

TECHNOLOGY TRANSFER

Fiscal Year 2019 Impact Report

An innovation hub working to bring OHSU's vision to life.



2019 has been an eventful year for research and innovation at OHSU. As chief research officer at OHSU, I directed a renaming of our office (“OHSU Research and Innovation”) to reflect the importance not only of research, but of activities that bring the fruits of that research to the public. While not all OHSU members are interested in developing technologies arising from their research, many are and supporting those members sufficiently is a priority for me.

We have streamlined the former Technology Transfer and Business Development office, focusing on the technology transfer aspects (and hence renaming the office “OHSU Technology Transfer”). The office has a renewed emphasis on supporting innovation and technology commercialization, and the excellent service offered by the office will only increase.

We also created a new office, OHSU Collaborations and Entrepreneurship, and hired Aditi Martin to run it. Aditi’s charge is to coordinate the many groups across campus that support OHSU in external collaborations and entrepreneurship activities developing OHSU technologies, for example, in the School of Medicine, the Knight Cancer Institute, and the Oregon Clinical and Translational Research Institute.

Our new president, Danny Jacobs, is equally committed to commercialization of OHSU innovations. Together we look to support the OHSU innovation community in years to come.



Peter Barr-Gillespie, Ph.D.

Executive Vice President and Chief Research Officer
OHSU Research & Innovation

I am pleased to report that this has been a very productive year for the conception, development and advancement of innovation at OHSU. This Fiscal Year 2019 Impact Report highlights key achievements and milestones of both the OHSU community and our partners working together to translate new technologies and products for maximum public benefit.

The process of transferring technology can be thought of as a continuous cycle where new discoveries fuel the development of products and services that eventually reach consumers, providing crucial funding for the next generation of innovative breakthroughs. We cannot do this alone, and we value and appreciate the relationships built between OHSU and the business and investment communities. I have witnessed firsthand over the past twelve years the tremendous growth and potential arising from the OHSU community. Developing new technology and seeing it have a positive impact can sometimes be a long process, but the rewards far outweigh any challenges and it is personally rewarding to be a part of the progress being made at OHSU.

Everyone affiliated with the OHSU community should be proud of the past year’s achievements. We look forward to the challenges ahead, helping to bring incredible OHSU technologies to the global community.



Andrew R.O. Watson, Ph.D., C.L.P.

Senior Director, Technology Transfer
OHSU Technology Transfer



An innovation hub working to bring OHSU’s vision to life.

At OHSU Technology Transfer, our mission is to support the advancement of OHSU research, innovation, commercialization and entrepreneurship for the benefit of society.

Table of contents	Innovators	4
	Startup Company Highlights	6
	Technology Highlights	8
	Innovation Support	10
	Technology Development Support	12
	By the Numbers	14
	Our Team	15

Innovators

Each year, OHSU Technology Transfer recognizes several individuals and teams from OHSU who have made great strides in developing new solutions to real world problems. These innovators are highlighted for their contributions in making a real difference in the world.



Summer L. Gibbs

**ASSOCIATE PROFESSOR OF BIOMEDICAL ENGINEERING,
SCHOOL OF MEDICINE**

Summer Gibbs has been a contributor on numerous new technologies over the past few years. One of her main areas of focus has been on developing libraries of novel, small-molecule, near-infrared, fluorophores for diagnostic use in fluorescence-guided surgery. She is designing, synthesizing and testing nerve-specific fluorophores and application methods that can be used to visualize nerve structures to be avoided or repaired during surgery. Surgeries are among one of the most common treatments for a variety of diseases, yet damage to nerves during surgery often leaves patients with chronic pain following the healing process or even with permanent loss of function. Being able to visualize nerves during surgery continues to be a significant challenge even for experienced clinicians.

