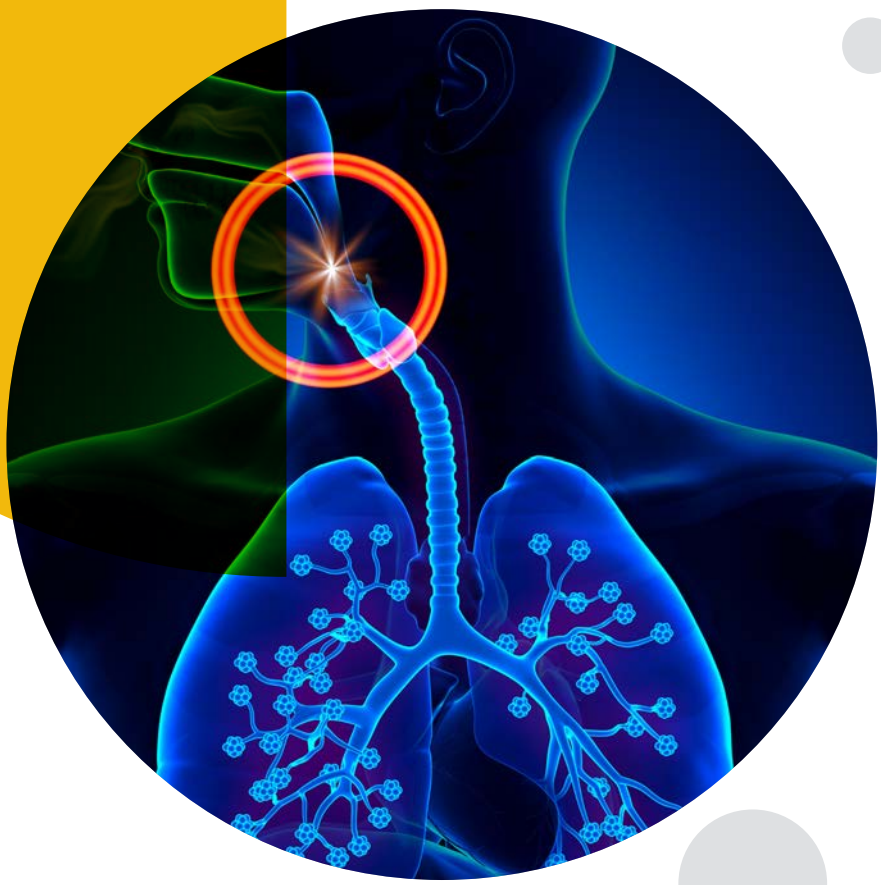
VANDERBILT

CTTC

Center for Technology Transfer & Commercialization



DRIVING *INNOVATION* FORWARD

FALL 2021

Turning Ideas Into Opportunities

This edition of Driving Innovation Forward celebrates 30 years of nurturing innovation at Vanderbilt. Over this period, technology commercialization efforts have grown dramatically in scale and scope. But our focus remains on CTTC's fundamental mission of helping researchers realize their goal: bringing the results of their research to practical application that positively benefit society.

Please take a moment to review our historical metrics and reflect on what has been accomplished over the past 30+ years, and catch up on some Vanderbilt's more recent accomplishments in technology commercialization, including a brief summary of some recent impactful licenses and the launch and growth of select new ventures. As demands for more complex and robust commercialization services increase, we are committed to meeting the moment.

INSIDE:

