UNC | INNOVATE CAROLINA

FYs 2021–2022 IMPACT REPORT

INNOVATE CAROLINA: FORWARD FOCUS

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

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Introduction

DO WELL. FOR GOOD.

At the University of North Carolina at Chapel Hill, research discoveries, creative ideas and promising inventions abound. Yet without focus, infinite ideas in a world of finite resources can result in imbalance, missed opportunities and important problems left unsolved. How do we focus our talent, skills and resources on the areas where Carolina innovators can make the biggest impact? How can we innovate for the greatest good?

Our innovation capacity finds focus and results through Innovate Carolina, the University's central team for innovation, entrepreneurship and economic development. We are honored to work with the many faculty, students, staff, industry partners and community members who use their passion and ingenuity to transform research and ideas into human and economic impact. Our aim and approach are clear: provide people and organizations with a deep set of practical tools, talent and partnerships that transform Carolina's innovative potential into products, services and ventures.

Our impact report highlights the evolving focus of Innovate Carolina over fiscal years 2021 and 2022. During that time, Carolina innovators have adapted to confront pandemic-related realities and solve a host of other pressing problems that grow increasingly complex. In parallel, the University's research portfolio continues to expand. Carolina now conducts more than $1.2 billion in research from all sources annually, making it the 13th largest research university in the United States.

Similarly, our team has adapted to meet the rising tide of challenges and opportunities that require new ways of thinking and working together. From a structural perspective, the University appointed its first chief innovation officer who sets a campus-wide innovation strategy and works as the executive director of Innovate Carolina to activate that strategy via a team of experienced practitioners. It also launched the Carolina Economic Development Strategy, a partnership between the University and the Town of Chapel Hill to attract and retain more innovation-oriented businesses, organizations and talent. Innovate Carolina hired new directors of technology commercialization, economic development and KickStart Venture Services, our program for accelerating research-based startups. We've also expanded our suite of innovation support services: targeted programs for venture creation and technology development, deeper entrepreneurial training for faculty and students, strategic campus-community-corporate partnerships, and plans for community-based innovation hubs that will open in 2023.

In this report, you will find impact measured in many ways. Some we count: the number of inventions, patents, technology licenses, startups and jobs. Others we monetize: licensing dollars, startup funding, and annual revenue. Yet the greatest impact happens through the results that we can't quantify on a graph or chart. The children who could not walk or see until a gene therapy made it possible. The daily struggle of mentally ill patients eased by breakthrough psychiatric treatments. Those with devastating diseases whose lives have been transformed — or saved — by new drugs or medical devices. And people in our local and global communities who now see brighter futures due to technologies and services that address social injustices and environmental hazards.

As we reflect on the progress made, we focus forward. Through a purposeful innovation strategy and practice, Carolina's innovative potential will meet intractable problems with the inventive, real-world answers that tomorrow demands.

– **Michelle Bolas**
Chief Innovation Officer, UNC-Chapel Hill
Executive Director, Innovate Carolina

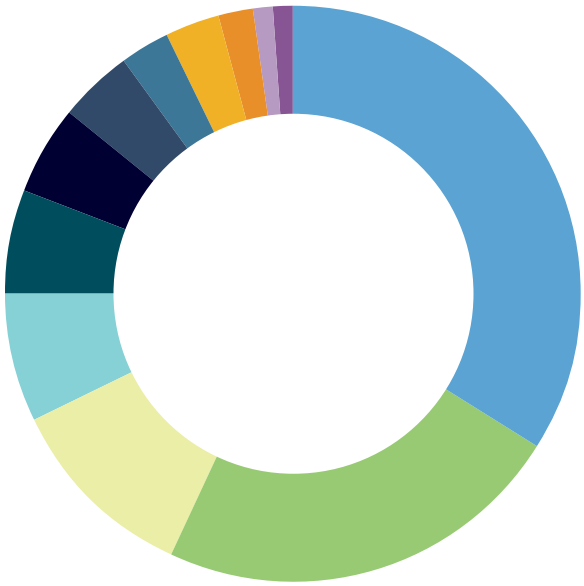
IN REVIEW: FYs 2021–2022

Facts, figures and trends on the impact UNC-Chapel Hill makes through commercialization, venture creation and innovation in practice.

TECHNOLOGY COMMERCIALIZATION

In fiscal year 2022, Innovate Carolina's Office of Technology Commercialization worked with UNC-Chapel Hill researchers on 140 invention disclosures, the submission of 80 new patent applications, the awarding of 58 issued U.S. patents, and 70 technology licenses.

Inventions Reported by Technology Type, FY2022



- Therapeutics **(34%)**
- Research Tools/Methods **(23%)**
- Biomarkers/Diagnostics **(11%)**
- Drug Delivery **(7%)**
- Health/Safety **(6%)**
- Medical Devices **(5%)**
- Industrial Process and Materials **(4%)**
- IT/Software **(3%)**
- Material Science **(3%)**
- Energy **(2%)**
- Education **(1%)**
- Imaging **(1%)**

UNC-Chapel Hill Licenses, FY2022

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 FY2022 provides a picture of how UNC-Chapel Hill's intellectual property was licensed:

- **36 PERCENT** of licenses were related to tangible property (research tools, including mice, cell lines and antibodies).
- **11 PERCENT** of licenses were executed with Carolina startups.
- **53 PERCENT** of licenses were executed with established companies.