“We are excited about the potential of our near infrared, nerve-specific imaging technology to decrease morbidity for patients and improve surgery” says Gibbs. The Gibbs laboratory has been developing both direct and systemic administration strategies for nerve-specific fluorophores that will permit first in human testing of their most promising agents facilitating translation to the clinic. Currently, using the early Phase 1 exploratory Investigational New Drug trial, she and her team are taking steps to move the most optimal of the nerve-specific fluorophores from the research bench to the clinic “I am fortunate to work with a talented group of scientists and committed collaborators who have made these advances possible” says Gibbs. “We appreciate our relationship with OHSU Technology Transfer. As academic researchers, we are naïve in the commercialization space and have learned a substantial amount from the dedicated staff about how to translate our technology towards the clinic.”



Perry Gliessman

FORMER DIRECTOR AND DATA CENTER DESIGNER, OHSU TECHNOLOGY SERVICES

Perry Gliessman has a long, innovative history at OHSU. For over 20 years, he developed technologies for medical research and data acquisition at the Oregon National Primate Research Center (ONPRC). His inventions ranged from unique patient monitoring systems and surgical instruments to multi-channel neurotransmitter infusion and sampling systems designed for neuroendocrine research. He also designed and implemented the first fiber optic network for the OHSU West Campus. Then, during his seven-year tenure as the Director of Technology Services for OHSU's Information Technology Group, he designed a new, state-of-the-art data center that was built on the university's West Campus.

Not all new technologies developed at OHSU are for use in healthcare. The Data Dome is a high-performance Tier 3+ data center in a geodesic dome with passive cooling, which is how it achieves top-class power efficiency. It costs significantly less to build than most data centers of its quality and can be run and monitored remotely. "My hope and vision for the Data Dome technology is to utilize the commercialization process to help disseminate the inherent efficiency concepts, reduce the global data center carbon footprint, and eliminate unnecessary infrastructure and power consumption in an industry that is projected to consume twenty percent of the world's power in the near future" says Perry.

The Data Dome remains OHSU's largest technology prototype. The design was most recently licensed to OHSU startup company Server Dome, which is taking it to market in hopes of having these energy-efficient data centers built around the world. "OHSU Technology Transfer has provided a highly collaborative and instructive team throughout the processes of intellectual property protection, market assessment, and relationship development" said Gliessman. "It has been incredibly rewarding and educational for me to be guided and supported throughout this incredible journey." When asked about his overall impression of his technology commercialization experience, Gliessman said he couldn't think of a more rewarding endeavor.

Startup Company Highlights

New startup companies are a critical part of OHSU's efforts to disseminate technology and commercialize OHSU innovations. In the past year, four new companies have launched based on technology in-part from OHSU. These include Orcorazon, based in the Portland area, Nous Imaging, based in St. Louis, and Cytotheryx, based in Rochester, Minnesota.

The fourth company, Quantiport, Inc., another Portland based startup, is focused on developing a novel blood volume measurement device. Here's how this new startup is breaking new ground in emergency medicine.

Quantiport, Inc.

Trauma-related hemorrhage is a leading cause of death among adults under 45 years old, as well as children of all age groups. The diagnostic challenge is determining the volume of blood loss or conversely, the volume of blood remaining in circulation. Younger individuals tend to maintain high vascular tone in a setting of acute blood loss; this compensatory mechanism often masks signs of hemorrhagic shock. When such robust compensatory mechanisms are overwhelmed, patients rapidly decompensate, leading to overt shock, multiple organ failure and often death.

OHSU startup QuantiPort, Inc. has developed a system for measuring blood volume quickly and accurately. This helps identify patients who have lost significant blood volume as well as to detect ongoing blood loss. The QuantiPort Blood Volume Measurement Device (Blood Volume MD) provides advance warning and a valuable head start for physicians to initiate emergency therapeutic intervention prior to patient decompensation, overt shock and death.



“Current methods of objective blood volume measurement are time-consuming, expensive and expose patients to radioactive substances that require special licensing and handling,” says Theodore Hobbs, head of surgery at the Oregon National Primate Research Center, and founder/president of QuantiPort, Inc. “We want to develop a device that is easy to administer—that within a few minutes can determine total blood volume without blood draws, radioactive substances or outside laboratory processing. This allows for fast, safe and reliable assessments at a much lower cost.”

