UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549

FORM 10-K

(Mark One)

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

For the fiscal year ended December 31, 2022

or

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

For the transition period from _____ to _____

Commission file number:001-41488

Shuttle Pharmaceuticals Holdings, Inc.

(Exact name of registrant as specified in its charter)

Delaware	**82-5089826**
State or other jurisdiction of incorporation or organization	(I.R.S. Employer Identification Number)

One Research Court, Suite 450
Rockville, Maryland 20850
(Address of principal executive offices) (Zip Code)

(240) 403-4212
Registrant's telephone number, including area code

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

Title of each class	Trading Symbol(s)	Name of each exchange on which registered
Common Stock	**SHPH**	**The Nasdaq Stock Market LLC**

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 Section 15(d) of the 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 such 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 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 has filed a report on and attestation to its management's assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report. ☐

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

The registrant was not a public company as of the last business day of its most recently completed second fiscal quarter and, therefore, cannot calculate the aggregate market value of its voting and non-voting common equity held by non-affiliates as of such date.

The number of shares outstanding of the registrant's common stock on March 14, 2023, was 13,654,127.

Shuttle Pharmaceuticals Holdings, Inc.

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FORWARD LOOKING STATEMENTS

This Annual Report on Form 10-K (including the section regarding Management's Discussion and Analysis and Results of Operations, the "Annual Report") contains forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, or the Securities Act, and Section 21E of the Securities Exchange Act of 1934, as amended, or the Exchange Act. These statements are based on our management's belief and assumptions and on information currently available to our management. Although we believe that the expectations reflected in these forward-looking statements are reasonable, these statements relate to future events or our future financial performance, and involve known and unknown risks, uncertainties and other factors that may cause our actual results, levels of activity, performance or achievements to be materially different from any future results, levels of activity, performance or achievements expressed or implied by these forward-looking statements. All statements other than statements of historical facts contained in this Form 10-K are forward-looking statements. In some cases, you can identify forward-looking statements by terminology such as "may," "could," "will," "would," "should," "expect," "plan," "anticipate," "believe," "estimate," "intend," "predict," "seek," "contemplate," "project," "continue," "potential," "ongoing" or the negative of these terms or other comparable terminology. These forward-looking statements include, but are not limited to, statements about:

- the initiation, timing, progress and results of our research and development programs, preclinical studies, any clinical trials and INDs, NDAs other regulatory submissions;
- our expected dependence on third party collaborators for developing, obtaining regulatory approval for and commercializing product candidates;
- our receipt and timing of any milestone payments or royalties under any research collaboration and license agreement we enter into;
- our ability to identify and develop product candidates;
- our or a collaborator's ability to obtain and maintain regulatory approval of any of our product candidates;
- the rate and degree of market acceptance of any approved products candidates;
- the commercialization of any approved product candidates;
- our ability to establish and maintain additional collaborations and retain commercial rights for our product candidates subject to collaborations;
- the implementation of our business model and strategic plans for our business, technologies and product candidates;
- our estimates of our expenses, ongoing losses, future revenue and capital requirements;
- our ability to obtain additional funds for our operations;
- our ability to obtain and maintain intellectual property protection for our technologies and product candidates and our ability to operate our business without infringing the intellectual property rights of others;
- our reliance on third parties to conduct our preclinical studies or any future clinical trials;
- our reliance on third party supply and manufacturing partners to supply the materials and components for, and manufacture, our research and development, preclinical and clinical trial drug supplies;
- our ability to attract and retain qualified key management and technical personnel;
- our use of net proceeds received by us from our initial public offering, or IPO, or any subsequent private placement;
- our expectations regarding the time during which we will be an emerging growth company under the JOBS Act;
- our financial performance; and
- developments relating to our competitors or our industry.

You should not place undue reliance on forward-looking statements, because they involve known and unknown risks, uncertainties and other factors, which are, in some cases, beyond our control and which could materially affect results. Factors that may cause actual results to differ materially from current expectations include, among other things, those listed in the reports we file with the SEC. Actual events or results may vary significantly from those implied or projected by the forward-looking statements due to these risk factors. No forward-looking statement is a guarantee of future performance. You should read this Annual Report on Form 10-K, the documents that we reference in this Annual Report on Form 10-K and the documentation we have filed as exhibits thereto with the Securities and Exchange Commission, or the SEC, with the understanding that our actual future results and circumstances may be materially different from what we expect.

Unless the context otherwise requires, the terms “the Company,” “we,” “us,” and “our” in this Annual Report refer to Shuttle Pharmaceuticals Holdings, Inc.

PART I

Item 1. Business

We are a clinical stage pharmaceutical company leveraging our proprietary technology to develop novel therapies designed to cure cancers. Our goal is to extend the benefits of cancer treatments with surgery, radiation therapy, chemotherapy and immunotherapy. Radiation therapy (RT) is one of the most effective modalities for treating cancers. We are developing a pipeline of products designed to address limitations of the current cancer therapies as well as to extend to the new applications of radiation therapy. We believe that our product candidates will enable us to deliver cancer treatments that are safer, more reliable and at a greater scale than that of the current standard of care.

Our product candidates include Ropidoxuridine, Extended Bio-availability Ropidoxuridine (IPdR/TPI), and a platform of HDAC inhibitors (SP-1-161, SP-2-225 and SP-1-303). We have advanced Ropidoxuridine through a Phase I clinical trial using non-dilutive National Institutes of Health (NIH) The Small Business Innovation Research (SBIR) contracts and are currently preparing a Phase II study that we intend to commence in 2023. We also plan to perform the IND-enabling studies in 2023 in order to submit an investigational new drug application (IND) for the selective HDAC6 inhibitor (SP-2-225) with the goal of initiating a Phase I clinical trial in 2024. We have applied for and received FDA approval of Orphan designation for Ropidoxuridine and RT for treating brain cancer (glioblastoma). We believe our management team's expertise in radiation therapy, combined modality cancer treatment and immuno-oncology will help drive the development and, if approved, the commercialization of these potentially curative therapies for patients with aggressive cancers.

Radiation Oncology has gone through transformative technological innovation over the last several years to better define tumors, allow improved shaping of radiation delivery and support dose escalation with shorter courses of treatment. Furthermore, achieving higher dose distributions within tumor volumes has reached a practical plateau, since cancers are frequently integrated with or surrounded by more sensitive normal tissues and further dose increases risk of tissue necrosis. To increase cancer cures at maximally tolerated radiation doses, pharmacological and biological modifications of cells are needed to sensitize cancers, protect normal tissues, and stimulate the immune system to react against antigens produced by irradiated, damaged cancer cells. Drugs that show sensitizing properties, or the ability to make cancer cells more sensitive to radiation, offer a solution to this problem. Currently, such drugs are used off-label, and many have inherent toxicities since they were designed for direct cancer treatments and not for sensitization.

We are developing our products with the goal of addressing the unmet need in cancer treatment for a commercially marketable radiation response modifier solution that leads to greater sensitivity of cancer cells to ionizing radiation therapy. The goal of our products is to increase the therapeutic index for patients receiving radiation and to decrease radiation-related toxicities in patients with solid tumors. Our products operate across three areas related to the treatment of cancer with RT:

1. Sensitization of growing cancer cells, rendering them more susceptible to the effects of radiation therapy.

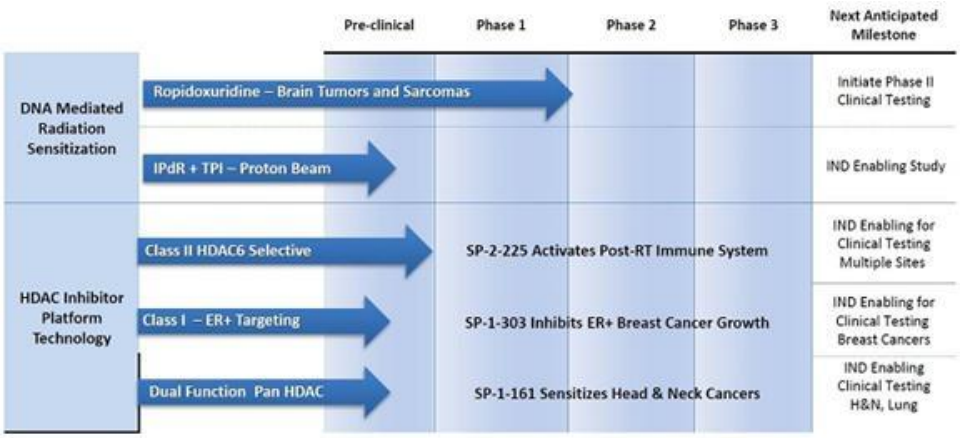
2. Activation of the DNA damage response pathway to kill cancer cells and protect adjacent normal cells.

3. Activation of the immune system to kill any remaining cells after RT.

Our platform technology allows for the creation of an inventory of products for radiation sensitizing, immune modulation, and protection of healthy tissue.

Our Pipeline

We are currently developing a pipeline of small molecule radiation sensitizers and immune response regulating drugs. Our most advanced product candidate is Ropidoxuridine, an orally available halogenated pyrimidine with strong cancer radiation sensitizing properties in preclinical studies. In addition to our clinical study-ready candidate, we have a pipeline of complimentary product candidates that we are developing to address a host of solid tumor cancer indications. Our pipeline is represented in the diagram below:



Timeline for clinical phase (Ropidoxuridine) and pre-clinical phase (HDAC inhibitors) pipeline.

Our lead product candidates include:

- **Ropidoxuridine (IPdR)** is our lead candidate radiation sensitizer for use in combination with RT to treat brain tumors (glioblastoma) and sarcomas. Phase I clinical trial results supported by Shuttle Pharma and the NCI (CTEP) were reported in the medical journal, Clinical Cancer Research, in July 2019, by our SBIR subcontractor. Eighteen patients completed dose escalations to 1,800 mg/day for 30 days, establishing the maximum tolerated dose (MTD) of 1,200 mg/day in combination with RT. Four partial responses, nine stable disease and one progressive disease in target lesions were reported. Four patients did not have measurable disease and, as a result, were not evaluable. These Phase I trial results demonstrate oral bioavailability and an MTD of 1,200 mg per day for 28 days for use in combination with radiation for Phase II clinical trials that we propose to perform in brain tumors and in sarcomas. The brain tumor, glioblastoma multiforme (GB) is eligible for orphan disease designations. Shuttle Pharma has advanced drug manufacture and formulation and prepared a draft clinical protocol of a "Phase 2 Single-Arm Study of IPdR as a Radiation Sensitizing Agent During Radiotherapy in Patients with Newly Diagnosed IDH-Wildtype MGMT Unmethlyated and Glioblastoma Multiforme." We anticipate submitting an Investigational New Drug (IND) application for FDA review in the second quarter of 2023.

- **Ropidoxuridine and Tipracil (IPdR/TPI)** is a new combination formulation demonstrating extended bioavailability after oral administration in an animal model system. The IPdR/TPI formulation will be developed for use as a radiation sensitizer of rectal cancers after the Phase II brain tumor clinical trial has been initiated.

- **SP-1-161** is Shuttle Pharma's pre-clinical candidate lead HDAC inhibitor, radiation sensitizing candidate product. This pan HDAC inhibitor initiates the mutated in ataxia-telangiectasia (ATM) response pathway. Using rational drug design, we discovered HDAC inhibitors and ATM activators capable of radiation sensitizing cancer cells and protecting normal cells. The candidate drug may serve as direct chemotherapeutic agents or as radiation sensitizers for treating cancers.

- **SP-2-225** is Shuttle Pharma's pre-clinical class IIb selective HDAC inhibitor that affects histone deacetylase HDAC6. SP-2-225 has effects on the regulation of the immune system. The interactions of RT with the immune response to cancers are of great current interest, offering insight into potential mechanisms for primary site and metastatic cancer treatment. For this reason, Shuttle Pharma has selected SP-2-225 as the candidate lead HDAC inhibitor for preclinical development. We are advancing drug manufacture and IND-enabling studies to enable a Phase I clinical trial in 2024. With the introduction of check-point inhibitors, CAR-T therapies and personalized medicine in cancer, regulation of the immune response following RT is of significant clinical and commercial interest.

- **SP-1-303** is Shuttle Pharma's pre-clinical selective Class I HDAC inhibitor that preferentially affects histone deacetylases HDAC1 and HDAC3 and is a member of the class I HDAC family. SP-1-303 data show direct cellular toxicity in ER positive breast cancer cells. Furthermore, SP-1-303 increases PD-L1 expression.

Our Approach

We believe that we have established a leadership position in radiation sensitizer discovery and development. Over approximately six years of research, we have identified two clinical phase product candidates and discovered new pre-clinical molecules using our proprietary platform technologies to increase the therapeutic index for patients receiving radiation for treatment of solid tumors. Our development strategy has four key pillars: (1) to improve the efficacy of RT by demonstrating improved disease-free survival rates in patients who undergo radiation therapy, (2) reduce the amount of radiation needed for a favorable tumor response, thereby limiting the potential for radiation related toxicities to healthy cells, (3) decrease the extent of surgery needed to remove cancers and improve quality of life, and (4) leverage our next generation technologies to create drugs that regulate the immune response assisting immune checkpoint and CAR-T therapies and other personalized medicines targeting cancers.

We propose to perform Phase I and Phase II clinical trials to advance our clinical product candidates. In addition, candidate HDAC inhibitor molecules will be tested, and IND-enabling studies will be performed to prepare for Phase I clinical trials.

To date, we have been awarded three SBIR contracts from the NIH to:

- Develop IPdR as a radiation sensitizer for the treatment of gastro-intestinal cancers, in combination with radiation therapy. This funding provided partial support for the Phase I clinical trial of Ropidoxuridine and RT.

- Develop prostate cancer cell cultures from African-American men, with donor matched normal prostate cells, with the goal of establishing 50 pairs for accelerating research to reduce prostate cancer health disparities in African-American men. This project was funded under "Moonshot" designation and Shuttle Pharma is eligible to submit an application for additional SBIR (Phase IIb) funding to establish the infrastructure required to expand and distribute cells for research purposes. Cells from African-American patients are distributed to investigators who are conducting health disparities research.

- Develop predictive biomarkers for determining outcomes for prostate cancer patients following treatment with SBRT. This SBIR-funded project was completed on March 15, 2022 and Shuttle Pharma is eligible to apply for additional funding through the SBIR (Phase IIb) mechanism to de-risk clinical validation to develop the predictive biomarkers.

All three SBIR funded projects have been completed. The Company is eligible to apply for SBIR Phase IIb funding to "bridge" the funding gap should Shuttle Pharma elect to advance the "Moonshot" health disparities or the predictive biomarker project. The NIH SBIR program is designed to encourage small businesses to engage in Federal Research/Research and Development ("R/R&D") that has the potential for commercialization.

Our Strategy

Our goal is to maintain and build upon our leadership position in radiation sensitization. We plan to develop Ropidoxuridine and the HDAC6 inhibitor (SP-2-225) and, if approved by the FDA, commercialize our product candidates for the treatment of cancers. While this process may require years to complete, we believe achieving this goal could result in new radiation sensitizer and immunotherapy products. Key elements of our strategy include:

- **Capitalize on Ropidoxuridine as an orally available, small molecule radiation sensitizer.** To date, there is one drug (Cetuximab, a monoclonal antibody) approved by the FDA specifically as a radiation sensitizer. If we are successful in developing Ropidoxuridine and obtaining FDA approval, a small molecule sensitizer would then be enabled for clinical applications for radiation sensitization.

- **Expand our leadership position within radiation sensitizers**. In addition to our traditional radiation sensitizers, we plan to advance our near-term pipeline to include radiation sensitizers for proton therapy. Proton Therapy is growing worldwide as a form of radiation therapy due to its unique beam shaping characteristics. As a result, this new technology offers a major opportunity for Shuttle Pharma to strive to develop an innovative and well-tolerated drug for proton therapy sensitization.

- **Execute a disciplined business development strategy to strengthen our portfolio of product candidates**. We have built our current product pipeline through in-house development, partnerships with leading academic institutions and through in-licensing. We will continue to evaluate new in-licensing opportunities and collaboration agreements with leading academic institutions and other biotechnology companies around programs that seek to address areas of high unmet need and for which we believe there is a high probability of clinical success, including programs beyond our target franchise areas and current technology footprint.

- **Invest in our HDAC platform technology and maximize its utility across cancer therapies**. We are initially applying the platform to develop drugs for cancer radiation sensitization, normal tissue radiation protection and post radiation immune stimulation. Based on the data we have obtained thus far, these drugs are immune regulatory. We intend to invest to develop other properties of our platform technology, as well.

- **Enter into collaborations to realize the full potential of our platform**. The breadth of our HDAC technology platform enables other therapeutic applications, including radiation sensitization and immune therapy. We intend to seek collaborations centered on our platform to maximize applications for cancer treatment.

Radiation Therapy

Radiation Oncologists use Radiation Therapy (RT) to treat cancers that cannot be completely removed by surgery but have not yet spread to distant sites within the body. RT has been a mainstay for the treatment of cancer malignancies for more than half a century. The combination treatment of radiation therapy and chemotherapy has involved the use of cytotoxic drugs, targeted biologic agents and targeted external beam radiation to increase the destruction of tumor cells and cure or delay cancer progression. The low number of drugs and biologic agents under investigation as radiation sensitizing agents highlights an unmet need for new approaches and agents that provide greater effectiveness, increased quality and better tolerability for patients.

Currently, "chemo-radiation" treatments are established in cancers of the head and neck, esophagus, lung, stomach, breast, brain, pancreas, rectum and uterine cervix. The ideal radiation sensitizer would reach the tumor in adequate concentrations and act selectively in the tumor, as compared to surrounding normal tissues. It would have predictable pharmacokinetics for timing with radiation therapy and could be administered with every radiation treatment approach. The ideal radiation sensitizer would have minimal toxicity or manageable enhancement of radiation toxicity.

The U.S. market for radiation sensitizing agents is experiencing dynamic growth through development of new radiation technology, the introduction of new agents, growth in the number of diagnosed patients in a variety of cancers and changes in treatment patterns. New agents have been introduced, including bevacizumab (Avastin®, Roche), panitumumab (Vectibix®, Amgen), temozolomide (Temodar®, Merck) and cetuximab (Erbitux®, Eli Lilly/Imclone), with potential as radiation sensitizing agents (though all but cetuximab are used off label); and all are recommended by the NCCN® (National Comprehensive Cancer Network) in clinical practice guidelines for use in combination with established therapies such as FOLFOX (leucovorin, 5-FU, oxaliplatin), CapeOX (capecitabine, oxaliplatin) and FOLFIRI (leucovorin, 5-FU, irinotecan).

The growth in the number of patients with cancers is being driven by an aging population and improved diagnostic tools. According to the National Cancer Institute (NCI), more than half (~50 - 60%) of all cancer patients undergo some type of radiotherapy during the course of their treatment. Confirming the patient estimate from the NCI, the American Society for Therapeutic Radiology and Oncology (ASTRO) factsheet states approximately 67% of approximately 1.25 million cancer patients are treated with radiation therapy annually, either one or more times during the course of treatment. In addition, in a study published by the Journal of Clinical Oncology in 2016, it is estimated that the number of cancer patients needing radiation therapy will increase by 22% in the next 10 years. (*See "The Future of Radiation Oncology in the United States From 2010 to 2020: Will Supply Keep Pace With Demand?" Benjamin D. Smith, Bruce G. Haffty, Lynn D. Wilson, Grace L. Smith, Akshar N. Patel, and Thomas A. Buchholz Journal of Clinical Oncology 2010 28:35, 5160-5165).*

The American Society of Clinical Oncology (ASCO) estimates more than 80% of cancers in the U.S. occur in people in the age group of 50 and above with over 60% of cancers occurring in those 65 and over. (*See*, 2018 Clinical Cancer Advances Report, American College of Clinical Oncology, 2018). For example, according to the American Cancer Society (ACS), more than 90% of colorectal cancer patients are individuals aged 50 years and older, with approximately 40% of all cases occur in patients aged 75 years and over. The Colon Cancer Alliance estimates that 90% of new cases and 95% of deaths from colorectal cancers occur in people aged 50 or older. Also, the U.S. Census estimates that the age group of 65-84 will grow by 23% within the next five years, indicating a likely increase in the overall number of cancer patients in the U.S.

The table below details the number and rate of cancers occurring in the United States in 2022:

Estimated New Cancer Cases in the U.S.

Male			Female		
Prostate	268,490	27%	Breast	287,850	31%
Lung & bronchus	117,910	12%	Lung & bronchus	118,830	13%
Colon & rectum	80,690	8%	Colon & rectum	70,340	8%
Urinary bladder	61,700	6%	Uterine corpus	65,950	7%
Melanoma of the skin	57,180	6%	Melanoma of the skin	42,600	5%
Kidney & renal pelvis	50,290	5%	Thyroid	31,940	3%
Non-Hodgkin lymphoma	44,120	4%	Non-Hodgkin lymphoma	36,350	4%
Oral cavity & pharynx	38,700	4%	Kidney & renal pelvis	28,710	3%
Leukemia	35,810	4%	Pancreas	29,240	3%
Pancreas	32,970	3%	Leukemia	24,840	3%
All sites	**983,160**		**All sites**	**934,870**	

2022 Clinical Cancer Advances Report, American College of Clinical Oncology, 2022

Colon Cancer Alliance. Colorectal Cancer Survival Rates from Facts and Figures, 2017. Chicago, IL; 2017

The U.S. 2019 estimated incidence, deaths and five-year survival rate of cancer patients responsive to radiation therapy is significant (ACS Facts & Figures, 2019). The top cancers responsive to radiation are shown, based on the number of newly diagnosed patients. The incidence rates for some cancers are increasing by approximately 1-2% per year in the U.S. The number of newly diagnosed patients is significant and growing due to the aging of the population and improved diagnostic techniques.

All of the listed cancers illustrate the opportunity presented for radiation sensitizers. Of note is the low five-year survival of pancreas, brain, lung and esophagus cancers—all are candidates for Shuttle's pipeline of radiation sensitizing compounds. Cancers with low survival rates are of interest since they show a high unmet need for new therapeutics and an opportunity for Shuttle to gain significant uptake of their pipeline compounds.

Factors that are challenges and may restrict growth in the radiation sensitizer market include the safety and tolerability of many of the newer agents with radiation sensitizing properties; a regulatory environment that engenders greater levels of scrutiny of clinical practice issues; the high cost of newer agents; and the changing (and more restrictive) reimbursement environment in radiation oncology through CMS (Center for Medicare and Medicaid Services) and private payors. These factors may negatively impact the potential for growth in the U.S. market.

Many of the drugs used "off-label" as radiation sensitizers currently require close scrutiny of their potential for side effects that can affect the safety and tolerability of their use with patients. All of the current agents carry significant potential for side effects that can affect patients' therapies and quality of life. Radiation sensitizing agents can cause both acute and chronic side effects in patients. Side effects can vary from person to person depending on age, sex, type of cancer, dose given per day, total dose given, and the patient's general medical condition. Some common side effects of currently used radiation sensitizers include leukopenia, skin damage, hair loss, fatigue, bladder problems, nausea, fibrosis, memory loss, infertility, and enhanced risk of developing a second cancer, which may arise as a result of the patient's weakened immune system due to cytotoxic drugs used in treatment or when newer biologic agents cause the over-production of specific cytokines or proteins, which can lead to developing secondary cancers.

Over the past five years, the FDA has taken an increasingly conservative approach to the approval of new agents for oncology treatment. There is greater scrutiny of results from clinical trials regarding progression free survival, overall survival, and safety and tolerability of new agents. Restrictions such as black box warnings and REMS (Risk Evaluation and Migration Strategies) are being applied to more new products over the past five years compared to the previous five years. These restrictions require physicians to be more careful in evaluating the use of newer agents and newer diagnostic tools to select the most appropriate patients for newer approved agents.

Many of the new agents are molecularly targeted therapies that are biologic in their development and manufacturing. The cost of the newer agents can be significant. For example, the cost for Avastin for one treatment course as a radiation sensitizer is estimated at $9,000-12,000 according to one Key Opinion Leader in the U.S. (Carl Schmidt, Consultant, Shuttle Pharmaceuticals Holdings, Inc., Business Plan 2018). Recently, a CAR-T gene therapy from Novartis was launched with a yearly cost of $475,000. Further, as many private payors scrutinize the cost and appropriate use of newer drugs, they require physicians to provide justification for use of newer agents through prior authorization requests, use of step therapy and to follow guidelines that delay treatment, increase administrative costs and limit the therapeutic choices for physicians and hospitals.

Public payors for radiation oncology therapies such as CMS have instituted reimbursement reductions that potentially affect the overall cost of therapy and can limit the acceptance of newer agents. With CMS announced reductions in reimbursement for radiation oncology, there is increased pressure to find a more potent radiation sensitizer agent with reduced side effects, and greater cost-effectiveness.

Escalating healthcare spending is adding pressure on government and commercial payors to contain drug costs. While the oncology space is arguably not as tightly managed by payors as other therapeutic areas, utilization management of costly cancer therapeutics has become an increasing priority for U.S. payors, especially with the advent of biologics. Payors (and market access agencies in the EU) will most often restrict high-cost drugs, drugs with limited or no survival benefits, and drugs deemed to be at high risk for widespread off-label use.

Beyond efforts at cost containment by insurers (which often require patients to first be prescribed lower cost drugs in order to determine effectiveness prior to allowing for reimbursements for more expensive (or less cost effective) drugs), payors are also looking toward implementing clinical pathways as a way to maintain or improve health outcomes while lowering costs. Clinical pathways are designed to address the limitations of prior authorization and of reduced fee schedules, offering more durable cost containment to payors. These pathways may lead to cost savings by encouraging the use of generics, streamlining treatment choices, and reducing side effects while maintaining outcomes.

Engineered Radiation Sensitizers

The market for radiation sensitizers in selected cancer types is defined by the need to improve local-regional tumor control. Treatment regimens have been developed to address patient needs for tumor control and quality of life. Since the initial applications of Ropidoxuridine and selective HDAC inhibitors are as adjuncts to the standard of care for the treatment of radiation responsive cancers, the unmet needs of the market lie in the potential for the following:

- Improvement in efficacy of radiation treatments as determined by overall survival, progression free survival and response rates in comparison to currently used “off-label” sensitizer drugs.
- Reduction in radiation doses needed to affect a positive clinical response for the patient.
- Reduction in the surgical extent that is needed to remove residual cancer.
- Improvement in quality-of-life outcomes.

Various sources have estimated that more than 800,000 patients in the U.S. are treated with radiation therapy for their cancers. According to the American Cancer Society, about 50% are treated for curative purposes and the balance for palliative care. The market opportunity for radiation sensitizers lies with the 400,000 patients treated for curative purposes. The number of patients being treated with RT is expected to grow by more than 22% over the next five years. Based on a rough estimate of a course of radiation sensitizing brand drug therapy (off label at this time) of $12,000 per patient—the market size would be in excess of $4.0 billion. This would represent about 4% of the annual cost of cancer care in the U.S.

In the past two decades, developments in the field of oncology have resulted in an increase in the number of clinical trials of marketed products that exhibit radiation sensitizing properties. The following are a few examples of recently approved products that exhibit radiation sensitizing properties: topotecan (Hycamtin®) was approved for ovarian and small-cell lung cancer and also in cervical cancer when used in combination with cisplatin. Irinotecan (Camptosar®) is used for metastatic colorectal carcinoma, trastuzumab (Hercepetin®) for breast cancer, and gefitinib (Iressa®) for locally advanced non-small-cell lung cancer. However, the claims on radiation sensitization are anecdotal in the scientific literature.

In addition, clinical trials are in progress to develop novel molecules (such as poly (ADP-ribose) polymerase (PARP), histone deacetylase (HDAC) inhibitors (such Zolinza® (vorinostat) and heat-shock protein 90 (hsp90) inhibitors with potential to increase the therapeutic use of compounds with radiation sensitizing properties for other cancers. Several drugs with radiation sensitizing properties are currently in Phase III clinical trials, such as nimorazole (for head and neck cancer), motexafin gadolinium (for brain metastases), and cisplatin (for cervical cancer); though none are likely to apply for a radiosensitizing claim with the FDA since the radiosensitizing element in their clinical trials are not primary endpoints. While additional drugs with radiation sensitizing properties are expected to be launched in the future, thereby driving the radiation sensitizers market further, to date, there is no indication that any drug in development is expected to be approved specifically as a radiation sensitizer.

The competitive environment for "off-label" radiation sensitizers for solid tumor cancers is anticipated to become predominantly generic. Avastin, Erbitux, Camptosar and Xeloda have or will lose patent protection in the next three years. Newer products under investigation or approved, such as Vectibix® (panitumumab) from Amgen will be promoted as having radiation sensitizing properties, along with indications for treatment for specific cancers. The high cost of these new therapies coupled with limited efficacy compared to current standard of care will be constrained by both public and private payors. Other new agents are in development but will face similar challenges.

We anticipate that new products launching into the cancer market with anecdotal claims for use as radiation sensitizers with improved effectiveness, quality and tolerability will initially be limited in their growth until they have been added to established clinical pathways and guidelines. If their effectiveness, quality and tolerability are demonstrated clinically, as determined by the FDA, it is anticipated the National Comprehensive Cancer Network (NCCN), the leading authority in oncology drug evaluation for treatment guidelines, would issue a recommendation and addition to standard of care within approximately six to twelve months after launch. An NCCN recommendation would positively impact the growth potential for a new product entering the market. Also, payors, both public and private, would add the new product to their approved drug lists and provide reimbursement giving providers incentive to use the product as neoadjuvant and adjuvant therapy to standard of care.

As with many cancer therapies, side effects can often have a distinct impact on quality of life and influence the potential for market growth. Patients increasingly have a stronger voice in the decision-making process for the appropriate therapies and costs to treat their cancers. As payors are increasingly placing more of the financial burden of the cost of therapy directly on patients, patients are voicing their opinions to their physicians and payors which have a direct effect on which products are selected. Many of the current therapies have significant side effects:

Private insurers are expected to have more restrictive formularies and medical benefits in which patients will be expected to carry more of the burden of the cost of drugs. Also, it is anticipated that increased application of third party developed treatment guidelines, such as those from the NCCN (National Comprehensive Cancer Network), are expected to be used by private payors to limit the access to products for specific conditions through prior authorizations and implementation of step therapy or increased out of pocket cost approaches. As many of the current drugs used as radiation sensitizers are expensive and not approved for use as radiation sensitizers (thus, such treatment is "off label"), and as many of the products in clinical trials are expected to be at the current or higher price levels, new products that may be specifically approved for an indication as the only approved product as a radiation sensitizer will have increased consideration for reimbursement.

CMS is increasingly moving many patients to private insurance through Medicare Advantage and ACOs. Medicare Advantage plans are capitation HMO and PPO plans offered through private insurers to Medicare patients. ACOs are being developed to increase quality of care for their patients. Most of the new ACOs are initially positioned for Medicare patients with over 400 approved by CMS. Several studies from the Center for Health Strategies, 2017, Journal of American Medical Association, 2018 and the Brookings Institute, 2015 estimated that almost 1000 ACOs for Medicare and non-Medicare patient populations would be approved by CMS or developed by a variety of healthcare entities to begin operating under the ACA in 2017. We expect the growth in ACOs to continue, regardless of any changes that may be made to the ACA going forward. In early 2017, Health Affairs, a magazine tracking ACOs, estimated that over 22 million patients are enrolled in Medicare and private ACOs. To address the quality of care measures designated by CMS and to gain additional incentives, use of clinical pathways or treatment guidelines is anticipated to be increasingly instituted to manage patient care. The impact on the uptake of new products in this environment can be profound if the new product is first in class and is included in national guidelines from organizations such as the NCCN and/or approval by the regional CMS contracting groups.

ROPIDOXURIDINE

The halogenated thymidine (TdR) analogs, bromodeoxyuridine (BUdR) and iododeoxyuridine (IUdR), are a class of pyrimidine analogs that have been recognized as potent radiosensitizing agents since the early 1960s. (*See* Kinsella TJ. An Approach to the Radiosensitization of Human Tumors. *Cancer J Sci Am.* Jul-Aug 1996:2(4); 184-193). Their cellular uptake and metabolism are dependent on the TdR salvage pathway where they are initially phosphorylated to the monophosphate derivative by the rate-limiting enzyme, thymidine kinase (TK). (*See* Shewach DS, Lawrence TS. Antimetabolite radiosensitizers. *J Clin Oncol*, Sep 10 2007; 25(26):4043-4050). After sequential phosphorylation to triphosphates, they are then used in DNA replication, in competition with deoxythymidine triphosphate (dTTP), by DNA polymerase. DNA incorporation is a prerequisite for radiosensitization of human tumors by the halogenated TdR analogs, and the extent of radiosensitization correlates directly with the percentage TdR replacement in DNA. (*See* Lawrence TS, Davis MA, Maybaum J, Stetson PL, Ensminger WD. The Dependence of Halogenated Pyrimidine Incorporation and Radiosensitization on the Duration of Drug Exposure. *International Journal of radiation oncology, biology, physics.* Jun 1990; 18(6);1393-1398). The molecular mechanisms of radiosensitization are most likely the result of increased susceptibility of TdR analog-substituted DNA to the generation of highly reactive uracil free radicals by ionizing radiation (IR), which may also damage unsubstituted complementary-strand DNA. Repair of IR damage may also be reduced by pre-IR exposure to these analogs.

The rationale for using Ropidoxuridine as a radiation sensitizer is based on prior clinical studies with the active metabolite IUdR; identified in NIH laboratories as a potent radiation sensitizer. Ropidoxuridine is an orally available prodrug of IUdR. In the body, Ropidoxuridine is metabolized in the liver into IUdR. IUdR is incorporated into the DNA of actively growing cells and when cells are exposed to ionizing radiation, DNA strand breaks are generated, resulting in more cell death and radiation sensitization. (*See* Gurkan E, Schupp JE, Aziz MA, Kinsella TJ, Loparo KA. Probabilistic modeling of DNA mismatch repair effects on cell cycle dynamics and iododeoxyuridine-DNA incorporation. Cancer Res. Nov 15 2007; 67(22):10993-11000).

Most of the clinical efficacy data were obtained from NIH supported studies performed with IUdR, the active metabolite of Ropidoxuridine. However, IUdR requires constant infusion over six weeks of therapy which creates a significant compliance issue for patients. Ropidoxuridine can be given as a capsule for oral administration, resulting in greater ease of medication delivery and potentially improved compliance and fewer complications.

Over the last 20 years, there has been renewed interest in these halogenated TdR analogs as experimental radiation sensitizers in selected cancer patient groups. These analogs are rapidly metabolized in both rodents and humans, principally with cleavage of deoxyribose and subsequent dehalogenation by hepatic and extrahepatic metabolism, when given as a bolus infusion with a plasma half-life of <5 min. Consequently, prolonged continuous or repeated intermittent drug infusions over several weeks before and during irradiation are necessary, based on in vivo human tumor kinetics, to maximize the proportion of tumor cells that incorporate these analogs into DNA during the S phase of the cell cycle. (*See* Fowler JF, Kinsella TJ. The Limiting Radiosensitization of Tumors by S-phase Sensitizers. *Br J Cancer*. 1996;74 (Suppl)(27):294-296). Phase I and Phase II trials using prolonged continuous or repeated intermittent intravenous infusions of BUdR or IUdR before and during radiation therapy (RT) have focused principally on patients with high-grade brain tumors. These clinically radiation resistant tumors can have a rapid proliferation rate (potential tumor doubling times of 5–15 days) and are surrounded by non-proliferating normal brain tissues that show little to no DNA incorporation of the TdR analogs. As such, high-grade brain tumors are ideal targets for this approach to radiation sensitization. In Phase I/Phase II clinical trials, prolonged survival outcomes were observed compared to RT alone in patients with anaplastic astrocytomas and in patients with glioblastoma multiforme IUdR continuous IV infusion (1000 mg/m^2/ day/ 14 days), Total 39 patients (F. Sullivan, et al. Int J Radiat Oncol Biol Phys. 1994; 30(3):583-90.) A therapeutic gain in clinical radiation sensitization using these halogenated TdR analogs was proposed for other types of clinically poorly radiation responsive (radiation resistant) cancers, including locally advanced cervical cancer, head and neck cancers, unresectable hepatic metastases from colorectal cancers, and locally advanced sarcomas, based on the results of other Phase I/Phase II clinical trials.

Target Indication: Glioblastoma, Sarcomas and Rectal Cancers

After completion of the Phase I clinical trial of Ropidoxuridine and RT in advanced GI cancers, we proposed to perform Phase II efficacy clinical trials in brain tumors (glioblastoma), soft tissue sarcomas, and rectal cancers. Glioblastoma multiforme is a deadly malignancy of the brain with no known cure. Radiation therapy provides delay of disease progression and is standard of care following surgical resection or biopsy. Radiation therapy is combined with Temodar, a drug that has shown activity (~ four months survival benefit) in treating brain tumors. Preliminary data using radiation therapy in combination with IUdR resulted in a delay of disease progression of up to six months. We propose to test IPdR in combination with radiation therapy in the Phase II clinical trial. Similarly, delay in disease progression has been observed following treatment of sarcomas by the combination of IUdR and RT. Based on the Phase I data of our clinical trial we know that therapeutic levels of IUdR are reached by administering the orally available prodrug, IPdR.

Clinical Data

The Phase I results of the clinical trial supported by an SBIR contract to Shuttle Pharma and a sub-contract to the Brown University Oncology Group (BrUOG) at the LifeSpan/Rhode Island Hospital were reported by the subcontractor at the 30th EORTC-NCI-AACR Symposium in November 2018 and in the medical journal, Clinical Cancer Research, in 2019. Eighteen patients completed dose escalation to 1800 mg/day for 30 days, establishing the maximum tolerated dose (MTD) of 1,200 mg/day in combination with RT. Therapeutic blood levels of IUdR were achieved. Four patients were scored as partial responses, nine patients had stable disease and one patient progressed in the target lesions. These data support advancing IPdR and RT to clinical trials for the FDA to determine efficacy.

Development Plan

A key to driving the Ropidoxuridine product forward, the new formulation of IPdR/TPI, is the development of a clinical plan with aggressive timelines and support within the radiation oncology community to participate in clinical trials with the appropriate patients to ensure a comprehensive NDA dossier for each product. Initially, the plan is focused on the Phase I and Phase II clinical trials. Upon completion of these studies, we will determine whether to extend the Phase II study to a randomized Phase II, or to perform a randomized Phase III clinical trial. Such determination will be based, in part, on results of the initial clinical trials and the end of a Phase II meeting with the FDA. Shuttle Pharmaceuticals requested and received FDA orphan drug status for Ropidoxuridine as a clinical radiation sensitizer for treatment of glioblastoma and pre-operative treatment of soft tissue sarcomas. As a result, the application for "orphan" designation for Ropidoxuridine with RT for glioblastoma has been approved. The application for sarcomas, however, was not approved and will require addressing certain FDA comments and resubmission. The IPdR/TPI formulation clinical plan will focus on resectable stage II and III rectal cancer patients.

Our clinical plan for Ropidoxuridine development includes:

- GMP manufacture and formulation of 24 kg of Ropidoxuridine for use in clinical trials.
- Completion of pre-clinical Ropidoxuridine and Temodar drug-drug interaction safety study.
- Submission of an IND for a Phase II clinical trial of Ropidoxuridine, Temodar and RT in glioblastoma.
- Negotiations for contract research organizations (CRO) contracts to perform the Phase II clinical trial.
- Completion of the Phase II clinical trial in glioblastomas to determine appropriate dosing, quality, effectiveness and tolerability.

We believe the data obtained from the NIH/NCI SBIR funded Phase I clinical trial supports efforts to raise additional capital to enable performing the Phase II clinical trials of Ropidoxuridine. We aim to conduct and complete the Phase II clinical trial so that we may present data to the FDA for its determination of efficacy. We believe this will support our efforts to raise the additional required capital to fund Phase III clinical trials and seek FDA approval of an NDA with "orphan" designation.

The clinical plan for the IPdR/TPI formulation will focus on resectable Stage II and Stage III rectal cancer patients. Nonetheless, we cannot guarantee the successful completion of any of these trials. Our inability to meet any of the aforementioned milestones in the Phase II or Phase III clinical trials will cause us to be unable to proceed with our present efforts and will likely cause us to be unable to raise additional funds.

Our HDAC Small Molecule Delivery Platform

General

Since the founding of Shuttle Pharma, our discovery research and development efforts have been focused on our small molecule technology delivery platform which uses HDAC inhibitors, designed to target cancer cells, while protecting healthy tissue.

HDACs are a class of enzymes that regulate gene expression through chemical modification of histones and non-histone proteins. Increased HDAC activity leads to a more condensed chromatin (which is a protein complex consisting of DNA and other proteins), decreased gene expression and loss of key gene products, including tumor suppressor gene function. Inhibition of HDAC activity leads to a more open chromatin and increased expression of the key gene products. This chromatin modification underlies the epigenetic cellular regulatory system and is an area of intense investigation.

Our research and development efforts to date have focused on the discovery of novel, dual functional molecules for potential use in cancer treatment as radiation sensitizers of cancers, protectors of normal tissues, and activators of the immune responses to antigens expressed by irradiated cancer cells. To date, we have produced three candidate molecules:

- SP-1-161, a candidate lead of compounds demonstrating activation of the "ATM" gene product (mutated in Ataxia-Telangiectasia). Ataxia-Telangiectasia is a human genetic disease characterized by neurological, immunological and radiobiological clinical features.

- SP-2-225, a candidate lead of compounds demonstrating Class II (HDAC6) selective inhibition. HDAC6 is a molecule integral to the presentation of antigens by macrophages to T-lymphocytes.

- SP-1-303 is a candidate Class I HDAC inhibitor with preferential efficacy against ER positive cancers.

SP-1-161 - A Dual Functional Agent

SP-1-161 is an HDAC inhibitor of the hydroxamate chemical class of compounds and an ATM activator of the indole chemical class. HDACs modify histones and non-histone proteins, which are key components of the chromatin structure, gene expression regulation, and cell growth. HDAC inhibitors inhibit cell proliferation, angiogenesis and immunity. Eighteen human HDACs have been identified, subdivided into four classes based on sequence and functional homology. In cancer cells, HDAC activity silences tumor suppressor genes important for cell growth regulation and to chromosomal instability. Abnormal HDAC activity is also associated with tumor cell growth, invasion, metastasis and resistance to therapy. Therefore, inhibitors of HDACs have emerged as anti-cancer agents for cancer therapy. Vorinostat and romidepsin have been approved by the FDA for treatment of patients with relapsed or refractory T-cell lymphomas. In addition, panobinostat received FDA approval for treatment of recurrent multiple myeloma in combination with bortezomib and dexamethasone.

In preclinical studies, SP-1-161 inhibited the activity of pan-HDACs and activated the ATM gene product. ATM is a critical protein for the activation of the cell stress response for cellular recovery from radiation exposure in normal cells, but not in cancer cells. ATM activates the P53 protein, referred to as the "guardian of the genome," and serves as a tumor suppressor critical for normal cell function and activation of programmed cell death in cancer cells.

In preclinical studies, SP-1-161 protected normal breast epithelial cells (184A1) following exposure to ionizing radiation while increasing sensitivity of breast cancer cells (MCF7). SP-1-161 provides this dual function in a single molecule and this molecule is differentiated from other HDAC inhibitors by treatment of cancers while protecting normal cells.