99 Licenses and Options Executed

187 End-User Licenses Executed

57 Confidentiality Agreements Executed

47 Clinical Trial Agreements Reviewed

Licensing Revenue Generated: **$13,503,265**

1,166 MTA's Reviewed

892 Incoming

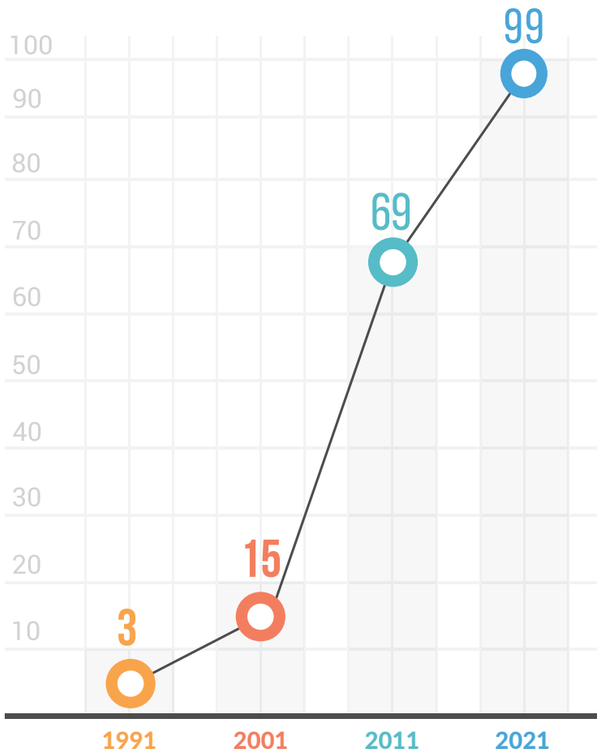
274 Outgoing

Research Support Generated: **$25,236,842**

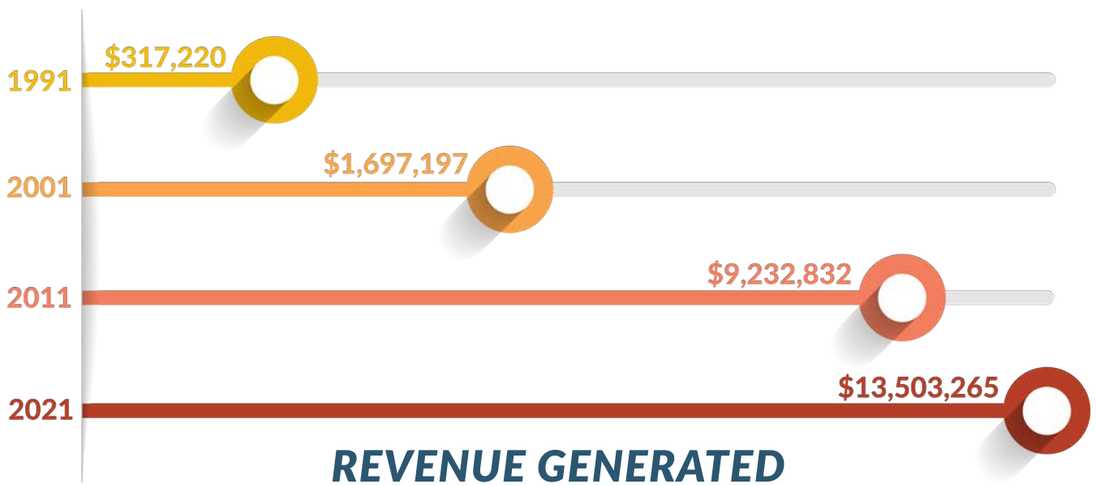
FY21 AT A GLANCE

30 YEARS of *INNOVATION*

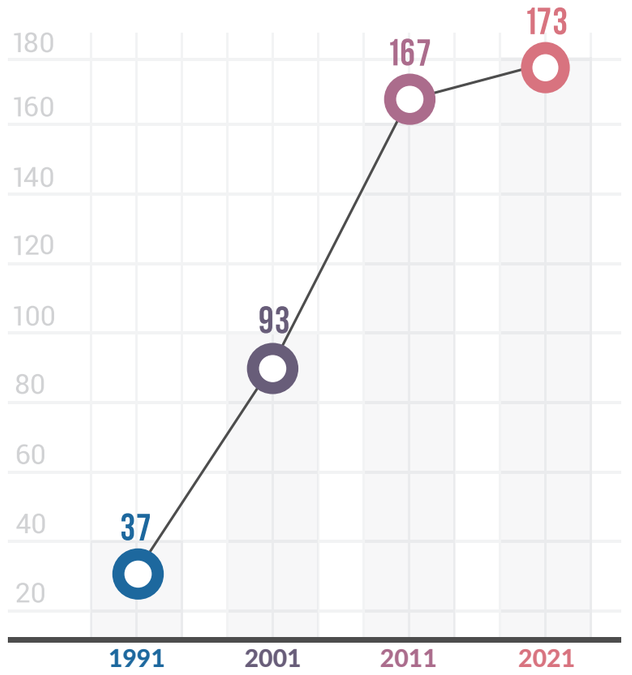
PLUS



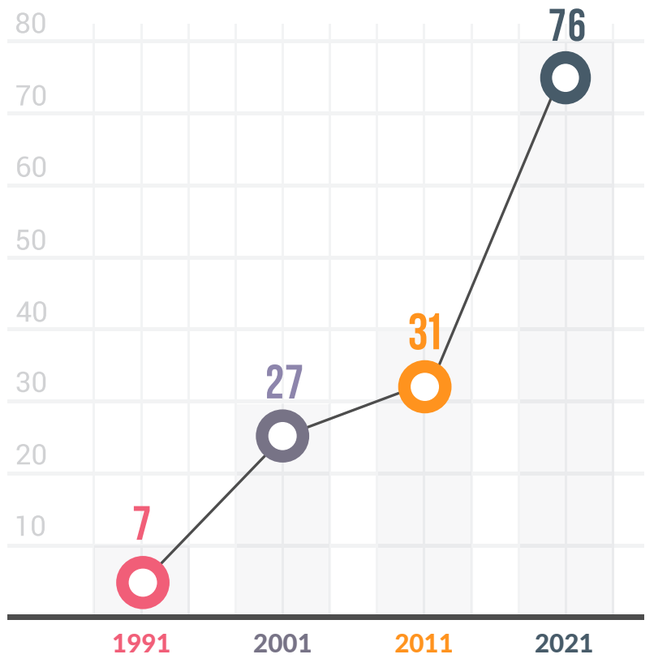
LICENSES EXECUTED



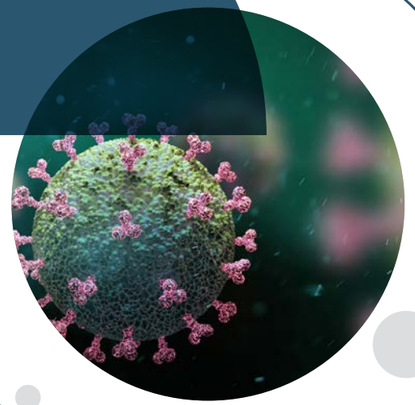
REVENUE GENERATED



NEW INVENTION DISCLOSURES



U.S. PATENTS ISSUED



Notable *TRANSACTIONS*

2014 — Sanofi and Vanderbilt University Medical Center initiate research collaboration on chikungunya virus antibodies

2015 — Patent filing on antibodies discovered

2017 — Antibodies licensed to Sanofi

2018 — Program transferred to Evotec from Sanofi along with license to Sanofi infectious disease unit

2021 — Phase I clinical trial initiated

The timeline of the partnership between Vanderbilt University and ***Evotec SE*** for the development of a therapeutic antibody for chikungunya virus.

Evotec SE

The Vanderbilt partnership with Evotec SE for a therapeutic antibody for chikungunya virus has entered into Phase I clinical trials.

The antibody drug was created by a team of individuals in the Vanderbilt Vaccine Center led by James E. Crowe, Jr., with funding from Sanofi and the NIH, and is one of the many candidate therapeutics identified by this team to address unmet medical needs for underserved populations around the globe.

The therapeutic antibody was licensed from Sanofi to Evotec in 2018 and is being studied for use both before infection or after infection. Check out the timeline for Evotec and Vanderbilt to the right.

Chinook Therapeutics, Inc.

A small molecule drug which inhibits the lactate dehydrogenase A enzyme arising from a collaboration among scientists from Vanderbilt University, NCATS, NCI, The University of Alabama, and The University of Pennsylvania was licensed to Chinook Therapeutics, Inc. by Vanderbilt.

Alex Waterson led the scientific effort at Vanderbilt. The drug is in development for use in kidney diseases such as primary hyperoxaluria and other oxalate disorders, and Chinook has received a rare pediatric disease designation from the FDA for primary hyperoxaluria.

Phase I clinical studies are planned for late 2021.

