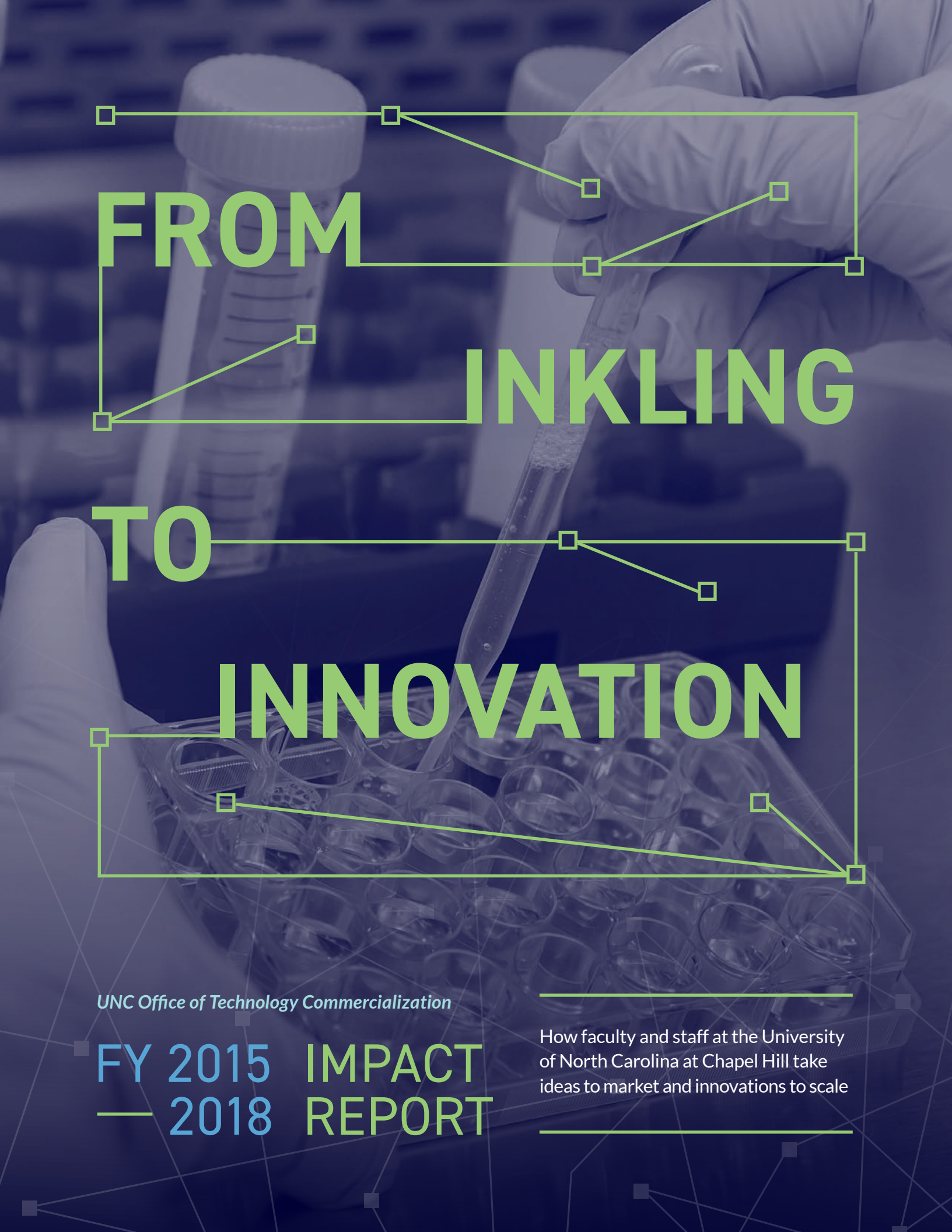


FROM INKLING TO INNOVATION

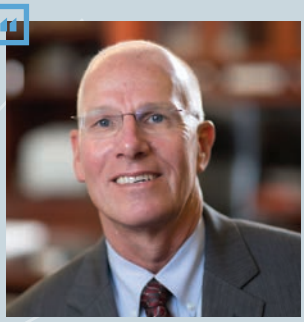
UNC Office of Technology Commercialization

FY 2015 — 2018 IMPACT REPORT

How faculty and staff at the University of North Carolina at Chapel Hill take ideas to market and innovations to scale

One of the reasons I came to Carolina as a faculty member in 1995 is because of our University's commitment to be the leading innovation and entrepreneurship center in higher education. Today, Carolina has created and nurtured a strong culture of innovation that is turning the knowledge of our faculty and students into practical solutions, taking valuable ideas to the inventive edge. Thanks to the dedication of Judith Cone and her team, we are working strategically, collaborating creatively and fully activating this culture of success. The ripple effect of this commitment is making a global impact: Talented researchers and those with entrepreneurial aspirations are moving more ideas, more rapidly and more effectively, into the world where this work has the greatest impact. We are far from done – Carolina is committed to innovation and entrepreneurship that boldly addresses our world's most pressing challenges.

KEVIN GUSKIEWICZ
INTERIM CHANCELLOR, UNC-CHAPEL HILL



One of the most important things that we can do for the people of North Carolina and the people of this country is to create that next big opportunity that is going to have a chance to change the world and make a difference in our lives.

BOB BLOUIN
EXECUTIVE VICE CHANCELLOR AND PROVOST, UNC-CHAPEL HILL

As a public institution and leading research university, Carolina has an obligation to seek the answer to this question: How do we ensure that the great talent of our faculty, staff and students is put to its highest use? For UNC-Chapel Hill, that means doing everything we can to support our people as they uncover solutions that make a real difference to the citizens of North Carolina and the world. As the university of the people, we are charged with focusing our energy on the ideas that will have the greatest economic, social and human impact in our state and beyond.

JUDITH CONE
VICE CHANCELLOR FOR INNOVATION, ENTREPRENEURSHIP AND ECONOMIC DEVELOPMENT, UNC-CHAPEL HILL

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Introduction

BIG BREAKTHROUGHS START SMALL

Brilliant ideas often bubble up in the corners of small laboratories. Many are concocted in the confines of tiny test tubes. Others are imagined in classrooms. And some are scribbled on the backs of napkins during dinner conversations. It seems that ideas can come from anywhere. Yet, in reality, they all come from the same place: the human mind.

Solutions that will move the world begin as inklings of ideas sparked inside the synapses of our brains. Think of it: the space between two brain cells is a fraction of the width of a sheet of paper. It's in this microscopic gap where neurons fire and world-changing concepts are born.

In the Office of Innovation, Entrepreneurship and Economic Development (IEED) at the University of North Carolina at Chapel Hill, we live by this idea: transformative discoveries, inventions and therapies often come from small beginnings.

Consider the economic impact of startups affiliated with the University. A single person or a small team of people begin building an organization based on an idea, passion or personal cause. They start small. So, how do these individual entities grow and add up to make a big difference to our economy, our citizens and the world at large?

When you look at only one subset of UNC-Chapel Hill ventures – those created on campus or within three years of a faculty member or student leaving the University – the economic boost delivered by Carolina's commercialization efforts is significant. In the single year of 2018, the 454 active startups affiliated with UNC-Chapel Hill were responsible for more than 8,900 jobs in North Carolina. In that same year, these companies generated annual revenues of $11 billion in the state. Beyond North Carolina, these ventures created a total of 71,986 jobs worldwide in the same year. In addition, the 575 total active and non-active ventures connected to UNC-Chapel Hill that the University has tracked since 1958 have raised a cumulative of $13.2 billion in funding. That funding is spent on jobs, rent, equipment, supplies and taxes.

While the effect on the economy is significant, the human impact is equal to or even more important than the economic. Carolina innovators and entrepreneurs pour their ideas, passion and perseverance into companies and nonprofits that feed the hungry, create clean energy solutions, and accelerate new treatments for devastating diseases like cancer, AIDS and cystic fibrosis.

And startup companies only tell part of the story. Consider the 3,109 inventions disclosed by UNC-Chapel Hill researchers over the University's history, the 580 technologies licensed to companies in the last 10 years alone, and the more than 50 research institutes and centers pushing forward with life-changing discoveries. The positive effect made by Carolina faculty, students and staff grows exponentially. These innovators are seeking treatments and cures that were recently thought to be impossible – and offering new hope to our neighbors, friends and families. The outcomes of their critical work, which was sparked by small early hunches or initial inklings that a better way is possible, extend far beyond Chapel Hill. From a small college town, throughout the state of North Carolina and across the globe, Carolina innovators are shaping bigger and better things for the world – one idea at a time.

History

UNC-CHAPEL HILL – THE ORIGINAL PUBLIC UNIVERSITY STARTUP

Today's economic, social and scientific returns are rooted in our history. As the first public university, UNC-Chapel Hill was, in its own way, a startup venture. The people of North Carolina were its earliest investors, and they've continued to support the University for more than 225 years. The goal of the University has always been clear: as the University of the people, it is meant to help lead the citizens of North Carolina into the future. To do so, it must fulfill a public obligation: to ensure that the immense talent of its faculty, staff and students is used wisely and focused on solving the most critical problems – tackling scientific, social and economic issues that have the greatest impact on the lives of North Carolinians and others around the world. Along the way, this mindset has imbued the University's people with a spirit of innovation that has made Carolina a place of firsts:

- **IN 1892,** when professor Francis Preston, undergraduates William Rand Kenan, Jr. and Thomas Clarke, and alumnus John Motley Morehead III collaborated to identify calcium carbide and its role in making acetylene gas, new possibilities were born. The discovery helped launch the modern petrochemical industry. Out of the University's lab, Union Carbide was founded and the global economy transformed.
- **IN 1936,** Carolina opened its School of Public Health, the first such school founded at a public university.
- **IN 1949,** the Morehead Planetarium opened its doors as the first planetarium in the world associated with a university. Generations of astronauts, including Neil Armstrong and John Glenn, have since used the planetarium for a training ground.
- **IN 1953,** UNC-Chapel Hill pathology researchers developed the partial thromboplastin time test, a procedure that detects blood-clotting disorders. This test is now used thousands of times each day in clinical diagnoses.
- **IN 1977,** Professor Fred Brooks' lab designed the first computer 3D interfaces, which set the standard for computer and game graphics.
- **IN 1992,** Professor Oliver Smithies' lab created the first animal model of cystic fibrosis, allowing researchers to test new therapies for the disease in a fast, thorough and safe manner. Smithies received the Nobel Prize in Physiology or Medicine in 2007 for his breakthrough research in gene targeting.
- **IN 1994,** David McConville, Michael Shoffner and Paul Jones initiated the first-ever online streaming radio at WXYC, the student-run Carolina radio station.
- **IN 2015,** Aziz Sancar, MD, a researcher in the School of Medicine, was honored with the Nobel Prize in Chemistry for his ground-breaking research on the natural mechanisms of DNA repair. The research marks the first time scientists have been able to map the repair of DNA damage over the entire human genome—information that may reveal how to deal with cancers, aging and other conditions.

As history shows, ideas abound in Chapel Hill. We celebrate the innovations of yesterday, but don't linger on them. Instead, we look to the discoveries of tomorrow. IEED works to ensure those discoveries make it into the market, where they can reach the most people and have the greatest human and economic impact possible. This office makes the most of its resources and serves citizens by putting more ideas into action faster. We want Carolina to be a place where innovators thrive, so that the economy and people of North Carolina can, too.

Our Office

TRANSFORMING TODAY'S IDEAS INTO TOMORROW'S INNOVATIONS

To accelerate the pipeline of important ideas that are generated via research and novel thinking across campus, former Chancellor Carol Folt created the Vice Chancellor's Office for IEED in February 2015. IEED takes a holistic, integrated approach to working on behalf of faculty, staff and student entrepreneurs to hone novel ideas, translate them into innovations and take them into society and the commercial market.

The IEED office is branded and known by the University community as **Innovate Carolina**. This brand has become synonymous with both the IEED office itself and the University's campus-wide, integrated network of people and programs involved in innovation and entrepreneurship. IEED is the central hub that unifies the collective network. IEED houses the **Office of Technology Commercialization (OTC)**.

OTC manages all aspects of UNC-Chapel Hill intellectual property. It is critical to the University because the large amount of sponsored and federally-funded research conducted at the University creates a major pipeline of ideas that have commercial potential. It's a pipeline that continues to grow. In fact, research at UNC-Chapel Hill has quadrupled over the past 15 years, which has established Carolina as one of America's top-ranked research universities.

In total, as of 2018 Carolina conducts $1.05 billion of sponsored research from all sources annually, making it the 11th largest US research university in research volume and annual expenses. Within that total, 71 percent of all research at UNC-Chapel Hill is federally sponsored. Carolina is ranked fifth in the United States among universities for federal research, which totals $676 million annually.

90 percent of UNC-Chapel Hill's federal funding comes from the National Institutes of Health (NIH), Agency for International Development (USAID), National Science Foundation (NSF) and the Department of Health and Human Services (DHHS). This funding breakdown is due to the University's outstanding schools of medicine, dentistry, pharmacy, nursing, public health and strong life sciences programs.