SP-2-225

SP-2-225 is a selective HDAC inhibitor that affects histone deacetylase (HDAC6) and is a member of the class IIb HDAC family. Class II HDACs play important roles in cancer motility, invasion, neurological diseases, and immune checkpoint. HDAC6 inhibition has been most extensively studied for its role in the treatment of hematological cancers. HDAC6 is unique among HDAC enzymes in having two active catalytic domains and a unique physiological function. In addition to the modification of histones, HDAC6 targets specific substrates including α-tubulin and HSP90, and are involved in protein trafficking and degradation, cell shape and migration. Selective HDAC6 inhibitors are an emerging class of pharmaceuticals due to the involvement of HDAC6 in pathways related to neurodegenerative diseases, cancer and immunology. Specifically, its potential to affect regulation of the immune system and enhance the immune response in cancer is of great interest. With the introduction of check-point inhibitors, CAR-T therapies and personalized medicine in cancer, regulation of the immune response to this therapy is of significant clinical and commercial interest. (*See* Grindrod S, Brown M, Jung M. "Development of dual Function Small Molecules as Therapeutic Agents for Cancer Research," Poster presentation #A178, American Association of Cancer Research Oct 2017).

Selective inhibition of HCAC6 reduces dose limiting side effects associated with non-selective HDAC inhibitors. Selective HDAC6 inhibitors may be combined with other cytotoxic agents. Shuttle's discovery of selective HDAC inhibitors has yielded several HDAC6 selective candidate molecules including SP-2-225. HDAC6 inhibitors are under investigation for roles in the treatment of diseases such as multiple myeloma.

SP-1-303 - Target Indication: Breast Cancer

Histone deacetylase inhibitors sensitize cancers to the effects of radiation, protect normal tissues from radiation injury and activate the immune system. SP-1-303 is a selective Class I HDAC inhibitor that inhibits HDAC1, 3 and 6 and has direct cellular toxicity in ER positive breast cancer cells. Furthermore, SP-1-303 increases the PD-L1 expression level in a time-dependent manner, support combination of SP-1-303 with an immune checkpoint blocker to enhance the therapeutic benefits. We are currently conducting preclinical efficacy studies of these molecules.

Development Plan

The HDAC inhibitor platform of candidate molecules will require pre-clinical evaluation, completion of IND-enabling studies and the lead drug candidates will be tested in Phase I clinical trials for pharmacokinetics and MTD determination. We have three lead candidates for potential development for the treatment of solid tumors, including breast cancer, lung cancer and multiple myeloma.

The results of Phase I and Phase II clinical trials will determine further drug development and Shuttle will seek to establish collaborative partnerships with other pharmaceutical companies to complete pre-clinical and clinical development, drug manufacturing and marketing of our product candidates. In the event we are unsuccessful in completing our clinical trials at any stage, or in the event we obtain negative results, we will likely be unable to raise additional funding related to our HDAC studies or will have to change direction of our research efforts regarding the HDAC inhibitor platform of candidate molecules.

Our Manufacturing Strategy

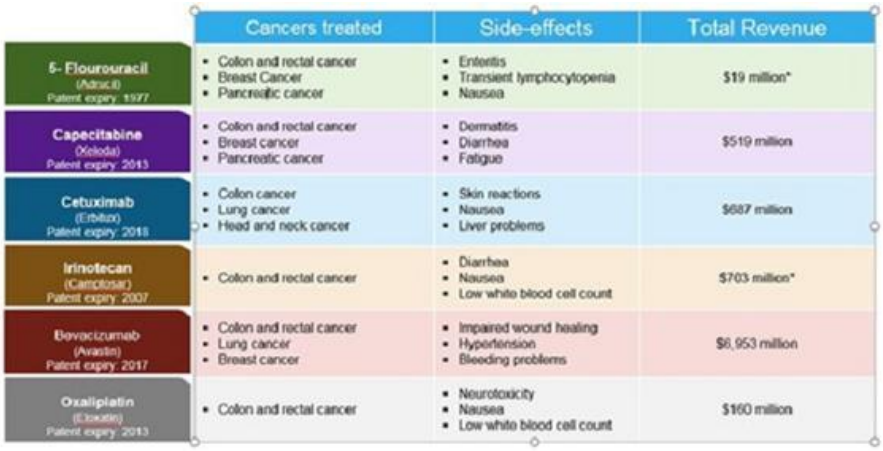
We have no manufacturing facilities that are company owned or operated. We have performed laboratory scale synthesis and testing in our research laboratories in Gaithersburg, Maryland. GMP synthesis of API, drug formulation and human dosage preparation will be performed under contracts with third-party manufacturers.

Strategic Agreements

We have developed important strategic agreements with academic institutions for access to resources such as intellectual property, core facilities and contracting relationships. In addition, we have established an agreement with Propagenix for intellectual property in-licensing. Our current and ongoing relationships include:

- Georgetown University
    - Sub-contractor for the SBIR supported African-American prostate cancer patient health disparities project (completed). The conditional reprogramming of cells (CRC) technology was invented at Georgetown University and Georgetown University owns the intellectual property. Propagenix holds the license for the intellectual property for the CRC technology from Georgetown University. The intellectual property for cells derived from African-American patients under the Georgetown University subcontract belong to Shuttle Pharmaceuticals, Inc. based on our sub-licensing agreement with Propagenix.
    - Sub-contractor for the SBIR supported metabolomic predictive biomarker project (completed). The metabolomic biomarker intellectual property belongs to Georgetown University and Shuttle Pharma holds an exclusive option to license the intellectual property.
- Brown University
    - Sub-contractor of the SBIR supported Phase I clinical trial of IPdR and RT (completed).
- University of Virginia
    - Research collaboration to develop heavy oxygen molecules for proton radiation sensitizer applications.
- George Washington University
    - Material transfer agreement for testing HDAC inhibitor effects in immune model systems
    - The material transfer agreement that protects our HDAC inhibitor intellectual property is with George Washington University, transferring drugs for research purposes and sharing authorship on publications. There is no transfer of funds related to such activities.
- Propagenix, Inc.
    - License agreement for “conditional re-programmed cell” (CRC) technology. The cells established by Shuttle Pharma scientists at Georgetown University belong to us, based on the sublicense from Propagenix, Inc. An up-front licensing fee of $25,000 was paid to Propagenix. No other future milestone or royalty payments owed related to the Propagenix agreement.

Competition "Off-Label" Use



	Cancers treated	Side-effects	Total Revenue
5- Flourouracil (Adrucil) Patent expiry: 1977	• Colon and rectal cancer • Breast Cancer • Pancreatic cancer	• Enteritis • Transient lymphocytopenia • Nausea	$19 million*
Capecitabine (Xeloda) Patent expiry: 2013	• Colon and rectal cancer • Breast cancer • Pancreatic cancer	• Dermatitis • Diarrhea • Fatigue	$519 million
Cetuximab (Erbitux) Patent expiry: 2016	• Colon cancer • Lung cancer • Head and neck cancer	• Skin reactions • Nausea • Liver problems	$687 million
Irinotecan (Camptosar) Patent expiry: 2007	• Colon and rectal cancer	• Diarrhea • Nausea • Low white blood cell count	$703 million*
Bevacizumab (Avastin) Patent expiry: 2017	• Colon and rectal cancer • Lung cancer • Breast cancer	• Impaired wound healing • Hypertension • Bleeding problems	$6,953 million
Oxaliplatin (Eloxatin) Patent expiry: 2013	• Colon and rectal cancer	• Neurotoxicity • Nausea • Low white blood cell count	$160 million

Drugs with radiation sensitizing properties.

Our Product Candidates

We are advancing a clinical stage product candidate, Ropidoxuridine, that we believe will target cancer cells while protecting healthy tissue when used in conjunction with RT.

Ropidoxuridine

Ropidoxuridine, an orally available halogenated pyrimidine with strong cancer radiation sensitizing properties, is our lead "clinical phase" product candidate. Halogenated pyrimidines are incorporated into DNA by rapidly growing cancer cells and become more sensitive to the effects of RT. We have received an SBIR contract from the NIH to fund a Phase I clinical trial in collaboration with Brown University at the Lifespan/Rhode Island Hospital to determine the maximum tolerated dose in patients with advanced gastrointestinal cancers. In connection with the trial, NCI has approved the Phase I clinical protocol and provided drug and clinical data management support to Rhode Island Hospital. The Phase I clinical trial has been completed and the results support advancing Ropidoxuridine to Phase II clinical trials of brain tumors, sarcomas and other tumors through CROs.

The following tables provide data from reported clinical trials of Iododeoxyuridine and RT therapy in brain cancers (glioblastoma multiforme) and high-grade sarcomas. Our primary strategy for Ropidoxuridine and RT therapy is to provide oral drug delivery to effect radiation sensitization of cancers and validate effectiveness in glioblastoma and sarcoma, potential "Orphan" indications.

Brain Cancer Treatment
Efficacy compared to historical RT-alone controls for treatment of high-grade primary brain tumors (RTOG*, NCI trials)**

Tumor	Treatment	Median survival (Months)
Anaplastic astrocytomas (Grade 3 of 4)* (21 patients)	RT alone	24
	RT + IUdR	39
Glioblastoma Multiforme (Grade 4 of 4)** (18 patients)	RT alone	9
	RT + IUdR	15

** IUdR continuous IV infusion (1000 mg/m2/ day/ 14 days), Total of 39 patients (F. Sullivan, et al. Int J Radiat Oncol Biol Phys. 1994; 30(3):583-90)

* IUdR continuous IV infusion (2000 mg/m2/ 4 day infusion/ 6 week treatment), Total of 21 patients (R. Urtasun, et al. Int J Radiat Oncol Biol Phys. 1996;36(5):1163-7.)

Sarcoma Treatment
Efficacy compared to historical RT-alone controls for treatment of high-grade sarcomas (University of Michigan* trials)**

Tumor	Treatment	Local control at 2 years
High grade sarcomas (resectable)***	RT + Surgery	25%
	RT + IUdR + Surgery	45%
High grade sarcomas (unresectable)**	RT alone	<10%
	RT + IUdR	60%

*** 16 patients were treated with continuous infusion (1000-1600 mg/m2/day) plus RT (J.M. Robertson, et al. Int J Radiat Oncol Biol Phys. 1995; 31(1):87-92).

In addition to our primary product candidate, we are developing and planning to develop other cancer radiation sensitizers and radiation protectors, which target protecting normal tissue during the administration of RT, and other products utilizing our HDAC small molecule technology platform.

SBIR Contracts

The SBIR Program

The Small Business Innovation Research program, as developed by Congress under the Small Business Innovation Development Act of 1982, is designed to encourage domestic small businesses to engage in Federal Research/Research and Development ("R/R&D") that has the potential for commercialization. Through a competitive awards-based program, SBIR enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization. Some of the SBIR's program goals include stimulating technological innovation, meeting Federal research and development needs and encouraging participation in innovation and entrepreneurship.

The SBIR program is a three-phase program. Phase 1 is to establish the technical merit and commercial potential of the proposed R/R&D efforts. Phase 2 is to continue the R/R&D efforts initiated in Phase 1 and funding is based on the results achieved in Phase 1. Phase 3 allows for the small business to pursue commercialization objectives resulting from the Phase 1 and 2 R/R&D activities. In addition, companies that have successfully completed Phases I and II are also eligible to apply for Phase IIb funding.

In addition to the SBIR contract to fund our Phase I clinical study on Ropidoxuridine in combination with RT for treatment of advanced gastrointestinal cancers, we have also received awards of SBIR contracts from the NIH to address prostate cancer health disparities and prostate cancer radiation biomarker development.

As of the date of this Annual Report, all SBIR contracts received by the Company have been completed. The Company submitted a final report for SBIR contract # 75N81018C00031 on March 28, 2022. The following summary of terms for the three Phase II SBIR contracts is provided below.

Summary of SBIR Contracts

- SBIR contract #261201400013C: Phase I ($191,971) and Phase II ($1,428,117) for Clinical Development of IPdR for Radiosensitization, dates September 19, 2014 through August 3, 2017, Subcontract to Brown University/LifeSpan Rhode Island Hospital. No related intellectual property.
- SBIR contracts # HHSN261201600038C; Phase I ($224,687) and #261201800016C: Cell-Based Models for Prostate Cancer Health Disparity Research - Moonshot Project (Phase II), award amount $1,484,350, dates September 19, 2016 through September 16, 2021, Subcontract to Georgetown University, Intellectual property consists of cell cultures and is property of Shuttle Pharmaceuticals, Inc. via licensing agreement.

- SBIR contracts #HHSN261201600027C ($299,502) and #75N81018C00031: Predictive Biomarkers of Prostate Cancer Patient Sensitivity for Radiation Late Effects, award amount $1,903,015, dates September 16, 2019 through March 15, 2022. Subcontract to Georgetown University, Intellectual property is owned by subcontractor Georgetown University with option to license to Shuttle Pharmaceuticals, Inc.

Prostate Cancer Studies to Address Health Disparities

Prostate cancer health disparities studies have shown that African-American men are at higher risk for developing prostate cancer, as well as at higher risk of cancer specific death rates as compared to Caucasian American men. The causes of disparities have been attributed to socioeconomic differences, environmental exposures and biological factors. Most disparities studies have been population based, in part, due to the lack of relevant in vitro and in vivo models to support biological studies.

Shuttle Pharma has been awarded Phase I and II SBIR contracts entitled "Cell-based models for prostate cancer health disparity research" to develop African-American prostate cancer cell lines with donor matched normal prostate epithelial cell lines from African American men.

The commercialization of the prostate cells will require additional support through the SBIR funding mechanism. Companies that have completed Phase I and II SBIR awards are eligible to apply for Phase IIb SBIR funding. These awards are intended to de-risk a project by providing up to $4 million of matching funding for product development to commercialization. We intend to apply for such government funding to advance laboratory facilities and to expand the availability of the cell cultures. We did not raising capital through our IPO for the health disparities project. Should we not be successful for SBIR IIb funding, we will pause and may have to terminate this project.

Prostate Cancer Biomarker Development

Patients treated for prostate cancer may experience treatment related late effects that adversely affect quality of life and may prove life-threatening. Shuttle Pharma has been awarded a Phase I SBIR contract entitled "Predictive biomarkers for prostate cancer patient sensitivity for radiation late effects" to determine the technical and commercial feasibility of a biomarker panel predictive of radiation mediated late effects in patients treated for prostate cancer.

Through collaboration with Georgetown University, patients treated with SBRT for prostate cancers will be analyzed for urinary and rectal symptoms and their blood will be analyzed by mass spectroscopy for predictive biomarkers. The discovery and validation of metabolite panels to serve as a predictive biomarker of patient outcomes following radiation therapy will support future development and commercialization of a diagnostic product through a Phase 2 SBIR effort.

The development to commercialization of the metabolite predictive biomarker panel will require additional support through the SBIR funding mechanism. We will be eligible to apply for Phase IIb SBIR funding the next round of solicitation. A Phase IIb will help de-risk the project by providing up to $4 million of matching funds for performing the clinical validation trial for product development to commercialization. We intend to apply for such government funding to advance this project. We do not intend to use the funds raised through our IPO for the health disparities project. Should we not be successful for SBIR IIb funding, we will terminate this project.

Collaborative Arrangements

While we intend to enter into collaborative arrangements to further develop our drug candidates in the future, at present we have not entered into any collaborative arrangements with third parties to develop our drug candidates as we are still completing clinical trials and, as a result, there can be no assurance that we will be able to do so on commercially reasonable terms or otherwise.

Intellectual Property

We invest significant amounts in research and development. Our research and development expenses before contract reimbursements were $1,699,985 and $1,527,185 for the fiscal years ended December 31, 2022 and 2021 respectively. After reimbursements for contracts of $211,455 and $505,377 for the fiscal years ended December 31, 2022 and 2021, net research and development expenses were $1,488,530 and $1,021,808, respectively.

We are seeking multifaceted protection for our intellectual property that includes licenses, confidentiality and non-disclosure agreements, copyrights, patents, trademarks and common law rights, such as trade secrets. We enter into confidentiality and proprietary rights agreements with our employees, consultants, collaborators, subcontractors and other third parties and generally control access to our documentation and proprietary information.

As of the date of this Annual Report, we have filed five patent applications with the USPTO with respect to various aspects of our HDAC small molecule delivery platform and Ropidoxuridine, our lead product candidate. The following is the status of the patent applications Shuttle has filed to date:

Summary of Shuttle Pharma's Intellectual Property Portfolio

USPTO number	Title	Date Filed	Date Granted	Anticipated Expiration Date**
U.S. Application No.: 16/475,999	Methods and compositions for cancer therapies that include delivery of halogenated thymidines and thymidine phosphorylase inhibitors in combination with radiation	7/3/2019		
U.S. Application No.: 17/484,876	Dual function molecules for histone deacetylase inhibition and ataxia telangiectasia mutated activation and methods of use thereof	9/24/2021		
U.S. Application No.: 17/315,567	Selective histone deacetylase inhibitors for the treatment of human disease	5/10/2021		
U.S. Patent No: 11,407,723 16/959,570	Selective histone deacetylase inhibitors for the treatment of human disease	7/01/2020	8/9/2022	
U.S. Patent No.: 9,809,539	Dual function molecules for histone deacetylase inhibition and ataxia telangiectasia mutated activation and methods of use thereof	3/3/2015	11/7/2017	3/3/2035
U.S. Patent No.: 11,034,667	Selective histone deacetylase inhibitors for the treatment of human disease	7/3/2019	6/15/2021	1/9/2038
U.S. Patent No.: 10,730,834	Selective histone deacetylase inhibitors for the treatment of human disease	8/4 /2020	8/4/2020	3/3/2035
U.S. Patent No.: 10,745,352	Selective histone deacetylase inhibitors for the treatment of human disease	8/18/2020	8/18/2020	3/3/2035
U.S. Patent Application No. 17/851,8551	Selective histone deacetylase inhibitors for the treatment of human disease	6/28/2022		

Morgan, Lewis & Bockius LLP prepared patent applications related to Ropidoxuridine (IpdR) and HDAC inhibitors, and, in the fourth quarter of 2018, found no freedom to operate (FTO) issue for Ropidoxuridine used as radiosensitizer and used with tipiracil, and HDAC inhibitors SP-1-161 and SP-2-225.

Our strategy around protection of our proprietary technology, including any innovations and improvements, is to obtain worldwide patent coverage with a focus on jurisdictions that represent significant global pharmaceutical markets. Generally, patents have a term of twenty years from the earliest priority date, assuming that all maintenance fees are paid, no portion of the patent has been terminally disclaimed and the patent has not been invalidated. In certain jurisdictions, and in certain circumstances, patent terms can be extended or shortened. We are obtaining worldwide patent protection for at least novel molecules, composition of matter, pharmaceutical formulations, methods of use, including treatment of disease, methods of manufacture and other novel uses for the inventive molecules originating from our research and development efforts. We continuously assess whether it is strategically more favorable to maintain confidentiality for the "know-how" regarding a novel invention rather than pursue patent protection. For each patent application that is filed we strategically tailor our claims in accordance with the existing patent landscape around a particular technology.

There can be no assurance that an issued patent will remain valid and enforceable in a court of law through the entire patent term. Should the validity of a patent be challenged, the legal process associated with defending the patent can be costly and time consuming. Issued patents can be subject to oppositions, interferences and other third-party challenges that can result in the revocation of the patent limit patent claims such that patent coverage lacks sufficient breadth to protect subject matter that is commercially relevant. Competitors may be able to circumvent our patents. Development and commercialization of pharmaceutical products can be subject to substantial delays and it is possible that at the time of commercialization any patent covering the product has expired or will be in force for only a short period of time following commercialization. We cannot predict with any certainty if any third-party U.S. or foreign patent rights or other proprietary rights will be deemed infringed by the use of our technology. Nor can we predict with certainty which, if any, of these rights will or may be asserted against us by third parties. Should we need to defend ourselves and our partners against any such claims, substantial costs may be incurred. Furthermore, parties making such claims may be able to obtain injunctive or other equitable relief, which could effectively block our ability to develop or commercialize some or all of our products in the U.S. and abroad, and could result in the award of substantial damages. In the event of a claim of infringement, we or our partners may be required to obtain one or more licenses from a third party. There can be no assurance that we can obtain a license on a reasonable basis should we deem it necessary to obtain rights to an alternative technology that meets our needs. The failure to obtain a license may have a material adverse effect on our business, results of operations and financial condition.

We also rely on trade secret protection for our confidential and proprietary information. No assurance can be given that we can meaningfully protect our trade secrets on a continuing basis. Others may independently develop substantially equivalent confidential and proprietary information or otherwise gain access to our trade secrets.

It is our policy to require our employees and consultants, outside scientific collaborators, sponsored researchers and other advisors who receive confidential information from us to execute confidentiality agreements upon the commencement of employment or consulting relationships. These agreements provide that all confidential information developed or made known to these individuals during the course of the individual's relationship with the company is to be kept confidential and is not to be disclosed to third parties except in specific circumstances. The agreements provide that all inventions conceived by an employee will be the property of our company. There can be no assurance, however, that these agreements will provide meaningful protection or adequate remedies for our trade secrets in the event of unauthorized use or disclosure of such information.

Our success will depend in part on our ability to obtain and maintain patent protection, preserve trade secrets, prevent third parties from infringing upon our proprietary rights and operate without infringing upon the proprietary rights of others, both in the U.S. and other territories worldwide.

Manufacturing and Supply

We do not currently own or operate manufacturing facilities for the production of preclinical, clinical or commercial quantities of any of our product candidates. We currently use a number of our suppliers for the raw materials and formulation to meet the preclinical and any clinical requirements of our product candidates. We do not have a long-term agreement with any of these parties and we believe alternative sources of supply exist.

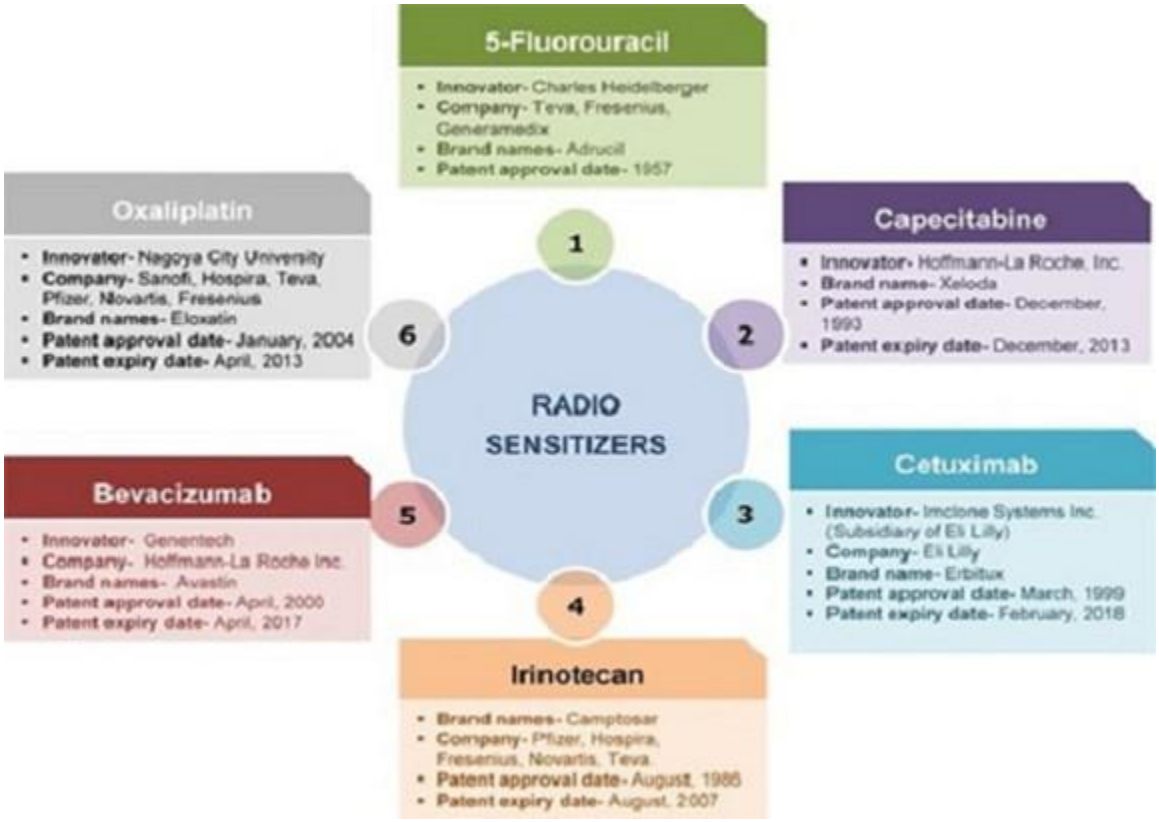
We intend to enter into collaborations for the manufacture of our product candidates, with our collaborators assuming responsibility for such manufacturing. Manufacturing is subject to extensive regulations that impose various procedural and documentation requirements, which govern record keeping, manufacturing processes and controls, personnel, quality control and quality assurance, among others. Any collaborator or third-party contract manufacturer we use would need to be compliant with cGMP. cGMP is a regulatory standard for the production of pharmaceuticals that will be used in humans.

Competition

The development and commercialization of drugs is highly competitive. We compete with a variety of multinational pharmaceutical companies and specialized biotechnology companies, as well as technology being developed at universities and other research institutions. Our competitors have developed, are developing or will develop product candidates and processes competitive with our product candidates. Competitive therapeutic treatments include those that have already been approved and accepted by the medical community and any new treatments that enter the market. We believe that a significant number of products are currently under development, and may become commercially available in the future, for the treatment of conditions for which we may try to develop product candidates.

Many of our competitors have significantly greater financial, technical, manufacturing, marketing, sales and supply resources or experience than we have. If we are able to obtain approval for any product candidate, we will face competition based on many different factors, including the quality and effectiveness of our products, the ease with which our products can be administered and the extent to which patients accept relatively new routes of administration, the timing and scope of regulatory approvals for these products, the availability and cost of manufacturing, marketing and sales capabilities, price, reimbursement coverage and patent position. Competing products could present superior treatment alternatives, including by being more effective, safer, and less expensive or marketed and sold more effectively than any products we may develop. Competitive products may make any products we develop obsolete or noncompetitive before we recover the expense of developing and commercializing our product candidates. Such competitors could also recruit our employees, which could negatively impact our level of expertise and our ability to execute our business plan.

The following figure provides summary information about cytotoxic drugs that may be used with radiation therapy for their sensitizing properties that currently comprise the competition for Shuttle's agents.



Fluorouracil (5-FU) is an anti-metabolite used to treat cancer, by injection, for colon cancer, esophageal cancer, stomach cancer, pancreatic cancer, breast cancer, and cervical cancer. Fluorouracil was patented in 1956 and is an effective and safe drug with radiation sensitizing properties. Capecitabine, an orally available formulation of 5-FU and was patented in 1992. It is used for the treatment of gastric, esophageal and other cancers for sensitization to radiation therapy.

Cetuximab is an epidermal growth factor receptor (EGFR) inhibitor used for the treatment of metastatic colorectal, lung cancer and head and neck cancers. This monoclonal antibody is administered by intravenous infusion and improves the 5-year survival of patients when used in combination with radiation therapy, compared with radiotherapy alone.

Platinum based compounds (cis-platin, carbo-platin and oxaloplatin) also exhibit radiation sensitizing properties. Platinum and radiation are used together for the treatment of locally advanced cervical cancer and for head and neck cancers. Cisplatin is believed to augment the effects of radiation by inhibiting the repair of radiation-induced sub-lethal damage.

Bevacizumab works as an anti-angiogenic agent. It was approved for medical use in the United States in 2004. The addition of bevacizumab to standard treatment can prolong the lives of breast and lung cancer patients by several months and may be used with radiation therapy.

Irinotecan is given by injection and is used to treat colon cancer and small cell lung cancer and can be combined with radiation therapy. For colon cancer it is used either alone or with fluorouracil.

Government Regulation and Product Approval

Governmental authorities in the U.S., at the federal, state and local level, and other countries extensively regulate, among other things, the research, development, testing, manufacture, labeling, packaging, promotion, storage, advertising, distribution, marketing and export and import of products such as those we are developing. Our product candidates must be approved by the FDA through the NDA process before they may be legally marketed in the U.S. and will be subject to similar requirements in other countries prior to marketing in those countries. The process of obtaining regulatory approvals and the subsequent compliance with applicable federal, state, local and foreign statutes and regulations require the expenditure of substantial time and financial resources.

U.S. government regulation

NDA approval processes

In the U.S., the FDA regulates drugs under the Federal Food, Drug, and Cosmetic Act (the "FDCA") and implementing regulations. Failure to comply with the applicable U.S. requirements at any time during the product development or approval process, or after approval, may subject an applicant to administrative or judicial sanctions, any of which could have a material adverse effect on us. These sanctions could include:

- refusal to approve pending applications;
- withdrawal of an approval;
- imposition of a clinical hold;
- warning letters;
- product seizures;
- total or partial suspension of production or distribution; or
- injunctions, fines, disgorgement, or civil or criminal penalties.

The process required by the FDA before a drug may be marketed in the U.S. generally involves the following:

- completion of nonclinical laboratory tests, animal studies and formulation studies conducted according to GLPs or other applicable regulations;
- submission to the FDA of an IND, which must become effective before human clinical trials may begin;
- performance of adequate and well-controlled human clinical trials according to GCPs to produce data that the FDA may review to determine safety and efficacy of the product candidate for its intended use;
- submission to the FDA of an NDA;
- satisfactory completion of an FDA inspection of the manufacturing facility or facilities at which the product candidate is produced to assess compliance with cGMPs to assure that the facilities, methods and controls are adequate to preserve the product candidate's identity, strength, quality and purity; and
- FDA review and approval of the NDA.

Once a pharmaceutical candidate is identified for development, it enters the preclinical or nonclinical testing stage. Nonclinical tests include laboratory evaluations of product chemistry, toxicity and formulation, as well as animal studies. An IND sponsor must submit the results of the nonclinical tests, together with manufacturing information and analytical data, to the FDA as part of the IND. Some nonclinical testing may continue even after the IND is submitted. In addition to including the results of the nonclinical studies, the IND will also include a protocol detailing, among other things, the objectives of the clinical trial, the parameters to be used in monitoring quality and the effectiveness criteria to be evaluated if the first phase lends itself to an efficacy determination. The IND automatically becomes effective thirty (30) days after receipt by the FDA, unless the FDA, within the thirty (30) day time period, places the IND on clinical hold. In such a case, the IND sponsor and the FDA must resolve any outstanding concerns before clinical trials can begin. A clinical hold may occur at any time during the life of an IND and may affect one or more specific studies or all studies conducted under the IND.

All clinical trials must be conducted under the supervision of one or more qualified investigators in accordance with GCPs. They must be conducted under protocols detailing the objectives of the trial, dosing procedures, research subject selection and exclusion criteria and the quality and effectiveness criteria to be evaluated. Each protocol must be submitted to the FDA as part of the IND, and progress reports detailing the status of the clinical trials must be submitted to the FDA annually. Sponsors also must timely report to FDA serious and unexpected adverse reactions, any clinically important increase in the rate of a serious suspected adverse reaction over that listed in the protocol or investigation brochure or any findings from other studies or animal or in vitro testing that suggest a significant risk in humans exposed to the drug. An IRB at each institution participating in the clinical trial must review and approve the protocol before a clinical trial commences at that institution and must also approve the information regarding the trial and the consent form that must be provided to each research subject or the subject's legal representative, monitor the study until completed and otherwise comply with IRB regulations.

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

- **Phase I**—The product candidate is initially introduced into healthy human subjects and tested for quality, dosage tolerance, absorption, metabolism, distribution and elimination. In the case of some product candidates for severe or life-threatening diseases, such as cancer, especially when the product candidate may be inherently too toxic to ethically administer to healthy volunteers, the initial human testing is often conducted in patients.

- **Phase II**—Clinical trials are performed on a limited patient population intended 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.

- **Phase III**—Clinical trials are undertaken to further evaluate dosage and produce data that the FDA may determine to establish clinical efficacy and safety in an expanded patient population at geographically dispersed clinical study sites. These studies are intended to establish the overall risk-benefit ratio of the product and provide an adequate basis for product labeling.

Human clinical trials are inherently uncertain and Phase I, Phase II and Phase III testing may not achieve desired results or otherwise be completed. The FDA or the sponsor may suspend a clinical trial at any time for a variety of reasons, including a finding that the research subjects or patients are being exposed to an unacceptable health risk. Similarly, an IRB can suspend or terminate approval of a clinical trial at its institution if the clinical trial is not being conducted in accordance with the IRB's requirements or if the product candidate has been associated with unexpected serious harm to patients.

During the development of a new product candidate, sponsors are given opportunities to meet with the FDA at certain points. These points may be prior to the submission of an IND, at the end of Phase II and before an NDA is submitted. Meetings at other times may be requested. These meetings can provide an opportunity for the sponsor to share information about the data gathered to date and for the FDA to provide advice on the next phase of development. Sponsors typically use the meeting at the end of Phase II to discuss their Phase II clinical results and present their plans for the pivotal Phase III clinical trial that they believe will support the approval of the new drug. If a Phase II clinical trial is the subject of discussion at the end of Phase II meeting with the FDA, a sponsor may be able to request a Special Protocol Assessment ("SPA"), the purpose of which is to reach agreement with the FDA on the Phase III clinical trial protocol design and analysis that will form the primary basis of an efficacy claim.

According to published guidance on the SPA process, a sponsor which meets the prerequisites may make a specific request for a SPA and provide information regarding the design and size of the proposed clinical trial. The FDA is supposed to evaluate the protocol within forty-five (45) days of the request to assess whether the proposed trial is adequate, which evaluation may result in discussions and a request for additional information. An SPA request must be made before the proposed trial begins, and all open issues must be resolved before the trial begins. If a written agreement is reached, it will be documented and made part of the record. The agreement will be binding on the FDA and may not be changed by the sponsor or the FDA after the trial begins except with the written agreement of the sponsor and the FDA or if the FDA determines that a substantial scientific issue essential to determining the safety or efficacy of the product candidate was identified after the testing began.

Concurrent with clinical trials, sponsors usually complete additional animal safety studies and also develop additional information about the chemistry and physical characteristics of the product candidate and finalize a process for manufacturing commercial quantities of the product candidate in accordance with cGMP requirements. The manufacturing process must be capable of consistently producing quality batches of the product candidate and the manufacturer must develop methods for testing the quality, purity and potency of the product candidate. Additionally, appropriate packaging must be selected and tested and stability studies must be conducted to demonstrate that the product candidate does not undergo unacceptable deterioration over its proposed shelf-life.

The results of product development, nonclinical studies and clinical trials, along with descriptions of the manufacturing process, analytical tests and other control mechanisms, proposed labeling and other relevant information are submitted to the FDA as part of an NDA requesting approval to market the product. The submission of an NDA is subject to the payment of user fees, but a waiver of such fees may be obtained under specified circumstances. The FDA reviews all NDAs submitted to ensure that they are sufficiently complete for substantive review before it accepts them for filing. It may request additional information rather than accept an NDA for filing. In this event, the NDA must be resubmitted with the additional information. The resubmitted application also is subject to review before the FDA accepts it for filing.

Once the submission is accepted for filing, the FDA begins an in-depth review. NDAs receive either standard or priority review. A drug representing a significant improvement in treatment, prevention or diagnosis of disease may receive priority review. The FDA may refuse to approve an NDA if the applicable regulatory criteria are not satisfied or may require additional clinical or other data. Even if such data are submitted, the FDA may ultimately decide that the NDA does not satisfy the criteria for approval. The FDA reviews an NDA to determine, among other things, whether a product is safe and effective for its intended use and whether its manufacturing is cGMP-compliant. The FDA may refer the NDA to an advisory committee for review and recommendation as to whether the application should be approved and under what conditions. The FDA is not bound by the recommendation of an advisory committee, but it generally follows such recommendations. Before approving an NDA, the FDA will inspect the facility or facilities where the product is manufactured and tested.

Expedited review and approval

The FDA has various programs, including Fast Track, priority review and accelerated approval, which are intended to expedite or simplify the process for reviewing product candidates, or provide for the approval of a product candidate on the basis of a surrogate endpoint. Even if a product candidate qualifies for one or more of these programs, the FDA may later decide that the product candidate no longer meets the conditions for qualification or that the time period for FDA review or approval will be shortened. Generally, product candidates that are eligible for these programs are those for serious or life-threatening conditions, those with the potential to address unmet medical needs and those that offer meaningful benefits over existing treatments. For example, Fast Track is a process designed to facilitate the development and expedite the review of product candidates to treat serious or life-threatening diseases or conditions and fill unmet medical needs. Priority review is designed to give product candidates that offer major advances in treatment or provide a treatment where no adequate therapy exists an initial review within six months as compared to a standard review time of ten (10) months.

Although Fast Track and priority review do not affect the standards for approval, the FDA will attempt to facilitate early and frequent meetings with a sponsor of a Fast Track designated product candidate and expedite review of the application for a product candidate designated for priority review. Accelerated approval, which is described in Subpart H of 21 CFR Part 314, provides for an earlier approval for a new product candidate that is intended to treat a serious or life-threatening disease or condition and that fills an unmet medical need based on a surrogate endpoint. A surrogate endpoint is a laboratory measurement or physical sign used as an indirect or substitute measurement representing a clinically meaningful outcome. As a condition of approval, the FDA may require that a sponsor of a product candidate receiving accelerated approval perform post-marketing clinical trials.

In the Food and Drug Administration Safety and Innovation Act ("FDASIA"), the U.S. Congress encouraged the FDA to utilize innovative and flexible approaches to the assessment of product candidates under accelerated approval. The law required the FDA to issue related draft guidance within a year after the law's enactment and also promulgate confirming regulatory changes. In June 2013, the FDA published a draft Guidance for Industry titled "Expedited Programs for Serious Conditions—Drugs and Biologics," which provides guidance on FDA programs that are intended to facilitate and expedite development and review of new product candidates as well as threshold criteria generally applicable to concluding that a product candidate is a candidate for these expedited development and review programs.

In addition to the Fast Track, accelerated approval and priority review programs discussed above, the FDA also provided guidance on a new program for Breakthrough Therapy designation. The FDA defines a Breakthrough Therapy 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. A drug designated as a Breakthrough Therapy is eligible for accelerated approval. The FDA must take certain actions, such as holding timely meetings and providing advice, intended to expedite the development and review of an application for approval of a Breakthrough Therapy. Even if a product qualifies for one or more of these programs, the FDA may later decide that the product no longer meets the conditions for qualification or decide that the time period for FDA review or approval will not be shortened. A request for Breakthrough Therapy designation should be submitted concurrently with, or as an amendment to an IND. FDA has already granted this designation to approximately thirty (30) new product candidates and has begun approving Breakthrough Therapy designated drugs.

Patent term restoration and marketing exclusivity

Depending upon the timing, duration and specifics of FDA approval of the use of our product candidates, some of our U.S. patents may be eligible for limited patent term extension under the Drug Price Competition and Patent Term Restoration Act of 1984, referred to as the Hatch- Waxman Act. The Hatch-Waxman Act permits a patent restoration term of up to five years as compensation for patent term lost during product development and the FDA regulatory review process. However, patent term restoration cannot extend the remaining term of a patent beyond a total of fourteen (14) years from the product candidate's approval date. The patent term restoration period is generally one half of the time between the effective date of an IND and the submission date of an NDA, plus the time between the submission date of an NDA and the approval of that application. Only one patent applicable to an approved product candidate is eligible for the extension and the application for extension must be made prior to expiration of the patent. The USPTO, in consultation with the FDA, reviews and approves the application for any patent term extension or restoration. In the future, we intend to apply for restorations of patent term for some of our currently owned or licensed patents to add patent life beyond their current expiration date, depending on the expected length of clinical trials and other factors involved in the submission of the relevant NDA.

Market exclusivity provisions under the FDCA also can delay the submission or the approval of certain applications. The FDCA provides a five-year period of non-patent marketing exclusivity within the U.S. to the first applicant to gain approval of an NDA for a new chemical entity. A product candidate is a new chemical entity if the FDA has not previously approved any other new product candidate containing the same active moiety, which is the molecule or ion responsible for the action of the product candidate substance. During the exclusivity period, the FDA may not accept for review an abbreviated new drug application ("ANDA") or a 505(b)(2) NDA submitted by another company for another version of such product candidate where the applicant does not own or have a legal right of reference to all the data required for approval. However, an application may be submitted after four years if it contains a certification of patent invalidity or non-infringement. The FDCA also provides three years of marketing exclusivity for an NDA, 505(b) (2) NDA, or supplement to an approved NDA if new clinical investigations, other than bioavailability studies, that were conducted or sponsored by the applicant are deemed by the FDA to be essential to the approval of the application, for example, for new indications, dosages or strengths of an existing product candidate. This three-year exclusivity covers only the conditions associated with the new clinical investigations and does not prohibit the FDA from approving ANDAs for product candidates containing the original active agent. Five-year and three-year exclusivity will not delay the submission or approval of a full NDA. However, an applicant submitting a full NDA would be required to conduct or obtain a right of reference to all of the preclinical studies and adequate and well-controlled clinical trials necessary to demonstrate quality and effectiveness.

Orphan drug designation

Under the Orphan Drug Act, the FDA may grant orphan drug designation to product candidates intended to treat a rare disease or condition, which is generally a disease or condition that affects fewer than 200,000 individuals in the U.S. or more than 200,000 individuals in the U.S. and for which there is no reasonable expectation that the cost of developing and making available in the U.S. a product candidate for this type of disease or condition will be recovered from sales in the U.S. for that product candidate. Orphan drug designation must be requested before submitting an NDA. After the FDA grants orphan drug designation, the FDA publicly discloses the identity of the therapeutic agent and its potential orphan use. Orphan drug designation does not convey any advantage in or shorten the duration of the regulatory review and approval process.

If a product candidate that has orphan drug designation subsequently receives the first FDA approval for the disease for which it has such designation, the product candidate is entitled to orphan product exclusivity, which means that the FDA may not approve any other applications to market the same product candidate for the same indication, except in very limited circumstances, for seven years. Orphan drug exclusivity, however, could also block the approval of one of our product candidates for seven years if a competitor obtains approval of the same product candidate as defined by the FDA or if our product candidate is determined to be contained within the competitor's product candidate for the same indication or disease.

Pediatric exclusivity and pediatric use

Under the Best Pharmaceuticals for Children Act ("BPCA"), certain product candidates may obtain an additional six months of exclusivity if the sponsor submits information requested in writing by the FDA (a "Written Request") relating to the use of the active moiety of the product candidate in children. The FDA may not issue a Written Request for studies on unapproved or approved indications or where it determines that information relating to the use of a product candidate in a pediatric population, or part of the pediatric population, may not produce health benefits in that population.

In addition, the Pediatric Research Equity Act ("PREA") requires a sponsor to conduct pediatric studies for most product candidates and biologics, for a new active ingredient, new indication, new dosage form, new dosing regimen or new route of administration. Under PREA, original NDAs, biologics license application and supplements thereto must contain a pediatric assessment unless the sponsor has received a deferral or waiver. The required assessment must assess the quality and effectiveness of the product candidate for the claimed indications in all relevant pediatric subpopulations and support dosing and administration for each pediatric subpopulation for which the product candidate is safe and effective. The sponsor or FDA may request a deferral of pediatric studies for some or all of the pediatric subpopulations. A deferral may be granted for several reasons, including a finding that the product candidate or biologic is ready for approval for use in adults before pediatric studies are complete, or that additional quality or effectiveness data needs to be collected before the pediatric studies begin. After April 2013, the FDA must send a noncompliance letter to any sponsor that fails to: submit the required assessment, keep a deferral current, or submit a request for approval of a pediatric formulation.

Post-approval requirements

Once an approval is granted, the FDA may withdraw the approval if compliance with regulatory requirements is not maintained or if problems occur after the product candidate reaches the market. Later discovery of previously unknown problems with a product candidate may result in restrictions on the product candidate or even complete withdrawal of the product candidate from the market. After approval, some types of changes to the approved product candidate, such as adding new indications, manufacturing changes and additional labeling claims, are subject to further FDA review and approval. In addition, the FDA may require testing and surveillance programs to monitor the effect of approved product candidates that have been commercialized, and the FDA has the power to prevent or limit further marketing of a product candidate based on the results of these post-marketing programs.