FY 2021	FY 2022	Cumulative
149 Invention Disclosures	140 Invention Disclosures	3,745 Invention Disclosures
186 Total U.S. Patent Applications	195 Total U.S. Patent Applications	1,938 Total U.S. Patent Applications
58 U.S. Patents Issued	58 U.S. Patents Issued	1,061 U.S. Patents Issued
64 Licenses	70 Licenses	1,617 Licenses
$29.5M Licensing Revenue	$11.8M Licensing Revenue	$123.3M Licensing Revenue

Five-Year Trends

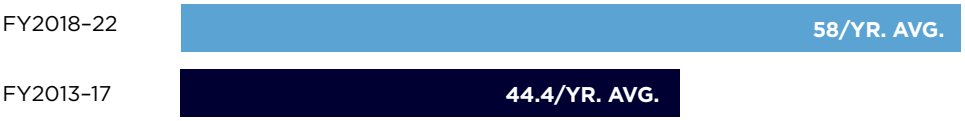
INVENTION DISCLOSURES

4%
Increase

TOTAL U.S. PATENT APPLICATIONS

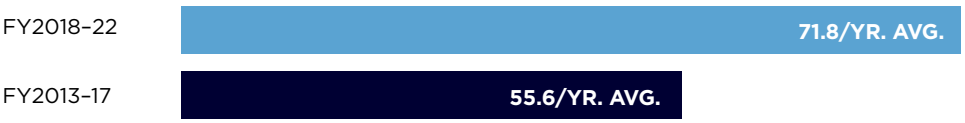
15%
Increase

U.S. PATENTS ISSUED



31%
Increase

TECHNOLOGIES LICENSED



29%
Increase

LICENSING REVENUE

168%
Increase

STARTUPS

UNC Startups – Total

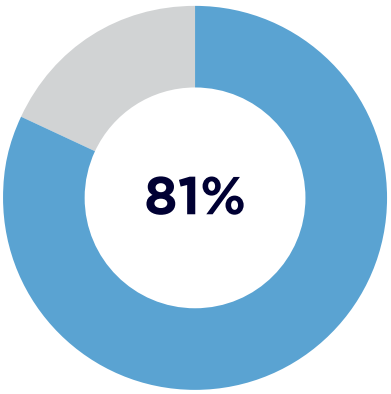
Carolina faculty, students and alumni launch a wide variety of startups. These include commercial businesses, research-based startups founded on University intellectual property, and social ventures and nonprofits.

863
UNC Startups Founded
(since 1958)

$18.3B
Annual Revenue
(2022 snapshot)

$19.1B
Total Funding Raised
(since 1958)

Startup Companies and Jobs



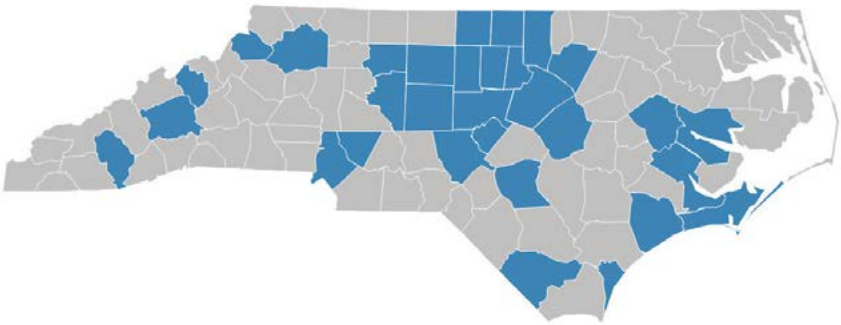
of active UNC-Chapel Hill startups are headquartered in North Carolina.

TOTAL STARTUPS (Snapshot: As of July 2022)

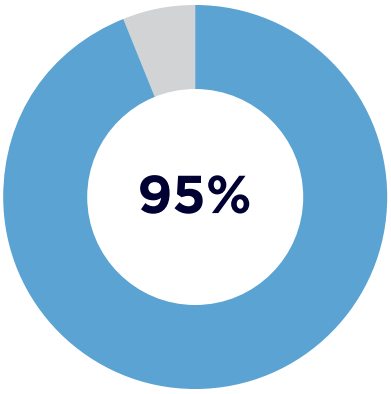
450 HQ in NC | **554** Active | **863** Total

JOBS (Snapshot: As of July 2022)

13,480 Jobs in NC | **102,429** Jobs Total



There are 450 UNC-affiliated startups headquartered in 31 North Carolina counties.



of revenue earned by UNC startups comes from those headquartered in NC.

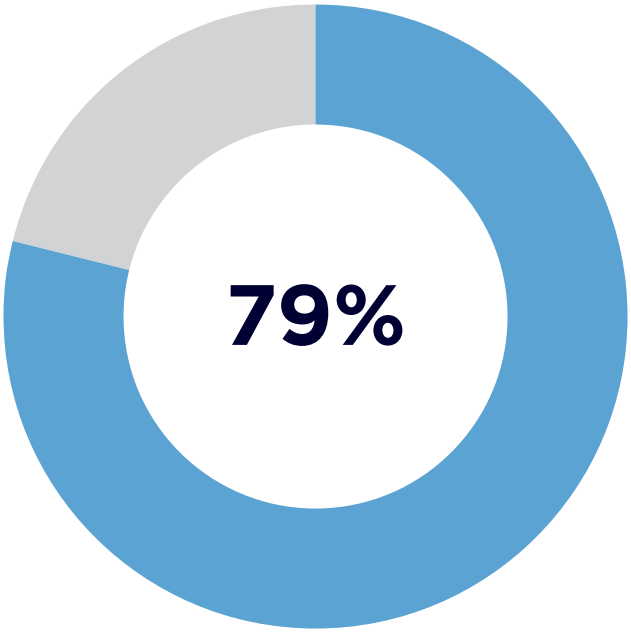
UNC Startups – IP-Based

153
UNC IP-Based Startups Founded
(since 1958)

$281M
Annual Revenue
(2022 snapshot)