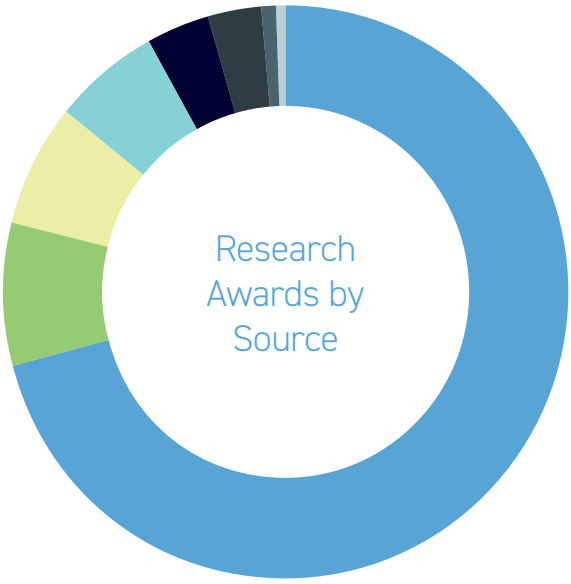
$1.1 billion
in sponsored research annually

11th
largest US research university in research volume and annual expenses

$676 million
in federal research annually

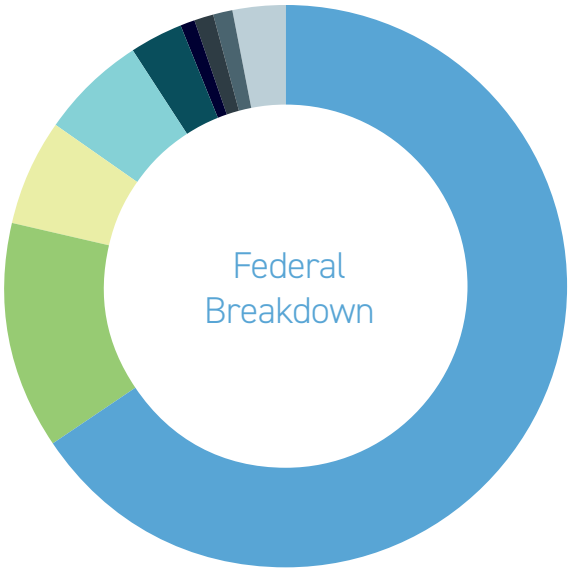
5th
ranked US university for federal research

Research Funding Sources (FY2018): All Funding Sources



- Federal Sponsors **(69.5%)**
- Foundations **(8.65%)**
- Educational Research Institutions **(7.48%)**
- Business & Industry **(6.43%)**
- Nonprofit Organizations **(3.44%)**
- NC State Government **(3.31%)**
- Associations **(0.52%)**
- Other **(0.67%)**

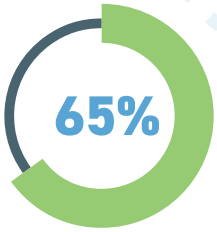
Research Funding Sources (FY2018): Federal Sources



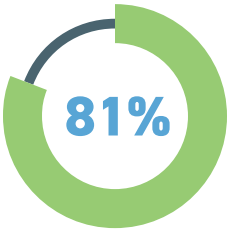
- National Institutes of Health (NIH) **(70%)**
- Agency for International Development (USAID) **(10%)**
- National Science Foundation (NSF) **(6%)**
- Department of Health and Human Services (DHHS) **(5%)**
- Department of Education (DOED) **(3%)**
- Department of Defense (DOD) **(1%)**
- Department of Energy (DOE) **(1%)**
- Environmental Protection Agency (EPA) **(1%)**
- All Others **(3%)**

RANKED 8TH

nationally in life sciences research expenditures
HERD Survey, 2017



of UNC-Chapel Hill research activity is focused on biosciences



of UNC-Chapel Hill IP-based startups work in life sciences

$799 million

in life sciences research expenditures
HERD Survey, 2017

OTC accelerates the University's research pipeline, puts ideas to practical use and returns revenue to the University. It also works to meet the University's mandate established under the Bayh-Dole Act. Under Bayh-Dole, the University has rights of ownership of any intellectual property that results from research funded by any federal government agency. By law, the University also has the responsibility to help get these inventions to market.

OTC partners with researchers through the entire translation process, which typically begins when a researcher reports an invention to the University. For example, a discovery from government-sponsored research may result in an academic paper, but may also include an idea with further commercial potential. The OTC team then meets with the inventor and evaluates the invention to determine if commercial potential exists. It also helps to decide if the intellectual property is best protected via patents, copyright, trademark or other means.

Once OTC decides to invest in protecting the intellectual property, the office works with outside legal counsel to initiate the necessary legal filings. On average, it costs tens of thousands of dollars to obtain an issued patent in the United States, and the costs are similar for foreign countries. Next, the OTC team collaborates with the inventor to develop a commercialization strategy based on the technology, the market landscape and the optimal path to market. For instance, the inventor may decide to license the IP to an established company or form a startup company based on the technology.

From a startup perspective, OTC assists UNC-born ventures with mentorship, leadership formation, and securing space and funding. Funding includes proof-of-concept dollars and support for product development, along with a connection to the Carolina Angel Network, Carolina Research Ventures Fund and external sources, including venture capital.

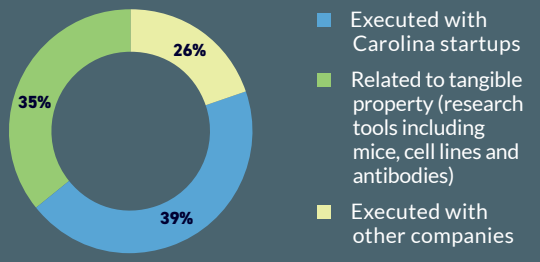
INNOVATION IMPACT DASHBOARD

From FY2015 to FY2018, OTC worked with UNC-Chapel Hill researchers on 679 invention disclosures, the submission of 375 US patent applications, the awarding of 231 issued US patents and the negotiation of 280 licenses.

Congruent with Carolina's research pipeline that is focused heavily on biomedical endeavors, the majority of its licenses are in the life sciences sector. In addition, a look at data from FY2018 provides a picture of how UNC-Chapel Hill's intellectual property was licensed:

- **35 PERCENT** of licenses were related to tangible property (research tools including mice, cell lines and antibodies)
- **39 PERCENT** of licenses were executed with Carolina startups
- **26 PERCENT** of licenses were executed with other companies

UNC-Chapel Hill Licenses, FY2018

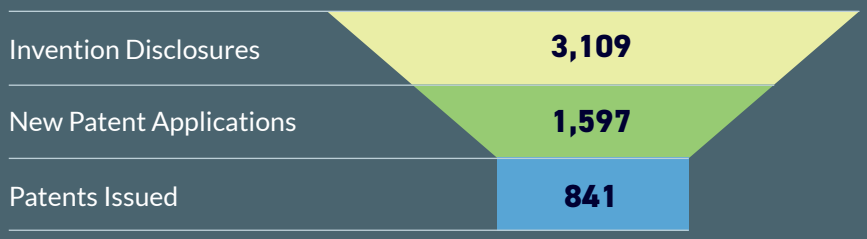


Through the work of its faculty founders and support from OTC, Carolina also launched 31 IP-based startup companies from FY2015 to FY2018.

CUMULATIVE

3,109	1,597	841	$69.4M	121
Invention Disclosures	New Patent Applications	Patents Issued	Licensing Revenue	IP-Based Startups Launched

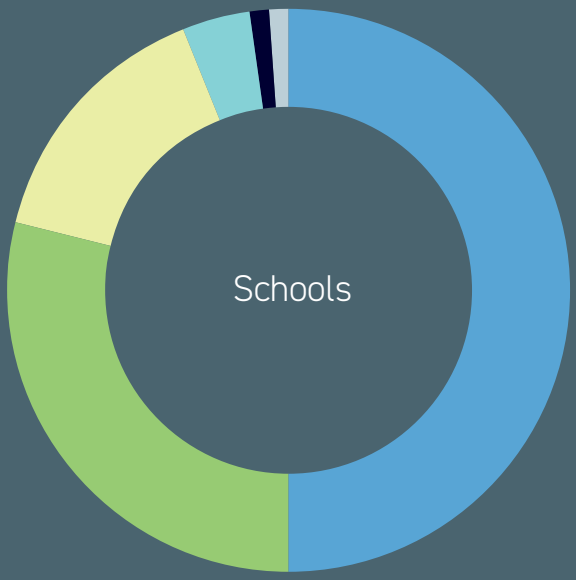
CAROLINA IP PIPELINE



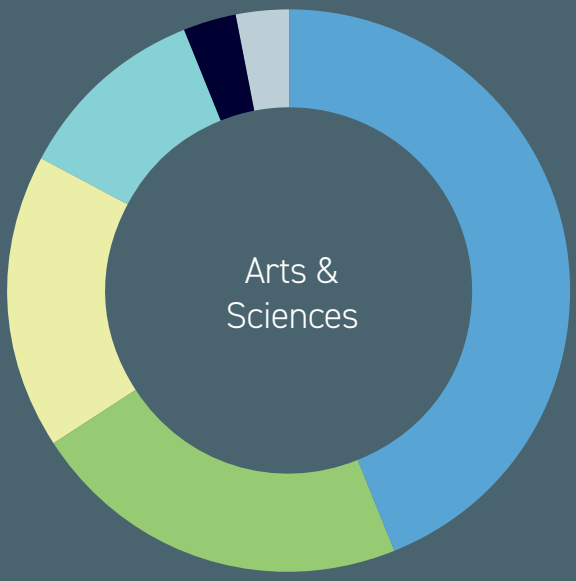
FY2018

183	109	70	$7.4M	5
Invention Disclosures	Patent Applications	Patents Issued	Licensing Revenue	IP-Based Startups Launched

IP-BASED STARTUPS BY SCHOOL AND DEPARTMENT



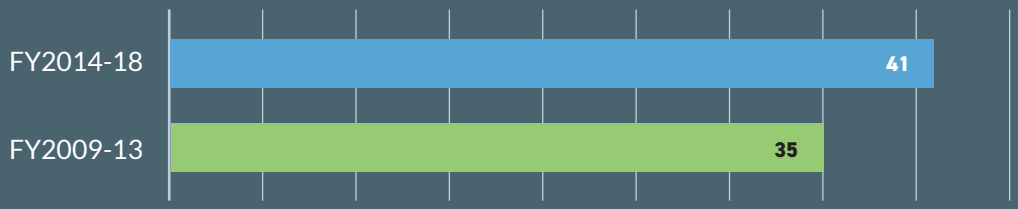
- School of Medicine **(50%)**
- College of Arts & Sciences **(29%)**
- Eshelman School of Pharmacy **(15%)**
- Gillings School of Global Public Health **(4%)**
- School of Dentistry **(1%)**
- School of Education **(1%)**



- Chemistry **(44%)**
- Computer Science **(22%)**
- Physics and Astronomy **(17%)**
- Biology **(11%)**
- Mathematics **(3%)**
- Marine Sciences **(3%)**

