2009. As of December 31, 2018, we had an accumulated deficit of $664.4 million. To date, substantially all of our revenues have been from collaboration and license agreements and we have received no revenues from the sale of commercial products. We have devoted substantially all of our efforts to research and development, including clinical trials, and we have not completed development of any commercial products. Our research and development activities, together with our selling, general and administrative expenses, are expected to continue to result in substantial operating losses for the foreseeable future. These losses, among other things, have had and will continue to have an adverse effect on our stockholders' equity, total assets and working capital. Because of the numerous risks and uncertainties associated with developing drug candidates, and if approved, commercial products, we are unable to predict the extent of any future losses, whether or when any of our drug candidates will become commercially available or when we will become profitable, if at all.

Liquidity and Capital Resources

Overview

We require cash to fund our operating expenses and to make capital expenditures. Historically, we have funded our cash requirements primarily through the following:

(i) sale of common stock, preferred stock and warrants;

(ii) exercise of warrants;

(iii) debt financing, including capital leases;

(iv) license fees, research funding and milestone payments under collaborative and license agreements; and

(v) interest income.

We filed a shelf registration statement on Form S-3 on August 10, 2017, which was declared effective on September 8, 2017. Under this registration statement, we may sell, in one or more transactions, up to $250.0 million of common stock, preferred stock, depository shares and warrants. As of February 15, 2019, we may sell up to an additional $191.1 million of securities under this registration statement.

See Notes 7 and 18 to the financial statements appearing elsewhere in this Annual Report on Form 10-K for additional information regarding our recent equity financings and common stock warrant activity.

Funding Requirements

We had cash and cash equivalents of approximately $71.4 million at December 31, 2018. We believe that, based on our current operating plan, our existing cash and cash equivalents will enable us to fund our operations through the one-year period subsequent to the filing date of this Annual Report on Form 10-K. Specifically, we believe that our available funds will be sufficient to enable us to perform the following during this one-year period:

(i) complete enrollment and continue to execute on:
   a) the Phase 1 portion of our ongoing Phase 1/2 clinical trial of tilsotolimod in combination with pembrolizumab in anti-PD1 refractory melanoma (ILLUMINATE-204);
b) the Phase 2 portion of our ongoing Phase 1/2 clinical trial of tilsotolimod in combination with ipilimumab in anti-PD1 refractory melanoma (ILLUMINATE-204);
c) the Phase 3 clinical trial of tilsotolimod in combination with ipilimumab for the treatment of anti-PD1 refractory metastatic melanoma (ILLUMINATE-301); and

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d) the Phase 1b monotherapy clinical trial of tilsotolimod in multiple refractory tumor types (ILLUMINATE-101);
(ii) initiate our Phase 2 study of tilsotolimod in combination with nivolumab and ipilimumab for the treatment of certain solid tumors (ILLUMINATE-206);
(iii) fund certain investigator initiated clinical trials of tilsotolimod; and
(iv) maintain our current level of general and administrative expenses in order to support the business.

We expect that we will need to raise additional funds in order to complete our ongoing clinical trials of tilsotolimod and to continue to fund our operations. We are seeking and expect to continue to seek additional funding through collaborations, the sale or license of assets or financings of equity or debt securities. We believe that the key factors that will affect our ability to obtain funding are:

(i) the results of our clinical development activities in our tilsotolimod program or any other drug candidates we develop on the timelines anticipated;
(ii) the cost, timing, and outcome of regulatory reviews;
(iii) competitive and potentially competitive products and technologies and investors' receptivity to tilsotolimod or any other drug candidates we develop and the technology underlying them in light of competitive products and technologies;
(iv) the receptivity of the capital markets to financings by biotechnology companies generally and companies with drug candidates and technologies similar to ours specifically;
(v) the receptivity of the capital markets to any in-licensing, product acquisition or other transaction we may enter into; and
(vi) our ability to enter into additional collaborations with biotechnology and pharmaceutical companies and the success of such collaborations.

In addition, increases in expenses or delays in clinical development may adversely impact our cash position and require additional funds or cost reductions.

Financing may not be available to us when we need it or may not be available to us on favorable or acceptable terms or at all. We could be required to seek funds through collaborative alliances or through other means that may require us to relinquish rights to some of our technologies, drug candidates or drugs that we would otherwise pursue on our own. In addition, if we raise additional funds by issuing equity securities, our then existing stockholders may experience dilution. The terms of any financing may adversely affect the holdings or the rights of existing stockholders. An equity financing that involves existing stockholders may cause a concentration of ownership. Debt financing, if available, may involve agreements that include covenants limiting or restricting our ability to take specific actions, such as incurring additional debt, making capital expenditures or declaring dividends, and are likely to include rights that are senior to the holders of our common stock. Any additional debt or equity financing may contain terms which are not favorable to us or to our stockholders, such as liquidation and other preferences, or liens or other restrictions on our assets. As discussed in Note 13 to the financial statements appearing elsewhere in this Annual Report on Form 10-K, additional equity financings may also result in cumulative changes in ownership over a three-year period in excess of 50% which would limit the amount of net operating loss and tax credit carryforwards that we may utilize in any one year.

If we are unable to obtain adequate funding on a timely basis or at all, we will be required to terminate, modify or delay our clinical trials of tilsotolimod, or relinquish rights to portions of our technology, drug candidates and/or products.

Common Stock Purchase Agreement

On March 4, 2019, the Company entered into a purchase agreement with Lincoln Park Capital Fund, LLC, or Lincoln Park, pursuant to which, upon the terms and subject to the conditions and limitations set forth therein, Lincoln Park has committed to purchase an aggregate of $35 million of shares of Company common stock from time to time at the Company's sole discretion, which we refer to as the Purchase Agreement. As consideration for entering into the Purchase Agreement, the Company issued 269,749 shares of Company common stock to Lincoln

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Park as a commitment fee, or the Commitment Shares. The Company did not receive any cash proceeds from the issuance of the Commitment Shares. See Item 9B, Other Information, contained in this Annual Report on Form 10-K for additional information.

Cash Flows

The following table presents a summary of the primary sources and uses of cash for the years ended December 31, 2018, 2017 and 2016:

	Year Ended December 31,		
(in thousands)	2018	2016	2015
Net cash provided by (used in):			
Operating activities	$ (51,916)	$ (55,259)	$ (28,203)
Investing activities	215	28,064	31,366
Financing activities	10,192	59,157	50,918
Increase (decrease) in cash, cash equivalents and restricted cash	$ (41,509)	$ 31,962	$ 54,081

Operating Activities. The net cash used in operating activities for all periods presented consists primarily of our net losses adjusted for non-cash charges and changes in components of working capital. The decrease in cash used in operating activities for the year ended December 31, 2018, as compared to 2017, was primarily due to decreases in cash outflows related to our discovery and development programs, including payments to contract research organizations, partially offset by merger-related costs. The increase in cash used in operating activities for the year ended December 31, 2017, as compared to 2016, was primarily due to increased internal and external research and development expenses as we continued to progress our tilsotolimod (IMO-2125) development program and TLR Modulation Technology Platform.

Investing Activities. Cash provided by investing activities primarily consisted of the following amounts relating to our investments in available-for-sale securities and purchases and disposals of property and equipment:

- for the year ended December 31, 2018, proceeds of $0.3 million from the sale of property and equipment, partially offset by purchases of less than $0.1 million of property and equipment;
- for the year ended December 31, 2017, proceeds from the maturity of available-for-sale securities of $28.3 million, partially offset by the purchase of $0.2 million of property and equipment; and
- for the year ended December 31, 2016, proceeds from the maturity of available-for-sale securities of $32.7 million and proceeds from the sale of available-for-sale securities of $2.0 million, partially offset by the purchase of $2.9 million of available-for-sale securities and $0.4 million of property and equipment.

Financing Activities. Cash provided by financing activities primarily consisted of the following amounts raised in connection with issuances of equity instruments:

- for the year ended December 31, 2018, $10.2 million in aggregate proceeds from the exercise of common stock options and warrants and $0.2 million in proceeds from employee stock purchases under our 2017 Employee Stock Purchase Plan, partially offset by $0.2 million in payments made on our previously outstanding note payable;
- for the year ended December 31, 2017, net proceeds of $53.8 million from our follow-on underwritten public offering of our common stock in October 2017, excluding less than $0.1 million of costs that were unpaid at December 31, 2017, and $5.7 million in aggregate net proceeds from employee stock purchases under our 2017 Employee Stock Purchase Plan, or 2017 ESPP, and the exercise of common stock options and warrants; and
- for the year ended December 31, 2016, net proceeds of $49.0 million from our follow-on underwritten public offering of our common stock in October 2016, excluding the $0.2 million of costs that were unpaid at December 31, 2016, and $2.2 million in aggregate net proceeds from employee stock purchases under our 1995 Employee Stock Purchase Plan, or 1995 ESPP, and the exercise of common stock warrants.

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Contractual Obligations

As of December 31, 2018, our contractual commitments and the effects such commitments are expected to have on our liquidity and cash flows in future periods were as follows:

	As of December 31, 2018			
(in thousands)	Total	2019	2020	2021 and thereafter
Operating leases	$ 298	$ 209	$ 89	$ —
Total	$ 298	$ 209	$ 89	$ —

Our only material lease commitments relate to our facility in Exton, Pennsylvania, which expires on May 31, 2020 subject to a three-year renewal option exercisable by us.

In the normal course of business, we enter into contracts with clinical research organizations, drug manufacturers and other vendors for preclinical and clinical research studies, research and development supplies and other services and products for operating purposes. These contracts generally provide for termination on notice, and therefore are cancellable contracts and not included in the table of contractual obligations and commitments.

Off-Balance Sheet Arrangements

As of December 31, 2018, we had no off-balance sheet arrangements.

New Accounting Pronouncements

New accounting pronouncements are discussed in Note 2 in the Notes to the Financial Statements in this Annual Report on Form10-K.

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Item 7A.Quantitative and Qualitative Disclosures about Market Risk.

As of December 31, 2018, all material assets and liabilities are in U.S. dollars, which is our functional currency.

We maintain investments in accordance with our investment policy. The primary objectives of our investment activities are to preserve principal, maintain proper liquidity to meet operating needs and maximize yields. Although our investments are subject to credit risk, our investment policy specifies credit quality standards for our investments and limits the amount of credit exposure from any single issue, issuer or type of investment. We regularly review our investment holdings in light of the then current economic environment. At December 31, 2018, all of our invested funds were invested in a money market fund and commercial paper classified in cash and cash equivalents on the accompanying balance sheet.

Based on a hypothetical ten percent adverse movement in interest rates, the potential losses in future earnings, fair value of risk sensitive financial instruments, and cash flows are immaterial, although the actual effects may differ materially from the hypothetical analysis.

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Item 8.Financial Statements and Supplementary Data.

All financial statements required to be filed hereunder are filed as listed under Item 15(a) of this Annual Report on Form 10-K and are incorporated herein by this reference.

Quarterly Operating Results (Unaudited)

The following table presents the unaudited statement of operations and comprehensive loss data for each of the eight quarters in the period ended December 31, 2018. The information for each of these quarters is unaudited, but has been prepared on the same basis as the audited financial statements appearing elsewhere in this Annual Report on Form 10-K. In our opinion, all necessary adjustments, consisting only of normal recurring adjustments, have been made to present fairly the unaudited quarterly results when read in conjunction with the audited financial statements and the notes thereto appearing elsewhere in this document. These operating results are not necessarily indicative of the results of operations that may be expected for any future period.

	Three months ended							
	Dec. 31, 2018	Sep. 30, 2018	Jun. 30, 2018	Mar. 31, 2018	Dec. 31, 2017	Sep. 30, 2017	Jun. 30, 2017	Mar. 31, 2017
	(In thousands, except per share data)							
tement of erations and mprehensive ss) Income a:								
iance revenue	$ 99	$ 145	$ 163	$ 255	$ 173	$ 164	$ 187	$ 378
erating enses:								
search and elopment	8,929	8,860	10,664	13,388	10,365	10,912	17,891	11,485
neral and ministrative	3,571	3,984	4,216	3,649	3,700	3,919	3,888	4,081
rger-related ts, net	—	(3,836)	1,583	3,498	1,128	—	—	—
structuring ts	95	3,017	—	—	—	—	—	—
al operating enses	12,595	12,025	16,463	20,535	15,193	14,831	21,779	15,566
s from rations	(12,496)	(11,880)	(16,300)	(20,280)	(15,020)	(14,667)	(21,592)	(15,188

er income pense):								
erest income	330	277	271	211	118	159	144	153
erest expense	—	—	(4)	(7)	(10)	(11)	(13)	(16)
eign currency hange gain ss)	16	(2)	2	(19)	(14)	(11)	(10)	(6)
loss	$ (12,150)	$ (11,605)	$ (16,031)	$ (20,095)	$ (14,926)	$ (14,530)	$ (21,471)	$ (15,057
loss per share licable to mmon ckholders (1)								
Basic	$ (0.45)	$ (0.43)	$ (0.59)	$ (0.81)	$ (0.66)	$ (0.78)	$ (1.15)	$ (0.81)
Diluted	(0.45)	(0.43)	(0.59)	(0.81)	(0.66)	(0.78)	(1.15)	(0.81)
ighted-average mber of mmon shares d in mputing net ss) income per re applicable ommon ckholders (1)								
Basic	27,183	27,175	27,133	24,880	22,647	18,705	18,677	18,638
Diluted	27,183	27,175	27,133	24,880	22,647	18,705	18,677	18,638
mprehensive :								
loss er mprehensive ome (loss): realized gain ss) on ilable-for-sale urities	$ (12,150) —	$ (11,605) —	$ (16,031) —	$ (20,095) —	$ (14,926) 2	$ (14,530) (1)	$ (21,471) —	$ (15,057 16
al other mprehensive ome (loss)	—	—	—	—	2	(1)	—	16
mprehensive s	$ (12,150)	$ (11,605)	$ (16,031)	$ (20,095)	$ (14,924)	$ (14,531)	$ (21,471)	$ (15,041

(1) Computed on the basis described in Note 16 to the financial statements appearing elsewhere in this Form 10-K.

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Item 9. Changes in and Disagreements with Accountants on Accounting and Financial Disclosure.

None.

Item 9A. Controls and Procedures.

Disclosure Controls and Procedures

Our management, with the participation of our principal executive officer and principal financial officer, evaluated the effectiveness of our disclosure controls and procedures (as defined in Rules 13a-15(e) and 15d-15(e) under the Exchange Act) as of December 31, 2018. In designing and evaluating our disclosure controls and procedures, management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving their objectives and our management necessarily applied its judgment in evaluating the cost-benefit relationship of possible controls and procedures. Based on this evaluation, our principal executive officer and principal financial officer concluded that as of December 31, 2018, our disclosure controls and procedures were (1) designed to ensure that material information relating to us is made known to our principal executive officer and principal financial officer by others, particularly during the period in which this report was prepared, and (2) effective, in that they provide reasonable assurance that information required to be disclosed by us in the reports we file or submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the SEC's rules and forms.

Internal Control over Financial Reporting

a) Management's Annual Report on Internal Control over Financial Reporting

Our management, with the participation of our principal executive officer and principal financial officer, is responsible for establishing and maintaining adequate internal control over financial reporting. Internal control over financial reporting is defined in Rule 13a-15(f) and 15d-15(f) promulgated under the Exchange Act as a process designed by, or under the supervision of, the Company's principal executive and principal financial officers and effected by the Company's board of directors, management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles and includes those policies and procedures that:

· Pertain to the maintenance of records that in reasonable detail accurately and fairly reflect the transactions and dispositions of the assets of the Company;

- Provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the Company are being made only in accordance with authorizations of management and directors of the Company; and

- Provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of the Company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Therefore, even those systems determined to be effective can provide only reasonable assurance with respect to financial statement preparation and presentation. Projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Management assessed the effectiveness of our internal control over financial reporting as of December 31, 2018. In making this assessment, management used the criteria set forth by the Committee of Sponsoring Organizations of the Treadway Commission in Internal Control — Integrated Framework (2013).

Based on its assessment, management believes that, as of December 31, 2018, the Company's internal control over financial reporting is effective based on those criteria.

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Ernst & Young LLP, our independent registered public accounting firm, has issued an attestation report on the effectiveness of our internal control over financial reporting as of December 31, 2018. This report appears immediately below.

b)Attestation Report of the Registered Public Accounting Firm

Report of Independent Registered Public Accounting Firm

To the Stockholders and the Board of Directors of Idera Pharmaceuticals, Inc.

Opinion on Internal Control over Financial Reporting

We have audited Idera Pharmaceuticals, Inc.'s internal control over financial reporting as of December 31, 2018, based on criteria established in Internal Control—Integrated Framework issued by the Committee of Sponsoring Organizations of the Treadway Commission (2013 framework) (the COSO criteria). In our opinion, Idera Pharmaceuticals, Inc. (the Company) maintained, in all material respects, effective internal control over financial reporting as of December 31, 2018, based on the COSO criteria.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (PCAOB), the balance sheets of Idera Pharmaceuticals, Inc. as of December 31, 2018 and 2017, and the related statements of operations and comprehensive loss, stockholders' equity and cash flows for each of the three years in the period ended December 31, 2018, and the related notes and our report dated March 6, 2019 expressed an unqualified opinion thereon.

Basis for Opinion

The Company's management is responsible for maintaining effective internal control over financial reporting and for its assessment of the effectiveness of internal control over financial reporting included in the accompanying Management's Annual Report on Internal Control Over Financial Reporting. Our responsibility is to express an opinion on the Company's internal control over financial reporting based on our audit. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects.

Our audit included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, testing and evaluating the design and operating effectiveness of internal control based on the assessed risk, and performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

Definition and Limitations of Internal Control Over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable

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assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

/s/ ERNST & YOUNG LLP

Philadelphia, Pennsylvania
March 6, 2019

c)Changes in Internal Control over Financial Reporting.

No change in our internal control over financial reporting occurred during the fourth quarter of the fiscal year ended December 31, 2018 that has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

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Item 9B.Other Information.

Purchase Agreement and Registration Rights Agreement

On March 4, 2019, we entered into a purchase agreement (the "Purchase Agreement") and a registration rights agreement (the "Registration Rights Agreement") with Lincoln Park Capital Fund, LLC ("Lincoln Park"), pursuant to which, upon the terms and subject to the conditions and limitations set forth therein, we have the right to sell to Lincoln Park up to $35 million of shares of our common stock, $0.001 par value per share, at our discretion as described below (the "Offering").

Over the 36-month term of the Purchase Agreement, for up to an aggregate amount of $35 million of shares of common stock (subject to certain limitations), we have the right, but not the obligation, from time to time, in our sole discretion and subject to certain conditions, to direct Lincoln Park to purchase up to 150,000 shares (the "Regular Purchase Share Limit") of our common stock (each such purchase, a "Regular Purchase"). The Regular Purchase Share Limit will increase to 200,000 shares if the closing price of our common stock on the purchase date is not below $5.00. In any case, Lincoln Park's maximum obligation under any single Regular Purchase will not exceed $2 million, unless we mutually agree to increase the maximum amount of such Regular Purchase. The purchase price for shares of common stock to be purchased by Lincoln Park under a Regular Purchase will be the equal to the lower of (in each case, subject to the adjustments described in the Purchase Agreement): (i) the lowest sale price for our common stock on the applicable purchase date and (ii) the arithmetic average of the three lowest sale prices for our common stock during the ten trading days prior to the purchase date.

If we direct Lincoln Park to purchase the maximum number of shares of common stock that we then may sell in a Regular Purchase, then in addition to such Regular Purchase, and subject to subject to certain conditions and limitations in the Purchase Agreement, we may direct Lincoln Park to make an "accelerated purchase" of an additional amount of common stock that may not exceed the lesser of (i) 300% of the number of shares purchased pursuant to the corresponding Regular Purchase and (ii) 30% of the total number of shares of our common stock traded during a specified period on the applicable purchase date as set forth in the Purchase Agreement. The purchase price for such shares will be the lesser of: (i) the closing sale price for the common stock on the date of sale and (ii) 97% of the volume weighted average price of the common stock over a certain portion of the date of sale as set forth in the Purchase Agreement. Under certain circumstances and in accordance with the Purchase Agreement, we may direct Lincoln Park to purchase shares in multiple accelerated purchases on the same trading day. There is no upper limit on the price per share that Lincoln Park must pay for our common stock under the Purchase Agreement.

The Purchase Agreement also prohibits us from directing Lincoln Park to purchase any shares of common stock if those shares, when aggregated with all other shares of our common stock then beneficially owned by Lincoln Park and its affiliates, would result in Lincoln Park and its affiliates having beneficial ownership, at any single point in time, of more than 9.99% of the then total outstanding shares of our common stock.

The Purchase Agreement does not limit our ability to raise capital from other sources at our sole discretion, except that (subject to certain exceptions) we may not enter into any Variable Rate Transaction, other than an Exempt Transaction (each as defined in the Purchase Agreement) during the 18 months after the commencement date of the Purchase Agreement.

The Purchase Agreement and the Registration Rights Agreement contain customary representations, warranties and agreements of us and Lincoln Park, indemnification rights and other obligations of the parties. We have the right to terminate the Purchase Agreement at any time, at no cost to us.

As consideration for entering into the Purchase Agreement, we issued 269,749 shares of our common stock to Lincoln Park as a commitment fee (the "Commitment Shares"). We will not receive any cash proceeds from the issuance of the Commitment Shares. Lincoln Park has covenanted not to cause or engage in any manner whatsoever, any direct or indirect short selling or hedging of our shares of common stock.

The Offering is being made pursuant to our effective Registration Statement on Form S-3 (SEC File No. 333-219851) (the "Registration Statement"), which was previously filed with the SEC on August 10, 2017, amended September 1, 2017 and September 8, 2017, and declared effective by the SEC on September 8, 2017. A prospectus supplement related to the Offering has been filed with the SEC on March 6, 2019. Pursuant to the

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Registration Rights Agreement, under certain circumstances, if the Registration Statement is no longer available for use with respect to the Offering, we will be required to file additional registration statement(s).

We expect to use the proceeds from the Offering for clinical development, general corporate purposes, and working capital.

Copies of the Registration Rights Agreement and the Purchase Agreement are attached hereto as Exhibits 4.5 and 10.37, respectively, and are incorporated herein by reference.

We are filing the opinion of our counsel, Morgan, Lewis & Bockius LLP, regarding the validity of the shares of common stock issued pursuant to the Purchase Agreement, as Exhibit 5.1 hereto.

Retirement of Chief Medical Officer

On March 6, 2019, we announced that effective July 31, 2019, Senior Vice President and Chief Medical Officer Joanna Horobin, M.B. Ch.B, will retire. We expect that Dr. Horobin will remain a consultant to us after that time in accordance with the terms of a consulting services agreement to be entered into by us and Dr. Horobin. We will disclose the terms of such consulting services agreement when they are reached.

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PART III.

Item 10.Directors, Executive Officers, and Corporate Governance.

Information about our Directors

Set forth below is information about each member of our board of directors, including (a) the year in which each director first became a director, (b) their age as of February 15, 2019, (c) their positions and offices with our Company, (d) their principal occupations and business experience during at least the past five years and (e) the names of other public companies for which they currently serve, or have served within the past five years, as a director. We have also included information about each director's specific experience, qualifications, attributes or skills that led our board of directors to conclude that such individual should serve as one of our directors. We also believe that all of our directors have a reputation for integrity, honesty and adherence to high ethical standards. They each have demonstrated business acumen and an ability to exercise sound judgment, as well as a commitment of service to Idera and our board of directors.

Class I Directors—Terms to Expire in 2020

Vincent J. Milano

Director since 2014

Vincent Milano, age 55, has been our President and Chief Executive Officer, and a member of our board of directors, since December 2014. Prior to joining us, Mr. Milano served as Chairman, President and Chief Executive Officer of ViroPharma Inc., a pharmaceutical company that was acquired by Shire Plc in January 2014, from March 2008 to January 2014, as its Vice President, Chief Financial Officer and Chief Operating Officer from January 2006 to March 2008 and as its Vice President, Chief Financial Officer and Treasurer from April 1996 to December 2005. Mr. Milano also served on the board of directors of ViroPharma from March 2008 to January 2014. Prior to joining ViroPharma, Mr. Milano served in increasingly senior roles, most recently senior manager, at KPMG LLP, an independent registered public accounting firm, from July 1985 to March 1996. Mr. Milano currently serves on the board of directors of Spark Therapeutics, Inc. and Vanda Pharmaceuticals Inc., each a publicly traded company, and VenatoRx Pharmaceuticals, Inc. Mr. Milano holds a Bachelor of Science degree in Accounting from Rider College. We believe Mr. Milano's qualifications to sit on our board of directors include his knowledge of our company as our President and Chief Executive Officer, knowledge of our industry, including over 20 years of experience serving in a variety of roles of increasing responsibility in the finance department, corporate administration and operations of a multinational

biopharmaceutical company, and understanding of pharmaceutical research and development, sales and marketing, strategy, and operations in both the United States and overseas. He also has corporate governance experience through service on other public company boards.

Kelvin M. Neu, M.D.

Director since 2014

Dr. Neu, age 45, is a Partner at Baker Bros. Advisors LP and has been with the firm since 2004. Baker Bros. Advisors LP is an investment adviser that manages investments in life sciences companies. Dr. Neu currently serves on the board of directors of Aquinox Pharmaceuticals, Inc., a publicly traded company. Dr. Neu previously served on the board of directors of XOMA Corporation, a publicly traded company, and resigned from that board in 2015. Dr. Neu holds an M.D. from the Harvard Medical School-MIT Health Sciences and Technology program, and spent three years in the Immunology Ph.D. program at Stanford University as a Howard Hughes Medical Institute Fellow. Dr. Neu holds an A.B. (summa cum laude) from Princeton University, where he was awarded the Khoury Prize for graduating first in his department of Molecular Biology. Prior to attending Princeton, Dr. Neu served for two and a half years in the military of his native Singapore. We believe that Dr. Neu's qualifications to sit on our board of directors include his scientific background, affiliation with one of our significant stockholders and knowledge of our industry.

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William S. Reardon

Director since 2002

Mr. Reardon, age 72, has been a director since 2002 and served as lead independent director of our board of directors from September 2010 to July 2013. He served as an audit partner at PricewaterhouseCoopers LLP, where he led the Life Science Industry Practice for New England and the Eastern United States from 1986 until his retirement from the firm in July 2002. Mr. Reardon currently serves as a trustee of closed-end mutual funds Tekla Healthcare Investors, Tekla Life Sciences Investors and of Tekla Healthcare Opportunities Fund and Tekla World Healthcare Fund. Mr. Reardon also previously served as a director of Synta Pharmaceuticals Corp., a publicly traded company. We believe that Mr. Reardon's qualifications to sit on our board of directors include his accounting and financial experience, including as a partner at a leading accounting firm leading its life science practice, his role in keeping the board of directors and senior management team abreast of current accounting regulations and his experience as a member of several boards of directors of biotechnology companies. Additionally, we value Mr. Reardon's role in leading the board on matters of corporate governance, before, during and after his service as lead independent director.

As announced in December 2018, Mr. Reardon will be resigning from our board of directors effective March 10, 2019.

Class II Directors—Terms to Expire in 2021

James A. Geraghty

Director since 2013

Mr. Geraghty, age 64, has served as chairman of our board of directors since July 2013. Mr. Geraghty is an industry leader with over 30 years of strategic and leadership experience, including more than 20 years as a senior member of executive teams at biotechnology companies developing and commercializing innovative therapies. From May 2013 to October 2016, Mr. Geraghty was an Entrepreneur in Residence at Third Rock Ventures, a leading biotech venture and company-formation fund. From April 2011 to December 2012, Mr. Geraghty served as a Senior Vice President of Sanofi, a global healthcare company. Prior to that, he served in various senior management roles at Genzyme Corporation, a biotechnology company, from 1992 to April 2011, including as Senior Vice President, International Development from January 2007 to April 2011. Mr. Geraghty currently serves as chairman of the board of Orchard Therapeutics, a publicly traded company, and as a member of the board of Voyager Therapeutics, Inc., a publicly traded company. He also serves as a director of Fulcrum Therapeutics, Inc. He previously served as chairman of the board of Juniper Pharmaceuticals, Inc. and as a director of bluebird bio Inc. and GTC Biotherapeutics, Inc. We believe that Mr. Geraghty's qualifications to sit on our board of directors include his public company board and management experience and his broad and deep knowledge of the industry in which we operate.

Maxine Gowen, Ph.D.

Director since 2016

Dr. Gowen, age 60, has served as the founding President and CEO from November 2007 to October 2018, and a member of the board of directors of Trevena, Inc., a biopharmaceutical company, since November 2007. Prior to joining Trevena, Dr. Gowen was Senior Vice President for the Center of Excellence for External Drug Discovery at GlaxoSmithKline plc, or GSK, where she held a variety of leadership positions during her tenure of 15 years. Before GSK, Dr. Gowen was Senior Lecturer and Head, Bone Cell Biology Group, Department of Bone and Joint Medicine, of the University of Bath, U.K. Dr. Gowen has served as a director of Akebia Therapeutics, Inc., a publicly traded company, since July 2014. From 2008 until 2012, Dr. Gowen served as a director of Human Genome Sciences, Inc., a publicly traded company. She received her Ph.D. from the University of Sheffield, U.K., an M.B.A. with academic honors from The Wharton School of the University of Pennsylvania, and a B.Sc. with Honors in Biochemistry from the University of Bristol, U.K. We believe that Dr. Gowen's qualifications to sit on our board of directors include her significant public company management and board experience and knowledge of our industry.