$7.8B
Total Funding Raised
(since 1958)

IP-Based Startup Companies and Jobs



of total UNC-Chapel Hill IP-based startups work in the life sciences sector.*

*For further detail, see innovate.unc.edu/impact

IP-BASED STARTUPS (Snapshot: As of July 2022)

JOBS (Snapshot: As of July 2022)

VENTURE FUNDING FOCUS

During fiscal years 2021 and 2022, UNC-affiliated startups found significant funding traction, raising capital from a variety of sources. These funding events signify the strength of UNC-born technologies and assisted companies — and propel new treatments, products and services toward the market.

Funding Raised: Top UNC Startups, FYs 2021 and 2022

Advanced Chemotherapy Technologies, Inc.
Funding Raised: $9.9 million
Focus: Potential treatment for borderline resectable and non-resectable pancreatic cancer
Funding Type: Federal SBIR/STTR grant, Series A

AgBiome
Funding Raised: $117.2 million
Focus: Biological and trait products for crop protection
Funding Type: Series C or later

Cell Microsystems
Funding Raised: $15 million
Focus: Platforms for single-cell workflows in CRISPR gene editing, cancer research, stem cell biology, immunology, and neurobiology
Funding Type: Venture fund — Series A

Codetta Bio
Funding Raised: $18.3 million
Focus: Digital spatial polymerase chain reaction providing more high-quality data from a single specimen
Funding Type: Federal SBIR/STTR grant, NC Biotechnology loan

Cullgen, Inc.
Funding Raised: $50 million
Focus: Platforms for single-cell workflows in CRISPR gene editing, cancer research, stem cell biology, immunology, and neurobiology
Funding Type: Venture fund — Series B

dMed-Clinipace
Funding Raised: $54.1 million
Focus: Global full-service clinical contract research organization (CRO)
Funding Type: Private equity; venture fund — Series C or later

EpiCypher
Funding Raised: $15.3 million
Focus: Cutting-edge tools and services for epigenetics and chromatin biology research
Funding Type: Federal SBIR/STTR grants; pitch/case competition; One NC Small Business Program

G1 Therapeutics
Funding Raised: $20 million
Focus: First-in-class therapy designed to improve outcomes for patients who are treated with chemotherapy
Funding Type: Corporate partner

Get Spiffy
Funding Raised: $34.6 million
Focus: On-demand car care tech startup
Funding Type: Venture fund — Series B

Inhalon Biopharma
Funding Raised: $9.9 million
Focus: Inhaled immunotherapy for acute respiratory infections
Funding Type: Contract: U.S. Army Medical Research & Development Command; seed funding

Liquidia Technologies
Funding Raised: $607 million
Focus: Particle engineering platform for precise production of uniform drug particles
Funding Type: Venture fund — Series C or later; corporate partner; IPO

Novan
Funding Raised: $40 million
Focus: Medical dermatology company developing therapeutic products for skin diseases
Funding Type: IPO

Ribometrix
Funding Raised: $25 million
Focus: Small molecule medicines that target RNA structures to treat human diseases
Funding Type: Corporate partner

StrideBio
Funding Raised: $48.9 million
Focus: Gene therapies for devastating conditions, including monogenic rare disease and beyond
Funding Type: Venture fund — Series B

Source: Innovate Carolina Startups Database. Funding data accumulated from public sources.

Gene Therapy Pioneer AskBio Acquired by Bayer for $4 Billion

In late 2020, UNC-affiliated startup Asklepios BioPharmaceutical (AskBio) made a seismic announcement: the gene therapy company was acquired by Bayer AG in a deal worth up to $4 billion. As part of the acquisition, AskBio became a wholly owned, independently operated subsidiary and the cornerstone of Bayer's newly formed cell and gene therapy platform. The company was launched in 2001 by UNC-Chapel Hill professors R. Jude Samulski, PhD, (founding director of the UNC Gene Therapy Center) and Xiao Xiao, PhD, along with current CEO Sheila Mikhail. The success of AskBio — and the talented top scientists who joined the UNC Gene Therapy Center and other area universities as a haven for research and innovation — continues to pay scientific and economic dividends. The Research Triangle Park is now recognized as a national epicenter for gene and cell therapy development — and home to nearly 30 companies focused on AAV-based therapies.