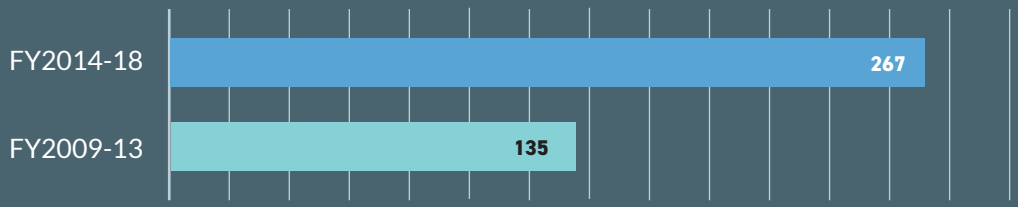
FIVE-YEAR COMPARISONS

IP-BASED STARTUPS



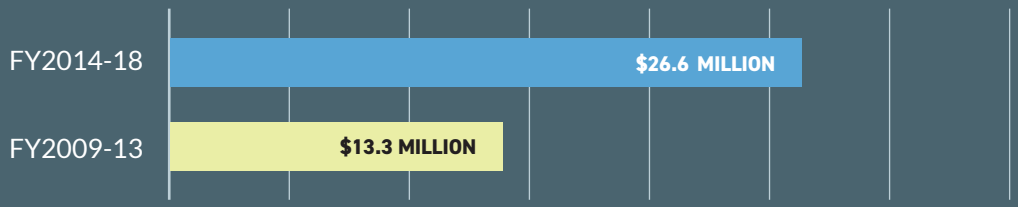
17% Increase

US PATENTS



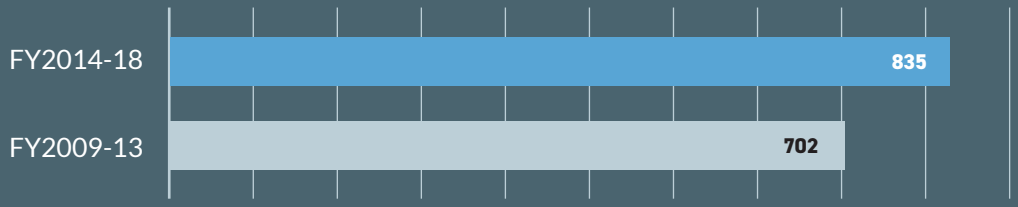
98% Increase

LICENSING REVENUE



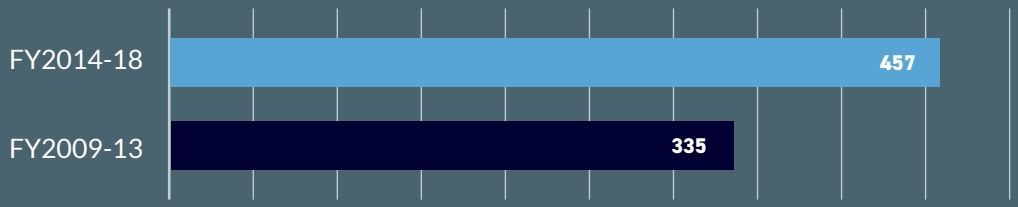
100% Increase

INVENTION DISCLOSURES



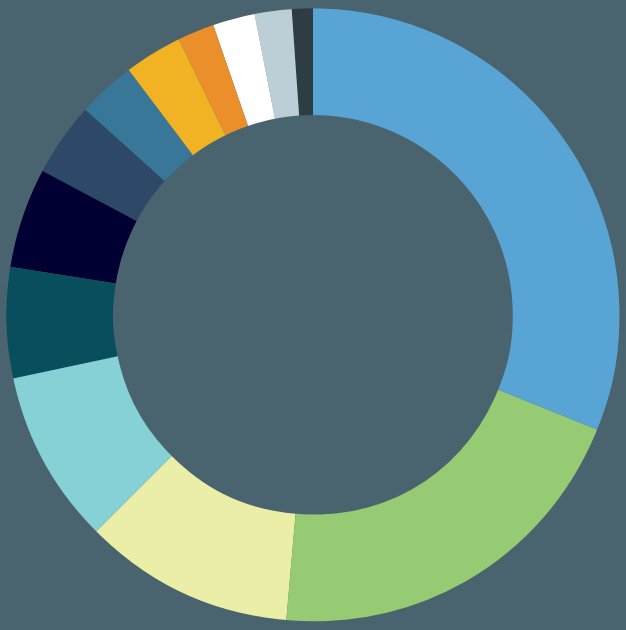
19% Increase

NEW PATENT APPLICATIONS



36% Increase

Inventions Reported by Technology Type, FY2018



- Therapeutics **(31%)**
- Research Tools/Methods **(20%)**
- IT/Software **(11%)**
- Biomarkers/Diagnostics **(9%)**
- Medical Devices **(6%)**
- Computer Science **(5%)**
- Health/Safety **(4%)**
- Drug Delivery **(3%)**
- Materials Science **(3%)**
- Industrial Process and Materials **(2%)**
- Imaging **(2%)**
- Energy **(2%)**
- Instrumentation **(2%)**

CAROLINA IP-BASED STARTUPS: STRENGTH IN NUMBERS

$2.9 billion

FUNDING RAISED

(since 1958)

$121.6 million

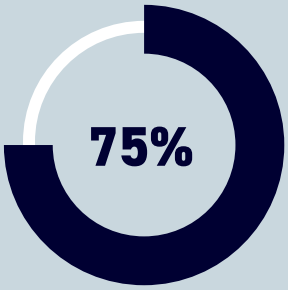
ANNUAL REVENUE

(Snapshot: 2017)

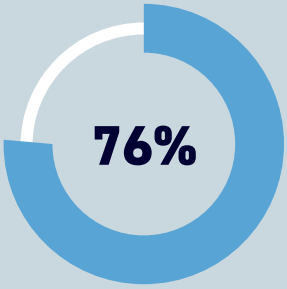
IP-Based Life Science Startups

- Therapeutics **(37%)**
- Research Tools/Methods **(15%)**
- IT/Software **(10%)**
- Biomarkers/Diagnostics **(8%)**
- Imaging **(7%)**
- Medical Devices **(5%)**
- Industrial Process/Materials **(4%)**
- Drug Delivery **(3%)**
- Education **(3%)**
- Energy **(3%)**
- Health/Safety **(3%)**
- Instrumentation **(2%)**

UNC-Chapel Hill IP-Based Startups: Jobs and Revenue

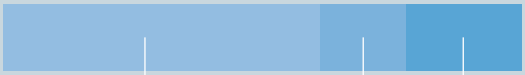


of active UNC-Chapel Hill IP-based startups are headquartered in North Carolina



of annual revenue earned by UNC-Chapel Hill IP-based startups comes from those headquartered in North Carolina

IP-BASED STARTUPS (Snapshot: As of June 2018)



78 HQ in NC

93 active

121 total

JOBS (Snapshot: As of June 2018)

599 employees in NC

841 employees total

INNOVATION BRIEFS

Innovators and entrepreneurs at UNC-Chapel Hill don't just think fast. They think forward. Explore a few of the many initiatives these leaders are putting into action on campus and beyond to bring the next big ideas to life. From programs and technologies that support startups to innovative physical spaces, partnerships and investment opportunities, inventive endeavors abound.

New Name for Commercialization Office

In June 2018, Carolina's commercialization office received a new name – the Office of Technology Commercialization (OTC). The office had previously been named the Office of Commercialization and Economic Development (OCED). This new, shorter name better reflects what the office does to support faculty, staff and students as they translate research and ideas into products and services. As part of the Vice Chancellor's Office for Innovation, Entrepreneurship and Economic Development, OTC manages all aspects of University intellectual property (IP) as it works to:

- Evaluate new discoveries and ideas.
- Assess and protect University IP.
- Perform patent and market landscape analysis.
- Market and license UNC-Chapel Hill technologies to industry and startup companies.
- Provide support for IP-related contracts, writing, filing and protecting patent applications, material transfer agreements (MTAs) and confidential disclosure agreements (CDAs).
- Ensure compliance with University and government regulations.
- Assist Carolina startup ventures with funding, mentorship, leadership formation and securing space.
- Administer proof-of-concept grants and startup investment funds.
- Structure partnerships that bring University research to market.

A Move Downtown

Since the creation of the new Vice Chancellor's Office for IEED in 2015, which consolidated tech transfer, startup consulting, startup research services and the core Innovate Carolina strategy group, team members were dispersed across different locations, both on campus and off. In 2017, the consolidated IEED team relocated to office spaces in downtown Chapel Hill. The move downtown brought all IEED teams together in close proximity for the first time, allowing for greater collaboration and efficiency across offices. It also placed team members close to the operations of the Carolina Angel Network, IEED's angel investment team for UNC-Chapel Hill startups.

Launch Chapel Hill is an international award-winning startup accelerator located in downtown Chapel Hill that was created through a partnership between UNC-Chapel Hill, the Town of Chapel Hill and Orange County. It supports entrepreneurs who are committed to building early-stage, high-potential businesses into a self-sustaining enterprises.

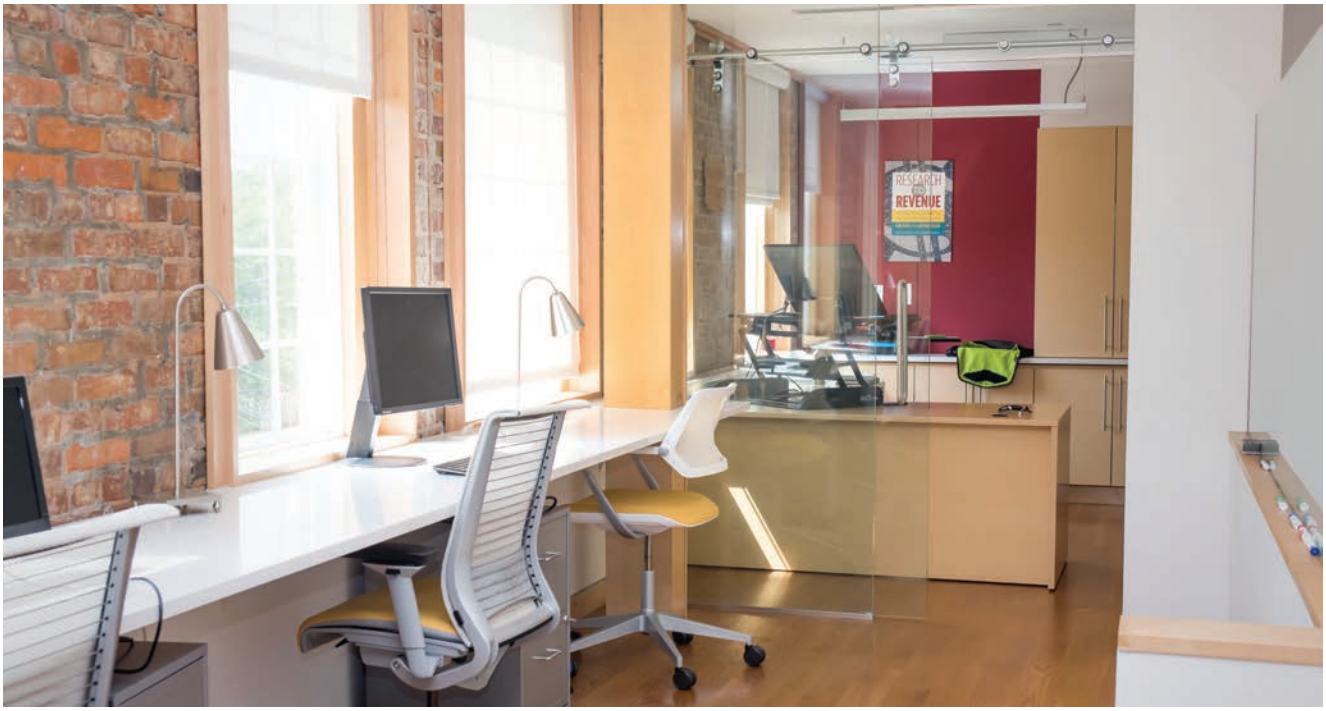
The University plans to open a new wet lab accelerator in 2019 to support UNC-Chapel Hill faculty who are launching life science startups.

Wet Lab Accelerator

In 2017, IEED worked with University leadership to begin exploring and planning for the creation of the first dedicated wet lab accelerator of its kind in Chapel Hill and Orange County. With 65 percent of the research activity at Carolina focused on biosciences and 81 percent of its IP-based startups operating in the life sciences sector, this new space is in high demand. Currently, when faculty and student startups outgrow faculty labs, they move off campus and away from Chapel Hill. A new wet lab accelerator would provide a facility where faculty and student researchers can grow their young life sciences startups. Such a space would offer a state-of-the-art lab equipped with benches, fume hoods, sinks, distilled water and gases. This would allow startup companies to conduct applied research in biology and chemistry. As a managed space, the accelerator would also provide a community atmosphere where companies could choose to collaborate with others. The goal is to accelerate research and development, position startups to receive major funding from government grants and private investors, and boost local and regional economic development.

Events: Innovation in Action

IEED holds regular in-person events for faculty and students to ensure innovation and commercialization are something the Carolina community can see, hear and experience firsthand. During the academic year, IEED hosts the Carolina Innovations Seminar, which is a monthly event series where 100 or more members of the Carolina innovation community convene to hear from a lineup of distinguished speakers who are experts in innovation, commercializing research and launching new ventures. Each year, the seminar series culminates with the Celebration of Inventorship. During this celebration, IEED presents the Inventor of the Year Award to a UNC-Chapel Hill innovator for their contributions to inventions and patents and their



In 2017, the Innovate Carolina venture hub became home to the KickStart Venture Services team, which provides coaching, funding and support to UNC faculty working to create early-stage, IP-based startups.

commitment to the University's culture of encouraging innovation, disseminating knowledge and promoting entrepreneurship. Each spring, the office also hosts an annual Innovation Showcase. During the 2018 showcase, approximately 400 people, including 150 investors, gathered to hear 50 of the most enterprising faculty, student and alumni ventures pitch their ideas and demo their products. Also in the spring, IEED hosts the Chancellor's Faculty Entrepreneurship Workshop, where faculty who have an inclination for innovation and commercialization gather for two-and-a-half days to learn the entrepreneurial skills that will help them develop and bring their ideas to life.

A Campaign for Innovation

In 2017, UNC-Chapel Hill launched a new university-wide fundraising campaign called "For All Kind: The Campaign for Carolina." It represents the most ambitious fundraising campaign by a university in the history of North Carolina, aiming to raise $4.25 billion by Dec. 31, 2022. Campaign goals include fostering an innovation generation that is prepared to lead the world to a better future through research and scholarship, example and ethos. IEED has several signature programs that are part of the campaign, including the creation of its new wet lab accelerator for life sciences startups. Other IEED campaign programs include an idea development fund designed to provide University investments and matching funds for external grants awarded to faculty and staff, along with a proof-of-concept program that helps innovators develop prototypes and test the market potential of their ideas. IEED is also planning Pathways to Impact™, a blended digital learning program that will teach faculty, students, staff and alumni how to navigate the processes, legalities and nuances of innovation and entrepreneurship.