The company is currently funded through a combination of grants and funding from the U.S. Department of Defense, Oregon Nanoscience and Microtechnologies Institute, Business Oregon, and Ideaship. Development of the device also received funding and support from the OHSU Biomedical Innovation Program, a collaborative program between OHSU Technology Transfer and the Oregon Clinical & Translational Research Institute. QuantiPort is working towards FDA Breakthrough Device designation.

Startup Company Milestones

Over the past ten years, OHSU has helped form over 35 new companies based on OHSU technology, with over two-thirds of these companies deciding to locate in Oregon. Some of these are service companies providing valuable services, while others are developing their own unique products that can take years to develop. Here are some of the startup company highlights from the past year.

Aronora Inc.

Despite currently approved treatments, over one million people still die from blood clots every year in the U.S. Aronora, a clinical stage biotechnology company developing first-in-class treatments for life-threatening diseases, was granted Fast Track designation by the U.S. Food and Drug Administration for proCase (E-WE thrombin, AB002), an enzyme that is intended to reverse blood clot formation without increasing the risk of bleeding. Aronora also entered into a deal with XOMA Corporation for XOMA to acquire certain rights in potential royalty payments and milestone payments associated with the five current drug assets of Aronora. This provides Aronora with critical funds to continue clinical development of its novel hematology drug candidates.

Cylerus, Inc.

A company developing the Drug-Eluting Cuff (DEC), an innovative new medical device that can dramatically reduce treatment complications for patients with end-stage renal disease who require life-sustaining hemodialysis. Cylerus has recently received a phase II Small Business Innovation Research fast track grant from the National Institutes of Health allowing the company to continue the development of the DEC graft into a commercially viable product. The technology could also be adapted to a variety of other medical conditions where, steady, localized delivery of drugs is key.

Fennec Pharmaceuticals Inc.

Cisplatin and other platinum compounds are essential chemotherapeutic components for many pediatric malignancies. Unfortunately, platinum-based therapies cause ototoxicity/hearing loss in many patients, and are particularly harmful to the survivors of pediatric cancer. There is currently no established preventive agent for this hearing loss and only expensive, technically difficult and sub-optimal cochlear (inner ear) implants have been shown to provide some benefit. Fennec Pharmaceuticals is a specialty pharmaceutical company that is targeting European and U.S. approval for its product PEDMARK™. PEDMARK™ is for the prevention of platinum-induced ototoxic hearing loss in children. PEDMARK™ has been granted Orphan Drug, Breakthrough Therapy and Fast Track designations from the U.S. Food and Drug Administration.

GoCheck Kids (Gobiquity, Inc.)

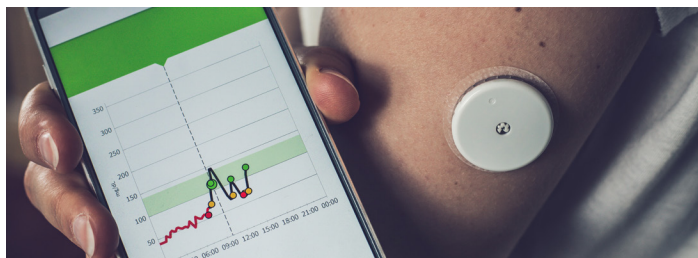
A pediatric ophthalmology focused company developed a U.S. Food and Drug Administration-registered and European CE-certified iPhone app that screens for amblyopia in pre-verbal children. The app is currently used by over 4,500 pediatricians to detect amblyopia, the leading cause of monocular visual impairment for children in the U.S. and a leading cause of childhood vision impairment worldwide. If left untreated, the disease can result in permanent vision loss, but can be effectively treated if detected early. The company recently raised \$6 million in Series B funding led by FCA Venture Partners. The investment will be used to add artificial intelligence capabilities to accelerate electronic health record integrations.