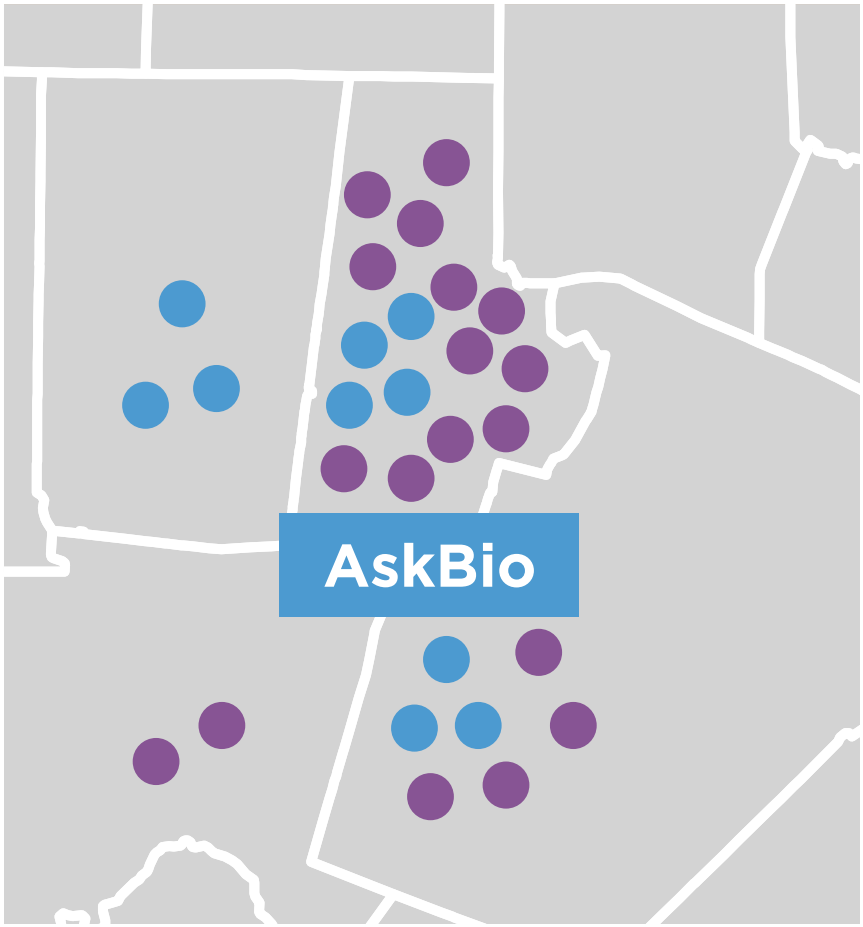
Photo courtesy of AskBio

Inside one of the labs at AskBio, a UNC-affiliated gene therapy company that was acquired by Bayer in a deal worth up to $4 billion in late 2020.

Cell and Gene Therapy Epicenter in Central North Carolina

When Jude Samulski, PhD, came to North Carolina to lead the new UNC Gene Therapy Center in 1993 and then co-founded AskBio in 2001 with Xiao Xiao, PhD and CEO Sheila Mikhail, few would have predicted the profound economic and human impact the company would make. By 2020, when AskBio was acquired by Bayer, Samulski had built an amazing company and was recognized as a national pioneer in the field — and had proven the viability of the gene therapy industry. Seeing AskBio's success and the skilled workforce in North Carolina, gene therapy companies and manufacturers have flocked to the state, while faculty at UNC-Chapel Hill and other universities have founded their own cell and gene therapy startups in the area.

In 2014, Samulski also co-founded gene therapy company Bamboo Therapeutics with Mikhail. Bamboo was quickly acquired by Pfizer in 2016 in a deal worth up to $645 million, also giving gene therapy in the Research Triangle region a major shot in the arm. The Research Triangle is now home to approximately 30 companies focused on cell and AAV-based gene therapies. Twenty years ago, there was only one that started the boom — AskBio.



Orange County

Bamboo Therapeutics, Inc.*

Couragen Biopharmaceutics, LLC*

NeuroGT, Inc.*

Durham County

Atsena Therapeutics, Inc.

Beam Therapeutics

CARsgen Therapeutics

Bluebird bio, Inc.

Kriya Therapeutics, Inc.

Lion Biotechnologies, Inc.*

Locus Biosciences, Inc.

NabGen, Inc.*

Novartis Gene Therapies

Precision BioSciences, Inc.

Resilience

Sarepta Therapeutics, Inc.

StrideBio, Inc.*

Taysha Gene Therapies, Inc.

Torque Bio, Inc.*

Tune Therapeutics

Research Triangle Park

Asklepios BioPharmaceutical (AskBio)*

Wake County

Bedrock Therapeutics, Inc.*

Biogen

Cellectis

GeneVentiv Therapeutics, Inc.*

RainBio, Inc.*

Jaguar Gene Therapy, Inc.

Lee County

Astellas Gene Therapies

Pfizer

* UNC-affiliated cell and gene therapy companies

Joe Ruiz, PhD, entrepreneur and founder of Enzerna Biosciences, works in KickStart Venture Services' on-campus wet lab accelerator for life science startups.

INNOVATION BRIEFS

What are some of the most strategic steps and milestones achieved in innovation and entrepreneurship during fiscal years 2021 and 2022? Explore news and notes on key initiatives, programs and outcomes led by Innovate Carolina.

Innovation Hub and Downtown District

In spring 2022, the University took a significant step forward by formally approving and launching plans for a full-scale innovation hub in downtown Chapel Hill. The UNC Board of Governors and UNC Board of Trustees approved the University's lease for approximately 20,000 square feet of space in the building located at 136 East Rosemary Street/137 East Franklin Street that is being renovated and reimagined by commercial developer Grubb Properties. The hub will become the new home for Innovate Carolina and its suite of services: market research, patent landscape analysis, design thinking for customer discovery, and a range of venture services. It will co-locate the University's programming that supports innovation, entrepreneurship and its research-to-market pipeline with the Launch Chapel Hill startup accelerator, co-working spaces, and a collaborative business environment for industry and community partners. Goals of the hub include job creation, attracting industry, accelerating new research-driven products, providing experiential learning for student entrepreneurs, and growing new companies and nonprofits focused on creating social and economic good.