Any product candidates manufactured or distributed by us pursuant to FDA approvals are subject to continuing regulation by the FDA, including, among other things:

- record-keeping requirements;
- reporting of adverse experiences with the product candidate;
- providing the FDA with updated data for the FDA's continuing safety and efficacy determination;
- drug sampling and distribution requirements;
- notifying the FDA and gaining its approval of specified manufacturing or labeling changes; and
- complying with FDA promotion and advertising requirements.

Drug manufacturers and other entities involved in the manufacture and distribution of approved product candidates are required to register their establishments with the FDA and certain state agencies and are subject to periodic unannounced inspections by the FDA and some state agencies for compliance with cGMP and other laws.

Regulation outside of the U.S.

In addition to regulations in the U.S., we will be subject to regulations of other countries governing any clinical trials and commercial sales and distribution of our product candidates. Whether or not we obtain FDA approval for a product, we must obtain approval by the comparable regulatory authorities of countries outside of the U.S. before we can commence clinical trials in such countries and approval of the regulators of such countries or economic areas, such as the European Union, before we may market products in those countries or areas. The approval process and requirements governing the conduct of clinical trials, product licensing, pricing and reimbursement vary greatly from place to place, and the time may be longer or shorter than that required for FDA approval.

Under European Union regulatory systems, a company may submit marketing authorization applications either under a centralized or decentralized procedure. The centralized procedure, which is compulsory for medicines produced by biotechnology or those medicines intended to treat AIDS, cancer, neurodegenerative disorders or diabetes and is optional for those medicines which are highly innovative, provides for the grant of a single marketing authorization that is valid for all European Union member states. The decentralized procedure provides for mutual recognition of national approval decisions. Under this procedure, the holder of a national marketing authorization may submit an application to the remaining member states. Within 90 days of receiving the applications and assessments report, each member state must decide whether to recognize approval. If a member state does not recognize the marketing authorization, the disputed points are eventually referred to the European Commission, whose decision is binding on all member states.

As in the U.S., we may apply for designation of a product candidate as an orphan drug for the treatment of a specific indication in the European Union before the application for marketing authorization is made. Orphan drugs in Europe enjoy economic and marketing benefits, including up to ten years of market exclusivity for the approved indication unless another applicant can show that its product is safer, more effective or otherwise clinically superior to the orphan-designated product.

Reimbursement

Sales of our products will depend, in part, on the extent to which the costs of our products will be covered by third-party payors, such as government health programs, commercial insurance and managed healthcare organizations. These third-party payors are increasingly challenging the prices charged for medical products and services. Additionally, the containment of healthcare costs has become a priority of federal and state governments and the prices of drugs have been a focus in this effort. The U.S. government, state legislatures and foreign 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 our net revenue and results. If these third-party payors do not consider our products to be cost-effective compared to other therapies, they may not cover our products after approved as a benefit under their plans or, if they do, the level of payment may not be sufficient to allow us to sell our products on a profitable basis.

The Medicare Prescription Drug, Improvement, and Modernization Act of 2003 (“MMA”) imposed new requirements for the distribution and pricing of prescription drugs for Medicare beneficiaries. Under Part D, Medicare beneficiaries may enroll in prescription drug plans offered by private entities which will provide coverage of outpatient prescription drugs. Part D plans include both stand-alone prescription drug benefit plans and prescription drug coverage as a supplement to Medicare Advantage plans. Unlike Medicare Part A and B, Part D coverage is not standardized. Part D prescription drug plan sponsors are not required to pay for all covered Part D drugs, and each drug plan can develop its own drug formulary that identifies which drugs it will cover and at what tier or level. However, Part D prescription drug formularies must include drugs within each therapeutic category and class of covered Part D drugs, though not necessarily all the drugs in each category or class. Any formulary used by a Part D prescription drug plan must be developed and reviewed by a pharmacy and therapeutics committee. Government payment for some of the costs of prescription drugs may increase demand for our products for which we receive marketing approval. However, any negotiated prices for our products covered by a Part D prescription drug plan will likely be lower than the prices we might otherwise obtain. Moreover, while the MMA applies only to drug benefits for Medicare beneficiaries, private payors often follow Medicare coverage policy and payment limitations in setting their own payment rates. Any reduction in payment that results from the MMA may result in a similar reduction in payments from non-governmental payors.

The American Recovery and Reinvestment Act of 2009 provides funding for the federal government to compare the effectiveness of different treatments for the same illness. A plan for the research will be developed by the Department of Health and Human Services, the Agency for Healthcare Research and Quality and the National Institutes for Health, and periodic reports on the status of the research and related expenditures will be made to the U.S. Congress. Although the results of the comparative effectiveness studies are not intended to mandate coverage policies for public or private payors, it is not clear what effect, if any, the research will have on the sales of any product, if any such product or the condition that it is intended to treat is the subject of a study. It is also possible that comparative effectiveness research demonstrating benefits in a competitor's product could adversely affect the sales of our product candidates. If third-party payors do not consider our products to be cost-effective compared to other available therapies, they may not cover our products as a benefit under their plans or, if they do, the level of payment may not be sufficient to allow us to sell our products on a profitable basis.

The Patient Protection and Affordable Care Act, as amended by the Health Care and Education Affordability Reconciliation Act of 2010, collectively referred to as the "ACA," enacted in March 2010, had a significant impact on the health care industry by expanding coverage for the uninsured. With regard to pharmaceutical products, among other things, ACA is expanded and increased industry rebates for drugs covered under Medicaid programs and made changes to the coverage requirements under the Medicare Part D program. The administration and Congress which took office in January 2017, has pledged to repeal and replace the ACA, largely because of significantly increasing health insurance premiums and decreasing participation by members of the insurance companies. We cannot predict the impact of any repeal, replacement or modifications which may be enacted.

In addition, in some non-U.S. jurisdictions, the proposed pricing for a product candidate must be approved before it may be lawfully marketed. The requirements governing drug pricing vary widely from country to country. For example, the European Union provides options for its member states to restrict the range of medicinal products for which their national health insurance systems provide reimbursement and to control the prices of medicinal products for human use. A member state may approve a specific price for the medicinal product or it may instead adopt a system of direct or indirect controls on the profitability of the company placing the medicinal product on the market. There can be no assurance that any country that has price controls or reimbursement limitations for pharmaceutical products will allow favorable reimbursement and pricing arrangements for any of our product candidates. Historically, product candidates launched in the European Union do not follow price structures of the U.S. and generally tend to be significantly lower.

Environment

Our third-party manufacturers are subject to inspections by the FDA for compliance with cGMP and other U.S. regulatory requirements, including U.S. federal, state and local regulations regarding environmental protection and hazardous and controlled substance controls, among others. Environmental laws and regulations are complex, change frequently and have tended to become more stringent over time. We have incurred, and may continue to incur, significant expenditures to ensure we are in compliance with these laws and regulations. We would be subject to significant penalties for failure to comply with these laws and regulations.

Sales and Marketing

Our current focus is on the development of our existing portfolio, the completion of clinical trials and, if and where appropriate, the registration of our product candidates. We currently do not have marketing, sales and distribution capabilities. If we receive marketing and commercialization approval for any of our product candidates, we intend to market the product either directly or through collaborations, strategic alliances and distribution agreements with third parties. The ultimate implementation of our strategy for realizing the financial value of our product candidates is dependent on the results of clinical trials for our product candidates, the availability of funds and the ability to negotiate acceptable commercial terms with third parties.

Employees

As of the date of this Annual Report, we have seven employees, including our four executive officers, one engaged in research and development and two in administration. We consider our relationship with our employees to be good.

Recent Financings – Our IPO and Post-2022 Financing

On September 2, 2022, we closed on our IPO of 1,225,888 units (each a "Unit," and collectively, the "Units"), with each Unit consisting of one share of the Company's common stock and one warrant to purchase one share of common stock, at a public offering price of $8.125 per Unit. Our IPO, which was underwritten by Boustead Securities, LLC ("Boustead"), resulted in gross proceeds of $9,960,430, before deducting underwriting discounts and commissions. On September 29, 2022, Boustead exercised its overallotment option, purchasing an additional 183,883 Units, resulting in gross proceeds of $1,494,041, before deducting underwriter commissions and discounts. As a result, our IPO raised a total of $11,454,474, before deducting underwriting discounts, commissions and related IPO expenses.

On January 11, 2023, we entered into a securities purchase agreement (the "SPA") with Alto Opportunity Master Fund, SPC – Segregated Master Portfolio B, a Cayman entity (the "Investor"), pursuant to which the Company sold to the Investor a $4.3 million convertible note (the "Convertible Note") and warrant (the "Warrant") to purchase 1,018,079 shares of common stock of the Company, in exchange for gross proceeds of $4.0 million (the "Investment Amount"). The Convertible Note amortizes on a monthly basis and the Company can make such monthly amortization payments in cash or, subject to certain equity conditions, in registered shares of common stock or a combination thereof. For equity repayment, the Convertible Note is convertible into shares of common stock at price per share equal to the lower of (i) $2.35 (ii) 90% of the three lowest daily VWAPs of the 15 trading days prior to the payment date or (iii) 90% of the VWAP of the trading day prior to payment date. The Convertible Note is repayable over 26 months and bears interest at the rate of 5% per annum. The Warrant is exercisable for four years from the date of closing and is exercisable at $2.35 per share. In the event the Investor exercises the Warrant in full, such exercise would result in additional gross proceeds to the Company of approximately $2.4 million.

Item 1A. Risk Factors

An investment in our securities involves a high degree of risk. You should carefully consider all of the risks described below, together with the other information contained in this Annual Report on Form 10-K, including our financial statements and related notes, before making a decision to invest in our securities. If any of the following events occur, our business, financial condition and operating results may be materially adversely affected. In that event, the trading price of our securities could decline, and you could lose all or part of your investment.

Summary Risk Factors

The risks described under the heading "Risk Factors" beginning on page 29 of this Annual Report on Form 10-K may cause us not to realize the full benefits of our strengths and/or may cause us to be unable to successfully execute all or part of our strategy. Some of the more significant challenges we face include:

- Our success is primarily dependent on the successful development, regulatory approval and commercialization of our product candidates, all of which are in the early stages of development.
- We currently have no source of product sales revenue.
- We face competition from entities that have developed or may develop product candidates for our target disease indications, including companies developing novel treatments and technology platforms based on modalities and technology similar to ours. If these companies develop technologies or product candidates more rapidly than we do or their technologies, including delivery technologies, are more effective, our ability to develop and commercialize product candidates may be adversely affected.
- If we fail to comply with U.S. and foreign regulatory requirements, regulatory authorities could limit or withdraw any marketing or commercialization approvals we may receive and subject us to other penalties that could materially harm our business.
- If we do not comply with laws regulating the protection of the environment and health and human safety, our business could be adversely affected.
- If we are not able to obtain and enforce patent protection for our technologies or product candidates, development and commercialization of our product candidates may be adversely affected.
- We or our licensors, or any future collaborators or a strategic partners may become subject to third party claims or litigation alleging infringement of patents or other proprietary rights or seeking to invalidate patents or other proprietary rights, and we may need to resort to litigation to protect or enforce our patents or other proprietary rights, all of which could be costly, time consuming, delay or prevent the development and commercialization of our product candidates, or put our patents and other proprietary rights at risk.
- If we are unable to protect the confidentiality of our trade secrets, our business and competitive position would be harmed.

- We may be unable to obtain U.S. or foreign regulatory approval and, as a result, unable to commercialize our product candidates.
- Any drugs we develop may become subject to unfavorable pricing regulations, third-party reimbursement practices or healthcare reform initiatives, thereby harming our business.
- Our ability to obtain services, reimbursement or funding from the federal government may be impacted by possible reductions in federal spending.
- If any of our product candidates receives marketing approval and we or others later identify undesirable side effects caused by the product candidate, our ability to market and derive revenue from the product candidates could be compromised.
- Our stock price may be volatile, and purchasers of our common stock could incur substantial losses.
- The future issuance of equity or of debt securities that are convertible into common stock will dilute our share capital.
- If securities or industry analysts do not publish research or reports about our business, or if they issue an adverse or misleading opinion regarding our stock, our stock price and trading volume could decline.

RISK FACTORS

An investment in our common stock involves a high degree of risk. You should carefully consider the following risk factors and all the other information in this Annual Report before you decide to buy our common stock. If any of the following risks related to our business actually occurs, our business, financial condition, operating results, and prospects would be adversely affected. The market price of our common stock could decline due to any of these risks and uncertainties related to our business, or related to an investment in our common stock, and you may lose part or all of your investment.

Risks Related to Our Business, Financial Condition and Capital Requirements

Because we had limited funds prior to our initial public offering, our independent auditing firm issued a going concern opinion related to our audit for the year ended December 31, 2021; we have since raised adequate funds through our IPO and post-IPO financing activities but will require additional funding to complete the required clinical trials.

Prior to the closing of our IPO on September 2, 2022, we were funded by investments from private investors and government contracts obtained from the NIH for performing research. While this has allowed us to complete a Phase I clinical trial for Ropidoxuridine and a pre-clinical trial for our HDAC inhibitor platform, we have not yet completed our clinical trials and do not know if any of our products will ever achieve commercial viability. The closing of our IPO and the underwriter's exercise of the overallotment option resulted in gross proceeds of $11,088,764. In addition, on January 11, 2023, in exchange for a $4.0 million investment, we closed on an offering of a $4.3 million convertible note, which note bears interest at 5% and is repayable over 26 months, and a warrant to purchase 1,018,079 shares of commons stock, exercisable for cash at a $2.35 per share exercise price. Following completion of our IPO and the convertible note and warrant offering, we believe will allow us to fund IND-enabling and Phase I and II clinical trials of our product candidates, including Ropidoxuridine, IPdR/TPI and our HDAC inhibitor small molecule technology platform. However, additional funding will be required to complete Phase III clinical trials.

Our success is primarily dependent on the successful development, regulatory approval and commercialization of our product candidates, all of which are in the early stages of development.

We currently have one clinical stage product candidate in the early stages of development. Ropidoxuridine has undergone an SBIR funded Phase 1 clinical trial at Lifespan/Rhode Island Hospital. We also have an HDAC inhibitor small molecule platform. The three lead drug candidate molecules are in preclinical phases of development. None of our product candidates have gained marketing approval for sale in the United States or any other country, and we cannot guarantee that we will ever have marketable products. To date, we have invested substantially all of our efforts and financial resources in the research and development and commercial planning for our current product candidate and our HDAC small molecule delivery platform. Our near-term prospects, including our ability to finance our Company and generate revenue, as well as our future growth, will depend heavily on the development, marketing approval and commercialization of our product candidates. The clinical and commercial success of product candidates will depend on a number of factors, including the following:

- obtaining favorable results from our Phase 1 clinical trial for IPdR and proceeding to Phase II and Phase III clinical trials, which may be slower or cost more than we currently anticipate;

- our ability to demonstrate safety and efficacy of our product candidates, which are ongoing determinations that are solely within the authority of the FDA;

- even if our clinical trials are completed, there can be no assurance that the FDA will agree that we have satisfactorily demonstrated safety or efficacy or that the FDA will not raise new issues regarding the design of our clinical trials;

- whether we are required by the FDA to conduct additional clinical trials to support the approval of our product candidates;

- the acceptance by the FDA of our proposed parameters for regulatory approval, including our proposed indication, endpoints and endpoint measurement tools relating to our product candidates;

- the incidence, duration and severity of adverse side effects;

- the timely receipt of necessary marketing approvals from the FDA;

- whether we are able to secure collaborations for completing the development and, if approved, commercialization of our product candidates;

- the effectiveness of our and our potential collaborators' marketing, sales and distribution strategy and operations of product candidates that are approved;

- our success in educating physicians and patients about the benefits, administration and use of our product candidates;

- the ability of our third-party manufacturers and potential collaborators to manufacture clinical trial and commercial supplies of our product candidates to remain in good standing with regulatory bodies, and to develop, validate and maintain commercially viable manufacturing processes that are compliant with current Good Manufacturing Practices ("cGMP") regulations;

- our ability to commercialize our product candidates, if approved for marketing;

- our ability to enforce our intellectual property rights;

- our ability to avoid third-party patent interference or patent infringement claims;

- acceptance of our product candidates as safe and effective by patients and the medical community; and

- a continued acceptable quality profile of our product candidates following approval.

Many of the above-listed factors are beyond our control. Accordingly, we cannot assure you that we will ever be able to generate revenue through the sale of our product candidates. Any one of these factors or other factors discussed in this Annual Report could affect our ability to commercialize product candidates, which could impact our ability to earn sufficient revenues to transition from a developmental stage company and continue our business. If we do not obtain marketing approval of and commercialization of our product candidates, or are significantly delayed in doing so, our business will be materially harmed. We have a limited operating history and have incurred significant losses since our inception, and we anticipate that we will continue to incur losses for the foreseeable future and may never achieve or maintain profitability.

We are a Phase I clinical stage pharmaceutical company with a limited operating history upon which you can evaluate our business and prospects. Specialty pharmaceutical product development is a highly speculative undertaking and involves a substantial degree of risk. We do not currently have any product candidates in advanced clinical trials or approved for sale, and we continue to incur significant research and development and general and administrative expenses related to our operations. In addition, we have limited experience and have not yet demonstrated an ability to successfully overcome many of the risks and uncertainties frequently encountered by companies in new and rapidly evolving fields, particularly in the specialty pharmaceutical industry. We have not generated any revenue and have incurred losses in each year since our founding in December 2012. Our accumulated deficit as of December 31, 2022 was $8,894,889. We expect to continue to incur significant losses for the foreseeable future. Even if we achieve profitability in the future, we may not be able to sustain profitability in subsequent periods.

We currently have no source of product sales revenue.

We have not generated any revenues from commercial sales of our product candidates. Our ability to generate product revenue depends upon our ability to develop and commercialize products, including any of our current product candidates or other product candidates that we may develop, in-license or acquire in the future. We do not anticipate generating revenue from the sale of products for the foreseeable future. Our ability to generate future product revenue from our current or future product candidates also depends on a number of additional factors, including our ability to:

- complete research and clinical development of current and future product candidates, either directly or through collaborative relationships;
- establish and maintain supply and manufacturing relationships with third parties, and ensure adequate and legally compliant manufacturing of bulk drug substances and drug products to maintain that supply;
- obtain regulatory approval from relevant regulatory authorities in jurisdictions where we intend to market our product candidates, either directly or through collaborative relationships;
- launch and commercialize future product candidates for which we obtain marketing approval, if any, through collaborative partners;
- obtain coverage and adequate product reimbursement from third-party payors, including government payors;
- achieve market acceptance for our products, if any;
- establish, maintain and protect our intellectual property rights; and
- attract, hire and retain qualified personnel.

In addition, because of the numerous risks and uncertainties associated with clinical product development, including that our product candidates may not advance through development or achieve the endpoints of applicable clinical trials, we are unable to predict the timing or amount of any potential future product sales revenues. Our expenses also could increase beyond expectations if we decide to or are required by the FDA, or comparable foreign regulatory authorities, to perform studies or trials in addition to those that we currently anticipate. Even if we complete the development and regulatory processes described above, we anticipate incurring significant costs associated with launching and commercializing these products.

The market may not be receptive to our product candidates based on our novel therapeutic modality, and we may not generate any future revenue from the sale or licensing of product candidates.

Even if approval is obtained for a product candidate, we may not generate or sustain revenue from sales of the product due to factors such as whether the product can be sold at a competitive cost and otherwise accepted in the market. The product candidates that we are developing are based on new delivery platform therapeutic approaches (there currently is no drug which has FDA approval for indications of radiation sensitization). Market participants with significant influence over acceptance of new treatments, such as physicians and third-party payors, may not accept our delivery platform, and we may not be able to convince the medical community and third-party payors to accept and use, or to provide favorable reimbursement for, any product candidates developed by us. Market acceptance of our product candidates will depend on, among other factors:

- timing of our receipt of any marketing and commercialization approvals;
- terms of any approvals and the countries in which approvals are obtained;
- safety and efficacy of our product candidates, which are determinations solely within the authority of the FDA;
- prevalence and severity of any adverse side effects associated with our product candidates;
- warnings contained in any labeling approved by the FDA or other regulatory authority;
- convenience and ease of administration of our product candidates;
- success of our physician education programs;
- availability of adequate government and third-party payor reimbursement;
- pricing of our products, particularly as compared to alternative treatments; and
- availability of alternative effective products for indications our product candidates are intended to treat.

We will require substantial additional financing in order to obtain marketing approval of our product candidates and commercialize our product candidates; a failure to obtain this necessary capital when needed on acceptable terms, or at all, could force us to delay, limit, reduce or terminate our product development, other operations or commercialization efforts.

Since our inception, substantially all of our resources have been dedicated to the preclinical and clinical development of our HDAC small molecule delivery platform and our initial product candidate, Ropidoxuridine. Our capital needs to date have been met by contributions from existing stockholders, as well as through private offerings and IPO of our securities and our SBIR contracts. We believe that we will continue to expend substantial resources for the foreseeable future on the completion of clinical development and regulatory preparedness of our product candidates, preparations for a commercial launch of our product candidates, if approved, and development of any other current or future product candidates we may choose to further develop. These expenditures will include costs associated with research and development, conducting preclinical studies and clinical trials, obtaining marketing approvals, and, if we are not able to enter into planned collaborations, manufacturing and supply as well as marketing and selling any products approved for sale. In addition, other unanticipated costs may arise. Because the outcome of any drug development process is highly uncertain, we cannot reasonably estimate the actual amounts necessary to complete the development and commercialization of our current product candidates, if approved, or future product candidates, if any.

We believe that the proceeds we received in our IPO and subsequent $4.0 million follow on convertible note offering, along with our existing capital resources, will be sufficient to fund our operations through 2024. In addition, should the investor in the convertible note offering choose to exercise its warrant, which is exercisable for four years we will receive an additional $2.39 million in funding, which would provide us enough funding through 2025 (assuming it is exercised in the next year). Notwithstanding the aforementioned funds, our operating plans may change as a result of factors currently unknown to us, and we may need to seek additional funds sooner than planned, through public or private equity or debt financings or other sources, such as strategic collaborations. Such financing may result in dilution to stockholders, imposition of debt covenants and repayment obligations, or other restrictions that may adversely affect our business. In addition, we may seek additional capital due to favorable market conditions or strategic considerations even if we believe we have sufficient funds for our current or future operating plans.

Our future capital requirements depend on many factors, including:

- the scope, progress, results and costs of researching and developing our current product candidates, future product candidates and conducting preclinical and clinical trials;
- the cost of commercialization activities if our current product candidates and future product candidates are approved for sale, including securing collaborative ventures for completing development of, securing marketing approval for and ultimately marketing, selling and distributing our product candidates, if approved or building a corporate infrastructure if we have to undertake these activities directly;
- our ability to establish and maintain strategic collaborations, licensing or other arrangements and the financial terms of such agreements;
- the number and characteristics of any additional product candidates we may develop or acquire;
- any product liability or other lawsuits related to our products or commenced against us;
- the expenses needed to attract and retain skilled personnel;
- the costs associated with being a public company;
- the costs involved in preparing, filing, prosecuting, maintaining, defending and enforcing patent claims, including litigation costs and the outcome of such litigation; and
- the timing, receipt and amount of sales of, or royalties on, any future approved products, if any.

Additional funds may not be available when we need them, on terms that are acceptable to us, or at all. If adequate funds are not available to us on a timely basis, we may be required to:

- delay, limit, reduce or terminate preclinical studies, clinical trials or other development activities for our current product candidates or future product candidates, if any;

- delay, limit, reduce or terminate our research and development activities; or

- delay, limit, reduce or terminate our establishment of sales and marketing capabilities or other activities that may be necessary to commercialize our current or future product candidates.

Raising additional capital may cause dilution to our existing stockholders, restrict our operations or require us to relinquish rights to our technologies or product candidates.

We may seek additional capital through a combination of public and private equity offerings, debt financings, strategic collaborations and alliances and licensing arrangements. To the extent that we raise additional capital through the sale of equity or convertible debt securities, your ownership interest will be diluted, and the terms may include liquidation or other preferences that adversely affect your rights as a stockholder. The incurrence of indebtedness would result in increased fixed payment obligations and could involve certain restrictive covenants, such as limitations on our ability to incur additional debt, limitations on our ability to acquire or license intellectual property rights and other operating restrictions that could adversely impact our ability to conduct our business. If we raise additional funds through strategic collaborations and alliances and licensing arrangements with third parties, we may have to relinquish valuable rights to our technologies or product candidates or grant licenses on terms unfavorable to us.

Unfavorable and/or unstable global market and economic conditions, including those caused by the ongoing conflict between the Ukraine and Russia and the ongoing COVID-19 pandemic, could have serious adverse consequences on our business, financial condition and results of operations.

The global economy, including credit and financial markets, has experienced extreme volatility and disruptions as a result of the ongoing conflict between the Ukraine and Russia and challenges arising from the ongoing COVID-19 pandemic, including severely diminished liquidity and credit availability, declines in consumer confidence, declines in economic growth, increases in unemployment rates, increases in inflation rates and uncertainty about economic stability. Our results of operations could be adversely affected by the general conditions of the global economy and the global financial markets. In addition, any such volatility and disruptions may have adverse consequences on us or the third parties upon whom we rely. For example, in 2008, the global financial crisis caused extreme volatility and disruptions in the capital and credit markets and the current COVID-19 pandemic has caused significant volatility and uncertainty in U.S. and international markets. Inflation rates, particularly in the United States, have increased recently to levels not seen in years. Increased inflation may result in increased operating costs (including our labor costs), reduced liquidity, and limitations on our ability to access credit or otherwise raise debt and equity capital. In addition, the United States Federal Reserve has raised, and may again raise, interest rates in response to concerns about inflation. Increases in interest rates, especially if coupled with reduced government spending and volatility in financial markets, may have the effect of further increasing economic uncertainty and heightening these risks, which may impact our ability to raise additional capital in the future. The March 2023 failure of Silicon Valley Bank, the pressure such failure has placed on other mid-sized banks, and its potential near- and long-term effects on the biotechnology industry and its participants such as our vendors, suppliers and investors, may also adversely affect our operations and stock price. In addition, U.S. and global markets are experiencing volatility and disruption following the escalation of geopolitical tensions and the start of the military conflict between Russia and Ukraine. On February 24, 2022, a full-scale military invasion of Ukraine by Russian troops began. Although the length and impact of the ongoing military conflict is highly unpredictable, the conflict in Ukraine has led to market disruptions, including significant volatility in commodity prices, credit and capital markets, as well as supply chain disruptions. Various of Russia's actions have led to sanctions and other penalties being levied by the United States, Australia, the European Union, and other countries, as well as other public and private actors and companies, against Russia and certain other geographic areas, including agreement to remove certain Russian financial institutions from the Society for Worldwide Interbank Financial Telecommunication payment system and restrictions on imports of Russian oil, liquified natural gas and coal. Additional potential sanctions and penalties have also been proposed and/or threatened. Russian military actions and the resulting sanctions could disrupt or otherwise adversely impact our operations and the operations of third parties upon which we rely, as well as the global economy and financial markets, and lead to instability and lack of liquidity in capital markets, potentially making it more difficult for us to obtain additional funds. Related sanctions, export controls or other actions that may be initiated by nations including the United States, the European Union or Russia (e.g., potential cyberattacks, disruption of energy flows, etc.), which could adversely affect our business and/or our supply chain, our CROs, CMOs and other third parties with which we conduct business. A severe or prolonged economic downturn, inflationary environment, rising interest rates, or political unrest could result in a variety of risks to our business, including, weakened demand for our product candidates and our ability to raise additional capital when needed on acceptable terms, if at all. A weak or declining economy could also strain our suppliers, possibly resulting in supply disruption, or cause our customers to delay making payments for our services. The extent and duration of the military action, sanctions, and resulting market disruptions are impossible to predict, but could be substantial. Any such disruptions may also magnify the impact of other risks described in this Annual Report on Form 10-K and the documents incorporated by reference herein.

Our product candidates are in the early stages of development and may fail in development or suffer delays that materially adversely affect their commercial viability.

We have no products on the market and all of our product candidates are in the early stages of development. Our ability to achieve and sustain profitability depends on obtaining regulatory approvals, including IRB approval, for and commercializing our product candidates, either alone or with third parties. Before obtaining regulatory approval for the commercial distribution of our product candidates, we or one of our collaborators must conduct extensive preclinical tests and clinical trials to demonstrate the safety and efficacy in humans of our product candidates, the final determination of which rests solely in the authority of the FDA. Preclinical testing and clinical trials are expensive, difficult to design and implement, can take many years to complete and are uncertain as to outcome. The start or end of a clinical study is often delayed or halted due to changing regulatory requirements, manufacturing challenges, required clinical trial administrative actions, slower than anticipated patient enrollment, changing standards of care, availability or prevalence of use of a comparative drug or required prior therapy, clinical outcomes or financial constraints. For instance, delays or difficulties in patient enrollment or difficulties in retaining trial participants can result in increased costs, longer development times or termination of a clinical trial. Clinical trials of a new product candidate require the enrollment of a sufficient number of patients, including patients who are suffering from the disease the product candidate is intended to treat and who meet other eligibility criteria. Rates of patient enrollment are affected by many factors, including the size of the patient population, the eligibility criteria for the clinical trial, the age and condition of the patients, the stage and severity of disease, the nature of the protocol, the proximity of patients to clinical sites and the availability of effective treatments for the relevant disease.

A product candidate can unexpectedly fail at any stage of preclinical and clinical development. The historical failure rate for product candidates is high due to scientific feasibility, lack of quality and effectiveness, changing standards of medical care and other variables. The results from preclinical testing or early clinical trials of a product candidate may not predict the results that will be obtained in later phase clinical trials of the product candidate. We, the FDA or other applicable regulatory authorities may suspend clinical trials of a product candidate at any time for various reasons, including a belief that subjects participating in such trials are being exposed to unacceptable health risks or adverse side effects. We may not have the financial resources to continue development of, or to enter into collaborations for, a product candidate if we experience any problems or other unforeseen events that delay or prevent regulatory approval of, or our ability to commercialize, product candidates, including:

- negative or inconclusive results from our clinical trials or the clinical trials of others for product candidates similar to ours, leading to a decision or requirement to conduct additional preclinical testing or clinical trials or abandon a program;
- serious and unexpected drug-related side effects experienced by participants in our clinical trials or by individuals using drugs similar to our product candidates;
- delays in submitting an Investigational New Drug application ("IND") or delays or failure in obtaining the necessary approvals from regulators to commence a clinical trial, or a suspension or termination of a clinical trial once commenced;
- conditions imposed by the FDA or comparable foreign authorities regarding the scope or design of our clinical trials;
- delays in enrolling research subjects in clinical trials;
- high drop-out rates of research subjects;
- greater than anticipated clinical trial costs;
- poor effectiveness of our product candidates during clinical trials;
- unfavorable FDA or other regulatory agency inspection and review of a clinical trial site;
- failure of our third-party contractors or investigators to comply with regulatory requirements or otherwise meet their contractual obligations in a timely manner, or at all;
- delays and changes in regulatory requirements, policy and guidelines, including the imposition of additional regulatory oversight around clinical testing generally or with respect to our technology in particular; or
- varying interpretations of data by the FDA and similar foreign regulatory agencies.

If third parties on which we depend to conduct our preclinical studies, or any future clinical trials, do not perform as contractually required, fail to satisfy regulatory or legal requirements or miss expected deadlines, our development program could be delayed with materially adverse effects on our business, financial condition, results of operations and prospects.

We are relying on third party collaborators to conduct our efficacy clinical trials for Ropidoxuridine and plan to rely on third party clinical investigators, CROs, clinical data management organizations and consultants to design, conduct, supervise and monitor preclinical studies of our product candidates and will do the same for any clinical trials. Because we plan to largely rely on third parties and do not have the ability to conduct preclinical studies or clinical trials independently, we have less control over the timing, quality and other aspects of preclinical studies and clinical trials than we would if we conducted them on our own. These investigators, CROs, and consultants are not our employees and we have limited control over the amount of time and resources that they dedicate to our programs. These third parties may have contractual relationships with other entities, some of which may be our competitors, which may draw time and resources from our programs. The third parties with whom we contract might not be diligent, careful or timely in conducting our preclinical studies or clinical trials, resulting in the preclinical studies or clinical trials being delayed or unsuccessful.

If we cannot contract with acceptable third parties on commercially reasonable terms, or at all, or if these third parties do not carry out their contractual duties, satisfy legal and regulatory requirements for the conduct of preclinical studies or clinical trials or meet expected deadlines, our clinical development programs could be delayed and otherwise adversely affected. In all events, we are responsible for ensuring that each of our preclinical studies and clinical trials is conducted in accordance with the general investigational plan and protocols for the trial. The FDA requires clinical trials to be conducted in accordance with good clinical practices, including for conducting, recording and reporting the results of preclinical studies and 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. Any such event could have a material adverse effect on our business, financial condition, results of operations and/or prospects.

Because we rely on third party manufacturing and supply partners, our supply of research and development, preclinical and clinical development materials may become limited or interrupted or may not be of satisfactory quantity or quality.

We rely on third party supply and manufacturing partners to supply the materials and components for, and manufacture, our research and development, preclinical and clinical trial drug supplies. We do not own manufacturing facilities or supply sources for such components and materials. There can be no assurance that our supply of research and development, preclinical and clinical development drugs and other materials will not be limited, interrupted, restricted in certain geographic regions or of satisfactory quality or continue to be available at acceptable prices. In particular, any replacement of any drug product formulation manufacturer we may use could require significant effort and expertise in the event there are a limited number of qualified replacements for a particular product candidate.

The manufacturing process for a product candidate is subject to FDA and foreign regulatory authority review. Suppliers and manufacturers must meet applicable manufacturing requirements and undergo rigorous facility and process validation tests required by regulatory authorities in order to comply with regulatory standards, such as Current Good Manufacturing Practice (or CGMP). In the event that any of our suppliers or manufacturers fail to comply with such requirements or to perform its obligations to us in relation to quality, timing or otherwise, or if our supply of components or other materials becomes limited or interrupted for other reasons, we may be forced to manufacture the materials ourselves, for which we currently do not have the capabilities or resources, or enter into an agreement with another third party, which we may not be able to do on reasonable terms, if at all. In some cases, the technical skills or technology required to manufacture our product candidates may be unique or proprietary to the original manufacturer, and we may have difficulty, or there may be contractual restrictions prohibiting us from, transferring such skills or technology to another third party and a feasible alternative may not exist. These factors would increase our reliance on such manufacturer or require us to obtain a license from such manufacturer in order to have another third party manufacture our product candidates. If we are required to change manufacturers for any reason, we will be required to verify that the new manufacturer maintains facilities and procedures that comply with quality standards and with all applicable regulations and guidelines. The delays associated with the verification of a new manufacturer could negatively affect our ability to develop product candidates in a timely manner or within budget.

We expect to continue to rely on third party manufacturers if we receive regulatory approval for any product candidate. To the extent that we have existing or future manufacturing arrangements with third parties, we will depend on these third parties to perform their obligations in a timely manner consistent with contractual and regulatory requirements, including those related to quality control and assurance. If we are unable to obtain or maintain third-party manufacturing for product candidates, or to do so on commercially reasonable terms, we may not be able to fully develop and commercialize our product candidates. Our or a third party's failure to execute on our manufacturing requirements could adversely affect our business in a number of ways, including:

- an inability to initiate or continue clinical trials of product candidates under development;
- delay in submitting regulatory applications, or receiving regulatory approvals, for product candidates;
- loss of the cooperation of a collaborator;
- subjecting our product candidates to additional inspections by regulatory authorities;
- requirements to cease distribution or to recall batches of our product candidates; and
- in the event of approval to market and commercialize a product candidate, an inability to meet commercial demands for our products.

We may be unsuccessful in engaging in strategic transactions which could adversely affect our ability to develop and commercialize product candidates, impact our cash position, increase our expense and present significant distractions to our management.

From time to time, we may consider strategic transactions, such as collaborations, acquisitions of companies, asset purchases and out- or in- licensing of product candidates or technologies. In particular, we will evaluate and, if strategically attractive, seek to enter into additional collaborations, including with major biotechnology or pharmaceutical companies to complete development and marketing of our product candidates, if approved. The competition for collaborators is intense, and the negotiation process is time-consuming and complex. Any proposed collaboration may be on terms that are not optimal for us, and we may not be able to maintain any new or existing collaboration if, for example, development or approval of a product candidate is delayed, sales of an approved product candidate do not meet expectations or the collaborator terminates the collaboration. Any such collaboration, or other strategic transaction, may require us to incur non-recurring or other charges, increase our near- and long-term expenditures and pose significant integration or implementation challenges or disrupt our management or business. These transactions would entail numerous operational and financial risks, including exposure to unknown liabilities, disruption of our business and diversion of our management's time and attention in order to manage a collaboration or develop acquired products, product candidates or technologies, incurrence of substantial debt or dilutive issuances of equity securities to pay transaction consideration or costs, higher than expected collaboration, acquisition or integration costs, write-downs of assets or goodwill or impairment charges, increased amortization expenses, difficulty and cost in facilitating the collaboration or combining the operations and personnel of any acquired business, impairment of relationships with key suppliers, manufacturers or customers of any acquired business due to changes in management and ownership and the inability to retain key employees of any acquired business. Accordingly, although there can be no assurance that we will undertake or successfully complete any transactions of the nature described above, any transactions that we do complete may be subject to the foregoing or other risks and have a material adverse effect on our business, results of operations, financial condition and prospects. Conversely, any failure to enter into any collaboration or other strategic transaction that would be beneficial to us could delay the development and potential commercialization of our product candidates and have a negative impact on the competitiveness of any product candidate that reaches market.

We face competition from entities that have developed or may develop product candidates for our target disease indications, including companies developing novel treatments and technology platforms based on modalities and technology similar to ours. If these companies develop technologies or product candidates more rapidly than we do or their technologies, including delivery technologies, are more effective, our ability to develop and commercialize product candidates may be adversely affected.

The development and commercialization of drugs is highly competitive. We compete with a variety of multinational pharmaceutical companies and specialized biotechnology companies, as well as with universities and other research institutions which are developing new technology. Our competitors have developed, are developing or will develop product candidates and processes competitive with our product candidates. Competitive therapeutic treatments include those that have already been approved and accepted by the medical community and any new treatments that enter the market. We believe that a significant number of products are currently under development, and may become commercially available in the future, for the treatment of conditions for which we may try to develop product candidates.

Many of our competitors have significantly greater financial, technical, manufacturing, marketing, sales and supply resources or experience than we have. If we obtain approval for any product candidate, we will face competition based on many different factors, including the quality and effectiveness of our products, the ease with which our products can be administered and the extent to which patients accept relatively new routes of administration, the timing and scope of regulatory approvals for these products, the availability and cost of manufacturing, marketing and sales capabilities, price, reimbursement coverage and patent position. Competing products could present superior treatment alternatives, including by being more effective, safer, less expensive or marketed and sold more effectively than any products we may develop. Competitive products may make any products we develop obsolete or noncompetitive before we recover the expense of developing and commercializing our product candidates. Such competitors could also recruit our employees, which could negatively impact our level of expertise and our ability to execute our business plan.

Any inability to attract and retain qualified key management and technical personnel would impair our ability to implement our business plan.

Our success largely depends on the continued service of certain key management and other specialized personnel, including Anatoly Dritschilo, M.D., our Chief Executive Officer, Mira Jung, Ph.D., our Chief Scientific Officer, Michael Vander Hoek, our Chief Financial Officer and Vice President Operations and Regulatory, and Peter Dritschilo, our President and Chief Operating Officer. The loss of one or more members of our management team or other key employees or advisors could delay our research and development programs and materially harm our business, financial condition, results of operations and prospects. The relationships that our key managers have cultivated within our industry make us particularly dependent upon their continued employment with us. We are dependent on the continued service of our technical personnel because of the highly technical nature of our product candidates and technologies and the specialized nature of the regulatory approval process. Because our management team and key employees are not obligated to provide us with continued service, they could terminate their employment with us at any time without penalty. We do not maintain key person life insurance policies on any of our management team members or key employees. Our future success will depend in large part on our continued ability to attract and retain other highly qualified scientific, technical and management personnel, as well as personnel with expertise in clinical testing, manufacturing, governmental regulation and commercialization. We face competition for personnel from other companies, universities, public and private research institutions, government entities and other organizations.

If our product candidates advance into Phase II and Phase III clinical trials, we may experience difficulties in managing our growth and expanding our operations.

We have limited experience in drug development and have not begun clinical trials for any of our product candidates, other than a Phase 1 clinical trial for Ropidoxuridine. As our product candidates enter and advance through preclinical studies and any clinical trials, we will need to expand our development, regulatory and manufacturing capabilities or contract with other organizations to provide these capabilities for us. In the future, we expect to have to manage additional relationships with collaborators or partners, suppliers and other organizations. Our ability to manage our operations and future growth will require us to continue to improve our operational, financial and management controls, reporting systems and procedures. We may not be able to implement improvements to our management information and control systems in an efficient or timely manner and may discover deficiencies in existing systems and controls.

If any of our product candidates are approved for marketing and commercialization and we are unable to develop sales, marketing and distribution capabilities on our own or enter into agreements with third parties to perform these functions on acceptable terms, we will be unable to commercialize any such future products.

We currently have no sales, marketing or distribution capabilities or experience. If any of our product candidates is approved, we plan to enter into collaborations with third parties to sell, market and distribute our products. In the alternative, we would have to develop internal sales, marketing and distribution capabilities to commercialize any approved product, which would be expensive and time-consuming, or, as is more likely, enter into collaborations with third parties to perform these services. If we rely on third parties with sales, marketing and distribution capabilities to market our products or decide to co-promote products with collaborators, we will need to establish and maintain marketing and distribution arrangements with third parties, and there can be no assurance that we will be able to enter into such arrangements on acceptable terms, if, at all. In entering into third-party marketing or distribution arrangements, any revenue we receive will depend upon the efforts of the third parties and there can be no assurance that such third parties will establish adequate sales and distribution capabilities or be successful in gaining market acceptance of any approved product. If we decide to market our products directly, we will need to commit significant financial and managerial resources to develop a marketing and sales force with technical expertise and supporting distribution, administration and compliance capabilities. If we are not able to commercialize any product approved in the future, either on our own or through third parties, our business, financial condition, results of operations and prospects could be materially adversely affected.

If we fail to comply with U.S. and foreign regulatory requirements, regulatory authorities could limit or withdraw any marketing or commercialization approvals we may receive and subject us to other penalties that could materially harm our business.

Even if we receive marketing and commercialization approval of a product candidate, there can be no assurance we will not be subject to future or continuing regulatory review, including in relation to adverse patient experiences with the product and clinical results that are reported after a product is made commercially available, both in the U.S. and any foreign jurisdiction in which we seek regulatory approval. The FDA has significant post-market authority, including the authority to require labeling changes based on new safety information and to require post-market studies or clinical trials to evaluate safety risks related to the use of a product or to require withdrawal of the product from the market. The FDA also has the authority to require a risk evaluation and mitigation strategies ("REMS") plan after approval, which may impose further requirements or restrictions on the distribution or use of an approved drug. The manufacturer and manufacturing facilities we use to make a future product, if any, will also be subject to periodic review and inspection by the FDA and other regulatory agencies, including for continued compliance with CGMP requirements. The discovery of any new or previously unknown problems with our third-party manufacturers, manufacturing processes or facilities may result in restrictions on the product, manufacturer or facility, including withdrawal of the product from the market. If we rely on third-party manufacturers, we will not have control over compliance with applicable rules and regulations by such manufacturers. Any product promotion and advertising will also be subject to regulatory requirements and continuing regulatory review. If we or our collaborators, manufacturers or service providers fail to comply with applicable continuing regulatory requirements in the U.S. or foreign jurisdictions in which we seek to market our products, we or they may be subject to, among other things, fines, warning letters, holds on clinical trials, refusal by the FDA to approve pending applications or supplements to approved applications, suspension or withdrawal of regulatory approval, product recalls and seizures, refusal to permit the import or export of products, operating restrictions, injunction, civil penalties and criminal prosecution.