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Howard Pien

Director since September 2018

Mr. Pien, age 61, has worked in the pharmaceutical and biotechnology industries for over 30 years. He was Non-Executive Chairman of Juno Therapeutics, a development stage company focused on immunotherapy aimed to cure cancer, until its acquisition by Celgene in 2018. He was also previously a director of Vanda, a commercial-stage public company specializing in CNS (three years as Chairman), ImmunoGen, a public biotechnology company, and an advisor to the Life Sciences Practice of Warburg Pincus. From 2007 to 2009, Mr. Pien was the Chairman and CEO of Medarex, Inc., a public biotechnology company, until it was acquired by Bristol-Myers Squibb. From 2003 to 2006, he was the Chairman and CEO of Chiron, a public biotechnology company, which was acquired by Novartis. Mr. Pien's previous Board directorships include Talon, Arresto, Ikaria and Biopharma (where he was lead independent director) – all biopharmaceutical companies that were acquired in strategic transactions. Between 1991 and 2003, he held various executive positions at GlaxoSmithKline plc (GSK) and SmithKline Beecham, as Presidents of US, International, and Pharmaceuticals. Prior to GSK, Mr. Pien worked for Abbott Labs for six years and Merck & Co., Inc. for five years. Mr. Pien holds a BS in engineering from MIT and an MBA from Carnegie-Mellon University. We believe that Mr. Pien's qualifications to sit on our board of directors include Mr. Pien's extensive experience as a chief executive officer in the pharmaceutical industry, including an immuno-oncology company, and his expertise in corporate governance matters.

Class III Directors—Terms to Expire in 2019

Mark Goldberg, M.D.

Director since 2014

Dr. Goldberg, age 64, served as consultant and medical and regulatory strategist for Synageva BioPharma Corp., a biopharmaceutical company, from October 2014 until June 2015. Prior to that, he served as the Executive Vice President for Medical and Regulatory Strategy of Synageva from January 2014 to October 2014 and as the Senior Vice President of Medical and Regulatory Affairs of Synageva from September 2011 to January 2014. Dr. Goldberg served in a variety of senior management positions at Genzyme Corporation from 1996 to July 2011, including most recently as Senior Vice President for Clinical Development and Therapeutic Group Head for Oncology and Personalized Genetic Health from 2009 to July 2011. Prior to working at Genzyme Corporation, he was a full time staff physician at Brigham and Women's Hospital and Dana Farber Cancer Institute, where he still holds appointments. He has also been an Associate Professor of Medicine at Harvard Medical School since 1996. Dr. Goldberg is a board-certified medical oncologist and hematologist and has more than 50 published papers. Dr. Goldberg currently serves on the board of directors of ImmunoGen, Inc. GlycoMimetics, Inc., Blueprint Medicines Corporation and Audentes Therapeutics, Inc., all publicly traded companies. He also served on the board of directors of aTyr Pharma, Inc. from 2015 to 2017. Dr. Goldberg holds an A.B. from Harvard College and an M.D. from Harvard Medical School. We believe that Dr. Goldberg's qualifications to sit on our board of directors include his extensive scientific and medical background, public company board experience and extensive experience in the

management and operations of pharmaceutical companies.

Carol A. Schafer

Director since December 2018

Ms. Schafer, age 55, has more than 25 years of experience in investment banking and equity capital markets, as well as corporate finance and business development in the biopharmaceutical sector, with substantial experience financing and facilitating investor access for public and private healthcare companies. Ms. Schafer most recently served as Vice Chair, Equity Capital Markets at Wells Fargo Securities. Prior to Wells Fargo, Ms. Schafer served as Vice President of Finance and Business Development at Lexicon Pharmaceuticals. Earlier in her career, Ms. Schafer served as an Equity Capital Markets Sector Head in her role as a Managing Director at J.P. Morgan. Ms. Schafer received a B.A. from Boston College and an M.B.A from New York University. We believe that Ms. Schafer's qualifications to sit on our board of directors include her extensive financial background, including experience in investment banking and equity capital markets, as well as corporate finance and business development in the biopharmaceutical sector.

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Audit Committee

Our board of directors has established a standing committee. Our audit committee operates under a charter that has been approved by our board of directors. A current copy of the charter for the audit committee is posted on our website, www.iderapharma.com, and can be accessed by clicking "Investors" and "Corporate Governance."

Our audit committee's responsibilities include:

- appointing, approving the compensation of, and assessing the independence of our independent registered public accounting firm;
- overseeing the work of our independent registered public accounting firm, including through the receipt and consideration of certain reports from such accounting firm;
- reviewing and discussing with management and our independent registered public accounting firm our annual and quarterly financial statements and related disclosures;
- monitoring our internal control over financial reporting, disclosure controls and procedures and code of business conduct and ethics;
- discussing our risk management policies;
- establishing procedures for the receipt and retention of accounting related complaints and concerns;
- reviewing and approving related party transactions;
- meeting independently with our independent registered public accounting firm and management; and
- preparing the audit committee report required by SEC rules.

The current members of our audit committee are Mr. Reardon (Chairman), Mr. Geraghty, Dr. Goldberg and Ms. Schafer. Our board of directors has determined that Mr. Reardon and Ms. Schafer are both "audit committee financial experts" within the meaning of SEC rules and regulations. Each member of the audit committee is independent as defined under applicable rules of the Nasdaq Stock Market, including the independence requirements contemplated by Rule 10A-3 under the Exchange Act. During 2018, our audit committee held seven meetings in person or by teleconference.

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Our Executive Officers

Our executive officers and their respective ages and positions as of February 15, 2019 are described below. Our executive officers serve until they resign or the board terminates their position.

Name	Age	Position
Vincent J. Milano*	55	President and Chief Executive Officer
R. Clayton Fletcher	56	Senior Vice President, Business Development and Strategy
Joanna Horobin, M.B., Ch.B	64	Senior Vice President, Chief Medical Officer
John J. Kirby	47	Vice President of Finance, Principal Financial and Accounting Officer
Bryant D. Lim	47	Senior Vice President, General Counsel and Corporate Secretary
Jonathan Yingling, Ph.D.	50	Senior Vice President, Chief Scientific Officer

* Mr. Milano is a member of our board of directors. See "Information about our Directors" above for more information about Mr. Milano.

R. Clayton Fletcher has been our Senior Vice President, Business Development and Strategic Planning since January 2015. Prior to joining us, Mr. Fletcher served in increasingly senior positions at ViroPharma Incorporated, which was acquired by Shire Plc in January 2014, from April 2001 until January 2014, including as Vice President, Business Development and Project Management from 2005 until January 2014. Mr. Fletcher served as Senior Project Manager at SmithKline Beecham plc, a pharmaceutical company, which was purchased by Glaxo Wellcome plc in December 2000, from 1997 until 2001. Prior to working at SmithKline Beecham, he served as Project Scientist, at Becton, Dickinson and Company, a medical devices company and as Principal Scientist at Intracel Corporation, a biopharmaceutical company. Prior to working at Intracel, he served as Senior Associate Scientist at Centocor Biotech, Inc., a biotechnology company from 1991 until 1993. Mr. Fletcher holds a B.S. and a M.S. in biology from Wake Forest University.

Joanna Horobin, M.B., Ch.B has been our Senior Vice President and Chief Medical Officer since November 2015. Prior to joining us, Dr. Horobin served as the Chief Medical Officer of Verastem, Inc., a biopharmaceutical company, from October 2012 to June 2015. Prior to joining Verastem, she served as President of Syndax Pharmaceuticals, a biopharmaceutical company, from September 2006 to October 2012 and as Chief Executive Officer from September 2006 until April 2012. Prior to that, Dr. Horobin held several roles of increasing responsibility at global pharmaceutical corporations such as Rhône-Poulenc Rorer (now Sanofi) and Chugai-Rhône-Poulenc. Dr. Horobin received her medical degree from the University of Manchester, England.

John J. Kirby joined the Company in 2015 as the Company’s Vice President of Corporate Accounting and has served as Vice President of Finance since July 2018 and as principal financial officer and principal accounting officer since

October 2018. Prior to joining us, Mr. Kirby served as Assistant Controller at Endo Pharmaceuticals, Inc. from November 2014 to October 2015. From August 2012 to July 2014, Mr. Kirby served as Vice President, Chief Accounting Officer and Corporate Controller at ViroPharma Incorporated. Mr. Kirby began his career at KPMG, LLP in their Healthcare and Life Science Practice and served as a Regional Audit Director at AstraZeneca Pharmaceuticals L.P. prior to joining ViroPharma Incorporated. Mr. Kirby received his B.S. in Accountancy from Villanova University and is a licensed certified public accountant in the Commonwealth of Pennsylvania.

Bryant D. Lim has been our Senior Vice President, General Counsel and Secretary since September 2018. Prior to joining us, Mr. Lim served as Vice President, Assistant General Counsel and, prior to that, Chief Compliance Officer at Incyte Corporation from March 2014 to September 2018. Prior to Incyte, Mr. Lim held roles of increasing responsibility at ViroPharma Incorporated from January 2009 until March 2014. Mr. Lim served as Assistant Counsel at Merck & Co., Inc. and also was associated with Morgan, Lewis & Bockius, LLP. Mr. Lim began his legal career as a law clerk for a federal judge. Mr. Lim received his J.D. from Villanova University School of Law, where he currently serves on its adjunct faculty. Mr. Lim received his B.A. from the University of Rochester.

Jonathan Yingling, Ph.D. joined our company as Senior Vice President, Early Development in February 2017 and since January 2018 has been serving as our Chief Scientific Officer. Prior to joining us, Dr. Yingling was Chief Scientific Officer at Bind Therapeutics Inc., a biotechnology company that filed for bankruptcy in May 2016, from December 2015 to August 2016. Prior to joining Bind Therapeutics, Dr. Yingling served as vice president, Oncology

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Discovery and Translational Research at Bristol-Myers Squibb Company, or BMS, a pharmaceutical company, from June 2013 to October 2015. During his tenure at BMS, he was responsible for the oncology research portfolio as well as translational capabilities in immuno-oncology. Dr. Yingling earned his Ph.D. in Cell and Molecular Biology and Pharmacology at Duke University and was a Howard Hughes Postdoctoral Fellow at Vanderbilt University.

Code of Business Conduct and Ethics

We have adopted a written code of business conduct and ethics that applies to our principal executive officer, principal financial officer, principal accounting officer or controller, or persons performing similar functions. We have posted a current copy of the Code of Business Conduct and Ethics in the “Investors — Corporate Governance” section of our website, which is located at www.iderapharma.com. We intend to satisfy the disclosure requirements under Item 5.05 of Form 8-K regarding an amendment to, or waiver from, a provision of our code of business conduct and ethics by posting such information on our website at www.iderapharma.com.

Section 16(a) Beneficial Ownership Reporting Compliance

Section 16(a) of the Exchange Act requires our directors, officers and the holders of more than 10% of our common stock, which we refer to collectively as reporting persons, to file with the SEC initial reports of ownership of our common stock and other equity securities on a Form 3 and reports of changes in such ownership on a Form 4 or Form 5. Reporting persons are required by SEC regulations to furnish us with copies of all Section 16(a) forms they file. To our knowledge, based solely on a review of our records and written representations by the persons required to file these reports, during 2018, the reporting persons complied with all Section 16(a) filing requirements, except that a Form 4 filed by Mr. Lim with respect to a grant of options to Mr. Lim upon his commencement of employment on September 10, 2018, was filed one day late, on September 13, 2018.

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Item 11.Executive Compensation.

Compensation Discussion and Analysis

This Compensation Discussion and Analysis, or CD&A, should be read in conjunction with the compensation tables and narratives that immediately follow this section.

Introduction

This CD&A provides an overview and analysis of the philosophy, objectives, process, components and additional aspects of our 2018 executive compensation program. This analysis focuses on the compensation paid to our named executive officers, or NEOs:

- Vincent J. Milano, President and Chief Executive Officer,
- R. Clayton Fletcher, Senior Vice President of Business Development and Strategy
- Joanna Horobin, Senior Vice President and Chief Medical Officer
- John J. Kirby, Vice President of Finance, Principal Financial and Accounting Officer
- Jonathan Yingling, Senior Vice President and Chief Scientific Officer
- Louis J. Arcudi, III, Former Chief Financial Officer and Senior Vice President, Operations,

Compensation Philosophy and Objectives

Our general executive compensation philosophy has been established by our compensation committee, which acts pursuant to authority delegated to it by our board. Our compensation committee is comprised solely of independent directors as defined by applicable rules and regulations of Nasdaq and the SEC. The compensation committee seeks to achieve the following broad goals in connection with our executive compensation program:

- attract, retain and motivate the best possible executive talent;
- ensure executive compensation is aligned with our corporate strategies and business objectives, including our short-term operating goals and longer-term strategic objectives;
- promote the achievement of key strategic and financial performance measures by linking short- and long-term cash and equity incentives to the achievement of measurable corporate and individual performance goals; and

- align executives' incentives with the creation of stockholder value.

To achieve these objectives, the compensation committee:

- sets short- and long-term compensation at levels the compensation committee believes are competitive with those of other companies in our industry and our region that compete with us for executive talent;
- ties a substantial portion of each executive officer's overall cash compensation to key strategic, financial, research, and operational goals such as clinical trial and regulatory progress, intellectual property portfolio development, establishment and maintenance of key strategic relationships, and exploration of business development opportunities, as well as our financial and operational performance; and
- provides a portion of our executive compensation in the form of stock options that vest over time from the date of grant of the option awards and from the time of achievement of performance milestones when applicable, which we believe helps to retain our executives and align their interests with those of our stockholders by allowing them to participate in the longer term success of our company as reflected in stock price appreciation.

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Advisory Vote on Executive Compensation

We conducted an advisory vote on executive compensation, commonly referred to as a "say-on-pay" proposal, at our 2018 Annual Meeting of Stockholders. While this vote was not binding on us, we value the opinions of our stockholders and, to the extent there is any significant vote against the compensation of our named executive officers in the future, we will consider our stockholders' concerns and our board and compensation committee will evaluate whether any actions are necessary to address those concerns.

At our 2018 Annual Meeting of Stockholders, approximately 97% of the votes cast on the advisory vote on executive compensation approved the compensation paid to our named executive officers as disclosed in the proxy statement for that meeting. The board of directors and compensation committee considered the results of this advisory vote, together with the other factors and data, in determining executive compensation decisions and will continue to consider the outcome of our say-on-pay votes when making future compensation decisions for our named executive officers.

Executive Compensation Process

Role of Our Compensation Committee and Our Chief Executive Officer

In order to accomplish its objectives consistent with its philosophy for executive compensation and determine compensation for our named executive officers, our compensation committee reviews competitive information on executive compensation practices from peer companies as well as an assessment of overall corporate performance and individual performance. In connection therewith, our compensation committee typically takes the following actions annually:

- reviews chief executive officer performance;
- seeks input from our chief executive officer on the performance of all other executive officers;
- reviews all components of executive officer compensation, including base salary, cash bonus targets and awards, equity compensation, the dollar value to the executive and cost to us of all health and life insurance and other employee benefits, and the estimated payout obligations under severance and change in control scenarios;
- consults with its independent compensation consultant;
- holds executive sessions (without our management present);
- reviews information regarding the performance and executive compensation of other companies; and

- reviews the outcomes from the foregoing with the board of directors.

Our chief executive officer does not submit an assessment of his own performance, does not present a recommendation on his own compensation, and does not participate in the portion of the meeting where his compensation is determined. Our compensation committee determines and recommends for final approval by the full Board, the compensation for our chief executive officer and other executive officers.

Under our annual performance review program for our executive officers, annual performance goals are determined for our company as a whole and for each executive officer individually.

- Annual corporate goals are proposed by management and approved by the board of directors. These corporate goals target the achievement of specific research, clinical, operational, and financial milestones. The compensation committee determines how the components of our annual corporate goals will contribute to the overall performance evaluation.
- Annual individual goals focus on contributions that facilitate the achievement of our corporate goals. Individual goals are proposed at the start of each year by each executive and approved by the chief

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executive officer and, as appropriate, the compensation committee. Typically, the compensation committee sets the chief executive officer's goals and reviews and discusses with the chief executive officer the goals for all other executive officers. The individual performance goals of each named executive officer consist primarily of the key objectives and goals from our annual business plan that relate to the functional area for which the executive officer is responsible. The individual performance goals for the chief executive officer are largely coextensive with the corporate goals.

At the end of each year, the compensation committee evaluates corporate and individual performance.

In assessing corporate performance, the compensation committee evaluates corporate performance alongside the approved corporate goals for the year and also evaluates other aspects of corporate performance, including achievements and progress made by us outside of the corporate goals.

In assessing individual performance, the compensation committee evaluates corporate performance in the areas of each officer's responsibility and relies on the chief executive officer's evaluation of each other officer. The chief executive officer prepares evaluations of the other executives and in doing so compares individual performance to the individual performance goals. The chief executive officer recommends annual executive salary increases, annual stock option awards and bonuses, if any, for the other executives, which are then reviewed and approved by the compensation committee. In the case of the chief executive officer, the compensation committee conducts his individual performance evaluation.

During this process, the compensation committee consults with its independent compensation consultant. To that end, in connection with the compensation committee's annual performance and compensation review in the fourth quarter of 2017, Pearl Meyer & Partners, LLC, or Pearl Meyer, provided the compensation committee with a blend of the data from the 2017 peer group (identified below) and compensation survey data from the Radford 2017 Global Life Sciences Survey, a survey of U.S. biotech companies. We refer to this blended data as the "2017 market compensation data."

For all executives, annual base salary increases, if any, are awarded during the first quarter following the end of the fiscal year. Annual stock option awards and bonuses, if any, are granted as determined by the compensation committee and are typically granted in the first quarter of the fiscal year. Beginning in 2019, the annual stock option awards will be given in two biannual tranches.

The compensation committee generally does not plan to approve annual equity grants to employees, including named executive officers, at a time when our company is in possession of material non-public information. We do not award stock options to named executive officers concurrently with the release of material non-public information.

Role of the Compensation Committee's Independent Consultant

In the fourth quarter of 2017, our compensation committee engaged Pearl Meyer in connection with our 2018 annual compensation assessment to review our executive compensation practices and to provide the compensation committee with an assessment of our compensation program against competitive market data. See "Use of Market Compensation Data" below for a discussion of the competitive market compensation data compiled by Pearl Meyer. Based on this assessment, Pearl Meyer made recommendations to our compensation committee regarding the amount and form of executive compensation, equity incentive programs, and compensation generally. Pearl Meyer did not provide any services to our company during 2017 or 2018 other than pursuant to their respective engagement by the compensation committee.

Our compensation committee analyzed whether the work of Pearl Meyer as a compensation consultant has raised any conflict of interest, taking into consideration the following factors: (a) the provision of other services to us by Pearl Meyer; (b) the amount of fees received from us by Pearl Meyer, as a percentage of the total revenue of Pearl Meyer; (c) Pearl Meyer’s policies and procedures that are designed to prevent conflicts of interest; (d) any business or personal relationship of Pearl Meyer or the individual advisors employed by Pearl Meyer with a member of the compensation committee or any executive officer; and (e) any shares of our stock owned by Pearl Meyer or the individual advisors employed by Pearl Meyer. Our compensation committee determined, based on its analysis of the above factors, that the work of Pearl Meyer and the individual compensation advisors employed by Pearl

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Meyer as compensation consultants has not created any conflict of interest and the compensation committee is satisfied with the independence of Pearl Meyer. Going forward, the compensation committee intends to assess the independence of any of our compensation advisers by reference to the foregoing factors, consistent with applicable rules and regulations of Nasdaq and the SEC.

Use of Market Compensation Data

In making compensation decisions, our compensation committee reviewed competitive market compensation data compiled by Pearl Meyer. As part of its engagement, Pearl Meyer worked with the compensation committee in the fourth quarter of 2017 to select a peer group of publicly traded companies to be used in connection with our 2018 compensation decisions, including stock options granted during 2018, fiscal year 2018 salary adjustments and fiscal year 2018 target bonus percentages. In selecting this peer group, the compensation committee and Pearl Meyer generally targeted mid- to late-development stage companies in the Pharmaceuticals, Biotechnology and Life Sciences sectors that generally met the following screening criteria:

- Company Size: revenue less than or equal to $150M; operating expense less than or equal to four times our operating expense (i.e., less than or equal to $240M); employees between 20-200;
- Business Operations: conducting Phase 2 or Phase 3 clinical trials in at least one of oncology, rare diseases, or leveraging a ‘technology platform’ model; and
- Other: exclude subsidiaries; companies with business challenges; companies having market valuations below $50M; and companies that have recently conducted an initial public offering.

The following table lists the companies included in the 2017 peer group used in connection with our 2018 compensation decisions referred to above:

Aduro BioTech, Inc.	Endocyte, Inc.	Regulus Therapeutics, Inc.
Advaxis, Inc.	Genocea Biosciences, Inc.	Sangamo Therapeutics, Inc.
Arrowhead Research Corp.	GlycoMimetics, Inc.	WAVE Life Sciences, Inc.
Celldex Therapeutics, Inc.	Immune Design Corp.	Xencor, Inc.

Concert Pharmaceuticals, Inc.	Immunomedics, Inc.	ZIOPHARM Oncology, Inc.
Dicerna Pharmaceuticals, Inc.	Inovio Pharmaceuticals, Inc.	
Dynavax Technologies Corp.	OncoMed Pharmaceuticals, Inc.	

The foregoing peer group companies were recommended by Pearl Meyer and approved by our compensation committee because they have similar business profiles to ours taking into account number of employees, market value and stage of development. Additionally, while there were no changes to the screening criteria used for determining the 2017 peer group used for 2018 compensation decisions, as compared to the determination of the 2016 peer group used for 2017 compensation decisions, certain companies were excluded from or added to the 2017 peer group, primarily due to application of our screening criteria (e.g. quantitative metrics and market capitalization).

Our compensation committee intends that if we achieve our corporate goals and the executive performs at the level expected, the executive should have the opportunity to receive compensation that is competitive with industry norms. Accordingly, our compensation committee generally targets overall compensation for executives towards the 50th percentile of the market data. However, the compensation committee does not apply those targets formulaically and allows for individuals to be positioned at different percentiles based on experience, performance levels and potential performance levels of the executive, and changes in duties and responsibilities.

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Components of Executive Compensation

The primary elements of our executive compensation program are:

- base salary;
- annual cash bonuses;
- stock option and restricted stock awards;
- health insurance, life insurance, and other employee benefits; and

- severance and change in control benefits.

The value of our variable, performance-based compensation is allocated between short-term compensation in the form of a cash bonus and long-term compensation in the form of stock option awards that vest over time from the date of grant of the option awards or from the time of achievement of performance milestones. The annual cash bonus is intended to provide an incentive to our executives to achieve short-term operational objectives. The stock option award is intended to provide an incentive for our executives to achieve longer-term strategic business goals, which should lead to higher stock prices and increased stockholder value. We have not had any formal or informal policy or target for allocating compensation between long-term and short-term compensation, between cash and non-cash compensation, or among the different forms of non-cash compensation. Instead, the compensation committee, after reviewing industry information and our cash resources, determines subjectively what it believes to be the appropriate level and mix of the various compensation components.

We do not have any defined benefit pension plans or any non-qualified deferred compensation plans.

We are party to employment agreements and employment offer letters with each of our named executive officers. Employment agreements and employment offer letters with our named executive officers are described below under the caption “Employment and Separation Agreements with our Named Executive Officers.”

Base Salary

In establishing base salaries for our named executive officers, our compensation committee typically reviews the market compensation data presented by the committee’s independent compensation consultant, considers historic salary levels of the executive officer and the nature of the executive officer’s responsibilities, compares the executive officer’s base salary with those of our other executives, and considers the executive officer’s experience, performance and contributions. The compensation committee also typically considers the challenges involved in hiring and retaining executive talent in our industry and region. In assessing the executive officer’s performance, the compensation committee considers the executive officer’s role in the achievement of the annual corporate goals, as

well as, in the case of our executive officers other than our chief executive officer, the performance evaluation prepared by our chief executive officer with respect to such executive officer. The compensation committee considers such evaluation as a means of informing the compensation committee's decision as to whether the executive officer's performance was generally consistent with our expectations.

As part of our 2017 annual performance and compensation review, the compensation committee approved annual base salaries for our executive officers for 2018. In setting these annual base salaries, the compensation committee reviewed the 2017 market compensation data presented by Pearl Meyer. Similarly, as part of our December 2018 annual performance and compensation review, the compensation committee reviewed the 2018 market compensation data and approved new annual base salaries for our executive officers for 2019. In each of the 2017 and 2018 reviews, after considering each executive's current salary, performance, and experience in the context of the market compensation data as well as relative to one another, the compensation committee approved the following salary increases and resulting base salaries:

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					% i
Executive	2017 Base Salary	2018 Base Salary	% Increase	2019 Base Salary	% Increase
Mr. Milano	$600,000	$600,000	0.0	$600,000	0.0
Mr. Fletcher	$386,300	$400,000	3.5	$400,000	0.0
Dr. Horobin	$410,000	$425,000	3.7	$425,000	0.0
Mr. Kirby (1)	$231,750	$280,000	20.8	$280,000	0.0
Mr. Lim (2)	—	$330,000	—	$336,000	1.8
Dr. Yingling	$385,000	$400,000	3.9	$400,000	0.0
Mr. Arcudi (3)	$357,900	$370,000	3.4	—	—

(1) Mr. Kirby commenced employment with us in November 2015 and became the Company's principal financial officer and principal accounting officer effective October 31, 2018. In connection with Mr. Kirby's appointment as principal financial officer and principal accounting officer, Mr. Kirby's annual base salary was increased from $239,850 to $280,000.
(2) Mr. Lim commenced employment with us in September 2018.
(3) Effective October 31, 2018, Mr. Arcudi, our former Chief Financial Officer and Senior Vice President, Operations, departed from us as a result of our consolidation to our Exton, PA headquarters.

Annual Cash Performance Bonuses

The compensation committee generally structures cash bonuses by linking them to the achievement of the annual corporate goals, corporate performance outside of the corporate goals (i.e. an unexpected opportunistic business development deal would be factored subjectively as an adjustment to the score that the committee derived from evaluation of the corporate goals), and individual performance. The amount of the bonus paid, if any, varies among the executive officers depending on individual performance and their contribution to the achievement of our annual corporate goals and corporate performance generally. The compensation committee reviews and assesses corporate goals and individual performance by executive officers and considers the reasons why specific goals have been achieved or have not been achieved. While achievement against the applicable corporate goals is given substantial weight in connection with the determination of annual bonuses, we also factor in an evaluation of our named executive officers' individual performance based on analysis of achievement of individual performance goals as well as the following subjective criteria:

· leadership;
· management;
· judgment and decision-making skills;
· results orientation; and

· communication

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The compensation committee sets the individual bonus target percentages for each of our named executive officers. In determining the target bonus percentages to be used for 2018, the compensation committee concluded that the target bonus percentages should be competitive with the 50th percentile of the 2017 market compensation data and that there be no difference in the target bonus percentages of our named executive officers, other than for Mr. Milano. The following table sets forth the individual bonus target percentages for each of our named executive officers for 2018 and 2019.

	Target Cash Bonus (% of Base Salary)	
Executive	2018	2019
Mr. Milano	50%	50%
Mr. Fletcher	40%	40%
Dr. Horobin	40%	40%
Mr. Kirby	30%	30%
Mr. Lim	40%	40%
Dr. Yingling	40%	40%
Mr. Arcudi	40%	—

Consistent with our company-wide annual incentive plan applicable to all employees, including our named executive officers, both a corporate performance score and individual performance score factored into the determination of each executive officer's cash bonus award for 2018.

Under the terms of our incentive plan, the corporate performance score is based on the degree to which corporate performance objectives have been achieved. This score is determined by the compensation committee and may range from 0-125%. The individual performance score is based on:

- the degree to which individual performance objectives have been achieved;
- the competencies and behaviors demonstrated in achieving results;
- the technical skills required by the position; and
- the completion of the ongoing responsibilities required by the position.