The hub is part of the Carolina Economic Development Strategy to catalyze a downtown innovation district that will retain, attract and grow more innovation-oriented companies and talent in Chapel Hill. This effort is led by Innovate Carolina, the Town of Chapel Hill and two town-gown committees comprised of University, town and community leaders. In fall 2021, BioLabs, a premier co-working space for life science startups, announced that it will be the first business partner to collaborate with the University and Town through the new innovation district. As an anchor to the district, Carolina's innovation hub is scheduled to open in spring 2023.

Image courtesy of Perkins Eastman

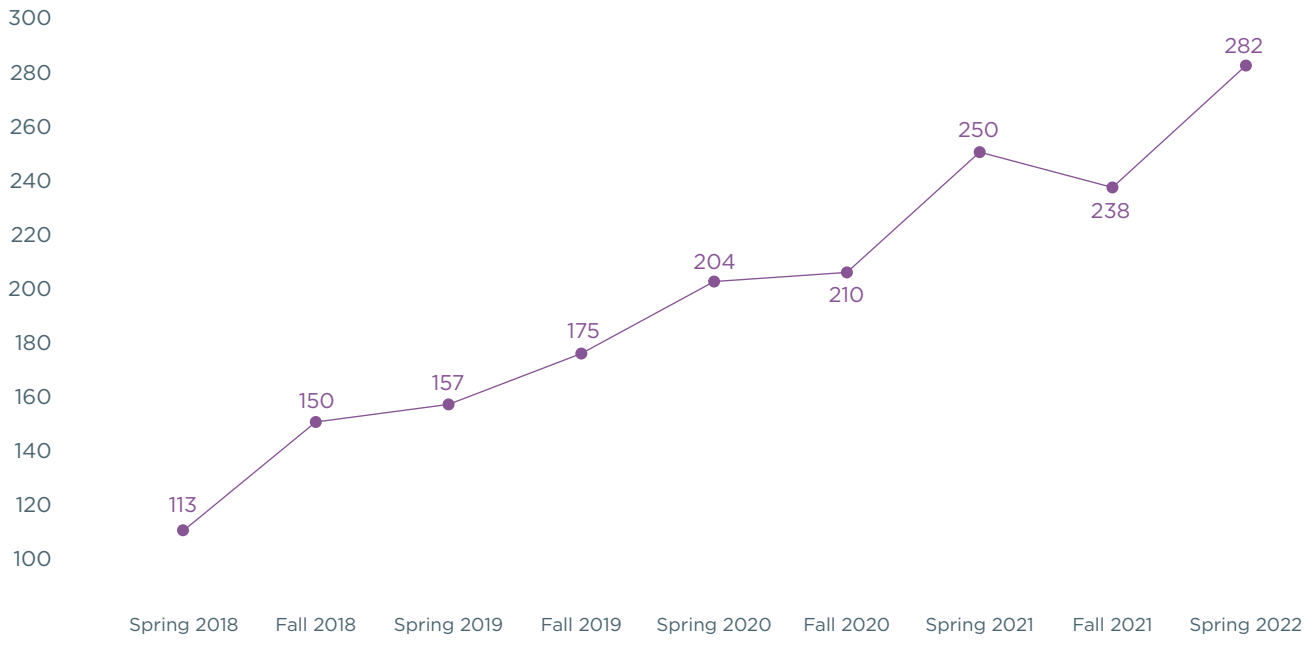
Design rendering of the University's new innovation hub at 136 E. Rosemary and 137 E. Franklin Streets. The hub will open in spring 2023 and be home to Innovate Carolina and its services for the entrepreneurial community on campus and in the local region.

Startup Accelerators and Venture Services

Innovate Carolina offers a variety of startup services and accelerators to launch and grow new ventures.

- **KickStart Venture Services.** This team of startup experts and enthusiasts provides faculty founders of research-based startups funding, on-campus wet lab accelerator space, coaching, grant-writing support, industry-guided advisement, and investor connections. Since 2009, KickStart has provided guidance and $2.7 million in funding to 115 companies. The companies have gone on to raise $132 million in federal SBIR/STTR grants and $1.1 billion in total funding (data as of July 2022). This is a 400-fold leverage over the dollars provided by KickStart. During 2022, KickStart companies earned $96.5 million in annual revenue and employed more than 700 people.
- **Launch Chapel Hill.** Created through a partnership between the University, the Town of Chapel Hill and Orange County, Launch Chapel Hill is an award-winning startup accelerator managed by Innovate Carolina. Launch is located downtown and serves startups from campus and the community. Since 2013, the accelerator has supported 177 companies that have gone on to raise $79.2 million in total funding. In 2022, these companies earned $108 million in annual revenue and employed over 1,239 people (data as of July 2022). In 2023, Launch Chapel Hill will move to UNC-Chapel Hill's innovation hub located in downtown Chapel Hill.
- **1789 Student Innovation Community.** Innovate Carolina's 1789 student innovation community provides a connected network of young aspiring founders, entrepreneurial mentors, innovation programs, and venture funding that helps student startups take off. As of spring 2022, the community has steadily grown to nearly 300 Carolina student members. Since 2014, 1789 has supported 287 student ventures and teams, which have raised $27.7 million in funding (data as of July 2022). In 2022, these student-launched ventures earned $33.3 million in annual revenue and employed nearly 470 people. Through its 1789 Student Venture Fund, Innovate Carolina awarded $16,650 to 14 student startups during the spring 2022 semester alone.