A Kickstart for Startups

Most faculty have never taken an idea to market or started their own company. Kickstart Venture Services (KVS) is an IEED program that gives Carolina faculty the guidance and resources they need to get up and running, while building sustainable momentum.

KVS supports faculty startup formation, business development and growth by providing coaching and mentoring, early-stage funding, and a connection with key service providers, management, investors and space. KVS awards funding of up to $200,000 annually to help UNC-Chapel Hill startups founded on University IP meet early commercialization milestones. As of June 2018, KVS has provided consulting services and $2 million in awards to 67 UNC-affiliated companies. These companies have gone on to raise $30 million in federal SBIR/STTR grants and $402 million in total funding.

Cindy Reifsnider and Patrick Kastian are part of Innovate Carolina's Research Services team, which supports innovators through patent landscape, market, funding and competitive research and analysis. This team also includes Lia Walberg, a database analyst who works with Reifsnider to manage the Innovate Carolina Startups Database.

Pioneering a Leading Startups Database

Saying that university startups have a positive effect on the economy is easy. Measuring their precise impact is difficult. However, as universities increase their role in cultivating startup companies, UNC-Chapel Hill is taking the lead in using data to measure how its startups strengthen the economy in North Carolina and across the globe. In 2014, the University created the Innovate Carolina Startups Database to measure the impact of its social and commercial ventures. This comprehensive, longitudinal database goes beyond traditional approaches used in the wider academic community for measuring the results of university-born companies. While other institutions only track the activity of IP-based startups, the Innovate Carolina Startups Database compiles results over time for both IP and non-IP startups, which renders a more complete picture. In 2017, there were 454 active UNC-affiliated startups that earned approximately $11.2 billion in annual revenue. 79 percent of the total Carolina-affiliated ventures launched since 1958 are still active (454 of 575 ventures). And the data shows that the local economic impact to North Carolina is significant. For example, 83 percent of active UNC-affiliated ventures are headquartered in 24 North Carolina counties (376 of 454 ventures). And 94 percent of the $11.2 billion in annual revenue earned in 2017 by the ventures comes from those headquartered in North Carolina.

Identifying Market-Ready Ideas

A lot of ideas sound promising, but how does someone know if their concept is ready for the market? Innovate Carolina's Research Services team helps UNC innovators and inventors answer this question. The team provides the following services to inventors and entrepreneurs at the University: patent landscaping, market and funding research, startup consulting, technical assistance and training workshops. Through a grant secured from the US Economic Development Administration, Innovate Carolina also created the Technology Commercialization Carolina (TCC) program, which enabled members of its research services team to provide similar services and early-stage venture support and funding to inventors and entrepreneurs across North Carolina. These services have bolstered business development and economic growth in many areas of the state where such resources are not readily available. From FY2015-18, the research services team supported 191 UNC-specific patent, market landscape and funding research projects. TCC completed 81 similar non-UNC projects for individuals across the state. It also provided consulting services to 20 North Carolina startup engagements and conducted 19 training workshops.

Inventive Investment Programs

Startups based on faculty research need early-stage funding for proof-of-concept work. In 2016, UNC-Chapel Hill created the Carolina Research Ventures Fund with an initial pool of $10 million to help move research assets to market. The University and UNC Hospitals/ UNC Health Care each contributed $5 million to the fund, which offers critical early-stage investments in startups founded on University IP-based research. In 2016, UNC-Chapel Hill also created the Carolina Angel Network (CAN). CAN dues are $1,500 per member annually. The University formed CAN when it joined a coalition of neighboring universities in the Research Triangle Park region to launch the Triangle Venture Alliance. This alliance is a recent collaboration among UNC-Chapel Hill, Duke University, NC State University and NC Central University to build a network of alumni angel groups that invest in startup companies founded by alumni, parents, staff, faculty and students. A university-oriented angel network is not new, but it is unique to have four universities working together in such a way. In its first year, CAN built significant momentum. As of June 30, 2018, 153 member investors joined, contributing to combined member investments of $3 million in nine UNC-affiliated companies.

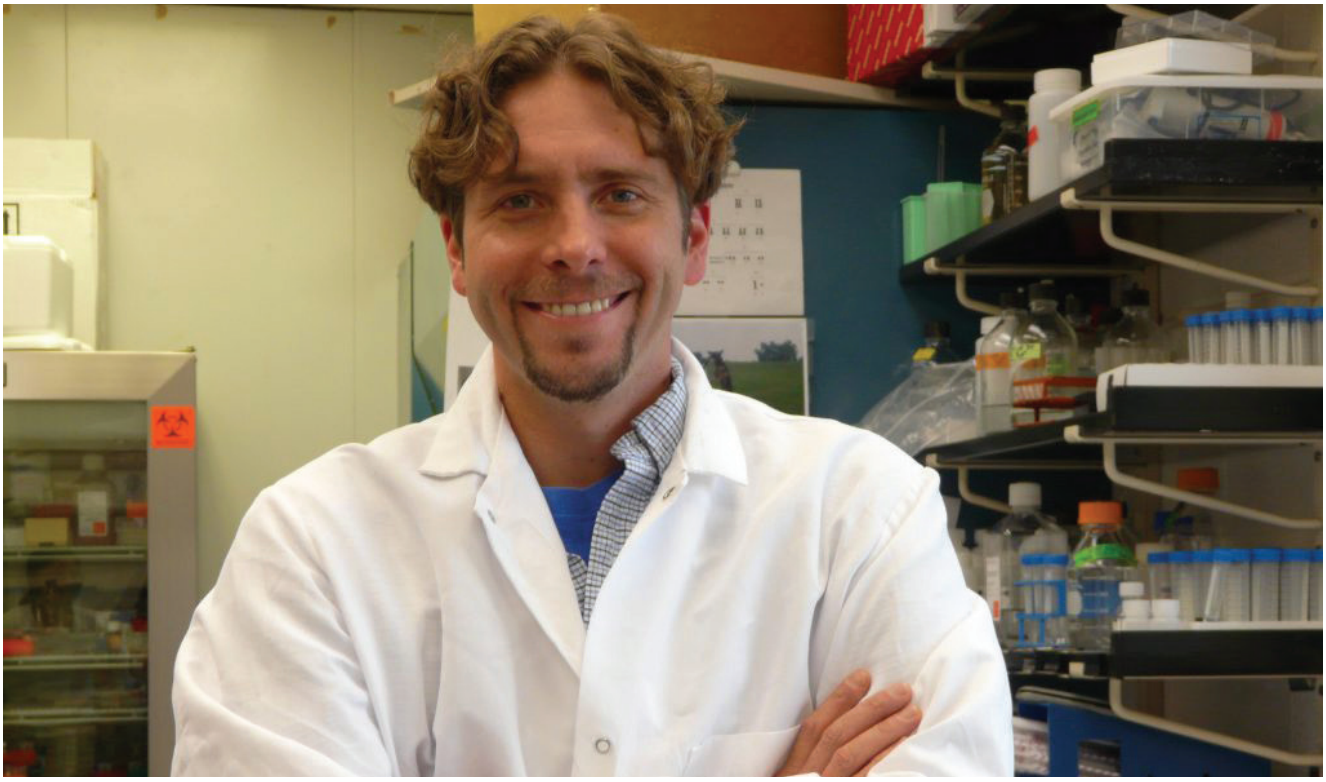
Building Strategic Partnerships

In order to expand its reach and explore new possibilities with industry partners, Carolina has formed a cross-university team dedicated to developing additional deep relationships with industry. The director of strategic partnerships from IEED is an active member of this group, which is working to build on prior novel collaborations with industry. Such collaborations include: The Lineberger Comprehensive Cancer Center partnering with IBM Watson to use cognitive computing capabilities to examine data sources and make more informed treatment decisions; the medical school partnering with pharmaceutical company GlaxoSmithKline to create the UNC HIV Cure Center and a jointly owned company focused on discovering and delivering a cure for HIV/AIDS; the chemistry department's partnership with Eastman Chemical Company on joint research.

UNC-Chapel Hill and GlaxoSmithKline announce the creation of the dedicated HIV Cure Center and the jointly owned Qura Therapeutics.

A LENS ON LICENSING

Technologies developed by UNC-Chapel Hill faculty have been making headlines. From gene therapy technologies to the emerging field of protein degradation, Carolina-born innovations are capturing the attention of investors and biotech companies that are helping to move these life-saving inventions from the lab into the market.



Matthew Hirsch in his lab that developed three AAV gene therapies to treat rare diseases, including one that progresses to blindness. The University licensed the technologies to Tamid Bio, a subsidiary of Fortress Biotech, in 2017.

UNC Licenses Three Gene Therapies to New York Biotech Company

December 6, 2017

The University of North Carolina, a powerhouse in gene therapy research, has signed exclusive licensing agreements with a New York City biotechnology company for three preclinical gene therapies that could treat an eye disease, certain muscular dystrophies and rejection of corneal transplants.

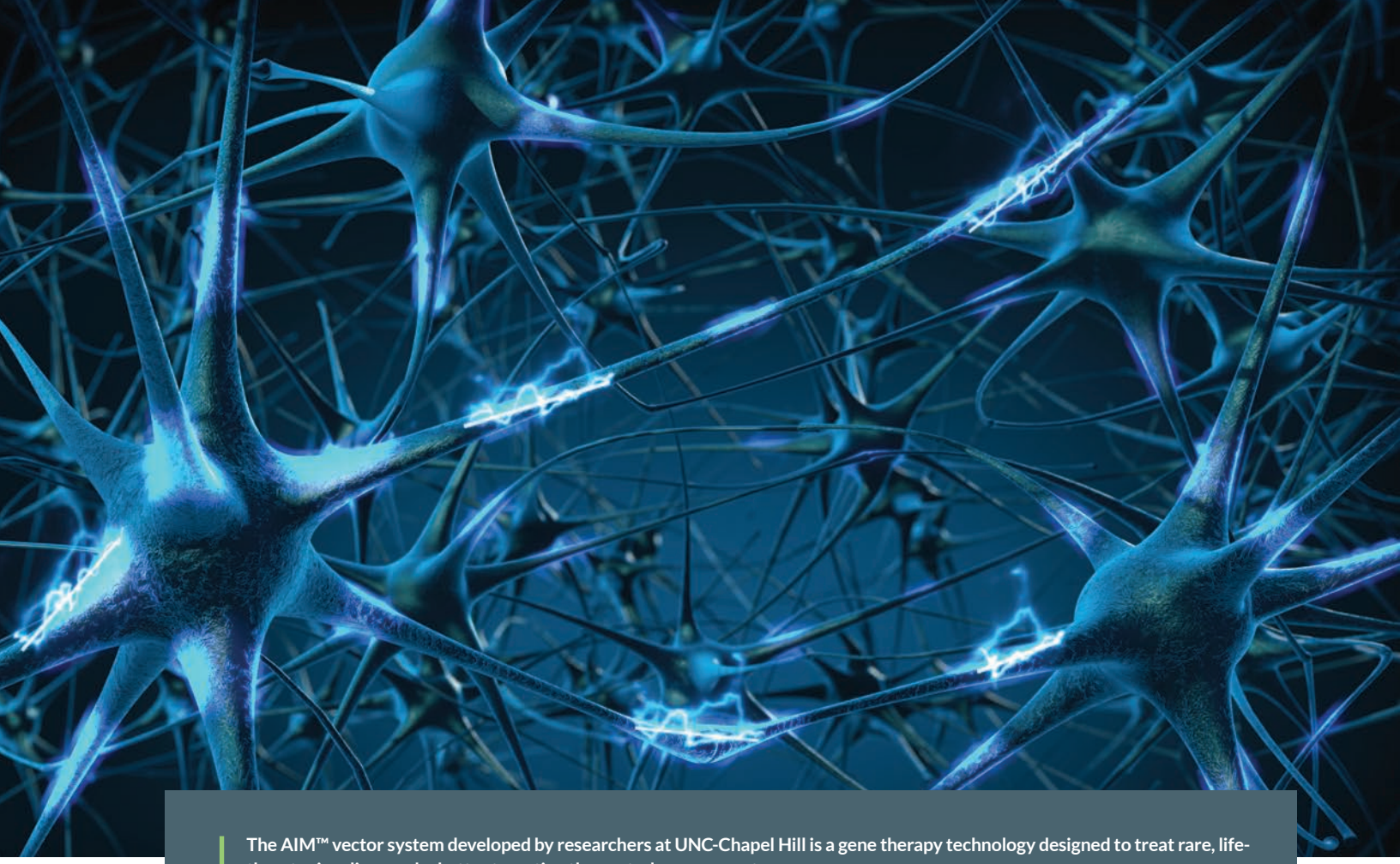
UNC signed the agreements with Tamid Bio, a newly formed subsidiary of Fortress Biotech, a publicly traded biopharmaceutical company that acquires, develops and commercializes novel pharmaceutical and biotechnology products. Tamid will focus on developing adeno-associated virus (AAV) gene therapies in rare diseases with unmet medical needs. Tamid acquired the rights to three AAV gene therapies developed in the lab of Matthew Hirsch, PhD, assistant professor of ophthalmology at the UNC Gene Therapy Center.