MolecularMD Corporation

A molecular diagnostic specialty company enabling the development and commercialization of precision medicines in oncology. The company spun out of OHSU in 2007, and was later acquired by ICON plc in 2019. MolecularMD's extensive scientific and clinical biomarker experience will expand ICON's capabilities in molecular diagnostic testing and expand ICON's laboratory service offerings.

Technology Highlights

OHSU Technology Transfer receives and reviews nearly 150 new technologies every year from members of the OHSU community. These new innovations are reviewed and evaluated based on several criteria, and many require additional development assistance that is provided by Technology Transfer in partnership with others both internally at OHSU and outside of OHSU. The ultimate goal is to transfer as many of these new technologies to others, typically companies, to continue product development and realize the full commercial and public benefit potential of each technology. Here is a snapshot of a few of OHSU's promising new technologies.



Glucose prediction algorithm using long-short term memory recurrent neural network

Robert Dodier, Peter Jacobs, Clara Mosquera-Lopez, Nichole Tyler

Patients with type 1 diabetes do not produce their own insulin and rely on continuous glucose monitoring (CGM) systems and insulin pumps to help manage glucose levels. Accurate glucose prediction algorithms are critical components of CGM systems to help people proactively avoid adverse hyper- or hypo-glycemic events.

Researchers at OHSU have developed a data-driven glucose prediction algorithm trained on a large dataset to predict glucose concentration within a short term (30 minute) period.

The OHSU algorithm can be integrated into CGM-based decision support tools to alert insulin pump Type 1 diabetes users of glycemic changes.

In addition to use in CGM systems, the OHSU algorithm can also be integrated into artificial pancreas systems.

New therapeutic strategy for treating Ewing sarcoma and other solid tumors

Moriah Arnold, Michael Cohen

Ewing sarcoma is the second most common type of bone cancer in children. Treatment options are limited to surgery and general chemotherapy; however, relapse often occurs in children with metastatic disease. In these cases, prognosis is especially dismal—less than 30% survival.

In several current cancer treatments, combination therapies (combining two or more single drugs) are demonstrating increased success. However, unlike other cancers, Ewing sarcoma has no obvious candidate drug targets and no current treatments.

To address this clear and unmet medical need and develop new drugs for Ewing sarcoma, researchers at OHSU have identified novel new drug candidates targeting a human enzyme called PARP1 that exhibit a unique dual mechanism of action. These new drug candidates combine modulation of DNA binding, and thereby inducing replication stress of tumor cells, with the induction of rapid cell death in Ewing sarcoma cells by inhibiting the activity of PARP1.

The dual mode of action of these small molecule inhibitors may allow them to be used as a potential single therapy for Ewing sarcoma and certain other solid tumors such as prostate cancer and ovarian cancer.



Activity MRI [aMRI]: Non-Invasive, High-Resolution Metabolic Imaging

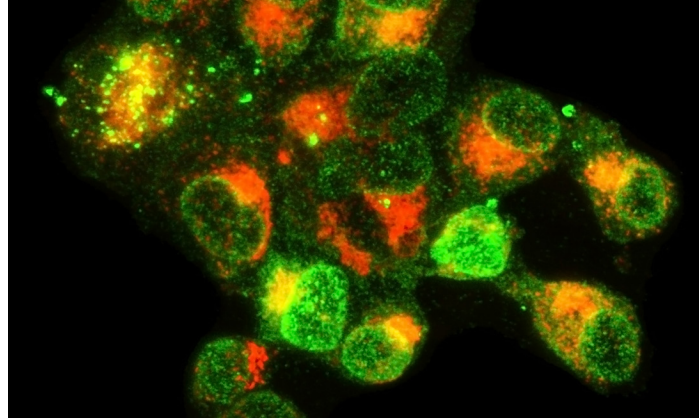
Tom Barbara, Wei Huang, Xin Li, Brendan Moloney, William Rooney, Charles Springer

The ubiquitous membrane transporter enzyme Na⁺K⁺-ATPase (NKA) actively pumps sodium ions out of and potassium ions into a cell. It is perhaps biology's most vital enzyme because it maintains the trans-membrane ion concentration differences and electrical potential.