The individual performance score may range from 0-125% and is approved by the compensation committee. The individual's actual award is then calculated as follows:

Annual Base Salary ($)
X
Individual Target Bonus %
X
Corporate Performance Score

(0-125%)
X
Individual Performance Score

(0-125%)
Annual Incentive Award

($ Individual Payout)

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In setting corporate goals in the first quarter of 2018, the committee agreed to group the business objectives into one of three primary categories, each of which would contribute toward the overall assessment of our corporate performance. In assessing our corporate performance against our 2018 corporate goals, and determining the corporate performance score, the compensation committee considered the extent to which the company achieved the business objectives in each of the categories, and assigned a score for each category, as summarized in the following table:

Primary Goals	Contribution toward Corporate Performance Score	Committee's Assessment of Performance (out of 100%)	Highlights of Performance on Key Objectives
Advance Tilsotolimod (IMO-2125) program through Phase 3 and beyond PD-1 refractory melanoma	75%	40%	Initiated ILLUMINATE-301 study. Progressed ILLUMINATE-204 and ILLUMINATE-301 enrollment. Continued program expansion initiatives for beyond anti-PD1 refractory melanoma.
Advance 3GA program and IMO-8400 program to next decision point	15%	10%	Timely analysis of both studies resulted in no-go decision for both 3GA and IMO-8400.
Enhance our ability to be successful through relevant foundational objectives	10%	10%	Implemented an "at-the-market" equity program to facilitate future capital raising. Reviewed strategic business development options.

Based on these achievements and resulting category scores, the compensation committee approved a corporate performance score of 60%. However, as a result of additional factors the compensation committee considered in determining the company score to be applied to executives, including proposed merger outcome and discovery outcomes during 2018, the compensation committee reduced the overall corporate performance score by 10% for the 2018 bonus calculation for executives and determined to use a corporate performance score of 50%, excluding Mr. Kirby and Mr. Lim due to the timing of their appointments.

In assessing each named executive officer's individual performance score, the compensation committee determined:

- Mr. Milano's overall score would be equivalent to the corporate performance score of 50%;
- Mr. Fletcher's individual performance score, recognizing his achievement against his personal objectives, including his role in business development along with his general leadership contributions, would be 115%, resulting in an overall bonus equal to 58% of his bonus target;
- Dr. Horobin's individual performance score, recognizing her achievement against her personal objectives, including her role in achievements against our tilsotolimod (IMO-2125) clinical program goals along with her general

leadership contributions, would be 85%, resulting in an overall bonus equal to 43% of her bonus target;

- Mr. Kirby's individual performance score, recognizing his achievement against his personal objectives, including his role as principal financial and accounting officer, and general leadership contributions, would be 120%. Using the broader corporate score of 60%, as noted above, this resulted in an overall bonus equal to 86% of his bonus target;

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- Mr. Lim's individual performance score, recognizing his achievement against his personal objectives, including legal support to the Illuminate program and Board-related matters, along with his general leadership contributions, would be 100%. Using the broader corporate score of 60% as noted above, this resulted in an overall bonus equal to 60% of his bonus target, prorated to his start date; and
- Dr. Yingling's individual performance score, recognizing his achievement against his personal objectives, including his role in advancing objective knowledge and understanding of our discovery platform, contributions to business development, and his general leadership contributions, would be 100%, resulting in an overall bonus equal to 50% of his bonus target.

Mr. Arcudi separated from the Company prior to the compensation committee's determinations and in connection with his severance agreement, received a prorated bonus for 2018 at 100% of target.

Equity Compensation

Our equity award program is the primary vehicle for offering long-term incentives to our executive officers, including our named executive officers. We believe that equity awards provide our executives with a strong link to our long-term performance, create an ownership culture and help to align the interests of our named executive officers and our stockholders. Equity grants are intended as both a reward for contributing to the long-term success of our company and an incentive for future performance. The vesting feature of our equity awards is intended to further our goal of executive retention by providing an incentive to our named executive officers to remain in our employ during the vesting period. In determining the size of equity awards to our executives, our compensation committee considers:

- the achievement of our annual corporate goals;
- individual performance;
- the applicable executive officer's previous awards, including the exercise price of such previous awards;
- the recommendations of management;
- the market compensation data presented by the committee's independent compensation consultant, and
- the combined components of the executive officer's compensation.

The compensation committee approves all equity awards to our executive officers. Our equity awards have typically taken the form of stock options. However, under the terms of our stock incentive plans, we may grant equity awards other than stock options, such as restricted stock awards, stock appreciation rights, and restricted stock units. In January 2019, restricted stock units were granted to all employees, including our executive officers, as part of our annual incentive program.

The compensation committee typically makes initial stock option awards to named executive officers upon commencement of their employment and annual stock option awards thereafter. Stock option awards to our named executive officers after the initial stock option awards have typically been granted annually after the annual performance review. For 2018, this review occurred at the regularly scheduled meeting of the compensation committee held in the first quarter of 2018. Beginning in 2019, the annual stock option awards will be given in two biannual tranches. In general, annual stock option grants vest with respect to 25% of the shares subject to the option

on the first anniversary of the date of grant and with respect to the balance of the shares subject to the option in 12 equal quarterly installments over the three-year period thereafter. The exercise price of stock options equals the fair market value of our common stock on the date of grant, which is typically equal to the closing price of our common stock on Nasdaq on the date of compensation committee approval except in the case of new-hire grants, which are approved in advance by the compensation committee with the grant occurring at an exercise price established at the closing price of our common stock on the first day of employment.

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In December 2017, as part of its annual executive compensation and performance review, the compensation committee reviewed the 2017 market compensation data regarding annual stock option grants. In January 2018, the committee granted our named executive officers options to purchase shares of our common stock. Additionally, in August 2018, in consideration of historical stock performance as well as reference to 2017 market compensation data, the compensation committee further granted our named executive officer options to purchase shares of our common stock. The following table sets forth the number of options granted to our named executive officers in January 2018 and August 2018:

	Option Awards	
	January 2018	August 2018
Executive	(# options)	(# options)
Mr. Milano	74,999	65,000
Mr. Fletcher	33,749	32,500
Dr. Horobin	33,749	32,500
Mr. Kirby	16,874	10,000
Mr. Lim (1)	—	—
Dr. Yingling	33,749	32,500
Mr. Arcudi	33,749	32,500

(1) Mr. Lim was not an employee of the Company in January 2018 or August 2018.

In connection with the hiring of Mr. Lim and upon commencement of employment in September 2018, Mr. Lim was granted a stock option to purchase 130,000 shares of our common stock.

Benefits and Other Compensation

We maintain broad-based benefits that are provided to all employees, including health and dental insurance, life and disability insurance, and a 401(k) plan. Through August 2018, consistent with our prior practice, we matched 50% of the employee contributions to our 401(k) plan up to a maximum of 6% of the participating employee's annual salary, resulting in a maximum company match of 3% of the participating employee's annual salary, and subject to certain additional statutory dollar limitations. Commencing in August 2018 and retroactive to January 2018, we matched 100% of the employee contributions to our 401(k) plan up to a maximum of 5% of the participating employee's annual salary. Named executive officers are eligible to participate in all of our employee benefit plans, in each case on the same basis as other employees and subject to any limitations in such plans. Each of our named executive officers except for Mr. Fletcher contributed to our 401(k) plan and their contributions were matched by us.

Our board of directors has adopted a retirement policy to address the treatment of options in the event of an employee's retirement that applies to all employees, including all officers. For purposes of this policy, an employee will be deemed to have retired if the employee terminates his or her employment with us, has been an employee of ours for more than 10 years and is older than 65 upon termination of employment. Under the policy, if an employee retires,

then:

· all outstanding options held by the employee will automatically vest in full; and

· the period during which the employee may exercise the options will be extended to the expiration of the term of the option under the applicable option agreement.

Our board adopted this policy for our employees in recognition of the importance of stock options to the compensation of employees and in order to provide each of our employees with the opportunity to get the full benefit of the options held by the employee in the event of his or her retirement after making 10 years of contributions to our company.

We occasionally pay relocation expenses for newly-hired executive officers who we require to relocate as a condition to their employment by us. We also occasionally pay local housing expenses and travel costs for executives who maintain a primary residence outside of a reasonable daily commuting range to our headquarters.

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We believe that these are typical benefits offered by comparable companies to executives who are asked to relocate and that we would be at a competitive disadvantage in trying to attract executives who would need to relocate in order to work for us if we did not offer such assistance. We did not provide any relocation benefits to any of our executives in 2018.

Our named executive officers may also participate in our employee stock purchase plan, which is generally available to all employees who work over 20 hours per week, so long as they own less than 5% of our common stock, including for this purpose vested and unvested stock options. Dr. Horobin, Mr. Kirby and Mr. Arcudi participated in the employee stock purchase plan in 2018.

Severance and Change in Control Benefits

Under our employment agreements and employment offer letters with our named executive officers, other than with Mr. Kirby, we have agreed to provide severance and other benefits in the event of the termination of their employment under specified circumstances. On March 7, 2017, the board of directors approved a form of Severance and Change of Control Agreement to be entered into between the Company and our named executive officers. The severance benefits contained in the Change of Control Agreements supersede the severance and change of control terms contained in the existing employment agreements and employment offer letters. We have provided more detailed information about these benefits, along with estimates of their value under various circumstances, under the captions “Employment and Separation Agreements with our Named Executive Officers” and “Potential Payments Upon Termination or Change in Control” below.

We believe providing severance and/or change in control benefits as a component of our compensation structure can help us compete for executive talent and attract and retain highly talented executive officers whose contributions are critical to our long-term success. After reviewing the practices of companies in general industry surveys published by Radford Survey + Consulting, and consultation with Pearl Meyer, we believe that our severance and change in control benefits are appropriate.

Tax Deductibility of Executive Compensation

Prior to December 22, 2017, when the TCJA was signed into law, Section 162(m) of the Internal Revenue Code generally disallowed a tax deduction to publicly held companies for compensation paid to the chief executive officer and the three other most highly compensated executives (other than the chief financial officer) in excess of $1 million per officer in any year that such compensation did not qualify as performance-based. In connection with fiscal 2018 compensation decisions, the compensation committee considered the potential tax deductibility of executive compensation under Section 162(m) of the Internal Revenue Code and sought to qualify certain elements of these applicable executives’ compensation as performance-based while also delivering competitive levels and forms of

compensation.

Under the TCJA, the performance-based exception has been repealed and the $1 million deduction limit now applies to anyone serving as the chief executive officer or the chief financial officer at any time during the taxable year and the top three other highest compensated executive officers serving at fiscal year end. In addition, once an individual becomes a covered employee under Section 162(m) for any taxable year beginning after December 31, 2016, this status carries forward to all future years, even in the event of the employee's termination or death. The new rules generally apply to taxable years beginning after December 31, 2017, but do not apply to remuneration provided pursuant to a written binding contract in effect on November 2, 2017 that is not modified in any material respect after that date.

The compensation committee reserves the right to use its judgment to authorize compensation payments that may be subject to the limit when the compensation committee believes such payments are appropriate and in the best interests of our company and our stockholders. There can be no assurance that compensation awarded to our executive officers will be treated as qualified performance-based compensation under Section 162(m).

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Employment and Separation Agreements with our Named Executive Officers

We have entered into agreements with our named executive officers, as discussed below, that provide benefits to the executives upon their termination of employment in certain circumstances or under which we have agreed to specific compensation elements. Our named executive officers are at-will employees.

Employment Agreements and Offer Letters

Vincent J. Milano

We are a party to an employment offer letter with Mr. Milano, our President and Chief Executive Officer. Under the employment offer letter, Mr. Milano is entitled to receive an annual base salary of $600,000 or such higher amount as our compensation committee or our board of directors may determine. In addition, under the employment offer letter, Mr. Milano is eligible to receive an annual bonus of 50% of his base salary, subject to adjustment, based on the achievement of both individual and company performance objectives as developed and determined by our board of directors.

Under the employment offer letter, if we terminate Mr. Milano's employment without cause, prior to a change-in-control, as such terms are defined in the agreement, he will be entitled to severance payments for 24 months equivalent to his then-current base salary, payable in accordance with our then-current payroll practices, and benefits continuation for the shorter of 24 months or the date his COBRA continuation coverage expires and to receive any bonus that he earned and that our board of directors approved prior to the termination to the extent not then paid. If we terminate Mr. Milano's employment without cause or Mr. Milano terminates his employment with us for good reason, as such terms are defined in the agreement, upon or within one year after a change in control, he will be entitled to severance payments for 24 months equivalent to his then-current base salary, payable in accordance with our then-current payroll practices, and benefits continuation for the shorter of 24 months or the date his COBRA continuation coverage expires and to receive any bonus that he earned and that our board of directors approved prior to the termination to the extent not then paid and the inducement option award that he received upon his commencement of employment with us will vest in full and become immediately exercisable.

Our agreement to pay severance and benefits pursuant to the employment offer letter is subject to Mr. Milano entering into a separation and release agreement and is superseded by his severance and change in control agreement described below to the extent then in effect.

R. Clayton Fletcher

We are a party to an employment letter with Mr. Fletcher, our Senior Vice President of Business Development and Strategic Planning. Under the terms of the employment letter, Mr. Fletcher is entitled to receive an annual base salary of $360,000 or such higher amount as our compensation committee or our board of directors may determine. In addition, under the employment letter, Mr. Fletcher is eligible to receive an annual bonus of 35% of his base salary, subject to adjustment, based on the achievement of both individual and company performance objectives as established by our board of directors. Under the employment letter, if we terminate Mr. Fletcher's employment without cause at any time, or if he terminates his employment for good reason upon a change in control or within one year after a change in control, as such terms are defined in the agreement, we have agreed to:

- continue to pay Mr. Fletcher his base salary as severance for 12 months following such termination payable in accordance with our then current payroll practices plus any bonus earned and approved by the board of directors but unpaid at the time of termination;
- continue to provide Mr. Fletcher with health and dental benefits for 12 months following such termination, except to the extent another employer provides Mr. Fletcher with comparable benefits; and

- only in the event of a termination described above that occurs upon or within one year after a change in control, fully vest all options granted to Mr. Fletcher upon the commencement of his employment.

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Our agreement to pay severance and benefits pursuant to the employment offer letter is subject to Mr. Fletcher entering into a separation and release agreement and is superseded by his severance and change in control agreement (described below) to the extent then in effect.

Joanna Horobin, M.B., Ch.B

We are a party to an employment letter with Dr. Horobin, our Chief Medical Officer. Under the terms of the employment letter, Dr. Horobin is entitled to receive an annual base salary of $390,000 or such higher amount as our compensation committee or our board of directors may determine. In addition, under the employment letter, Dr. Horobin is eligible to receive an annual bonus of 40% of her base salary, subject to adjustment, based on the achievement of both individual and company performance objectives as established by our board of directors. Under the employment letter, if we terminate Dr. Horobin's employment without cause at any time, or if she terminates her employment for good reason upon a change in control or within one year after a change in control, as such terms are defined in the agreement, we have agreed to:

- continue to pay Dr. Horobin her base salary as severance for 12 months following such termination payable in accordance with our then current payroll practices plus any bonus earned and approved by the board of directors but unpaid at the time of termination;
- continue to provide Dr. Horobin with health and dental benefits for 12 months following such termination, except to the extent another employer provides Dr. Horobin with comparable benefits; and

- only in the event of a termination described above that occurs upon or within one year after a change in control, fully vest all options granted to Dr. Horobin upon the commencement of her employment.

Our agreement to pay severance and benefits pursuant to the employment offer letter is subject to Dr. Horobin entering into a separation and release agreement and is superseded by her severance and change in control agreement (described below) to the extent then in effect.

John J. Kirby

We are a party to an employment letter with Mr. Kirby, our prior Vice President of Corporate Accounting and, effective October 31, 2018, our current Vice President of Finance and principal financial and accounting officer. Under the terms of the employment letter, Mr. Kirby is entitled to receive an annual base salary of $225,000 or such higher amount as our compensation committee or our board of directors may determine. In addition, under the employment letter, Mr. Kirby is eligible to receive an annual bonus of 30% of his base salary, subject to adjustment, based on the achievement of both individual and company performance objectives as established by our board of directors. Mr. Kirby currently does not have a severance and change in control agreement (described below) with us.

Bryant D. Lim

We are a party to an employment letter with Mr. Lim, our Senior Vice President, General Counsel and Secretary. Under the terms of the employment letter, Mr. Lim is entitled to receive an annual base salary of $330,000 or such higher amount as our compensation committee or our board of directors may determine. In addition, under the employment letter, Mr. Lim is eligible to receive an annual bonus of 40% of his base salary, subject to adjustment, based on the achievement of both individual and company performance objectives as established by our board of directors.

Our agreement to pay severance and benefits if we terminate Mr. Lim's employment without cause at any time, or if he terminates his employment for good reason upon a change in control or within one year after a change in control, are covered under a separate severance and change in control agreement (described below) to the extent then in effect.

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Jonathan Yingling, Ph.D.

We are a party to an employment letter with Dr. Yingling, our prior Senior Vice President of Early Development and, effective January 1, 2018, our current Chief Scientific Officer. Under the terms of the employment letter, Dr. Yingling is entitled to receive an annual base salary of $385,000 or such higher amount as our compensation committee or our board of directors may determine. In addition, under the employment letter, Dr. Yingling is eligible to receive an annual bonus of 40% of his base salary, subject to adjustment, based on the achievement of both individual and company performance objectives as established by our board of directors. Under the employment letter, if we terminate Dr. Yingling's employment without cause at any time, or if he terminates his employment for good reason upon a change in control or within one year after a change in control, as such terms are defined in the agreement, we have agreed to:

- continue to pay Dr. Yingling his base salary as severance for 12 months following such termination payable in accordance with our then current payroll practices plus any bonus earned and approved by the board of directors but unpaid at the time of termination;
- continue to provide Dr. Yingling with health and dental benefits for 12 months following such termination, except to the extent another employer provides Dr. Yingling with comparable benefits; and

- only in the event of a termination described above that occurs upon or within one year after a change in control, fully vest all options granted to Dr. Yingling upon the commencement of his employment.

Our agreement to pay severance and benefits pursuant to the employment offer letter is subject to Dr. Yingling entering into a separation and release agreement and is superseded by his severance and change in control agreement (described below) to the extent then in effect.

Louis J. Arcudi, III

Prior to his resignation on October 31, 2018, the terms of Mr. Arcudi's employment as our Senior Vice President of Operations, Chief Financial Officer, Treasurer and Assistant Secretary were set forth in an employment letter, as amended, with Mr. Arcudi. Under the employment letter, Mr. Arcudi was initially entitled to receive an annual base salary of $315,000, such amount subject to adjustment from time to time in accordance with normal business practices. In addition, under the employment letter, Mr. Arcudi was entitled to receive an annual bonus in an amount approved by our board or the compensation committee based on the achievement of both individual and company performance objectives as developed and determined by our board of directors.

Pursuant to his employment letter, if we terminated Mr. Arcudi's employment without cause at any time, or if he terminated his employment for good reason upon a change in control or within one year after a change of control, as such terms are defined in the agreement, we agreed to:

- continue to pay Mr. Arcudi his base salary as severance for 12 months following such termination payable in accordance with our then current payroll practices; and

- continue to provide Mr. Arcudi with health and dental benefits for 12 months following such termination, except to the extent another employer provides Mr. Arcudi with comparable benefits.

Our agreement to pay severance and benefits pursuant to the employment letter is subject to Mr. Arcudi entering into a separation and release agreement and is superseded by his severance and change in control agreement described below to the extent then in effect.

On October 31, 2018, we entered into a separation agreement and release with Mr. Arcudi, under which Mr. Arcudi agreed to resign as our Senior Vice President of Operations, Chief Financial Officer, Treasurer and Assistant Secretary. Pursuant to the agreement, we provided Mr. Arcudi the following separation benefits in exchange for him agreeing to a release of claims and complying with certain other continuing obligations contained therein (including compliance with the restrictive covenants in his employment agreement):

- We paid Mr. Arcudi a pro-rated 2018 bonus payment of $103,182, less all applicable taxes and withholdings;

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- We have agreed that, commencing on the first regular payroll date following his separation date until October 31, 2019, we will pay Mr. Arcudi with severance pay in the total gross amount of $525,115, payable in equal installments in accordance with our regular payroll practices;
- Mr. Arcudi is eligible to receive health and dental benefits through reimbursement of COBRA premiums from his separation date through no later than October 31, 2019; and
- Any stock options or other equity incentive awards previously granted to Mr. Arcudi and held by Mr. Arcudi on his separation date shall continue to remain exercisable until the earlier of (i) twelve months from the end of the quarter in which Mr. Arcudi terminates services from the with us, or (ii) the original expiration date of such option.

In addition, we (a) paid all of Mr. Arcudi's compensation due and owing to him as of October 31, 2018 in accordance with our usual compensation and payroll practices, and (b) reimbursed Mr. Arcudi for all reasonable unreimbursed business expenses incurred by him as of October 31, 2018 in accordance with our expense reimbursement policy.

Mr. Arcudi also entered into a consulting agreement with us, effective October 31, 2018, under which Mr. Arcudi agreed to provide consulting services to us, and we have agreed to pay Mr. Arcudi consulting fees at a rate of $500 per hour for any such services provided, not to exceed $50,000 without our consent, as well as reimbursement for pre-approved reasonable expenses for a term of twelve months. The agreement also contains non-solicit provisions that apply during the consulting period and the one-year period thereafter.

Severance and Change in Control Agreements

We have entered into a Severance and Change of Control Agreement with each of Messrs. Milano, Arcudi, Lim and Fletcher, and Drs. Yingling and Horobin.

The Severance and Change of Control Agreements provide that if we consummate a change of control (as defined in the Severance and Change of Control Agreements), we will employ the executive for a period of 24 months from the date of the consummation of the change of control. Pursuant to the Severance and Change of Control Agreements, during such period:

(i) the executive's position and duties for the company will be commensurate with the most significant of the duties and positions held by the executive during the 90 day period preceding the date of the consummation of the change of control;
(ii) the executive's annual base salary will equal at least 12 times the highest monthly base salary paid to the executive during the 12 months prior to the date of the change of control;
(iii) the executive will be entitled to an annual bonus equal to at least the greatest of (a) the average bonus paid to the executive in respect of the three years immediately preceding the year in which the change of control occurs, (b) the annual bonus paid for the year immediately preceding the year in which the change of control occurs and (c) 100% of the target bonus for (1) the year immediately preceding the year in which the change of control occurs, (2) the year in which the change of control occurs or (3) any year following the year in which the change of control occurs and prior to the then-current year, whichever is highest; and

(iv) the executive will be entitled to certain other benefits as are consistent with the benefits paid to the executive during the year prior to the change of control.

The Severance and Change of Control Agreements also provide that if an executive is terminated without "cause" or resigns for "good reason" (as such terms are defined in the Severance and Change of Control Agreements) in either case, within 24 months following a change of control, subject to the executive's timely execution and non-revocation of a general release of claims in a form provided by us and the executive's continued compliance with the invention, non-disclosure and non-competition agreement previously entered into in connection with the commencement of executive's employment, executives would receive a lump sum cash payment payable within 30 days after the date of termination equal to:

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(i) the executive's target bonus for the year of termination prorated for the portion of the year worked;
(ii) 150% of the sum of (a) such executive's annual base salary for the year immediately preceding the year of termination and (b) the greatest of (1) the average bonus paid or earned and accrued, but unpaid to the executive in respect of the three years immediately preceding the year of termination, (2) the annual bonus paid for the year immediately preceding the year of termination and (3) the target bonus for the year of termination; and
(iii) 150% of the Company’s share of the annual premium for group medical and/or dental insurance coverage that was in place for the executive immediately prior to the date of termination.

In addition, all unvested options, restricted stock or stock appreciation rights held by the executive as of the date of termination will be immediately and automatically vested and/or exercisable in full as of the date of termination, and the executive will have the right to exercise any such options or stock appreciation rights for the longer of (A) the period of time provided for in the applicable equity award agreement or plan, or (B) the shorter of one year after the date of termination or the remaining term of the applicable equity award. However, under the terms of the Merger Agreement the post-termination exercise period of all outstanding stock options will continue in the event of the executive's termination of employment within 24 months following the effective time of the Mergers (other than for cause or due to the executive's resignation without good reason), until the three-year anniversary of such executive's termination, but in no event past the remaining term of the applicable equity award.

If the executive is terminated without “cause” or resigns for “good reason,” prior to the date of a change of control, such executive will be entitled to the following under the Severance and Change of Control Agreement, subject to the executive’s timely execution and non-revocation of a general release of claims in a form provided by us and the executive’s continued compliance with the invention, non-disclosure and non-competition agreement previously entered into in connection with the commencement of executive’s employment:

(i) a lump sum cash payment payable within 30 days after the date of termination in an amount equal to the greater of (x) the average bonus paid or earned and accrued, but unpaid to the executive in respect of the three years immediately preceding the year of termination, and (y) the annual bonus paid for the year immediately preceding the year of termination prorated for the portion of the year worked;
(ii) continued payment of the executive's base salary payable in accordance with our standard payroll practices over the one-year period following termination; and
(iii) if the executive elects to continue receiving group medical and/or dental insurance under COBRA (to the extent the executive previously participated in such group insurance plans immediately prior to the date of termination), payment by us of our share of the premium for such coverage that we pay for active and similarly-situated employees who receive the same type of coverage for the one-year period following termination.

The Severance and Change of Control Agreements expire on December 31, 2018, but on each anniversary thereof, unless notice of termination has been provided by a party, the term of such agreements will automatically be extended by one year.

Indemnification Agreements

On March 7, 2017, the board of directors approved a form of Indemnification Agreement to be entered into between the Company and our directors and officers. Each of Messrs. Milano, Arcudi, Fletcher, Kirby and Lim and Drs. Horobin and Yingling entered into an Indemnification agreement with the Company. In general, the Indemnification Agreements provide that the Company will indemnify the director or officer to the fullest extent permitted by law for claims arising in his or her capacity as a director or officer of the Company or in connection with their service at our request for another corporation or entity. The Indemnification Agreements also provide for procedures that will apply in the event that a director or officer makes a claim for indemnification and establish certain presumptions that are favorable to the director or officer.

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Formal Clawback Policy

In April 2015, ahead of any such requirement in the Dodd-Frank Wall Street Reform and Consumer Protection Act, our compensation committee adopted a formal clawback policy, which will apply in the event we are required to prepare an accounting restatement after the adoption of the clawback policy due to any material noncompliance with any financial reporting requirement under the U.S. federal securities laws. This policy requires us to use reasonable efforts to recover from any of our current or former executive officers who receive incentive-based compensation (including stock options awarded as compensation) during the three-year period preceding the date on which we are required to prepare an accounting restatement based on erroneous data, the excess of what would have been paid to such executive officer under the accounting restatement.

Compensation Committee Report

The compensation committee has reviewed and discussed the Compensation Discussion and Analysis required by Item 402(b) of Regulation S-K with our management. Based on this review and discussion, the compensation committee recommended to our board of directors that the Compensation Discussion and Analysis be included in this Annual Report on Form 10-K.

By the compensation committee of the board of directors,

Maxine Gowen, Chair

Howard Pien

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Additional Compensation Information

Summary Compensation Table

The table below summarizes compensation paid to or earned by our named executive officers for 2018, 2017 and 2016.

Summary Compensation Table for Fiscal Year 2018

Name and Principal Position	Year	Salary ($)	Bonus ($)	Option Awards ($)(1)	Non-Equity Incentive Plan Compensation ($)	All Other Compensation ($)(2)	Total ($)
Vincent J. Milano	2018	600,000	—	998,081	150,000	33,863	1,781,944
President and Chief	2017	600,000	—	296,634	270,000	31,106	1,197,740
Executive Officer	2016	600,000	—	573,780	211,680	31,555	1,417,015
R. Clayton Fletcher	2018	400,000	—	461,837	92,000	23,613	977,450
Senior Vice President,	2017	386,300	—	182,924	145,908	22,988	738,120
Business Development and Strategy	2016	375,000	—	353,831	114,660	23,580	867,071
Joanna Horobin	2018	425,000	—	461,837	72,250	34,838	993,925
Senior Vice President,	2017	410,000	—	182,924	132,840	31,754	757,518
Chief Medical Officer	2016	390,000	—	—	119,246	31,187	540,433
John J. Kirby	2018	249,888	—	206,479	64,771	32,735	553,873
Vice President of Finance,	2017	231,750	—	98,878	62,573	28,676	421,877
Principal Financial and Accounting Officer (3)	2016	225,000	—	172,150	54,607	28,540	480,297
Jonathan Yingling	2018	400,000	—	461,837	80,000	33,926	975,763
Senior Vice President,	2017	348,542	—	577,782	144,296	31,277	1,101,897
Chief Scientific Officer (4)							
Louis J. Arcudi, III	2018	308,333	103,183	(6) 461,837	—	112,776	986,129

Former Senior Vice President of Operations, Chief Financial Officer, Treasurer and Assistant Secretary (5)	2017	357,900	—	182,924	122,436	25,786	689,046
	2016	347,500	—	353,831	116,760	26,276	844,367

(1) Represents the aggregate grant date fair value of options granted to each of the named executive officers as computed in accordance with ASC 718. These amounts do not represent the actual amounts paid to or realized by the named executive officers. See Note 11 to the financial statements included elsewhere in this Annual Report on Form 10-K regarding assumptions we made in determining the fair value of option awards.

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(2) "All Other Compensation" for 2018 for each of the named executive officers includes the following:

	Premiums paid by us for all insurance plans ($)	Company match on 401(k) ($)	Severance ($)	Total ($)
Mr. Milano	23,613	10,250	—	33,863
Mr. Fletcher	23,613	—	—	23,613
Dr. Horobin	24,525	10,313	—	34,838
Mr. Kirby	23,239	9,496	—	32,735
Dr. Yingling	23,613	10,313	—	33,926
Mr. Arcudi	14,944	10,313	87,519	112,776

(3) Upon Mr. Kirby's appointment as our principal financial officer and principal accounting officer effective October 31, 2018, Mr. Kirby's annual base salary was increased from $239,850 to $280,000.