Article by NCBiotech
Full story at ncbiotech.org

Abeona Therapeutics Announces Licensing of the AIM™ Next-Generation AAV Gene Therapy Vector Platform From UNC

September 21, 2016

Abeona Therapeutics Inc., a clinical-stage biopharmaceutical company focused on developing therapies for life-threatening rare genetic diseases, announced the exclusive worldwide license of a next-generation gene therapy AAV capsid portfolio from the



The AIM™ vector system developed by researchers at UNC-Chapel Hill is a gene therapy technology designed to treat rare, life-threatening diseases by better targeting the central nervous system.

University of North Carolina at Chapel Hill. The AIM™ vector system is a novel AAV-based vector technology platform that may target central nervous system and other tissues with increased efficiency and tissue specificity. Importantly, the AIM vector system may provide second-generation treatment approaches for patients that have received a previous AAV injection.

Article by Yahoo! Finance
Full story at finance.yahoo.com

Durham Life Science Startup StrideBio Raises $15.7M in Oversubscribed VC Round

June 14, 2018

StrideBio, a life science startup focused on gene editing technology, has raised nearly $16 million from investors in what it described as an oversubscribed round of venture capital. And the firm landed some high-profile backers:

- Durham-based Hatteras Venture Partners, which led the round
- Takeda Ventures
- Alexandria Venture Investments
- UCB Ventures

StrideBio is focused on what it calls engineered viral vectors, or AAV, for gene therapy. The firm has already announced it has struck a deal with Crispr Therapeutics to develop in vivo gene delivery applications. As part of the deal, StrideBio will receive development funding, milestones and royalties on licensed vectors, and retain certain rights to use the novel AAV vectors for gene therapy applications.

Article by WRAL TechWire
Full story at wraltechwire.com

Bamboo Therapeutics Acquires UNC Manufacturing Site for Gene Therapies

January 14, 2016

Bamboo Therapeutics, Inc., a biotechnology company focused on developing gene therapies for rare central nervous system and neuromuscular diseases, including Friedrich's ataxia, announced that it has acquired the University of North Carolina at Chapel Hill's viral Vector Core gene therapy manufacturing facility.

Viral vectors are tools, tailored to specific applications, commonly used by molecular biologists to deliver genetic material into cells. An example is their use in the development of therapies to correct defective genes that cause certain diseases.

Founded in 1993 as a full-service viral vector production organization with experience in vector design and process development, UNC's Vector Core manufactures research- and clinical-grade vectors at its 11,000-square-foot facility. The vectors are for use by pharmaceutical and biotechnology companies, universities and foundations.

Article by Friedreich's Ataxia News
Full story at friedreichsataxianews.com

UNC Gene Therapy Spinout Bamboo Therapeutics Raises $49.5M Series A

February 11, 2016

North Carolina gene therapy startup Bamboo Therapeutics has raised a stunning $49.5 million, according to an SEC filing. The startup is focused on advancing the work of Dr. Richard Jude Samulski, director of the gene therapy center at the University of North Carolina, into the clinic to treat rare neurologic diseases like Duchenne's muscular dystrophy.

Bamboo says that Samulski was the first person to use adeno-associated viruses to replace defective genes with healthy ones; as a result, the company holds more than 20 patents in using AAV for therapeutic applications.

The startup is developing gene therapies for rare neurologic diseases, which include Giant axonal neuropathy (GAN), Canavan disease, Friedreich's ataxia as well as Duchenne muscular dystrophy.

Article by MedCityNews
Full story at medcitynews.com

In August 2016, Pfizer acquired startup company Bamboo Therapeutics in a deal worth $645 million. Bamboo, which developed treatments for rare neuromuscular and central nervous system diseases, was founded on the work of Richard Jude Samulski, professor of pharmacology and director of the UNC Gene Therapy Center. Spurred by the acquisition of Bamboo, Pfizer announced in 2017 plans to invest $100 million to expand its research and manufacturing facility in Sanford, NC.

Pfizer Acquires Bamboo Therapeutics to Beef Up Gene Therapy Arsenal

August 1, 2016

Pfizer Inc said it had acquired privately held gene therapy developer Bamboo Therapeutics Inc. in a deal worth up to $645 million to boost its presence in the treatment of rare diseases. Research into gene therapy, which aims to insert corrective genes into malfunctioning cells, goes back a quarter of a century but the field has experienced multiple setbacks and been plagued by safety concerns. However, the discovery of better ways to carry replacement genes into cells is building optimism.

Bamboo was formed in 2014 to advance the work of Dr. Richard Jude Samulski, who is considered a pioneer in the field after he became the first to realize the potential of using adeno-associated virus's (AAV) as a vehicle to replace a defective gene with a healthy gene.

Through the acquisition, Pfizer will gain access to Bamboo's experimental gene therapies for rare diseases such as Duchenne Muscular Dystrophy (DMD), giant axonal neuropathy (GAN), Friedreich ataxia (FA) and Canavan disease.

Article by Reuters
Full story at reuters.com

STARTUP STANDOUTS

At UNC-Chapel Hill, life sciences faculty and students work side-by-side in labs across campus. Every day brings new discoveries. And many days deliver breakthroughs with go-to-market potential: cancer diagnostics and treatments, stem cell research, gene therapy, advances in cystic fibrosis and neurodegenerative diseases, and unlocking the disease-fighting potential of RNA, just to name a few.

UNC-Chapel Hill professor Niels Lindquist and commercial fisherman David "Clammerhead" Cessna invented a novel biodegradable composite material to restore and protect oyster reefs and salt marshes – key components of environmentally friendly living shorelines that effectively prevent shoreline erosion and create a habitat for fish.

SANDBAR OYSTER COMPANY

Restoring oyster populations for the environment and coastal economy

Oysters have long been a favorite choice among seafood lovers. They're also a renewable natural resource. According to the North Carolina Coastal Federation, oysters help keep estuarine waters healthy and provide a habitat for important types of North Carolina seafood, including blue crabs and finfish valued at more than $62 million annually. Oyster reefs also provide exceptional protection against storm surge and shoreline erosion for coastal properties worth billions of dollars.

Despite once being the world's most valuable water crop, the state's oyster populations are in trouble. More than 100 years ago, the state was harvesting 1.8 million bushels of oysters a year, but only five percent of those same oyster populations remain today, according to Niels Lindquist, professor at the UNC Institute of Marine Sciences. In recent years, many groups have tried to restore valuable oyster populations using conventional materials and strategies, but with limited success.

Lindquist is meeting this challenge head on. He and Carteret County commercial fisherman David "Clammerhead" Cessna, co-invented a revolutionary biodegradable hardscape on which oysters grow and thrive and that can protect and promote the growth of salt marshes. UNC-Chapel Hill filed US and foreign patent applications for the invention, and Lindquist and Cessna formed Sandbar Oyster Company to bring the company's versatile Oyster Catcher™ and Marsh Maker™ technologies to the coastal restoration/protection tool box.

Oyster Catcher™ isn't just producing all-natural oysters for seafood lovers to enjoy. Together with Marsh Maker™, it's creating environmentally friendly living shorelines that provide effective natural protection against increasingly strong storms and sea-level rise that are serious challenges to future coastal habitability and seafood production.

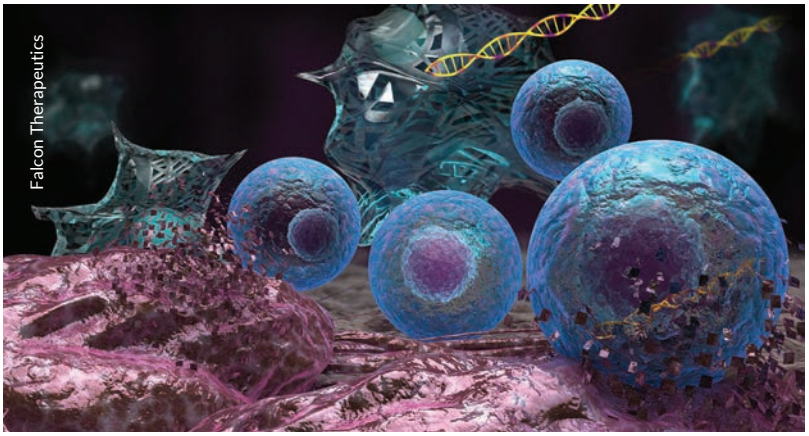
Importantly, the novel hardscape concept received the support of UNC-Chapel Hill in the form of a technology development grant from the Office of Technology Commercialization. The University also supported the launch of Sandbar Oyster Company through a commercialization award from KickStart Venture Services to advance its work. Additional startup support for the company included an award from NC IDEA. In 2017, Sandbar Oyster Company was a finalist in the Fish 2.0 Global Business Impact Challenge in Sustainable Fisheries.

As the company continues to thrive, both Lindquist and Cessna remain dedicated to rapidly bringing their impactful new tools for enhancing coastal resilience and economies to other regions of the US and around the globe.

FALCON THERAPEUTICS

Developing personalized stem cell therapies to treat cancer

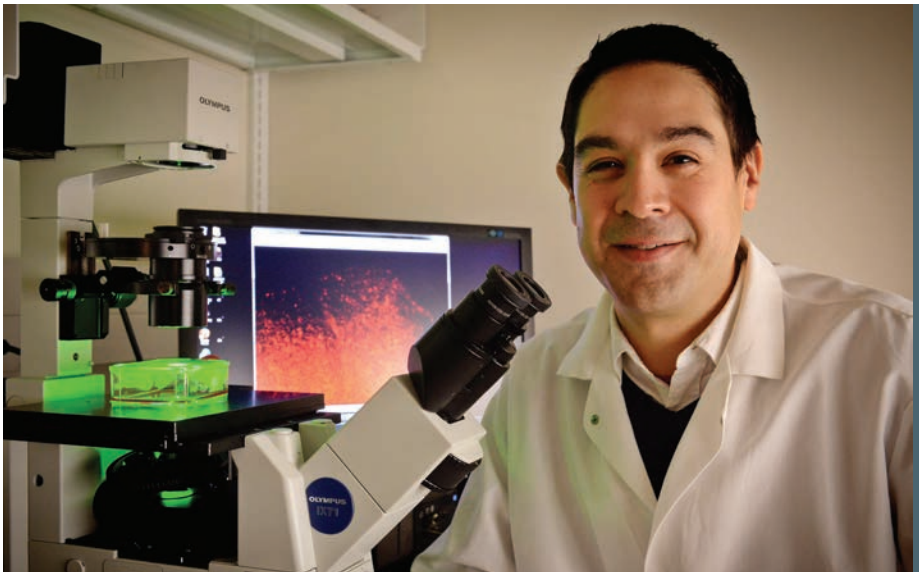
In a single year, more than 13,000 women in the United States will die of ovarian cancer, which ranks fifth in cancer-related deaths among females. But Falcon Therapeutics aims to change that. The company's entirely new approach to ovarian cancer therapy uses revolutionary stem cell technology to create personalized genetically engineered stem cell therapies from a cancer patient's own skin.



Falcon Therapeutics is developing a technology to engineer stem cells from a cancer patient's own skin that can target and eradicate the remnants of ovarian tumors.

Founded in 2015 by Shawn Hingtgen, an associate professor at the Eshelman School of Pharmacy, Falcon Therapeutics is a biotechnology company developing a technology to treat ovarian cancer with autologous stems cells that seek out and destroy cancer cells.

Most often, traditional therapies are unable to eradicate cancer cells, and tumor recurrence is nearly inevitable. In contrast to traditional regenerative medicine applications, engineered stem cells are emerging as a promising new therapeutic strategy for cancer therapy. Working toward a personalized tumor homing stem cell therapy for cancer, initial testing shows positive results, giving hope that this approach is feasible and can extend the life of patients living with ovarian and a wide variety of other cancers.



Shawn Hingtgen is an associate professor at the Eshelman School of Pharmacy and founder of the startup company Falcon Therapeutics. The company is advancing a new way to fight ovarian and other types of cancer.

IMPULSONIC

Developing immersive audio for games and virtual reality

With the number of active virtual reality (VR) users forecast to reach 171 million by 2019, the technology industry is moving at a rapid pace to keep stride with consumers' daily lives – everywhere from arts, entertainment and gaming to military, business and sports applications.

As gaming fans, Carolina doctoral students Anish Chandak and Lakulish Antani had an idea that if they could enhance audio within VR applications, a game could be so much more realistic and give consumers a more immersive experience. Furthering their idea to use existing UNC-Chapel Hill technologies for physically based sound simulation, they worked with computer science professors Ming Lin and Dinesh Manocha to create the startup Impulsonic.

As a 3D audio company, Impulsonic created true-to-life sounds in VR experiences and games. It achieved quick success – so much so that it was acquired by gaming giant Valve in 2017. The acquisition by Valve, a video game and digital distribution company, provided additional resources to further develop Impulsonic's 3D-sound simulation solutions into a more fine-tuned product.