Mapping NKA metabolic fluxes provides key information in diagnosing and monitoring essentially all human diseases. However, there are very few imaging technologies available that can map metabolic activity, and each of these have drawbacks due in part by utilizing any one of the commonly used contrast agents, where there is growing concern over possible long-term medical side effects and environmental issues with their use. In order to address the current need for a contrast agent-free metabolic imaging approach, OHSU researchers have developed a novel method of metabolic imaging using magnetic resonance imaging (MRI), introduced here as Activity MRI (aMRI).

This approach is completely non-invasive (contrast agent-free) and can provide both anatomical as well as metabolic information. It can be used for early detection, monitoring progression and/or therapeutic response in disease; e.g., breast, prostate, head and neck, and pancreatic cancer [in principle, any cancer], heart muscle, etc.

Another important application of this method is that it can be used in the brain to obtain information crucial for acute stroke evaluation and brain cancer therapy evaluation.



Software for deep learning-based inference of biomarker distribution in cancer histopathological images

Erik Burlingame, Geoffrey Schau, Elliot Gray, Young Hwan Chang

Multiplexed imaging, such as multicolor immunofluorescence (IF) staining, enables the determination of the spatially-resolved molecular profile of a cancer, which is important for disease subtyping and choosing a patient's course of treatment. However, despite its clinical value, multiplex IF staining methods are costly, can degrade the tissue with each successive IF staining cycle, and require computationally intensive image processing. Moreover, assessment is typically limited to a small representative section of a tumor, which may not be fully representative of the neoplasm.

To address these real-world limitations, OHSU researchers have developed a novel, deep learning-based computational method—speedy histopathological-to-immunofluorescent translation (SHIFT)—which takes histologic images of hematoxylin and eosin-stained tissue as input, then in near-real time returns inferred virtual IF images that accurately depict the underlying distribution of the tissue's molecular features, without requiring actual IF staining of the tissue being tested. SHIFT could therefore serve as an efficient preliminary, auxiliary, or substitute for IF by delivering multiplexed virtual IF images at a fraction of the cost and in a fraction of the time required by traditional multiplexed imaging technologies. Furthermore, the portability of SHIFT allows it to be integrated into existing imaging workflows with minimal effort. Thus, this technology has the potential to greatly increase the efficiency of cancer diagnosis and ultimately improve the quality of patient care.

Recently, members of the SHIFT inventor team received The Impact Award from the inventOR student competition.

Innovation Support

OHSU Technology Transfer continually strives to support the OHSU community in its efforts to advance research and innovation by developing new partnerships and establishing new programs.

Ximbio

This year, OHSU Technology Transfer formed a joint internship position with Ximbio, one of the world's largest non-profit tech transfer services dedicated to life science research.

The internship is intended to benefit OHSU researchers who are generating new reagents and biomaterials, as well as scientists at other academic institutions and industry. The goal is to accelerate life science research and make all research reagents widely and easily available.

"I really like this program because it allows researchers to find a home for reagents they no longer actively need but which are still important to the research community, and that it frees up valuable space in our laboratories" said Kathryn Goforth, OHSU's Biochemistry and Molecular Biology Department Administrator.