(4) Dr. Yingling joined our company and became our Senior Vice President, Early Development effective as of February 6, 2017 and has served as our Chief Scientific Officer since January 1, 2018.

(5) Mr. Arcudi served as our Senior Vice President of Operations, Chief Financial Officer, Treasurer and Assistant Secretary until his resignation, effective October 31, 2018.

(6) Pursuant to Mr. Arcudi's separation agreement, Mr. Arcudi received a pro-rated cash bonus in 2018 calculated as the product of (i) the greater of (a) the average bonus paid or that has been earned and accrued, but unpaid to Mr. Arcudi by us, in respect of the three fiscal years immediately preceding the fiscal year in which the separation date occurred, and (b) the annual bonus paid for the fiscal year immediately preceding the separation date (both (a) and (b) annualized for any fiscal year consisting of less than twelve full months or with respect to which Mr. Arcudi has been employed by us for less than twelve full months) and (ii) a fraction, the numerator of which is the number of days in the current fiscal year through the separation date, and the denominator of which is 365.

CEO Pay Ratio

Following is a reasonable estimate, prepared under applicable SEC rules, of the ratio of the annual total compensation of our CEO to the median of the annual total compensation of our other employees. We determined our median employee based on annualized 2018 base salary and annualized 2018 bonus awards for each of our 36 employees (excluding the CEO) as of December 31, 2018. The annual total compensation of our median employee (other than the CEO) for 2018 was $297,391. As disclosed in the Summary Compensation Table included in this CD&A, our CEO's annual total compensation for 2018 was $1,781,944. Based on the foregoing, the ratio of the 2018 annual total compensation of our CEO to the median of the annual total compensation of all other employees was 6 to 1. Given the different methodologies that various public companies will use to determine an estimate of their pay ratio, the estimated ratio reported above should not be used as a basis for comparison between companies.

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Grants of Plan-Based Awards

The following table sets forth information regarding grants of plan-based awards to our named executive officers during 2018.

Grants of Plan-Based Awards for Fiscal Year 2018

Name	Grant Date	Estimated Possible Payouts Under Non-Equity Incentive Plan Awards Threshold ($)	Target ($)	Maximum ($)	All Other Option Awards: Number of Securities Underlying Options (#)(1)	Exercise or Base Price of Option Awards ($/Sh)	Grant Date Fair Value of Option Awards ($)(2)
Vincent J. Milano		—	300,000	468,750			
	1/3/2018 (3)				74,999	17.92	743,965
	8/13/2018 (3)				65,000	7.39	254,116
R. Clayton Fletcher		—	160,000	250,000			
	1/3/2018 (3)				33,749	17.92	334,779
	8/13/2018 (3)				32,500	7.39	127,058
Joanna Horobin		—	170,000	265,625			
	1/3/2018 (3)				33,749	17.92	334,779
	8/13/2018 (3)				32,500	7.39	127,058
John J. Kirby		—	74,966	117,135			
	1/3/2018 (3)				16,874	17.92	167,384
	8/13/2018 (3)				10,000	7.39	39,095
Jonathan Yingling		—	160,000	250,000			
	1/3/2018 (3)				33,749	17.92	334,779
	8/13/2018 (3)				32,500	7.39	127,058
Louis J. Arcudi, III (4)		—	123,333	192,708			
	1/3/2018 (3)				33,749	17.92	334,779
	8/13/2018 (3)				32,500	7.39	127,058

(1) The term of these options is ten years. The vesting of these stock options is time-based. See “Compensation Discussion and Analysis — Components of Executive Compensation — Equity Compensation” for a full description of the vesting terms for these options. See “Employment and Separation Agreements with our Named Executive Officers” for further information about acceleration of vesting of options in the event of the termination of employment and/or a change of control.

(2) Represents the aggregate grant date fair value of option awards made to the named executive officers in 2017 as computed in accordance with ASC 718. These amounts do not represent the actual amounts paid to or realized by the named executive officers during 2018. See Note 11 to the financial statements included elsewhere in this Annual Report on Form 10-K regarding assumptions we made in determining the fair value of option awards.

(3) Granted pursuant to our 2013 Stock Incentive Plan.

(4) The target and maximum amounts reported under Estimated Possible Payouts Under Non-Equity Incentive Plan Awards for Mr. Arcudi are pro-rated for Mr. Arcudi’s resignation effective October 31, 2018. Pursuant to the Separation Agreement and Release dated October 31, 2018 by and between Mr. Arcudi and us, Mr. Arcudi received a pro-rated bonus for 2018 in the amount of $103,183, the calculation of which is more fully described in the footnotes to the “Summary Compensation Table for Fiscal Year 2018.”

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Outstanding Equity Awards at Fiscal Year-End

The following table sets forth information regarding the outstanding stock options held by our named executive officers as of December 31, 2018. None of our named executive officers held shares of unvested restricted stock as of December 31, 2018.

Outstanding Equity Awards at Fiscal Year-End for 2018

Name	Number of Securities Underlying Unexercised Options (#) Exercisable	Number of Securities Underlying Unexercised Options (#) Unexercisable		Option Exercise Price ($)	Option Expiration Date
Vincent J. Milano	250,000	—		24.96	12/1/2024
	25,780	11,719	(1)	23.04	1/6/2026
	16,406	21,094	(2)	12.72	1/4/2027
	—	74,999	(3)	17.92	1/3/2028
	—	65,000	(4)	7.39	8/13/2028
R. Clayton Fletcher	70,312	4,688	(5)	37.36	1/26/2025
	15,897	7,227	(1)	23.04	1/6/2026
	10,117	13,007	(2)	12.72	1/4/2027
	—	33,749	(3)	17.92	1/3/2028
	—	32,500	(4)	7.39	8/13/2028
Joanna Horobin	56,248	18,751	(6)	31.04	11/30/2025
	10,117	13,007	(2)	12.72	1/4/2027
	—	33,749	(3)	17.92	1/3/2028
	—	32,500	(4)	7.39	8/13/2028
John J. Kirby	14,061	4,689	(7)	24.88	11/2/2025
	7,734	3,515	(1)	23.04	1/6/2026
	5,468	7,031	(2)	12.72	1/4/2027
	—	16,874	(3)	17.92	1/3/2028
	—	10,000	(4)	7.39	8/13/2028
Jonathan Yingling	32,811	42,188	(8)	12.40	2/6/2027

	—	33,749	(3) 17.92	1/3/2028
	—	32,500	(4) 7.39	8/13/2028
Louis J. Arcudi, III	13,749	—	41.92	12/23/2019
	11,874	—	21.92	12/27/2020
	18,247	—	9.26	11/28/2021
	43,541	—	5.52	5/22/2023
	37,500	—	20.48	12/10/2023
	24,999	—	31.76	12/10/2024
	15,898	7,226	(1) 23.04	1/6/2026
	10,117	13,007	(2) 12.72	1/4/2027
	—	33,749	(3) 17.92	1/3/2028
	—	32,500	(4) 7.39	8/13/2028

(1) Represents unvested portion of stock option award that vested 25% on January 6, 2017 (first anniversary date following the January 6, 2016 grant date), with the remainder vesting in 12 equal quarterly installments thereafter (until January 6, 2020), provided the named executive officer is still employed with us on each vesting date.

(2) Represents unvested portion of stock option award that vested 25% on January 4, 2018 (first anniversary date following the January 4, 2017 grant date), with the remainder vesting in 12 equal quarterly

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installments thereafter (until January 4, 2021), provided the named executive is still employed with us on each vesting date.

(3) Represents unvested portion of stock option award that will vest 25% on the first anniversary date following the January 3, 2018 grant date, with the remainder vesting in 12 equal quarterly installments thereafter (until January 3, 2022), provided the named executive is still employed with us on each vesting date.

(4) Represents unvested portion of stock option award that will vest 25% on the first anniversary date following the August 13, 2018 grant date, with the remainder vesting in 12 equal quarterly installments thereafter (until August 13, 2022), provided the named executive is still employed with us on each vesting date.

(5) Represents unvested portion of stock option award that vested 25% on January 26, 2016 (first anniversary date following the January 26, 2015 grant date), with the remainder vesting in 12 equal quarterly installments thereafter (until January 26, 2019), provided the named executive is still employed with us on each vesting date.

(6) Represents unvested portion of stock option award that vested 25% on November 30, 2016 (first anniversary date following the November 30, 2015 grant date), with the remainder vesting in 12 equal quarterly installments thereafter (until November 30, 2019), provided the named executive is still employed with us on each vesting date.

(7) Represents unvested portion of stock option award that vested 25% on November 2, 2016 (first anniversary date following the November 2, 2015 grant date), with the remainder vesting in 12 equal quarterly installments thereafter (until November 2, 2019), provided the named executive is still employed with us on each vesting date.

(8) Represents unvested portion of stock option award that will vest 25% on the first anniversary date following the February 6, 2017 grant date, with the remainder vesting in 12 equal quarterly installments thereafter (until February 6, 2021), provided the named executive is still employed with us on each vesting date

Option Exercises and Stock Vested

None of our named executive officers exercised any options during the year ended December 31, 2018.

Potential Payments Upon Termination or Change in Control

Under our employment agreement and employment offer letters with our executive officers, we have agreed to provide severance and other benefits in the event of the termination of their employment under specified circumstances. These agreements are described above under the caption “Employment and Separation Agreements with our Named Executive Officers.”

However, in March 2017, we entered into a Severance and Change of Control Agreement with each of Messrs. Milano, Arcudi and Fletcher, and Drs. Horobin and Yingling that superseded the severance and change in control provisions of each of their respective employment offer letters. These agreements are also described above under the caption “Employment and Separation Agreements with our Named Executive Officers.”

In October 2018, we entered into a separation agreement and release with Mr. Arcudi, in connection with Mr. Arcudi's resignation effective October 31, 2018, as our Senior Vice President of Operations, Chief Financial Officer, Treasurer and Assistant Secretary, and we agreed to provide him certain severance benefits and other compensation. This agreement is described above under the caption "Employment and Separation Agreements with our Named Executive Officers," and the payments upon Mr. Arcudi's resignation were paid in accordance with this agreement and are set forth above in the "Summary Compensation Table."

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Termination of Employment Not In Connection With or Following a Change in Control

The following table sets forth the estimated potential benefits that our named executive officers would be entitled to receive upon their termination of employment with our company (other than a termination in connection with or following a change in control of our company) if the named executive officer's employment was terminated on December 31, 2018. This table represents estimates only and does not necessarily reflect the actual amounts that would be paid to our named executive officers, which would only be known at the time that they become eligible for payment following their termination.

Name	Cash Severance (1) ($)	Perquisites/ Benefits (2) ($)	Total ($)
Vincent J. Milano	810,560	25,414	835,974
R. Clayton Fletcher	517,523	25,414	542,937
Joanna Horobin	533,112	25,414	558,526
John J. Kirby (3)	—	—	—
Jonathan Yingling	519,695	25,414	545,109

(1) Cash severance under the Severance and Change of Control Agreements would be payable to Messrs. Milano and Fletcher, and Drs. Horobin and Yingling upon a termination of the executive's employment by the executive for "good reason" or by us without "cause", in either case, subject to the executive's timely execution and non-revocation of a general release of claims in a form provided by the Company and the executive's continued compliance with the invention, non-disclosure and non-competition agreement previously entered into in connection with the commencement of executive's employment. In such an event, executives would receive:

(i) a lump sum cash payment payable within 30 days after the date of termination equal to the greater of (1) the average bonus paid or earned and accrued, but unpaid to the executive in respect of the three fiscal years immediately preceding the year of termination, and (2) the annual bonus paid for the year immediately preceding the year of termination ($210,560 for Mr. Milano, $117,523 for Mr. Fletcher, $108,112 for Dr. Horobin and $119,695 for Dr. Yingling); and

(ii) salary continuation payments at the executive's base salary on termination date for a period of 12 months paid in accordance with the Company's normal payroll practices and subject to applicable tax withholding ($600,000 for Mr. Milano, $400,000 for Mr. Fletcher, $425,000 for Dr. Horobin and $400,000 for Dr. Yingling).

(2) Under the Severance and Change of Control Agreements, upon a qualifying termination by Messrs. Milano and Fletcher, and Drs. Horobin and Yingling, to the extent the executives participated in our group medical/dental insurance immediately prior to the termination date, if executives elect to continue receiving group medical and/or dental insurance under the continuation coverage rules known as COBRA, the Company will pay the Company's share of the premium for such coverage that it pays for active and similarly-situated employees who receive the same type of coverage until the end of the period for which the Company is paying the salary continuation payments described within note (1)(ii), above.

The payments described in this column include an estimated value of the employer share of the premiums for our insurance plans as follows:

Name	Medical Insurance Premiums ($)	Dental Insurance Premiums ($)	Total ($)
Vincent J. Milano	23,584	1,830	25,414
R. Clayton Fletcher	23,584	1,830	25,414
Joanna Horobin	23,584	1,830	25,414
Jonathan Yingling	23,584	1,830	25,414

(3) Mr. Kirby currently does not have a Severance and Change in Control Agreement with us.

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Termination of Employment In Connection With or Following a Change in Control

The following table sets forth the estimated potential benefits that our named executive officers would be entitled to receive upon their termination of employment with our company in connection with or following a change in control of our company if the named executive officer's employment was terminated on December 31, 2018. The amounts indicated below are estimates based on the material assumptions described in the notes to the table below, which may or may not actually occur. Some of these assumptions are based on information currently available and, as a result, the actual amounts, if any, that may become payable to a named executive officer may differ in material respects from the amounts set forth below. Furthermore, for purposes of calculating such amounts, we have assumed:

- a change of control date of December 31, 2018;
- each named executive officer's employment is terminated by us without "cause" or by the named executive officer for "good reason", in each case on the date of the change of control; and
- the value of the accelerated vesting of any equity award is calculated assuming a market price per share of our common stock equal to $2.77 (which equals the closing price of a share of our common stock on the Nasdaq Capital Market on December 31, 2018).

This table represents estimates only and does not necessarily reflect the actual amounts that would be paid to our named executive officers, which would only be known at the time that they become eligible for payment following their termination.

Name	Cash Severance (1) ($)	Equity (2) ($)	Perquisites/ Benefits (3) ($)	Total ($)
Vincent J. Milano	1,650,000	—	38,121	1,688,121
R. Clayton Fletcher	1,000,000	—	38,121	1,038,121
Joanna Horobin	1,062,500	—	38,121	1,100,621
John J. Kirby (4)	—	—	—	—
Jonathan Yingling	1,000,000	—	38,121	1,038,121

(1) Cash severance under the Severance and Change of Control Agreements would be payable to Messrs. Milano and Fletcher, and Drs. Horobin and Yingling upon a termination of the executive's employment by the executive for "good reason" or by us without "cause", in either case, within 24 months following a change of control (i.e., pursuant to a "double trigger" arrangement), subject to the executive's timely execution and non-revocation of a general release of claims in a form provided by the Company and the executive's continued compliance with the invention,

non-disclosure and non-competition agreement previously entered into in connection with the commencement of executive's employment. In such an event, executives would receive a lump sum cash payment payable within 30 days after the date of termination equal to:

(i) the executive's target bonus for the year of termination prorated for the portion of the year worked ($300,000 for Mr. Milano, $160,000 for Mr. Fletcher, $170,000 for Dr. Horobin and $160,000 for Dr. Yingling); and

(ii) 150% of the sum of (a) such executive's annual base salary for the year immediately preceding the year of termination and (b) the greatest of (1) the average bonus paid or earned and accrued, but unpaid to the executive in respect of the three years immediately preceding the year of termination, (2) the annual bonus paid for the year immediately preceding the year of termination and (3) the target bonus for the year in which the termination occurs ($1,350,000 for Mr. Milano, $840,000 for Mr. Fletcher, $892,500 for Dr. Horobin and $840,000 for Dr. Yingling).

(2) Amounts in this column quantify the intrinsic value of the unvested stock options held by the named executive officers that would accelerate upon a qualifying termination of employment in connection with a change in control based on the assumptions described above.

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Under the Severance and Change of Control Agreements, upon a qualifying termination by Messrs. Milano and Fletcher, and Drs. Horobin and Yingling within 24 months following a change of control, all outstanding stock options held by the executive as of the date of termination will be automatically vested in full as of the date of termination, and the executive will have the ability to exercise any such options until the three year anniversary of such executive's termination, but in no event past the remaining term of the applicable equity award. Upon a qualifying change in control event, Mr. Kirby's outstanding options shall fully vest, regardless of whether a termination event also occurs.

(3) Under the Severance and Change of Control Agreements, upon a qualifying termination by Messrs. Milano and Fletcher, and Drs. Horobin and Yingling within 24 months following a change of control, the executive will be eligible to receive 150% of the Company's share of the annual premium for group medical and/or dental insurance coverage that was in place for the executive immediately prior to the date of termination, payable in a lump sum cash payment within 30 days after the date of termination.

The payments described in this column include an estimated value of the employer share of the premiums for our insurance plans as follows:

Name	Medical Insurance Premiums ($)	Dental Insurance Premiums ($)	Total ($)
Vincent J. Milano	35,376	2,745	38,121
R. Clayton Fletcher	35,376	2,745	38,121
Joanna Horobin	35,376	2,745	38,121
Jonathan Yingling	35,376	2,745	38,121

(4) Mr. Kirby currently does not have a Severance and Change in Control Agreement with us. However, following a qualifying change in control event, unvested stock options held by Mr. Kirby would accelerate in connection with a change control as governed by his outstanding stock option agreements.

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Director Compensation

We use a combination of cash and equity-based compensation to attract and retain candidates to serve on our board of directors. We do not compensate directors who are also our employees for their service on our board of directors. As a result, Mr. Milano does not receive any compensation for his service on our board of directors.

We generally review our director compensation program every two years with the advice of an independent compensation consultant. In January 2018, we modified our director compensation program, effective January 1, 2018, to include annual cash compensation for directors serving as members of the Scientific Advisory Committee. In September 2018, we modified our director compensation program, effective September 18, 2018, to revise the number of shares issued and awarded upon initial election and on an annual basis. In November 2018, we modified our director compensation program, effective January 1, 2019, to increase the cash compensation for service on the board of directors from $35,000 to $40,000.

Under our director compensation program, we pay our non-employee directors retainers in cash. Each director receives a cash retainer for service on the board of directors and for service on each committee on which the director is a member. The chairmen of each committee receive higher retainers for such service. These fees are paid quarterly in arrears. The fees paid to non-employee directors for service on the board of directors and for service on each committee of the board of directors on which the director was a member during 2018 were as follows:

	Member Annual Fee	Chairman Annual Fee
Board of Directors	$ 35,000	$ 70,000
Audit Committee	$ 7,500	$ 15,000
Compensation Committee	$ 6,250	$ 12,500
Nominating and Corporate Governance Committee	$ 4,000	$ 8,000
Scientific Advisory Committee	$ 4,000	$ 4,000

Our director compensation program includes a stock-for-fees policy, under which directors have the right to elect to receive common stock in lieu of cash fees. These shares of common stock are issued under our 2013 Stock Incentive Plan. The number of shares issued to participating directors is determined on a quarterly basis by dividing the cash fees to be paid through the issuance of common stock by the fair market value of our common stock, which is the closing price of our common stock, on the first business day of the quarter following the quarter in which the fees are earned. In 2018, several of our directors elected to receive shares of our common stock in lieu of cash fees as set forth in the footnotes to the Director Compensation table below.

Under our director compensation program, we also reimburse our directors for travel and other related expenses for attendance at meetings.

Under our current director compensation program, upon their initial election to the board of directors, new non-employee directors receive an initial option grant to purchase 23,000 shares of our common stock, and all non-employee directors, other than the chairman, receive an annual option grant to purchase 11,500 shares of our common stock. The chairman receives an annual option grant for 14,500 shares of our common stock. The annual grants are made on the date of our annual meeting of stockholders and fully vest one year from that date of grant. The initial options granted to our non-employee directors vest with respect to one third of the underlying shares on the first anniversary of the date of grant and the balance of the underlying shares vest in eight equal quarterly installments following the first anniversary of the date of grant, subject to continued service as a director, and are granted under our 2013 Stock Incentive Plan. These options are granted with exercise prices equal to the fair market value of our common stock, which is the closing price of our common stock, on the date of grant and will become immediately exercisable in full if there is a change in control of our company.

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Under our retirement policy for non-employee members of the board, if a non-employee director is deemed to retire, then:

- all outstanding options held by such director will automatically vest in full; and
- the period during which such director may exercise the options will be extended to the expiration of the option under the plan.

Under the policy, a non-employee director will be deemed to have retired if:

- the director resigns from the board or determines not to stand for re-election or is not nominated for re-election at a meeting of our stockholders and has served as a director for more than 10 years; or
- the director does not stand for re-election or is not nominated for re-election due to the fact that he or she is or will be older than 75 at the end of such director's term.

The following table sets forth a summary of the compensation we paid to our non-employee directors who served on our board in 2018.

DIRECTOR COMPENSATION FOR 2018

Name	Fees Earned or Paid in Cash ($)		Option Awards ($) (1)	All Other Compensation ($)	Total ($)
Julian C. Baker (2)	25,014	(3)	53,955	—	78,969
James A. Geraghty	85,500	(4)	67,983	—	153,483
Mark Goldberg	46,500		53,955	—	100,455
Maxine Gowen	47,033		53,955	—	100,988
Kelvin M. Neu	51,500	(5)	53,955	—	105,455
Howard Pien (6)	11,770	(7)	130,365	—	142,135
William S. Reardon	54,000		53,955	—	107,955
Carol A. Schafer (8)	1,617		50,246	—	52,043

(1) These amounts represent the aggregate grant date fair value of option awards made to each listed director in 2017 as computed in accordance with Financial Accounting Standards Board Accounting Standards Codification Topic 718, "Stock Compensation," or ASC 718. These amounts do not represent the actual amounts paid to or realized by the directors during 2018. See Note 11 to the financial statements included elsewhere in this Annual Report on Form 10-K regarding assumptions we made in determining the fair value of option awards. As of December 31, 2018, our non-employee directors, or former director in the case of Mr. Baker, held options to purchase shares of our common stock as follows: Mr. Baker: 34,375; Mr. Geraghty: 96,686; Dr. Goldberg: 34,375; Dr. Gowen:

25,625; Dr. Neu: 34,375; Mr. Pien: 23,000; Mr. Reardon: 40,625; and Ms. Schafer: 23,000.

(2) Mr. Baker resigned from our board of directors on September 18, 2018.

(3) Includes cash meeting fees of $25,014 in lieu of which Mr. Baker elected to receive 12,892 shares of our common stock.

(4) Includes cash meeting fees of $10,688 in lieu of which Mr. Geraghty elected to receive 8,096 shares of our common stock.

(5) Includes cash meeting fees of $51,500 in lieu of which Dr. Neu elected to receive 22,838 shares of our common stock.

(6) Mr. Pien was appointed to our board of directors on September 18, 2018.

(7) Includes cash meeting fees of $10,313 in lieu of which Mr. Pien elected to receive 2,929 shares of our common stock.

(8) Ms. Schafer was appointed to our board of directors on December 18, 2018.

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Compensation Committee Interlocks and Insider Participation

Our compensation committee currently consists of Dr. Gowen and Mr. Pien. Dr. Gowen, Mr. Pien and Dr. Neu each served as members of our compensation committee for all or a portion of 2018. No member of our compensation committee was at any time during 2018, or was formerly, an officer or employee of ours. No member of our compensation committee engaged in any related person transaction involving our company during 2018. None of our executive officers has served as a director or member of the compensation committee (or other committee serving the same function as the compensation committee) of any other entity, while an executive officer of that other entity served as a director or member of our compensation committee.

Maxine Gowen, Chair

Howard Pien

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Item 12.Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters.

SECURITY OWNERSHIP OF CERTAIN BENEFICIAL OWNERS AND MANAGEMENT

The following table sets forth, as of February 15, 2019, information we know about the beneficial ownership of our common stock by:

- each person or entity, including any "group" as that term is used in Section 13(d)(3) of the Exchange Act, who is known by us to own beneficially more than 5% of the issued and outstanding shares of our common stock;
- each of our current directors;
- each of our named executive officers, as defined in Item 11 of Part III of this Annual Report on Form 10-K; and
- all of our current directors and executive officers as a group.

We have determined beneficial ownership in accordance with the rules of the SEC, and the information in the table below is not necessarily indicative of beneficial ownership for any other purpose. The SEC has defined "beneficial" ownership of a security to mean the possession, directly or indirectly, of voting power and/or investment power. In computing the percentage ownership of each person, shares of common stock subject to options, warrants or rights held by that person that are currently exercisable, or exercisable within 60 days of February 15, 2019, are deemed to be outstanding and beneficially owned by that person. These shares, however, are not deemed outstanding for the purpose of computing the percentage ownership of any other person.

To our knowledge and except as indicated in the notes to this table and pursuant to applicable community property laws, each stockholder named in the table has sole voting and investment power with respect to the shares set forth opposite such stockholder's name. The percentage of ownership is based on 27,620,102 shares of our common stock issued and outstanding on February 15, 2019. All fractional common share amounts have been rounded to the nearest whole number.

Name and Address of Beneficial Owner (1)	Number of Shares Beneficially Owned		Percentage of Outstanding Shares
5% Stockholders			
Affiliates of Baker Brothers Advisors, LLC, 860 Washington Street, 3rd Floor, New York, NY 10014	4,839,895	(2)	17.69%
Pillar Investment Entities c/o Pillar Invest Offshore SAL, Starco Center, Bloc B, 3rd Flr, Omar Daouk St., Beirut, M8 2020-3313, Lebanon	2,447,402	(3)	8.97%

Castellina Ventures Ltd., 325 Waterfront Drive, Omar Hodge Building, 2nd Floor, Wickham's Cay, Road Town, Tortola, British Virgin Islands	2,137,638	(4)	7.74%
Blackrock, Inc., 55 East 52nd Street, New York, NY 10055	1,478,231	(5)	5.35
Named Executive Officers and Directors			
Vincent J. Milano	380,814	(6)	1.36%
Louis J. Arcudi, III	198,645	(7)	*
R. Clayton Fletcher	117,341	(8)	*
James A. Geraghty	153,697	(9)	*
Mark Goldberg	37,760	(10)	*
Maxine Gowen	79,917	(11)	*
Joanna Horobin	86,532	(12)	*
John J. Kirby	39,472	(13)	*
Kelvin M. Neu	44,319	(14)	*
Howard Pien	2,929		*
William S. Reardon	38,131	(15)	*
Carol A. Schafer	5,000		*
Jonathan Yingling	48,044	(16)	*
All current directors and executive officers as a group (13 individuals)	170,3115	(17)	3.44%

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* Denotes less than 1% beneficial owner.

(1) Except as otherwise noted, the address for each person listed above is c/o Idera Pharmaceuticals, Inc., 505 Eagleview Boulevard, Exton, PA 19341.

(2) Consists of (i) 496,758 shares of our common stock owned by 667, L.P., (ii) 4,258,065 shares of our common stock owned by Baker Brothers Life Sciences, L.P., (iii) 59,267 shares of our common stock owned by 14159, L.P., (iv) (a) 9,246 shares of our common stock held directly by Julian Baker and (b) 16,559 shares of our common stock held directly by Dr. Neu, and in which each of 667, L.P., Baker Brothers Life Sciences, L.P. and 14159, L.P., which we refer to collectively as the Funds, has an indirect pecuniary interest and may be deemed to own a portion of these shares, and (v) (a) 27,760 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019 held by Mr. Baker and (b) 27,760 shares of common stock subject to outstanding options that are exercisable within 60 days after February 15, 2019 held by Dr. Neu. As a result of the application of the Beneficial Ownership Cap, as described below in this footnote, the table above does not include the following as being beneficially owned by the Funds: (a) 298,741 shares of common stock issuable upon exercise of warrants to purchase common stock owned by 667, L.P., (b) 2,410,071 shares of common stock issuable upon exercise of warrants to purchase common stock owned by Baker Brothers Life Sciences, L.P. and (c) 60,070 shares of common stock issuable upon exercise of warrants to purchase common stock owned by 14159, L.P. The information in this footnote is based on a Schedule 13D/A filed with the SEC on September 20, 2018; Form 4s filed with the SEC on October 3, 2018 and January 4, 2019; and on information provided to us by the Funds, Julian Baker and Dr. Neu. Mr. Baker, a member of the our board until his resignation in September 2018, is a managing member of Baker Bros. Advisors LP and is a principal of Baker Bros. Advisors (GP), LLC, the sole general partner of Baker Bros. Advisors LP. Baker Bros. Advisors LP serves as the investment advisor to the Funds. Accordingly, Mr. Baker may be deemed to have sole power to direct the voting and disposition of the shares of common stock held directly by the Funds and indirectly by Baker Bros. Advisors LP and Baker Bros. Advisors (GP), LLC. Mr. Baker expressly disclaims beneficial ownership over shares held directly by the Funds and indirectly by Baker Bros. Advisors LP and Baker Bros. Advisors (GP), LLC, except to the extent of his pecuniary interest therein, if any, by virtue of his pecuniary interest therein. Dr. Neu, a member of the Idera board, is an employee of Baker Bros. Advisors LP. Under the terms of the warrants issued to the Funds, the Funds are not permitted to exercise such warrants to purchase common stock to the extent that such exercise would result in the Funds (and their affiliates) beneficially owning more than 4.99% of the number of shares of our common stock issued and outstanding immediately after giving effect to the issuance of shares of common stock issuable upon exercise of such warrants to purchase common stock. This limitation on exercise of the warrants to purchase common stock issued to the Funds is referred to in this footnote as the Beneficial Ownership Cap. The Funds have the right to increase this beneficial ownership limitation in their discretion on 61 days' prior written notice to us, provided that in no event are the Funds permitted to exercise such warrants to purchase common stock to the extent that such exercise would result in the Funds (and their affiliates) beneficially owning in the aggregate more than 19.99% of the number of shares of our common stock issued and outstanding or the combined voting power of our securities outstanding immediately after giving effect to the issuance of shares of common stock issuable upon exercise of such warrants to purchase common stock.