Our business entails a significant risk of product liability and our ability to obtain sufficient insurance coverage could have a material effect on our business, financial condition, results of operations or prospects.

Our business exposes us to significant product liability risks inherent in the development, testing, manufacturing and marketing of therapeutic treatments. Product liability claims could delay or prevent completion of our development programs. If we succeed in marketing products, such claims could result in an FDA investigation of the quality and effectiveness of our products, our manufacturing processes and facilities or our marketing programs and potentially a recall of our products or more serious enforcement action, limitations on the approved indications for which they may be used or suspension or withdrawal of approvals. Regardless of the merits or eventual outcome, liability claims may also result in decreased demand for our products, injury to our reputation, costs to defend the related litigation, a diversion of management's time and our resources, substantial monetary awards to trial participants or patients and a decline in our stock price. We currently have product liability insurance that we believe is appropriate for our stage of development and may need to obtain higher levels prior to marketing any of our product candidates. Any insurance we have or may obtain may not provide sufficient coverage against potential liabilities. Furthermore, clinical trial and product liability insurance is becoming increasingly expensive. As a result, we may be unable to obtain sufficient insurance at a reasonable cost to protect us against losses caused by product liability claims that could have a material adverse effect on our business.

Our employees, principal investigators, CROs and consultants may engage in misconduct or other improper activities, including noncompliance with regulatory standards and requirements.

We are exposed to the risk that our employees, principal investigators, CROs and consultants may engage in fraud, other misconduct or illegal activity. Misconduct by these parties could include intentional failures to comply with FDA regulations, provide accurate information to the FDA, comply with manufacturing standards we may establish, comply with federal and state healthcare fraud and abuse laws and regulations, report financial information or data accurately or disclose unauthorized activities to us. In particular, sales, marketing and business arrangements in the healthcare industry are subject to extensive laws and regulations, kickbacks, self-dealing and other abusive practices. These laws and regulations may restrict or prohibit a wide range of pricing, discounting, marketing and promotion, sales commission, customer incentive programs and other business arrangements. While we make an effort to maintain strict work processes and oversight of our employees, contractors and consultants, any misconduct could expose us to liability through the improper use of information obtained in the course of clinical trials, which could result in regulatory sanctions and serious harm to our reputation. Furthermore, it is not always possible to identify and deter such 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 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, including the imposition of significant fines or other sanctions.

Our internal computer systems, or those of our CROs or other contractors or consultants, may fail or suffer security breaches, which could result in a material disruption of our product development programs.

Despite the implementation of cyber security measures, our internal computer systems and those of our CROs and other contractors and consultants are vulnerable to damage from computer viruses, unauthorized access, natural disasters, terrorism, war and telecommunication and electrical failures. Such events could cause interruptions of our operations. For example, the loss of preclinical data or data from any future clinical trial involving our product candidates could result in delays in our development and regulatory filing efforts and significantly increase our costs. To the extent that any disruption or security breach were to result in a loss of, or damage to, our data, or inappropriate disclosure of confidential or proprietary information, we could incur liability and the development of our product candidates could be delayed.

Our proprietary information, or that of our customers, suppliers and business partners, may be lost or we may suffer security breaches.

In the ordinary course of our business, we collect and store sensitive data, including intellectual property, clinical trial data, our proprietary business information and that of our customers, suppliers and business partners, and personally identifiable information of our customers, clinical trial subjects and employees, in our data centers and on our networks. The secure processing, maintenance and transmission of this information is critical to our operations. Despite our security measures, our information technology and infrastructure may be vulnerable to attacks by hackers or breached due to employee error, malfeasance or other disruptions. Although to our knowledge we have not experienced any such material security breach to date , any such breach could compromise our network, or the networks of our CROs or other third party service providers, and the information stored there could be accessed, publicly disclosed, lost or stolen. Any such access, disclosure or other loss of information could result in legal claims or proceedings, liability under laws that protect the privacy of personal information, regulatory penalties, disrupt our operations, damage our reputation, and cause a loss of confidence in our products and our ability to conduct clinical trials, which could adversely affect our business and reputation and lead to delays in gaining regulatory approvals for our drugs. Although we maintain business interruption insurance coverage, our insurance might not cover all losses from any future breaches of our systems.

Failure of our information technology systems could significantly disrupt the operation of our business.

Our business increasingly depends on the use of information technologies, which means that certain key areas such as research and development, production and sales are to a large extent dependent on our information systems or those of third-party providers. Our ability to execute our business plan and to comply with regulatory requirements with respect to data control and data integrity, depends, in part, on the continued and uninterrupted performance of our information technology systems, or IT systems and the IT systems supplied by third-party service providers. These systems are vulnerable to damage from a variety of sources, including telecommunications or network failures, malicious human acts and natural disasters. Moreover, despite network security and backup measures, some of our servers are potentially vulnerable to physical or electronic break-ins, computer viruses and similar disruptive problems. Despite the precautionary measures we and our third-party service providers have taken to prevent unanticipated problems that could affect our IT systems, sustained or repeated system failures or problems arising during the upgrade of any of our IT systems that interrupt our ability to generate and maintain data, and in particular to operate our proprietary technology platform, could adversely affect our ability to operate our business.

If we do not comply with laws regulating the protection of the environment and health and human safety, our business could be adversely affected.

Our research, development and manufacturing involve the use of hazardous materials and various chemicals. We maintain quantities of various flammable and toxic chemicals in our facilities in Gaithersburg, Maryland that are required for our research, development and manufacturing activities. We are subject to federal, state and local laws and regulations governing the use, manufacture, storage, handling and disposal of these hazardous materials. We believe our procedures for storing, handling and disposing these materials in our Gaithersburg facilities comply with the relevant guidelines of Gaithersburg, the State of Maryland and the Occupational Safety and Health Administration of the U.S. Department of Labor. Although we believe that our safety procedures for handling and disposing of these materials comply with the standards mandated by applicable regulations, the risk of accidental contamination or injury from these materials cannot be eliminated. If an accident occurs, we could be held liable for resulting damages, which could be substantial. We are also subject to numerous environmental, health and workplace safety laws and regulations, including those governing laboratory procedures, exposure to blood-borne pathogens and the handling of animals and biohazardous materials. 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 these 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 or hazardous materials. Additional federal, state and local laws and regulations affecting our operations may be adopted in the future. We may incur substantial costs to comply with, and substantial fines or penalties if we violate any of these laws or regulations.

Our information technology systems could face serious disruptions that could adversely affect our business.

Our information technology and other internal infrastructure systems, including corporate firewalls, servers, leased lines and connection to the Internet, face the risk of systemic failure that could disrupt our operations. A significant disruption in the availability of our information technology and other internal infrastructure systems could cause interruptions in our collaborations with our partners and delays in our research and development work.

Changes in accounting rules and regulations, or interpretations thereof, could result in unfavorable accounting charges or require us to change our compensation policies.

Accounting methods and policies for pharmaceutical companies, including policies governing revenue recognition, research and development and related expenses and accounting for stock-based compensation are subject to review, interpretation and guidance from relevant accounting authorities, including the SEC. Changes to accounting methods or policies, or interpretations thereof, may require us to reclassify, restate or otherwise change or revise our financial statements, including those contained in this Annual Report.

Risks Related to Our Intellectual Property

If we are not able to obtain and enforce patent protection for our technologies or product candidates, development and commercialization of our product candidates may be adversely affected.

Our success depends in part on our ability to obtain and maintain patents and other forms of intellectual property rights, including in-licenses of intellectual property rights of others, for our product candidates, methods used to manufacture our product candidates and methods for treating patients using our product candidates, as well as our ability to preserve our trade secrets, to prevent third parties from infringing upon our proprietary rights and to operate without infringing upon the proprietary rights of others. As of the date of this Annual Report, we have filed five patent applications with the U.S. Patent and Trademark Office (the "USPTO") with respect to various aspects of our HDAC inhibitor small molecule delivery platform and Ropidoxuridine, our lead product candidate. However, we may not be able to apply for patents on certain aspects of our product candidates or delivery technologies in a timely fashion or at all. To date, four U.S. patents and two European patents have been granted. There is no guarantee that any of our pending patent applications will result in issued or granted patents, that any of our issued, granted or licensed patents will not later be found to be invalid or unenforceable or that any issued, granted or licensed patents will include claims that are sufficiently broad to cover our product candidates or delivery technologies or to provide meaningful protection from our competitors. Moreover, the patent position of specialty pharmaceutical companies can be highly uncertain because it involves complex legal and factual questions. We will be able to protect our proprietary rights from unauthorized use by third parties only to the extent that our current and future proprietary technology and product candidates are covered by valid and enforceable patents or are effectively maintained as trade secrets. If third parties disclose or misappropriate our proprietary rights, it may materially and adversely impact our position in the market.

The USPTO and various foreign governmental patent agencies require compliance with a number of procedural, documentary, fee payment and other requirements during the patent process. There are situations in which noncompliance can result in abandonment or lapse of a patent or patent application, resulting in partial or complete loss of patent rights in the relevant jurisdiction. In such an event, competitors might be able to enter the market earlier than would otherwise have been the case. The standards applied by the USPTO and foreign patent offices in granting patents are not always applied uniformly or predictably. For example, there is no uniform worldwide policy regarding patentable subject matter or the scope of claims allowable in pharmaceutical patents. As such, we do not know the degree of future protection that we will have on our proprietary products and technology. While we will endeavor to try to protect our product candidates with intellectual property rights such as patents, as appropriate, the process of obtaining patents is time-consuming, expensive and sometimes unpredictable.

We may decide for business reasons to no longer pursue or to abandon certain intellectual property rights in the U.S. or elsewhere, including due to non-cooperation of inventors or owners of such intellectual property, prior art, or scope of protection, or for other reasons.

Once granted, patents may remain open to opposition, interference, re-examination, post-grant review, inter partes review, nullification or derivation action in court or before patent offices or similar proceedings for a given period after allowance or grant, during which time third parties can raise objections against such initial grant. In the course of such proceedings, which may continue for a protracted period of time, the patent owner may be compelled to limit the scope of the allowed or granted claims thus attacked, or may lose the allowed or granted claims altogether. In addition, there can be no assurance that:

- others will not or may not be able to make, use or sell compounds that are the same as or similar to our product candidates but that are not covered by the claims of the patents that we own or license;
- we or our licensors, collaborators or any future collaborators are the first to make the inventions covered by each of our issued patents and pending patent applications that we own or license;
- we or our licensors, collaborators or any future collaborators are the first to file patent applications covering certain aspects of our inventions;
- others will not independently develop similar or alternative technologies or duplicate any of our technologies without infringing our intellectual property rights;
- A third party may not challenge our patents and, if challenged, a court may not hold that our patents are valid, enforceable and infringed;
- any issued patents that we own or have licensed will provide us with any competitive advantages, or will not be challenged by third parties;
- we may develop additional proprietary technologies that are patentable;
- the patents of others will not have an adverse effect on our business; and
- our competitors do not conduct research and development activities in countries where we do not have enforceable patent rights and then use the information learned from such activities to develop competitive products for sale in our major commercial markets.

We intend to license patent rights from third-party owners or licensees. If such owners or licensees do not properly or successfully obtain, maintain or enforce the patents underlying such licenses, or if they retain or license to others any competing rights, our competitive position and business prospects may be adversely affected. We may not be able to protect our intellectual property rights throughout the world.

Obtaining a valid and enforceable issued or granted patent covering our technology in the U.S. and worldwide can be extremely costly. In jurisdictions where we have not obtained patent protection, competitors may use our technology to develop their own products and further, may export otherwise infringing products to territories where we have patent protection, but where it is more difficult to enforce a patent as compared to the U.S. Competitor products may compete with our future products in jurisdictions where we do not have issued or granted patents or where our issued or granted patent claims or other intellectual property rights are not sufficient to prevent competitor activities in these jurisdictions. The legal systems of certain countries, particularly certain developing countries, make it difficult to enforce patents and such countries may not recognize other types of intellectual property protection, particularly that relating to biopharmaceuticals. This could make it difficult for us to prevent the infringement of patents or marketing of competing products in violation of our proprietary rights generally in certain jurisdictions. Proceedings to enforce our patent rights in foreign jurisdictions could result in substantial cost and divert our efforts and attention from other aspects of our business.

We generally file a provisional patent application first (a priority filing) at the USPTO. A U.S. utility application and international application under the Patent Cooperation Treaty (PCT) are usually filed within twelve months after the priority filing. Based on the PCT filing, national and regional patent applications may be filed in the European Union, Japan, Australia and Canada and other countries. We have so far not filed for patent protection in all national and regional jurisdictions where such protection may be available. In addition, we may decide to abandon national and regional patent applications before grant. Finally, the grant proceeding of each national or regional patent is an independent proceeding which may lead to situations in which applications might in some jurisdictions be refused by the relevant registration authorities, while granted by others. It is also quite common that depending on the country, various scopes of patent protection may be granted on the same product candidate or technology. The laws of some jurisdictions do not protect intellectual property rights to the same extent as the laws in the U.S., and many companies have encountered significant difficulties in protecting and defending such rights in such jurisdictions. If we or our licensors encounter difficulties in protecting, or are otherwise precluded from effectively protecting, the intellectual property rights important for our business in such jurisdictions, the value of these rights may be diminished, and we may face additional competition from others in those jurisdictions. Many countries have compulsory licensing laws under which a patent owner may be compelled to grant licenses to third parties. In addition, many countries limit the enforceability of patents against government agencies or government contractors. In these countries, the patent owner may have limited remedies, which could materially diminish the value of such patent. If we or any of our licensors are forced to grant a license to third parties with respect to any patents relevant to our business, our competitive position in the relevant jurisdiction may be impaired and our business and results of operations may be adversely affected.

We or our licensors, or any future collaborators or a strategic partners may become subject to third party claims or litigation alleging infringement of patents or other proprietary rights or seeking to invalidate patents or other proprietary rights, and we may need to resort to litigation to protect or enforce our patents or other proprietary rights, all of which could be costly, time consuming, delay or prevent the development and commercialization of our product candidates, or put our patents and other proprietary rights at risk.

We or our licensors, or any future collaborators or strategic partners may be subject to third-party claims for infringement or misappropriation of patent or other proprietary rights. We are generally obligated under our license or collaboration agreements to indemnify and hold harmless our licensors or collaborator for damages arising from intellectual property infringement by us. If we or our licensors, or any future collaborators or strategic partners are found to infringe a third-party patent or other intellectual property rights, we could be required to pay damages, potentially including treble damages, if we are found to have willfully infringed. In addition, we or our licensors, collaborators or any future strategic partners may choose to seek, or be required to seek, a license from a third party, which may not be available on acceptable terms, if at all. Even if a license can be obtained on acceptable terms, the rights may be non-exclusive, which could give our competitors access to the same technology or intellectual property rights licensed to us. If we fail to obtain a required license, we or our collaborator, or any future collaborator, may be unable to effectively market product candidates based on our technology, which could limit our ability to generate revenue or achieve profitability and possibly prevent us from generating revenue sufficient to sustain our operations. In addition, we may find it necessary to pursue claims or initiate lawsuits to protect or enforce our patent or other intellectual property rights. The cost to us in defending or initiating any litigation or other proceeding relating to patent or other proprietary rights, even if resolved in our favor, could be substantial, and litigation would divert our management's attention. Some of our competitors may be able to sustain the costs of complex patent litigation more effectively than we can because they have substantially greater resources. Uncertainties resulting from the initiation and continuation of patent litigation or other proceedings could delay our research and development efforts and limit our ability to continue our operations.

If we were to initiate legal proceedings against a third party to enforce a patent covering one of our products or our technology, the defendant could counterclaim that our patent is invalid or unenforceable. In patent litigation in the U.S., defendant counterclaims alleging invalidity or unenforceability are commonplace. Grounds for a validity challenge could be an alleged failure to meet any of several statutory requirements, for example, lack of novelty, obviousness or non-enablement. Grounds for an unenforceability assertion could be an allegation that someone connected with prosecution of the patent withheld relevant information from the USPTO, or made a misleading statement, during prosecution. The outcome following legal assertions of invalidity and unenforceability during patent litigation is unpredictable. With respect to the validity question, for example, we cannot be certain that there is no invalidating prior art, of which we and the patent examiner were unaware during prosecution. If a defendant were to prevail on a legal assertion of invalidity or unenforceability, we would lose at least part, and perhaps all, of the patent protection on one or more of our products or certain aspects of our platform technology. Such a loss of patent protection could have a material adverse impact on our business. Patents and other intellectual property rights also will not protect our technology if competitors design around our protected technology without legally infringing our patents or other intellectual property rights.

Intellectual property rights of third parties could adversely affect our ability to commercialize our product candidates, and we might be required to litigate or obtain licenses from third parties in order to develop or market our product candidates. Such litigation or licenses could be costly or not available on commercially reasonable terms.

Our competitive position may suffer if patents issued to third parties or other third-party intellectual property rights cover our products or elements thereof, or our manufacture or uses relevant to our development plans. In such cases, we may not be in a position to develop or commercialize products or product candidates unless we successfully pursue litigation to nullify or invalidate the third-party intellectual property right concerned, or enter into a license agreement with the intellectual property right holder, if available on commercially reasonable terms.

Third party intellectual property right holders may also actively bring infringement claims against us. We cannot guarantee that we will be able to successfully settle or otherwise resolve such infringement claims. If we are unable to successfully settle future claims on terms acceptable to us, we may be required to engage in or continue costly, unpredictable and time-consuming litigation and may be prevented from or experience substantial delays in marketing our products. If we fail in any such dispute, in addition to being forced to pay damages, we may be temporarily or permanently prohibited from commercializing any of our product candidates that are held to be infringing. We might, if possible, also be forced to redesign product candidates so that we no longer infringe the third-party intellectual property rights. Any of these events, even if we were ultimately to prevail, could require us to divert substantial financial and management resources that we would otherwise be able to devote to our business.

If we fail to comply with our obligations under any license, collaboration or other agreements, we may be required to pay damages and could lose intellectual property rights that are necessary for developing and protecting our product candidates and delivery technologies or we could lose certain rights to grant sublicenses.

Our current licenses impose, and any future licenses we enter into are likely to impose, various development, commercialization, funding, milestone, royalty, diligence, sublicensing, insurance, patent prosecution and enforcement, and other obligations on us. If we breach any of these obligations, or use the intellectual property licensed to us in an unauthorized manner, we may be required to pay damages and the licensor may have the right to terminate the license, which could result in us being unable to develop, manufacture and sell products that are covered by the licensed technology or enable a competitor to gain access to the licensed technology. Moreover, our licensors may own or control intellectual property that has not been licensed to us and, as a result, we may be subject to claims, regardless of their merit, that we are infringing or otherwise violating the licensor's rights. In addition, while we cannot currently determine the amount of the royalty obligations we would be required to pay on sales of future products, if any, the amounts may be significant. The amount of our future royalty obligations will depend on the technology and intellectual property we use in products that we aim to develop and commercialize, if any. Therefore, even if we are able to develop and commercialize products, we may be unable to achieve or maintain profitability.

If we are unable to protect the confidentiality of our trade secrets, our business and competitive position would be harmed.

In addition to seeking patent protection for certain aspects of our product candidates and delivery technologies, we also consider trade secrets, including confidential and unpatented know-how important to the maintenance of our competitive position. We protect trade secrets and confidential and unpatented know-how, in part, by entering into non-disclosure and confidentiality agreements with parties who have access to such knowledge, such as our employees, corporate collaborators, outside scientific collaborators, CROs, contract manufacturers, consultants, advisors and other third parties. We also enter into confidentiality and invention or patent assignment agreements with our employees and consultants that obligate them to maintain confidentiality and assign their inventions to us. Despite these efforts, any of these parties may breach the agreements and disclose our proprietary information, including our trade secrets, and we may not be able to obtain adequate remedies for such breaches. Enforcing a claim that a party illegally disclosed or misappropriated a trade secret is difficult, expensive and time-consuming, and the outcome is unpredictable. In addition, some courts in the U.S. and certain foreign jurisdictions are less willing or unwilling to protect trade secrets. If any of our trade secrets were to be lawfully obtained or independently developed by a competitor, we would have no right to prevent them from using that technology or information to compete with us. If any of our trade secrets were to be disclosed to or independently developed by a competitor, our competitive position would be harmed.

We may be subject to claims that we or our employees or consultants have wrongfully used or disclosed alleged trade secrets of our employees' or consultants' former employers or their clients. These claims may be costly to defend and if we do not successfully do so, we may be required to pay monetary damages and may lose valuable intellectual property rights or personnel.

Many of our employees were previously employed at universities or biotechnology or pharmaceutical companies, including our competitors or potential competitors. Although no claims against us are currently pending, we may be subject to claims that these employees or we have inadvertently or otherwise used or disclosed trade secrets or other proprietary information of their former employers. Litigation may be necessary to defend against these claims. If we fail in defending such claims, in addition to paying monetary damages, we may lose valuable intellectual property rights or personnel. A loss of key research personnel or their work product could hamper our ability to commercialize, or prevent us from commercializing, our product candidates, which could severely harm our business. Even if we are successful in defending against these claims, litigation could result in substantial costs and be a distraction to management.

If our trademarks and trade names are not adequately protected, then we may not be able to build name recognition in our markets of interest and our business may be adversely affected.

Our trademarks or trade names may be challenged, infringed, circumvented or declared generic or determined to be infringing on other marks. We may not be able to protect our rights to these trademarks and trade names or may be forced to stop using these names, which we need for name recognition by potential partners or customers in our markets of interest. If we are unable to establish name recognition based on our trademarks and trade names, we may not be able to effectively compete and our business may be adversely affected.

Risks Related to Government Regulation and Product Approvals

We may be unable to obtain U.S. or foreign regulatory approval and, as a result, unable to commercialize our product candidates.

Our product candidates are subject to extensive governmental regulations relating to, among other things, research, testing, development, manufacturing, safety, efficacy, approval, recordkeeping, reporting, labeling, storage, packaging, advertising and promotion, pricing, marketing and distribution of drugs. Rigorous preclinical testing and clinical trials and an extensive regulatory approval process are required to be completed in the U.S. and in many foreign jurisdictions before a new drug can be marketed. Satisfaction of these and other regulatory requirements is costly, time consuming, uncertain and subject to unanticipated delays. It is possible that none of the product candidates we may develop will obtain the regulatory approvals necessary for us or our collaborators to begin selling them.

We have very limited experience in conducting and managing the clinical trials necessary to obtain regulatory approvals, including approval by the FDA. The time required to obtain FDA and other approvals is unpredictable but typically takes many years following the commencement of clinical trials, depending upon the type, complexity and novelty of the product candidate. The standards that the FDA and its foreign counterparts use when regulating us are not always applied predictably or uniformly and can change. Any analysis we perform of data from preclinical and clinical activities is subject to confirmation and interpretation by regulatory authorities, which could delay, limit or prevent regulatory approval. We may also encounter unexpected delays or increased costs due to new government regulations, for example, from future legislation or administrative action, or from changes in FDA policy during the period of product development, clinical trials and FDA regulatory review. It is impossible to predict whether legislative changes will be enacted, or whether FDA or foreign regulations, guidance or interpretations will be changed, or what the impact of such changes, if any, may be.

Any delay or failure in obtaining required approvals could have a material adverse effect on our ability to generate revenues from the particular product candidate for which we are seeking approval. Furthermore, any regulatory approval to market a product may be subject to limitations on the approved uses for which we may market the product or the labeling or other restrictions. In addition, the FDA has the authority to require a Risk Evaluation and Mitigation Strategy (REMS) plan as part of an NDA or biologics license application (BLA) or after approval, which may impose further requirements or restrictions on the distribution or use of an approved drug or biologic, such as limiting prescribing to certain physicians or medical centers that have undergone specialized training, limiting treatment to patients who meet certain safe-use criteria and requiring treated patients to enroll in a registry. These limitations and restrictions may limit the size of the market for the product and affect reimbursement by third-party payors.

If we or our collaborators, manufacturers or service providers fail to comply with healthcare laws and regulations, we or they could be subject to enforcement actions, which could affect our ability to develop, market and sell our products and may harm our reputation.

We and our collaborators are subject to federal, state, and foreign healthcare laws and regulations pertaining to fraud and abuse and patients' rights. These laws and regulations include:

- the U.S. federal healthcare program anti-kickback law, which prohibits, among other things, persons from soliciting, receiving or providing remuneration, directly or indirectly, to induce either the referral of an individual for a healthcare item or service, or the purchasing or ordering of an item or service, for which payment may be made under a federal healthcare program such as Medicare or Medicaid;

- the U.S. federal false claims law, which prohibits, among other things, individuals or entities from knowingly presenting or causing to be presented, claims for payment by government funded programs such as Medicare or Medicaid that are false or fraudulent, and which may apply to us by virtue of statements and representations made to customers or third parties;

- the U.S. federal Health Insurance Portability and Accountability Act (HIPAA) and Health Information Technology for Economic and Clinical Health (HITECH) Act, which prohibit executing a scheme to defraud healthcare programs, impose requirements relating to the privacy, security, and transmission of individually identifiable health information, and require notification to affected individuals and regulatory authorities of certain breaches of security of individually identifiable health information;

- the federal Open Payments regulations under the National Physician Payment Transparency Program have been issued under the Patient Protection and Affordable Care Act, as amended by the Health Care and Education Affordability Reconciliation Act, and will require that manufacturers of pharmaceutical and biological drugs covered by Medicare, Medicaid, and Children's Health Insurance Programs report all consulting fees, travel reimbursements, research grants, and other payments or gifts with values over $10 made to physicians and teaching hospitals; and

- state laws comparable to each of the above federal laws, such as, for example, anti-kickback and false claims laws applicable to commercial insurers and other non-federal payors, requirements for mandatory corporate regulatory compliance programs, and laws relating to patient data privacy and security.

If our operations are found to be in violation of any such requirements, we may be subject to penalties, including civil or criminal penalties, monetary damages, the curtailment or restructuring of our operations, loss of eligibility to obtain approvals from the FDA, or exclusion from participation in government contracting, healthcare reimbursement or other government programs, including Medicare and Medicaid, any of which could adversely our financial results. Although effective compliance programs can mitigate the risk of investigation and prosecution for violations of these laws, these risks cannot be entirely eliminated. Any action against us for an alleged or suspected violation could cause us to incur significant legal expenses and could divert our management's attention from the operation of our business, even if our defense is successful. In addition, achieving and sustaining compliance with applicable laws and regulations may be costly to us in terms of money, time and resources.

If we or our collaborators, manufacturers or service providers fail to comply with applicable federal, state or foreign laws or regulations, we could be subject to enforcement actions, which could affect our ability to develop, market and sell our products successfully and could harm our reputation and lead to reduced acceptance of our products by the market. These enforcement actions include, among others:

- adverse regulatory inspection findings;

- warning letters;

- voluntary or mandatory product recalls or public notification or medical product safety alerts to healthcare professionals;

- restrictions on, or prohibitions against, marketing our products;

- restrictions on, or prohibitions against, importation or exportation of our products;

- suspension of review or refusal to approve pending applications or supplements to approved applications;
- exclusion from participation in government-funded healthcare programs;
- exclusion from eligibility for the award of government contracts for our products;
- suspension or withdrawal of product approvals;
- product seizures;
- injunctions; and
- civil and criminal penalties and fines.

Any drugs we develop may become subject to unfavorable pricing regulations, third-party reimbursement practices or healthcare reform initiatives, thereby harming our business.

The regulations that govern marketing approvals, pricing and reimbursement for new drugs vary widely from country to country. Some countries require approval of the sale price of a drug before it can be marketed. In many countries, the pricing review period begins after marketing or product licensing approval is granted. In some foreign markets, prescription pharmaceutical pricing remains subject to continuing governmental control even after initial approval is granted. Although we intend to monitor these regulations, our programs are currently in the early stages of development and we will not be able to assess the impact of price regulations for a number of years. As a result, we might obtain regulatory approval for a product in a particular country, but then be subject to price regulations that delay our commercial launch of the product and negatively impact the revenues we are able to generate from the sale of the product in that country.

Our ability to commercialize any products also will depend in part on the extent to which reimbursement for these products and related treatments will be available from government health administration authorities, private health insurers and other organizations. Even if we succeed in bringing one or more products to the market, these products may not be considered cost-effective, and the amount reimbursed for any products may be insufficient to allow us to sell our products on a competitive basis. Because our programs are in the early stages of development, we are unable at this time to determine their cost effectiveness or the likely level or method of reimbursement. Increasingly, the third-party payors who reimburse patients or healthcare providers, such as government and private insurance plans, are requiring that drug companies provide them with predetermined discounts from list prices and are seeking to reduce the prices charged or the amounts reimbursed for pharmaceutical products. If the price we are able to charge for any products we develop, or the reimbursement provided for such products, is inadequate in light of our development and other costs, our return on investment could be adversely affected.

Our current product candidates will need to be administered under the supervision of a physician on an outpatient basis. Under currently applicable U.S. law, certain drugs that are not usually self-administered (including injectable drugs) may be eligible for coverage under the Medicare Part B program if:

- they are incident to a physician’s services;
- they are reasonable and necessary for the diagnosis or treatment of the illness or injury for which they are administered according to accepted standards of medical practice; and
- they have been approved by the FDA and meet other requirements of the statute.

There may be significant delays in obtaining coverage for newly-approved drugs, and coverage may be more limited than the purposes for which the drug is approved by the FDA. Moreover, eligibility for coverage does not imply that any drug will be reimbursed in all cases or at a rate that covers our costs, including research, development, manufacture, sale and distribution. Interim payments for new drugs, if applicable, may also not be sufficient to cover our costs and may not be made permanent. Reimbursement may be based on payments allowed for lower- cost drugs that are already reimbursed, may be incorporated into existing payments for other services and may reflect budgetary constraints or imperfections in Medicare data. Net prices for drugs may be reduced by mandatory discounts or rebates required by government healthcare programs or private payors and by any future relaxation of laws that presently restrict imports of drugs from countries where they may be sold at lower prices than in the U.S. Third-party payors often rely upon Medicare coverage policy and payment limitations in setting their own reimbursement rates. Our inability to promptly obtain coverage and adequate reimbursement rates from both government-funded and private payors for new drugs that we develop and for which we obtain regulatory approval could have a material adverse effect on our operating results, our ability to raise capital needed to commercialize products and our financial condition.

We believe that the efforts of governments and third-party payors to contain or reduce the cost of healthcare and legislative and regulatory proposals to broaden the availability of healthcare will continue to affect the business and financial condition of pharmaceutical and biopharmaceutical companies. A number of legislative and regulatory changes in the healthcare system in the U.S. and other major healthcare markets have been proposed in recent years, and such efforts have expanded substantially in recent years. These developments have included prescription drug benefit legislation that was enacted and took effect in January 2006, healthcare reform legislation enacted by certain states, and Patient Protection and Affordable Care Act, as amended by the Health Care and Education Affordability Reconciliation Act (the "ACA"), a sweeping law intended to broaden access to health insurance, reduce or constrain the growth of healthcare spending and enhance remedies against fraud and abuse. The ACA also contains provisions that will affect companies in the pharmaceutical industry and other healthcare related industries by imposing additional costs and changes to business practices. Provisions affecting pharmaceutical companies include the following:

- mandatory rebates for drugs sold into the Medicaid program have been increased, and the rebate requirement has been extended to drugs used in risk-based Medicaid managed care plans;

- the 340B Drug Pricing Program under the Public Health Services Act has been extended to require mandatory discounts for drug products sold to certain critical access hospitals, cancer hospitals and other covered entities;

- pharmaceutical companies are required to offer discounts on brand-name drugs to patients who fall within the Medicare Part D coverage gap, commonly referred to as the "Donut Hole"; and

- pharmaceutical companies are required to pay an annual non-tax deductible fee to the federal government based on each company's market share of prior year total sales of branded products to certain federal healthcare programs, such as Medicare, Medicaid, Department of Veterans Affairs and Department of Defense. Since we expect our branded pharmaceutical sales to constitute a small portion of the total federal health program pharmaceutical market, we do not expect this annual assessment to have a material impact on our financial condition.

Moreover, we cannot predict what healthcare reform initiatives may be adopted in the future. Further federal and state legislative and regulatory developments are likely, and we expect ongoing initiatives in the U.S. to increase pressure on drug pricing. Such reforms could have an adverse effect on anticipated revenues from product candidates that we may develop and for which we may obtain regulatory approval and may affect our overall financial condition and ability to develop product candidates.

Our ability to obtain services, reimbursement or funding from the federal government may be impacted by possible reductions in federal spending.

U.S. federal government agencies currently face potentially significant spending reductions. Under the Budget Control Act of 2011, the failure of Congress to enact deficit reduction measures of at least $1.2 trillion for the years 2013 through 2021 triggered automatic cuts to most federal programs. These cuts would include aggregate reductions to Medicare payments to providers of up to two percent per fiscal year, starting in 2013. Under the American Taxpayer Relief Act of 2012, which was enacted on January 1, 2013, the imposition of these automatic cuts was delayed until March 1, 2013. Certain of these automatic cuts have been implemented. The full impact on our business of these automatic cuts is uncertain. If federal spending is reduced, anticipated budgetary shortfalls may also impact the ability of relevant agencies, such as the FDA or the NIH to continue to function at current levels. Amounts allocated to federal grants and contracts may be reduced or eliminated. These reductions may also impact the ability of relevant agencies to timely review and approve drug research and development, manufacturing, and marketing activities, which may delay our ability to develop, market and sell any products we may develop.

If any of our product candidates receives marketing approval and we or others later identify undesirable side effects caused by the product candidate, our ability to market and derive revenue from the product candidates could be compromised.

In the event that any of our product candidates receive regulatory approval and we or others identify undesirable side effects caused by one of our products, any of the following adverse events could occur, which could result in the loss of significant revenue to us and materially and adversely affect our results of operations and business:

- regulatory authorities may withdraw their approval of the product or seize the product;

- we may be required to recall the product or change the way the product is administered to patients;

- additional restrictions may be imposed on the marketing of the particular product or the manufacturing processes for the product or any component thereof;

- we may be subject to fines, injunctions or the imposition of civil or criminal penalties;

- regulatory authorities may require the addition of labeling statements, such as a "black box" warning or a contraindication;

- we may be required to create a Medication Guide outlining the risks of such side effects for distribution to patients;

- we could be sued and held liable for harm caused to patients;

- the product may become less competitive; and

- our reputation.

Risks Related to our Common Stock

Our internal controls may be inadequate, which could cause our financial reporting to be unreliable and lead to misinformation being disseminated to the public.

Our management is responsible for establishing and maintaining adequate internal control over financial reporting. As defined in Rule 13a-15(f) under the Securities Exchange Act of 1934, as amended (the "Exchange Act"), internal control over financial reporting is a process designed by, or under the supervision of, the principal executive and principal financial officer and effected by the 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 our assets;

- 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/or 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.

We are required to include a report of management on the effectiveness of our internal control over financial reporting. We expect to incur additional expenses and diversion of management's time as a result of performing the system and process evaluation, testing and remediation required in order to comply with the management certification requirements.

We do not have a sufficient number of employees to segregate responsibilities and may be unable to afford increasing our staff or engaging outside consultants or professionals to overcome our lack of employees. During the course of our testing, we may identify other deficiencies that we may not be able to timely remediate. Moreover, effective internal controls, particularly those related to revenue recognition, are necessary for us to produce reliable financial reports and are important to help prevent financial fraud. If we cannot provide reliable financial reports or prevent fraud, our business and operating results could be harmed, investors could lose confidence in our reported financial information, and the trading price of our common stock, if a market ever develops, could drop significantly.

The Jobs Act has reduced the information that we are required to disclose.

Under the Jobs Act, the information that we will be required to disclose has been reduced in a number of ways.

As a company that had gross revenues of less than $1.0 billion during the Company's last fiscal year, the Company is an "emerging growth company," as defined in the Jobs Act (an "EGC"). We will retain that status until the earliest of (a) the last day of the fiscal year which we have total annual gross revenues of $1,000,000,000 (as indexed for inflation in the manner set forth in the Jobs Act) or more; (b) the last day of the fiscal year of following the fifth anniversary of the date of the first sale of the common stock pursuant to an effective registration statement under the Securities Act of 1933, as amended (the "Securities Act"); (c) the date on which we have, during the previous three year period, issued more than $1,000,000,000 in non-convertible debt; or (d) the date on which we are deemed to be a "large accelerated filer," as defined in Rule 12b-2 under the Exchange Act or any successor thereto. As an EGC, the Company is relieved from the following:

- The Company is excluded from Section 404(b) of Sarbanes-Oxley Act ("Sarbanes-Oxley"), which otherwise would have required the Company's auditors to attest to and report on the Company's internal control over financial reporting. The JOBS Act also amended Section 103(a)(3) of Sarbanes-Oxley to provide that (i) any new rules adopted by the PCAOB requiring mandatory audit firm rotation or changes to the auditor's report to include auditor discussion and analysis (in the event the PCAOB adopts an auditor rotation requirement) will not apply to an audit of an EGC; and (ii) any other future rules adopted by the PCAOB will not apply to the Company's audits unless the SEC determines otherwise.

- The Jobs Act amended Section 7(a) of the Securities Act to provide that the Company need not present more than two years of audited financial statements in an initial public offering registration statement and in any other registration statement, need not present selected financial data pursuant to Item 301 of Regulation S-K for any period prior to the earliest audited period presented in connection with such initial public offering. In addition, the Company is not required to comply with any new or revised financial accounting standard until such date as a private company (i.e., a company that is not an "issuer" as defined by Section 2(a) of Sarbanes-Oxley) is required to comply with such new or revised accounting standard. Corresponding changes have been made to the Exchange Act, which relates to periodic reporting requirements, which would be applicable if the Company were required to comply with them.

- As long as we are an EGC, we may comply with Item 402 of Regulation S-K, which requires extensive quantitative and qualitative disclosure regarding executive compensation, by disclosing the more limited information required of a "smaller reporting company."

- The Jobs Act will also exempt us from the following additional compensation-related disclosure provisions that were imposed on U.S. public companies pursuant to the Dodd-Frank Act: (i) the advisory vote on executive compensation required by Section 14A(a) of the Exchange Act; (ii) the requirements of Section 14A(b) of the Exchange Act relating to stockholders advisory votes on "golden parachute" compensation; (iii) the requirements of Section 14(i) of the Exchange Act as to disclosure relating to the relationship between executive compensation and our financial performance; and (iv) the requirement of Section 953(b)(1) of the Dodd-Frank Act, which requires disclosure as to the relationship between the compensation of our chief executive officer and median employee pay.

Our stock price may be volatile, and purchasers of our common stock could incur substantial losses.

Since commencement of trading on Nasdaq Stock Market LLC or Nasdaq, on August 29, 2022, our stock price has been extremely volatile, having traded as high as $126.26 and as low as $1.67. As a result of this volatility, investors may not be able to sell their common stock at or above the initial public offering price. The market price for our common stock may be influenced by many factors, including the other risks described in this section of this Annual Report entitled "Risk Factors" and the following:

- the success of competitive products or technologies;

- results of preclinical and clinical studies of our product candidates, or those of our competitors, our existing collaborator or any future collaborators;

- regulatory or legal developments in the U.S. and other countries, especially changes in laws or regulations applicable to our products;

- introductions and announcements of new products by us, our commercialization partners, or our competitors, and the timing of these introductions or announcements;

- actions taken by regulatory agencies with respect to our products, clinical studies, manufacturing process or sales and marketing terms;
- actual or anticipated variations in our financial results or those of companies that are perceived to be similar to us;
- the success of our efforts to acquire or in-license additional technologies, products or product candidates;
- developments concerning our collaborations, including but not limited to those with our sources of manufacturing supply and our commercialization partners;
- announcements by us or our competitors of significant acquisitions, strategic partnerships, joint ventures or capital commitments;
- developments or disputes concerning patents or other proprietary rights, including patents, litigation matters and our ability to obtain patent protection for our products;
- our ability or inability to raise additional capital and the terms on which we raise it;
- the recruitment or departure of key personnel;
- changes in the structure of healthcare payment systems;
- market conditions in the pharmaceutical and biotechnology sectors;
- actual or anticipated changes in earnings estimates or changes in stock market analyst recommendations regarding our common stock, other comparable companies or our industry generally;
- our failure or the failure of our competitors to meet analysts' projections or guidance that we or our competitors may give to the market;
- fluctuations in the valuation of companies perceived by investors to be comparable to us;
- announcement and expectation of additional financing efforts;
- speculation in the press or investment community;
- trading volume of our common stock;
- sales of our common stock by us or our stockholders;
- the concentrated ownership of our common stock;
- changes in accounting principles;
- terrorist acts, acts of war or periods of widespread civil unrest;
- natural disasters and other calamities; and
- general economic, industry and market conditions.

In addition, the stock markets in general, and the markets for pharmaceutical stocks, in particular, have experienced extreme volatility that has been often unrelated to the operating performance of the issuer. These broad market and industry factors may seriously harm the market price of our common stock, regardless of our operating performance.

The future issuance of equity or of debt securities that are convertible into common stock will dilute our share capital.

We may choose to raise additional capital in the future, depending on market conditions, strategic considerations and operational requirements. To the extent that additional capital is raised through the issuance of shares or other securities convertible into shares of our common stock, our stockholders will be diluted. Future issuances of our common stock or other equity securities, or the perception that such sales may occur, could adversely affect the trading price of our common stock and impair our ability to raise capital through future offerings of shares or equity securities. No prediction can be made as to the effect, if any, that future sales of common stock or the availability of common stock for future sales will have on the trading price of our common stock.

Following our IPO on August 29, 2022, Holders of 1% or more of our common stock prior to our IPO are subject to a six month lock-up agreement, and all directors, officers and 10% shareholders are subject to a one year lock-up post-IPO. At such time as such stock becomes available for sale, it is possible a significant number of our shares may cause the market price of our common stock to drop significantly.

Commencing at the end of February 2023, 6,348,990 shares of our fully diluted common stock outstanding as of the date of this Annual Report will be eligible for sale in the public market from time to time thereafter pursuant to Rule 144 under the Securities Act, and 3,030,108 shares of our fully diluted common stock will be eligible for resale following a one-year lock-up period; some of such shares may be subject to the volume and other restrictions of Rule 144. Further, we have 2,581,146 shares reserved for issuance under our 2018 Equity Incentive Plan (the "Plan"), which shares may be issued from time to time by our management and which will then be subject to vesting and other requirements, and 23,724 shares which have been issued under the Plan but remain subject to vesting conditions. At such time as the lock-up periods end, or if it ends earlier pursuant to the discretion of the underwriter for our initial public offering, it is possible that a significant number of such shares will be sold into the market. At such time, the sale of a significant number of shares of our common stock in the public market or the perception that such sales may occur could significantly reduce the market price of our common stock.

If we fail to maintain applicable listing requirements, Nasdaq may delist our common stock from trading, in which case the liquidity and market price of our common stock could decline.

We cannot assure you that we will be able to meet the continued listing standards of Nasdaq in the future. If we fail to comply with the applicable listing standards and Nasdaq delists our common stock, we and our stockholders could face significant material adverse consequences, including:

- a limited availability of market quotations for shares of our common stock;
- reduced liquidity for our common stock;
- a determination that our common stock is "penny stock," which would require brokers trading in our common stock to adhere to more stringent rules and possibly result in a reduced level of trading activity in the secondary trading market for shares of our common stock;
- a limited amount of news about us and analyst coverage of us; and
- a decreased ability for us to issue additional equity securities or obtain additional equity or debt financing in the future.

The National Securities Markets Improvement Act of 1996, which is a federal statute, prevents or preempts the states from regulating the sale of certain securities, which are referred to as "covered securities." Because our common stock are listed on Nasdaq, such securities will be deemed covered securities. Although the states will be preempted from regulating the sale of our securities, the federal statute does allow states to investigate companies if there is a suspicion of fraud and, if there is a finding of fraudulent activity, then the states can regulate or bar the sale of covered securities in a particular case. Further, if we were no longer listed on Nasdaq, our securities would not be covered securities and we would be subject to regulations in each state in which we offer our securities.