Featured Inventor:
DAVID KENT, MD

ASSISTANT PROFESSOR OF OTOLARYNGOLOGY

DIRECTOR OF SLEEP SURGERY

David Kent, MD, became interested in sleep medicine and surgery when he was a resident because the field had so many unanswered questions – questions he is now aiming to answer as an assistant professor of Otolaryngology and Director of Sleep Surgery at Vanderbilt University Medical Center.

Kent's research focuses on the causes and treatment of Obstructive Sleep Apnea (OSA), the most common sleep-related breathing disorder. It occurs when the muscles of the throat relax during sleep, causing snoring and repeated blockages in breathing. OSA is common, affecting around 936 million people globally between the ages of 30 and 69. And the long-term effects of the disorder can be devastating. If left untreated, the negative impacts on patient's health can include cardiovascular diseases, depression, and stroke.

"Sleep apnea and poor sleep are associated with mood disorders, and being sleepy during the day increases the risk of workplace accidents and decreased work productivity. It also significantly increases the risk of motor vehicle accidents if it goes untreated," explained Kent.

Unfortunately, treating patients for OSA can be complicated and there isn't a clear-cut treatment option for each person.

"We have many treatment options to offer patients, but sometimes it's difficult to recognize what treatment is right for a patient, or what procedure will get them the outcome they're seeking. Even more challenging is seeing a patient and knowing that all the surgical tools I currently have just aren't right for their anatomy! The challenges underlying these seemingly simple decisions are part of what attracted me to the field."

Patients with OSA usually try a CPAP machine (continuous positive airway pressure) for treatment first. CPAP increases air pressure in the throat, which keeps your upper airway passages open, preventing snoring and obstructive sleep apnea. However, this treatment option is only tolerated by all patients. Other treatment options include oral appliances, which hold the lower jaw forward, or different surgical treatments in the throat or on the jaws to create more space in the airway. There isn't current a treatment that's perfect for every patient.

> WE'RE WORKING ON MANY EXCITING NEUROSTIMULATION RESEARCH INITIATIVES AT ALL LEVELS OF DEVELOPMENT.

"As I got further into my own practice, I became interested in finding and developing treatment options for the patients without any good current options. That research ultimately led to the treatment options patented and licensed by CTTC."

Several companies are already working on surgically implanted neurostimulation devices for OSA that stimulate the main nerve to the tongue, the hypoglossal nerve, which gently pulls the tongue away from the back of the throat during sleep, relieving airway obstruction. However, stimulating just the tongue muscles doesn't work well for patients with certain patterns of throat collapse. Seeing a need for sleep apnea sufferers, Kent worked to develop several new technologies for the treatment of OSA. One promising neurostimulation technology works involves stimulating the ansa cervicalis, which controls muscles in the neck that help pull the airway down towards the chest. The thinking is that this stretches the airway soft tissue, making it less floppy and collapsible. The CTTC patents cover several other potential nerve targets to additional muscles.

Kent's initial anatomy and neurostimulation studies leading to the patents have been promising. Based on these data, Vanderbilt University entered into an exclusive licensing agreement with Belgium medical device company, Nyxoah S.A. in January 2021. Nyxoah is a health-technology company focused on the delivery of innovative solutions and services to treat OSA.

Kent's technology portfolio includes a variety of therapeutic approaches for opening the upper airway during sleep to combat OSA, primarily through neurostimulation of nerves that control muscles in the head and neck. Nyxoah's current product, Genio, is a system for bilaterally stimulating the hypoglossal nerve to maintain an open upper airway during sleep. The Vanderbilt portfolio could be employed in addition to hypoglossal stimulation, or as a stand-alone product.

"Partnering with Nyxoah creates the opportunity to build new technologies based on Vanderbilt's intellectual property. We share the same vision of developing disruptive solutions, always having in mind that patients should be put at the center. Our mission will be to demonstrate the unique potential of such new technologies resulting in a broader OSA treatment portfolio." - David Kent

A Year with

IDBiologics, Inc.

Several antibodies that may protect or treat infection with COVID-19 have been partnered with the company IDBiologics, Inc. and are in preclinical development. These antibodies were invented by James E. Crowe, Jr., Robert Carnahan and others in the Vanderbilt Vaccine Center as the team worked tirelessly during the early stages of the pandemic to discover new therapies.