Growth of 1789 Student Innovation Community Student Members



Carolina Angel Network: Five Years In

With five years down and countless investments to go, the Carolina Angel Network (CAN) continues to help early-stage startups grow by providing advice, networks and capital that startups need to become well positioned for success. CAN is an angel investing platform that connects UNC-affiliated entrepreneurs and startups to its member investor network. CAN launched in early 2017 with great energy and support from University leaders. Since that time, it has quickly grown into one of the largest angel networks in the United States. During the first five years, CAN supported more than 20 startups, with members investing more than $20 million across 35 investment rounds and generating more than $108 million in revenue for these ventures.

Tim Flood, PhD, clinical associate professor of management and corporate communication at Kenan-Flagler Business School, leads a pitch workshop at the 79° West co-working space in Chatham County.

Growing Chatham County's Innovation Economy

During the summer of 2022, Innovate Carolina launched a partnership with 79° West, a new co-working space in the MOSAIC mixed-use development of Chatham Park. Innovate Carolina regularly visits 79° West to provide free workshops, fireside chats, panel discussions and professional networking sessions designed to help people in the Chatham community build entrepreneurial skills and professional connections. During the programs, expert practitioners from Innovate Carolina, university professors, and experienced entrepreneurs from the wider community work with remote workers, startup founders and small businesses to hone practical skills and knowledge that are useful when launching new businesses or ideas. For example, Innovate Carolina is teaming with Central Carolina Community College to offer a new program at 79° West called Next Level, which will take local startups on a step-by-step journey to validate and strengthen their business concepts.

UNC and Duke Partner to Boost Regional Startups

Thanks to a partnership between Innovate Carolina's KickStart Venture Services team and Duke University's Office for Translation and Commercialization, research-based startups in the area are thriving more than ever. After receiving a joint grant from the U.S. Economic Development Administration's (EDA) SPRINT Challenge award in May 2021 to scale pandemic resilience through innovation and technology, the two universities have created a new entrepreneurial network that positions startups for success. The network provides startups with access to an entrepreneurial ecosystem, a joint talent network and an established database of service providers.

Over 18 months, the partnership is supporting up to 40 startups, helping prepare them to raise significant dilutive and non-dilutive funding.

Innovation Services for Campus and Community

As Innovate Carolina ramped up for the launch of its innovation hub in 2023, the team expanded access to services it provides to individuals and organizations at UNC-Chapel Hill as well as those outside the University. One such offering is the patent landscape and market research service, which helps innovators assess a variety of critical go-to-market factors, including the market potential of their technologies, the competitive landscape, and potential investment funding. During fiscal years 2021 and 2022, Innovate Carolina's dedicated research team provided 177 custom reports and project consultations that helped people at the University and beyond complete research and launch new products, services and businesses. Another such offering is Innovate Carolina's design thinking service. In-house experts provide workshops, accelerators, advising and coaching sessions on how to identify customer needs and create more usable products, services and outcomes. Innovate Carolina's design thinking team supported nine clients on 11 projects during fiscal years 2021 and 2022 and has worked with organizations such as BlueCross Blue Shield, the University of North Carolina System, and the Chapel Hill Economic Development Council.

Associate professor of cell biology and physiology Martina Gentzsch, PhD, works with Innovate Carolina's Patrick Kastian, an expert in market research analysis.

INNOVATE CAROLINA PROVIDES SERVICES THAT HELP UNC AND NON-UNC TEAMS ASSESS THE MARKET, IDENTIFY CUSTOMER NEEDS, AND BUILD USEFUL PRODUCTS AND VENTURES.

Licensing Revenue Milestone: Beyond the $100 Million Mark

During December 2020, UNC-Chapel Hill hit a significant economic impact milestone: the University crossed the $100 million mark of cumulative licensing revenue created by commercializing its intellectual property. And by the end of fiscal year 2022, the University had generated $123.3 million in total licensing revenue from its technologies and inventions. This achievement was made possible by federal agencies and other funders investing billions of dollars into faculty research coupled with the University's support for bringing the subsequent research discoveries to market. Carolina's intellectual property portfolio targets treatments and cures for diseases, often rare and neglected ones, with an emphasis in areas such as cancer, infectious disease, and gene and cell therapies.

Chancellor's Economic Development Council members participate in a design thinking session for Chapel Hill's downtown innovation district: Gordon Merklein, associate vice chancellor for real estate and campus enterprises; Sheryl Waddell, director of economic development and innovation hubs; Kavita Hall, associate vice chancellor for corporate and foundation relations.

Training Carolina's Innovation Corps

In August 2021, UNC-Chapel Hill joined the National Science Foundation (NSF) Innovation Corps (I-Corps™) program as part of its newly funded Mid-Atlantic hub. The University's membership represents a major nationally accredited designation in entrepreneurial leadership. Carolina's I-Corps program provides innovators with real-world training on the customer discovery process, giving them a better understanding of their market potential. Participants learn about entrepreneurship, starting a business, and industry requirements and challenges — knowledge that will help them move their inventions to market faster. The program site is managed by Innovate Carolina's KickStart Venture Services team and the Institute for Convergent Science.

The UNC-Chapel Hill I-Corps program will receive $620,000 in NSF funding over five years. It aims to train 100 teams locally and send 15 of these teams to participate in a national I-Corps program. As of June 2022, eight UNC teams had already completed the Mid-Atlantic program, with one team selected to participate at the national level.