Because our management has broad discretion over the use of the net proceeds we received from our IPO and follow-on offering, you may not agree with how we use them and the proceeds may not be invested successfully.

We intend to use the net proceeds to us from our IPO and follow-on offering to fund preclinical and clinical trials of product candidates, Ropidoxuridine and new formulations of Ropidoxuridine with Tipiracil, O-18 containing molecules for proton radiation sensitization, continued HDAC technology platform development, working capital and general corporate purposes, including the costs of operating as a public company, as well as potential acquisition or in-licensing activities. Therefore, our management has broad discretion as to the use of the IPO proceeds and proceeds from our subsequent private placement. Accordingly, you will be relying on the judgment of our management with regard to the use of these net proceeds, and you will not have the opportunity, as part of your investment decision, to assess whether the proceeds are being used appropriately. It is possible that the proceeds will be invested in a way that does not yield a favorable, or any, return for our Company.

If securities or industry analysts do not publish research or reports about our business, or if they issue an adverse or misleading opinion regarding our stock, our stock price and trading volume could decline.

The trading market for our common stock will be influenced by the research and reports that industry or securities analysts publish about us or our business. We do not currently have and may never obtain research coverage by securities and industry analysts. If no or few securities or industry analysts commence coverage of us, the trading price for our stock would be negatively impacted. In the event we obtain securities or industry analyst coverage, if any of the analysts who cover us issue an adverse or misleading opinion regarding us, our business model, our intellectual property or our stock performance, or if our target studies and operating results fail to meet the expectations of analysts, our stock price would likely decline. If one or more of these analysts cease coverage of us or fail to publish reports on us regularly, we could lose visibility in the financial markets, which in turn could cause our stock price or trading volume to decline.

Our board of directors has the authority, without stockholder approval, to issue preferred stock with terms that may not be beneficial to holders of our common stock and such issuance could potentially adversely affect stockholders' voting power and perpetuate their control over us.

Our Certificate of Incorporation, as amended to date, allows us to issue shares of preferred stock without any vote or further action by our stockholders. Our board of directors has the authority to fix and determine the relative rights and preferences of any preferred stock. As a result, our board of directors could authorize the issuance of a series of preferred stock that would grant to holders the preferred right to our assets upon liquidation, the right to receive dividend payments before dividends are distributed to the holders of common stock and the right to the redemption of the shares, together with a premium, prior to the redemption of shares of our common stock. These rights and preferences could negatively affect the holders of our common stock.

The ability of our executive officers and directors, who are our principal stockholders, to control our business may limit or eliminate the ability of minority stockholders to influence corporate affairs.

Our executive officers and directors, who are our principal stockholders, own approximately 47.6% of our issued and outstanding common stock. Accordingly, they may be able to effectively control the election of directors, as well as all other matters requiring stockholder approval. The interests of our principal stockholders may differ from the interests of other stockholders with respect to the issuance of shares, business transactions with or sales to other companies, selection of other directors and other business decisions. The minority stockholders have no way of overriding decisions made by our principal stockholders. This level of control may also have an adverse impact on the market value of our shares because our principal stockholders may institute or undertake transactions, policies or programs that result in losses and may not take any steps to increase our visibility in the financial community and/or may sell sufficient numbers of shares to significantly decrease our price per share.

Our Certificate of Incorporation and Bylaws, each as amended to date, provide for indemnification of officers and directors at the expense of the Company and limit their liability that may result in a major cost to us and hurt the interests of our stockholders because corporate resources may be expended for the benefit of officers and/or directors.

Our Certificate of Incorporation and Bylaws, each as amended to date, provide for the indemnification of our officers and directors. We have been advised that, in the opinion of the SEC, indemnification for liabilities arising under federal securities laws is against public policy as expressed in the Securities Act and is therefore, unenforceable.

Our Certificate of Incorporation, as amended to date, provides that disputes must be resolved in the Court of Chancery of the State of Delaware, except for cases brought under the Securities Act or Exchange Act.

Our Certificate of Incorporation, as amended to date, provides that the Court of Chancery in the State of Delaware will be the exclusive forum for dispute resolution for certain enumerated actions, excluding any actions brought under the Securities Act or Exchange Act, or unless the Company consents in writing to an alternative jurisdiction. This exclusive forum selection clause may cause inconvenience of our stockholders or other stakeholders, should they need to bring suit against the Company for an action other than one arising under the Securities Act or Exchange Act.

We do not expect to pay cash dividends in the foreseeable future.

We have never paid cash dividends on our common stock. We do not expect to pay cash dividends on our common stock at any time in the foreseeable future. The future payment of dividends on our common stock directly depends upon our future earnings, capital requirements, financial requirements and other factors that our board of directors will consider. Since we do not anticipate paying cash dividends on our common stock, return on your investment, if any, will depend solely on an increase, if any, in the market value of our common stock.

Provisions in our amended and restated certificate of incorporation, as amended, and bylaws, as amended, as well as Delaware law, might discourage, delay or prevent a change of control of our company or changes in our management and, therefore, depress the market price of our common stock.

Our Certificate of Incorporation and Bylaws, each as amended to date, and bylaws contain provisions that could depress the market price of our common stock by acting to discourage, delay, or prevent a change in control of our company or changes in our management that the stockholders of our company may deem advantageous. These provisions, among other things:

- permit the board of directors to establish the number of directors;
- provide that directors may only be removed "for cause" and only with the approval of 66 2/3 percent of our stockholders;
- require super-majority voting to amend some provisions in our Certificate of Incorporation and Bylaws;
- authorize the issuance of "blank check" preferred stock that our board of directors could use to implement a stockholder rights plan (also known as a "poison pill");
- eliminate the ability of our stockholders to call special meetings of stockholders;
- prohibit stockholder action by written consent, which requires all stockholder actions to be taken at a meeting of our stockholders;
- provide that the board of directors is expressly authorized to make, alter or repeal our bylaws; and
- establish advance notice requirements for nominations for election to our board of directors or for proposing matters that can be acted upon by stockholders at annual stockholder meetings.

In addition, Section 203 of the Delaware General Corporation Law may discourage, delay or prevent a change in control of our company. Section 203 imposes certain restrictions on merger, business combinations and other transactions between us and holders of 15% or more of our common stock.

Item 1B. Unresolved Staff Comments

None.

Item 2. Properties

Facilities

Our corporate headquarters are presently located in Rockville, Maryland, where we lease shared access to office space and reception services. Our research and development activities are performed in approximately 1,727 square feet of laboratory and office space located in Gaithersburg, Maryland. All of such space is leased from a non-affiliated third party, pursuant to leases expiring in October, 2023, which provide for an aggregate monthly rental of $6,990. As the lease for our current laboratory space will soon expire, on October 31, 2023, we entered into an agreement to lease 2,109 square feet of laboratory and office space in new facility in Gaithersburg, Maryland (the "New Lease"). The New Lease has an initial term of 5.25 years, with the option to extend for an additional three years, with a monthly rent of $7,206 per month, subject to increase at the rate of 3% per year.

We believe that the above facilities are adequate for our current needs and have sufficient laboratory space to house additional scientists as we grow.

Item 3. Legal Proceedings

Currently, there are no legal proceedings pending or threatened against us. We are not presently party to any pending or other threatened legal proceedings or claims that we believe will have a material adverse effect on our business, financial condition or operating results, although from time to time, we may become involved in legal proceedings in the ordinary course of business.

Item 4. Mine Safety Disclosures

Not applicable.

PART II

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

Market Information

Our common stock commenced trading on the Nasdaq Capital Market, under the symbol "SHPH" on August 29, 2022. Prior to that time, our common stock was not traded on any exchange or quoted on any over the counter market. The prices set forth below reflect the quarterly high and low sales prices per share for our common stock for the fiscal year ended December 31, 2022, as reported by the Nasdaq:

Holders

As of March 14, 2023, we had 58 holders of record of our common stock and 13,654,127 shares of common stock issued and outstanding.

Dividends

We have not paid any dividends on our common stock since inception and we currently expect that, in the foreseeable future, all earnings (if any) will be retained for the development of our business and no dividends will be declared or paid on our common stock. Any future dividends on our common stock will be subject to the discretion of our board of directors and will depend upon, among other things, our earnings (if any), operating results, financial condition and capital requirements, general business conditions and other pertinent facts.

Preferred dividends

Our board of directors has designated and authorized the issuance of up to 10,000 shares of Series A Convertible preferred stock, par value $0.00001 per share (the "Series A Convertible Preferred Stock"), of which there were 1,212.5 shares issued, all of which were converted into 336,810 shares of or common stock and 336,810 warrants to purchase common stock upon closing of our IPO on September 2, 2022. The Series A Convertible Preferred Stock had a stated value of $1,000 per share, was entitled to receive a dividend at the rate of 8.5% per annum, which dividend was cumulative and was payable at our option in shares of common stock or cash upon the date of conversion or redemption, as so determined by the Company.

For the year ended December 31, 2022, the Company accrued $71,009 for the 8.5% cumulative dividends on the Series A Convertible Preferred Stock and $103,062 for the year ended December 31, 2021, for a total of $402,068 and $331,059 respectively, all of which was paid in the form of 100,517 shares of our common stock following completion of our IPO.

Securities authorized for issuance under equity compensation plans

2018 Equity Incentive Plan

Our 2018 Equity Incentive Plan provides for equity incentives to be granted to our employees, executive officers or directors and to key advisers and consultants. Equity incentives may be in the form of stock options with an exercise price of not less than the fair market value of the underlying shares as determined pursuant to the 2018 Equity Incentive Plan, restricted stock awards, other stock- based awards, or any combination of the foregoing. The 2018 Equity Incentive Plan is administered by the Company's compensation committee or, alternatively, if there is no compensation committee, the Company's board of directors. We have reserved 3,000,000 shares of our common stock for issuance under the 2018 Equity Incentive Plan (the "Plan"), of which 419,754 shares have been granted under the Plan as of the date of this Annual Report, of which 23,725 remain subject to vesting.

The following table provides information as of December 31, 2022 about our equity compensation plans and arrangements.

Plan category	Number of securities to be issued upon exercise of outstanding options, warrants and rights	Weighted-average exercise price of outstanding options, warrants and rights	Number of securities remaining available for future issuance under equity compensation plans
Equity compensation plans approved by security holders	23,725	$ *	2,581,146
Equity compensation plans not approved by security holders	–	–	–
Total	23,725	*	$ 2,581,146

*Outstanding equity incentive grants consist entirely of restricted stock units which automatically vest over time into an equal number of shares of common stock at no additional cost to the holder.

You may find additional information regarding our equity compensation plans in Note 7 of the Notes to our Consolidated Financial Statements.

Recent Sales of Unregistered Securities

None.

Issuer Purchases of Equity Securities

None.

Use of proceeds

None.

Item 6. [Reserved]

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

The following Management's Discussion and Analysis should be read in conjunction with our financial statements and the related notes thereto included elsewhere in this Annual Report. The Management's Discussion and Analysis contains forward-looking statements that involve risks and uncertainties, such as statements of our plans, objectives, expectations and intentions. Any statements that are not statements of historical fact are forward-looking statements. When used, the words "believe," "plan," "intend," "anticipate," "target," "estimate," "expect," and the like, and/or future-tense or conditional constructions ("will," "may," "could," "should," etc.), or similar expressions, identify certain of these forward-looking statements. These forward-looking statements are subject to risks and uncertainties that could cause actual results or events to differ materially from those expressed or implied by the forward-looking statements in this Annual Report. Our actual results and the timing of events could differ materially from those anticipated in these forward-looking statements as a result of several factors including, but not limited to, those noted under "Risk Factors" in this Annual Report.

We do not undertake any obligation to update forward-looking statements to reflect events or circumstances occurring after the date of this Annual Report, except as required by U.S. federal securities laws.

Overview

Founded by Georgetown University Medical School faculty members, we are a discovery and development stage pharmaceutical company leveraging our proprietary technology to develop novel therapies that are designed to cure cancer. Originally formed as Shuttle Pharmaceuticals, LLC in 2012, our goal is to extend the benefits of cancer treatments by leveraging insights into cancer therapy with surgery, radiation therapy, chemotherapy and immunotherapy. While there are several therapies being developed with the goal of curing cancer, one of the most effective and proven approaches to this is radiation therapy (RT). We are developing a pipeline of products designed to address the limitations of this current standard of cancer therapies. We believe that our product candidates will enable us to deliver cancer treatments that are safer, more reliable and at a greater scale than that of the current standard of care.

Operations to date have focused on continuing our research and development efforts to advance Ropidoxuridine clinical testing and improved drug formulation, to advance HDAC6 inhibitor (SP-2-225) preclinical development, and complete SBIR contract work on predictive biomarkers of radiation response, as well as prostate cell lines for health disparities research. We have received SBIR contract funding from the NIH for the aforementioned projects. The clinical development of Ropidoxuridine has shown drug bioavailability and a maximum tolerated dose has been established for use in Phase II clinical trials. The radiation biomarker project and the health disparities project have been completed. Changes in operational, administrative, legal and professional expenses related to our operations are set forth in more detail in the discussion below.

Results of Operations

Comparison of the year ended December 31, 2022 and 2021

The following table summarizes the results of our operations:

	Years Ended December 31,			
	2022	**2021**	**Change**	**%**
Revenue	$ -	$ -	$ -	-
Operating expenses:				
Research and development, net of contract expense reimbursements	1,488,530	1,021,808	466,722	46%
General and administrative	198,978	36,500	162,478	445%
Legal and professional	866,770	684,684	182,086	27%
Total operating expenses	2,554,278	1,742,992	811,286	47%
Other income (expense):				
Interest expense - related party	(52,010)	(46,947)	(5,063)	(11)%
Interest expense	(917,879)	(3,841)	(914,038)	23797%
Change in fair value of warrant liability	94,025	579,146	(485,121)	(84)%
Gain on settlement of accounts payable	328,687	-	328,687	100%
Gain on forgiveness of Paycheck Protection Program note payable	73,007	62,500	10,507	17%
Total other expense	(474,170)	590,858	(1,065,028)	(180)%
Net loss	$ 3,028,448	$ 1,152,134	$ 1,876,314	163%

Research and Development-Net of contract expense reimbursements. Research and development-net of contract expense reimbursements ("R&D") was $1,488,530 for the year ended December 31, 2022, as compared to $1,021,808 for year ended December 31, 2021. For the year ended December 31, 2022, the Company received $211,455 in reimbursement from the NIH contracts and incurred $1,699,985 in R&D expenses. For the year ended December 31, 2021, the Company received $505,377 in reimbursement from NIH contracts and incurred $1,527,185 in research and development expenses. The increase of $466,722, or 46%, is primarily related to the Company increasing R&D spending as a result of funding from the public offering and the NIH contracts ending. The no cost extension from the NIH ended on March 15, 2022, and the final report to the NIH was filed and accepted, resulting in a payment of $211,455 during the year ended December 31, 2022.

R&D expense reimbursements were $505,377 and $211,455 during the years ended December 31, 2021 and 2022, respectively. NIH requires that milestones included in the fixed price contract be met, therefore, compensation related expenses continued in 2022 under the no cost extension from the NIH. Compensation related expenses were $883,602 in the year ended December 31, 2021 as compared to $1,115,001 in the year ended December 31, 2022. Compensation related expenses increased from 58% of total R&D in the year ended December 31, 2021 as compared to 66% in the year ended December 31, 2022. Subcontract work made up 35%, compensation made up 58%, and supplies and other expenses 7% of total R&D expense in the year ended December 31, 2021. Subcontract work made up 28%, compensation made up 66%, and supplies and other expenses 7% of total R&D expense during the year ended December 31, 2022.

Below is a breakdown of the actual costs and reimbursements received by the Company for the years ended December 31, 2022 and 2021, and a breakdown of how such cost and reimbursements were distributed across research projects.

For the year ended December 31, 2022, total research and development costs were $1,699,985 for which $211,455 was paid by reimbursements received from the NIH, leaving a net of $1,488,530. For the year ended December 31, 2021, total R&D costs were $1,527,185 for which $505,377 was paid by reimbursements received from the NIH, leaving a net of $1,021,808. The Company funded R&D activities decreased in the year ended December 31, 2021 and increased during the year ended December 31, 2022 primarily due to the funding provided by the public offering. A summary of the breakdown of costs is listed below.

Key Research and Development Projects

R & D, Net of Contract Expense Reimbursements **Twelve Months**

Years ending December 31, 2021 and 2022

Research & Development	NIH Topic 345		NIH Topic 352		Shuttle Funded		Total	
Revenue and Expenses	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
NIH Reimbursement	(422,910)	(211,455)	(82,467)	-	-	-	(505,377)	(211,455)
Compensation	198,426	-	-	-	685,176	1,115,001	883,602	1,115,001
Subcontracts	539,043	-	-	-	-	469,680	539,043	469,680
Supplies	30,181	-	-	-	-	21,381	30,181	21,381
Other, Lab	72,611	-	-	-	1,748	93,923	74,359	93,923
Expense total	840,261	-	-	-	686,924	1,699,985	1,527,185	1,699,985
R&D, Net of Contracts	**417,351**	**(211,455)**	**(82,467)**	**-**	**686,924**	**1,699,985**	**1,021,808**	**1,488,530**

Note: Project 352 reimbursements were not received in 2021 and research costs were Company funded through an NIH extension without cost Project 345 reimbursement for the period of performance ending March 15, 2022, which reimbursement was received in April 2022

In addition, the CEO and CMO are actively involved in the research and development activities, but neither received a salary from the Company prior to the completion of our initial public offering in September 2022. As such, research and development expenses for the year ended December 31, 2022 are lower than might be incurred in the future.

The allocation of costs to the NIH research project for the year ended December 31, 2021 were as follows:

NIH Cost Allocation for the year Ending December 31, 2021

- **Compensation** - $883,602, making up 58% of total R&D expenses, with $685,176 allocated to the Company.
- **Subcontracts** - $539,043, making up 35% of total R&D expenses.
- **Remaining costs** – $104,540, making up 7% of total R&D costs.

General and Administrative Expenses. General and Administrative expenses increased by $162,478, from $36,500 in the year ended December 31, 2021 to $198,978 in the year ended December 31, 2022. The increase was primarily related to increases in insurance costs, SEC and Nasdaq filing fees, processing fees and other expenses related to preparing for and closing on our IPO, which closed in December 2022.

Legal and Professional Expenses. Legal and professional expenses increased by $182,086, or 27%, primarily due to increases in fees related to obtaining pre-IPO financing and expenses incurred related to preparing for the IPO.

Other Income (Expense). Other expense was $474,170 for the year ended December 31, 2022, which consisted of $917,879 in interest expense on convertible loans, $52,010 in interest expense on related party loans, a gain on change in warrant liability of $94,025, a $328,687 gain on settlement of accounts payable, and a $73,007 gain on the forgiveness of the Company's Paycheck Protection Program loan. Other income was $590,858 for the year ended December 31, 2021, which consisted of $3,841 in interest expense, $46,947 in interest expense on related party loans and a gain on change in warrant liability of $579,146, and a $62,500 gain on the forgiveness of the Company's Paycheck Protection Program loan.

Liquidity and Capital Resources

Our capital needs to date have been met by contributions from existing shareholders, as well as through private offerings of our securities, SBIR contracts and other grants, and our public offering. In the year ended December 31, 2022, we raised a total of $10,672,908 through the sale of convertible notes, notes payable, shares of common stock and warrants, repaying $50,000 in notes payable in cash for net cash raised of $10,622,908. In the year ended December 31, 2021, we raised a total of $525,715 through the sale of convertible notes, warrants, and common shares. In addition, since inception, we have received a total of $5,531,722 in SBIR contracts and other grants received primarily through the National Institutes of Health.

We believe that we will continue to expend substantial resources for the foreseeable future on the completion of clinical development and regulatory preparedness of our product candidates, preparations for a commercial launch of our product candidates, if approved, and development of any other current or future product candidates we may choose to develop. These expenditures will include costs associated with research and development, conducting preclinical studies and clinical trials, obtaining marketing approvals, and, if we are not able to enter into planned collaborations, manufacturing and supply as well as marketing and selling any products approved for sale. In addition, other unanticipated costs may arise. Because the outcome of any drug development process is highly uncertain, we cannot reasonably estimate the actual amounts necessary to complete the development and commercialization of our current product candidates, if approved, or future product candidates, if any.

There can be no assurance that additional financing will be available to us when needed, on favorable terms or otherwise. Moreover, any such additional financing may dilute the interests of existing shareholders. The absence of additional financing, when needed, could cause us to delay implementation of our business plan in whole or in part, curtail our business activities and seriously harm us and our prospects.

Balance Sheet Data:

	December 31, 2022	December 31, 2021	Change	%
Current assets	$ 8,578,351	$ 509,615	$ 8,068,736	1,583%
Current liabilities	975,676	2,217,331	(1,241,655)	(56%)
Working capital (deficiency)	$ 7,602,675	$ (1,707,716)	$ 9,310,391	(545%)

As of December 31, 2022, total current assets were $8,578,351. Total current liabilities as of December 31, 2022, were $975,676, resulting in working capital of $7,602,675. As of December 31, 2021, total current assets were $509,615. Total current liabilities as of December 31, 2021, were $2,217,331, resulting in a working capital deficit of $1,707,716 for the year ended December 31, 2021. The current assets primarily resulted from $10,022,193 and $650,715 for a total of $10,672,908 cash received from the issuance of common stock and notes payable, respectively, with a $50,000 note repaid to a related party during the period ended December 31, 2022 for net cash provided by financing activities for the period of $10,622,908. The decrease in current liabilities is due to the repayment of notes payable, forgiveness of the PPP loan, payment of dividends payable and payments on trades payable.

Cash Flows from Operating Activities

	Years Ended December 31,			
	2022	2021	Change	%
Cash used in operating activities	$ (2,710,454)	$ (300,336)	$ (2,410,118)	802%
Cash used in investing activities	$ -	$ -	$ -	-
Cash provided by financing activities	$ 10,622,908	$ 687,932	$ 9,934,976	1,444%
Cash on hand	$ 8,417,203	$ 504,749	$ 7,912,454	1,568%

We have not generated positive cash flows from operating activities. For the year ended December 31, 2022, net cash flows used in operating activities was $2,710,454, consisting of a net loss of $3,028,448, reduced by depreciation expense of $5,972, gain on change in warranty liability of $94,025, amortization of right of use assets of $60,860, amortization of debt discount of $885,505, stock-based compensation of $403,956, gain on forgiveness of the PPP loan of $73,007, gain on settlement of accounts payable of $328,687, $12,625 gain on interest relief on conversion of notes payable and a net change in working capital of $555,205. For the year ended December 31, 2021, net cash flows used in operating activities was $300,336, consisting of a net loss of $1,152,134, adjusted for depreciation expense of $6,218, change in warranty liability of $579,146, amortization of right of use assets of $54,616, stock-based compensation of $910,067, gain on forgiveness of the PPP of loan of $62,500, and a net change in working capital of $519,154.

Cash Flows from Investing Activities

For the year ended December 31, 2022 and 2021, we had no investing activities.

Cash Flows from Financing Activities

For the year ended December 31, 2022, we received $10,022,193 from the issuance of common shares and $650,715 from the issuance of convertible notes and repaid $50,000 for a related party note payable. For the year ended December 31, 2021, we received $73,007 from the Paycheck Protection Program and $120,000 from the issuance of notes payable.

Recent Financing

On January 11, 2023, Shuttle Pharmaceuticals Holdings, Inc., a Delaware corporation (the "Company"), entered into a securities purchase agreement (the "SPA") with Alto Opportunity Master Fund, SPC – Segregated Master Portfolio B, a Cayman entity (the "Investor"), pursuant to which the Company sold to the Investor a $4.3 million convertible note (the "Convertible Note") and warrant (the "Warrant") to purchase 1,018,079 shares of common stock, par value $0.00001 per share ("Common Stock"), in exchange for gross proceeds of $4.0 million (the "Investment Amount"). The Convertible Note amortizes on a monthly basis and the Company can make such monthly amortization payments in cash or, subject to certain equity conditions, in registered shares of Common Stock or a combination thereof. For equity repayment, the Convertible Note is convertible into shares of Common Stock at price per share equal to the lower of (i) $2.35 (ii) 90% of the three lowest daily VWAPs of the 15 trading days prior to the payment date or (iii) 90% of the VWAP of the trading day prior to payment date. The Convertible Note is repayable over 26 months and bears interest at the rate of 5% per annum. The Warrant is exercisable for four years from the date of closing and is exercisable at $2.35 per share. In the event the Investor exercises the Warrant in full, such exercise would result in additional gross proceeds to the Company of approximately $2.4 million.

Boustead Securities, LLC ("Boustead") served as a placement agent for the Convertible Note and Warrant offering, and received $320,000 cash compensation and a warrant to purchase 71,266 shares of Common Stock, exercisable at $2.35 per share.

Off-Balance Sheet Arrangements

We do not have any off-balance sheet arrangements that have or are reasonably likely to have a current or future effect on our financial condition, changes in financial condition, revenues or expenses, results of operations, liquidity, capital expenditures or capital resources that are material to investors.

Critical Accounting Policies and Significant Judgments and Estimates

This discussion and analysis of our financial condition and results of operations is based on our financial statements, which have been prepared in accordance with generally accepted accounting principles in the United States ("GAAP"). The preparation of these financial statements requires us 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, as well as the reported expenses incurred during the reporting periods. Our estimates are based on our historical experience and on various other factors that we believe are reasonable under the circumstances, the results of which form the basis for making judgments about the carrying value of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions. While our significant accounting policies are described in more detail in the notes to our financial statements included elsewhere in this registration statement, we believe that the following accounting policies are critical to understanding our historical and future performance, as these policies relate to the more significant areas involving management's judgments and estimates.

Our most critical accounting policies and estimates relate to the following:

- Research and Development Expenses
- Operating Lease Accounting
- Derivative Financial Instruments
- Income Taxes

Research and Development

Research and Development expenses are offset by contract receivable payments from an NIH SBIR contract that supports this scientific research. This is stated in the financials as research and development-net of contract expense reimbursements.

Operating Lease Right-of-use Assets and Operating Lease Liability

Operating lease right-of-use assets and liabilities are recognized at the present value of the future lease payments at the lease commencement date. The interest rate used to determine the present value is our incremental borrowing rate, estimated to be 10%, as the interest rate implicit in most of our leases is not readily determinable. Operating lease expense is recognized on a straight-line basis over the lease term.

Derivative Financial Instruments

We evaluate all of our agreements to determine if such instruments have derivatives or contain features that qualify as embedded derivatives. For derivative financial instruments that are accounted for as liabilities, the derivative instrument is initially recorded at its fair value and is then re-valued at each reporting date, with changes in the fair value reported in the statements of operations. For stock-based derivative financial instruments, we use a Binomial Simulation model to value the derivative instruments at inception and on subsequent valuation dates. The classification of derivative instruments, including whether such instruments should be recorded as liabilities or as equity, is evaluated at the end of each reporting period. Derivative instrument liabilities are classified in the balance sheet as current or non-current based on whether or not net-cash settlement of the derivative instrument could be required within 12 months of the balance sheet date. As of December 31, 2022, we have no derivative financial instruments.

Item 7A. Quantitative and Qualitative Disclosures About Market Risk

As a “smaller reporting company,” this item is not required.

Item 8. Financial Statements and Supplementary Data

Index to Financial Statements

Report of Independent Registered Public Accounting Firm

To the shareholders and the board of directors of Shuttle Pharmaceuticals Holdings, Inc.

Opinion on the Financial Statements

We have audited the accompanying consolidated balance sheets of Shuttle Pharmaceuticals Holdings, Inc. (the "Company") as of December 31, 2022, the related statements of operations, stockholders' equity (deficit), and cash flows for the years then ended, 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 as of December 31, 2022, and the results of its operations and its cash flows for the years then ended, in conformity with accounting principles generally accepted in the United States.

Basis for Opinion

These financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's financial statements based on our audit. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) ("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 the financial statements are free of material misstatement, whether due to error or fraud.

Our audit 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 regarding the amounts and disclosures in the financial statements. Our audit 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 audit provides a reasonable basis for our opinion.

/s/ BF Borgers CPA PC
BF Borgers CPA PC

Served as Auditor since 2021
Lakewood, CO
March 15, 2023

Shuttle Pharmaceuticals Holdings, Inc.
Consolidated Balance Sheets

	December 31, 2022	December 31, 2021
Assets		
Current assets		
Cash	$ 8,417,203	$ 504,749
Prepaid expenses	161,148	4,866
Total current assets	8,578,351	509,615
Property and equipment, net	12,592	18,564
Other assets	6,480	6,480
Operating lease right-of-use asset	56,122	116,982
Total Assets	$ 8,653,545	$ 651,641
Liabilities and Stockholders' Equity (Deficit)		
Current Liabilities		
Accounts payable and accrued expenses	$ 116,745	$ 828,313
Accrued expenses – related party	12,500	-
Accrued interest payable	-	552
Accrued interest payable - related parties	98,135	46,947
Dividends Payable	-	331,059
Notes payable to related parties	685,473	685,473
Notes payable	-	91,021
Paycheck Protection Program note payable	-	73,007
Warrant liability	-	94,025
Operating lease liability current portion	62,823	66,934
Total Current Liabilities	975,676	2,217,331
Operating lease liability non-current	-	62,442
Total Liabilities	975,676	2,279,773
Stockholders' Equity (Deficit)		
Series A convertible preferred stock, $0.00001 par value; $1,000 per share liquidation value or aggregate of $1,212,500; 20,000,000 shares authorized; no shares outstanding at December 31, 2022 and 1,213 at December 31, 2021	-	-
Common stock, $0.00001 par value; 100,000,000 shares authorized; 13,603,129 and 9,312,152 shares issued and outstanding at December 31, 2022 and 2021, respectively	136	93
Additional paid in capital	16,572,622	4,150,867
Common stock to be issued	-	16,340
Accumulated deficit	(8,894,889)	(5,795,432)
Total Stockholders' Equity (Deficit)	7,677,869	(1,628,132)
Total Liabilities and Stockholders' Equity (Deficit)	$ 8,653,545	$ 651,641

The accompanying footnotes are an integral part of these consolidated financial statements.

Shuttle Pharmaceuticals Holdings, Inc.
Consolidated Statements of Operations

	Years Ended December 31,	
	2022	**2021**
Revenue	$ -	$ -
Operating expenses		
Research and development, net of contract expense reimbursements	1,488,530	1,021,808
General and administrative	198,978	36,500
Legal and professional	866,770	684,684
Total operating expenses	2,554,278	1,742,992
Net loss from operations	(2,554,278)	(1,742,992)
Other income (expense)		
Interest expense - related parties	(52,010)	(46,947)
Interest expense	(917,879)	(3,841)
Change in fair value of warrant liability	94,025	579,146
Gain on settlement of accounts payable	328,687	-
Gain on forgiveness of Paycheck Protection Program note payable	73,007	62,500
Total other income (expense)	(474,170)	590,858
Loss before income taxes	(3,028,448)	(1,152,134)
Provision for income taxes	-	-
Net loss	$ (3,028,448)	$ (1,152,134)
Dividend on Series A Preferred Stock	(71,009)	(103,062)
Net loss attributable to common stockholders	$ (3,099,457)	$ (1,255,196)
Weighted average common shares outstanding - basic and diluted	10,351,046	9,301,750
Net loss per shares - basic and diluted	$ (0.29)	$ (0.12)

The accompanying footnotes are an integral part of these consolidated financial statements.

Shuttle Pharmaceuticals Holdings, Inc.
Consolidated Statements of Changes in Stockholders' Equity (Deficit)

	Series A Preferred Stock		Common Stock		Additional Paid in	Common Stock to be	Accumulated	Total Stockholders' Equity
	Shares	Amount	Shares	Amount	Capital	Issued	Deficit	(Deficit)
Balance - December 31, 2020	1,213	$ -	9,291,526	$ 93	$ 2,833,507	$ 16,340	$ (4,540,236)	$ (1,690,296)
Stock based compensation	-	-	-	-	420,000	-	-	420,000
Warrants issued for financing costs	-	-	-	-	407,293	-	-	407,293
Common stock issued for restricted stock units	-	-	20,626	-	490,067	-	-	490,067
Dividends on Series A convertible preferred stock	-	-	-	-	-	-	(103,062)	(103,062)
Net loss	-	-		-	-	-	(1,152,134)	(1,152,134)
Balance - December 31, 2021	1,213	$ -	9,312,152	$ 93	$ 4,150,867	$ 16,340	$ (5,795,432)	$ (1,628,132)
Common stock issued for cash	-	-	1,409,771	14	10,008,081	-	-	10,008,095
Warrants exercised for cash	-	-	1,409,771	14	14,084	-	-	14,098
Warrants issued for financing costs	-	-	-	-	412,241	-	-	412,241
Common stock issued for conversion of convertible debt and accrued interest.	-	-	148,339	1	604,863	(16,340)	-	588,524
Common stock issued for exercise of warrants with settlement of notes payable	-	-	857,780	9	576,467	-	-	576,476
Common stock issued for restricted stock units	-	-	27,989	-	403,956	-	-	403,956
Dividends on Series A preferred stock	-	-	-	-	-	-	(71,009)	(71,009)
Common shares issued for dividends on and conversion of Series A preferred stock	(1,213)	-	437,327	5	402,063	-	-	402,068
Net loss	-	-	-	-	-	-	(3,028,448)	(3,028,448)
Balance - December 31, 2022	-	$ -	13,603,129	$ 136	$16,572,622	$ -	$ (8,894,889)	$ 7,677,869

The accompanying footnotes are an integral part of these consolidated financial statements.

Shuttle Pharmaceuticals Holdings, Inc.
Consolidated Statements of Cash Flows

	Years Ended December 31,	
	2022	**2021**
CASH FLOWS FROM OPERATING ACTIVITIES:		
Net loss	$ (3,028,448)	$ (1,152,134)
Adjustments to reconcile net loss to net cash used in operating activities:		
Depreciation	5,972	6,218
Change in fair value of derivative liability	(94,025)	(579,146)
Amortization of right-of-use asset	60,860	54,616
Amortization of debt discount	885,505	3,389
Gain on settlement of accounts payable	(328,687)	-
Gain on forgiveness of Paycheck Protection Program note payable	(73,007)	(62,500)
Gain on interest relief on conversion of notes payable	12,625	-
Stock-based compensation	403,956	910,067
Changes in operating assets and liabilities:		
Contracts receivable	-	211,455
Prepaid expenses	(156,282)	7,713
Accounts payable and accrued expenses	(382,881)	311,347
Accrued expenses – related parties	12,500	-
Accrued interest payable	(13,177)	160
Accrued interest payable - related parties	51,188	46,947
Operating lease liability	(66,553)	(58,468)
Net Cash used in Operating Activities	(2,710,454)	(300,336)
	-	-
CASH FLOWS FROM FINANCING ACTIVITIES:		
Proceeds from issuance of common shares	10,022,193	-
Repayment of note payable-related party	(50,000)	-
Proceeds from notes payable-related parties	50,000	120,000
Proceeds from PPP note payable	-	73,007
Proceeds from notes payable	600,715	494,925
Net Cash provided by Financing Activities	10,622,908	687,932
Net change in cash	7,912,454	387,596
Cash, beginning of period	504,749	117,153
Cash, end of period	$ 8,417,203	$ 504,749
Cash paid for:		
Interest	$ 39,201	$ 293
Income taxes	$ -	$ -
Supplemental non-cash financing activities:		
Shares issued for conversion of accrued interest	$ 16,340	$ -
Common stock issued for conversion of convertible debt	$ 588,524	$ -
Common stock issued for exercise of warrants with settlement of notes payable	$ 576,476	$ -
Common stock issued for dividend payable	$ 402,068	$ -

The accompanying footnotes are an integral part of these consolidated financial statements.

Shuttle Pharmaceuticals Holdings, Inc.
Notes to Consolidated Financial Statements
Years Ended December 31, 2022 and 2021

Note 1 – Organization

Organization and Line of Business

The Company was formed as Shuttle Pharmaceuticals, LLC, in the State of Maryland on December 18, 2012. On August 12, 2016, the Company filed articles of conversion with the state of Maryland to convert from an LLC to a C corporation, at which time the Company changed its name to Shuttle Pharmaceuticals, Inc. ("Shuttle"). In connection with the conversion the Company issued 45,000,000 shares of common stock in exchange for 100% of the outstanding membership interests in Shuttle prior to conversion. On June 4, 2018, Shuttle completed a reverse merger with Shuttle Pharmaceuticals Holdings, Inc. (then known as Shuttle Pharma Acquisition Corp, Inc.), a Delaware corporation (the "Company"), pursuant to which Shuttle, our operating entity, became a wholly owned subsidiary of the Company.

The Company's primary purpose is to develop and commercialize unique drugs for the sensitization of cancers and protection of normal tissues, with the goal of improving outcomes for cancer patients receiving radiation therapy. Shuttle has deployed its proprietary technology to develop novel cancer immunotherapies, producing a pipeline of selective HDAC inhibitors for cancer and immunotherapy applications. The Company's HDAC platform is designed to target candidate molecules with potential roles in therapeutics beyond cancer, including autoimmune, inflammatory, metabolic, neurological and infectious diseases. The Company's Ropidoxuridine product, which is used with radiation therapy to sensitize cancer cells, was funded by a Small Business Innovation Research ("SBIR") contract provided by the National Cancer Institute ("NCI"), a unit of the National Institutes of Health ("NIH"). Ropidoxuridine has been further developed though the Company's collaborations with scientists at the University of Virginia for use in combination with proton therapy to improve patient survival. Historically, the Company has been working on developing products through NIH grants, including a product to predict late effects of radiation with metabolite biomarkers and develop prostate cancer cell lines in health disparities research.

The production and marketing of the Company's products and its ongoing research and development activities will be subject to extensive regulation by numerous governmental authorities in the United States. Prior to marketing in the United States, any combination product developed by the Company must undergo rigorous preclinical (animal) and clinical (human) testing and an extensive regulatory approval process implemented by the Food and Drug Administration ("FDA") under the Food, Drug and Cosmetic Act. There can be no assurance that the Company will not encounter problems in clinical trials that will cause the Company or the FDA to delay or suspend clinical trials.

The Company's success will depend in part on its ability to obtain patents and product license rights, maintain trade secrets, and operate without infringing on the proprietary rights of others, both in the United States and other countries. There can be no assurance that patents issued to or licensed by the Company will not be challenged, invalidated or circumvented, or that the rights granted thereunder will provide proprietary protection or competitive advantages to the Company now or in the future.

Reverse Stock Split

Effective April 1, 2022, we effected a 2-for-1 reverse stock split of our issued and outstanding shares of common stock (the "Reverse Stock Split"). All references to shares of our common stock in this Annual Report on Form 10-K refers to the number of shares of common stock after giving effect to the Reverse Stock Split (unless otherwise indicated).

Note 2 – Summary of Significant Accounting Policies

Basis of Presentation

These financial statements and related disclosures have been prepared pursuant to the rules and regulations of the Securities and Exchange Commission ("SEC"). The financial statements have been prepared using the accrual basis of accounting in accordance with Generally Accepted Accounting Principles of the United States ("GAAP").

Basis of Consolidation

The financial statements have been prepared on a consolidated basis with those of the Company's wholly-owned subsidiary, Shuttle Pharmaceuticals, Inc. All intercompany transactions and balances have been eliminated.

Use of Estimates

The preparation of consolidated financial statements in conformity with GAAP requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the consolidated financial statements and the reported amounts of revenues and expenses during the reporting period. The Company regularly evaluates estimates and assumptions. The Company bases its estimates and assumptions on current facts, historical experience, and various other factors that it believes to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities and the accrual of costs and expenses that are not readily apparent from other sources. The actual results experienced by the Company may differ materially and adversely from the Company's estimates. To the extent there are material differences between the estimates and the actual results, future results of operations will be affected. Significant estimates in the accompanying financial statements include useful lives of property and equipment, valuation of derivatives, valuation of warrants, and the valuation allowance on deferred tax assets.

Property and Equipment

Property and equipment are stated at cost. Expenditures for maintenance and repairs are charged to earnings as incurred; additions, renewals and betterments are capitalized. When property and equipment are retired or otherwise disposed of, the related cost and accumulated depreciation are removed from the respective accounts, and any gain or loss is included in operations. Depreciation of property and equipment is provided using the straight-line method for substantially all assets with estimated lives as follows:

Furniture	5 years
Computers and equipment	5 years
Research Equipment	10 years

Research and Development Expenses

Research and development expenses are charged to expense as incurred. Research and development expenses include, but are not limited to, product development, clinical and regulatory expenses, payroll and other personnel expenses, materials, supplies, related subcontract expenses, and consulting costs. The expenses assigned to NIH SBIR sponsored research are related to: (1) "Topic 352: Cell-Based Models for Prostate Cancer Health Disparity Research – Moonshot Project" and (2) "Topic 345: Predictive Biomarkers of Prostate Cancer Patient Sensitivity for Radiation Late Effects."

The research expenses are assigned to the research projects to demonstrate proof of principle in patients with prostate cancer that may support development and commercialization of biomarker products and to gather prostate cancer cell lines in African American men to serve as the product for use in health disparities research. Costs that are not covered by the SBIR contract for performing the Phase I contract to determine commercialization feasibility included partial salary support of personnel and a consultant to develop a commercialization plan. Costs that are not covered in the Phase II contract include business development and partial salary support.

Research expenses related to new drug discovery include partial support of personnel, space, supplies and legal costs.

During fiscal year 2022, the Company completed two SBIR contracts from the NIH to support research projects with potential for commercialization. The SBIR contract awards are fixed payments made by the NIH in response to quarterly Shuttle invoices and provide non-dilutive funds that do not include a repayment obligation. Details on the three contracts follow:

1. Contract #HHSN261201600027C/75N91018C00016 supported "Topic 345: Predictive Biomarkers of Prostate Cancer Patient Sensitivity for Radiation Late Effects." This $299,502 Phase I award includes funded research from September 19, 2016 through September 18, 2017 and was advanced to Phase II of the awards with funding of $1,903,095 with a fixed price contract period of September 17, 2018 through September 16, 2020 and subsequent no cost extensions through September 15, 2021 and then March 15, 2022 (Reference 75N91019C00031). The Company received quarterly payments of $211,455 for a total of $845,820 in 2020; and 2 quarterly payments related to Topic 345 for a total of $422,910 in 2021. On April 6, 2022, the Company submitted the final invoice for "Topic 345: Predictive Biomarkers of Prostate Cancer Patient Sensitivity for Radiation Late Effects," for $211,455, following the completion of the Final Quarterly Progress Report to NIH covering the performance period of September 16, 2019-March 15, 2022. The invoice was paid in full on April 27, 2022. In Phase II of the SBIR effort, the Company completed an analytical validation of the metabolic test kit, extended the option to license the metabolite signatures (intellectual property) from Georgetown University, manufacture 500 "kits," test and developed plans for a multi-institutional clinical trial to be implemented in the Phase III effort. This contract included a subcontract to Georgetown University ("Georgetown") for use of Mass Spectrometry core facilities to analyze clinical samples. The contract was extended to complete the milestones which were delayed due to the impact of COVID-19 but have now been completed.

On December 6, 2019, the Company engaged Georgetown to perform the $795,248 subcontract of its Phase II contract #HHSN75N91019C00031. The Company agreed to reimburse Georgetown for its allowable costs not to exceed the ceiling amount of $795,248. Georgetown invoiced the Company for a total of $791,017 which was paid in full as of April 2022. No additional work has been performed since the April 2022 payment. Therefore, the balance of $4,231 is not expected in the future. In the event Georgetown does not invoice for the total allowable amount, the Company is not obligated to pay the ceiling amount. As of April 2022, cumulative payments of $791,017 were made to Georgetown, including an additional invoice for $282,643 which was received but not paid until the second quarter of 2022. All invoices have now been paid.