Pre-COVID-19, Dr. Crowe's team had been funded by DARPA for several years specifically to develop the capacity to rapidly identify therapeutics for emerging infectious diseases. They rose to challenge and delivered on a number of therapeutic candidates when the SARS-CoV-2 virus was identified, and codified partnerships for development such as this one with IDBiologics, Inc.

Twist Bioscience

A collection of antibodies to SARS-CoV-2 identified by the Vanderbilt Vaccine Center were licensed to Twist for use in Twist's synthetic antibody library and other applications for COVID-19.

One of these antibodies, TB181-36 performed well in a hamster model of COVID-19 infection and Twist is exploring internal development or partnership opportunities for this antibody.

AstraZeneca

The timeline of development for AZD7442, a COVID-19 antibody drug candidate licensed by AstraZeneca from Vanderbilt University Medical Center.

April 2020 — Collaboration between Vanderbilt and AstraZeneca for antibody therapeutics for COVID-19 announced

June 2020 — License from Vanderbilt to AstraZeneca announced

July 2020 — Publication in Nature shows activity of therapeutic antibody candidates

August 2020 — Phase 1 study initiated

January 2021 — Multiple Phase III studies launch

August 2021 — First positive outcome of Phase III clinical trial announced

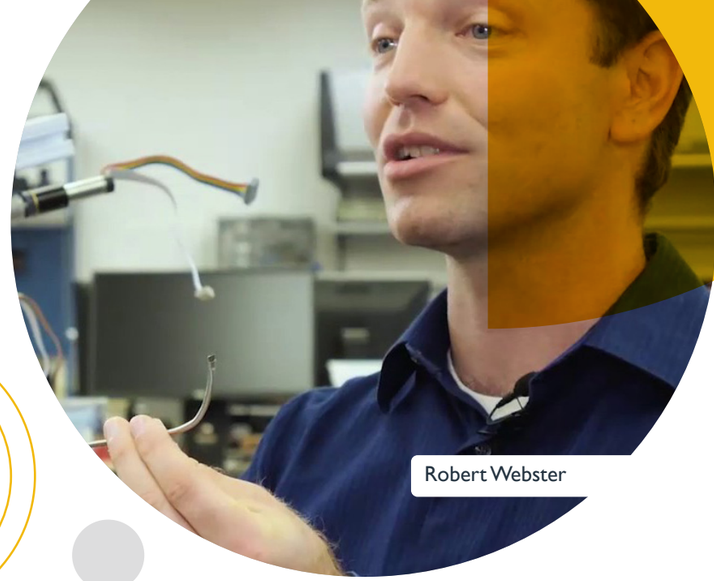
October 2021 — AstraZeneca seeks an EUA from the FDA for its long-acting antibody (LAAB) combination treatment

AZD7442, a combination of two long-acting antibodies (LAAB), reduced the risk of developing symptomatic COVID-19 by 77% (95% confidence interval (CI): 46, 90), compared to placebo.

START UP
Success

SCALE HOLDINGS

Scale Holdings is an early-stage company founded by Vanderbilt's recent Ph.D. graduate Liudmyla Prozorovska. The company aims to commercialize a technology developed as part of the founder's Ph.D. thesis under the guidance of her mentor, Kane Jennings of the Chemical and Biomolecular engineering department. The company aims to utilize a novel combination of processes to create polymer thin films with unique properties. These thin films have potential applications in a variety of markets spanning ion-absorption to sensors. The company is in active discussions with potential end-users to generate market interest and acceptance.


Robert Webster

YAYA SCIENTIFIC LLC


Justin Baba

YaYa Scientific is an early-stage company formed by Justin Baba (pictured left) of the Vanderbilt's Biomedical Engineering Department. It aims to commercialize a technology developed in collaboration with colleagues in the Biophotonics Center that addresses a significant need identified by Vanderbilt University Medical Center clinicians.

The unusual company name is the founder's homage to his influential mother in Nigeria. A frequent problem during many surgical procedures is inadvertent nerve damage in the surgical field. The company aims to develop a polarimetric diffuse reflectance spectroscopy-based system to visualize nerves during surgery. Designed as a stand-off system, no impact is anticipated in surgical work-flow.