(3)Consists of (i) 216,266 shares of common stock held by Pillar Pharmaceuticals I, L.P., or Pillar I, (ii) 673,985 shares of common stock held by Pillar Pharmaceuticals II, L.P., or Pillar II, (iii) 293,980 shares of common stock held by Pillar Pharmaceuticals III, L.P., or Pillar III, (iv) 25,000 shares of common stock held by Pillar Pharmaceuticals IV, L.P., or Pillar IV, (v) 109,375 shares of common stock held by Pillar V, (vi) 1,061,212 shares of common stock held by Participations Besancon, or Besancon, and over which Pillar Invest Corporation has investment discretion, pursuant to an advisory agreement between Pillar Invest Corporation and Besancon, or the Advisory Agreement, (vii) 67,584 shares of common stock held directly by Youssef El Zein and (viii) 34,375 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019 held by Mr. El Zein. Mr. El

Zein, a member of our board until October 31, 2017, is a director and controlling stockholder of Pillar Invest Corporation, which is the general partner of Pillar I, Pillar II, Pillar III, Pillar IV and Pillar V and is a limited partner of Pillar I, Pillar II, Pillar III, Pillar IV and Pillar V. Mr. El Zein expressly disclaims beneficial ownership over shares held directly by Pillar I, Pillar II, Pillar III, Pillar IV, Pillar V and indirectly by Pillar Invest Corporation. Besancon is an

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investment fund having no affiliation with Mr. El Zein, Pillar I, Pillar II, Pillar III, Pillar IV, Pillar V or Pillar Invest Corporation. The information in this footnote is based on a Schedule 13D/A filed with the SEC on October 17, 2016; Form 4s filed with the SEC on October 17, 2017 and August 17, 2018; and on information provided to us by Pillar Invest Corporation and Mr. El Zein.

(4)Based on Schedule 13G filed with the SEC on September 4, 2018 by Castellina Ventures Ltd. ("Castellina"). The Ballaison Trust ("Ballaison"), a trust established under the laws of New Zealand whose principal business address and principal office address is 14, rue de la Corraterie, PO Box 5209, CH-1211 Geneva 11, is the sole shareholder of Castellina and may be deemed a beneficial owner. Edward Martin-Du Pan and Yves Bruderlein are the trustees of Ballaison. The Ballaison Trust was established for the principal purpose of holding and preserving assets for the benefit of its beneficiaries. Castellina reported that it had sole voting power and sole dispositive power over all shares beneficially owned. The Schedule 13G does not identify any shares with respect to which there is a right to acquire beneficial ownership. The Schedule 13G states that the shares were acquired and are held in the ordinary course of business and were not acquired and are not held for the purpose of or with the effect of changing or influencing the control of us.

(5) Based on the Schedule 13G filed with the SEC on February 8, 2019 by BlackRock, Inc. and certain subsidiaries ("BlackRock"). BlackRock reported that it had sole voting power over 1,451,102 shares and sole dispositive power over all shares beneficially owned. The Schedule 13G does not identify any shares with respect to which there is a right to acquire beneficial ownership. The Schedule 13G states that the shares were acquired and are held in the ordinary course of business and were not acquired and are not held for the purpose of or with the effect of changing or influencing the control of us.

(6)Includes 324,998 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(7)Includes 192,251 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(8)Consists of 117,341 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(9)Includes of 88,264 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(10)Includes of 27,760 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(11)Includes 19,010 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019, and 875 shares of common stock held in the name Brian Macdonald for Maxine Gowen Trust, for which Dr. Gowen is a beneficiary and trustee.

(12)includes of 84,488 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(13)Consists of 36,677 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(14)Includes of 27,760 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(15)Includes 34,010 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(16)Consists of 48,044 shares of common stock subject to outstanding stock options that are exercisable within 60 days after February 15, 2019.

(17)Includes 808,352 shares of common stock subject to outstanding stock options held by the directors and executive officers as a group that are exercisable within 60 days after February 15, 2019.

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EQUITY COMPENSATION PLAN INFORMATION

The following table provides information as of December 31, 2018 regarding total shares subject to outstanding stock options, warrants and rights and total additional shares available for issuance under our existing equity incentive and employee stock purchase plans. In addition, from time to time, we grant "inducement grants" pursuant to Nasdaq Listing Rule 5635(c)(4).

Plan Category	Number of Securities to be Issued Upon Exercise of Outstanding Options, Warrants and Rights (a)	Weighted-Average Exercise Price of Outstanding Options, Warrants and Rights (b)	Number of Securities Remaining Available for Future Issuance Under Equity Compensation Plans (Excluding Securities Reflected in Column (a)) (c)
Equity compensation plans approved by stockholders (1)	2,910,781	$ 17.28	989,790
Equity compensation plans not approved by stockholders (2)	393,750	$ 26.76	—
Total	3,304,531	$ 18.41	989,790

(1) Consists of our: 2008 Stock Incentive Plan; 2013 Stock Incentive Plan and 2017 Employee Stock Purchase Plan.

Shares are available for future issuance only under our 2013 Stock Incentive Plan and 2017 Employee Stock Purchase Plan.

(2) Consists of stock options issued as inducement grants as of December 31, 2018. These stock options are generally subject to the same terms and conditions as those awarded pursuant to the plans approved by our stockholders.

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Item 13.Certain Relationships and Related Transactions, and Director Independence.

TRANSACTIONS WITH RELATED PERSONS

Since January 1, 2018, we have not entered into or engaged in any related party transactions, as defined by the SEC, with our directors, officers and stockholders who beneficially owned more than 5% of our outstanding common stock, as well as affiliates or immediate family members of those directors, officers and stockholders.

Policies and Procedures for Related Person Transactions

Our board of directors is committed to upholding the highest legal and ethical conduct in fulfilling its responsibilities and recognizes that related party transactions can present a heightened risk of potential or actual conflicts of interest. Accordingly, as a general matter, it is our preference to avoid related party transactions.

In accordance with our audit committee charter, members of the audit committee, all of whom are independent directors, review and approve all related party transactions for which approval is required under applicable laws or regulations, including SEC and the Nasdaq Listing Rules. Current SEC rules define a related party transaction to include any transaction, arrangement or relationship in which we are a participant and the amount involved exceeds $120,000, and in which any of the following persons has or will have a direct or indirect interest:

- our executive officers, directors or director nominees;
- any person who is known to be the beneficial owner of more than 5% of our common stock;
- any person who is an immediate family member, as defined under Item 404 of Regulation S-K, of any of our executive officers, directors or director nominees or beneficial owners of more than 5% of our common stock; or
- any firm, corporation or other entity in which any of the foregoing persons is employed or is a partner or principal or in a similar position or in which such person, together with any other of the foregoing persons, has a 5% or greater beneficial ownership interest.

In addition, the audit committee reviews and investigates any matters pertaining to the integrity of management, including conflicts of interest and adherence to our code of business conduct and ethics. Under our code of business conduct and ethics, our directors, officers and employees are expected to avoid any relationship, influence or activity that would cause or even appear to cause a conflict of interest. Under our code of business conduct and ethics, a director is required to promptly disclose to our board of directors any potential or actual conflict of interest involving him or her. In accordance with our code of business conduct and ethics, the board of directors will determine an appropriate resolution on a case-by-case basis. All directors must recuse themselves from any discussion or decision affecting their personal, business or professional interests.

DIRECTOR INDEPENDENCE

Under applicable rules of the Nasdaq Stock Market, a director will only qualify as an “independent director” if, in the opinion of our board of directors, that person does not have a relationship which would interfere with the exercise of independent judgment in carrying out the responsibilities of a director. Our board of directors has determined that Mr. Geraghty, Dr. Goldberg, Dr. Gowen, Dr. Neu, Mr. Pien, Mr. Reardon, Ms. Schafer and all of the members of each of the audit, compensation and nominating and corporate governance committees are independent as defined under applicable rules of the Nasdaq Stock Market including, in the case of all members of the audit committee, the independence requirements contemplated by Rule 10A-3 under the Exchange Act and, in the case of all members of the compensation committee, the independence requirements contemplated by Rule 10C-1 under the Exchange Act.

Our board of directors had previously made a similar determination of independence with respect to Mr. Baker, who served as a director until September 2018.

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Item 14.Principal Accountant Fees and Services.

ACCOUNTING MATTERS

Report of the Audit Committee

The audit committee has reviewed our audited financial statements for the fiscal year ended December 31, 2018 and discussed them with our management and our independent registered public accounting firm.

The audit committee has also received from, and discussed with, our independent registered public accounting firm various communications that our independent registered public accounting firm is required to provide to the audit committee, including the matters required to be discussed by the AS 1301: Communications with Audit Committees, as adopted by the Public Company Accounting Oversight Board.

The audit committee has received from Ernst & Young LLP the letter and other written disclosures required by applicable requirements of the Public Company Accounting Oversight Board regarding its communication with the audit committee concerning independence, and has discussed with Ernst & Young LLP its independence from the Company. The audit committee has also considered whether the provision of other non-audit services by Ernst & Young LLP is compatible with maintaining their independence.

Based on the review and discussions referred to above, the audit committee recommended to our board of directors that the audited financial statements be included in this Annual Report on Form 10-K for the year ended December 31, 2018.

By the audit committee of the board of directors,

William S. Reardon, Chairman

James Geraghty

Mark Goldberg, M.D.

Carol Schafer

Independent Registered Public Accounting Firm Fees

The following table sets forth all fees paid or accrued by us for professional services rendered by Ernst & Young LLP during the years ended December 31, 2018 and 2017:

Fee Category	2018	2017
Audit Fees	$ 581,145	$ 600,122
Audit-Related Fees	230,318	204,814
Tax Fees	26,780	126,980
All Other Fees	1,925	1,995
Total Fees	$ 840,168	$ 933,911

Audit Fees

Audit fees represent the aggregate fees billed for professional services rendered by our independent registered public accounting firm for the audit of our annual financial statements and internal controls over financial reporting, review of financial statements included in our quarterly reports on Form 10-Q and services that are normally provided in connection with statutory and regulatory filings or engagements.

Audit-Related Fees

Audit-related fees represent the aggregate fees billed for assurance and related professional services rendered by our independent registered public accounting firm that are reasonably related to the performance of the audit or review of our financial statements and that are not reported under "Audit Fees" including consultations regarding internal controls, financial accounting and reporting standards; the issuance of consents in connection with registration statement filings with the SEC and comfort letters in connection with securities offerings.

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Tax Fees

Tax fees represent the aggregate fees billed for professional services rendered by our independent registered public accounting firm for tax compliance, tax advice and tax planning services. Tax compliance services, which relate to preparation of tax returns, accounted for $27,000 of the total tax fees billed in both 2018 and 2017. Tax advice and tax planning services primarily relate to consultations on our net operating loss carry forwards and payroll taxes.

All Other Fees

All other fees represent the aggregate fees billed for all other products and services rendered by our independent registered public accounting firm other than the services reported in the other categories. All other fees for all periods presented related to our subscription to Ernst & Young's online accounting research tool.

Our audit committee believes that the non-audit services described above did not compromise Ernst & Young LLP's independence. Our audit committee charter, which you can find by clicking "Investors" and "Corporate Governance" on our website, www.iderapharma.com, requires that all proposals to engage Ernst & Young LLP for services, and all proposed fees for these services, be submitted to the audit committee for approval before Ernst & Young LLP may provide the services.

Pre-Approval Policies and Procedures

Our audit committee has adopted policies and procedures relating to the approval of all audit and non-audit services that are to be performed by our independent registered public accounting firm. This policy generally provides that we will not engage our independent registered public accounting firm to render audit or non-audit services unless the service is specifically approved in advance by the audit committee or the engagement is entered into pursuant to the pre-approval procedures described below.

From time to time, the audit committee may pre-approve specified types of services that are expected to be provided to us by our independent registered public accounting firm during the next 12 months. Any such pre-approval is detailed as to the particular service or type of services to be provided and is also generally subject to a maximum dollar amount. All of the services described above under the headings "Audit Fees," "Audit-Related Fees," "Tax Fees" and "All Other Fees" were pre-approved by our audit committee.

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PART IV.

Item 15.Exhibits and Financial Statement Schedules.

(a) (1) Financial Statements.

(2) We are not filing any financial statement schedules as part of this Annual Report on Form 10-K because they are not applicable or the required information is included in the financial statements or notes thereto.

(3) The list of Exhibits filed as a part of this Annual Report on Form 10-K is set forth on the Exhibit Index below.

(b)The list of Exhibits filed as a part of this Annual Report on Form 10-K is set forth on the Exhibit Index below.

(c)None.

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Exhibit Index

Exhibit Number	Description	Incorporated by Reference to Form	SEC File No.	Exhibit(s)	Filing Date
1.1	Equity Distribution Agreement, dated November 26, 2018, by and between Idera Pharmaceuticals, Inc. and JMP Securities LLC	8-K	001-31918	1.1	November 26, 2018
2.1	Agreement and Plan of Merger, dated as January 21, 2018, by and among Idera Pharmaceuticals, Inc., BioCryst Pharmaceuticals, Inc., Nautilus Holdco, Inc., Island Merger Sub, Inc. and Boat Merger Sub, Inc.	8-K	001-31918	2.1	January 22, 2018
3.1	Restated Certificate of Incorporation of Idera Pharmaceuticals, Inc., as amended.	10-Q	001-31918	3.1	August 2, 2018
3.2	Amended and Restated Bylaws of Idera Pharmaceuticals, Inc.	10-K	001-31918	3.2	March 7, 2018
4.1	Specimen Certificate for shares of Common Stock, $.001 par value, of Idera Pharmaceuticals, Inc.	S-1	33-99024	4.1	December 8, 1995
4.2	Form of Pre-Funded Warrant issued in May 2013 to purchasers in Idera Pharmaceuticals, Inc.'s registered public offering on Idera Pharmaceuticals, Inc.'s registration statement on Form S-1 (File No. 333-187155)	10-Q	001-31918	10.5	May 15, 2013
4.3	Form of Pre-Funded Warrant issued in September 2013 to purchasers in Idera Pharmaceuticals, Inc.'s registered public offering on Idera Pharmaceuticals, Inc.'s registration statement on Form S-3 (File No. 333-191073)	8-K	001-31918	4.1	September 26, 2013
4.4	Form of Pre-Funded Warrant issued in February 2014 to purchasers in Idera Pharmaceuticals, Inc.'s registered public offering on Idera Pharmaceuticals, Inc.'s registration statement on Form S-3 (File No. 333-191073)	8-K	001-31918	4.1	February 5, 2014
4.5*	Registration Rights Agreement, dated as of March 4, 2019, by and between Idera Pharmaceuticals, Inc. and Lincoln Park Capital Fund, LLC				

5.1*	Opinion Of Morgan, Lewis & Bockius LLP				
10.1	Unit Purchase Agreement by and among Idera Pharmaceuticals, Inc. and certain persons and entities listed therein, dated April 1, 1998	10-K	000-27352	10.39	April 1, 2002
10.2	Registration Rights Agreement, dated March 24, 2006, by and among Idera Pharmaceuticals, Inc. and the Investors named therein	8-K	001-31918	10.2	March 29, 2006

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Exhibit Number	Description	Incorporated by Reference to Form	SEC File No.	Exhibit(s)	Filing Date
10.3	Registration Rights Agreement, dated February 9, 2015, among Idera Pharmaceuticals, Inc. and the Selling Stockholders named therein	8-K	001-31918	4.1	February 9, 2015
10.4	Amendment to the Registration Rights Agreement, dated January 21, 2018, by and among Idera Pharmaceuticals, Inc., 667, L.P., Baker Brothers Life Sciences, L.P. and 14159, L.P.	8-K	001-31918	10.1	January 22, 2018
10.5†	2005 Stock Incentive Plan, as amended	10-Q	001-31918	10.4	August 14, 2006
10.6†	2008 Stock Incentive Plan, as amended	8-K	001-31918	99.2	June 17, 2011
10.7†	2013 Stock Incentive Plan, as amended	8-K	001-31918	10.1	June 13, 2014
10.8†	Amendment to 2013 Stock Incentive Plan, as amended	8-K	001-31918	10.1	June 11, 2015
10.9†	Amendment to 2013 Stock Incentive Plan, as amended	8-K	001-31918	10.1	June 9, 2017
10.10†	2017 Employee Stock Purchase Plan	8-K	001-31918	10.2	June 9, 2017
10.11†	Policy on Treatment of Stock Options in the Event of Retirement, approved April 28, 2014	10-Q	001-31918	10.1	August 12, 2014
10.12†	Form of Incentive Stock Option Agreement Granted Under the 2008 Stock Incentive Plan	8-K	001-31918	10.2	June 10, 2008
10.13†	Form of Nonstatutory Stock Option Agreement Granted Under the 2008 Stock Incentive Plan	8-K	001-31918	10.3	June 10, 2008
10.14†	Form of Nonstatutory Stock Option Agreement (Non-Employee Directors) Granted Under the 2008 Stock Incentive Plan	8-K	001-31918	10.4	June 10, 2008
10.15†	Form of Restricted Stock Agreement Under the 2008 Stock Incentive Plan	8-K	001-31918	10.5	June 10, 2008
10.16†	Form of Incentive Stock Option Agreement granted under the 2013 Stock Incentive Plan	8-K	001-31918	10.2	July 29, 2013

10.17†	Form of Nonstatutory Stock Option Agreement granted under the 2013 Stock Incentive Plan	8-K	001-31918	10.3	July 29, 2013
10.18†	Form of Nonstatutory Stock Option Agreement (Non-Employee Directors) granted under the 2013 Stock Incentive Plan	8-K	001-31918	10.4	July 29, 2013
10.19†	Form of Inducement Stock Option Award – Nonstatutory Stock Option Agreement	10-Q	001-31918	10.1	November 6, 2015
10.20†	Separation Agreement and Release of Claims dated April 18, 2017 between Idera Pharmaceuticals, Inc. and Sudhir Agrawal	10-Q	001-31918	10.1	August 7, 2017
10.21†	Scientific Advisor Agreement effective June 1, 2017 by and between Idera Pharmaceuticals, Inc. and Sudhir Agrawal	10-K	001-31918	10.30	March 7, 2018

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Exhibit Number	Description	Incorporated by Reference to Form	SEC File No.	Exhibit(s)	Filing Date
10.22†	Consulting Services Agreement, dated October 31, 2018, by and between Idera Pharmaceuticals, Inc. and Louis J. Arcudi, III	8-K	001-31918	99.1	November 2, 2018
10.23†	Separation Agreement and Release, dated October 31, 2018, by and between Idera Pharmaceuticals, Inc. and Louis J. Arcudi, III	8-K	001-31918	99.2	November 2, 2018
10.24†	Employment Letter Agreement, dated December 1, 2014, by and between Idera Pharmaceuticals, Inc. and Vincent Milano	10-K	001-31918	10.24	March 12, 2015
10.25†	Employment Letter, dated January 26, 2015, by and between Idera Pharmaceuticals, Inc. and Clayton Fletcher	10-Q	001-31918	10.1	May 11, 2015
10.26†*	Employment Offer Letter, dated October 15, 2015, by and between Idera Pharmaceuticals, Inc. and John J. Kirby				
10.27†	Employment Letter, dated November 11, 2015 by and between Idera Pharmaceuticals, Inc. and Joanna Horobin	10-K	001-31918	10.35	March 7, 2018
10.28†	Employment Letter, dated February 2, 2017, by and between Idera Pharmaceuticals, Inc. and Jonathan Yingling	10-K	001-31918	10.36	March 7, 2018
10.29†	Employment Offer Letter, dated August 20, 2018, by and between Idera Pharmaceuticals, Inc. and Bryant D. Lim	10-Q	001-31918	10.1	November 6, 2018
10.30†	Form of Director and Officer Indemnification Agreement	10-Q	001-31918	10.1	May 4, 2017
10.31†	Form of Executive Severance and Change of Control Agreement	10-Q	001-31918	10.2	May 4, 2017
10.32††	Development and Commercialization Agreement, dated May 1, 2014, by and between Abbott Molecular Inc. and Idera Pharmaceuticals, Inc.	10-Q	001-31918	10.3	August 12, 2014
10.33††		10-K	001-31918	10.56	March 15, 2017

	License Agreement, dated November 28, 2016, by and between Idera Pharmaceuticals, Inc. and Vivelix Pharmaceuticals, Ltd.				
10.34††	Clinical Trial Collaboration and Supply Agreement, by and between Idera Pharmaceuticals, Inc. and Bristol-Myers Squibb Company, dated May 18, 2018	10-Q	001-31918	10.1	August 2, 2018
10.35	Lease Agreement dated March 31, 2015 between Idera Pharmaceuticals, Inc. and 505 Eagleview Boulevard Associates, L.P.	10-K	001-31918	10.45	March 7, 2018
10.36	First Amendment dated September 23, 2015 to Lease Agreement dated March 31, 2015 between Idera Pharmaceuticals, Inc. and 505 Eagleview Boulevard Associates, L.P.	10-K	001-31918	10.46	March 7, 2018

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Exhibit Number	Description	Incorporated by Reference to			
		Form	SEC File No.	Exhibit(s)	Filing Date
10.37*	Purchase Agreement, dated as of March 4, 2019, by and between Idera Pharmaceuticals, Inc. and Lincoln Park Capital Fund, LLC				
23.1*	Consent of Independent Registered Public Accounting Firm				
23.2*	Consent of Morgan, Lewis & Bockius LLP (contained in Exhibit 5.1)				
31.1*	Certification of Chief Executive Officer pursuant to Exchange Act Rules 13a-14 and 15d-14, as adopted pursuant to Section 302 of Sarbanes-Oxley Act of 2002				
31.2*	Certification of Chief Financial Officer pursuant to Exchange Act Rules 13a-14 and 15d-14, as adopted pursuant to Section 302 of Sarbanes-Oxley Act of 2002				
32.1*	Certification of Chief Executive Officer pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002				
32.2*	Certification of Chief Financial Officer pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002				
101.INS	XBRL Instance Document				
101.SCH	XBRL Taxonomy Extension Schema				
101.CAL	XBRL Taxonomy Extension Calculation Linkbase Document				
101.DEF	XBRL Taxonomy Extension Definition Linkbase Document				
101.LAB	XBRL Taxonomy Extension Labels Linkbase Document				
101.PRE	XBRL Taxonomy Extension Presentation Linkbase Document				

* Filed herewith.

†

Management contract or compensatory plan or arrangement required to be filed as an Exhibit to the Annual Report on Form 10-K.

†† Confidential treatment granted as to certain portions, which are omitted and filed separately with the Commission.

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Item 16.Form 10-K Summary.

Not applicable.

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SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, as amended, the Registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized, on this 6th day of March 2019.

Idera Pharmaceuticals, Inc.

By: /S/ VINCENT J. MILANO
Vincent J. Milano
President and
Chief Executive Officer

Pursuant to the requirements of the Securities Exchange Act of 1934, as amended, this report has been signed below by the following persons on behalf of the Registrant and in the capacities and on the dates indicated.

Signature	Title	Date
/S/ VINCENT J. MILANO Vincent J. Milano	President, Chief Executive Officer and Director (Principal Executive Officer)	March 6, 2019
/S/ JOHN J. KIRBY John J. Kirby	Vice President of Finance (Principal Financial and Accounting Officer)	March 6, 2019
/S/ JAMES A. GERAGHTY James A. Geraghty	Chairman of the Board of Directors	March 6, 2019
/S/ MARK GOLDBERG Mark Goldberg, M.D.	Director	March 6, 2019
/S/ MAXINE GOWEN Maxine Gowen, Ph.D.	Director	March 6, 2019

/S/ KELVIN M. NEU Kelvin M. Neu, M.D.	Director	March 6, 2019
/S/ HOWARD H. PIEN Howard H. Pien	Director	March 6, 2019
/S/ WILLIAM S. REARDON William S. Reardon	Director	March 6, 2019
/S/ CAROL A. SCHAFER Carol A. Schafer	Director	March 6, 2019

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IDERA PHARMACEUTICALS, INC.

INDEX TO FINANCIAL STATEMENTS

December 31, 2018

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REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Stockholders and the Board of Directors of Idera Pharmaceuticals, Inc.

Opinion on the Financial Statements

We have audited the accompanying balance sheets of Idera Pharmaceuticals, Inc. (the Company) as of December 31, 2018 and 2017, and the related statements of operations and comprehensive loss, stockholders' equity and cash flows for each of the three years in the period ended December 31, 2018, and the related notes (collectively referred to as the "financial statements"). In our opinion, the financial statements present fairly, in all material respects, the financial position of the Company at December 31, 2018 and 2017, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2018, in conformity with U.S. generally accepted accounting principles.

We have also audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (PCAOB), the Company's internal control over financial reporting as of December 31, 2018, based on criteria established in Internal Control—Integrated Framework issued by the Committee of Sponsoring Organizations of the Treadway Commission (2013 framework) and our report dated March 6, 2019 expressed an unqualified opinion thereon.

Basis for Opinion

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 are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud. Our audits included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that our audits provide a reasonable basis for our opinion.

/s/ ERNST & YOUNG LLP

We have served as the Company's auditor since 2002.

Philadelphia, Pennsylvania
March 6, 2019

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IDERA PHARMACEUTICALS, INC.

BALANCE SHEETS

(In thousands, except per share amounts)	December 31, 2018	December 31, 2017
ASSETS		
Current assets:		
Cash and cash equivalents	$ 71,431	$ 112,629
Prepaid expenses and other current assets	1,376	3,992
Total current assets	72,807	116,621
Property and equipment, net	207	1,472
Other assets	9	324
Total assets	$ 73,023	$ 118,417
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Accounts payable	$ 1,134	$ 1,334
Accrued expenses	7,884	8,000
Note payable	—	209
Deferred revenue	—	566
Total current liabilities	9,018	10,109
Other liabilities	11	613
Total liabilities	9,029	10,722
Commitments and contingencies (Note 12)		
Stockholders' equity:		
Preferred stock, $0.01 par value, Authorized — 5,000 shares:		
Series A convertible preferred stock; Designated — 1,500 shares, Issued and outstanding — 1 share	—	—
Common stock, $0.001 par value, Authorized — 70,000 shares; Issued and outstanding — 27,188 and 24,453 shares at December 31, 2018 and December 31, 2017, respectively	27	24
Additional paid-in capital	728,342	712,165
Accumulated deficit	(664,375)	(604,494)
Total stockholders' equity	63,994	107,695
Total liabilities and stockholders' equity	$ 73,023	$ 118,417

The accompanying notes are an integral part of these financial statements.

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IDERA PHARMACEUTICALS, INC.

STATEMENTS OF OPERATIONS AND COMPREHENSIVE LOSS

	Year Ended December 31,		
(In thousands, except per share amounts)	2018	2017	2016
Alliance revenue	$ 662	$ 902	$ 16,199
Operating expenses:			
Research and development	41,841	50,653	39,824
General and administrative	15,420	15,588	15,132
Merger-related costs, net	1,245	1,128	—
Restructuring costs	3,112	—	—
Total operating expenses	61,618	67,369	54,956
Loss from operations	(60,956)	(66,467)	(38,757)
Other income (expense):			
Interest income	1,089	574	415
Interest expense	(11)	(50)	(80)
Foreign currency exchange (loss) gain	(3)	(41)	33
Net loss	$ (59,881)	$ (65,984)	$ (38,389)
Net loss per share applicable to common stockholders - basic and diluted (Note 16)	$ (2.25)	$ (3.35)	$ (2.41)
Weighted-average number of common shares used in computing net loss per share applicable to common stockholders - basic and diluted	26,601	19,675	15,950
Comprehensive loss:			
Net loss	$ (59,881)	$ (65,984)	$ (38,389)
Other comprehensive income (loss):			
Unrealized gain on available-for-sale securities	—	17	117
Total other comprehensive income	—	17	117
Comprehensive loss	$ (59,881)	$ (65,967)	$ (38,272)

The accompanying notes are an integral part of these financial statements.

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IDERA PHARMACEUTICALS, INC.