The Phonon product developed by Impulsonic – now called Steam Audio – is a software that replicates the paths that sounds take before they reach our ears. This allows people to hear realistic sounds in an accurate way when playing games, such as this demo of a virtual hangar environment.

Founders Chandak and Antani now work for Valve, which is providing access to additional resources that allow them to focus on further developing the technology. Both are hopeful their UNC research will be adopted and continue to make an impact on the world of 3D sound.

171 million
active virtual reality users in 2019

$700,000
National Science Foundation grant secured by Impulsonic in 2015

With its headquarters in Research Triangle Park, G1 Therapeutics is a clinical-stage oncology company with a technology designed to protect the immune systems of cancer patients. G1 was the first UNC-affiliated company to receive a KickStart commercialization award, a University program designed to bridge the funding gap for promising early-stage faculty startups.

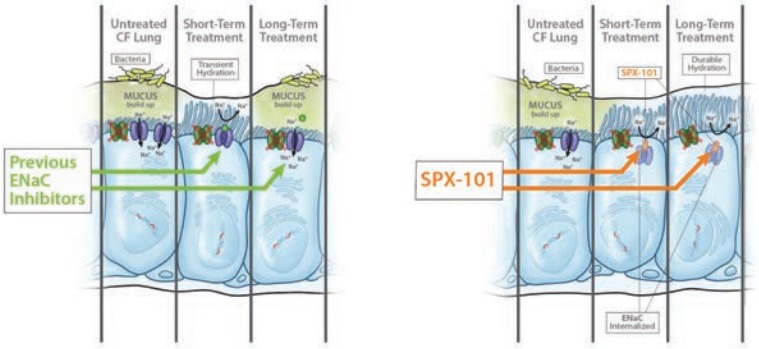
G1 THERAPEUTICS

Protecting patients from the toxic effects of cancer treatments

Dealing with a cancer diagnosis is an extremely difficult process for any individual or family. And the toxic effects of radiation and chemotherapy treatments make it all the more difficult. However, G1 Therapeutics, a clinical-stage oncology company, is developing novel therapeutics to help shield cancer patients from the devastating effects associated with these treatments. Headquartered in Research Triangle Park, and with ties to the UNC Lineberger Comprehensive Cancer Center, G1 is advancing a pipeline of potential best-in-class and first-in-class drug candidates in multiple oncology indications. Its drug candidates are designed to be administered in combination with many conventional and emerging cancer therapeutics.

In 2017, G1 successfully raised approximately $108.6 million in an initial public offering of its stock and began trading on the NASDAQ Global Market under the ticker symbol "GTHX." The company is developing novel therapeutics based on discoveries made by former UNC Lineberger Director Norman Sharpless, MD, and Kwok-Kin Wong, MD, PhD. The early research that led to the formation of G1 was supported by the University Cancer Research Fund.

Founded in 2008, G1 received early financial support via a KickStart Venture Services commercialization award. G1 used the awarded funding from KickStart to get off the ground and make early advances in its research and company formation. In addition, G1 also received support from the Carolina Research Ventures Fund. In 2017, Sharpless received a presidential appointment to become the director of the National Cancer Institute in Washington, DC. He was then named acting director of the US Food and Drug Administration.



Spyryx has developed SPX-101, a novel inhaled peptide designed to treat severe pulmonary diseases by increasing airway hydration, clearing mucus accumulation and improving lung performance.

SPYRYX BIOSCIENCES

Developing a clearer path for cystic fibrosis patients

According to the Cystic Fibrosis Foundation Patient Registry, more than 30,000 people in the United States and more than 70,000 worldwide are living with cystic fibrosis (CF). In addition, nearly 15.7 million Americans have been diagnosed with chronic obstructive pulmonary disease (COPD) according to the Centers for Disease Control and Prevention, and more than 250 million people have the disease worldwide (World Health Organization).

Both cystic fibrosis and COPD are characterized by dehydration of the lung lining fluid that leads to thickened mucus, a failure to clear inhaled bacteria and a decline in lung function. Although there is no cure for either CF or COPD, Spyryx Biosciences is hoping to translate laboratory findings into treatments for both diseases. The clinical-stage biopharmaceutical company was founded by UNC-Chapel Hill Associate Professor Robert Tarran. His research in the field of CF led to discoveries targeting a new way to rehydrate lung lining fluid.

Spyryx's core product and lead clinical candidate SPX101 is a novel peptide-based treatment for CF that has successfully completed Phase I and Phase IIa clinical studies in healthy volunteers and CF patients. The drug is designed to increase airway hydration and promote mucociliary clearance, which is dysfunctional in CF. The mechanism of action of SPX-101 is independent of the genetic mutations that cause CF, which makes it a potential therapy for all CF patients.

Robert Tarran, associate professor and scientific founder of Spyryx Biosciences

Tarran remains involved with Carolina's innovation community as associate professor of cell biology and physiology at the School of Medicine. He is also an investigator for the UNC CF/Pulmonary Research & Treatment Center and was director of the UNC Center for Tobacco Regulatory Science and Lung Health program.

BAMBOO THERAPEUTICS

Re-wiring genes to help patients suffering from devastating diseases

There are about 7,000 known rare diseases, but only five percent have an approved medication, according to biopharmaceutical company Pfizer. For many patients suffering from devastating diseases related to neuromuscular conditions and those affecting the central nervous system, gene therapy is a promising treatment option.

Gene therapy involves altering the genes inside your body's cells in an effort to treat or stop disease. Aimed at correcting or supplementing a gene that may be defective, gene therapy holds medical promise for rare diseases and addresses the root cause of diseases sparked by genetic mutation.

Based on the research of UNC-Chapel Hill professors Jude Samulski and Xiao Xiao, Bamboo Therapeutics made immediate strides in the gene therapy community. So much so that it was acquired by Pfizer in 2016. A spinout of Chapel Hill-based Asklepios Biopharmaceutical, Bamboo has experimental gene therapies for neuromuscular and central nervous system disorders. Bamboo co-founder, executive chairman and chief scientific officer, Samulski has also served as a professor of pharmacology and director of the UNC Gene Therapy Center.

There are about 7,000 known rare diseases, but only five percent have an approved medication.

Technologies developed by the company allow for further advances in targeting diseases such as giant axonal neuropathy – a rare genetic disorder that leads to numbness in the arms and legs, rapid back and forth movement of the eyes and impaired cognitive development; Canavan disease, a neurological disorder; and muscular disorders like Friedreich's Ataxia and Duchenne Muscular Dystrophy.

A Redbud Labs employee working on a technology that will allow a client to implement Redbud's microfluidic chip technology.

REDBUD LABS

Improving diagnostic products through microfluidics

Thanks to technology developed by professors in the physics and astronomy department, applied physical science department and at the UNC Center for Computer-Integrated Systems for Microscopy and Manipulation, startup company Redbud Labs is helping to improve diagnostic test performance. It's moving individualized diagnostics from the bench to the clinic to the bedside.

Redbud Labs — founded by UNC-Chapel Hill professor Rich Superfine, former professor Russell Taylor and alumnus Richard Spero '10 (PhD) — is a microfluidic chip (biochip) manufacturer whose patented technology allows mixing of extremely small volumes of fluids. Mimicking the conditions of complex biological systems, microfluidic devices have wide applicability in biomedical research, clinical diagnostics and drug development.

As a post-doctoral student at Carolina, Spero took advantage of an Innovation Fellowship, which allowed him to continue working on the technology after he graduated. Without the fellowship, Redbud may have never materialized.

Redbud's new microfluidic mixing technology, called MXR, enables scientists to perform point-of-care molecular diagnostics, analyzing thousands of genes simultaneously at speeds up to 10 times faster than traditional methods. In hospitals, for example, MXR can purify and concentrate pathogens from whole blood to reveal if patients have picked up a life-threatening infection during their stay.

MXR is the world's first microfluidic mixing module designed specifically for use with diagnostic products. One chip can house multiple chambers, which reduces the number of components and the cost of materials. It's the fastest, most adaptable biochip on the market.

Story by UNC Office of University Development

RIBOMETRIX

Pioneering technology to target RNA, unlock new disease therapies

Today, the majority of drugs and pharmaceuticals on the market that treat human disease are designed to target a specific protein. But UNC-affiliated startup Ribometrix has a very different, revolutionary approach to new drug discovery that's proving to be a breakthrough in the industry.

Ribometrix's novel approach has the potential to improve millions of lives by offering new treatments for a range of diseases, including cancer, neurological disorders, immunological diseases and rare diseases.

Until now, many didn't think the science behind this exciting technology would be applicable to drug discovery. But Ribometrix figured out how to drug RNA in a way that is systematic. One disease Ribometrix is pursuing is Huntington's Disease, whose sufferers have a tremendous, unmet need for therapies and treatment. According to the Huntington's Disease Society of America, the disease is a fatal genetic disorder that deteriorates a person's physical and mental abilities and has no cure.

The company was founded in 2015 by Kevin Weeks, a Kenan Distinguished Professor of chemistry at UNC-Chapel Hill, along with Katie Warner, his former undergraduate student, who earned her doctorate at Cambridge University and now serves as senior director of research for the company.

Ribometrix scientists Natalie McDonald (front) and Carolina Lin (back) work in the startup company's lab.

With the help of KickStart Venture Services and the Innovate Carolina network, Ribometrix was able to incorporate, recruit its first CEO, apply for NIH grants, find temporary lab space and create the business structure needed to continue to move forward with its work. And the company is growing at a steady pace. By early 2018, it had eight full-time employees and is looking to add more.

The company continues to attract investors as well. In 2017, it raised $7.5 million in seed capital to support the translation of its research on RNA-targeted small molecules, which allows the company to continue developing the platform and discovering new drug candidates.

30,000
symptomatic Americans with Huntington's Disease

$7.5 million
in seed capital raised in 2017

8
full-time employees in early 2018 and poised for growth

EmpowerRT

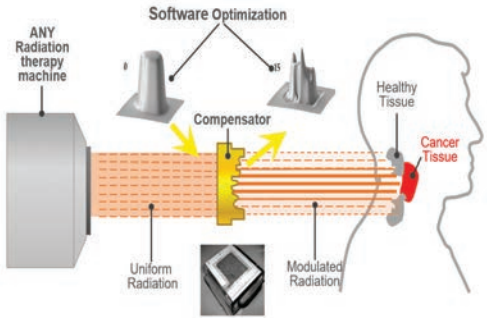
Providing personalized cancer care anywhere

Cases of cancer continue to steadily rise across the globe, particularly in developing countries. According to Harvard's School of Public Health, the percentage of new cases of cancer was similar for developed and developing regions 20 years ago. But today, 55 percent of new cancer cases arise in developing nations—a figure that could reach 60 percent by 2020 and 70 percent by 2050.

One early-stage company at UNC-Chapel Hill is looking to address this challenge with its unique technology solution. EmpowerRT is a new, social enterprise startup with a mission to help people in developing countries by improving cancer radiation therapy without spending millions of dollars on modern treatment technology.

In many developing countries, there is a lack of resources dedicated to cancer research and treatments. Many radiotherapy clinics still rely on basic or outdated equipment and lack the funds, training and supporting infrastructure to implement modern 3D and IMRT (intensity-modulated radiation therapy) technology, which is more effective in treating cancer with fewer side effects.

EmpowerRT offers clinically-proven and user-friendly software, patient-specific device fabrication knowledge, and hands-on training to enable resource-limited cancer clinics to reduce treatment toxicity similar to high-tech solutions, but at five-to-ten percent of the cost. The company's three-prong solution of software, existing hardware and training allows cancer clinics in low-and-middle-income countries to save up to $3 million in medical technology expenses.



EmpowerRT's solution optimizes the delivery of radiation to cancer tissue and spares normal tissue with a simple compensator device.

EmpowerRT's technology enables old machines to perform better. This is achieved with a simple device – a compensator – which is both recyclable and affordable. At the end of a treatment course, the compensator can be reused.

The company is now avidly working to register test sites around the world. Zambia Cancer Disease Hospital in Africa is its first test site, with other potential locations including Brazil, India, Honduras and Peru.

55%
of new cancer cases arise in developing nations

1,500
patients treated by EmpowerRT technology at UNC Hospitals

UP TO
$3 million
saved in medical technology expenses by individual cancer clinics in low-and-middle-income countries

BIVARUS

Building a smarter patient survey and a successful startup

If you notice improvements in the care you receive during your next visit to the doctor, a technology developed by a company co-founded by UNC-Chapel Hill professor Seth Glickman may be the reason why.