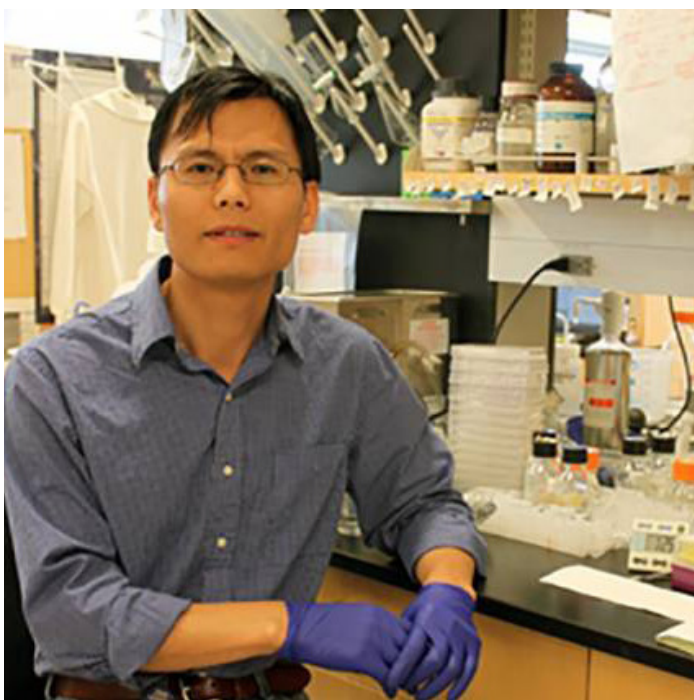
West Coast CTIP | www.westcoastctip.org

OHSU and nine other members of a network known as the West Coast Consortium for Technology and Innovation in Pediatrics (West Coast CTIP) received more than \$6 million to support new medical device innovation and small businesses focused on pediatric medical technology development. Resulting devices could yield new cutting-edge treatment opportunities that span pediatric home health, acute and critical care.

The West Coast CTIP is playing a vital role in the advancement of pediatric devices in multiple avenues including awarding research grants as well as supporting small businesses aimed at pediatric device development.

In addition to the financial resources, there is a vast network of consultants and professionals that can aide busy clinicians and researchers in advancing their ideas. David Sheridan, the OHSU principal investigator of West Coast CTIP says, "Pediatric devices is a significantly underserved population of technology development and so critical to the care of young children and adolescents. This type of support is critical to take clinical ideas from the experts at the bed and bench-side to commercialization. We have already seen support of multiple OHSU investigators as well as small businesses in Portland. We view this consortium as not only a huge advantage for OHSU's innovation mission, but also for the local biotechnology ecosystem."

The West Coast CTIP is supported by the U.S. Food and Drug Administration's Office of Orphan Product Development through a grant awarded to UCLA Health.



M.J. Murdock Charitable Trust Commercialization Initiation Program

Xiangshu Xiao and his team were awarded \$120,000 to develop a new therapy for drug-resistant ovarian cancer as well as breast cancer. OHSU Technology Transfer, Xiangshu and the OHSU Foundation worked together to secure a \$60,000 grant from the M.J. Murdock Charitable Trust's Commercialization Initiation Program with another \$60,000 contributed by OHSU Technology Transfer through OHSU's University Venture Development Fund. "The outcome for women with drug-resistant ovarian cancer is abysmal" says Dr. Xiao. "We are very grateful for the M.J. Murdock Charitable Trust in providing such generous financial support that will enable us to investigate the potential of a new drug we are developing. OHSU Technology Transfer made a great turning point for us in connecting us with entrepreneurs and investors to advance this opportunity."