STATEMENTS OF STOCKHOLDERS' EQUITY

(In thousands, except per share amounts)	Common Stock Number of Shares	$0.001 Par Value	Additional Paid-In Capital	Accumulated Deficit	Accumulated Other Comprehensive (Loss)/Income	Total Stockholders' Equity
Balance, December 31, 2015	15,158	$ 15	$ 583,782	$ (500,081)	$ (134)	$ 83,582
Sale of common stock and warrants, net of issuance costs	3,278	3	48,845	—	—	48,848
Issuance of common stock under employee stock purchase plan	15	—	172	—	—	172
Exercise of common stock options and warrants	171	—	2,000	—	—	2,000
Issuance of common stock for services	11	—	172	—	—	172
Non-employee stock option expense	—	—	—	—	—	—
Stock-based compensation	—	—	6,847	—	—	6,847
Unrealized loss on marketable securities	—	—	—	—	117	117
Net loss	—	—	—	(38,389)	—	(38,389)
Balance, December 31, 2016	18,633	$ 18	$ 641,818	$ (538,470)	$ (17)	$ 103,349
Cumulative effect from adoption of new accounting standard (Note 2)	—	—	40	(40)	—	—
Sale of common stock, net of issuance costs	4,792	5	53,741	—	—	53,746
Issuance of common stock under employee stock purchase plan	22	—	253	—	—	253
Exercise of common stock options and warrants	996	1	5,443	—	—	5,444
Issuance of common stock for services	10	—	150	—	—	150
Stock-based compensation	—	—	10,720	—	—	10,720
Unrealized gain on marketable securities	—	—	—	—	17	17
Net loss	—	—	—	(65,984)	—	(65,984)
Balance, December 31, 2017	24,453	$ 24	$ 712,165	$ (604,494)	$ —	$ 107,695
Issuance of common stock under employee stock purchase plan	25	—	243	—	—	243
Issuance of common stock upon exercise of common stock options and warrants	2,702	3	10,163	—	—	10,166
Issuance of common stock for services rendered	8	—	97	—	—	97
Stock-based compensation	—	—	5,674	—	—	5,674
Net loss	—	—	—	(59,881)	—	(59,881)
Balance, December 31, 2018	27,188	$ 27	$ 728,342	$ (664,375)	$ —	$ 63,994

The accompanying notes are an integral part of these financial statements.

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IDERA PHARMACEUTICALS, INC.

STATEMENTS OF CASH FLOWS

	Year Ended December 31,		
(In thousands)	2018	2017	2016
Cash Flows from Operating Activities:			
Net loss	$ (59,881)	$ (65,984)	$ (38,389)
Adjustments to reconcile net loss to net cash used in operating activities:			
Stock-based compensation	5,674	10,720	6,847
Issuance of common stock for services rendered	97	150	172
Accretion of discounts and premiums on investments	—	94	566
Depreciation and amortization expense	432	746	656
Loss on disposal or impairment of property and equipment	477	—	4
Changes in operating assets and liabilities:			
Prepaid expenses and other assets	2,717	(1,962)	1,064
Accounts payable, accrued expenses, and other liabilities	(866)	1,674	1,988
Deferred revenue	(566)	(697)	(1,111)
Net cash used in operating activities	(51,916)	(55,259)	(28,203)
Cash Flows from Investing Activities:			
Purchases of available-for-sale securities	—	—	(2,946)
Proceeds from maturity of available-for-sale securities	—	28,270	32,746
Proceeds from sale of available-for-sale securities	—	—	1,974
Proceeds from the sale of property and equipment	290	—	—
Purchases of property and equipment	(75)	(206)	(408)
Net cash provided by investing activities	215	28,064	31,366
Cash Flows from Financing Activities:			
Proceeds from equity financings, net of issuance costs	—	53,763	49,014
Proceeds from employee stock purchases	243	253	172
Proceeds from exercise of common stock options and warrants	10,166	5,444	2,000
Payments on note payable	(209)	(292)	(261)
Payments on capital leases	(8)	(11)	(7)
Net cash provided by financing activities	10,192	59,157	50,918
Net increase (decrease) in cash, cash equivalents and restricted cash	(41,509)	31,962	54,081
Cash, cash equivalents and restricted cash, beginning of period	112,940	80,978	26,897
Cash, cash equivalents and restricted cash, end of period	$ 71,431	$ 112,940	$ 80,978

The accompanying notes are an integral part of these financial statements.

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IDERA PHARMACEUTICALS, INC.

NOTES TO FINANCIAL STATEMENTS

December 31, 2018

Note 1. Business and Organization

Business Overview

Idera Pharmaceuticals, Inc. ("Idera" or the "Company"), a Delaware corporation, is a clinical-stage biopharmaceutical company with a business strategy focused on the clinical development, and ultimately the commercialization, of drug candidates for both oncology and rare disease indications characterized by small, well-defined patient populations with serious unmet medical needs. The Company's current focus is on its Toll-like receptor, or TLR, agonist, tilsotolimod (IMO-2125), for oncology. The Company believes it can develop and commercialize targeted therapies on its own. To the extent the Company seeks to develop drug candidates for broader disease indications, it has entered into and may explore additional collaborative alliances to support development and commercialization.

Agreement and Plan of Merger

On January 21, 2018, the Company, BioCryst Pharmaceuticals, Inc., a Delaware corporation ("BioCryst"), Nautilus Holdco, Inc., a Delaware corporation and a direct, wholly owned subsidiary of BioCryst ("Holdco"), Island Merger Sub, Inc., a Delaware corporation and a direct, wholly owned subsidiary of Holdco, and Boat Merger Sub, Inc., a Delaware corporation and a direct, wholly owned subsidiary of Holdco, entered into an Agreement and Plan of Merger (the "Merger Agreement"). The board of directors of each of Idera and BioCryst unanimously approved the Merger Agreement and the transactions contemplated thereby and the required regulatory approvals were received. However, the proposed merger was subject to approval by the stockholders of Idera and BioCryst, and satisfaction of other customary closing conditions, as specified in the Merger Agreement. At a special meeting of BioCryst stockholders held on July 10, 2018, BioCryst's stockholders voted against the adoption of the Merger Agreement. Following such vote and in accordance with the terms of the Merger Agreement, BioCryst terminated the Merger Agreement. In accordance with the Merger Agreement, BioCryst paid the Company a fixed expense reimbursement amount of $6 million in July 2018 in connection with the termination of the Merger Agreement. The fixed expense reimbursement amount is included in "Merger-related costs, net" in the accompanying statements of operations.

Liquidity and Financial Condition

As of December 31, 2018, the Company had an accumulated deficit of $664.4 million and a cash and cash equivalents balance of $71.4 million. The Company expects to incur substantial operating losses in future periods and will require additional capital as it seeks to advance tilsotolimod and any future drug candidates through development to commercialization. The Company does not expect to generate product revenue, sales-based milestones or royalties until the Company successfully completes development of and obtains marketing approval for tilsotolimod or other future drug candidates, either alone or in collaboration with third parties, which the Company expects will take a number of years. In order to commercialize tilsotolimod and any future drug candidates, the Company needs to complete clinical development and comply with comprehensive regulatory requirements. The Company is subject to a number of risks and uncertainties similar to those of other companies of the same size within the biotechnology industry, such as uncertainty of clinical trial outcomes, uncertainty of additional funding and history of operating losses. The Company believes, based on management's current operating plan, that its existing balance of cash and cash equivalents on hand as of December 31, 2018, plus cash received from the ATM Agreement (Note 7) through February 2019 and cash received from interest income throughout the period, is sufficient to enable the Company to continue as a going concern through the one-year period subsequent to the filing date of this Annual Report on Form 10-K. Further, management has concluded that it is probable that management's plans can be effectively implemented and will mitigate the relevant conditions that raise substantial doubt about the Company's ability to continue as a going concern while not impeding the advancement of its drug development. These plans may also include the possible deferral of certain operating expenses unless additional capital is received. The Company has and will continue to evaluate available alternatives to extend its operations beyond this date.

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Note 1. Business and Organization (Continued)

Reverse Stock Split

As further described in Note 7, on July 27, 2018, the Company effected a 1-for-8 reverse stock split of the Company's outstanding shares of common stock, as authorized at a special meeting of stockholders on June 20, 2018. All share and per share amounts of common stock, options and warrants in the accompanying financial statements and notes thereto have been retroactively adjusted for all periods presented to reflect the reverse stock split.

Note 2. Summary of Significant Accounting Policies

Basis of Presentation

The accompanying financial statements have been prepared in accordance with U.S. generally accepted accounting principles (“GAAP”).

Reclassifications

The prior year financial statements contain certain reclassifications to the results of operations for the year ended December 31, 2017 to conform to the presentation for the year ended December 31, 2018. Merger-related costs of approximately $1.1 million were reclassified from general and administrative expenses to merger-related costs, net for the year ended December 31, 2017.

Use of Estimates

The preparation of financial statements in conformity with GAAP requires management to make estimates, judgements, and assumptions that affect the reported amounts of assets, liabilities, equity, revenues and expenses, and related disclosure of contingencies in the accompanying Financial Statements and these Notes. In addition, management’s assessment of the Company’s ability to continue as a going concern involves the estimation of the amount and timing of future cash inflows and outflows. On an ongoing basis, the Company evaluates its estimates, judgments and methodologies. The Company bases its estimates on historical experience and on various other

assumptions that are believed to be reasonable. Actual results could differ materially from those estimates.

Segment Information

Operating segments are defined as components of an enterprise in which separate discrete information is available for evaluation by the chief operating decision maker, or decision-making group, in deciding how to allocate resources and assessing performance. The Company views its operations and manages its business as one operating segment, which is the business of developing novel therapeutics for oncology and rare diseases.

Financial Instruments

The fair value of the Company's financial instruments is determined and disclosed in accordance with the three-tier fair value hierarchy specified in Note 3. The Company is required to disclose the estimated fair values of its financial instruments. As of December 31, 2018, the Company's financial instruments consisted of cash, cash equivalents, and accounts receivable. As of December 31, 2017, the Company's financial instruments consisted of cash, cash equivalents, accounts receivable and a note payable. The estimated fair values of these financial instruments approximate their carrying values as of December 31, 2018 and 2017. As of December 31, 2018, the Company did not have any derivatives, hedging instruments or other similar financial instruments.

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Note 2. Summary of Significant Accounting Policies (Continued)

Concentration of Credit Risk

Financial instruments that subject the Company to credit risk primarily consist of cash, cash equivalents and investments. The Company's credit risk is managed by investing in highly rated money market instruments, certificates of deposit, corporate bonds, commercial paper and debt securities. Due to these factors, no significant additional credit risk is believed by management to be inherent in the Company's assets. As of December 31, 2018, all of the Company's cash and cash equivalents were held at one financial institution.

Cash and Cash Equivalents

The Company considers all highly liquid investments with maturities of 90 days or less when purchased to be "cash equivalents." Cash and cash equivalents at December 31, 2018 consisted of cash, commercial paper and a money market fund. Cash and cash equivalents at December 31, 2017 consisted of cash and two money market funds.

Restricted Cash

As part of the Company's prior lease arrangement for its office and laboratory facility in Cambridge, Massachusetts, the Company was required to restrict cash held in a certificate of deposit securing a line of credit for the lessor. The restricted cash amounted to $0.3 million and was recorded in "Other assets" as of December 31, 2017 in the accompanying balance sheets. In July 2018, the Company terminated the lease agreement, effective September 30, 2018, in connection with restructuring activities which are more fully described in Note 10. Accordingly, the Company is no longer required to restrict cash for this purpose as it has satisfied all obligations under the lease agreement, including payment of a $0.2 million lease termination fee which is included in "Restructuring costs" in the accompanying statements of operations.

The following table provides a reconciliation of cash, cash equivalents, and restricted cash reported within the balance sheets that sum to the total of the same such amounts shown in the statements of cash flows:

(In thousands)	December 31, 2018	2017

Cash and cash equivalents	$ 71,431	$ 112,629
Restricted cash	—	311
Cash, cash equivalents and restricted cash	$ 71,431	$ 112,940

Property and Equipment

Property and equipment is carried at acquisition cost less accumulated depreciation, subject to review for impairment whenever events or changes in circumstances indicate that the carrying amount of the asset may not be recoverable as described further under the heading "Impairment of Long-Lived Assets" below. The cost of normal, recurring, or periodic repairs and maintenance activities related to property and equipment are expensed as incurred. The cost for planned major maintenance activities, including the related acquisition or construction of assets, is capitalized if the repair will result in future economic benefits.

Depreciation and amortization are computed using the straight-line method based on the estimated useful lives of the related assets. Laboratory and other equipment are depreciated over three to five years. Leasehold improvements are amortized over the remaining lease term or the related useful life, if shorter.

When an asset is disposed of, the associated cost and accumulated depreciation is removed from the related accounts on the Company's balance sheet with any resulting gain or loss included in the Company's statement of operations.

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Note 2. Summary of Significant Accounting Policies (Continued)

Impairment of Long-Lived Assets

In accordance with Financial Accounting Standards Board ("FASB") Accounting Standards Codification ("ASC") 360-10-35, Impairment or Disposal of Long-Lived Assets, the Company reviews its long-lived assets and identifiable finite-lived intangible assets for impairment whenever events or changes in circumstances indicate that the carrying amount of an asset may not be recoverable (i.e. impaired). Once an impairment is determined, the actual impairment recognized is the difference between the carrying amount and the fair value (less costs to sell for assets to be disposed of) as estimated using one of the following approaches: income, cost and/or market. Fair value using the income approach is determined primarily using a discounted cash flow model that uses the estimated cash flows associated with the asset or asset group under review, discounted at a rate commensurate with the risk involved. Fair value utilizing the cost approach is determined based on the replacement cost of the asset reduced for, among other things, depreciation and obsolescence. Fair value, utilizing the market approach, benchmarks the fair value against the carrying amount.

Revenue Recognition

Effective January 1, 2018, the Company adopted Accounting Standards Codification ("ASC") Topic 606, Revenue from Contracts with Customers, using the modified retrospective transition method. Under this method, the Company recognizes the cumulative effect of initially adopting ASC Topic 606, if any, as an adjustment to the opening balance of retained earnings. Additionally, under this method of adoption, the Company applies the guidance to all incomplete contracts in scope as of the date of initial application. This standard applies to all contracts with customers, except for contracts that are within the scope of other standards, such as leases, insurance, collaboration arrangements and financial instruments.

In accordance with ASC Topic 606, the Company recognizes revenue when its customer obtains control of promised goods or services, in an amount that reflects the consideration which the entity expects to receive in exchange for those goods or services. To determine revenue recognition for arrangements that the Company determines are within the scope of ASC Topic 606, it performs the following five steps:

(i) identify the contract(s) with a customer;
(ii) identify the performance obligations in the contract;
(iii) determine the transaction price;
(iv) allocate the transaction price to the performance obligations in the contract; and
(v) recognize revenue when (or as) the entity satisfies a performance obligation.

The Company only applies the five-step model to contracts when it determines that it is probable it will collect the consideration to which it is entitled in exchange for the goods or services it transfers to the customer. At contract inception, once the contract is determined to be within the scope of ASC Topic 606, the Company assesses the goods

or services promised within each contract and determines those that are performance obligations, and assesses whether each promised good or service is distinct. The Company then recognizes as revenue the amount of the transaction price that is allocated to the respective performance obligation when (or as) the performance obligation is satisfied.

Amounts received prior to satisfying the revenue recognition criteria are recognized as deferred revenue in the Company's balance sheet. Amounts expected to be recognized as revenue within the 12 months following the balance sheet date are classified as current portion of deferred revenue. Amounts not expected to be recognized as revenue within the 12 months following the balance sheet date are classified as deferred revenue, net of current portion.

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Note 2. Summary of Significant Accounting Policies (Continued)

Alliance Revenues

The Company's revenues have primarily been generated through collaborative research, development and/or commercialization agreements. The terms of these agreements may include payment to the Company of one or more of the following: nonrefundable, up-front license fees; research, development and commercial milestone payments; and other contingent payments due based on the activities of the counterparty or the reimbursement by licensees of costs associated with patent maintenance. Each of these types of revenue are recorded as Alliance revenues in the Company's statements of operations.

In determining the appropriate amount of revenue to be recognized as it fulfills its obligations under each of its agreements, the Company performs the following steps:

(i) identification of the promised goods or services in the contract;
(ii) determination of whether the promised goods or services are performance obligations including whether they are distinct in the context of the contract;
(iii) measurement of the transaction price, including the constraint on variable consideration;
(iv) allocation of the transaction price to the performance obligations; and
(v) recognition of revenue when (or as) the Company satisfies each performance obligation.

See Note 9, "Collaboration and License Agreements" for additional details regarding the Company's collaboration arrangements.

As part of the accounting for these arrangements, the Company allocates the transaction price to each performance obligation on a relative stand-alone selling price basis. The stand-alone selling price may be, but is not presumed to be, the contract price. In determining the allocation, the Company maximizes the use of observable inputs. When the stand-alone selling price of a good or service is not directly observable, the Company estimates the stand-alone selling price for each performance obligation using assumptions that require judgment. Acceptable estimation methods include, but are not limited to: (i) the adjusted market assessment approach, (ii) the expected cost plus margin approach, and (iii) the residual approach (when the stand-alone selling price is not directly observable and is either highly variable or uncertain). In order for the residual approach to be used, the Company must demonstrate that (a) there are observable stand-alone selling prices for one or more of the performance obligations and (b) one of the two criteria in ASC 606-10-32-34(c)(1) and (2) is met. The residual approach cannot be used if it would result in a stand-alone selling price of zero for a performance obligation as a performance obligation, by definition, has value on a stand-alone basis.

An option in a contract to acquire additional goods or services gives rise to a performance obligation only if the option provides a material right to the customer that it would not receive without entering into that contract. Factors that the Company considers in evaluating whether an option represents a material right include, but are not limited to:

(i) the overall objective of the arrangement, (ii) the benefit the collaborator might obtain from the arrangement without exercising the option, (iii) the cost to exercise the option (e.g. priced at a significant and incremental discount) and (iv) the likelihood that the option will be exercised. With respect to options determined to be performance obligations, the Company recognizes revenue when those future goods or services are transferred or when the options expire.

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Note 2. Summary of Significant Accounting Policies (Continued)

The Company's revenue arrangements may include the following:

Up-front License Fees: If a license is determined to be distinct from the other performance obligations identified in the arrangement, the Company recognizes revenues from nonrefundable, up-front fees allocated to the license when the license is transferred to the licensee and the licensee is able to use and benefit from the license. For licenses that are bundled with other promises, the Company utilizes judgment to assess the nature of the combined performance obligation to determine whether the combined performance obligation is satisfied over time or at a point in time and, if over time, the appropriate method of measuring progress for purposes of recognizing revenue from non-refundable, up-front fees. The Company evaluates the measure of progress each reporting period and, if necessary, adjusts the measure of performance and related revenue recognition.

Milestone Payments: At the inception of an agreement that includes research and development milestone payments, the Company evaluates whether each milestone is considered probable of being achieved and estimates the amount to be included in the transaction price using the most likely amount method. If it is probable that a significant revenue reversal would not occur, the associated milestone value is included in the transaction price. Milestone payments that are not within the control of the Company or the licensee, such as regulatory approvals, are not considered probable of being achieved until those approvals are received. The transaction price is then allocated to each performance obligation on a relative stand-alone selling price basis, for which the Company recognizes revenue as or when the performance obligations under the contract are satisfied. At the end of each subsequent reporting period, the Company re-evaluates the probability of achievement of such milestones and any related constraint, and if necessary, adjusts its estimate of the overall transaction price. Any such adjustments are recorded on a cumulative catch-up basis, which would affect Alliance revenues and earnings in the period of adjustment.

Research and Development Activities: If the Company is entitled to reimbursement from its collaborators for specified research and development activities or the reimbursement of costs associated with patent maintenance, the Company determines whether such funding would result in Alliance revenues or an offset to research and development expenses. Reimbursement of patent maintenance costs are recognized during the period in which the related expenses are incurred as Alliance revenues in the Company's statements of operations.

Royalties: If the Company is entitled to receive sales-based royalties from its collaborator, including milestone payments based on the level of sales, and the license is deemed to be the predominant item to which the royalties relate, the Company recognizes revenue at the later of (i) when the related sales occur, provided the reported sales are reliably measurable, or (ii) when the performance obligation to which some or all of the royalty has been allocated has been satisfied (or partially satisfied). To date, the Company has not recognized any royalty revenue resulting from any of its collaboration and license arrangements.

Manufacturing Supply and Research Services: Arrangements that include a promise for future supply of drug substance, drug product or research services at the licensee's discretion are generally considered as options. The Company assesses if these options provide a material right to the licensee and if so, they are accounted for as separate performance obligations. If the Company is entitled to additional payments when the licensee exercises these options, any additional payments are recorded in Alliance revenues when the licensee obtains control of the goods, which is upon delivery, or as the services are performed.

The Company receives payments from its licensees based on schedules established in each contract. Upfront payments and fees are recorded as deferred revenue upon receipt, and may require deferral of revenue recognition to a future period until the Company performs its obligations under these arrangements. Amounts are recorded as accounts receivable when the Company's right to consideration is unconditional. The Company does not assess whether a contract has a significant financing component if the expectation at contract inception is such that the period between payment by the licensees and the transfer of the promised goods or services to the licensees will be one year or less.

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Note 2. Summary of Significant Accounting Policies (Continued)

Research and Development Expenses

All research and development expenses are expensed as incurred. Research and development expenses are comprised of costs incurred in performing research and development activities, including drug development trials and studies, drug manufacturing, laboratory supplies, external research, payroll including stock-based compensation and overhead. Nonrefundable advance payments for goods or services to be received in the future for use in research and development activities are deferred and capitalized. The capitalized amounts are expensed as the related goods are accepted by the Company or the services are performed. As of December 31, 2018 and 2017, the Company recorded approximately $0.6 million and $2.6 million as prepaid research and development, respectively, which is included within prepaid expenses and other current assets in the accompanying balance sheets.

Stock-Based Compensation

The Company accounts for stock-based compensation using ASC 718, Compensation – Stock Compensation (“ASC 718”), or ASC 505-50, Equity – Equity Based Payments to Non-Employees, as applicable. The Company accounts for stock-based awards to employees and non-employee directors using the fair value based method to determine compensation expense for all arrangements where shares of stock or equity instruments are issued for compensation. In addition, the Company accounts for stock-based compensation to other non-employees in accordance with the accounting guidance for equity instruments that are issued to entities or persons other than employees.

The Company recognizes all share-based payments to employees and directors as expense in the statements of operations and comprehensive loss based on their fair values. The Company records compensation expense over an award’s requisite service period, or vesting period, based on the award’s fair value at the date of grant. Vesting is generally four years for employees and one year for directors. The Company uses a Black-Scholes option-pricing model to determine the fair value of each option grant as of the date of grant for expense incurred. The Black-Scholes option pricing model requires inputs for risk-free interest rate, dividend yield, expected stock price volatility and expected term of the options. The value of the award that is ultimately expected to vest based on the achievement of a performance condition (i.e., service period) is recognized as expense on a straight-line basis over the requisite service period. See Note 11, “Stock-based Compensation” for additional details.

Prior to the adoption of Accounting Standards Update (“ASU”) 2016-09, Compensation - Stock Compensation (Topic 718): Improvements to Employee Share-Based Payment Accounting (“ASU 2016-09”), ASC 718 required forfeitures to be estimated at the time of grant and revised, if necessary, in subsequent periods if actual forfeitures differed from those estimates. However, ASU 2016-09 allows an entity to elect as an accounting policy upon adoption either to continue to estimate the total number of awards for which the requisite service period will not be rendered or to

account for forfeitures when they occur. In connection with the adoption of this ASU in the first quarter of 2017, the Company made an accounting policy election to account for forfeitures as they occur and applied this change in accounting policy on a modified retrospective basis, resulting in less than a $0.1 million reduction in Additional paid-in capital and an increase in Accumulated deficit as of January 1, 2017, to reflect the cumulative effect of previously estimated forfeitures. See the caption “Cumulative effect from adoption of new accounting standard” within the accompanying statements of stockholders’ equity.

Merger-related Costs, net

Merger-related costs, net includes amounts related to the transactions contemplated under the Merger Agreement, which was terminated in July 2018, as more fully described in Note 1. The line item includes charges incurred for transaction and integration-related professional fees, employee retention costs, and other incremental costs directly related to the potential merger. These costs were offset by the $6 million termination fee, which was received by the Company in July 2018.

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Note 2. Summary of Significant Accounting Policies (Continued)

Restructuring Costs

Restructuring charges are primarily comprised of severance costs related to workforce reductions, contract termination and wind-down costs and asset impairments. In accordance with ASC 420, Exit or Disposal Cost Obligations, the Company recognizes restructuring charges when the liability has been incurred, except for one-time employee termination benefits that are incurred over time. Generally, one-time employee termination benefits (i.e. severance costs) are accrued at the date management has committed to a plan of termination and employees have been notified of their termination dates and expected severance payments. Other costs will be recorded as incurred. Asset impairment charges have been, and will be, recognized when management has concluded that the assets have been impaired in accordance with ASC 360-10-35, Impairment or Disposal of Long-Lived Assets, or other applicable authoritative guidance. See Note 10 for additional details.

Income Taxes

An asset and liability approach is used for financial accounting and reporting for income taxes. Deferred income taxes arise from temporary differences between income tax and financial reporting and principally relate to recognition of revenue and expenses in different periods for financial and tax accounting purposes and are measured using currently enacted tax rates and laws. In addition, a deferred tax asset can be generated by a net operating loss carryover. If it is more likely than not that some portion or all of a deferred tax asset will not be realized, a valuation allowance is recognized.

In the event the Company is charged interest or penalties related to income tax matters, the Company would record such interest as interest expense and would record such penalties as other expense in the Statements of Operations. No such charges have been incurred by the Company. For each of the years ended December 31, 2018, 2017 and 2016, the Company had no uncertain tax positions. See Note 13, “Income Taxes” for additional details.

Net Loss per Common Share applicable to Common Stockholders

Basic and diluted net loss per common share applicable to common stockholders is computed using the weighted average number of shares of common stock outstanding during the period. Diluted net loss per common share applicable to common stockholders is the same as basic net loss per common share applicable to common stockholders for each of the three years in the period ended December 31, 2018 as the effects of the Company’s potential common stock equivalents are antidilutive (see Note 16).

Comprehensive Income (Loss)

Comprehensive income (loss) is defined as the change in equity of a business enterprise during a period from transactions and other events and circumstances from non-owner sources. Comprehensive income (loss) for the years ended December 31, 2018, 2017 and 2016 is comprised of reported net income (loss) and any change in net unrealized gains and losses on investments in available-for-sale securities during each year, which is included in “Accumulated other comprehensive income” on the accompanying balance sheets. As of December 31, 2018 and 2017, the Company held no investments in available-for-sale securities. In accordance with ASC Topic 220, Comprehensive Income, the Company has elected to present the components of net income and other comprehensive income as one continuous statement.

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Note 2. Summary of Significant Accounting Policies (Continued)

New Accounting Pronouncements

Recently Adopted Accounting Pronouncements

In May 2014, the Financial Accounting Standards Board ("FASB") issued ASU No. 2014-09, Revenue from Contracts with Customers (Topic 606), which was subsequently amended by several other ASU's related to Topic 606 to, among other things, defer the effective date and clarify various aspects of the new revenue guidance including principal versus agent considerations, identifying performance obligations, and licensing, and include other improvements and practical expedients (as amended, "ASU 2014-09"). The Company adopted ASU 2014-09 in the first quarter of 2018 using the modified retrospective transition method. See "Revenue Recognition" above. To date, the Company has derived substantially all of its revenues from a limited number of license and collaboration agreements. The consideration the Company is eligible to receive under these agreements includes upfront payments, research and development funding, contingent revenues in the form of commercial and development milestones and option payments and royalties. Each of the Company's license and collaboration agreements has unique terms and was evaluated separately under Topic 606. With respect to its license and collaboration agreements with Vivelix Pharmaceuticals, Ltd. ("Vivelix") and GlaxoSmithKline Intellectual Property Development Limited ("GSK"), there was no material impact to Alliance revenues for any of the years presented upon adoption of Topic 606. Additionally, there were no revisions to any balance sheet components of Alliance revenues such as accounts receivable and deferred revenues or beginning retained earnings as a result of the adoption of the modified retrospective method. The primary impact on the Company's financial statements was that revised or additional disclosures were made with respect to revenues and cash flows arising from contracts with customers, which are included in Notes 8 and 9.

In January 2016, the FASB issued ASU No. 2016-01, Recognition and Measurement of Financial Assets and Financial Liabilities ("ASU 2016-01"). The amendments in ASU 2016-01 address certain aspects of recognition, measurement, presentation and disclosure of financial instruments. The Company adopted ASU 2016-01 in the first quarter of 2018. The adoption of this new standard did not have a material impact on the Company's financial position or results of operations.