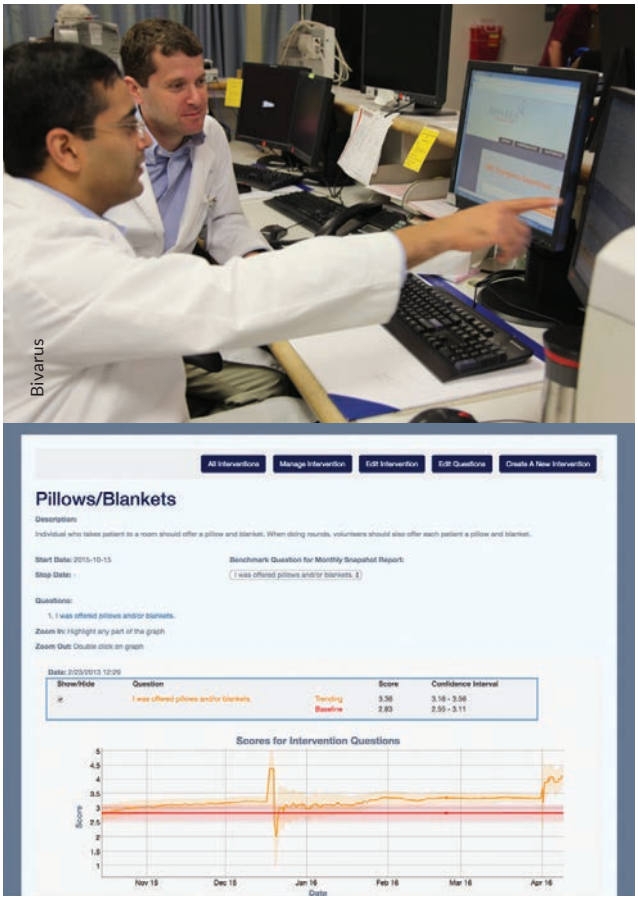
Bivarus, a company that developed a survey-based cloud analytics platform to gain insight into patient experiences, was acquired in 2018 by Press Ganey, a leading provider of patient experience measurement and performance analytics for health care organizations.

Bivarus was co-founded and launched in 2012 by Seth Glickman, president and executive medical director of the UNC Health Alliance and associate professor of emergency medicine at the School of Medicine.

As a clinician, Glickman experienced frustration with the inability to obtain precise, useable data around the patient experience, particularly around communication and safety. This sparked an idea – what if a survey could measure the patient experience in real time, providing statistically reliable data that health care practices could use to improve clinical performance? Glickman's idea grew, and startup company Bivarus was born.

Bivarus combines immediacy, convenience and data-driven insights. Within 24 hours of a visit, patients receive a digital survey that allows them to provide insight about their overall experience over email or text message. Based on an analytical algorithm, the surveys are targeted to the individual and ask significantly fewer – but more highly targeted and relevant – questions than traditional patient surveys. The short length of the surveys leads to better response rates, better data and a more scientific way to provide feedback to physicians.

Based on the strength of its technology and bolstered by funding and support from Innovate Carolina, Bivarus experienced early success. Enthusiasm from its clients at hospitals, physician practices and surgery centers allowed Bivarus to grow quickly. In 2016, it reported



The Bivarus patient experience and satisfaction platform developed by UNC-Chapel Hill professor Seth Glickman includes dashboards for visualizing trends in patient responses.

700 percent annual revenue growth. This positioned the company to receive an investment from the Carolina Angel Network. It also helped Bivarus raise a separate round of funding in 2017 from a group of venture capital firms led by Hatteras Venture Partners via its management of the Carolina Research Ventures Fund. By late 2017, its staff had grown to 50 employees prior to the Press Ganey acquisition.

Beyond providing for a better patient experience, the company's creation of new jobs in the North Carolina region has lasting long-term benefits that the founders and University can be proud of.

IP-BASED STARTUP ROSTER FY15-18

Each year, entrepreneurial-oriented faculty and students at Carolina decide to make the leap from campus to company. The startups listed below were launched by UNC-Chapel Hill innovators from fiscal year 2015 to 2018. Carolina focuses on offering a supportive environment that provides these companies with the access to funding, space, coaching, mentorship and education to help them succeed in their ultimate missions: bringing ideas to market that help people live healthier, more productive lives.

FY2015

Blue Current
Enzerna Bioscience
New Paradigm Therapeutics
Sonovol
Couragen Biopharmaceutics
Path BioAnalytics
Chimera Biotechnology
New Paradigm Biosciences
Nutrigene Sciences

FY2016

Capture Pharmaceuticals
Advanced Chemotherapy Technologies (ACT)
Mission3
Ribometrix
Initos Pharmaceuticals
StrideBio
Genturi
Dualogics

FY2017

Advanced Cochlear Diagnostics
Nanosonic Bioreagents
Premirr Plastics
Zeropoint Dynamics
Altis Biosystems
Sandbar Oyster Company
Mucommune
Falcon Therapeutics
Epiodyne

FY2018

Oncotrap
Mizar Imaging
EmpowerRT
Tamid Bio
Triangle Biotechnology

INVENTOR OF THE YEAR

The Inventor of the Year Award recognizes a UNC-Chapel Hill inventor for their contributions to University inventions and patents. It also honors his or her commitment to the University's culture of encouraging innovation, disseminating knowledge and promoting entrepreneurial initiatives. The Office of Technology Commercialization presents this award yearly, and recipients provide a short presentation during the final Carolina Innovations Seminar of the year. The presentations highlight the recipient's personal experiences in innovation and entrepreneurship.

2018 Inventor of the Year

MARK SCHOENFISCH MAKES "NO" THE OPTIMISTIC ANSWER

Mark Schoenfisch likes to quip that his favorite letters are "N" and "O." That might seem like a surprising preference for a chemistry professor who teaches his students to explore new scientific possibilities and whose own entrepreneurial spirit leads him to develop life-improving inventions.

Yet, when you hear Schoenfisch explain that his fondness for these two letters isn't based on the word that they form or a contrarian perspective on the world, but rather his passion for researching the molecule nitric oxide (NO), you make the connection. Through his research, he's discovered a number of potentially huge medical benefits associated with this tiny molecule and is inventing novel ways for using nitric oxide to make a positive difference in the lives of many.

On the basis of that research, Schoenfisch has founded three companies and been issued 13 US patents and 13 foreign patents, with 22 patent applications pending.

"I've spent decades of work on nitric oxide, and I continue to do so because it's rich with important chemistry problems to solve," said Schoenfisch, a professor of chemistry at UNC-Chapel Hill. "It extends into medical devices, pharmaceutics and drug development. I'm lucky to have picked an interesting molecule and area of study."

It wasn't luck, however, that resulted in Schoenfisch being honored by the Office of Technology Commercialization as the University's 2018 Inventor of the Year. Instead, it was his commitment to innovation and his success in translating his research on nitric oxide into devices and therapeutics for patients dealing with a range of diseases: diabetes, sepsis, cystic fibrosis, dermatological conditions and others.

During the award presentation at the annual Celebration of Inventorship, Executive Vice Chancellor and Provost Bob Blouin remarked on the importance that the University places on the work of Schoenfisch and other faculty inventors like him. "One of the most important things that we can do for the people of North Carolina and the people of this country is to create that next big opportunity that is going to have a chance to change the world and make a difference in our lives," said Blouin.

> **I've spent decades of work on nitric oxide, and I continue to do so because it's rich with important chemistry problems to solve.**
>
> **MARK SCHOENFISCH**
> PROFESSOR OF CHEMISTRY

That next big thing at Clinical Sensors, one of Schoenfisch's companies, is a nitric oxide-releasing glucose biosensor for people with diabetes. It can produce more accurate readings than the FDA-approved sensors already on the market, which still require patients to perform intermittent finger pricks.

Schoenfisch said nitric oxide has two critical physiological properties – the ability to reduce

inflammation and the ability to help new blood vessels develop – that make this possible.

The problem with intermittent blood samples is that they do not capture the highs and lows of glucose levels that lead to complications. And the issue with current monitoring systems is that once they are implanted under a patient's skin, the area becomes inflamed and scar tissue forms around the sensor. This makes it difficult to get an accurate measurement of glucose levels.

After experimenting with numerous approaches, Schoenfisch's lab developed a nitric-oxide-releasing membrane that could be applied to continuous glucose monitoring sensors.

Because nitric oxide is produced as part of the human immune response to pathogens, Schoenfisch and his research team investigated if a spike in nitric oxide in the bloodstream could tip off doctors that their patients are battling serious bacterial infections, such as sepsis. Similarly, they wanted to find out if clinicians could monitor a decrease in nitric oxide to determine if the antibiotic used to fight an infection was actually working.

With these goals in mind, Schoenfisch's research team began to coat microfluidic-based sensors that allow for the measurement of nitric oxide in very small volumes of blood. The result is a point-of-care device that Clinical Sensors plans to move to the marketplace. It would allow clinical staff to take real-time and direct measurements of nitric oxide.

During the annual Celebration of Inventorship, Mark Schoenfisch, professor of chemistry, presents an overview of his inventions and startup ventures that are centered around his research on nitric oxide.

This ability to detect and treat infections more rapidly holds the promise of saving lives.

"Clinicians want to have an idea if a patient is septic as soon as possible," Schoenfisch said. "Mortality increases 8 percent for every hour treatment is delayed. If the correct antibiotic isn't identified and treatment is not started, the ultimate outcome is death."

3
companies founded

13
issued US patents

13
issued foreign patents

22
pending patent applications

Inventor of the Year Award presentation (left to right): Judith Cone, vice chancellor for innovation, entrepreneurship and economic development; Jeffrey Johnson, A. Ronald Gallant Distinguished Professor and chair, Department of Chemistry; Mark Schoenfisch, professor of chemistry; Bob Blouin, executive vice chancellor and provost.

Schoenfisch has applied the multi-pronged benefits of nitric oxide to address other diseases as well.

Novan is a clinical-stage biotechnology company Schoenfisch founded in 2006 that uses nitric oxide to treat dermatological conditions such as acne. "With acne, nitric oxide has multiple mechanisms of action," Schoenfisch said. "In addition to killing the bacteria, you can reduce inflammation."

Vast Therapeutics is a development-stage pharmaceutical company that Schoenfisch founded that seeks to use inhalable treatments for patients suffering from cystic fibrosis and other severe respiratory diseases.

When Schoenfisch set out to explore the use of nitric oxide to combat respiratory infections in cystic fibrosis patients, he created biodegradable scaffolds made from chitosan, a substance that forms the outer layers of shellfish and mushrooms, to deliver nitric oxide into the lungs.

"The idea is that this could be nebulized into the lungs and be an alternative to antibiotics," said Schoenfisch. "It can actually eradicate all the main bacteria that are causing infections in CF patients."

The ultimate hope, Schoenfisch said, is to reduce the number of pills CF patients take every day and to extend their lives.

2017 Inventor of the Year

NANCY ALLBRITTON INSPIRES FUTURE ENTREPRENEURS TO DEFY SKEPTICS

If there's one invention Nancy Allbritton is hiding from the world, it might be a new kind of clock that gives her more than 24 hours to work each day, while the rest of the world struggles to keep pace. How else does she get it all done?

That's at least what other UNC-Chapel Hill researchers and campus leaders might have been thinking as they gathered to honor Allbritton for her productive portfolio of work, translating lab-born research ideas into a bevy of successful commercial ventures.

Allbritton, a Kenan Distinguished Professor and chair of the joint Department of Biomedical Engineering at UNC-Chapel Hill and NC State University, has co-founded four startup companies and holds 11 patents, with eight more pending. Those accomplishments, which grew from her diverse, multidisciplinary approach to research, earned her the prestigious 2017 Inventor of the Year Award from UNC-Chapel Hill.

While receiving the award during Carolina's annual Celebration of Inventorship event hosted by the Office of Technology Commercialization, Allbritton shared the lessons she's learned during decades of work creating university-based startups stemming from her research at UNC-Chapel Hill and the University of California at Irvine. Her research includes advancements in biomedical applications such as cell sorting, cell cloning, organ-on-a-chip platforms and cell signaling evaluation.

Nancy Allbritton is the Kenan Distinguished Professor and chair of the joint Department of Biomedical Engineering at UNC-Chapel Hill and NC State University.

Translating research into commercial enterprises all starts with an inquisitive mind for cutting-edge science and hard work, Allbritton told attendees. Keeping the right perspective throughout the entrepreneurial journey is also important. The keys for researchers, she notes, are to use failures as learning experiences, to keep pushing forward and to find opportunities to make smart changes.

Her ability to adapt is a lesson that's paid off. Cell Microsystems, a company she founded after several scientific twists and turns and which develops cell

> **Nancy is pulling in research expertise from a lot of different areas. That has been very fertile ground for scientific scholarship and has fed into phenomenal entrepreneurial activities.**

JEFFREY JOHNSON
A. RONALD GALLANT DISTINGUISHED PROFESSOR AND CHAIR, CHEMISTRY DEPARTMENT

separation and isolation tools, had revenue of $2.2 million from 2012 to 2016. "It's a win-win all around for the University and the company," Allbritton notes. "Approximately $1 million has flowed back to UNC in various types of funds."

Allbritton's ability to find diversity in perspectives, research and scholarship is vital, says Jeffrey Johnson, the A. Ronald Gallant Distinguished Professor and chair of the chemistry department. "Nancy is pulling in research expertise from a lot of different areas," Johnson says. "That has been very fertile ground for scientific scholarship and has fed into phenomenal entrepreneurial activities." Those fields of research include cell biology and physiology, chemistry, biomedical engineering, physics and material science.