OHSU Commercialization Conference

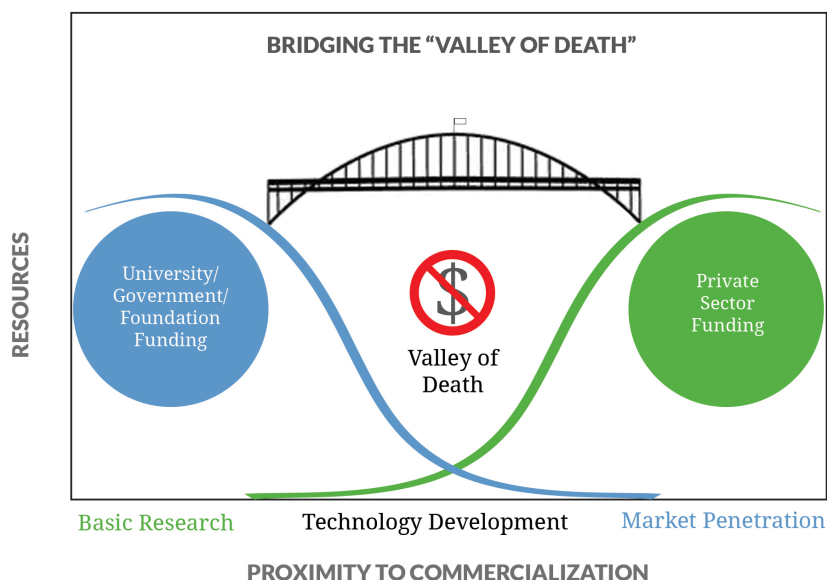
This year, OHSU hosted the sixth OHSU Commercialization Conference, formerly the OHSU Startup Symposium, focused on fueling healthcare innovation. Conference attendees came from seven states representing fifteen various professions and industries across the U.S. Topics ranged from investment in healthcare innovation, the future drivers for healthcare innovation and delivery, the digitization of healthcare, and how best to advance healthcare innovation through public/private partnerships. A highlight of the event included a company pitch showcase where four OHSU startup companies presented on their technology advancements to improve patient care. "The startup pitches were the highlight of the conference for me. They were concise and very well done" remarked one conference attendee.

Technology Development Support

Funding towards the commercialization of a new technology is not typically provided by traditional government and other research funding sources. The 'Valley of Death' often refers to a point where many new technologies die due to a lack of funding and support.

OHSU has been fortunate over the last several years to support the development of new technologies and bridge this Valley of Death through funds raised as part of the state-wide Oregon University Venture Development Fund (UVDF). This unique program in the state allows donors to claim a sixty percent state tax credit. Thanks to two bills created by the Oregon Legislative Assembly, individuals and organizations can help to create a vibrant economy for Oregon and its citizens—and receive a generous tax credit for their investment—by supporting the OHSU UVDF. Through the OHSU Foundation's receipt of donations into this unprecedented state program, OHSU Technology Transfer has supported new innovations at the critical proof-of-concept stage, before they are ready for external investment.

www.ohsu.edu/foundation/ohsu-venture-development-fund



This past year OHSU Technology Transfer has once again partnered with the Oregon Clinical and Translational Research Institute on the Biomedical Innovation Program (BIP) to provide crucial funding to the following projects:

- Development of agonists for the prevention of obesity and obesity-related diseases (R. Stephen Lloyd)
- Decoy CD74 peptide constructs for treatment of progressive Multiple Sclerosis (Arthur Vandenberg)

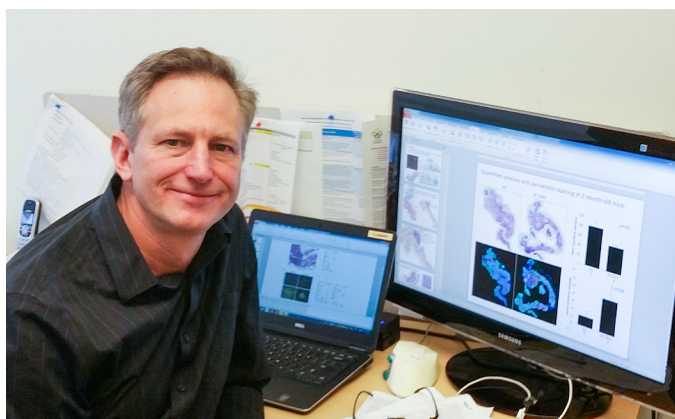
Also, this year we launched a new program to provide entrepreneurial opportunities and travel support for OHSU personnel interested in transforming their innovations into viable commercial ventures, though the use of OHSU UVDF funds. For example, OHSU entrepreneurs involved in two recent startup companies were able to attend the JP Morgan Healthcare Conference, the largest healthcare investment conference in the country. Additionally, a team of OHSU researchers were able to meet with the U.S. Food and Drug Administration to discuss the development of their point-of-care software algorithm as an assistive medical device for diagnosis of a devastating ophthalmic disease affecting premature infants. Finally, an OHSU team was able to conduct an externship at a major medical device company to gain knowledge and insights on how to successfully develop and commercialize new products within a corporate environment.