In November 2016, the FASB issued ASU No. 2016-18, Statement of Cash Flows (Topic 230) — Restricted Cash ("ASU 2016-18"). The amendments in ASU 2016-18 require that a statement of cash flows explain the change during the period in the total of cash, cash equivalents, and amounts generally described as restricted cash and restricted cash equivalents. Accordingly, amounts generally described as restricted cash or restricted cash equivalents should be included with cash and cash equivalents when reconciling the beginning of period and end of period total amounts shown on the statement of cash flows. The Company adopted ASU 2016-18 in the first quarter of 2018, and the guidance has been retrospectively applied to all periods presented. The total of the Company's cash, cash equivalents and restricted cash is described earlier in this Note 2.

Recently Issued (Not Yet Adopted) Accounting Pronouncements

In February 2016, the FASB issued ASU No. 2016-02, Leases (Topic 842) (“ASU 2016-02”). ASU 2016-02 requires organizations that lease assets, with lease terms of more than 12 months, to recognize on the balance sheet the assets and liabilities for the rights and obligations created by those leases. Consistent with GAAP, the recognition, measurement, and presentation of expenses and cash flows arising from a lease by a lessee primarily will depend on its classification as a finance or operating lease. However, unlike current GAAP which requires only capital leases to be recognized on the balance sheet, ASU No. 2016-02 will require both types of leases to be recognized on the balance sheet. This guidance is applicable to the Company's fiscal year beginning January 1, 2019 and the Company will adopt ASU 2016-02 in the first quarter of 2019 using the alternative modified retrospective transition method, which allows the Company to apply the new lease standard to the beginning of the 2019 period and does not require adjusting comparative period financial information. Additionally, the Company intends to elect the package of practical expedients to not reassess prior conclusions related to contracts containing leases, lease classification and initial direct costs and is evaluating the other practical expedients available under the guidance. While the Company continues to assess the effects of adoption, it believes the most significant effects relate to the recognition of a right-of-use asset and corresponding liability on its balance sheet, primarily related to the existing operating lease, as well as new disclosure with regards to the Company’s leasing activities. The expected impact of adopting ASU 2016-02 is not expected to be material.

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Note 3. Fair Value Measurements

Assets and Liabilities Measured at Fair Value on a Recurring Basis

The Company applies the guidance in ASC 820, Fair Value Measurement, to account for financial assets and liabilities measured on a recurring basis. Fair value is measured at the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. As such, fair value is a market-based measurement that is determined based on assumptions that market participants would use in pricing an asset or liability.

The Company uses a fair value hierarchy, which distinguishes between assumptions based on market data (observable inputs) and an entity's own assumptions (unobservable inputs). The guidance requires that fair value measurements be classified and disclosed in one of the following three categories:

- Level 1: Unadjusted quoted prices in active markets that are accessible at the measurement date for identical, unrestricted assets or liabilities;
- Level 2: Quoted prices in markets that are not active or inputs which are observable, either directly or indirectly, for substantially the full term of the asset or liability;
- Level 3: Prices or valuation techniques that require inputs that are both significant to the fair value measurement and unobservable (i.e., supported by little or no market activity).

Determining which category an asset or liability falls within the hierarchy requires significant judgment. The Company evaluates its hierarchy disclosures each reporting period. There were no transfers between Level 1, 2 and 3 during the years ended December 31, 2018, 2017 and 2016.

The table below presents the assets and liabilities measured and recorded in the financial statements at fair value on a recurring basis at December 31, 2018 and 2017 categorized by the level of inputs used in the valuation of each asset and liability.

	December 31, 2018			
(In thousands)	Total	Level 1	Level 2	Level 3

Assets				
Money market funds	$ 61,177	$ 61,177	$ —	$ —
Other cash equivalents – commercial paper	1,808	—	1,808	—
Total assets	$ 62,985	$ 61,177	$ 1,808	$ —
Total liabilities	$ —	$ —	$ —	$ —

	December 31, 2017			
(In thousands)	Total	Level 1	Level 2	Level 3
Assets				
Money market funds	$ 66,183	$ 66,183	$ —	$ —
Total assets	$ 66,183	$ 66,183	$ —	$ —
Total liabilities	$ —	$ —	$ —	$ —

The Level 1 assets consist of money market funds, which are actively traded daily. The Level 2 assets consist of commercial paper whose fair value may not represent actual transactions of identical securities. The fair value of commercial paper is generally determined based on the relationship between the investment’s discount rate and the discount rates of the same issuer’s commercial paper available in the market which may not be actively traded daily. Since these fair values may not be based upon actual transactions of identical securities, they are classified as Level 2.

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Note 4. Property and Equipment

At December 31, 2018 and 2017, net property and equipment at cost consisted of the following:

(In thousands)	December 31, 2018	December 31, 2017
Leasehold improvements	$ 104	$ 671
Laboratory equipment and other	767	5,261
Total property and equipment, at cost	871	5,932
Less: Accumulated depreciation and amortization	664	4,460
Property and equipment, net	$ 207	$ 1,472

Depreciation and amortization expense on Property and equipment was approximately $0.4 million, $0.7 million and $0.6 million in 2018, 2017 and 2016, respectively. See Note 17, “Supplemental Disclosure of Cash Flow Information” for information related to non-cash property additions.

During the year ended December 31, 2018, the Company recorded asset impairments related to its property equipment in the amount of $0.5 million in connection with restructuring activities more fully described in Note 10. No impairment charges were recognized during the years ended December 31, 2017 and 2016.

Note 5. Accrued Expenses

At December 31, 2018 and 2017, accrued expenses consisted of the following:

(In thousands)	December 31, 2018	December 31, 2017
Payroll and related costs	$ 1,962	$ 3,108
Clinical and nonclinical trial expenses	3,958	3,495
Professional and consulting fees	605	1,317
Restructuring expenses	1,147	—
Other	212	80
Total accrued expenses	$ 7,884	$ 8,000

Included in accrued Payroll and related costs as of December 31, 2018 is the remaining $0.7 million of salary continuation severance benefits to be paid in equal installments through October 31, 2019 to former executives. As of December 31, 2017, the current portion, or $0.6 million, of the remaining $0.9 million of such salary continuation severance benefits is included in accrued Payroll and related costs. The long-term portion of $0.3 million is included within Other liabilities in the Company's balance sheet as of December 31, 2017.

Note 6. Note Payable

On September 30, 2014, the Company executed a loan and security agreement with Oxford Finance LLC ("Oxford"). Under the agreement, Oxford committed to lend the Company up to an aggregate principal amount of $3 million, through December 31, 2015, in one or more advances each of which is to be evidenced by a promissory note. The Company received total advances of $0.9 million under the loan and security agreement during the draw down period. The Company's obligations to Oxford were secured by the specific laboratory, manufacturing, office or computer equipment financed under the agreement. Each equipment advance included interest at a fixed interest rate equal to the greater of 7.50% per annum and 7.27% plus the three-month U.S. Libor Rate per annum, set at the time of funding. The principal amount of each equipment advance was repaid in 36 monthly installments commencing on the applicable amortization date, which was July 1, 2015 for any equipment advance made on or before June 30, 2015. Monthly installments payable prior to July 1, 2015 consisted of interest only and monthly installments payable on or after July 1, 2015 consisted of principal and accrued interest. In June 2018, the Company satisfied its obligations under the note payable, including payment of a final payment in an amount equal to 5.7% of the aggregate advanced amount under each equipment advance which was accrued as interest expense over the term of each equipment advance using the effective interest method. As of December 31, 2017, the total outstanding balance of the note payable to Oxford in the amount of $0.2 million is classified in Current portion of note payable within the accompanying balance sheet.

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Note 7. Stockholders' Equity

Preferred Stock

The Restated Certificate of Incorporation, as amended, of the Company permits its board of directors to issue up to 5,000,000 shares of preferred stock, par value $0.01 per share, in one or more series, to designate the number of shares constituting such series, and fix by resolution, the powers, privileges, preferences and relative, optional or special rights thereof, including liquidation preferences and dividends, and conversion and redemption rights of each such series. As of December 31, 2018, the Company has designated 1,500,000 shares as Series A convertible preferred stock.

Series A Convertible Preferred Stock. The dividends on the Series A convertible preferred stock are payable semi-annually in arrears at the rate of 1% per annum, at the election of the Company, either in cash or additional duly designated, fully paid and nonassessable shares of Series A preferred stock. In the event of liquidation, dissolution or winding up of the Company, after payment of debts and other liabilities of the Company, the holders of the Series A convertible preferred stock then outstanding will be entitled to a distribution of $1 per share out of any assets available to shareholders. The Series A convertible preferred stock is non-voting. All remaining shares of Series A preferred stock rank as to payment upon the occurrence of any liquidation event senior to the common stock. Shares of Series A convertible preferred stock are convertible, in whole or in part, at the option of the holder into fully paid and nonassessable shares of common stock at $272.00 per share, subject to adjustment. As of December 31, 2018 and 2017, there were 655 shares of Series A convertible preferred stock outstanding.

Common Stock

On June 20, 2018, the Company's stockholders approved an amendment to the Company's Restated Certificate of Incorporation, as amended, to effect a reverse stock split of the Company's outstanding shares of common stock at a ratio within a range from 1-for-4 to 1-for-8 and set the number of authorized shares of the Company's common stock at a number determined by calculating the product of 280,000,000 (previous number of authorized shares) multiplied by two times (2x) the reverse stock split ratio. On July 27, 2018, the Company implemented a 1-for-8 reverse split of its issued and outstanding shares of common stock (the "Reverse Split"), and set the number of its authorized shares of common stock to 70,000,000. The Reverse Split became effective on July 27, 2018 at 5:00 p.m., Eastern Time, and the Company's common stock began trading on the Nasdaq Capital Market on a Reverse Split-adjusted basis at the opening of trading on July 30, 2018. As of a result of the Reverse Split, every eight shares of the Company's issued and outstanding common stock were combined into one share of its common stock, except to the extent that the Reverse Split resulted in any of the Company's stockholders owning a fractional share, which was settled in cash. In connection with the Reverse Split, there was no change in the nominal par value per share of $0.001. The Reverse Split did not change the number of authorized shares or par value of the Company's preferred stock.

Common Stock Authorized

As of December 31, 2018, the Company had 70,000,000 shares of common stock authorized of which 7,063,444 shares of common stock were reserved for the issuance upon the exercise of outstanding warrants and options to purchase common stock, the conversion of Series A convertible preferred stock, shares available for grant under the Company's 2013 Stock Incentive Plan and shares available for purchase under the Company's 2017 Employee Stock Purchase Plan.

Put Shares

Pursuant to the terms of a unit purchase agreement dated as of May 5, 1998, the Company issued and sold a total of 149,960 shares of common stock (the "Put Shares") at a price of $128.00 per share. Under the terms of the unit purchase agreement, the initial purchasers (the "Put Holders") of the Put Shares have the right (the "Put Right") to require the Company to repurchase the Put Shares. The Put Right may not be exercised by any Put Holder unless: (1) the Company liquidates, dissolves or winds up its affairs pursuant to applicable bankruptcy law, whether voluntarily or involuntarily; (2) all of the Company's indebtedness and obligations, including without

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Note 7. Stockholders' Equity (Continued)

limitation the indebtedness under the Company's then outstanding notes, has been paid in full; and (3) all rights of the holders of any series or class of capital stock ranking prior and senior to the common stock with respect to liquidation, including without limitation the Series A convertible preferred stock, have been satisfied in full. The Company may terminate the Put Right upon written notice to the Put Holders if the closing sales price of its common stock exceeds $256.00 per share for the twenty consecutive trading days prior to the date of notice of termination. Because the Put Right is not transferable, in the event that a Put Holder has transferred Put Shares since May 5, 1998, the Put Right with respect to those shares has terminated. As a consequence of the Put Right, in the event the Company is liquidated, holders of shares of common stock that do not have Put Rights with respect to such shares may receive smaller distributions per share upon the liquidation than if there were no Put Rights outstanding.

As of December 31, 2018, the Company has repurchased or received documentation of the transfer of 49,993 Put Shares and 4,472 of the Put Shares continued to be held in the name of Put Holders. The Company cannot determine at this time what portion of the Put Rights of the remaining 95,494 Put Shares have terminated.

Equity Financings

"At-The-Market" Equity Program

In November 2018, the Company entered into a Equity Distribution Agreement (the "ATM Agreement") with JMP Securities LLC ("JMP") pursuant to which the Company may issue and sell shares of its common stock, $0.001 par value per share, having an aggregate offering price of up to $50.0 million (the "Shares") through JMP as its agent.

Subject to the terms and conditions of the Agreement, JMP will use its commercially reasonable efforts to sell the Shares from time to time, based upon the Company's instructions, by methods deemed to be an "at the market offering" as defined in Rule 415(a)(4) promulgated under the Securities Act of 1933, as amended, or if specified by the Company, by any other method permitted by law, including but not limited to in negotiated transactions. The Company has no obligation to sell any of the Shares, and the Company or JMP may at any time suspend sales under the ATM Agreement or terminate the ATM Agreement. JMP is entitled to a fixed commission of 3.0% of the gross proceeds from Shares sold. Through December 31, 2018, no Shares had been sold pursuant to the ATM Agreement.

October 2017 Follow-on Underwritten Public Offering

On October 30, 2017, the Company closed a follow-on underwritten public offering, in which it sold 4,166,666 shares of common stock at a price to the public of $12.00 per share for aggregate gross proceeds of $50.0 million ("2017 Offering"). On November 1, 2017, the Company sold an additional 625,000 shares of common stock pursuant to the exercise in full of the underwriters' 30-day option to purchase additional shares of the Company's common stock at the public offering price less the underwriting discount. The net proceeds to the Company from the 2017 Offering, including the exercise by the underwriters of their option to purchase additional shares and after deducting underwriters' discounts and commissions and other offering costs and expenses, were approximately $53.7 million. Baker Brothers, which is affiliated with two of the Company's directors, participated in the 2017 Offering and purchased 1,000,000 shares of the Company's common stock at the price offered to the public.

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Note 7. Stockholders' Equity (Continued)

October 2016 Follow-on Underwritten Public Offering

On October 13, 2016, the Company closed a follow-on underwritten public offering, in which it sold 3,125,000 shares of common stock at a price to the public of $16.00 per share for aggregate gross proceeds of $50.0 million. On October 28, 2016, the Company sold an additional 153,155 shares of common stock pursuant to the underwriters' 30-day option to purchase additional shares at the public offering price less the underwriting discount. The net proceeds to the Company from the offering, including the exercise by the underwriters of their option to purchase additional shares and after deducting underwriters' discounts and commissions and other offering costs and expenses, were approximately $48.8 million. Investment funds affiliated with Baker Brothers and Pillar Invest Corporation, two of the Company's principal stockholders, and certain members of the Company's board of directors, purchased a total of 640,625 shares in this offering at the price offered to the public.

Common Stock Warrants

In connection with various financing transactions, the Company has issued warrants to purchase shares of the Company's common stock. The Company accounts for common stock warrants as equity instruments, derivative liabilities, or liabilities, depending on the specific terms of the warrant agreement. As of December 31, 2018 and 2017, all of the Company's outstanding common stock warrants were equity-classified.

The following table summarizes outstanding warrants to purchase shares of the Company's common stock as of December 31, 2018 and 2017:

	Number of Shares			
Description	December 31, 2018	December 31, 2017	Weighted-Average Exercise Price	Expiration Date
Issued in May 2013 financing	—	2,700,791	$ 3.76	May 2018
Issued in May 2013 financing (pre-funded)	1,977,041	1,977,041	$ 0.08	May 2020
Issued in September 2013 financing (pre-funded)	521,997	521,997	$ 0.08	Sep 2020
Issued in February 2014 financing (pre-funded)	269,844	269,844	$ 0.08	Feb 2021
Total	2,768,882	5,469,673		

The table below is a summary of the Company's warrant activity for the year ended December 31, 2018.

	Number of Warrants	Weighted-Average Exercise Price
Outstanding at December 31, 2017	5,469,673	$ 1.90
Issued	—	—
Exercised (1)	(2,700,791)	3.76
Expired	—	—
Outstanding at December 31, 2018	2,768,882	$ 0.08

(1) During the year ended December 31, 2018, certain related parties exercised warrants as more fully described in Note 15.

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Note 8. Alliance Revenue

Alliance revenue for the years ended December 31, 2018, 2017 and 2016 represents revenue from contracts with customers accounted for in accordance with ASC Topic 606, which the Company adopted in the first quarter of 2018, as more fully described in Note 2. There was no impact to Alliance revenue previously recognized by the Company as a result of the adoption of ASC Topic 606.

For the years ended December 31, 2018, 2017 and 2016, Alliance revenue in the accompanying statements of operations and comprehensive loss is comprised of the following:

(In thousands)	2018	2017	2016
GSK collaboration (1)	$ 517	$ 863	1,111
Vivelix collaboration (2)	56	14	$ 15,000
Other (3)	89	25	88
Total Alliance revenue	$ 662	$ 902	$ 16,199

(1) For all periods presented, revenue recognized primarily relates to the amortization of the deferred up-front payment received at inception of the Company's collaboration and license agreement with GSK Agreement, as more fully described in Note 9. Revenue recognized for the year ended December 31, 2017 also includes an additional $0.1 million related to additional research services provided in connection with the collaboration and license agreement with GSK.

(2) For each of the years ended December 31, 2018 and 2017, revenue recognized relates to services provided under the research program provided for under the Company's exclusive license and collaboration agreement with Vivelix, as more fully described in Note 8. Revenue recognized for the year ended December 31, 2016 relates to the upfront, nonrefundable payment received in connection with the execution of the Vivelix agreement.

(3) For all periods presented, revenue recognized relates to collaborations which are not material to the Company's current operations nor expected to be material in the future, including reimbursements by licensees of costs associated with patent maintenance.

The following table presents changes in the Company's contract assets and liabilities during the years ended December 31, 2018 and 2017:

Year ended December 31, 2018

(In thousands)	Beginning	Additions	Deductions	Ending
Contract assets	$ —	$ —	$ —	$ —
Contract liabilities:				
Deferred revenue	$ 566	$ —	$ (566)	$ —

	Year ended December 31, 2017			
(In thousands)	Beginning	Additions	Deductions	Ending
Contract assets	$ —	$ —	$ —	$ —
Contract liabilities:				
Deferred revenue	$ 1,263	$ 50	$ (747)	$ 566

During each of the years months ended December 31, 2018 and 2017, the Company recognized Alliance revenues of $0.6 million and $0.7 million, respectively, as a result of changes in the contract liability balances associated with its contracts with customers. Revenue recognized during each of the years ended December 31, 2018 and 2017 were included in the contract liability at the beginning of each respective period.

See Note 9 for additional details regarding the Company’s collaboration arrangements.

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Note 9. Collaboration and License Agreements

Collaboration with Vivelix

In November 2016, the Company entered into an exclusive license and collaboration agreement with Vivelix pursuant to which the Company granted Vivelix worldwide rights to develop and market IMO-9200, an antagonist of TLR7, TLR8, and TLR9, for non-malignant gastrointestinal disorders (the "GI Field" or "Field" as defined in the Vivelix Agreement), and certain back-up compounds to IMO-9200 (the "Vivelix Agreement"). The Company was previously developing IMO-9200 for potential use in selected autoimmune disease indications. However, the Company determined not to proceed with internal development of IMO-9200 because the large autoimmune disease indications for which IMO-9200 had been developed did not fit within the strategic focus of the Company. Under the terms of the Vivelix Agreement, Vivelix is solely responsible for the development and commercialization of IMO-9200 and any designated back-up compounds. In connection with the Vivelix Agreement, Idera also transferred certain drug material to Vivelix for Vivelix's use in its development activities.

Pursuant to the Vivelix Agreement, Vivelix could request that the Company create, characterize and perform research on back-up compounds (the "Research Program"). Such activity was to be mutually agreed upon and moderated by the Joint Research Committee ("JRC") established under the Vivelix Agreement. The research period commenced with the execution of the agreement and may last for up to three years. As a result of the Company's decision to wind-down its discovery operations as described in Note 10, in July 2018, the Company informed Vivelix that no additional research projects will be undertaken by the Company.

Vivelix has certain rights under the agreement whereby it may exercise (i) the right of first refusal to develop and commercialize products in any available field ("Right of First Refusal"), (ii) the right of first negotiation to obtain an exclusive license for any compound controlled by Idera that has activity in the field of inflammatory bowel disease ("Right of First Negotiation") and (iii) the right to request an expanded Field beyond the GI Field ("Expanded Field Option").

Under the terms of the Vivelix Agreement, the Company received an upfront, non-refundable fee of $15 million. In addition, the Company will be eligible for future IMO-9200 related development, regulatory and sales milestone payments totaling up to $140 million, including development and regulatory milestones totaling up to $65 million and sales milestones totaling up to $75 million, and escalating royalties ranging from the mid single-digits to low double-digits of global net sales, which percentages are subject to reduction under agreed upon circumstances. As it relates to back-up compounds, including certain compounds controlled by the Company as of the effective date of the Vivelix Agreement and/or those created at Vivelix's request under the Research Program, the Company will be eligible for related designation payments and development, regulatory and sales milestone payments totaling up to $52.5 million, including development and regulatory milestones totaling up to $35 million and sales milestones totaling up to $17.5 million and escalating royalties ranging from the mid single-digits to low double-digits of global net sales, which percentages are subject to reduction under agreed upon circumstances. Under the terms of the agreement, the

Company has performed research services, as requested by Vivelix and at Vivelix's expense. As of December 31, 2018, Vivelix has not designated any back-up compounds subject to the Research Program.

At the effective date of the Vivelix Agreement, Baker Bros. Advisors LP and certain of its affiliated funds (collectively "Baker Brothers") beneficially owned approximately 7.0% of the Company's outstanding common stock and affiliates of Baker Brothers constituted two of the four directors on the board of directors of Vivelix and two of the seven directors on the board of directors of the Company. However, the boards of the Company and Vivelix share no individual common board members. See Note 15 for information on related parties of the Company as of December 31, 2018.

Subsequent to December 31, 2018, the Company and Vivelix mutually agreed to terminate the Vivelix Agreement on March 4, 2019. Accordingly, the Company is no longer eligible to receive any future milestone or royalty-based payments and all rights previously granted to Vivelix with respect to IMO-9200 and certain back-up compounds to IMO-9200 revert back to the Company.

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Note 9. Collaboration and License Agreements (Continued)

Accounting Analysis under ASC 606

In evaluating the Vivelix Agreement in accordance with ASC Topic 606, the Company concluded that the contract counterparty, Vivelix, is a customer. The Company identified the following performance obligations as of the inception of agreement: (i) a research and commercialization license for IMO-9200 and back-up compounds to IMO-9200 (the "IMO-9200 License") and (ii) drug materials transferred, which were both deemed to be distinct. The Company determined that participation in the JRC was immaterial in the context of the contract. Consistent with the guidance under ASC 606-10-25-16A, the Company disregarded immaterial promised goods and services when determining performance obligations.

The Company concluded that the IMO-9200 License was distinct within the context of the contract (i.e. separately identifiable) because it has stand-alone value from other promised goods and services as Vivelix could benefit from the IMO-9200 License on a stand-alone basis and sell the compound in the market without any additional involvement or participation from Idera. Additionally, Idera has no further obligations related to the IMO-9200 License. In the event that Vivelix does not make a designated compound payment, the license to back-up compounds reverts back to Idera at the end of the research term at no cost or payment by either party. The services provided under the Research Program relate to the back-up compounds and Vivelix would be able to conduct research and development activities with external third parties, as IMO-9200 is at an advanced enough stage where Idera's expertise would not be required. Accordingly, the IMO-9200 License is a separate performance obligation.

The Company concluded that the drug materials transferred identified at the inception are also distinct within the context of the contract (i.e. separately identifiable) because they have standalone value from other promised goods and services based on their nature. Accordingly, the drug materials transferred are a separate performance obligation.

Allocable arrangement consideration at inception of the Vivelix Agreement was comprised of the up-front payment of $15 million. The $15 million was allocated based on the relative stand-alone selling prices of each performance obligation. Allocated revenue associated with the IMO-9200 License was recognized at the inception of the Vivelix Agreement in the fourth quarter of 2016 as Vivelix was granted an exclusive, perpetual license to develop and commercialize IMO-9200 and certain back-up compounds to IMO-9200, subject to certain designation milestone and royalty payments, and the performance obligations of Idera under the agreement were extinguished at that point. Allocable revenue associated with drug materials transferred shortly after the inception of the agreement was recognized upon delivery, also in the fourth quarter of 2016.

At inception of the contract, the transaction price included only the $15.0 million up-front consideration received. None of the development and commercialization milestones were included in the transaction price, as all milestone

amounts were fully constrained. As part of its evaluation of the constraint, the Company considered numerous factors, including that receipt of the milestones is outside the control of the Company and contingent upon success in future clinical trials and the licensee's efforts. Similarly, other variable consideration related to services that may be provided under the Research Program and back-up compound designation payments were fully constrained. Any consideration related to sales-based royalties will be recognized when the related sales occur, provided that the reported sales are reliably measurable and the Company has no remaining performance obligations, as such sales were determined to relate predominantly to the license granted to Vivelix and therefore have also been excluded from the transaction price. The Company re-evaluates the transaction price in each reporting period and as uncertain events are resolved or other changes in circumstances occur.

The up-front payment of $15 million was recognized as revenue during the fourth quarter of 2016. Revenue associated with goods and services provided to Vivelix under the Research Program have been immaterial to date and such revenue is recognized as the related performance obligations under each research project are satisfied. See Note 8 for details on revenue recognized in connection with the Company's collaboration with Vivelix for each of the years ended December 31, 2018, 2017 and 2016.

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Note 9. Collaboration and License Agreements (Continued)

Collaboration with GSK

In November 2015, the Company entered into a collaboration and license agreement with GSK to license, research, develop and commercialize pharmaceutical compounds from the Company's nucleic acid chemistry technology for the treatment of selected targets in renal disease (the "GSK Agreement"). The initial collaboration term is currently anticipated to last between two and four years. In connection with the GSK Agreement, GSK identified an initial target for the Company to attempt to identify a potential population of development candidates to address such target under a mutually agreed upon research plan, which was estimated to take 36 months to complete. From the population of identified development candidates, GSK may designate one development candidate in its sole discretion to move forward into clinical development. If GSK designates a development candidate, GSK would be solely responsible for the development and commercialization activities for that designated development candidate.

The GSK Agreement also provided GSK with the option to select up to two additional targets at any time during the first two years of the GSK agreement, for further research under mutually agreed upon research plans. Upon selecting additional targets, GSK then had the option to designate one development candidate for each additional target, at which time GSK would have sole responsibility to develop and commercialize each such designated development candidate. GSK did not select any additional targets for research through expiry of the option period.

In accordance with the GSK Agreement, a Joint Steering Committee ("JSC") was formed with equal representation from Idera and GSK. The responsibilities of the JSC, include, but are not limited to monitoring the progress of the collaboration, reviewing research plans and dealing with disputes that may arise between the parties. If a dispute cannot be resolved by the JSC, GSK has final decision-making authority.

Under the terms of the GSK Agreement, the Company received a $2.5 million upfront, non-refundable, non-creditable cash payment upon the execution of the GSK Agreement. Additionally, the Company was eligible to receive a total of up to approximately $100 million in license, research, clinical development and commercialization milestone payments, of which $9 million of these milestone payments would have been payable by GSK upon the identification of the additional targets, the completion of current and future research plans and the designation of development candidates and $89 million would have been payable by GSK upon the achievement of clinical milestones and commercial milestones. As a result of GSK not selecting additional targets during the two-year option period, the Company is now only eligible to receive a total of up to approximately $20 million in license, research, clinical development and commercialization milestone payments, of which $1 million would be payable by GSK upon the designation of a development candidate from the initial target and $17 million would be payable by GSK upon the achievement of clinical milestones and commercial milestones. In addition, the Company is eligible to receive royalty payments based on sales of licensed products following commercialization at varying rates of up to 5% percent on annual net sales, as defined in the GSK Agreement.

Accounting Analysis under ASC 606

In evaluating the GSK Agreement in accordance with ASC Topic 606, the Company concluded that the contract counterparty, GSK, is a customer. The Company identified the following performance obligations as of the inception of the agreement: (i) research services, combined with the license for Idera's proprietary technology related to the initial target (collectively, the "Collaboration License and Research Services") and (ii) daily options to extend the Collaboration License and Research Services. The Company determined that participation in the JSC and materials transferred were deemed immaterial in the context of the contract. Consistent with the guidance under ASC 606-10-25-16A, the Company disregarded immaterial promised goods and services when determining performance obligations.

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Note 9. Collaboration and License Agreements (Continued)

The Company concluded that the research services related to the initial target and collaboration license to the Company's proprietary technology related to the initial target were not capable of being distinct as the collaboration license related to the initial target is highly interdependent upon the research services to be provided related to the initial target. As it relates to the assessment of standalone value, the Company determined that GSK cannot fully exploit the value of the collaboration license without receipt of the research services from the Company. The research services involve unique skills and specialized expertise, particularly as it relates to the Company's proprietary technology, which is not available in the marketplace. Accordingly, GSK must obtain the research services from the Company which significantly limits the ability for GSK to utilize the collaboration license for its intended purpose on a standalone basis. Similarly, the Company concluded that the daily option to extend the collaboration license and the daily option to extend the research services were also highly interdependent as the license has no value to GSK without the accompanying research services using the Company's proprietary technology. Accordingly, the Collaboration License and Research Services were determined to represent a single performance obligation and the daily options to extend the Collaboration License and Research Services were determined to represent a single performance obligation. Factors considered in this determination included, among other things, the capabilities of the collaborator, whether any other vendor sells the item separately, whether the value of the deliverable is dependent on the other elements in the arrangement, whether there are other vendors that can provide the items and if the customer could use the item for its intended purpose without the other deliverables in the arrangement.