The latest pursuit in her diverse set of research and commercial interests is launching a new UNC-based company called Altis Biosystems. This emerging venture has developed a patent-pending stem cell technology, recreating the human intestinal epithelium for compound screening and microbiome research. The goal is to make drug discovery faster, cheaper and safer, while reducing the need for animal testing.

The work at Altis is centered on the idea that bacteria in the gut help control our immune systems, metabolism, cardiovascular health and mental function. Those are issues Allbritton believes she and her team can help with – and they're taking the same advice she offers to researchers who are just getting started.

Professors and department chairs Nancy Allbritton (biomedical engineering) and Jeffrey Johnson (chemistry) show their respective awards: Inventor of the Year for Allbritton and patent plaque for Johnson.

"Keep going and keep innovating," says Allbritton. "Just because someone tells you you're crazy, don't believe them. They may be right, but go ahead, give it a shot and try it."

4 companies founded

11 patents issued

8 patents pending

INVENTIONS REPORT: FY2018

Filing an invention report is how faculty and students start the process of taking their ideas to market through a license, startup company or other path. Yet, the following list is less about process and more about productivity. It is an impressive roster of inventions that moved us toward technological advancements, better treatments, new cures and greater hope for tomorrow.

INVENTIONS REPORT: FY2018

Biomarkers/Diagnostics

Discovery of Recombinant Antigens for Differential Serological Detection of Remote Zika Infection

DNA-Based Predictors of Complex Cancer Phenotypes

Identification of Risk Gene and Therapeutic Indication for Periodontal Disease

Markers of Nodal Metastasis and Survival in Head and Neck Squamous Cell Carcinoma

Biomarker of Metformin Response in Endometrial Cancer

Genomic Patterns for Developing Personalized Prognostic or Diagnostic Markers

Prognostic Signatures of Checkpoint Function

A Decatenation G2 Checkpoint Prognostic Signature

Membranes for Nitric Oxide Measurements

Diagnostic Methods for Detection of Biomarkers From Urine

Serum Autoantibodies as Biomarkers of Eosinophilic Esophagitis

Multiplexed Digital PCR Assay to Detect High-Risk HPV DNA

Methods for Subtyping of Bladder Cancer

Molecular Signature of Metastatic Potential in P16-Positive Oropharyngeal Squamous Cell Carcinoma (OPSCC)

Allergen-Specific Immune Signature-Directed Approach to Dietary Elimination in Eosinophilic Esophagitis

A Method to Improve Multiplexed Immuno-PCR Assays

Biomarkers of Mab and ADC PK and PD

Computer Science

Video Rendering for Virtual Screens Using Compressed Textures

Improved Eye Tracking Using Multiple Light Sources, Multiple Cameras, and Deep Learning

Byzantine Fault Tolerance With Verifiable Secret Sharing at Constant Overhead

Autofocus AR Eyeglasses for Both Real and Virtual for All Age Groups

Features for High Frame Rate Multi-Camera Tracking

Beating Diffraction Limits In Light Engines

Projector With Foveation Capabilities

Hogel Free Holography

Eye Tracking Using Camera and Lenslet Array

Fast Eye Tracking With Rolling Shutter Cameras

Drug Delivery

Transdermal Drug Delivery System

Long Acting Drug Delivery System

Systems and Methods for Targeted Drug Delivery

Permealization of Endothelial Layers Using Nanodroplets

Oligonucleotide Delivery Enhancing Compounds

Nanofiber Nanodrug Delivery System for Immunotherapeutic Delivery to the Atherosclerotic Niche

Energy

Selective Salt Management for Wellbore Fluids Using Microgel Particles

Fast Blading Large Area Perovskite Solar Cells

Tandem Solar Cell Connection Unit

Increased Efficiency of OIHP Polycrystalline Solar Cells

Health/Safety

Novel Toilet Design and Disinfectant Formulations for Rapid Disinfection of Highly Infectious Human Wastes

Pediatric Eating Assessment Tool

Early Feeding Skills Assessment Tool

Spatial-Fractionation-Based Wearable Personal Radiation Protection Methods and Equipment

Advanced Disinfectant Formulations

A Novel Assay for Rapid Antibiotic Susceptibility Testing of Bacteria Using an Optical DVD Drive

Two-Dimensional X-Ray Scintillator Radiation Detection Systems and Methods for Radiation Therapy

Imaging

DSA Perfusion Analysis

Materials for High Resolution Radiation Detection

Multi-Channel MR-Compatible Flexible Microelectrode for Recording and Stimulation

A System for Reconstructing a Textured Surface From an Endoscopic Video and Registering It to CT

Industrial Process and Materials

Regioselective C–H Xanthylation as a Platform Technology for Polyolefin Functionalization

Nanocomposite Membranes for Water Purification Applications

Catalysts to Create New Analogs of Cyclosporin A

Information Technology/ Software

Systems and Methods for the Automated Assessment of Athletic Performance and Movement Quality

Web-Based Pain Coping Skills Training Program

Optimizing Source Placement for Noise Minimization Using Hybrid Acoustic Simulation

Graphene Library Operating System

Improving Precision of Antibody Targeting

360 Video Multi-Site Integration

Binary Expansion Testing

Video Gaming Software to Teach Cell Biology

ReferED Patient Management and Tracking Portal

Selective Data Encryption

UNC Classroom and Event Check-In App

Method and System for Transforming a Link or URL to Identify and Reward a Sender and Receiver

Approach to Efficiently Remove Electrical Stimulation Artifacts in Intracranial Electroencephalography (IEEG)

Symbolic Execution at Near-Native Speed

Camera Control Unit Communications Breakout Box

Safety Needs Assessment

Software Tool for Simple Analysis of Drug Screening/Discovery Data

Hospital AR App for Mobilizing Hospital Patients

Gear Up VR App for Student Engagement

UNC Afib Assistant

Instrumentation

Tensegrity Wheel Robot With Forced-Based Motion

Methods and Devices for Improved Sealing of Microwell Array Reactions on Plastic Microfluidic Devices

Materials Science

Polymers With Tissue-Like Mechanical Properties

Nanowire Morphological Diodes

High Performance Polymer Nanocomposites

Injectable and Moldable Tissue-Mimetic Elastomers

Method for Size-Selective Electrodeposition of Materials

Nanoporous Platinum, Silver, Gold, Palladium, Copper, Rhenium, Cerium, and Tin Nanoparticles

Medical Devices

A Method for Quantifying Recurrent Patterns of Local Wavefront Direction During Atrial Fibrillation

Catheter for the Treatment of Intestinal Obstruction

Osseous Distractor for Cranial Reconstruction

Targeting Brain Oscillations for the Treatment of Psychiatric Illnesses

Curette With Integrated Cleaning Mechanism

Mammographic Localization Paddle

Biologically Targeted Photo-Crosslinkable Nano-Patch to Prevent Postsurgical Peritoneal Adhesion

Catheter for Precise Administration of Cell Therapies

Particles Enhancing Sonothrombolysis

INVENTIONS REPORT: FY2018

Drug-Eluting String for Treatment of Esohpageal Disorders

Novel Long-Acting Injectable Combinatory Implants for Treatment of Osteoporosis

Research Tools/Methods

Laser Energized Multi-Sample Sonication System for Biological Sample Processing

Assay System for Identifying Read-Through Agents

Dnaic1 Conditional Knockout Mouse

FOXJ1-EGFP Mouse

BBN963 Cell Line

UPPL1541 Cell Line

Methods to Enable Phospholipids Cell-Permeable and Photoactivatable

Mouse Surgical Bed/Ligature Holder

Naturally Fluorescent Matrix Gla (MGP) Mouse

The Use of Kmer-Based Comparison to Design Synthetic Noncoding Rnas With Pre-Programmed Function

Anti-Cdc42 Monoclonal Antibody

Methods to Create Self-Sustaining Hypoxia For In Vitro Cell Culture

An Excipient for Biologics

Method to Extract Chromatin From Formalin Fixed, Paraffin Embedded (FFPE) Tissue

A "Molecular Ruler" For Quantifying Protein Numbers via In Vivo Imaging Techniques

Apoe-Flox Mice

Mgp-Loxp Mice

Anti-Llg1 Mab17-35 Monoclonal Antibody

Human High Affinity Ige Receptor (FCER1A) Mice

Selective and Non-Reducible Receptors for Asymmetric Dimethylarginine

A Non-Destructive Technology for Measuring the Length of Human Telomeres

TILT 360 Illuminator for Light Sheet Fluorescence Imaging

ORBIT: Doubling Light Gathering in Confocal Microscopes

Methods to Create Self-Sustaining Hypoxia for In Vitro Cell Culture

15-Hydroxyprostaglandin Dehydrogenase (PGDH) Deficient Mice

GRK1-S21A Mice

Tethered GPCR/Transducer Complexes for Scalable Drug Discovery and In Vitro Drug Screening

Ventral Hernia Simulation Model

Perfused Liver Simulation Model

Model of Efavirenz Pharmacokinetics Including Pharmacogenomics and Aging Markers

PK/PD Model of Lopinavir/ Ritonavir in Pregnancy

Humanized FCGR Mice

Arrays of Planar Intestinal Crypts Possessing a Stem/Proliferative Cell Compartment and Differentiated Cell Zone

Simulation Model for Laparoscopic and Robotic Foregut Surgery

TET2 H1803R Mice

Portable Strength Dynamometer

Method for Improved Sonication of Biological Samples

Therapeutics

Biological Basis of Adult Wellness and Aging

Targeting a Key Regulator of Mucus Production

AAV Gene Therapy for Alcoholism

Novel Therapeutic Approach for Graft-Versus-Host Disease

Key Target for Treatment of Acute Alcoholic Hepatitis

Two Novel Highly-Specific Zika Neutralizing Human Antibodies

Minimizing Accelerated Blood Clearance of Pegylated Therapeutics

A Bacterial Strain for Development of a Gonorrhea Vaccine and Strategy for Its Use

Peptides That Increase AAV Ability to Cross the BBB and Enhance Brain Transduction

Topical Formulation to Control Endodontic Infections

Peptides for the Treatment of Cardiovascular Diseases

Small Chemokine Agonist Peptides for Cardiovascular Disease

Inhibition of Antigen Presentation During Gene Therapy Using Peptides

Synthesis of Nitric Oxide Releasing Polymers

Methods and Compositions for Ocular Gene Transfer

Methods for the Treatment of Kaposi's Sarcoma or KSHV-Induced Lymphoma

Novel Approach for AAV-Mediated Gene Therapy in Hemophilia Patients With Inhibitors

Gene Therapy to Inhibit Th17 Cell Function

Novel Compounds for Protection Against Drug-Induced Liver Damage

Tyrosine Kinase Inhibitors

Novel Small Molecules for Cancer Therapy

Bacterial Strains and Proteins With Antibacterial Properties

A Circular Peptide That Blocks LPL Inhibition

Muco-Trapping Antibodies Delivered to Lung

Nitric Oxide-Releasing Materials

Polymers for Nitric Oxide Release

Compositions and Methods for Treating ALK-Mediated Cancer

Novel Molecules and Repurposed Drugs for RAS Family Gtpase

Method to Treat Angelman Syndrome

Small Molecules That Inhibit Host-Mediated Intracellular Bacteria Growth

Novel Chimeric Antigen Receptor

Small Molecule Potentiators of Dopamine

Chemokine Trapping for Cancer Therapy

Peptides for Treatment of Cardiovascular Disease

A Method of Inhibiting Human Cytomegalovirus Disease

Antibody Evading AAV Modifications

A Novel Chimeric Antigen Receptor Construct And Its Use in CAR-T Cells

Long-Acting HIV Drug Conjugates

Engineered Proteins for Higher AAV Vector Yield

Expression Cassette for AAV

Novel Use of Drugs for Orthodontic Retention and Enhanced Anchorage

Nanocarrier-Mediated Chemo-Immuno Therapy for Treatment of Desmoplastic Melanoma

Patch Grafts: Strategies for Transplantation of Cells Into Internal Organs

Repurposed Agent to Reduce Chemotherapy-Induced Heart Failure

Tyrosine Kinase Selective Analogues

Feedback-Enabled Viral Genome For The Purpose of Regulating Transgene Expression in Target Tissue

A Nanoceria-Based Ph Dependent Tumor-Directed Synergetic Treatment for Cancer

Determined Endodermal Stem Cells From Duodenal Brunner's Glands and Methods of Isolating Them

Multimeric Sperm-Binding Antibody Constructs

Small Molecule Inhibitors of Calcium Binding Proteins

HIV Immunogens Eliciting HIV-Neutralizing Antibodies

Novel Use of Agents as HIV Latency Reversing Agents

Treatment of Hunter Syndrome (MPS II) Using Raav Gene Therapy

Targeting Hepatic Stellate Cells to Treat Liver Fibrosis and Metastasis

Genetic Engineered Liver-Tropic Adeno-Associated Virus (AAV) Capsids and Their Use

Small-Molecule Degraders of an Anti-Cancer Therapy Target

Gene Therapy Cassette for Batten Disease

UNC

INNOVATION,
ENTREPRENEURSHIP AND
ECONOMIC DEVELOPMENT

Technology Commercialization