Student Innovations: National and Global Recognitions

Student innovation teams at Carolina continue to find regional, national and global avenues to share their ingenuity.

- **ACC InVenture Prize.** In the springs of 2021 and 2022, Innovate Carolina identified and prepared top student innovation teams to represent UNC-Chapel Hill at the ACC InVenture Prize. This annual competition features undergraduate student entrepreneurs from 15 Atlantic Coast Conference (ACC) schools. The teams compete against one another and pitch their inventions or businesses before a panel of judges. The top UNC team for 2021 was a student-founded venture called EATS2SEATS, which helps nonprofits conveniently sign up to work concession stands at sports arenas — in a way that fits their schedules, staffing capacities and fundraising goals. EATS2SEATS won the 2021 competition's Peoples' Choice Award. In 2022, Carolina was represented by student venture QUVI, which developed a device that cleans reusable water bottles using UV light.
- **ACCelerate Festival.** Two UNC-Chapel Hill student startups stepped onto the national stage when they exhibited at the 2022 ACCelerate: Creativity and Innovation Festival in Washington, D.C. This annual festival takes place at the Smithsonian National Museum of American History and honors creative exploration and innovative research happening at the intersection of science, engineering, arts and design from across the Atlantic Coast Conference. Over three days in April, two Innovate Carolina-supported teams presented interactive exhibits and demonstrations to more than 31,000 festival visitors: Chapel Thrill Escapes, the first student-designed, student-built and student-operated nonprofit escape room in the country; and LiRA, a graduate-student venture that provides lip-reading technology to improve the medical care and lives of voiceless individuals.
- **Map the System Competition.** More than 40 UNC student teams now work with Innovate Carolina each year to participate in Map the System, a global competition hosted by Oxford University. Teams use systems thinking to explain the roots of pressing social and environmental issues, identify where existing solutions fall short, and propose routes to change. The top UNC team receives a stipend from Innovate Carolina to travel abroad to Oxford, where it competes in the global finals against leading student teams from around the world. In 2020, the top UNC student team placed third globally based on its work exploring racial and ethnic disparities in tobacco control. In 2021, the top Carolina team presented its findings on community flooding resiliency. In 2022, out of 950 teams that registered worldwide, Carolina's top team was selected as one of 45 finalists from 21 countries to compete in the global finals at Oxford, where it discussed maternal health equity.

Building the Innovation Workforce

From fellowships to internships to student-specific startup accelerators, there are a variety of ways that Innovate Carolina helps students bridge classroom and company.

- **Venture Catalyst Program.** In the fall of 2020, Innovate Carolina's KickStart Venture Services team launched the Venture Catalyst Program to combine experiential education in entrepreneurship with real-world startup operations. The program matches faculty-founded startups with doctoral and MBA candidates as well as postdocs who have a passion for new venture creation and support. Each student/faculty team is also paired with an entrepreneur-in-residence who has expertise in the company's field of work. The graduate and postdoc fellows help with primary market research, development plans, grant applications, company valuation

72% OF COMPANIES THAT ATTENDED CAROLINA STARTUP CONNECT 2021 HIRED A UNC STUDENT INTERN WITHIN SIX MONTHS.

and other critical functions. The program's first cohort graduated in spring 2021, with 10 fellows working with nine faculty-founded startups. The 2022 cohort included nine fellows who teamed with nine companies.

- **Carolina Startup Connect.** Carolina Startup Connect allows students to apply for awards to supplement unpaid or underfunded internships with startup companies. In summer 2021, Innovate Carolina granted internship awards totaling $12,000 to nine students who worked at three Launch Chapel Hill startup companies. In November 2021, Innovate Carolina hosted a diversity-focused panel where 80 students met with 20 minority startup founders. Following the panel, a general meet-and-greet session brought together 25 more startup companies and 143 students. After the meet-and-greet, 97% of student attendees indicated that they planned to reach out to a startup company they met there. Within six months, 72% of the participating startups hired an intern whom they met at the session. During summer 2022, Innovate Carolina provided 10 student interns with stipends totaling $31,400, allowing them to complete 2,000 hours of work at five companies in Chapel Hill and Raleigh.
- **Launch Summer Accelerator.** The summer accelerator at Launch Chapel Hill gives student startups chances to work full-time over the summer to scale their ventures. In summer 2021, each of the nine accepted teams received $5,000 stipends as well as mentoring, intensive programming and office space in downtown Chapel Hill.

The Venture Catalyst Program's 2022 cohort featured nine fellows, including MBA students, doctoral students and postdoctoral researchers from several schools: Kenan-Flagler Business School, the Eshelman School of Pharmacy, the School of Medicine, and the School of Education.

STORIES OF IMPACT

Read a few of the many stories of Carolina faculty and students who work with Innovate Carolina to take new technologies to market, launch impact-driven startups, and apply the tools of innovation for human and economic good.

BREAKTHROUGH GENE THERAPIES IN SIGHT

Patients with genetic lysosomal storage diseases — particularly children — are living longer because of better treatments. But with promising advances and longer lives comes complications, including the loss of eyesight, as these rare diseases take their toll over time.

According to the National Organization for Rare Disorders, lysosomal storage diseases are inherited metabolic diseases characterized by an abnormal buildup of various toxic materials in the body's cells as a result of enzyme deficiencies. With these diseases, patients are missing the mucopolysaccharidosis type 1 (MPS1) gene. Current therapies that allow patients to live longer don't address corneal clouding caused by these diseases. However, one UNC-affiliated startup, RainBio, is developing a novel gene therapy called RBIO-1 for MPS1 corneal blindness.