Almost any new early-stage innovation can benefit from initial amounts of seed funding in order to answer key questions. This past year with funds from the OHSU UVDF, a new early-stage technology

development program was created to provide such funding to a handful of early innovations. Some of the projects that received funding this year included i) a mobile device application for assessing wound healing, ii) a mobile device application providing encouragement and monitoring for suicidal adolescents following hospital discharge, and iii) a novel device providing significant relief for neuropathic pain sufferers.

OHSU Technology Transfer values the partnership with the OHSU Foundation and donors in helping to provide funds to support projects like these.

Benefits of Technology Development



John L. Muschler
PH.D.

To see the true value of programs providing support for advancing technology development, the story of John Muschler's research is a great example. Dr. Muschler has been researching novel approaches to detect and treat early stage bladder cancer since he joined OHSU in 2011. There are very few treatment options for this disease, and those therapies are ineffective and costly.

In 2014, Muschler's laboratory developed an early-stage technology platform that effectively targeted early stage tumor cells in the bladder, making possible early detection and treatment. Working with the OHSU Technology Transfer office, patent protection

was filed on this early-stage technology. However, the technology was a long-ways away from having commercial potential. In 2015, he applied for and was provided an award from the OHSU Biomedical Innovation Program (BIP) that facilitated the next stage of technology development. According to Muschler, the early stage funding was crucial in keeping the project alive and in advancing the research. Without it, the project may have fallen into the 'Valley of Death' and never advanced. The BIP helped him to plan ahead and efficiently prepare for the next steps in the commercialization process.

More recently, Muschler and the OHSU Technology Transfer team have been working to form a new startup company around his new therapeutic antibody technology with a group of investors. However, the investor group was wanting some critical experiments completed. As Muschler had his current funding sources committed to other projects and therefore had no funding available to apply to his new technology, OHSU Technology Transfer was able to award him an early-stage technology development award using UVDF funding to carry out the necessary experiments. The early-stage development funds helped to overcome an obvious funding hurdle and allowed Muschler to continue advancing the technology towards clinical application.

In response to receiving the support to continue the development of his technology, Muschler said "I am very grateful to OHSU Technology Transfer for the excellent support, and excellent timing. These funds will be put to immediate and very good use." Through these experiences, Muschler has increased his understanding of what it takes to advance projects from research discovery to product commercialization.

He admits he's begun to step out of the traditional 'research scientist' mold and think more like a true inventor and entrepreneur. "A new healthcare product that makes it to market offers many benefits to patients; there's a lot to gain in working through the commercialization process with little to lose in trying," said Muschler.

By the Numbers

OHSU ranked #42 in the 2019 *Reuters* report of the World's Top 100 Most Innovative Universities—up ten spots from the previous year.

CATEGORY	FY 2019	AVERAGE FY 2015 - 2019
New Technology Disclosures	144	142
OHSU Innovators involved in Technology Disclosures	272	253
License and Option Agreements Executed	118	102
Patent Applications Filed on New Subject Matter	43	44
U.S. Patents Issued	24	22
Sponsored Research Agreements Executed	79	88
Material Transfer Agreements Executed (MTAs)	556	479
Incoming MTAs Executed	407	346
Outgoing MTAs Executed	149	133
New Startup Companies Formed	4	5

Our Team



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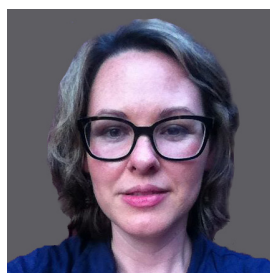
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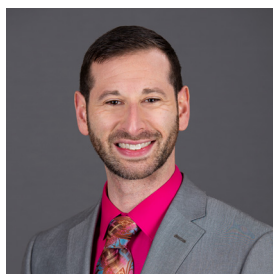
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