2. The Phase II contract #HHSN261201800016C supports the discovery work following a Phase I contract # HHSN261600038C "Topic 352 – SBIR Phase II Cell-based Models for Prostate Cancer Health Disparity Research" and was awarded to provide $1,484,350 to fund research from September 17, 2018 through September 16, 2020 and was extended without cost through November 16, 2021 due to delays caused by the impact of COVID-19. For the entire contract period, the Company invoiced and received a total of $1,411,883. The final draft report was filed with the NIH along with the final invoice for $10,000, which payment was made on December 3, 2021, and no additional payments are expected. The Phase II contract also included a subcontract to Georgetown University for $742,002 to establish prostate cancer cell lines from African American patients undergoing prostate surgery for cancers.

On December 5, 2018, the Company engaged Georgetown University to perform the $742,002 subcontract of its Phase II contract #HHSN261201800016C. Depending on the resources it uses, Georgetown may or may not invoice for the total subcontract amount. In the event Georgetown does not invoice for the total allowable amount, the Company is not obligated to pay the ceiling amount. The Company has been invoiced by Georgetown and has paid Georgetown a total of $305,866 as of December 31, 2022.

The Company recognizes the amounts received from the contract at fair value when there is reasonable assurance that the contract amount will be received, and it is probable that all attaching conditions will be complied with. The Company recognizes the amounts received in accordance with the contract as a reduction of research and development expenses over the periods necessary to match the contract on a systematic basis to the costs that it is intended to compensate. The Company records reimbursements on the balance sheet as contract receivables upon meeting the criteria discussed above until cash is received. During the year ended December 31, 2022, the Company recorded a net deficit of $83,868 with the Company funding the NIH no-cost extension along with other R&D activities. The NIH made the final payment of $211,455 in April 2022 for Topic 345. No additional activities with NIH funding for these projects are in progress as of December 31, 2022.

In September of 2022, TCG GreenChem, Inc. ("TCG GreenChem") was contracted for process research, development and cGMP compliant manufacture of IPdR. The total project cost is $1,500,000 based on four milestone payments, the first payment of $450,000 was paid during the year ended December 31, 2022, pursuant to which TCG GreenChem commenced work on the project.

Regarding the accounting treatment for reimbursements, GAAP provides limited guidance on the accounting for government grants received by for-profit companies. We understand there is more than one acceptable alternative for the accounting treatment – a reduction of costs, a deferred credit to be amortized, revenue or other income. Due to the terms of the contracts we have entered into, the Company concluded that the reimbursements were more akin to a reduction of costs rather than any of the other alternatives that would match the contract reimbursements on a systematic basis to the costs that the contract is intended to compensate.

Derivative Financial Instruments

The Company evaluates all of its agreements to determine if such instruments have derivatives or contain features that qualify as embedded derivatives. For derivative financial instruments that are accounted for as liabilities, the derivative instrument is initially recorded at its fair value and is then re-valued at each reporting date, with changes in the fair value reported in the statements of operations. For stock-based derivative financial instruments, the Company uses a Binomial Simulation model to value the derivative instruments at inception and on subsequent valuation dates. The classification of derivative instruments, including whether such instruments should be recorded as liabilities or as equity, is evaluated at the end of each reporting period. Derivative instrument liabilities are classified in the balance sheet as current or non-current based on whether or not net-cash settlement of the derivative instrument could be required within 12 months of the balance sheet date. As of December 31, 2022, the Company had no derivative instruments. As of December 31, 2021 the Company's only derivative financial instrument was an embedded warrant feature associated with its Series A Convertible Preferred Stock due to certain provisions that allow for a change in the warrant value based on fluctuations of the Company's fair value of common stock at the date of issuance of the warrant based on certain contingent call features.

Fair Value of Financial Instruments

For certain of the Company's financial instruments, including cash, accounts receivable, accounts payable, accrued liabilities and short-term debt, the carrying amounts approximate their fair values due to their short maturities.

FASB ASC Topic 820, *Fair Value Measurements and Disclosures*, requires disclosure of the fair value of financial instruments held by the Company. FASB ASC Topic 825, *Financial Instruments*, defines fair value, and establishes a three-level valuation hierarchy for disclosures of fair value measurement that enhances disclosure requirements for fair value measures. The carrying amounts reported in the consolidated balance sheets for receivables and current liabilities each qualify as financial instruments and are a reasonable estimate of their fair values because of the short period of time between the origination of such instruments and their expected realization and their current market rate of interest. The three levels of valuation hierarchy are defined as follows:

- Level 1 inputs to the valuation methodology are quoted prices for identical assets or liabilities in active markets.
- Level 2 inputs to the valuation methodology include quoted prices for similar assets and liabilities in active markets, quoted prices for identical or similar assets in inactive markets, and inputs that are observable for the asset or liability, either directly or indirectly, for substantially the full term of the financial instrument.
- Level 3 inputs to the valuation methodology use one or more unobservable inputs which are significant to the fair value measurement.

The Company analyzes all financial instruments with features of both liabilities and equity under FASB ASC Topic 480, *Distinguishing Liabilities from Equity*, and FASB ASC Topic 815, *Derivatives and Hedging*.

For certain financial instruments, the carrying amounts reported in the balance sheets for cash and current liabilities, including convertible notes payable, each qualify as a financial instrument, and are a reasonable estimate of their fair values because of the short period of time between the origination of such instruments and their expected realization and their current market rate of interest.

An established trading market for the Company's common stock does not exist. The fair value of the shares was determined based on the then most recent price per share at which we sold preferred stock to unrelated parties in a private placement during the six months then ended.

During the year ended December 31, 2020, the Company utilized $25.22 (post-share exchange) per share as the fair value of its common stock for accounting purposes based on preferred share transactions with investors from August 2018 through December 2019, with no transactions occurring in 2020 and $5.00 in 2021, $4.00 through March 31, 2022 and $6.00 through June 30, 2022.

At December 31, 2022, the Company identified no liabilities required to be presented on the balance sheet at fair value.

At December 31, 2021, the Company identified the following liabilities that are required to be presented on the balance sheet at fair value:

December 31, 2021	**Level 1**	**Level 2**	**Level 3**	**Total**
Liabilities				
Warrant Liabilities	$ -	$ -	$ 94,025	$ 94,025

Revenue Recognition

Revenue from providing research and development is recognized under *Topic 606* in a manner that reasonably reflects the delivery of its services to customers in return for expected consideration and includes the following elements:

- executed contracts with the Company's customers that it believes are legally enforceable;
- identification of performance obligations in the respective contract;
- determination of the transaction price for each performance obligation in the respective contract;

- allocation the transaction price to each performance obligation; and

- recognition of revenue only when the Company satisfies each performance obligation.

To satisfy these five elements, the Company records revenue for research and development services on a quarterly basis as services are provided. Revenue received from NIH contracts is received in accordance with Federal grants and contracts policies. Research and development expenses are posted against revenue and recorded on the statement of operations as "Research and development, net of contract expense reimbursements."

Impairment of Long-Lived Assets

The Company reviews its long-lived assets for impairment whenever events or changes in business circumstances indicate that the carrying amount of the asset may not be fully recoverable. Recoverability of assets is measured by a comparison of the carrying amount of an asset to the estimated undiscounted cash flows expected to be generated by the asset. If the carrying amount of the asset exceeds its estimated future cash flows, an impairment charge will be recognized in the amount by which the carrying amount of the asset exceeds the fair value of the asset. There were no impairments of long-lived assets during the periods presented.

Income Taxes

The Company accounts for income taxes in accordance with ASC Topic 740, *Income Taxes*. ASC 740 requires a company to use the asset and liability method of accounting for income taxes, whereby deferred tax assets are recognized for deductible temporary differences, and deferred tax liabilities are recognized for taxable temporary differences. Temporary differences are the differences between the reported amounts of assets and liabilities and their tax bases. Deferred tax assets are reduced by a valuation allowance when, in the opinion of management, the Company does not foresee generating taxable income in the near future and utilizing its deferred tax asset, therefore, it is more likely than not that some portion, or all of, the deferred tax assets will not be realized. Deferred tax assets and liabilities are adjusted for the effects of changes in tax laws and rates on the date of enactment.

Under ASC 740, a tax position is recognized as a benefit only if it is "more likely than not" that the tax position would be sustained in a tax examination, with a tax examination being presumed to occur. The amount recognized is the largest amount of tax benefit that is greater than 50% likely of being realized on examination. For tax positions not meeting the "more likely than not" test, no tax benefit is recorded. The Company has no material uncertain tax positions for any of the reporting periods presented.

Basic and Diluted Earnings Per Share

Basic earnings per share ("EPS") is computed based on the weighted average number of shares of common stock outstanding during the period. Diluted EPS is computed based on the weighted average number of shares of common stock plus the effect of dilutive potential shares of common stock outstanding during the period using the treasury stock method and as if converted method. Dilutive potential shares of common stock include outstanding warrants and Series A preferred stock.

For the year ended December 31, 2022 and year ended December 31, 2021, the following common stock equivalents were excluded from the computation of diluted net loss per share as the result of the computation was anti-dilutive.

	December 31, 2022	**December 31, 2021**
Series A preferred stock.....	-	97,062
Warrants.....	356,810	48,531
	356,810	145,593

Recent Accounting Pronouncements

In August 2020, the FASB issued ASU 2020-06, ASC Subtopic 470-20 "Debt—Debt with "Conversion and Other Options" and ASC subtopic 815-40 "Hedging—Contracts in Entity's Own Equity." The standard reduced the number of accounting models for convertible debt instruments and convertible preferred stock. Convertible instruments that continue to be subject to separation models are (1) those with embedded conversion features that are not clearly and closely related to the host contract, that meet the definition of a derivative, and that do not qualify for a scope exception from derivative accounting; and (2) convertible debt instruments issued with substantial premiums for which the premiums are recorded as paid-in capital. The amendments in this update are effective for fiscal years beginning after December 15, 2021, including interim periods within those fiscal years. Early adoption is permitted. The Company adopted this standard on January 1, 2021.

Management does not believe that any recently issued, but not yet effective, accounting standards could have a material effect on the accompanying financial statements. As new accounting pronouncements are issued, we will adopt those that are applicable under the circumstances.

Note 3 – Property and Equipment, Net

Property and equipment consisted of the following:

	December 31, 2022	December 31, 2021
Office Furniture and equipment	$ 8,861	$ 8,861
Laboratory equipment	118,605	118,605
	127,466	127,466
Less accumulated depreciation	(114,874)	(108,902)
Property and equipment, net	$ 12,592	$ 18,564

Depreciation expense for the year ended December 31, 2022 and 2021, was $5,972 and $6,218, respectively.

Note 4 – Operating Lease Right-of-use Asset and Operating Lease Liability

Operating lease right-of-use assets and liabilities are recognized at the present value of the future lease payments at the lease commencement date. The interest rate used to determine the present value is our incremental borrowing rate, estimated to be 10%, as the interest rate implicit in most of our leases is not readily determinable. Operating lease expense is recognized on a straight-line basis over the lease term. During the twelve months ended December 31, 2022, and 2021, the Company recorded $70,175 and $74,028, respectively, as operating lease expense.

The Company currently has a lease agreement which allows for the use of a laboratory facility for a monthly payment of $6,480, which monthly lease payment increases by 3% every year. The laboratory lease commenced October 1, 2018, with the first payment due January 1, 2019, and expires on October 31, 2023. A security deposit of $6,480 is being held for the duration of the lease term.

In adopting ASC Topic 842, Leases (Topic 842), the Company has elected the 'package of practical expedients,' which permits the Company to avoid reassessing its prior conclusions about lease identification, lease classification and initial direct costs under the new standard. The Company did not elect the use-of-hindsight or the practical expedient pertaining to land easements, as the latter is not applicable to the Company. In addition, the Company elected not to apply ASC Topic 842 to arrangements with lease terms of 12 month or less. On January 1, 2019, upon adoption of ASC Topic 842, the Company recorded a right-of-use asset.

The Right-of-use assets are summarized below:

	December 31, 2022	December 31, 2021
Office Lease	$ 265,207	$ 265,207
Less accumulated amortization	(209,085)	(148,225)
Right-of-use asset, net	$ 56,122	$ 116,982

Amortization on the right-of-use asset is included in rent expense on the statements of operations.

Operating lease liabilities are summarized below:

	December 31, 2022	December 31, 2021
Office Lease	$ 62,823	$ 129,376
Less: current portion	(62,823)	(66,934)
Long term portion	$ -	$ 62,442

The Maturities of lease liabilities are summarized below:

	As of December 31, 2022
2023	$ 64,800
Total future minimum lease payments	64,800
Less imputed interest	(1,977)
PV of Payments	$ 62,823

Note 5 – Notes Payable-Related Party

On December 1, 2020, the Company consolidated all of the outstanding loans owed to an officer of the Company and to his spouse, resulting in the following two loans: (i) a single loan from the spouse of an officer of the Company, dated December 1, 2020, with a principal balance of $426,243, bearing interest at the rate of 7.5% per annum, with a maturity date of December 31, 2021; and (ii) a single loan owed to an officer of the company in the principal amount of $139,229, bearing interest at the rate of 7.5% per annum, with a maturity date of December 31, 2021. In December of 2021 the maturity dates of these loans were extended to June 30, 2022. In July of 2022 the notes were extended to June 30, 2023. As of December 31, 2022, the accrued interest was $63,608 and $20,768, respectively, and the total balances with accrued interest of $489,851 and $159,997, respectively. Subsequent to December 31, 2022 the December 1, 2020 note with a principal balance of $426,243 and accrued interest was paid in full on January 15, 2023 (Note 9).

On June 21, 2021, the Company entered into a loan from the spouse of an officer of the Company in the amount of $120,000 (principal) with an interest rate of 7.5% per annum due June 21, 2022, due at maturity. In July of 2022 the notes were extended to June 30, 2023. As of December 31, 2022, the accrued interest was $13,759 and the total balance with accrued interest was $133,759. Subsequent to December 31, 2022 the note and accrued interest was paid in full on January 15, 2023 (Note 9).

On August 1, 2022, in conjunction with a private placement of 10% notes and warrants (as detailed in Note 7 below), in exchange for a $50,000 payment upon subscription, the Company issued a note to the spouse of an officer of the Company in the amount of $50,000 (principal) with an interest rate of 10% per annum due August 31, 2022, with interest due at maturity, and warrants to purchase 20,000 shares of common stock, at an exercise price of $2.50 per share. The value of the warrants was determined using a computed volatility of 101%, 0% dividend rate, and a risk free interest rate of 4.25%, and was applied as a discount on the notes payable. The loan was fully repaid including $822 of accrued interest in September of 2022.

Note 6 - Notes Payable

On March 9, 2021, the Company obtained a $73,007 term note issued under the Coronavirus Aid, Relief, and Economic Security Act's Paycheck Protection Program (the "PPP"). The note bears an interest rate of 1% per annum, has a six-month deferral period with payments beginning the seventh month and all outstanding principal and interest is due within two years from the note's inception date. All or a portion of the note may be forgiven in accordance with PPP requirements. No more than 25% of the amount forgiven can be attributable to non-payroll costs. As of December 31, 2021, a "Loan Forgiveness Application" was submitted to PNC Bank along with the requested documentation and during the quarter ended March 31, 2022 the note liability was reduced in its entirety.

On May 15, 2020, the Company obtained a $62,500 term note issued under the Coronavirus Aid, Relief, and Economic Security Act's Paycheck Protection Program (the "PPP"). The note bears an interest rate of 1% per annum, has a six-month deferral period with payments beginning the seventh month and all outstanding principal and interest is due within two years from the note's inception date. All or a portion of the note may be forgiven in accordance with PPP requirements. No more than 25% of the amount forgiven can be attributable to non-payroll costs. A "Loan Forgiveness Application" was submitted to PNC Bank along with the requested documentation and the note liability was reduced in its entirety during the year ended December 31, 2021.

	December 31, 2022	December 31, 2021
PPP Note payable		
PPP Note May 15, 2020	$ -	$ 62,500
PPP Note March 9, 2021	73,007	73,007
Loan Forgiveness	(73,007)	(62,500)
	$ -	$ 73,007

On December 28, 2021, the Company issued $500,000 note units, consisting of two $250,000 notes, for a total of $500,000 10% unsecured promissory notes with a maturity date of December 28, 2022, and warrants to purchase 500,000 shares of common stock exercisable at $1.00 per share with an expiry date of December 28, 2026, and fees of $5,075. The value of the warrants was determined using a computed volatility of 85.5%, 0% dividend rate, and a risk free interest rate of 1.27% and was applied as a discount on the notes payable. In September 2022, the warrants were exercised fully reducing the principal and the Company paid $16,667 of interest in cash. In November of 2022, the remaining balance of accrued interest of $21,712 was paid in full.

On February 8, 2022 and March 11, 2022, the Company sold $365,000 and $224,985, respectively, in 6% convertible notes (the "Notes"), which notes bore 6% interest, were repayable three years from the date of issuance, and, upon completion of the Company's initial public offering, converted automatically into units, with each unit consisting of one share of common stock and a warrant to purchase one share of commons stock (the "Conversion Units") at a conversion price equal to 50% of the per unit offering price upon closing of our initial public offering. Boustead Securities LLC acted as placement agent for the convertible note offering and received compensation of $36,500 and $22,250, respectively, and warrants to purchase shares of common stock equal to 10% of the Conversion Units, exercisable at the conversion price of the Convertible Notes. The value of the warrants was determined using computed volatility of 83.4%, 0% dividend rate, and a risk free interest rate of 1.27%, and computed volatility of 85.5% %, 0% dividend rate, and a risk free interest rate of 1.96%, and was applied as a discount on the notes payable. In December 2022, the notes were fully converted, relieving the Company of $12,625 of accrued interest recorded as a gain on settlement of debt.

On August 1, 2022, the Company issued $125,000 in 10% convertible notes payable and warrants to purchase 50,000 shares of common stock to three accredited investors (which amount includes the $50,000 note and warrant purchased by a related party as detailed in Note 5 above). The warrants issued in this transaction were exercisable at price of $2.50 per share. The value of the warrants was determined using a computed volatility of 101%, 0% dividend rate, and a risk free interest rate of 4.25% and was applied as a discount on the notes payable. In December 2022, 30,000 warrants were exercised in exchange for cancellation of $75,000 in notes, thus reducing $75,000 of the principal. The remaining $50,000 note owed to the related party was then paid off in full.

	December 31, 2022	December 31, 2021
Promissory note issued on December 28, 2021	-	500,000
Promissory note issued on February 8, 2022	-	-
Promissory note issued on March 11, 2022	-	-
Promissory note issued on August 1, 2022	$ -	-
	-	500,000
Less debt discount	-	(408,979)
Total outstanding notes payable	$ -	$ 91,021

During the year ending December 31, 2022, the Company fully amortized the debt discount and included $408,979 in interest expense.

Note 7 – Stockholders' Equity

Pursuant to the Company's amended and restated articles of incorporation, the Company is authorized to issue 100,000,000 shares of common stock, with a par value of $0.00001 per share, and 20,000,000 shares of preferred stock, with a par value of $0.00001 per share.

Series A Preferred Shares

The Series A Preferred Stock, in accordance with its terms, is automatically convertible into a number of shares of the Company's common stock upon the closing of the sale of shares of common stock to the public in a qualified offering (as set forth in the Series A certificate of designation) or upon listing of the Company's common stock on a national securities exchange.

During the year ended December 31, 2022, the Company converted 1,213 shares of Series A Preferred Stock into 336,810 shares of common stock and warrants to purchase 336,810 shares of common stock, which conversion shares and warrants were calculated using a conversion price of 90% of the IPO price of $4.00 per share, resulting in a discounted conversion price of $3.60 per share. The warrants issued to the Series A Preferred Stockholders are exercisable at $4.00 per share for a period of three years.

For the year ended December 31, 2022, the Company accrued $71,009 for the 8.5% cumulative dividends on the Series A Preferred stock and $103,062 for the year ended December 31, 2021, for a total of $402,068 and $331,059 respectively.

For the year ended December 31, 2022, the Company paid the dividend payable balance of $402,068 to the Series A Stockholders through the issuance of 100,517 shares of common stock.

As of December 31, 2022, the Company had no shares of Series A Preferred Stock outstanding, and 1,213 shares as of December 31, 2021.

Common Stock

As of December 31, 2022 and December 31, 2021, the Company had 13,603,129 and 9,312,152 shares of common stock issued and outstanding, respectively. The balance includes 27,989, 20,626 and 21,530 shares of restricted stock issued in 2022, 2021 and 2020 respectively and 839 shares of common stock issued to settle shares of common stock owed to Shuttle's original membership holders.

During the year ended December 31, 2022, the Company issued:

Issuance	Shares	Value $
Public offering[(1)]	1,409,771	10,008,095
Notes payable	147,500	588,524
Warrant exercises[(2)]	2,267,551	590,574
Common stock payable	839	16,340
Preferred Share and Dividends Payable[(3)]	437,327	402,068

(1) Value is net of $1,430,582 of fees associated with the issuances.

(2) Includes 197,273 broker warrants exercised on a cashless basis for 180,280 shares of common stock and warrants to purchase 1,409,771 shares of common stock exercised as part of the Company's initial public offering.

(3) Includes 336,810 shares of common stock issued upon conversion of 1,213 Preferred Shares and 100,517 common shares to settle dividends payable balance.

Common Stock to be Issued

On June 4, 2018, $120,250 outstanding convertible notes were converted to 6,182 shares of common stock of the Company at a price of $19.44 per share. The Company recorded $16,340 of common stock to be issued for the accrued interest. As of December 31, 2022, 839 shares of common stock were issued to settle the $16,340 of common stock to be issued to Shuttle's original membership interest holders.

Warrants

The Series A Preferred Stock sold in the Company's 2018 and 2019 private placement offerings included warrants to be issued upon the earlier of a closing of the sale of shares of common stock to the public at a prices per share of at least $13.88 or in a firm commitment underwritten public offering pursuant to an effective registration statement resulting in gross proceeds of at least $15,000,000. The warrants shall be exercisable for a period of three years after the date of issuance. The warrant exercise price is contingent on the terms of the public offering. If an initial public offering occurs at a price at or above $13.88 per share, then the exercise price shall be set to the issuance price of the common stock with the number of warrants determined based on a 10% discount to the per share common stock issuance price. In the scenario where the common stock is listed with the common stock issuance price below $13.88, the exercise price will be set to $20.82 with the number of warrants based on a fixed conversion price of $12.49, which represents a 10.0% discount to the $13.88 threshold. The warrants also have contingent call features based on the terms of the public offering. If an initial public offering occurs at a price at or above $13.88, then the warrants are callable if the 20-day VWAP of the common stock in at or above 150% of the variable exercise price. In the scenario where the common stock is listed with a common stock issuance price below $13.88, then the warrants are callable if the 20-day VWAP of the common stock is at or above the $20.82 exercise price. The detachable warrants contained terms and features that gave rise to derivative liability classification.

Effective April 6, 2022, the Company amended its certificate of designation for the Series A Preferred Stock (the "Amended Series A Preferred Certificate of Designation") in order to modify the conditions pursuant to which the Series A Preferred Stock would automatically convert. Under the Amended Series A Certificate of Designation, the automatic conversion feature was amended so as to allow for conversion upon completion of a $10,000,000 public offering or the listing of the Company's common stock on a qualified exchange, in which case the Series A Preferred Stock would convert at either 90% of the per share IPO price or $5.00 per share. As a result, upon completion of our initial public offering, the Series A Preferred Stock was converted and warrants were issued in relation to the conversion, with each warrant then exercisable at the equivalent of the per share initial public offering price.

Current accounting principles that are provided in ASC 815 - Derivatives and Hedging require derivative financial instruments to be classified in liabilities and carried at fair value with changes recorded in income. The Company has selected the Binomial Option Pricing valuation technique to fair value the compound embedded derivative. Inherent in a binomial options pricing model are assumptions related to expected stock-price volatility, expected life, risk-free interest rate, and dividend yield. The Company estimates the volatility of its ordinary shares based on historical volatility of comparable companies that matches the expected remaining life of the warrants. The risk-free interest rate is based on the U.S. Treasury zero-coupon yield curve on the grant date for a maturity similar to the expected remaining life of the warrants.

The derivative warrant liability linked to the Series A Preferred Stock as of December 31, 2022 and December 31, 2021 was $0 and $94,025, respectively. For the period ended December 31, 2022 and 2021, the change in fair value of warrant liability was a gain of $94,025 and a gain of $30,971, respectively.

The estimated fair values of the liability measured on a recurring basis are as follows:

	December 31, 2022	December 31, 2021
Expected average volatility	84.87%	85.50%
Dividend yield	-	-
Expected life	2.08 Years	2.33 Years
Risk-free interest rate	2.45%	0.73%

A continuity schedule of the Series A Preferred Stock warrants is set forth below:

	Number of Warrants	Weighted Average Exercise Price	Weighted Average Life (years)
Outstanding, December 31, 2020	48,532	$ 24.98	3.33
Granted	-	-	-
Forfeited	-	-	-
Exercised	-	-	-
Outstanding and Exercisable, December 31, 2021	48,532	$ 24.98	2.33
Granted	-	-	-
Forfeited	-	-	-
Exercised	(48,532)	24.98	-
Outstanding and Exercisable, December 31, 2022	-	$ -	-

A continuity schedule of the common stock warrants is set forth below:

	Number of Warrants	Weighted Average Exercise Price	Weighted Average Life (years)
Outstanding, December 31, 2021	-	$ -	-
Issued[(1)]	2,641,354	0.75	4.75
Forfeited	-	-	-
Exercised[(2)]	(2,284,544)	0.26	-
Outstanding and Exercisable, December 31, 2022	356,810	$ 3.92	2.79

(1) Issued warrants include those issued on conversion of Notes Payable - 677,500 (Note 6), Notes Payable – Related Parties – 20,000 (Note 5), Series A Preferred Shares - 336,810 (Note 7) and issued during the IPO - 1,607,044 (Note 7).
(2) Includes 197,273 warrants exercised on a cashless basis for 180,280 common stock.

Equity Incentive Plan

Our 2018 Equity Incentive Plan provides for equity incentives to be granted to our employees, executive officers or directors and to key advisers and consultants. Equity incentives may be in the form of stock options with an exercise price of not less than the fair market value of the underlying shares as determined pursuant to the 2018 Equity Incentive Plan, restricted stock awards, other stock-based awards, or any combination of the foregoing. The 2018 Equity Incentive Plan is administered by the Company's compensation committee. We have reserved 3,000,000 shares of our common stock for issuance under the 2018 Equity Incentive Plan. As of December 31, 2022, 419,754 shares have been granted under the 2018 Equity Incentive Plan.

Restricted Stock Units. We may grant restricted stock units under our 2018 Plan. Restricted stock units are bookkeeping entries representing an amount equal to the fair market value of one share of our common stock. Subject to the provisions of our 2018 Plan, the administrator determines the terms and conditions of restricted stock units, including the vesting criteria and the form and timing of payment. The administrator, in its sole discretion, may pay earned restricted stock units in the form of cash, in shares or in some combination thereof. Notwithstanding the foregoing, the administrator, in its sole discretion, may accelerate the time at which any restrictions will lapse or be removed.

On August 16, 2019, five individuals were appointed to the Board of Directors of the Company to serve as directors. Each individual entered into an agreement outlining the terms of their service as a director and pursuant to which they would each receive a grant of $75,000 worth of Restricted Stock Units ("RSUs") issuable under the Company's 2018 Equity Incentive Plan (the "2018 Plan"). The RSUs vested annually in one third increments from the date of appointment. Under the terms of the director agreements, the Company has also agreed to pay each director $25,000 per annum, payable in equal quarterly installments commencing 90 days following the Company becoming a publicly reporting company under the Securities Exchange Act of 1934, as amended.

During the year ended December 31, 2022 and 2021, pursuant to the agreements with directors and officers, compensation expense for the RSUs of $403,956 and $910,067 was included in compensation, respectively.

As of December 31, 2022, there was $61,111 of total unrecognized compensation cost related to non-vested share-based compensation arrangements which is expected to be recognized within the next two years.

A continuity schedule of the Restricted Stock Units (RSUs) is set forth as follows:

	Number of RSU	Weighted Average Exercise Price
Outstanding, December 31, 2020	64,586	$ 22.76
Granted	-	
Forfeited	(900)	27.76
Outstanding, December 31, 2021	63,686	$ 23.87
Granted	35,588	2.81
Forfeited	-	
Outstanding, December 31, 2022	99,274	$ 15.06
Vested, December 31, 2022	75,549	$ 20.56

Note 8 – Income Taxes

The Company has not made provision for income taxes for the years ended December 31, 2022, since the Company has the benefit of net operating losses in these periods.

The reconciliation of income tax benefit at the U.S. statutory rate of 21% to the Company's tax expense is as follows:

	December 31, 2022	December 31, 2021
Federal tax benefit at statutory rate	(635,974)	$ (153,748)
State income tax benefit, net of federal tax effect	(249,847)	(60,401)
Rate change	0	
R & D Tax Credits	(83,975)	
Return to Provision Adjustments	66,214	
Permanent differences	(21,355)	19,381
Change in valuation allowance	924,936	194,768
	$ -	$ -

The principal components of deferred tax assets consist of the following:

	December 31, 2022	December 31, 2021
Deferred income tax asset:		
Net operation loss carryforwards	$ 1,173,451	$ 768,120
Fixed assets	7,801	7,479
Intangibles (includes Section 174 Capitalization)	399,644	7,788
Interest	45,574	45,574
R&D tax credits	215,229	87,801
Total deferred income tax asset	1,841,698	916,762
Less: valuation allowance	(1,841,698)	(916,762)
Total deferred income tax asset	$ -	$ -

The Company has approximately $4,011,180 of net operating losses ("NOL") carried forward to offset taxable income, if any, in future. In assessing the realization of deferred tax assets, management considers whether it is more likely than not that some portion or all of the deferred tax assets will be realized. The ultimate realization of deferred tax assets is dependent upon the generation of future taxable income during the periods in which those temporary differences become deductible. Management considers the scheduled reversal of deferred tax liabilities, projected future taxable income and tax planning strategies in making this assessment. Based on the assessment, management has established a full valuation allowance against all of the deferred tax asset relating to NOLs for every period because it is more likely than not that all of the deferred tax asset will not be realized.

Note 9 – Subsequent Events

Management evaluated all additional events subsequent to the balance sheet date through March 14, 2023, the date the financial statements were available to be issued, and determined the following items:

On January 11, 2023, the Company entered into a securities purchase agreement ("Securities Purchase Agreement") with Alto Opportunity Master Fund, SPC – Segregated Master Portfolio B (the "Alto Opportunity Master Fund"), for a 26 month $4.3 million convertible note with 5% annual interest rate (the "Note") and a four year warrant to purchase 1,018,079 shares of common stock exercisable at $2.35 per common share, for gross proceeds of $4.0 million in cash (the "Funds"). The Note is convertible into Common Stock at the lower of (i) $2.35 (ii) 90% of the three lowest daily VWAPs of the 15 trading days prior to the payment date or (iii) 90% of the VWAP of the trading day prior to payment date. On February 2, 2023 50,998 shares of Common Stock were issued at a conversion price of $1.6921, converting $66,150 of outstanding principal and $20,142 of unpaid interest, for a total of $86,292.

On January 15, 2023, the Company repaid two related party notes payable from the spouse of an officer of the Company entered on June 21, 2021 with a principal balance of $120,000, and December 01, 2020 with a principal balance of $426,243 (Note 5) plus total accrued interest of $79,044 for a total of $625,287.

On February 16, 2023, the Company entered into a lease agreement with ARE-QRS Corp, for purposes of renting 2,109 square feet of office and laboratory space in Gaithersburg, Maryland, which will serve as the Company's new office space commencing on or about June 1, 2023. The lease has a term of 5.25 years, with an option to extend the lease for an additional three years. The base rent will be $7,206 per month, subject to a customary rent abatement at the outset of the lease and a customary percentage increase in the Base Rent each year. The new office and laboratory space is located in a building with 63,154 square feet of office and laboratory space, largely occupied by other pharmaceutical and biotech companies.

On March 11, 2023, the Company entered into a letter agreement with Alto Opportunity Master Fund, as collateral agent (the "Collateral Agent"), pursuant to which the Company and the Collateral Agent agreed to amend Section 15(q) of the Note so as to allow for the transfer of the Funds held by First Republic Bank into the Collateral Agent's account at HSBC. The Funds had been held at First Republic Bank under a springing deposit account control agreement (or DACA). Under the terms of the Letter Agreement, the parties agreed that the Funds would be held in trust in the Collateral Agent's account pending the Company's location of a new bank, acceptable to the Collateral Agent, at which the Funds could be held subject to a similar DACA. All other terms and conditions related to the Securities Purchase Agreement, Note and related documents remain the same.

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

None.

Item 9A. Controls and Procedures

Evaluation of Disclosure Controls and Procedures

Although we are not required to, as a newly public company, we maintain disclosure controls and procedures that are designed to ensure that information required to be disclosed in our reports filed under the Securities Exchange Act of 1934, as amended, is recorded, processed, summarized and reported within the time periods specified in the Securities and Exchange Commission's rules, regulations and forms, and that such information is accumulated and communicated to our management, including our Chief Executive Officer and Chief Financial Officer, to allow for timely decisions regarding required disclosure.

As of December 31, 2022, our management carried out an evaluation of the effectiveness of the design and operation of our disclosure controls and procedures. Such evaluation was carried out under the supervision of our Chief Executive Officer with the participation of our President and Chief Operating Officer, our Chief Financial Officer, and our accounting and financial service provider, PubCo Reporting Solutions, Inc., an out-sourced accounting and financial services provider ("PubCo Reporting"). Based on the foregoing, our management concluded that our internal controls over financial reporting should be strengthened because, among other things, (i) we did not maintain a sufficient complement of personnel with an appropriate degree of technical knowledge commensurate with the Company's accounting and reporting requirements, (ii) written communication procedures and organization of files could be improved and automated, and (iii) our controls related to the financial statement closing process needed to be redesigned for a more orderly and less cumbersome closing process that would more easily identify material misstatements in our financial reporting on a timely basis. We have been working to address these deficiencies through the review, recommendation and implementation of changes from our accounting and financial services provider, PubCo Reporting. As a result, our knowledge base of public company accounting reporting requirements and related procedures has been augmented by PubCo Reporting, whose services include a "…focus on US GAAP Corporate Accounting, Financial Reporting, SEC EDGAR iXBRL & SEDAR Filings, Internal (SOX) Compliance And Controls, and Regulatory Compliance." Our collaboration with PubCo Reporting, an experienced accounting and financial reporting company with technical knowledge commensurate with the Company's accounting and reporting requirements, has served to enhance our accounting disclosure controls and procedures.

Management has taken steps to improve policies and procedures relevant to the Code of Federal Regulations (CFR) Section 240.13a-15. These changes are listed below and are being refined through quarterly meetings between PubCo and Company

Changes in Internal Controls

In connection with our continued monitoring and maintenance of our controls procedures as part of the implementation of Section 404 of the Sarbanes-Oxley Act, we continue to review, test, and improve the effectiveness of our internal controls. The following changes in our internal control over financial reporting (as such term is defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act) that occurred during the period ending December 31, 2022 or subsequent to the date the Company completed its evaluation, that have materially affected, or are reasonably likely to materially affect, our internal control over financial reporting were:

(1) Automation and electronic data interfaces of banking and payroll systems with our accounting system to improve accuracy, efficiency, and timeliness of reporting;

(2) Reorganization of, and additional procedures for, recordkeeping;

(3) Additional segregated monthly review and month end close procedures to identify errors or omissions in recording transactions;

(4) Addition of accounting staff supervised by an experienced financial reporting company to improve preparation of financial statements in accordance with GAAP; and

(5) Segregation of approval and review of financial transactions

Management will continue to monitor and evaluate the effectiveness of our internal controls and procedures over financial reporting on and ongoing basis and are committed to taking further action and implementing additional improvements as necessary.

Item 9B. Other Information

None.

Item 9C. Disclosure Regarding Foreign Jurisdictions that Prevent Inspections

Not applicable.

PART III

Item 10. Directors, Executive Officers and Corporate Governance

MANAGEMENT

Our directors and executive officers and their respective ages and titles are as follows:

Name	Age	Position(s) and Office(s) Held
Anatoly Dritschilo, M.D.	78	Chairman of the board of directors and Chief Executive Officer
Michael Vander Hoek	63	Chief Financial Officer, VP for Operations and Regulatory
Peter Dritschilo	53	President and Chief Operating Officer
Mira Jung, Ph.D.	73	Chief Scientific Officer
Tyvin Rich, M.D.	75	Chief Clinical Officer
Milton Brown, M.D., Ph.D.	57	Director
Steven Richards	54	Independent Director (1)(2)(3)
Joshua Schafer	51	Independent Director (2)(3)
Chris H. Senanayake, Ph.D.	65	Independent Director (1)
Bette Jacobs, Ph.D.	71	Independent Director (1)(3)

(1) Member of the Audit Committee
(2) Member of the Compensation Committee
(3) Member of the Nominating and Corporate Governance Committee

Set forth below is a description of the background and business experience of our directors and executive officers.

Anatoly Dritschilo, M.D. is a co-founder of the Company and has served as Chief Executive Officer and Chairman of the board of directors since the Company's formation in December 2012. Dr. Dritschilo is a radiation oncologist by training and has held multiple leadership positions in health care. At Georgetown University Medical School in Washington, D.C., he served principally as Department Chair from 1980 to 2022; Chief of Radiation Oncology at MedStar-Georgetown University Hospital from 2005 to 2022; Medical Director of Georgetown University Hospital from 1994 to 1997; and Interim Director of the NCI-funded Lombardi Comprehensive Cancer Center from 2005 to 2007. He has also served on the boards of directors of MedStar-Georgetown University Hospital, the National Capital Rehabilitation Hospital and the MedStar Health Research Institute. Previously, he was a founding director of Oncomed, Inc. and member of the board of directors of Neopharm, Inc. His 250+ scientific publications and 12 issued patents have earned him election as a Fellow of the National Academy of Inventors. Dr. Dritschilo holds a Bachelor of Science degree in Chemical Engineering from the University of Pennsylvania, a medical degree from the College of Medicine of New Jersey and residency training from the Harvard, Joint Center for Radiation Therapy. His qualifications support his service as our Chief Executive Officer and Chairman of the board of directors.

Michael P. Vander Hoek serves as the Company's Chief Financial Officer, a position he was appointed to in August 2019, and Vice President, Operations and Regulatory, a position he has held since 2019. From November 2019 until April 2021, Mr. Vander Hoek served as Director, Finance and Business Development at Georgetown Lombardi Comprehensive Cancer Center ("LCCC"), where he directed a new five-year $221.9 million institutional commitment for cancer center research under a new NCI-approved cancer consortium arrangement and recruited scientists to fulfill strategic objectives with senior leaders to improve cancer research and treatment. From 2007 until November 2019, Mr. Vander Hoek served as Associate Director, Administration, at Georgetown's LCCC, where he was responsible for direct administrative operations for more than 400 faculty and staff in the department of oncology, radiation medicine, pathology and biostatistics, bioinformatics and biomathematics, including managing $216.9 million in institutional commitments to LCCC from Medstar Health, John Theurer Cancer Center ("JTCC"), and Georgetown University. and implementing an enterprise-wide clinical trial management system for Georgetown University and Medstar Health. From 2004 until 2007, Mr. Vander Hoek served as Chief Financial Officer at Georgetown's LCCC. During his time at Georgetown, Mr. Vander Hoek negotiated a series of 12 research integration agreements between LCCC and the JTCC that resulted in the approval of an NCI recognized Consortium in 2019. From 2001 until 2004, Mr. Vander Hoek served as Vice-Chair, Planning and Administration, at MedStar Georgetown University Hospital, where he was responsible for managing administrative and financial operations for some 440 staff, physicians, residents and fellows in the departments of Medicine and Neurology. From 1996 until 2001, Mr. Vander Hoek served as Senior Associate Administrator, Finance and Information Systems, for the Department of Medicine, Georgetown University Medical Center, where he designed and managed the faculty compensation system, while managing the finances and information systems for the department. His financial management experience in publicly held companies includes Director of Managed Care Reimbursement for Critical Care America from 1990 to 1993 and Regional Controller for Laboratory Corporation of America (LabCorp) from 1993 to 1996. His responsibilities at both companies included extensive financial management related to mergers, acquisitions, and start-up operations. Mr. Vander Hoek holds a Master's in Health Services Administration from The George Washington University and a Bachelor of Arts in Biology and Psychology from Hope College.

Peter Dritschilo has served as our President and Chief Operating Officer since Shuttle was formed in December 2012. He also served as our Chief Financial Officer until 2019. Mr. Dritschilo has more than 25 years of business management experience in medical services and cancer treatment. He has held administrative positions with Medstar-Rad America from 2001 to 2005, Georgetown University 2005 to 2006, Prince William Hospital and the Fauquier Hospital Cancer Center 2006 to 2011 and Inova Health System's Schar Cancer Institute from 2011 to 2018. In 2014, Mr. Dritschilo filed for Chapter 7 bankruptcy protection due to the failure of a personal business venture. Mr. Dritschilo graduated from Georgetown University and received his MBA from the George Washington University.

Mira Jung, Ph.D., a co-founder of our company, has served as our Chief Scientific Officer for Biology since December 2012, and was a member of our board of directors from our formation in December 2012 until 2019. Since 2004, Dr. Jung has served as Professor of Radiation Medicine and Microbiology at Georgetown University Medical School. With over 30 years of experience in molecular radiation biology research, she is an expert in mechanisms of radiation resistance and on the roles of HDAC inhibitors in modifying the radiation response. Dr. Jung's research has been funded by NIH and the DOD leading to 100+ publications and nine patents granted by the USPTO, including the first reports of HDAC inhibitor drug classes modifying cancer cell radiation resistance and protecting normal tissues from radiation damage. Dr. Jung holds an MA degree and a PhD in Microbiology and Molecular Virology from the University of Kansas, Lawrence.

Tyvin A. Rich, M.D. serves as our company's Chief Medical Officer and is responsible for the clinical development of novel radiation sensitizers. Since 2010, Dr. Rich has served as a Staff Radiation Oncologist at the Hampton University Proton Therapy Institute in Hampton Virginia and Professor Emeritus at University of Virginia Health Sciences Center, Department of Radiation Oncology. From 1995 until 2010, Dr. Rich was a Professor and Chairman of the Department of Therapeutic Radiology and Oncology at the University of Virginia Health Sciences Center. Prior to that, from 1984 through 1995, Dr. Rich was a Professor of Radiotherapy and Director of Clinics in the Department of Radiotherapy of the University of Texas M. D. Anderson Cancer Center. He has served as the protocol chair for RTOG clinical trials that advanced the use of chemoradiation for the treatment of rectal and pancreatic cancers. He is an expert in the applications of infusional 5-Fluorouracil for chemoradiation therapy of gastro-intestinal cancers and has authored more than 200 scientific articles, reviews and book chapters. Dr. Rich received his undergraduate degree at Rutgers University, his medical degree at the University of Virginia, and completed residencies in internal medicine at Georgetown University Medical Center and radiation therapy at Massachusetts General Hospital, Harvard Medical School.