Allocable arrangement consideration at inception of the GSK Agreement consisted of the up-front payment of $2.5 million. The $2.5 million was allocated based on the relative stand-alone selling prices of each performance obligation, calculated based on the expected period of time over which the initial license term will be in place, as well as the expected period of time over which the optional renewals occur. The Company will recognize the consideration allocated to the Collaboration License and Research Services over time as GSK is receiving the benefit of the Company's expertise and know-how on an on-going basis as the research progresses towards the goal of the development candidate designation for the initial target. The exercise of the daily options to extend the Collaboration License and Research Services are treated as a continuation of the contract and allocated consideration is recognized point-in-time upon commencement of each daily exercise.

At inception of the contract, the transaction price included only the $2.5 million up-front consideration received. None of the development and commercialization milestones were included in the transaction price, as all milestone amounts were fully constrained. As part of its evaluation of the constraint, the Company considered numerous factors, including that receipt of the milestones is outside the control of the Company and contingent upon success in future clinical trials and the licensee's efforts. Any consideration related to sales-based royalties will be recognized when the related sales occur, provided that the reported sales are reliably measurable and the Company has no remaining performance obligations, as such sales were determined to relate predominantly to the license granted to GSK and therefore have also been excluded from the transaction price. The Company re-evaluates the transaction price in each reporting period and as uncertain events are resolved or other changes in circumstances occur.

The up-front payment of $2.5 million was recorded as deferred revenue in the Company's balance sheet upon receipt and was recognized as revenue on a straight-line basis over the estimated 36-month research plan period, which approximated the timing in which performance obligations are satisfied. See Note 8 for details on revenue recognized in connection with the Company's collaboration with GSK for each of the years ended December 31, 2018, 2017 and 2016.

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Note 9. Collaboration and License Agreements (Continued)

Collaboration with Abbott Molecular Inc.

In May 2014, the Company entered into a development and commercialization agreement with Abbott Molecular, Inc. ("Abbott Molecular") for the development of an in vitro companion diagnostic for use in the Company's clinical development programs to treat certain genetically defined forms of B-cell lymphoma with IMO-8400, the Company's TLR antagonist lead drug candidate. The agreement provides for the development and subsequent commercialization by Abbott Molecular of a companion diagnostic test utilizing polymerase chain reaction technology to identify with high sensitivity and specificity the presence in tumor biopsy samples of the oncogenic mutation referred to scientifically as MYD88 L265P. Under the agreement, Abbott Molecular is primarily responsible for developing and obtaining regulatory approvals for the companion diagnostic in accordance with an agreed development plan and regulatory plan and for making the companion diagnostic test commercially available in accordance with an agreed commercialization plan. Abbott Molecular will retain all proceeds from commercialization of the companion diagnostic test. Subject to the terms of the agreement, the Company will pay Abbott Molecular fees and fund Abbott Molecular's development of the companion diagnostic test in an approximate aggregate amount of $6.7 million over an approximately five-year development period, which includes clinical trial site costs and Abbott Molecular's costs of preparation and filing fees for regulatory submissions for the companion diagnostic with the U.S. Food and Drug Administration. This amount is subject to increase if Abbott Molecular incurs additional expenses in order to meet unexpected material requirements or obligations not included in the agreement or if the Company is required to conduct additional or different clinical trials which result in Abbott Molecular incurring additional costs. The Company incurred approximately $0.4 million, $0.8 million and $0.4 million in expenses under the Abbott Molecular agreement during the years ended December 31, 2018, 2017 and 2016, respectively. In September 2016, the Company suspended internal clinical development of IMO-8400 for B-cell lymphomas. However, the Company has maintained its relationship with Abbott under the agreement as the Company may explore potential collaborative alliances to support the development of IMO-8400 for B-cell lymphomas.

Note 10. Restructuring Costs

In July 2018, the Company determined to wind-down its discovery operations, reduce the workforce in Cambridge, Massachusetts that supports such operations, and close its Cambridge facility. In connection with the reduction-in-workforce, 18 positions are being eliminated, primarily in the area of discovery, representing approximately 40% of the Company's employees. Of the 18 positions being eliminated, 15 were effective July 31, 2018 with the remaining expected to be eliminated by the second quarter of 2019.

Restructuring-related charges for the year ended December 31, 2018 totaled $3.1 million and were comprised of (i) one-time termination costs in connection with the reduction in workforce, including severance, benefits and related costs, of approximately $2.6 million; (ii) contract termination costs of approximately $0.2 million in connection with the early lease termination for the Cambridge facility, as further discussed below; and (iii) non-cash asset impairments

of approximately $0.7 million, which includes $0.5 million of fixed asset impairments and $0.2 million in write-offs of facility-related prepaid expenses; offset by (iv) a non-cash gain of approximately $0.4 million related to the write-off of the remaining deferred rent liability associated with the Cambridge facility lease.

(in thousands)	Employee Severance and Benefits	Contract Termination Costs	Asset Impairments	Total
Accrued restructuring balance as of December 31, 2017	$ —	$ —	$ —	$ —
Charges incurred (1)	2,635	225	674	3,534
Cash payments	(1,380)	(225)	—	(1,605)
Non-cash settlements	(24)	—	(674)	(698)
Adjustments	(84)	—	—	(84)
Accrued restructuring balance as of December 31, 2018	$ 1,147	$ —	$ —	$ 1,147

(1) Excludes $0.4 million gain due to the write-off of the remaining deferred rent liability associated with the termination of the Cambridge, Massachusetts facility lease.

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Note 10. Restructuring Costs (Continued)

As of December 31, 2018, the entire accrued restructuring balance is classified as a current liability and included in “Accrued expenses” in the accompanying balance sheets. See Note 5.

In connection with the closing of its Cambridge facility, on July 27, 2018, the Company entered into a termination agreement with the landlord terminating the lease agreement, dated October 31, 2006, as amended, between the Company and the landlord effective September 30, 2018. The Company leased its facility at 167 Sidney Street in Cambridge under the lease agreement. Under the terms of the termination agreement, the Company has agreed to pay an early termination fee of $0.2 million. The Company recorded a charge for the $0.2 million early termination fee and a non-cash gain of $0.4 million due to the write-off of the remaining deferred rent liability associated with the lease in the third quarter of 2018. The Company completed the consolidation of its operations to its Exton, Pennsylvania location in the third quarter of 2018.

Note 11. Stock-based Compensation

As of December 31, 2018, the only equity compensation plans from which the Company may currently issue new awards are the Company’s 2013 Stock Incentive Plan (as amended to date, the “2013 Plan”) and 2017 Employee Stock Purchase Plan (the “2017 ESPP”), each as more fully described below.

Equity Incentive Plans

2013 Stock Incentive Plan

The Company's board of directors adopted the 2013 Plan, which was approved by the Company’s stockholders effective July 26, 2013. The 2013 Plan is intended to further align the interests of the Company and its stockholders with its employees, including its officers, non-employee directors, consultants and advisers by providing equity-based incentives. The 2013 Plan allows for the issuance of up to such number of shares of the Company’s common stock as equal to (a) 3,153,057 shares of common stock; plus (b) such additional number of shares of common stock (up to 868,372 shares) as is equal to the sum of the number of shares of common stock subject to awards granted under the Company’s 2005 Stock Incentive Plan (the “2005 Plan”) or the Company’s 2008 Stock Incentive Plan (the “2008 Plan” and, together with the 2005 Plan, the “Existing Plans”) which awards expire, terminate or are otherwise surrendered, canceled, forfeited or repurchased by the Company at their original issuance price pursuant to a contractual repurchase right (subject, however, in the case of Incentive Stock Options to any limitations of the Internal Revenue Code).

Under the 2013 Plan, the Company may grant options to purchase common stock, stock appreciation rights, restricted stock awards and other forms of stock-based compensation. Stock options generally vest over one to four years, and expire no later than 10 years from the date of grant. The maximum number of shares of common stock with respect to which awards may be granted to any participant under the plan is 187,500 per calendar year. The compensation committee of the board of directors has the authority to select the employees to whom options are granted and determine the terms of each option, including (i) the number of shares of common stock subject to the option; (ii) when the option becomes exercisable, which generally may be no earlier than the first anniversary of the date of grant; (iii) the option exercise price, which must be at least 100% of the fair market value of the common stock as of the date of grant; and (iv) the duration of the option, which may not exceed 10 years. Stock options may not be re-priced without shareholder approval. Discretionary awards to non-employee directors are granted and administered by a committee comprised of independent directors. As of December 31, 2018, options to purchase a total of 2,446,534 shares of common stock were outstanding and up to 957,496 shares of common stock remain available for grant under the 2013 Plan.

The Company is no longer granting stock options or other awards pursuant to the share-based compensation plans that were utilized prior to the approval of the 2013 Plan, including the Existing Plans. Under these earlier plans, stock options generally vested over three to four years and expired no later than 10 years from the date of grant. As of December 31, 2018, options to purchase a total of 464,247 shares of common stock were outstanding under these earlier plans.

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Note 11. Stock-based Compensation (Continued)

In addition, as of December 31, 2018, non-statutory stock options to purchase an aggregate of 393,750 shares of common stock were outstanding that were issued outside of the 2013 Plan to certain employees in 2017, 2015 and 2014 pursuant to the Nasdaq inducement grant exception as a material component of new hires' employment compensation.

Employee Stock Purchase Plans

1995 Employee Stock Purchase Plan

The Company's 1995 Employee Stock Purchase Plan (the "1995 ESPP"), as amended, provided for the issuance of up to 62,500 shares of common stock to participating employees of the Company or its subsidiaries. The 1995 ESPP was terminated effective August 31, 2017 as a result of the adoption by the Company's board of directors and approval of shareholders of the 2017 Employee Stock Purchase Plan (the "2017 ESPP"), as described below.

2017 Employee Stock Purchase Plan

The Company's board of directors adopted the 2017 ESPP which was approved by the Company's stockholders and became effective June 7, 2017. The 2017 ESPP provides for the issuance of up to 62,500 shares of common stock to participating employees of the Company or its subsidiaries. Participation is limited to employees that would not own 5% or more of the total combined voting power or value of the stock of the Company after the grant. As of December 31, 2017, 32,294 shares remained available for issuance.

Stock Purchase Plan Administration

The 1995 ESPP provided for and 2017 ESPP provides for offerings to employees to purchase common stock with offerings beginning on dates determined by the compensation committee of the board of directors or on the first business day thereafter. Each offering begins a "plan period" during which payroll deductions are to be made and held for the purchase of common stock at the end of the plan period. The compensation committee may, at its discretion, choose a plan period of 12 months or less for subsequent offerings and/or choose a different commencement date for

offerings. During each plan period participating employees may elect to have a portion of their compensation, ranging from 1% to 10% of compensation as defined by the plan, withheld and used for the purchase of common stock at the end of each plan period. The purchase price is equal to 85% of the lower of the fair market value of a share of common stock on the first trading date of each plan period or the fair market value of a share of common stock on the last trading day of the plan period, and is limited by participant to $25,000 in fair value of common stock per year as well as other quarterly plan limitations as defined by each plan.

For the years ended December 31, 2018, 2017 and 2016, the Company issued 24,824, 21,869 and 15,182 shares of common stock, respectively, under the Company's employee stock purchase plans and recognized $0.1 million, $0.2 million and less than $0.1 million, respectively, in related stock-based compensation expense.

Accounting for Stock-based Compensation

The Company recognizes non-cash compensation expense for stock-based awards under the Company's equity incentive plans over an award's requisite service period, or vesting period, using the straight-line attribution method, based on their grant date fair value, determined using the Black-Scholes option-pricing model. The fair value of the discounted purchases made under the Company's 2015 and 2017 ESPP is calculated using the Black-Scholes option-pricing model. The fair value of the look-back provision plus the 15% discount is recognized as compensation expense over each plan period.

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Note 11. Stock-based Compensation (Continued)

Total stock-based compensation expense attributable to stock-based payments made to employees and directors and employee stock purchases included in operating expenses in the Company's statements of operations for the years ended December 31, 2018, 2017 and 2016 was as follows:

(in thousands)	2018	2017	2016
Stock-based compensation:			
Research and development			
Employee Stock Purchase Plans	$ 71	$ 96	$ 53
Equity Incentive Plans	1,780	6,398	2,666
	$ 1,851	$ 6,494	$ 2,719
General and administrative			
Employee Stock Purchase Plans	$ 48	$ 63	$ 50
Equity Incentive Plans	3,751	4,163	4,078
	$ 3,799	$ 4,226	$ 4,128
Restructuring costs			
Employee Stock Purchase Plans	$ 24	—	—
	$ 24	—	—
Total stock-based compensation expense	$ 5,674	$ 10,720	$ 6,847

The 2017 charge to research and development expense includes approximately $4.3 million of additional stock-based compensation recognized as a result of modifications to previously issued stock option awards in connection with the resignation of an executive.

During the years ended December 31, 2018, 2017 and 2016, the weighted average fair market value of stock options granted was $7.00, $8.08 and $14.00, respectively.

Assumptions Used in Determining Fair Value of Stock Options

Inherent in the Black-Scholes option-pricing model are the following assumptions:

Volatility. The Company estimates stock price volatility based on the Company’s historical stock price performance over a period of time that matches the expected term of the stock options.

Risk-free interest rate. The risk-free interest rate is based on the U.S. Treasury yield curve in effect at the time of grant commensurate with the expected term assumption.

Expected term. The expected term of stock options granted is based on an estimate of when options will be exercised or cancelled in the future.

Dividend rate. The dividend rate is based on the historical rate, which the Company anticipates will remain at zero.

Forfeitures. The Company accounts for forfeitures when they occur. Ultimately, the actual expense recognized over the vesting period will be for only those shares that vest. See Note 2.

The fair value of each option award at the date of grant was estimated using the Black-Scholes option pricing model. All options granted during the three years in the period ended December 31, 2018 were granted at exercise prices equal to the fair market value of the common stock on the dates of grant.

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Note 11. Stock-based Compensation (Continued)

The following weighted average assumptions apply to the options to purchase 1,136,874, 527,039 and 418,281 shares of common stock granted to employees and directors during the years ended December 31, 2018, 2017 and 2016, respectively:

	2018	2017	2016
Average risk-free interest rate	2.5%	1.7%	1.4%
Expected dividend yield	—	—	—
Expected lives (years)	3.7	4.0	4.2
Expected volatility	74%	86%	93%
Weighted average exercise price (per share)	$ 12.63	$ 12.96	$ 21.12

Stock Option Activity

The following table summarizes stock option activity for the year ended December 31, 2018.

($ in thousands, except per share data)	Stock Options	Weighted-Average Exercise Price	Weighted-Average Remaining Contractual Life (in years)	Aggregate Intrinsic Value
Outstanding at December 31, 2017	2,675,184	$ 23.52	6.5	$ 5,805
Granted	1,136,874	12.63		
Exercised	(858)	12.77		
Forfeited	(279,444)	18.15		
Expired	(227,225)	49.58		
Outstanding at December 31, 2018 (1)	3,304,531	$ 18.41	6.6	$ —
Exercisable at December 31, 2018	1,976,059	$ 21.88	5.0	$ —

(1) Includes both vested stock options as well as unvested stock options for which the requisite service period has not been rendered but that are expected to vest based on achievement of a service condition.

The fair value of options that vested during 2018, 2017 and 2016 amounted to $6.0 million, $7.3 million and $6.9 million, respectively. As of December 31, 2018, there was $7.3 million of unrecognized compensation cost related to unvested options, which the Company expects to recognize over a weighted average period of 2.6 years.

Note 12. Commitments and Contingencies

Lease Commitments

As of December 31, 2018, the Company's leased assets consisted of its office headquarters in Exton, Pennsylvania. Prior to the September 30, 2018 termination date, the Company also leased a facility in Cambridge, Massachusetts. During 2018, 2017 and 2016, rent expense, including real estate taxes, was $1.7 million, $2.4 million and $1.9 million, respectively. The leases are classified as operating leases.

Future minimum commitments as of December 31, 2018 under the Company's lease agreements are approximately:

December 31,	Operating Leases
	(In thousands)
2019	$ 209
2020	89
2021 and thereafter	—
	$ 298

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Note 12. Commitments and Contingencies (Continued)

The Company entered into the Exton facility lease on April 1, 2015 and amended it on September 23, 2015 to include additional space. The Exton facility lease term ends on May 31, 2020 subject to a three-year renewal option exercisable by the Company.

Note 13. Income Taxes

In December 2017, the Tax Cuts and Jobs Act ("TCJA") was signed into law. Among other things, the TCJA permanently lowers the corporate federal income tax rate to 21% from the existing maximum rate of 35%, effective for tax years including or commencing January 1, 2018. As a result of the reduction of the corporate federal income tax rate to 21%, GAAP required companies to revalue their deferred tax assets and deferred tax liabilities as of the date of enactment, with the resulting tax effects accounted for in the reporting period of enactment. This revaluation resulted in a provision of $27.6 million to income tax expense and a corresponding reduction in the valuation allowance for the year ended December 31, 2017. As a result, there was no impact to the Company's statement of operations and comprehensive loss for the year ended December 31, 2017 as a result of reduction in tax rates.

The Company's preliminary estimate of the TCJA and the remeasurement of its deferred tax assets and liabilities was subject to the finalization of management's analysis related to certain matters, such as developing interpretations of the provisions of the TCJA, changes to certain estimates and the filing of the Company's tax returns. The final determination of the TCJA and the remeasurement of the Company's deferred assets and liabilities was completed during 2018, within one year from the enactment of the TCJA, as additional information became available. For the year ended December 31, 2018, there were no changes to management's analysis of the effects of TCJA originally performed as of December 31, 2017.

Certain provisions from the Tax Reform Act of 1986 were not impacted by TCJA, such as those limiting the amount of net operating loss carryforwards ("NOLs") and tax credit carryforwards that companies may utilize in any one year in the event of cumulative changes in ownership over a three-year period in excess of 50%. The Company has completed several financings since the effective date of the Tax Reform Act of 1986, which as of December 31, 2018, have resulted in ownership changes in excess of 50% that will significantly limit the Company's ability to utilize its NOL and tax credit carryforwards. In December 2017, the Company completed a study which determined that a cumulative three-year ownership change in excess of 50% had occurred in February 2015. The 2017 and 2016 federal and state NOLs, tax credit carryforwards and related deferred tax assets shown below have been adjusted to reflect the ownership change limitations that resulted from this study. As no study has been completed subsequent to 2017, additional ownership change limitations may result from ownership changes that occurred after February 2015, or may occur in the future.

As of December 31, 2018, the Company had cumulative federal and state NOLs of approximately $253.8 million and $263.5 million available to reduce federal and state taxable income, respectively. As a result of TCJA, federal net operating losses incurred for taxable years beginning after January 1, 2018 have an unlimited carryforward period, but can only be utilized to offset 80% of taxable income in future taxable periods. Of the $253.8 million of federal NOLs, $56.4 million have an unlimited carryforward and the remaining NOLs are still subject to expiration through 2037. During the current year, $3.0 million of federal NOLs expired unused and 2032 will be the next year in which federal NOLs will expire should they remain unused. State NOLs are still subject to expiration according to the laws of each respective jurisdiction. The Company files state tax returns in Massachusetts and Pennsylvania whereby both jurisdictions impose a 20-year carryforward period. All $263.5 million of state NOLs expire through 2038, with the first year of expiration being 2032 for $21.0 million of Massachusetts NOLs. In addition, at December 31, 2018, the Company had cumulative federal and state tax credit carryforwards of $17.0 million and $1.9 million, respectively, available to reduce federal and state income taxes, respectively, which expire through 2038 and 2033, respectively, for federal and state purposes.

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Note 13. Income Taxes (Continued)

As of December 31, 2018 and 2017, the components of the deferred tax assets are approximately as follows:

	2018	2017
	(In thousands)	
Operating loss carryforwards	$ 70,509	$ 53,276
Tax credit carryforwards	18,514	14,099
Other	8,627	7,552
Total deferred tax assets	97,650	74,927
Valuation allowance	(97,650)	(74,927)
Net deferred tax assets	$ —	$ —

The Company has provided a full valuation allowance for its deferred tax asset due to the uncertainty surrounding the ability to realize these assets.

The difference between the U.S. federal corporate tax rate and the Company's effective tax rate for the years ended December 31, 2018, 2017 and 2016 is as follows:

	2018		2017		2016	
Expected federal income tax rate	(21.0)	%	(34.0)	%	(34.0)	%
Expiring credits and NOLs	1.0		—		—	
Change in valuation allowance	37.9		0.9		42.2	
Federal and state credits	(7.4)		(6.9)		(9.9)	
State income taxes, net of federal benefit	(9.7)		(3.7)		(3.7)	
Permanent differences	0.5		2.4		3.5	
Rate change related to TCJA	—		41.9		—	
Other	(1.3)		(0.6)		1.9	
Effective tax rate	0.0	%	0.0	%	0.0	%

The Company applies ASC 740-10, Accounting for Uncertainty in Income Taxes, an interpretation of ASC 740. ASC 740-10 clarifies the accounting for uncertainty in income taxes recognized in financial statements and requires the impact of a tax position to be recognized in the financial statements if that position is more likely than not of being sustained by the taxing authority. The Company had no unrecognized tax benefits resulting from uncertain tax positions at December 31, 2018 and 2017.

The Company has not, as of yet, conducted a study of its research and development credit carryforwards. Such a study might result in an adjustment to the Company's research and development credit carryforwards, however, until a study is completed and any adjustment is known, no amounts are being presented as an uncertain tax position under ASC 740-10. A full valuation allowance has been provided against the Company's research and development credits and, if an adjustment is required, this adjustment would be offset by an adjustment to the valuation allowance. Thus, there would be no impact to the statements of operations and comprehensive loss if an adjustment was required.

The Company files income tax returns in the U.S. federal, Massachusetts and Pennsylvania jurisdictions. The Company is no longer subject to tax examinations for years before 2015, except to the extent that it utilizes NOLs or tax credit carryforwards that originated before 2015. The Company does not believe there will be any material changes in its unrecognized tax positions over the next 12 months. The Company has not incurred any interest or penalties. In the event that the Company is assessed interest or penalties at some point in the future, they will be classified in the statements of operations and comprehensive loss as general and administrative expense.

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Note 14. Employee Benefit Plan

The Company has an employee benefit plan under Section 401(k) of the Internal Revenue Code. The plan allows employees to make contributions up to a specified percentage of their compensation. Under the plan, the Company matches a portion of the employees' contributions up to a defined maximum. The Company has historically contributed up to 3% of employee base salary, by matching 50% of the first 6% of annual base salary contributed by each employee. Effective August 2018, the Company began contributing up to 5% of employee base salary, by matching 100% of the first 5% of annual base salary contributed by each employee. Approximately $0.2 million, $0.3 million and $0.3 million of 401(k) benefits were charged to operating expenses during 2018, 2017 and 2016, respectively.

Note 15. Related Party Transactions

Overview of Related Parties

Youssef El Zein, a member of the Company's board of directors until his resignation in October 2017, is a director and controlling stockholder of Pillar Invest Corporation ("Pillar Invest"), which is the general partner of Pillar Pharmaceuticals I, L.P. ("Pillar I"), Pillar Pharmaceuticals II, L.P. ("Pillar II"), Pillar Pharmaceuticals III, L.P. ("Pillar III"), Pillar Pharmaceuticals IV, L.P. ("Pillar IV") and Pillar Pharmaceuticals V, L.P. ("Pillar V") and limited partner of Pillar I, Pillar II, Pillar III, Pillar IV and Pillar V. Entities affiliated with Pillar Invest and Participations Besancon ("Besancon"), an investment fund advised by Pillar Invest having no affiliation with Mr. El Zein, Pillar I, Pillar II, Pillar III, Pillar IV, Pillar V or Pillar Invest (collectively, the "Pillar Investment Entities"), own approximately 9% of the Company's common stock as of December 31, 2018.

Julian C. Baker, a member of the Company's board of directors until his resignation in September 2018, is a principal of Baker Bros. Advisors LP. Baker Bros. Advisors LP, and certain of its affiliated funds, owned approximately 18% of the Company's common stock as of December 31, 2018. Additionally, one of the Company's directors, Kelvin M. Neu, is an employee of Baker Bros. Advisors LP as of December 31, 2018.

Pillar Investment Entities

During 2018, Besancon exercised warrants to purchase 150,000 shares of the Company's common stock at an exercise price of $3.76 per share for a total exercise price of approximately $0.6 million.

During 2017, Pillar II exercised 629,257 warrants to purchase shares of the Company's common stock at a total exercise price of approximately $3.5 million and Besancon exercised 364,752 warrants to purchase shares of the Company's common stock at a total exercise price of approximately $1.9 million. The warrant exercise prices had been established at the time that the warrants were purchased.

During 2016, Pillar I exercised 171,250 warrants to purchase shares of the Company's common stock at a total exercise price of approximately $2 million. The warrant exercise prices had been established at the time that the warrants were purchased. Additionally during 2016, investment funds affiliated with Pillar Invest Corporation purchased shares of the Company's common stock in connection with the 2016 Offering as more fully described in Note 7.

Baker Brothers

During 2018, Baker Brothers exercised warrants to purchase 2,700,791 shares of the Company's common stock at an exercise price of $3.76 per share for a total exercise price of approximately $9.5 million.

During 2017 and 2016, Baker Brothers purchased shares of the Company's common stock in connection with underwritten public offerings of shares of the Company's common stock as more fully described in Note 7.

As of December 31, 2018, Baker Brothers held pre-funded warrants to purchase up to 2,768,882 shares of the Company's common stock at an exercise price of $0.08 per share.

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Note 15. Related Party Transactions (Continued)

Board Fees Paid in Stock

Pursuant to the Company's director compensation program, in lieu of director board and committee fees of approximately $0.1 million, $0.1 million, and $0.2 million incurred during the years ended December 31, 2018, 2017 and 2016, respectively, the Company issued 13,654, 7,867 and 12,654 shares of common stock, respectively, to certain of its directors. Director board and committee fees are paid in arrears and the number of shares issued was calculated based on the market closing price of the Company's common stock on the issuance date.

Note 16. Net Loss per Common Share

Basic and diluted net loss per common share applicable to common stockholders is calculated by dividing net loss applicable to common stockholders by the weighted-average number of shares of common stock outstanding during the period, without consideration of common stock equivalents. The Company's potentially dilutive shares, which include outstanding stock option awards, common stock warrants and convertible preferred stock, are considered to be common stock equivalents and are only included in the calculation of diluted net loss per share when their effect is dilutive. For the years ended December 31, 2018, 2017 and 2016, diluted net loss per common share applicable to common stockholders was the same as basic net loss per common share applicable to common stockholders as the effects of the Company's potential common stock equivalents are antidilutive.

Total antidilutive securities that were excluded from the calculation of diluted net loss per share, due to their anti-dilutive effect, were 6,075,339, 8,145,188 and 8,714,113 as of December 31, 2018, 2017 and 2016, respectively, and consisted of stock options, preferred stock and warrants.

Note 17. Supplemental Disclosure of Cash Flow Information

Supplemental disclosure of cash flow information for the periods presented is as follows:

Year Ended December 31,

	2018	2017	2016
	(In thousands)		
Supplemental disclosure of cash flow information:			
Cash paid for interest	$ 9	$ 42	$ 72
Supplemental disclosure of non-cash financing and investing activities:			
Non-cash property additions	$ —	$ 150	$ 425
Accrued financing transaction costs	$ 101	$ 17	$ 166

18. Subsequent Events

The Company considers events or transactions that occur after the balance sheet date but prior to the issuance of the financial statements to provide additional evidence relative to certain estimates or to identify matters that require additional disclosure.

"At-The-Market" Equity Program

During the period January 1, 2019 through March 6, 2019, the Company sold 425,610 Shares pursuant to the ATM Agreement, as more fully described in Note 7, resulting in net proceeds after deduction of commissions and other offering expenses of $1.3 million.

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18. Subsequent Events (Continued)

Common Stock Purchase Agreement

On March 4, 2019, the Company entered into a Purchase Agreement with Lincoln Park Capital Fund, LLC (“Investor”), pursuant to which, upon the terms and subject to the conditions and limitations set forth therein, Investor has committed to purchase an aggregate of $35 million of shares of Company common stock from time to time at the Company’s sole discretion (the “Purchase Agreement”). As consideration for entering into the Purchase Agreement, the Company issued 269,749 shares of Company common stock to Investor as a commitment fee (the Commitment Shares”). The Company did not receive any cash proceeds from the issuance of the Commitment Shares. Additionally, no shares were sold to Investor under the Purchase Agreement through March 6, 2019.

Collaboration with Vivelix

On March 4, 2019, the Company and Vivelix mutually agreed to terminate the Vivelix Agreement, as more fully described in Note 9.