ENDOTHEIA

Based on technology developed at the MEDLab laboratories led by Robert Webster (pictured above), this company was formed in a collaborative effort between engineers, roboticists, and clinicians from Vanderbilt University. Located in downtown Nashville, the company licensed the technology from Vanderbilt and is currently led by a team all of whom are either current Vanderbilt faculty or alumni of Vanderbilt. The company aims to improve standards of care in flexible endoscopy by creating highly dexterous manipulators which can be adjuncts to standard, widely-used, and commercially-available endoscopic tools.

CHEM BIOMED, LLC

A serial technology entrepreneur from California, Roshan Shetty, has recently founded Chem Biomed, LLC with the purpose of commercializing a technology from Vanderbilt's Biophotonics Center. This follows the successful development, regulatory approval and launch of the PTEye™ product by Shetty's previous startup, AIBiomed, based on technology invented by Vanderbilt University, which has since been acquired by Medtronic, Inc. (Read more about this on page 15.)

The present technology utilizes biophotonics to differentiate between various bacterial strains responsible for otitis media, the much-prevalent middle-ear infection afflicting pediatric patients. The technology can help obviate the growing problem of broad-spectrum antibiotic resistance by enabling the prescribing of specific antibiotics.

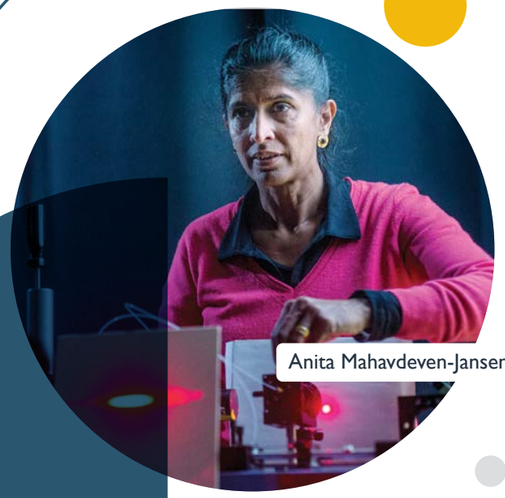
Technology Spotlight


Anna Douglas

Medtronic
PTEye™

In March of 2020, Medtronic acquired AIBiomed (a Vanderbilt startup and licensee) and since then has successfully launched the first product commercially, aptly named PTEye™ (pictured left). The PTeye™ system is an intra operative probe-based technology that aids surgeons in confirming suspected parathyroid tissue during thyroid and parathyroid surgery.

AIBiomed was spun off from ANASYS INSTRUMENTS, Inc. who in 2012 licensed a photonics technique for discerning between parathyroid and thyroid tissue developed in Anita Mahavdeven-Jansen's laboratory in the Vanderbilt Biophotonics Center. The company successfully developed a hand-held product design that was subsequently approved by the FDA as a Class II device in 2018.


Anita Mahavdeven-Jansen

SkyNano
R&D100 WINNER

For the fourth year in a row, a Vanderbilt technology took home the one of the prestigious R&D100 awards in 2020. The winning technology comes from the Vanderbilt startup SkyNano who won the award for their innovative process that overcomes the high cost and scalability limitations of traditional carbon nanotube manufacturing techniques while simultaneously repurposing harmful greenhouse gases into useful, functional nanomaterials.

Their technology, licensed from Vanderbilt University, generates high value carbon nanotubes while using only carbon dioxide, inexpensive materials, and electricity.

Traditional manufacturing techniques used to create advanced carbon additives require high vacuum and high pressure gas flow systems, which are both expensive and suffer from a lack of scalability - this accounts for the high price of advanced carbon structures. SkyNano, however, is developing a low cost manufacturing technique to create these carbon additives by using inexpensive materials, electricity and carbon dioxide as direct inputs. The technique is based on a process developed by Cary Pint's laboratory and makes use of high-value secondary material produced from greenhouse gases and relies on electrochemistry, rather than environmentally unfriendly catalysis. The result is a highly efficient process that converts atmospheric carbon dioxide into useful functional nanomaterials.

Currently, SkyNano is run by Anna Douglas (pictured above), Cary Pint, and Anna Klug.

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