Milton Brown, M.D., Ph.D., FNAI is a co-founder of our company, previously served as our Chief Scientific Officer for Chemistry, and has served a member of our board of directors since the Company's formation in December 2012. Since August 2022, Dr. Brown has also served as Vice Dean of Research, Professor of Internal Medicine and the Prudence and Louis Ryan endowed chair in translational research at Eastern Virginia Medical School. Previously, he was Director of the Center for Drug Discovery at the George Mason University from 2020 to 2022 and Director of the Inova Center for Drug Discovery and Development from 2016 to 2020. Dr. Brown was a founder of Rivanna Pharmaceuticals in 2004 and co-founder, Chairman and CEO of Trocar Pharma in 2020, both of which are Virginia-based biopharmaceutical companies engaged in the discovery and development of novel small molecule therapeutics for the treatment of neurological, oncological, and infectious diseases. Dr. Brown has also served as Director of the Drug Discovery Center at Georgetown University Medical School from 2012 to 2016 and principal investigator of the NIH/NCI funded Chemical Diversity Center from 2010 to 2015. Dr. Brown brings to Shuttle Pharma 25 years of experience in drug discovery with over 100 publications and 67 issued patents, including discovery of novel HDAC inhibitors. Dr. Brown was a 2015 recipient of the Percy Julian Award by the National Organization of Black Chemists and Chemical Engineers for significant contributions in pure and/or applied research in science. He has served on government committees including the NIH Experimental Therapeutics Study Section, the NIH Drug Discovery and Molecular Pharmacology Study Section and was a scientific counselor to the U.S. Secretary of Health. Dr. Brown holds a Ph.D. in synthetic chemistry from University of Alabama, and an MD from the University of Virginia. He is an elected fellow of the National Academy of Inventors (FNAI). His extensive experience and expertise in drug discovery makes him uniquely qualified to guide the company's drug discovery program as a member of our board of directors.

Steven Richards was appointed to be a member of our company's board of directors in 2019. He is CEO and Founder of Endurance Media, a media finance company based in Santa Monica, California, that launched in 2014 with a strategic alliance with eOne Entertainment and a mandate to produce and finance commercially driven feature films. From 2006 to 2014, Mr. Richards served as Co-President and Chief Operating Officer of Silver Pictures where he oversaw all business activities and managed a team of more than 20 people responsible for film development, production and financial information. From 2000 to 2006, he served as Chief Financial Officer at Silver Pictures and from 1995 to 2000 as Vice President, Finance, at Silver Pictures. Mr. Richards holds an MBA in Finance from UCLA, a BBA in accounting from Temple University, and holds his CPA license. We believe his experience as a chief financial officer and his knowledge of accounting will assist in providing guidance and oversight to our board of directors as we grow our company.

Joshua Schafer was appointed to be a member of our company's board of directors in 2019. From January 2023 until present, Mr. Schafer has been serving as the Chief Commercial Officer, and EVP Business Development at Zevra Therapeutics, a rare disease company. November 2022 until January 2023, Mr. Schafer was interim CEO and Chair of the Board at PHARNEXT, an entity he has served on the board of since July 2020. From December 2020 until November 2022, Mr. Schafer served as Senior Vice President and General Manager, Autoimmune and Rare Disease Business for Mallinckrodt Pharmaceuticals Incorporated. In addition, he served as Chief Strategy and Business Development Officer from September 2019 until December 2020, and from 2015 to September 2019 he was SCP of Business Development and General Manager of International Operations at Mallinckrodt Pharmaceuticals. From 2009 until 2015, he served as Vice President and Oncology Therapeutic Area Head at Astellas Pharmaceuticals Incorporated, where he was responsible for building the company's global oncology franchise. From 2000 until 2009, Mr. Schafer served in positions of increasing seniority at Takeda Pharmaceuticals North America, including Manager and Senior Manager, New Product and New Business Development; Senior Product Manager, Gastrointestinal Marketing; and Director, Oncology and Renal Marketing and Commercial Development. He began working in the healthcare and pharmaceutical industry in 1998 and has served in various positions including management consulting at Accenture (formerly Anderson Consulting), G.D. Searle & Co. (later acquired by Pfizer) and Cognia Corporation. He received his Bachelor of Arts in Biology and German at the University of Notre Dame, his MS in Biotechnology from Northwestern University and his MBA from Northwestern University. We believe Mr. Schafer's extensive experience in pharmaceutical strategy, marketing and business development will assist our board of directors' oversight role as we build and develop our Company.

Chris H. Senanayake, Ph.D. was appointed to be a member of the Company's board of directors in 2021. In 2019, Dr. Senanayake founded TCG GreenChem, Inc., a U.S. subsidiary of TCG Lifesciences Pvt. Ltd., a leading global Contract Research and Manufacturing Services (CRAMS) company in the area of drug discovery, development and commercialization, where he serves as chief executive officer. Dr. Senanayake has more than 30 years of pharmaceutical industry experience, making him an invaluable asset to Shuttle Pharma's mission as the Company advances its pharmaceutical candidates in clinical trials. He has held positions of Senior Scientist at Dow Chemical, and Research Fellow at Merck & Co, Inc. (from 1990 to 1996), Director and Executive Director of Process Research at Sepracor, Inc. (1996 to 2002), Director of Chemical Development and Vice President of Chemical Development for Boehringer Ingelheim Pharmaceuticals, Inc. In 2018, he was appointed as the CEO of Asta GreenChem, Inc in Richmond VA and Astatech (Chengdu) Biopharmaceuticals Corp. in China. He has a record of leading and delivering on high complexity APIs for manufacturing. Dr. Senanayake participated in development activities of many drugs, including multi-billion-dollar blockbuster drugs, such as Crixivan, Lunesta, Jardiance, Formotorol, Desvenlafaxine and other drug candidates. He is co-author of 425 scientific publications and is co-inventor of more than 150 patents. Dr. Senanayake received his Ph.D. in synthetic organic chemistry at Wayne State University, where he developed the total synthesis of complex natural products and completed the first total synthesis of grosshemin in the guaianolide family. In his postdoctoral fellowship, he conducted total synthesis of polyol systems such as amphotericin B, compactin and C-nucleosides. We believe Dr. Senanayake's detailed and in-depth experience as an executive and developer of pharmaceuticals will enable him to provide value to us by introducing potential joint venture partners, as well as enhancing our oversight through his in-depth understanding of and experience in the pharmaceuticals industry.

Bette Jacobs, Ph.D. was appointed to be a member of the Company's board of directors in October 2022. Dr. Jacobs is an experienced researcher, administrator and businesswoman currently serving as a professor in the department of health systems administration at Georgetown University and as a distinguished scholar at the O'Neill Institute for National and Global Health Law. Dr. Jacobs holds her Ph.D. from the University of Texas and is noted for her groundbreaking transdisciplinary and cross-sector work in systems design. As a voting member of the Cherokee Nation, she has lifetime involvement in equity programs and has testified before Congress. In addition to serving on several start-up boards, Dr. Jacobs founded the National Coalition of Ethnic Minority Nurse Associations funded by the NIH National Institute of General Medical Sciences. Prior to her current role at Georgetown, she served as dean at the Georgetown School of Nursing and Health Studies, vice president for Honda of America Manufacturing, associate director of applied research at UAB Civitan International Research Center and acting dean of graduate studies and research at California State University. She has been a fellow and visiting professor at the University of Oxford and an academic guest scholar and lecturer at several acclaimed universities worldwide. Her wealth of experience in research, administration and serving on boards coupled with her unique background and perspectives makes her ideally suited to serving as a member of our board of directors.

Scientific Advisory Committee

Theodore L. Phillips, M.D. has served as the Chair of our Scientific Advisory Committee since 2018. He held the position of Chief Medical Officer and Clinical Director at Shuttle Pharmaceuticals from 2014 until 2018. Dr. Phillips' distinguished career has included positions of Chair of the Department of Radiation Oncology (from1978 to 1998) and Associate Director (from 1996 to 1999) of the UCSF Cancer Center at the University of California at San Francisco. He is highly experienced in radiation oncology clinical trials of hypoxic radiation sensitizers. Dr. Phillips served as the principal investigator of the SBIR contract for the Phase I clinical trial of Ropidoxuridine. He previously served as Associate Director of the Northern California Oncology Group from 1983-1990, president of the American Society of Therapeutic Radiation Oncologists from 1984 to 1985, and is an elected member of the Institute of Medicine of the National Academy of Science. Dr. Phillips holds a BS degree from Dickinson College in Carlisle, Pennsylvania and a MD from the University of Pennsylvania. He provides advice to the leadership team to help design and implement clinical trials of radiation therapy and radiation response modifying drugs.

Ralph R. Weichselbaum, M.D. has served as Scientific Advisor to Shuttle Pharmaceuticals for translational research for the discovery and development of radiation response modifiers since 2013. Dr. Weichselbaum is the Daniel K. Ludwig Professor and Chairman of the Department of Radiation and Cellular Oncology, the University of Chicago, a position he has held since 1985. He is also an elected member of the Institute of Medicine, National Academy of Sciences. He has devoted his career to translational research in cancer with combined radiotherapy and chemotherapy. Dr. Weichselbaum and his colleagues conceived "genetic radiotherapy" and developed viral constructs for use in clinical tumor radiation sensitization. These were commercialized as TNFerade (GenVec, Inc.) and tested in a Phase I clinical trial in prostate cancer and a Phase III clinical trial for pancreatic cancer.

J. Martin Brown, Ph.D. has served as a Scientific Advisor to Shuttle Pharmaceuticals for translational research for the development of hypoxic radiation sensitizers since 2017. Dr. Brown received his Ph.D.in Cancer Biology from Oxford University in 1968 and was Director of the Division of Radiation and Cancer Biology at Stanford University from 1984 to 2004. He is an expert in the radiation biology of hypoxia in cancers and has more than 300 peer-reviewed published articles. He has received awards in recognition of his work, including the Gold Medal, American Society for Therapeutic Radiology and Oncology (1999, the Failla Memorial Award, Radiation Research Society (2000), the Weiss Medal, Association for Radiation Research (2001) and the Henry S. Kaplan Distinguished Scientist Award, International Association for Radiation Research (2007). He developed etanidazole, a hypoxic radiation sensitizer, and tirapazamine, a hypoxic cytotoxic drug, from bench to clinical trials.

Alejandro Villagra, Ph.D. has served as a Scientific Advisor to Shuttle Pharmaceuticals with expertise in cellular signaling pathways, epigenetics and immunology since 2017. Dr. Villagra received his Ph.D. in Molecular Biology from the University of Concepcion, in Chile in 2004 and completed post-graduate training at the H. Lee Moffitt Cancer Center and Research Institute in Tampa, Florida in Molecular Immunology in 2009, in the Laboratory of Eduardo Sotomayor, MD. He joined the faculty of the Moffitt Cancer Center and Research Institute, as a research scientist from 2009 through 2015 and advanced to Assistant Professor of Oncologic Sciences. He became an Assistant Professor in the Department of Biochemistry and Molecular Medicine at the George Washington University (GWU) School of Medicine and Health Sciences in 2015, as a member of the GWU Cancer Center. His research is focused on molecular and cellular roles of histone deacetylases (HDACs) in tumor immunology and as adjuvants for immunotherapy of cancers.

Joseph Armstrong, III, Ph.D. joined as a Scientific Advisor to Shuttle Pharmaceuticals in 2021, He received his Ph.D. from the University of Colorado in 1988, completed his post-doctoral work at the University of Virginia at Charlottesville and holds the position of Chief Operating Officer at and Global Head of Business Development TCG GreenChem, Inc. He provides industry experience in chemistry, drug development and process research, having previously held positions at Merck & Co. Inc. in Rahway, N.J and in the U.K. for two pharmaceutical companies in the areas of Pharmaceutical Research and Development. His primary areas of focus have been in the design and implementation of efficient synthesis of drug candidates amenable to large scale production. Dr. Armstrong led the development team that designed, developed and implemented the manufacturing process for the new treatment for Type II diabetes, Januvia TM. His team was awarded the Solvias Prize in 2004 (Basel, Switzerland), the IChemE Aztra-Zeneca Award for Green Chemistry and Engineering in 2005 (London, England), Dr. Armstrong has more than 40 publications and holds 10 patents.

Family Relationships

Dr. Anatoly Dritschilo and Peter Dritschilo are father and son. There are no other family relationships among our directors and executive officers.

Board of Directors

Our board of directors is responsible for overseeing the Company's business consistent with its fiduciary duty to the stockholders. This significant responsibility requires highly skilled individuals with various qualities, attributes and professional experience. There are general requirements for service on the board of directors that are applicable to directors and there are other skills and experience that should be represented on the board of directors as a whole but not necessarily by each director. Our Corporate Governance and Nominating Committee, detailed below, considers the qualifications of director candidates individually and in the broader context of the board of directors' overall composition and the Company's current and future needs.

Terms of Office

All of our directors are elected to one-year terms to hold office until the next annual meeting of our stockholders and until a successor is appointed and qualified, or until their removal, resignation, or death. Executive officers serve at the pleasure of the board of directors.

Director Independence

In order to qualify for continued listing on Nasdaq, our board of directors must consist of a majority of "independent" directors, as defined under Nasdaq listing standards and Rule 10A-3(b)(1) under the Exchange Act. At present, four of the six directors serving on our board of directors qualify as "independent." Our independent directors consist of Messrs. Richards and Schafer, Dr. Senanayake and Dr. Jacobs.

Board Committees

General

Our board of directors has established three committees consisting of an audit committee, a compensation committee, and a nominating and corporate governance committee. The members of each committee qualify as "independent" as defined under Nasdaq listing standards and Rule 10A-3(b)(1). Moreover, at least one member of the audit committee qualifies as an "audit committee financial expert" as the term is defined under Nasdaq listing standards and applicable rules and regulations of the SEC, based on their respective business professional experience in the financial and accounting fields.

Audit Committee

The audit committee, which consists of Steve Richards, MBA, CPA (Chair), Bette Jacobs and Chris H. Senanayake, assists our board of directors in its oversight of the Company's accounting and financial reporting processes and the audits of the Company's financial statements, including (a) the quality and integrity of the Company's financial statements (b) the Company's compliance with legal and regulatory requirements, (c) the independent auditors' qualifications and independence and (d) the performance of the Company's internal audit functions and independent auditors, as well as other matters which may come before it as directed by the board of directors. Further, the audit committee, to the extent it deems necessary or appropriate, among its several other responsibilities, will:

- be responsible for the appointment, compensation, retention, termination and oversight of the work of any independent auditor engaged for the purpose of preparing or issuing an audit report or performing other audit, review or attest services for the Company;

- discuss the annual audited financial statements and the quarterly unaudited financial statements with management and the independent auditor prior to their filing with the SEC in our Annual Report on Form 10-K and Quarterly Reports on Form 10-Q;

- review with the Company's management on a periodic basis (i) issues regarding accounting principles and financial statement presentations, including any significant changes in our company's selection or application of accounting principles; and (ii) the effect of any regulatory and accounting initiatives, as well as off-balance sheet structures, on the financial statements of the company;

- monitor the Company's policies for compliance with federal, state, local and foreign laws and regulations and the Company's policies on corporate conduct;

- maintain open, continuing and direct communication between the board of directors, the audit committee and our independent auditors; and

- monitor our compliance with legal and regulatory requirements and will have the authority to initiate any special investigations of conflicts of interest, and compliance with federal, state and local laws and regulations, including the Foreign Corrupt Practices Act, as may be warranted.

Compensation Committee

The compensation committee, which consists of Steve Richards (Chair) and Joshua Schafer, aids our board of directors in meeting its responsibilities relating to the compensation of the Company's executive officers and to administer all incentive compensation plans and equity-based plans of the Company, including the plans under which Company securities may be acquired by directors, executive officers, employees and consultants. Further, the compensation committee, to the extent it deems necessary or appropriate, among its several other responsibilities, will:

- review periodically our Company's philosophy regarding executive compensation to (i) ensure the attraction and retention of corporate officers; (ii) ensure the motivation of corporate officers to achieve the Company's business objectives; and (iii) align the interests of key management with the long-term interests of the Company's stockholders;

- review and approve corporate goals and objectives relating to chief executive officer compensation and other executive officers of Shuttle;

- make recommendations to the board of directors regarding compensation for non-employee directors, and review periodically non- employee director compensation in relation to other comparable companies and in light of such factors as the compensation committee may deem appropriate; and

- review periodically reports from management regarding funding the Company's pension, retirement, long-term disability and other management welfare and benefit plans.

Nominating and Corporate Governance Committee

The nominating and corporate governance committee, which consists of Joshua Schafer (Chair), Steve Richards and Bette Jacobs, recommends to the board of directors individuals qualified to serve as directors and on committees of the board of directors to advise the board of directors with respect to the board of directors composition, procedures and committees to develop and recommend to the board of directors a set of corporate governance principles applicable to the Company, and to oversee the evaluation of the board of directors and Shuttle's management. In addition, the nominating and corporate governance committee will consider diversity of background including diversity of race, ethnicity, international background, gender and age when evaluating candidates for board of directors membership.

Further, the nominating and corporate governance committee, to the extent it deems necessary or appropriate, among its several other responsibilities will:

- recommend to the board of directors and for approval by a majority of independent directors for election by stockholders or appointment by the board of directors as the case may be, pursuant to our bylaws and consistent with the board of director's evidence for selecting new directors;

- review the suitability for continued service as a director of each member of the board of directors when his or her term expires or when he or she has a significant change in status;

- review annually the composition of the board of directors and to review periodically the size of the board of directors;

- make recommendations on the frequency and structure of board of directors meetings or any other aspect of procedures of the board of directors;

- make recommendations regarding the chairmanship and composition of standing committees and monitor their functions;

- review annually committee assignments and chairmanships;

- recommend the establishment of special committees as may be necessary or desirable from time to time; and

- develop and periodically review corporate governance procedures and consider any other corporate governance issue.

Code of Ethics

We have adopted a code of ethics that applies to all of our executive officers, directors and employees. The code of ethics codifies the business and ethical principles that govern all aspects of our business. This document will be made available in print, free of charge, to any stockholder requesting a copy in writing from our Secretary at our executive offices in Rockville, Maryland. A copy of our code of ethics is available on our website at www.shuttlepharma.com.

Insider Trading Policies and Procedures

The Company has adopted an insider trading policy, as amended and restated on March 10, 2023 (the "Insider Trading Policy"), overseen by the Company's corporate secretary, that applies to all (i) directors, (ii) executive officers and (iii) employees who are exposed to insider information (together, the "Covered Persons"). The Insider Trading Policy prohibits the use of material non-public information obtained by Covered Persons through their involvement with the Company when making decisions to purchase, sell, give away or otherwise trade in the Company's securities or to provide such information to others outside the organization. Under the Insider Trading Policy, material non-public information includes, among other things, significant changes in the Company's prospects, significant write-downs, liquidity problems, changes in management, extraordinary borrowings, changes in debt, planned public offerings or any other information that may be deemed material to the Company or the Company's prospects. Further, we have established black-out periods to which all Covered Persons are subject, including quarterly black-out periods, which commence three weeks before the end of each quarter and continue until the quarterly results are disclosed by filing the Company's Quarterly Report on Form 10-Q or Annual Report on Form 10-K. The Company may impose black-out periods from time to time as other types of material non-public information occur when material non-public events or disclosures are pending. If the Company imposes a special black-out period, the Company will notify Covered Persons accordingly. Covered Persons are permitted to trade in the Company's securities only when there is no black-out period in effect and such trade has been pre-cleared by the Company's corporate secretary, or when a qualified 10b5-1 plan has been established in accordance with federal securities laws.

Clawback Policy

While the Company does not presently have in place any significant incentive compensation agreements or awards related to the Company's overall financial performance, the Company's board of directors has adopted a clawback policy in order to comply with federal securities laws. As such, we have adopted a clawback policy in which we may seek the recovery or forfeiture of incentive compensation paid by us, including cash, equity or equity-based compensation, in the event we restate our financial statements under certain circumstances. The clawback policy applies to our Section 16 officers, any employee who was eligible to receive incentive compensation and whose conduct contributed to the need for a restatement, and any other former Section 16 officer or other employee who contributed to the need for such restatement.

Board of Directors Role in Risk Oversight

Members of the board of directors have periodic meetings with management and the Company's independent auditors to perform risk oversight with respect to the Company's internal control processes. The Company believes that the board of directors' role in risk oversight does not materially affect the leadership structure of the Company. The Company believes that its founders, leadership team and members of the board of directors exemplify diversity and inclusivity with respect to race, sex and ethnic origin. The board of directors presently has two diverse directors and is in the process of reviewing and vetting a female candidate to serve as a director. As such, the Company anticipates being in full compliance with Nasdaq's newly adopted diversity requirements by the end of its first year of listing.

Section 16(A) Beneficial Ownership Reporting Compliance

Section 16(a) of the Securities Exchange Act requires our executive officers and directors, and persons who own more than 10% of our common stock, to file reports regarding ownership of, and transactions in, our securities with the Securities and Exchange Commission and to provide us with copies of those filings. Based solely on our review of the copies of such forms furnished to us and written representations by our officers and directors regarding their compliance with applicable reporting requirements under Section 16(a) of the Exchange Act, we believe that all Section 16(a) filing requirements for our executive officers, directors and 10% stockholders were met during the year ended December 31, 2022, except for the following:

Name	Late Reports	Transactions Covered*	Number of Shares
Milton Brown, M.D., Ph.D.	Form 4	common stock	995
Steven Richards	Form 4	common stock	995
Bette Jacobs, Ph.D.	Form 3	RSUs	35,587
William Adkins**	Form 4	common stock	995
	Form 4	warrants (right to buy)	138,889

*All reference to RSUs refer to restricted stock units, which are periodically convertible into the Company's common stock upon achievement of certain vesting conditions. All references to common stock refer to the Company's common stock. All references to warrants refer to the warrants to purchase the Company's common stock.

**William Adkins is a former director of the Company.

Item 11. Executive Compensation

Summary Compensation Table

The table below summarizes all compensation awarded to, earned by, or paid to our Chief Executive Officer and Chief Financial Officer and certain of our other executive officers for 2022 and 2021.

SUMMARY COMPENSATION TABLE

Name and principal position	Year	Salary ($)	Bonus ($)	Stock Awards ($)	Option Awards ($)	Non-Equity Incentive Plan Compensation ($)	Nonqualified Deferred Compensation Earnings ($)	All Other Compensation ($)	Total ($)
Anatoly Dritschilo									
M.D., CEO	2022	91,418	-	171,668	-	-	-	-	263,086
	2021	18,829	-	171,668	-	-	-	-	190,497
Michael Vander Hoek,									
CFO, VP	2022	79,480	-	46,000	-	-	-	-	125,480
	2021	18,338	-	46,000	-	-	-	-	64,338
Peter Dritschilo,									
President and COO	2022	94,289	-	78,333	-	-	-	-	172,622
	2021	31,534	-	78,333	-	-	-	-	109,867
Tyvin Rich, Chief									
Medical Officer	2022	65,065	-	29,000	-	-	-	-	94,065
	2021	-	-	29,000	-	-	-	-	29,000

Employment Agreements

Each of our executive officers has entered into an employment agreement with us. The employees each will receive compensation on an annual basis in cash, payable in monthly installments commencing at the completion of our IPO, as well as restricted stock units subject to achieving certain key performance indicators. Certain of our executive officers are entitled to various target bonuses, upon achievement of certain milestones. The terms of the employment agreements are as follows:

Employment Agreement with Anatoly Dritschilo, MD

On June 28, 2019, we entered into an employment agreement with our Chief Executive Officer and Chairman of the board of directors, Anatoly Dritschilo, M.D. Under Dr. Dritschilo's employment agreement, Dr. Dritschilo will receive base compensation of $274,000 per year. Dr. Dritschilo also received an initial restricted stock unit grant of 45,495 restricted stock units ("RSUs") (22,747 on a post-reverse split basis) issuable under the Company's 2018 Equity Incentive Plan, which RSUs vested over three years in substantially equal one-third installments on each one year anniversary of the agreement. Under his employment agreement, if Dr. Dritschilo terminates his employment for "Good Reason," as defined in the agreement, Dr. Dritschilo will be entitled to his then applicable base salary for period of 12 months, subject to his continued compliance with certain requirements of his employment agreement. Dr. Dritschilo accepted a reduced salary prior to the Company's completion of its initial public offering in September 2022.

Employment Agreement with Michael Vander Hoek

On September 1, 2019, we entered into an amended employment agreement with our Chief Financial Officer and Vice President for Operations and Regulatory, Michael Vander Hoek. Under Mr. Vander Hoek's employment agreement, he will receive base compensation of $227,000 and is entitled to a target bonus of $72,000 upon achievement of certain milestones. Mr. Vander Hoek also received an initial restricted stock unit grant of 6,096 RSUs (on a post-reverse split basis) issuable under the Company's 2018 Equity Incentive Plan, which RSUs vest over three years in substantially equal installments on each one year anniversary of the agreement. Under Mr. Vander Hoek's employment agreement, if he terminates his employment for "Good Reason," as defined in the agreement, he will be entitled to his then applicable base salary for period of 12 months, subject to his continued compliance with certain requirements of his employment agreement. Mr. Vander Hoek accepted a reduced salary prior to the Company's completion of its initial public offering in September 2022.

Employment Agreement with Peter Dritschilo

On May 30, 2019, we entered into an employment agreement with our President and Chief Operating Officer, Peter Dritschilo. Under Mr. Dritschilo's employment agreement, Mr. Dritschilo will receive base compensation of $236,000 and is entitled to a target bonus of $72,000 upon achievement of certain milestones. Mr. Dritschilo also received an initial restricted stock unit grant of 20,760 RSUs (10,380 on a post-reverse split basis) issuable under the Company's 2018 Equity Incentive Plan, which RSUs vest over three years in substantially equal installments on each one year anniversary of the agreement. Under Mr. Dritschilo's employment agreement, if Mr. Dritschilo terminates his employment for "Good Reason," as defined in the agreement, he will be entitled to his then applicable base salary for period of 12 months, subject to his continued compliance with certain requirements of his employment agreement. Mr. Dritschilo accepted a reduced salary prior the Company's completion of its initial public offering in September 2022.

Employment Agreement with Tyvin Rich, M.D.

On May 31, 2019, we entered into an employment agreement with our Chief Clinical Officer, Tyvin Rich, M.D. Under Dr. Rich's employment agreement, Dr. Rich receives base compensation of $218,000 per year and is entitled to a target bonus of $43,000 upon achievement of certain milestones. Dr. Rich also received an initial restricted stock unit grant of 3,843 RSUs (on a post-reverse split basis) issuable under the Company's 2018 Equity Incentive Plan, which RSUs vest over three years in substantially equal installments on each one year anniversary of the agreement. Under Dr. Rich's employment agreement, if Dr. Rich terminates his employment for "Good Reason," as defined in the agreement, he is entitled to his then applicable base salary for period of 12 months, subject to his continued compliance with certain provisions of his employment agreement. Dr. Rich accepted a reduced salary prior to the Company's completion of its initial public offering in September 2022.

Employment Agreement with Mira Jung, Ph.D.

On May 30, 2019, we entered into an employment agreement with our Chief Scientific Officer, Mira Jung, Ph.D. Under Dr. Jung's employment agreement, Dr. Jung receives base compensation of $46,800 and is entitled to a target bonus of $14,200 upon achievement of certain milestones. Dr. Jung also received an initial restricted stock unit grant of 892 RSUs (on a post-reverse split basis) issuable under the Company's 2018 Equity Incentive Plan, which RSUs vest over three years in substantially equal installments on each one year anniversary of the agreement. Under Dr. Jung's employment agreement, if Dr. Jung terminates her employment for "Good Reason," as defined in the agreement, Dr. Jung is then entitled to her then applicable base salary for period of 12 months, subject to her continued compliance with certain requirements of her employment agreement. Dr. Jung accepted a reduced salary prior to the Company's completion of its initial public offering in September 2022.

Outstanding Equity Awards at Fiscal Year-End

As of December 31, 2022, on a post-reverse split basis, a total of 410,754 RSUs have been granted to our executive officers under our 2018 Equity Incentive Plan (the "Plan"), of which 21,748 remain subject to vesting. The Company has filed a registration statement on Form S-8 (SEC File No. 333-268758) to register the shares granted under our 2018 Equity Incentive Plan.

The following table sets forth information concerning the number of shares of common stock underlying outstanding equity incentive awards for each of our executive officers as of December 31, 2022:

	Option Awards					Stock Awards	
Name	Grant Date	Number of Securities Underlying Unexercised Options Exercisable (#)	Number of Securities Underlying Unexercised Options Unexercisable (#)	Option Exercise Price ($)	Option Expiration Date	Number of Shares or Units of Stock not yet Vested (#))	Market Value of Shares or Units not yet Vested ($)
Bette Jacobs.....	10/28/2022	-	-	-	-	23,725[(1)]	46,501

(1) These restricted stock units vest in two installments on the anniversary of the grant date.

2018 Equity Incentive Plan

Our 2018 Equity Incentive Plan provides for equity incentives to be granted to our employees, executive officers or directors and to key advisers and consultants. Equity incentives may be in the form of stock options with an exercise price of not less than the fair market value of the underlying shares as determined pursuant to the 2018 Equity Incentive Plan, restricted stock awards, other stock- based awards, or any combination of the foregoing. The 2018 Equity Incentive Plan is administered by the Company's compensation committee or, alternatively, if there is no compensation committee, the Company's board of directors. We have reserved 3,000,000 shares of our common stock for issuance under the 2018 Equity Incentive Plan (the "Plan"), of which 419,754 shares have been granted under the Plan as of the date of this Annual Report.

Director Compensation

Each of our non-employee directors, pursuant to the terms of director agreements (the "Director Agreements"), between each of the directors and the Company, receives compensation on an annual basis consisting of $25,000 in cash, payable in quarterly installments commencing 90 days after completion of our initial public offering, and received $100,000 in restricted stock units ("RSUs") upon their respective dates of election. The RSUs vest over a two-year period in one third increments, with one-third vesting immediately upon signing and one-third vesting on each of the first and second anniversary of election. In addition, non-employee directors will also be reimbursed for out-of-pocket costs incurred in connection with attending meetings.

Item 12. Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters

PRINCIPAL STOCKHOLDERS

The following table sets forth, as of the date of this Annual Report, the beneficial ownership of our common stock by each director and executive officer, by each person known by us to beneficially own 5% or more of our common stock and by directors and executive officers as a group. Unless otherwise stated, the address of the persons set forth in the table is c/o Shuttle Pharmaceuticals Holdings, Inc., One Research Court, Suite 450, Rockville, Maryland 20850.

Beneficial ownership is determined in accordance with SEC rules and generally includes voting or investment power with respect to securities. Unless otherwise indicated, the stockholders listed in the table below have sole voting and investment power with respect to the shares indicated.

All share ownership figures include shares of our commons stock issuable upon securities convertible or exchangeable into shares of our common stock, whether or not convertible or exchangeable within 60 days of the effective date of this Annual Report. Such shares are deemed outstanding and beneficially owned by such person only for purposes of computing his or her percentage ownership, but not for purposes of computing the percentage ownership for any other person.

As of March 14 2023, there were issued and outstanding 13,654,127 shares of common stock.

Names and addresses	Number of shares of common stock beneficially owned (#)	Percentage of shares of common stock beneficially owned (%)
Directors and Named Executive Officers:		
Anatoly Dritschilo, M.D.[(1)]	4,309,607	31.6
Milton Brown, M.D., Ph.D.[(2)]	1,072,531	7.9
Mira Jung, Ph.D.	1,071,388	7.8
Michael Vander Hoek	3,852	-
Peter Dritschilo	6,560	-
Tyvin A. Rich, M.D.	2,492	-
Steve Richards	1,707	-
Joshua Schafer	1,707	-
Chris H. Senanayake	2,791	-
Bette Jacobs[(3)]	7,496	-
All directors and officers as a group (ten persons)	6,480,131	47.5
Other 5% beneficial owners:		
Amir F. Heshmatpour[(4)]	1,569,581	11.4

- Denotes the holder owns less than one percent of the outstanding common stock.

± The persons named above have full voting and investment power with respect to the shares indicated. Under the rules of the SEC, a person (or group of persons) is deemed to be a "beneficial owner" of a security if he or she, directly or indirectly, has or shares the power to vote or to direct the voting of such security, or the power to dispose of or to direct the disposition of such security. Accordingly, more than one person may be deemed to be a beneficial owner of the same security.

(1) Consists of (i) 1,085,200 shares of common stock held of record by Dr. Anatoly Dritschilo and (ii) 3,204,407 shares of common stock and warrants to purchase 20,000 shares of commons stock, each held of record by Joy Dritschilo, his spouse. Dr. Dritschilo disclaims beneficial ownership over all securities held by Mrs. Dritschilo.

(2) Does not include options to purchase 25,000 shares of common stock, which remain subject to vesting.

(3) Does not include 23,725 restricted stock units which remain subject to vesting conditions.

(4) Includes (i) 1,119,581 shares of our common stock held of record by AFH Holding & Advisory, LLC, of which Mr. Heshmatpour is the sole member and over which he has sole voting and investment control; (ii) 300,000 shares of our common stock held of record by KIG LLC of which Mr. Heshmatpour's spouse, Kathy Heshmatpour, exercises sole voting and investment control; and (iii) 150,000 shares held by Angelina Heshmatpour, the minor daughter of Mr. Heshmatpour.

Item 13. Certain Relationships and Related Transactions, and Director Independence

Related Party Transactions

Unless described below, during the last two fiscal years, there were no transactions or series of similar transactions to which we were a party or will be a party, in which:

- the amounts involved exceed or will exceed $120,000; and
- any of our directors, executive officers or holders of more than 5% of our capital stock, or any member of the immediate family of any of the foregoing had, or will have, a direct or indirect material interest.

On January 25, 2018, Shuttle entered into a loan from Joy Dritschilo, the wife of our Chief Executive Officer, Anatoly Dritschilo, in the amount of $300,000 (the "January 2018 Loan"). The January 2018 Loan bears an interest rate of 7.5% per annum. The loan plus accrued interest was payable in full on January 25, 2019. On January 25, 2019, the Company amended the terms to extend the maturity date from January 25, 2019 to October 25, 2019.

On April 4, 2018, Shuttle entered into a loan from Mrs. Dritschilo in the amount of $50,000 (the "April 2018 Loan"). The April 2018 Loan bears an interest rate of 7.5% per annum. The loan plus accrued interest were payable in full on September 4, 2018. On October 31, 2018, the Company amended the terms to extend the maturity date of the April 2018 Loan from September 4, 2018 to April 4, 2019. On April 4, 2019, the Company amended the terms to extend the maturity date from April 4, 2019 to October 25, 2019.

On April 5, 2018, our predecessor in interest, Shuttle Pharma Acquisition Corp. Inc. ("Acquisition Corp."), issued 3,600,000 shares to its founders, AFH Holding & Advisory, LLC and its affiliates (together, "AFH"). Such shares were issued at par value. AFH has also served as an advisor and consultant to the Company, and its owner, Amir Heshmatpour, has also served as a board member to our Company, a position he relinquished in advance of our commencement of the IPO process.

On May 31, 2018, the Company entered into a loan with our Chief Executive Officer in the amount of $25,000 (the "May 2018 Loan"). The May 2018 Loan bears interest at the rate of 7.5% per annum. The loan plus accrued interest were payable in full on July 15, 2018. On October 31, 2018, the Company amended the terms to extend the maturity date from July 15, 2018 to November 30, 2019.

On June 29, 2018, the Company entered into a loan with our Chief Executive Officer in the amount of $25,000. The loan bears an interest rate of 7.5% per annum. The loan plus accrued interest were payable in full on August 15, 2018. On December 6, 2018, the Company amended the terms to extend the maturity date from August 15, 2018 to February 15, 2019. On February 19, 2019, the Company paid off this note in full. The interest expense incurred on this loan was $1,223 for the year ended December 31, 2019.

On June 24, 2019, the Company entered into a loan from Mrs. Dritschilo in the amount of $70,000. The loan bears an interest rate of 7.5% per annum. The loans plus accrued interest are payable in full on June 23, 2020. This loan has since been satisfied in full.

In the fall of 2018 through to June 2019, we paid a total of $500,000 in cash to pay for a deposit on Acquisition Corp. in order to facilitate the process of taking the Company public.

On July 15, 2019, the Company issued 639,161 RSUs to our then consultant, AFH, to satisfy certain compensation owed to the consultant in relation to certain advisory services provided during 2018 and 2019. Such shares were issued pursuant to the Company's 2018 Equity Incentive Plan.

On August 24, 2019, the Company entered into a loan with our Chief Executive Officer in the amount of $70,000. The loan bears interest at the rate of 7.5% per annum. The loan plus accrued interest is due and payable in full on August 24, 2020. This loan has since been satisfied in full.

On September 23, 2019, the Company entered into a loan with our Chief Executive Officer in the amount of $100,000 (the "September 2019 Loan"). The September 2019 Loan bear interest at the rate of 7.5% per annum and the loan plus accrued interest.

On December 1, 2020, the Company consolidated the January 2018 Loan and the April 2018 Loan into a single loan between Mrs. Dritschilo and the Company (the "2018 Consolidated Loan") such that, with accrued interest, the 2018 Consolidated Loan had a principal balance of $424,005.65, bears interest at a rate of 7.5% per annum, and has a maturity date of December 31, 2021. The 2018 Consolidated Loan was extended until June 30, 2022, pursuant to an amendment to the 2018 Consolidated Loan agreement dated January 24, 2022. On July 29, 2022, the Company and Mrs. Dritschilo entered into an amendment to the 2018 Consolidated Loan, pursuant to which repayment was extended through June 30, 2023. On January 15, 2023, following closing on the Convertible Note and Warrant offering to Ayrton Capital, the 2018 Consolidated Loan was paid off in full.

On December 1, 2020, the Company consolidated the May 2018 Loan and the September 2019 Loan with our Chief Executive Officer (the "2019 Consolidated Loan"), such that, with accrued interest, the 2019 Consolidated Loan had a principal balance of $138,448.20, bears interest at the rate of 7.5% per annum, and has a maturity date of December 31, 2021. The 2019 Consolidated Loan was extended until June 30, 2022, pursuant to an amendment to the 2019 Consolidated Loan agreement dated January 24, 2022. On July 29, 2022, the Company and our Chief Executive Officer entered into an amendment to the 2019 Consolidated Loan, pursuant to which repayment was extended through June 30, 2023.

On June 21, 2021, the Company entered into a loan agreement with Mrs. Dritschilo in the amount of $120,000 (principal), bearing interest at the rate of 7.5% per annum, with a single balloon payment due at maturity on June 21, 2022 (the "June 2021 Loan Agreement"). On July 29, 2022, the Company and Mrs. Dritschilo entered into an amendment to the June 2021 Loan Agreement, pursuant to which repayment was extended through June 30, 2023.

On September 22, 2021, Mrs. Dritschilo, who is one of our major stockholders, transferred 210,000 shares (105,000 shares post-split) of common stock of the Company in a private transaction to Steven Bayern, who had also been engaged by the Company to perform certain consulting services for the Company. Such shares, which represent approximately three percent of her total share ownership, were sold at par value pursuant to an exemption from registration under Section 4(a)(7) of the Securities Act. As a result of the transfer, the Company recognized $420,000 in non-cash stock compensation in legal and professional fees.

On August 1, 2022, in conjunction with our private placement of $125,000 of units consisting of 10% notes and warrants to purchase common stock, which were sold to three accredited investors in total, Mrs. Dritschilo purchased a $50,000 note and received warrants to purchase 20,000 shares of common stock at $2.50 per share. The notes and warrants were sold pursuant to an exemption from registration pursuant to Rule 506(b) of Regulation D of the Securities Act.

Review, Approval and Ratification of Related Party Transactions

All related party transactions are subject to the review, approval, or ratification of our board of directors or an appropriate committee thereof.

Item 14. Principal Accountant Fees and Services

The following table represents fees for professional audit services for the audit of the Company's annual financial statements for the fiscal years ended December 31, 2022 and 2021, rendered by BF Borgers CPA PC .

	Fiscal year ended December 31,	
	2022	2021
Audit fees [1]	$ 30,000	$ 31,000
Audit-related fees [2]		
Total fees	$ 30,000	$ 31,000

1. *Audit fees consist of fees for professional services rendered by the principal accountant for the audit of the Company's annual financial statements and review of the financial statements included in the Company's Initial Public Offering, Form 10-K and Form 10-Q and for services that are normally provided by the accountant in connection with statutory and regulatory filings or engagements.*

2. *Audit-related fees consist primarily of fees for assurance and related services by the accountant that are reasonably related to the performance of the audit or review of the Company's financial statements.*

Audit Committee Pre-Approval Policies

The Audit Committee is tasked with pre-approving any non-audit services proposed to be provided to the Company by the independent auditors.

PART IV

Item 15. Exhibit and Financial Statement Schedules

Exhibit No.	Description
3.1	Amended and Restated Certificate of Incorporation (incorporated by reference to Exhibit 3.1 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
3.2	Certificate of Amendment to Amended and Restated Certificate of Incorporation, effective March 30, 2022 (incorporated by reference to Exhibit 3.2 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
3.3	Amended and Restated Certificate of Designation for Series A Convertible Preferred Stock, effective April 6, 2022 (incorporated by reference to Exhibit 3.4 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
3.4	Certificate of Amendment to Amended and Restated Certificate of Incorporation, effective June 22, 2022 (incorporated by reference to Exhibit 3.5 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on June 23, 2022).
3.5	Second Amended and Restated By-Laws (incorporated by reference to Exhibit 3.1 to the current Report on Form 8-K filed on November 1, 2022).
4.1	Form of Convertible Note, dated February 2022 (incorporated by reference to Exhibit 4.1 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
4.2	Form of 10% Promissory Note, dated August 2022 (incorporated by reference to Exhibit 4.2 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on August 18, 2022).
4.3	Form of Warrant, dated August 2022 (incorporated by reference to Exhibit 4.3 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on August 18, 2022).
4.4	Form of Public Offering Warrant (incorporated by reference to Exhibit 4.4 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on August 18, 2022).
4.5	Form of Underwriting Warrant issuable to Boustead Securities LLC (incorporated by reference to Exhibit 4.5 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on August 18, 2022).
10.1	Form of Subscription Agreement for Series A Convertible Preferred Stock (incorporated by reference to Exhibit 10.1 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.2	2018 Equity Incentive Plan (incorporated by reference to Exhibit 10.2 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.3	Employment Agreement, dated July 30, 2014, between Shuttle Pharmaceuticals Holdings, Inc. and Tyvin Rich (incorporated by reference to Exhibit 10.4 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.4	SBIR Contract #HHSN261201400013C, dated September 19, 2014, between Shuttle Pharmaceuticals, LLC and National Institute of Health National Cancer Institute (incorporated by reference to Exhibit 10.5 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.5	SBIR Contract #HHSN261201400013C Amendment of Solicitation/Modification of Contract, dated August 3, 2015, between Shuttle Pharmaceuticals, LLC and National Institute of Health National Cancer Institute (Radiosensitizer Option Phase II) (incorporated by reference to Exhibit 10.6 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.6	SBIR Contract #HHSN261201600027C, dated September 19, 2016, between Shuttle Pharmaceuticals, LLC and National Institute of Health National Cancer Institute (incorporated by reference to Exhibit 10.7 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.7	SBIR Contract #HHSN261600038C dated September 19, 2016 between Shuttle Pharmaceuticals, LLC. and National Institute of Health National Cancer Institute (incorporated by reference to Exhibit 10.8 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.8	Material Transfer Agreement, dated April 25, 2017, between Shuttle Pharmaceuticals, Inc. and George Washington University (incorporated by reference to Exhibit 10.9 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.9	Employment Agreement, dated May 30, 2019, between Shuttle Pharmaceuticals Holdings, Inc. and Peter Dritschilo (incorporated by reference to Exhibit 10.10 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.10	Employment Agreement, dated May 30, 2019, between Shuttle Pharmaceuticals Holdings, Inc. and Mira Jung (incorporated by reference to Exhibit 10.11 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.11	Employment Agreement, dated June 28, 2019, between Shuttle Pharmaceuticals Holdings, Inc. and Anatoly Dritschilo (incorporated by reference to Exhibit 10.12 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).

Exhibit No.	Description
10.12	Amended and Restated Employment Agreement, dated September 1, 2019, between Shuttle Pharmaceuticals Holdings, Inc. and Michael Vander Hoek (incorporated by reference to Exhibit 10.13 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.13	Form of Letter Agreement with Director (incorporated by reference to Exhibit 10.14 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.14	Subaward Agreement dated October 28, 2014 between Shuttle Pharmaceuticals, LLC and LifeSpan/Rhode Island Hospital (incorporated by reference to Exhibit 10.15 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.15	Sublicense Agreement, dated February 15, 2019, between Shuttle Pharmaceuticals Inc. and Propagenix, Inc. (incorporated by reference to Exhibit 10.16 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.16	SBIR Contract #HHSN261201800016C/75N91018C00016 Agreement between Shuttle Pharmaceuticals, LLC and National Institute of Health National Cancer Institute (incorporated by reference to Exhibit 10.17 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.17	Promissory Note, dated as of August 24, 2019, between Shuttle Pharmaceuticals Holdings, Inc. and Anatoly Dritschilo (incorporated by reference to Exhibit 10.18 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.18	SBIR Phase II Contract #75N9101C00031, dated September 6, 2019, between Shuttle Pharmaceuticals, Inc. and National Institute of Health National Cancer Institute (incorporated by reference to Exhibit 10.19 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.19	Director Offer Letter, dated December 2, 2020, between Chris H. Senanayake and Shuttle Pharmaceuticals Holdings, Inc. (incorporated by reference to Exhibit 10.20 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.20	Promissory Note, dated December 1, 2020, between Shuttle Pharmaceuticals Holdings, Inc. and Joy Dritschilo (incorporated by reference to Exhibit 10.21 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.21	Promissory Note, dated December 1, 2020, between Shuttle Pharmaceuticals Holdings, Inc. and Anatoly Dritschilo (incorporated by reference to Exhibit 10.22 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.22	Non-Disclosure, Evaluation and Option Agreement, dated May 30, 2019, between Shuttle Pharmaceuticals, Inc. and University of Virginia Licensing & Ventures Group (incorporated by reference to Exhibit 10.23 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.23	First Amendment to Non-Disclosure, Evaluation and Option Agreement, dated November 30, 2019, between Shuttle Pharmaceutical, Inc. and University of Virginia Licensing & Ventures Group (incorporated by reference to Exhibit 10.24 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.24	Form of Note and Warrant Subscription Agreement, dated December 28, 2021 (incorporated by reference to Exhibit 10.25 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.25	Form of Note, dated December 28, 2021 (incorporated by reference to Exhibit 10.26 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.26	Form of Common Stock Purchase Warrant, dated December 28, 2021 (incorporated by reference to Exhibit 10.27 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.27	Consulting Agreement, dated January 1, 2022, between Shuttle Pharmaceuticals Holdings, Inc. and Steven Bayern (incorporated by reference to Exhibit 10.28 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.28	Amendment to Promissory Note, dated January 25, 2022, between Shuttle Pharmaceuticals Holdings, Inc. and Joy Dritschilo (incorporated by reference to Exhibit 10.29 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.29	Amendment to Promissory Note, dated January 25, 2022, between Shuttle Pharmaceuticals Holdings, Inc. and Anatoly Dritschilo (incorporated by reference to Exhibit 10.30 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.30	Form of Convertible Note Subscription Agreement and Investor Rights Agreement (incorporated by reference to Exhibit 10.31 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
10.31	Amendment No. 1 to Promissory Note, dated July 29, 2022, between Shuttle Pharmaceuticals Holdings, Inc. and Joy Dritschilo (incorporated by reference to Exhibit 10.32 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on August 18, 2022).
10.32	Amendment No. 2 to Promissory Note, dated July 29, 2022, between Shuttle Pharmaceuticals holdings, Inc. and Joy Dritschilo (incorporated by reference to Exhibit 10.33 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on August 18, 2022).
10.33	Amendment No. 2 to Promissory Note, dated July 29, 2022, between Shuttle Pharmaceuticals Holdings, inc. and Anatoly Dritschilo (incorporated by reference to Exhibit 10.34 to the Registration Statement on Form S-1/A (File No. 333-265429) filed on August 18, 2022).

Exhibit No.	Description
10.34	Manufacturing Agreement, dated September 14, 2022, between Shuttle Pharmaceuticals, Inc. and TCG GreenChem, Inc. (incorporated by reference to Exhibit 10.1 to the Current report on Form 8-K filed September 19, 2022).
10.35	Form of Securities Purchase Agreement, dated January 11, 2023, between Shuttle Pharmaceuticals Holdings, Inc. and the investors named therein (incorporated by reference to Exhibit 10.1 to the Current Report on Form 8-K filed January 12, 2023).
10.36	Form of Note, dated January 11, 2023 (incorporated by reference to Exhibit 10.2 to the Current Report on form 8-K filed January 12, 2023).
10.37	Form of Warrant, dated January 11, 2023 (incorporated by reference to Exhibit 10.3 to the Current Report on form 8-K filed January 12, 2023).
10.38	Form of Security Agreement, dated January 11, 2023, between Shuttle Pharmaceuticals Holdings, Inc., Shuttle Pharmaceuticals, Inc. and Alto Opportunity Master Fund, SPC – Segregated Portfolio B (incorporated by reference to Exhibit 10.4 to the Current Report on form 8-K filed January 12, 2023).
10.39	Form of Intellectual Property Security Agreement, dated January 11, 2023 (incorporated by reference to Exhibit 10.5 to the Current Report on form 8-K filed January 12, 2023).
10.40	Form of Subsidiary Guaranty (incorporated by reference to Exhibit 10.6 to the Current Report on form 8-K filed January 12, 2023).
10.41	Form of Registration Rights Agreement, dated January 11, 2023 (incorporated by reference to Exhibit 10.7 to the Current Report on form 8-K filed January 12, 2023).
10.42	Form of Director Offer Letter (incorporated by reference to Exhibit 10.1 to the Current Report on Form 8-K filed February 22, 2023).
10.43	Proposal for Service Agreement, dated March 7, 2023, between Shuttle Pharmaceuticals, Inc. and University of Iowa Pharmaceuticals (incorporated by reference to Exhibit 10.1 to the Current Report on Form 8-K filed March 9, 2023).
10.44	Amended and Restated Insider Trading Policy, effective March 10, 2023.*
10.45	Form of Executive Compensation Clawback Policy, effective March 10, 2023.*
10.46	Letter Agreement, dated March 11, 2023, between Shuttle Pharmaceuticals Holdings, Inc. and Alto Opportunity Master Fund, SPC – Segregated Portfolio B, as Collateral Agent.*
14.1	Code of Business Conduct and Ethics (incorporated by reference to Exhibit 10.3 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
21	List of Subsidiaries (incorporated by reference to Exhibit 15.1 to the Registration Statement on Form S-1 (File No. 333-265429) filed on June 3, 2022).
23.1	Consent of BF Borgers CPA PC.*
31.1	Certification of Chief Executive Officer pursuant to Section 302 of the Sarbanes-Oxley Act of 2002*
31.2	Certification of Chief Financial Officer pursuant to Section 302 of the 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*
99.1	Press release, dated March 15, 2023.*
101.INS	Inline XBRL Instance Document – the instance document does not appear in the Interactive Data File because XBRL tags are embedded within the Inline XBRL document.
101.SCH	Inline XBRL Taxonomy Schema Document
101.CAL	Inline XBRL Taxonomy Calculation Linkbase Document
101.DEF	Inline XBRL Taxonomy Definition Linkbase Document
101.LAB	Inline XBRL Taxonomy Label Linkbase Document
101.PRE	Inline XBRL Taxonomy Presentation Linkbase Document
104	Cover Page Interactive Data File (embedded within the Inline XBRL document)

*Filed herewith.

Item 16. Form 10–K Summary

None.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the Company has duly caused this Annual Report to be signed on its behalf by the undersigned, thereunto duly authorized.

Shuttle Pharmaceuticals Holdings, Inc.

By: */s/ Anatoly Dritschilo, M.D.*
Anatoly Dritschilo, M.D.
Chairman of the board of directors,
Chief Executive Officer and President
Principal Executive Officer

Date: March 15, 2023

Pursuant to the requirements of the Securities Exchange Act of 1934, this Annual 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/ Anatoly Dritschilo Anatoly Dritschilo	Chairman of the board of directors, Chief Executive Officer (principal executive officer)	March 15, 2023
/s/ Michael Vander Hoek Michael Vander Hoek	Chief Financial Officer (principal financial and accounting officer)	March 15, 2023
/s/ Chris H. Senanayake Chris H. Senanayake	Director	March 15, 2023
/s/ Steven Richards Steven Richards	Director	March 15, 2023
/s/ Joshua Schafer Joshua Schafer	Director	March 15, 2023
/s/ Milton Brown Milton Brown	Director	March 15, 2023
/s/ Bette Jacobs Bette Jacobs	Director	March 15, 2023

Exhibit 10.44

SHUTTLE PHARMACEUTICALS HOLDINGS, INC.

Amended and Restated Policy on Insider Trading

This Amended and Restated Insider Trading Policy, effective March 10, 2023, provides the standards of Shuttle Pharmaceuticals Holdings, Inc. (the "**Company**") on trading and causing the trading of the Company's securities or securities of other publicly-traded companies while in possession of confidential information. This policy is divided into two parts: the first part prohibits trading in certain circumstances and applies to all directors, officers, employees and certain independent contractors of the Company and the second part imposes special additional trading restrictions and applies to all (i) directors of the Company, (ii) executive officers of the Company and (iii) the employees or persons listed on Appendix A (collectively, "**Covered Persons**").

One of the principal purposes of the federal securities laws is to prohibit so-called "insider trading." Simply stated, insider trading occurs when a person uses material non-public information obtained through involvement with the Company to make decisions to purchase, sell, give away or otherwise trade the Company's securities or to provide that information to others outside the Company. The prohibitions against insider trading apply to trades, tips and recommendations by virtually any person, including all persons associated with the Company, if the information involved is "material" and "non-public." These terms are defined in this Policy under Part I, Section 3 below. The prohibitions would apply to any director, officer or employee who buys or sells Company stock on the basis of material non-public information that he or she obtained about the Company, its customers, suppliers, or other companies with which the Company has contractual relationships or may be negotiating transactions.

PART I

1. Applicability

This Policy applies to all transactions in the Company's securities, including common stock, options and any other securities that the Company may issue, such as preferred stock, notes, bonds and convertible securities, as well as to derivative securities relating to any of the Company's securities, whether or not issued by the Company.

This Policy applies to all employees of the Company and its subsidiaries, all officers of the Company and its subsidiaries and all members of the Company's board of directors.

2. General Policy: No Trading or Causing Trading While in Possession of Material Non-Public Information

(a). No director, officer or employee may purchase or sell any Company security, whether or not issued by the Company, while in possession of material non-public information about the Company. (The terms "material" and "non-public" are defined in Part I, Section 3(a) and (b) below.)

(b). No director, officer or employee who knows of any material non-public information about the Company may communicate that information to any other person, including family and friends.

(c). In addition, no director, officer or employee may purchase or sell any security of any other company, whether or not issued by the Company, while in possession of material non-public information about that company that was obtained in the course of his or her involvement with the Company. No director, officer or employee who knows of any such material non-public information may communicate that information to any other person, including family and friends.

(d). For compliance purposes, you should never trade, tip or recommend securities (or otherwise cause the purchase or sale of securities) while in possession of information that you have reason to believe is material and non-public unless you first consult with, and obtain the advance approval of, the Compliance Officer (which is defined in Part I, Section 3(c) below).

(e). Covered Persons must "pre-clear" all trading in securities of the Company in accordance with the procedures set forth in Part II, Section 3 below.

3. Definitions

(a) Materiality. Insider trading restrictions come into play only if the information you possess is "material." Materiality, however, involves a relatively low threshold. Information is generally regarded as "material" if it has market significance, that is, if its public dissemination is likely to affect the market price of securities, or if it otherwise is information that a reasonable investor would want to know before making an investment decision.

Information dealing with the following subjects is reasonably likely to be found material in particular situations:

(i) significant changes in the Company's prospects;

(ii) significant write-downs in assets or increases in reserves;

(iii) developments regarding significant litigation or government agency investigations;

(iv) liquidity problems;

(v) changes in earnings estimates or unusual gains or losses in major operations;

(vi) major changes in management;

(vii) changes in dividends;

(viii) extraordinary borrowings;

(ix) award or loss of a significant contract;

(x) changes in debt ratings;

(xi) proposals, plans or agreements, even if preliminary in nature, involving mergers, acquisitions, divestitures, recapitalizations, strategic alliances, licensing arrangements, or purchases or sales of substantial assets;

(xii) public offerings; and

(xiii) pending statistical reports (such as, consumer price index, money supply and retail figures, or interest rate developments).

Material information is not limited to historical facts but may also include projections and forecasts. With respect to a future event, such as a merger, acquisition or introduction of a new product, the point at which negotiations or product development are determined to be material is determined by balancing the probability that the event will occur against the magnitude of the effect the event would have on a company's operations or stock price should it occur. Thus, information concerning an event that would have a large effect on stock price, such as a merger, may be material even if the possibility that the event will occur is relatively small. When in doubt about whether particular non-public information is material, presume it is material. **If you are unsure whether information is material, you should consult the Compliance Officer before making any decision to disclose such information (other than to persons who need to know it) or to trade in or recommend securities to which that information relates.**

(b) Non-public Information. Insider trading prohibitions come into play only when you possess information that is material and "non-public." The fact that information has been disclosed to a few members of the public does not make it public for insider trading purposes. To be "public" the information must have been disseminated in a manner designed to reach investors generally, and the investors must be given the opportunity to absorb the information. Even after public disclosure of information about the Company, you must wait until the close of business on the second trading day after the information was publicly disclosed before you can treat the information as public.

Non-public information may include:

(i) information available to a select group of analysts or brokers or institutional investors;

(ii) undisclosed facts that are the subject of rumors, even if the rumors are widely circulated; and

(iii) information that has been entrusted to the Company on a confidential basis until a public announcement of the information has been made and enough time has elapsed for the market to respond to a public announcement of the information (normally two or three days).

As with questions of materiality, if you are not sure whether information is considered public, you should either consult with the Compliance Officer or assume that the information is "non-public" and treat it as confidential.

(c) Compliance Officer. The Company has appointed the Corporate Secretary as the Compliance Officer for this Policy. The duties of the Compliance Officer include, but are not limited to, the following:

(i) assisting with implementation of this Policy;

(ii) circulating this Policy to all employees and ensuring that this Policy is amended as necessary to remain up-to-date with insider trading laws;

(iii) pre-clearing all trading in securities of the Company by Covered Persons in accordance with the procedures set forth in Part II, Section 3 below; and

(iv) providing approval of any transactions under Part II, Section 4 below.

4. Violations of Insider Trading Laws

Penalties for trading on or communicating material non-public information can be severe, both for individuals involved in such unlawful conduct and their employers and supervisors, and may include jail terms, criminal fines, civil penalties and civil enforcement injunctions. Given the severity of the potential penalties, compliance with this Policy is absolutely mandatory.

(a) Legal Penalties. A person who violates insider trading laws by engaging in transactions in a company's securities when he or she has material non-public information can be sentenced to a substantial jail term and required to pay a penalty of several times the amount of profits gained or losses avoided.

In addition, a person who tips others may also be liable for transactions by the tippees to whom he or she has disclosed material non-public information. Tippers can be subject to the same penalties and sanctions as the tippees, and the SEC has imposed large penalties even when the tipper did not profit from the transaction.

The SEC can also seek substantial penalties from any person who, at the time of an insider trading violation, "directly or indirectly controlled the person who committed such violation," which would apply to the Company and/or management and supervisory personnel. These control persons may be held liable for up to the greater of $1 million or three times the amount of the profits gained or losses avoided. Even for violations that result in a small or no profit, the SEC can seek a minimum of $1 million from a company and/or management and supervisory personnel as control persons.

(b) Company-imposed Penalties. Employees who violate this Policy may be subject to disciplinary action by the Company, including dismissal for cause. Any exceptions to the Policy, if permitted, may only be granted by the Compliance Officer and must be provided before any activity contrary to the above requirements takes place.

PART II

1. Blackout Periods

All Covered Persons are prohibited from trading in the Company's securities during blackout periods.

(a) Quarterly Blackout Periods. Trading in the Company's securities is prohibited during the period beginning three weeks prior to the last day of each fiscal quarter and ending three business days following the date the Company's financial results are publicly disclosed and the Form 10-Q or the Form 10-K is filed. During these periods, Covered Persons generally possess or are presumed to possess material non-public information about the Company's financial results.

(b) Other Blackout Periods. From time to time, other types of material non-public information regarding the Company (such as negotiation of mergers, acquisitions or dispositions or new product developments) may be pending and not be publicly disclosed. While such material non-public information is pending, the Company may impose special blackout periods during which Covered Persons are prohibited from trading in the Company's securities. If the Company imposes a special blackout period, it will notify the Covered Persons affected.

(c) Exception. These trading restrictions do not apply to transactions under a pre-existing written plan, contract, instruction, or arrangement under Rule 10b5-1 (an "**Approved 10b5-1 Plan**") that:

(i) (x) in the case of directors and executive officers, the Approved 10b5-1 Plan has been reviewed and approved the later of (A) at least 90 days in advance of any trades thereunder by the Compliance Officer (or, if revised or amended, such revisions or amendments have been reviewed and approved by the Compliance Officer at least 90 days in advance of any subsequent trades) or (B) at least two business days after the filing of the Company's Form 10-Q or Form 10-K (subject to a maximum of 120 after the date of adoption or modification); and (y) directors or executive officers must certify at the time of such plan's adoption that they (A) were not in possession of Material Non-Public Information at the time of adoption of such plan and (B) are adopting such plan in good faith and not as part of a plan or scheme to evade insider trading prohibitions of Rule 10b-5;

(ii) for other person who are not directors and executive officers, the Approved 10b5-1 Plan has been reviewed and approved at least one month in advance of any trades thereunder by the Compliance Officer (or, if revised or amended, such revisions or amendments have been reviewed and approved by the Compliance Officer at least 90 days in advance of any subsequent trades);

(iii) was entered into in good faith by the Covered Person at a time when the Covered Person was not in possession of material non-public information about the Company, and the Covered Person continues to operate in good faith in its use of the Approved 10b5-1 Plan for the duration of such plan; and

(iv) gives a third party the discretionary authority to execute such purchases and sales, outside the control of the Covered Person, so long as such third party does not possess any material non-public information about the Company; or explicitly specifies the security or securities to be purchased or sold, the number of shares, the prices and/or dates of transactions, or other formula(s) describing such transactions.

2. Trading Window

Covered Persons are permitted to trade in the Company's securities when no blackout period is in effect. Generally this means that Covered Persons can trade during the period beginning on the fourth business day following the filing of the Form 10-Q or the Form 10-K and ending on the day prior to three weeks before the end of a fiscal quarter close. However, even during this trading window, a Covered Person who is in possession of any material non-public information should not trade in the Company's securities until the information has been made publicly available or is no longer material. In addition, the Company may close this trading window if a special blackout period under Part II, Section 1(b) above is imposed and will re-open the trading window once the special blackout period has ended.

3. Pre-clearance of Securities Transactions

(a). Because Covered Persons are likely to obtain material non-public information on a regular basis, the Company requires all such persons to refrain from trading, even during a trading window under Part II, Section 2 above, without first providing notice of any transactions in the Company's securities.

(b). Subject to the exemption in subsection (d) below, no Covered Person may, directly or indirectly, purchase or sell (or otherwise make any transfer, gift, pledge or loan of) any Company security at any time without first notifying the Compliance Officer. These procedures also apply to transactions by such person's spouse, other persons living in such person's household and minor children and to transactions by entities over which such person exercises control.

(c). The Compliance Officer shall record the date of each notification if provided. If the transaction does not occur within a two-week period, pre-notification of the transaction must be re-provided.

(d). Pre-notification is not required for purchases and sales of securities under an Approved 10b5-1 Plan. With respect to any purchase or sale under an Approved 10b5-1 Plan, the third party effecting transactions on behalf of the Covered Person should be instructed to send duplicate confirmations of all such transactions to the Compliance Officer.

4. Prohibited Transactions

(a). Directors and executive officers of the Company are prohibited from, trading in the Company's equity securities during a blackout period imposed under an "individual account" retirement or pension plan of the Company, during which at least 50% of the plan participants are unable to purchase, sell or otherwise acquire or transfer an interest in equity securities of the Company, due to a temporary suspension of trading by the Company or the plan fiduciary.

(b). A Covered Person, including such person's spouse, other persons living in such person's household and minor children and entities over which such person exercises control, is prohibited from engaging in the following transactions in the Company's securities unless advance approval is obtained from the Compliance Officer:

(i) Short-term trading. Covered Persons who purchase Company securities may not sell any Company securities of the same class for at least six months after the purchase;

(ii) Short sales. Covered Persons may not sell the Company's securities short;

(iii) Options trading. Covered Persons may not buy or sell puts or calls or other derivative securities on the Company's securities;

(iv) Trading on margin. Covered Persons may not hold Company securities in a margin account or pledge Company securities as collateral for a loan; and

(v) Hedging. Covered Persons may not enter into hedging or monetization transactions or similar arrangements with respect to Company securities.

5. Acknowledgment and Certification

All Covered Persons are required to sign the attached acknowledgment and certification.

ACKNOWLEDGMENT AND CERTIFICATION

The undersigned does hereby acknowledge receipt of the Company's Insider Trading Policy. The undersigned has read and understands (or has had explained) such Policy and agrees to be governed by such Policy at all times in connection with the purchase and sale of securities and the confidentiality of non-public information.

_____
(Signature)

_____
(Please print name)

Date: _____

APPENDIX A

[Company to list all employees other than officers and directors who will be subject to the blackout periods – generally those employees involved in preparing the quarterly and annual reports and disclosures related there]

Exhibit 10.45

SHUTTLE PHARMACEUTICALS HOLDINGS, INC.
CLAWBACK POLICY

I. Purpose

Shuttle Pharmaceuticals Holdings, Inc. (the "Company") is establishing this clawback policy to appropriately align the interests of the executives of the Company, who have been designated as Executive Officers, with those of the Company. This policy has been approved by the Board and is effective as of the Effective Date.

II. Administration

This policy shall be administered by the Board, which shall have authority to (i) exercise all of the powers granted to it under the policy, (ii) construe, interpret and implement this policy, (iii) make all determinations necessary or advisable in administering this policy, and (iv) amend this policy, including to reflect changes in applicable law.

III. Recoupment

If (i) the Company is required to undertake an accounting restatement due to the Company's material noncompliance, whether or not as a result of any fault or misconduct by an Executive Officer, with any financial reporting requirement under the U.S. federal securities laws, (ii) an Executive Officer engages in Misconduct, or (iii) an Executive Officer breaches in any material respect a restrictive covenant set forth in any agreement between the Executive Officer and the Company, including but not limited to, a breach in any material respect of a confidentiality provision (any such event under clause (i), (ii), or (iii), a "Clawback Event"), then the Board may, in its sole discretion, to the extent permitted by applicable law, seek to recover all or any portion of the Recoverable Amounts awarded to any such Executive Officer after the Effective Date.

In determining the appropriate action to take, the Board may consider such factors as it deems appropriate, including:

- the associated costs and benefits of seeking the Recoverable Amounts,
- the requirements of applicable law,
- the extent to which the Executive Officer participated or otherwise bore responsibility for the Clawback Event, and
- the extent to which the Executive Officer's current compensation may or may not have been impacted had the Board, or the Compensation Committee of the Board, known about the Clawback Event.

In addition, the Board may, in its sole discretion, determine whether and to what extent additional action is appropriate to address the circumstances surrounding the Clawback Event so as to minimize the likelihood of any recurrence and to impose such other discipline as it deems appropriate.

Nothing in this policy will limit in any respect (i) the Company's right to take or not to take any action with respect to any Executive Officer's or any other person's employment or (ii) the obligation of the Chief Executive Officer or the Chief Financial Officer to reimburse the Company in accordance with Section 304 of the Sarbanes-Oxley Act of 2002, as amended. Any determination regarding this policy and any application and implementation thereof need not be uniform with respect to each Executive Officer, or payment recovered or forfeited under this policy.

To the extent permitted by applicable law, the Board may seek to recoup Recoverable Amounts by all legal means available, including but not limited to, by requiring any affected Executive Officer to repay such amount to the Company, by set-off, by reducing future compensation of the affected Executive Officer, or by such other means or combination of means as the Board, in its sole discretion, determines to be appropriate.

IV. Disclosure

If the Board determines that a Clawback Event has occurred that is subsequently disclosed by the Company in a public filing required under the Exchange Act (a "Disclosed Event"), the Company will disclose in the proxy statement relating to the year in which such determination is made (i) if any amount is clawed back from an Executive Officer and the aggregate amount clawed back or (ii) if no amount is clawed back from the Executive Officer as a result of the Disclosed Event, the fact that no amount was clawed back.

V. Definitions

For purposes of this policy, the following terms shall have the following meanings:

1) "Board" means the Board of Directors of the Company.

2) "Effective Date" means March 10, 2023

3) "Exchange Act" means the Securities Exchange Act of 1934, as amended.

4) "Executive Officer" means each current and former "officer," as defined in Rule 16a-1 under the Exchange Act, and any other senior executive as designated by the Board.

5) "Misconduct" means, with respect to an Executive Officer, the occurrence of any of the following events, as reasonably determined by the Board in its discretion:

(i) the Executive Officer's conviction of, or plea of nolo contendere to, any felony (other than a vehicular-related felony);

(ii) the Executive Officer's commission of, or participation in, intentional acts of fraud or dishonesty that in either case results in material harm to the reputation or business of the Company;

(iii) the Executive Officer's intentional, material violation of any term of the Executive Officer's employment agreement with the Company or any other contract or agreement between the Executive Officer and the Company or any statutory duty the Executive Officer owes to the Company that in either case results in material harm to the business of the Company;

(iv) the Executive Officer's conduct that constitutes gross insubordination or habitual neglect of duties and that in either case results in material harm to the business of the Company;

(v) the Executive Officer's intentional, material refusal to follow the lawful directions of the Board, the Company's Chief Executive Officer, or his or her direct manager (other than as a result of physical or mental illness); or

(vi) the Executive Officer's intentional, material failure to follow, or intentional conduct that violates (or would have violated, if such conduct occurred within ten (10) years prior to the Effective Date and has not been previously disclosed to the Company), the Company's written policies that are generally applicable to all employees or all officers of the Company and that results in material harm to the reputation or business of the Company; provided, however, that willful bad faith disregard will be deemed to constitute intentionality for purposes of this definition.

6) "Recoverable Amounts" means (i) any equity compensation (including stock options, restricted stock, restricted stock units, and any other equity awards) awarded after the Effective Date or (ii) any severance or cash incentive-based compensation (other than base salary) awarded after the date on which restatement of the Company's financial statements is required, to the extent permitted under applicable law.

Exhibit 10.46

Alto Opportunity Master Fund, SPC - Segregated Master Portfolio B
55 Post Road W., 2nd Floor
Westport, CT 06880

March 12, 2023

Shuttle Pharmaceutical Holdings, Inc.
1 Research Court, Ste 450
Rockville, MD 20850

Re: Senior Secured Convertible Note dated January 11, 2023 (the "Note")

Ladies and Gentlemen:

Reference is made to Section 15(q) of the Note. Capitalized terms used herein but not otherwise defined herein shall have the respective meanings given in the Note.

This letter is to confirm that, in lieu of holding the proceeds from the issuance and sale of the Note in the account at First Republic Bank, for the convenience of the parties such funds shall be held in an account of the Collateral Agent in trust for the Company. The respective rights and obligations of the Holder, the Collateral Agent and the Company in such funds is not modified or amended in any manner by this arrangement. Such funds remain the property of the Company, may be released to the Company in accordance with the terms of the Note, subject to the terms and conditions of the Note and the other Transaction Documents.

The Company and Collateral Agent agree that, as the banking and financial markets settle, they will discuss whether to move the funds to a new bank under a separate deposit account control agreement ("DACA"). Should the Company desire to establish a new DACA at a new banking institution, which DACA shall be substantially similar in form and substance to the existing DACA with First Republic Bank, Collateral Agent will not object and will take such appropriate action to allow for such transfer and entry into a new DACA.

The Note and the other Transaction Documents remain in full force and effect without modification.

Very truly yours,

Alto Opportunity Master Fund, SPC – Segregated Portfolio B, as collateral agent

By: /s/ Waqas Khatri
Name: Waqas Khatri
Title: Director
E-mail: wk@ayrtonllc.com

AGREED AND ACCEPTED:

Shuttle Pharmaceuticals Holdings, Inc.

By: /s/ Anatoly Dritschilo
Name: Anatoly Dritschilo
Title: Chief Executive Officer
E-mail: dritscha@georgetown.edu

Exhibit 23.1

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Board of Directors of

Shuttle Pharmaceuticals Holdings, Inc.

We consent to the inclusion by reference in the Registration Statement on Form S-8 (File No. 333-268758) of Shuttle Pharmaceuticals Holdings, Inc. (the "Company") of our report dated March 15, 2023 relating to the financial statements which appears in this Annual Report on Form 10-K for the year ended December 31, 2022.

/s/ BF Borgers CPA PC

Certified Public Accountants
Lakewood, Colorado
March 15, 2023

Exhibit 31.1

Certification

I, Anatoly Dritschilo, certify that:

1. I have reviewed this Annual Report on Form 10-K for the year ended December 31, 2022 of Shuttle Pharmaceuticals Holdings, Inc. (the "registrant");

2. Based on my knowledge, this Annual Report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this Annual Report;

3. Based on my knowledge, the financial statements, and other financial information included in this Annual Report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this Annual Report;

4. The registrant's other certifying officers and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15I and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this Annual Report is being prepared;

b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, 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;

c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this Annual Report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this Annual Report based on such evaluation; and

d. Disclosed in this Annual Report any change in the registrant's internal control over financial reporting that occurred during the registrant's fourth fiscal quarter that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 15, 2023

/s/ Anatoly Dritschilo, M.D.

Anatoly Dritschilo, M.D.
Chief Executive Officer
(Principal Executive Officer)

Exhibit 31.2

CERTIFICATION

I, Michael Vander Hoek, certify that:

1. I have reviewed this Annual Report on Form 10-K for the year ended December 31, 2022 of Shuttle Pharmaceuticals Holdings, Inc. (the "registrant");

2. Based on my knowledge, this Annual Report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this Annual Report;

3. Based on my knowledge, the financial statements, and other financial information included in this Annual Report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this Annual Report;

4. The registrant's other certifying officers and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this Annual Report is being prepared;

b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, 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;

c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this Annual Report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this Annual Report based on such evaluation; and

d. Disclosed in this Annual Report any change in the registrant's internal control over financial reporting that occurred during the registrant's fourth fiscal quarter that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 15, 2023

/s/ Michael Vander Hoek

Michael Vander Hoek
Chief Financial Officer
(Principal Financial Officer)

Exhibit 32.1

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report of Shuttle Pharmaceuticals Holdings, Inc. (the "Company") on Form 10-K pursuant for the year ended December 31, 2022, as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I, Anatoly Dritschilo, Chief Executive Officer of the Company, certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that:

(1) The Report fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: March 15, 2023

/s/ Anatoly Dritschilo
Anatoly Dritschilo M.D.
Chief Executive Officer
(Principal Executive Officer)

Exhibit 32.2

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report of Shuttle Pharmaceuticals Holdings, Inc. (the "Company") on Form 10-K for the year ended December 31, 2022, as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I, Michael Vander Hoek , Chief Financial Officer of the Company, certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that:

(1) The Report fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: March 15, 2023

/s/ Michael Vander Hoek
Michael Vander Hoek
Chief Financial Officer
(Principal Financial Officer)

Exhibit 99.1

Shuttle Pharmaceuticals Provides Fiscal Year 2022 Corporate Update

ROCKVILLE, Md., March 15, 2023 /PRNewswire/ — Shuttle Pharmaceuticals Holdings, Inc. (Nasdaq: SHPH), a discovery and development stage specialty pharmaceutical company focused on improving outcomes for cancer patients treated with radiation therapy (RT), today provided a corporate update in connection with the filing of its Annual Report on Form 10-K for the year ended December 31, 2022.

Recent Highlights

- Completed an initial public offering ("IPO") raising gross proceeds of $11.5 million, inclusive of the overallotment option, listing its common stock on the Nasdaq Capital Market.
- Closed on private placement of $4.3 Million of Senior Secured Convertible Note and Warrants to purchase 1.018 million shares of common stock in exchange for $4.0 million investment.
- Entered into agreements with TCG GreenChem, Inc. and UI Pharmaceuticals for drug manufacture and formulation development of Ropidoxuridine, the Company's lead clinical sensitizer drug candidate, for use in the Company's upcoming Phase II clinical trial evaluating Ropidoxuridine in combination with radiation therapy for the treatment of glioblastoma.
- Engaged Theradex Oncology, a leading clinical research organization, to help prepare for its upcoming clinical study of Ropidoxuridine.
- Entered into an agreement to lease new laboratory and office space, commencing in June 2023, to assist in furthering the development of the Company's lead drug candidates and accelerate broader diagnostic capabilities on predictive biomarkers.
- Published manuscripts discussing prostate cancer cell lines derived from African American men for precision medicine and immune responses taking place in patients after radiation therapy for cancer.
- Awarded patents in the U.S. and Hong Kong for its radiation sensitizing HDAC inhibitor technology platform.
- Appointed Dr. Bette Jacobs to its Board of Directors as an independent director.
- Rang the Nasdaq opening bell in January 2023.
- At December 31, 2022, the Company's Cash balance was $8.4 million. Subsequently, on January 11, 2023, the Company closed on the $4.0 million private placement.

"We continue to execute on the necessary steps to advance Ropidoxuridine, our lead clinical sensitizer drug candidate, towards the commencement of our upcoming Phase II clinical trial in brain cancer patients undergoing radiation therapy with an expectation of final submission to the FDA at the end of the second quarter of 2023," commented Shuttle Pharma's Chairman and CEO, Anatoly Dritschilo, M.D. "Since our August 2022 IPO, we have moved swiftly to advance drug manufacturing agreements, prepare our IND application for the planned Phase II clinical study of Ropidoxuridine and radiation therapy, and lease new laboratory space to complement the development of the Company's lead drug candidates and accelerate broader diagnostic capabilities on predictive biomarkers. Importantly, we anticipate that our improved balance sheet will provide us with sufficient capital to fund operations into the 4th quarter of 2025, which will allow for the advancement of Ropidoxuridine and our HDAC inhibitors to reach additional important milestones. I look forward to 2023 with enthusiasm as we work to complete a number of key upcoming milestones on the horizon."

Radiation Therapy Sensitizer Platform

Radiation therapy is a proven modality for cancer treatment. By developing radiation sensitizers, Shuttle Pharma aims to increase cancer cure rates, prolong patient survival and improve quality of life when radiation is used as a primary treatment, or in combination with, surgery, chemotherapy and immunotherapy.

Modern oncology incorporates multi-modality strategies that use combinations of surgery, chemo or immunotherapy, and radiation to treat cancers. Radiation therapy requires delivery and shaping of high doses of radiation energy to tumors to kill or slow the growth of cancer cells by damaging their cellular DNA. State-of-the-art technologies to deliver the radiation doses include image guided treatments with linear accelerators and particle radiation with protons. However, radiation therapy of adjacent healthy tissues can lead to injuries of normal organs. The addition of radiation sensitizers allows preferential increased killing of cancer cells.

Currently, there is only one drug on the market approved by the FDA as a radiation sensitizer. However, that drug has a host of side effects that limit its utility. Other drugs are used "off label" by radiation oncologists, but these often have additional side effects. There is an urgent need for an effective radiation sensitizer with low toxicity for use in combination with radiation therapy.

The Company's lead candidate, Ropidoxuridine, is an orally available prodrug, that once ingested, metabolizes into iododeoxyuridine, a pyrimidine analog, that has been recognized as a radio sensitizing agent since the 1960s. The Company is advancing its planned Phase II clinical trial of Ropidoxuridine in brain cancer patients undergoing radiation therapy for glioblastoma. Shuttle is currently preparing the Investigational New Drug application for the study with an expectation of final submission to the FDA at the end of the second quarter of 2023.

Beyond Ropidoxuridine, Shuttle is also developing a platform of HDAC inhibitors (SP-1-161, SP-2-225 and SP-1-303), with SP-2-225 being Shuttle's lead HDAC inhibitor for preclinical development. SP-2-225 has effects on the regulation of the immune system. The interactions of RT with the immune response to cancers are of great current interest, offering insight into potential mechanisms for primary site and metastatic cancer treatment. The Company is currently advancing drug manufacture and IND-enabling studies to enable a Phase I clinical trial in 2024.

Various sources have estimated that more than 800,000 patients are treated annually in the U.S. with radiation therapy for their cancers. About 50% are treated for curative purposes and the balance for palliative care. The market opportunity for radiation sensitizers lies with the 400,000 patients treated with curative intent. Based on a rough estimate of a course of radiation sensitizing brand drug therapy, which are used off label at this time, the potential market size is estimated to be in excess of $4.0 billion annually.

Manufacturing Agreements

In September 2022, the Company announced it entered into an agreement with TCG GreenChem, Inc. to manufacture Ropidoxuridine, the Company's lead clinical sensitizer drug candidate, for use in formulating the drug product for testing in clinical trials of Ropidoxuridine and RT of cancers. The agreement with TCG GreenChem allows the Company to advance its clinical research, including its proposed Phase II clinical trials, to establish the data necessary for the FDA to determine efficacy in treating brain tumors, sarcomas and pancreatic cancers, diseases that offer potential for orphan designations. In conjunction with manufacturing Ropidoxuridine, TCG GreenChem will perform process research, development and optimization work for Shuttle Pharma related to Ropidoxuridine and create working standards of starting materials and intermediates to support the qualitative/quantitative analysis of the drug reaction progress, determination of impurities, total mass balance and assay yields of the reactions. Shuttle Pharma will own all intellectual property and improvements developed through the Manufacturing Agreement.

In March 2023, Shuttle signed an agreement with the University of Iowa (UI) Pharmaceuticals for formulation development and clinical batch manufacture of drug capsules of Ropidoxuridine. This is expected to be the final step required in the drug manufacturing process for use in the Company's upcoming Phase II clinical trial evaluating Ropidoxuridine in combination with radiation therapy for the treatment of glioblastoma. UI Pharmaceuticals offers pharmaceutical product development, manufacturing, and testing services for tablets, capsules, and non-sterile powder, semisolid, and liquid products. Because UI Pharmaceuticals is registered with the FDA as a Drug Product Manufacturing and Testing Facility, they have the capability to produce and test products intended for both clinical studies and commercial sales.

Engagement of Theradex Oncology

In November 2022, Shuttle announced it had engaged Theradex Oncology, a leading clinical research organization ("CRO"), to help prepare for its upcoming clinical study of Ropidoxuridine. Specifically, Theradex Oncology will assist the Company in meetings with the FDA and preparation of the IND (Investigational New Drug) application for the planned Phase II clinical study of Ropidoxuridine and radiation therapy. Theradex's expertise in regulatory and statistical design is particularly helpful in meeting FDA requirements and providing guidance in study design and statistical support for the clinical trial.

Theradex Oncology has provided full oncology clinical trial services in the U.S. and Europe for over three decades. Meg Valnoski, president of Theradex, will be directly involved in the regulatory support provided to Shuttle Pharmaceuticals, working closely with a diverse team of experts to ensure the successful execution of clinical trials.

Laboratory Space Expansion

The Company entered an agreement to lease new laboratory and office space, commencing in June 2023, to complement the development of the Company's lead drug candidates and accelerate broader diagnostic capabilities on predictive biomarkers. The new laboratory space, located in Gaithersburg, Maryland, is located within the Maryland Biotech Corridor.

Publications

In December 2022, Shuttle Pharma announced the publication of a manuscript discussing prostate cancer cell lines derived from African American men for precision medicine. The manuscript, titled "Novel paired normal prostate and prostate cancer model cell systems derived from African American patients," by Dr. Mira Jung, was published in Cancer Research Communications, a journal affiliated with the American Association for Cancer Research (AACR), the premier international cancer research society. Unique cell cultures were developed by a collaborative effort of Shuttle Pharma and Georgetown University scientists and clinicians in a "Moonshot" project funded by the NIH SBIR program to address prostate cancer health disparities in African American men. Prostate cancer is the most frequently diagnosed solid malignancy in men. African American (AA) men are at greater risk for developing prostate cancer, and experience higher mortality rates, as compared to Caucasian American (CA) men. However, mechanistic studies to understand this health disparity have been limited by the lack of relevant in vitro and in vivo models. There is an urgent need for preclinical cellular models to investigate molecular mechanisms underlying prostate cancer in AA men. By collecting clinical specimens from radical prostatectomies of AA patients, ten paired tumor-derived and normal epithelial cell cultures were established from the same donors and cultivated to extend the growth under "conditional reprogramming (CR)."

In January 2023, Shuttle Pharma announced the publication of a manuscript discussing immune responses taking place in patients after radiation therapy for cancer. The manuscript, titled, "Radiation therapy induces innate immune responses in patients treated for prostate cancers," by Dr. Amrita K Cheema, was published in Clinical Cancer Research, a journal affiliated with the American Association for Cancer Research (AACR), the premier international cancer research society. The report provided insight into the immune response taking place in patients after radiation therapy for cancer. These data inform potential development of biomarkers of radiation response and therapeutic strategies for sequencing radiation and immune therapy modalities for cancer treatment.

Patent Awards

In September 2022, Shuttle Pharma announced it had been awarded patents in the U.S. and Hong Kong for its radiation sensitizing HDAC inhibitor technology platform, which is focused on reducing side effects and improving outcomes for cancer patients treated with radiation therapy (RT). Histone deacetylase (HDAC) inhibitors have been described as "a novel class of drugs that target enzymes involved in regulation of critical cellular functions that can inhibit cancer growth and activate cellular immunity," according to Scott Grindrod, PhD, lead inventor and Laboratory Director at Shuttle Pharma.

Treatment with HDAC inhibitors allows regulation of gene expression by blocking HDAC enzyme activity and allowing genes to be "turned on" to express proteins involved in regulation of the cell cycle, DNA damage response and immune activation. Inhibiting HDAC enzymes can turn on tumor suppressor genes to help control cell division and slow down cancer progression. Non-cytotoxic, highly selective inhibitors target the histone deacetylase 6 (HDAC6) enzyme to stimulate the immune system for applications in the treatment of cancers, neurological diseases and immunological disorders.

About Shuttle Pharmaceuticals

Founded in 2012 by faculty members of the Georgetown University Medical Center, Shuttle Pharma is a discovery and development stage specialty pharmaceutical company focused on improving the outcomes for cancer patients treated with radiation therapy (RT). Our mission is to improve the lives of cancer patients by developing therapies that are designed to maximize the effectiveness of RT while limiting the side effects of radiation in cancer treatment. Although RT is a proven modality for treating cancers, by developing radiation sensitizers, we aim to increase cancer cure rates, prolong patient survival and improve quality of life when used as a primary treatment or in combination with surgery, chemotherapy and immunotherapy. For more information, please visit our website at www.shuttlepharma.com.

Safe Harbor Statement

Statements in this press release about future expectations, plans and prospects, as well as any other statements regarding matters that are not historical facts, may constitute "forward-looking statements." These statements include, but are not limited to, statements concerning the development of our company. The words "anticipate," "believe," "continue," "could," "estimate," "expect," "intend," "may," "plan," "potential," "predict," "project," "should," "target," "will," "would" and similar expressions are intended to identify forward-looking statements, although not all forward-looking statements contain these identifying words. Actual results may differ materially from those indicated by such forward-looking statements as a result of various important factors, including factors discussed in the "Risk Factors" section of Shuttle Pharma's Annual Report on Form 10-K for the year ended December 31, 2022, filed with the SEC on March 15, 2023. Any forward-looking statements contained in this press release speak only as of the date hereof and, except as required by federal securities laws, Shuttle Pharmaceuticals specifically disclaims any obligation to update any forward-looking statement, whether as a result of new information, future events or otherwise.

Shuttle Pharmaceuticals

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