Co-founded by Matthew Hirsch, PhD, associate professor of ophthalmology at the UNC Gene Therapy Center, RainBio is the only ocular gene therapy pioneer focused on blindness in the cornea. The company's first candidate is an adeno-associated virus gene therapy for corneal clouding in MPS1 patients who have vision loss.

"With our product, you inject the missing gene right into the cornea," says Fran Martin, RainBio president. "This allows for prevention of corneal clouding or blindness, and can even reverse the blindness or cornea clouding if the treatment is given early enough."

Photo courtesy of Susan Ervin

Matthew Hirsch, PhD (right), associate professor of ophthalmology at the UNC Gene Therapy Center and RainBio co-founder, meets with MPS1 patients.

For kids who are losing their sight, another option is to have a cornea transplant. But those transplants don't come without risks.

"Transplants can sometimes result in high rejection rates and potential infection," adds Martin. "We can offer a treatment that patients can try before moving to a corneal transplant."

RainBio was acquired by clinical-stage biopharmaceutical company Graybug Vision, Inc., in March 2022 for approximately $2.2 million.

WE CAN OFFER A TREATMENT THAT PATIENTS CAN TRY BEFORE MOVING TO A CORNEAL TRANSPLANT.

Fran Martin, President, RainBio

High Alpha Innovation + Epulate

DIGITAL HEALTH AND A NEW KIND OF STARTUP STUDIO


Photo courtesy of UNC School of Medicine

Associate professors Eric Weimer (medicine) and Katherine Newhall (mathematics) created a tech solution and startup that uses artificial intelligence to improve the speed and precision of organ donor matching.

With more than 550 active startups launched by its faculty, staff and students, UNC-Chapel Hill exemplifies the national trend: universities are becoming increasingly adept at spinning out companies. But, despite the numerous examples of ventures that find traction taking campus-born ideas and research to market nationwide, the overall failure rate of startups in the wider world lingers around 90 percent. And research shows that 21 percent fail in the first year, and 70 percent by year 10.

Eager to give UNC startups a promising new avenue, leaders at the Eshelman Institute for Innovation, Innovate Carolina, UNC Health and UNC Research came together to pilot a venture studio approach.

"Carolina has a lot of digital health research, and we are one of the top five NIH-funded universities in the country. Leveraging a venture studio can really unlock digital software commercialization here," says Bob Dieterle, the managing director of the Digital Health Venture Studio at the Eshelman Institute for Innovation and an entrepreneur-in-residence with Innovate Carolina.

UNC'S VENTURE STUDIO PILOT LAUNCHED THE STARTUP EPULATE, WHICH USES AI TECH TO RAPIDLY MATCH ORGAN DONORS TO PATIENTS.

Venture studios combine company-building capabilities with a source of initial capital, providing speed, financial advantage and functional support to emerging startups.

"We know how important digital health is to our industry," says Carol Lewis, vice president of UNC Health Enterprises. "Digital transformation is coming, and it is coming at us from every angle. As health care experts, we need to help drive this industry transformation to create high-quality, impactful digital health solutions."

Dieterle identified a strong venture studio partner in High Alpha Innovation. In collaboration with corporations and universities, High Alpha Innovation generates and validates business ideas, sources entrepreneurial founders, launches and nurtures companies to scale, and establishes permanent startup creation capabilities.

The pilot with High Alpha Innovation presents a new possibility for tapping into industry-driven entrepreneurial expertise that can accelerate a pipeline of potential UNC-based ventures.

Lewis, Dieterle and others on the team invited 25 promising digital health concepts from across the University and health care system to take part in the 13-week pilot program.

From the 13-week program, two concepts were chosen to go through sprint week, a high-stakes, all-hands-on-deck process where teams work non-stop to test assumptions and build confidence for a go- or no-go launch decision.

The teams worked fervently to compress the first six months of business building into just one week, with 16 people (eight per startup concept) gathering at UNC-Chapel Hill for 10 hours each day.

By the end of the sprint, each venture concept had a go-to-market strategy, potential customers identified, a product wireframe and a dedicated team in place. The week culminated with a pitch day presentation to the venture studio investment committee, which included venture capitalists and executives from UNC Health.

A concept based on the expertise of Eric Weimer, PhD, associate professor of pathology and laboratory medicine at the UNC School of Medicine, and Katherine Newhall, PhD, associate professor of mathematics in the Carolina Center for Interdisciplinary Applied Mathematics, emerged as the startup venture — now named Epulate — that High Alpha Innovation and the University would propel forward. The concept identified an unmet need for matching organ donors to patients in a quicker, more precise way.

Currently, transplant organs and patients are matched in a labor-intensive, manual process based on point-solutions and scientists' judgment. Epulate's solution is an emerging modeling workflow driven by artificial intelligence technology. Transplant lab directors can use the new machine learning solution to more quickly match donor organs to immunologically compatible patients. The software accesses a national database to perform advanced analysis of large numbers of recipient-donor combinations in minutes — a process that used to take hours.

Pulvinar Neuro

A NEW WAVE OF PSYCHIATRIC CARE

Flavio Frohlich, PhD (left), the founder of Pulvinar Neuro, is a professor of psychiatry and director of the Carolina Center for Neurostimulation at the UNC School of Medicine. Leah Townsend, PhD (right), serves as Pulvinar Neuro's CEO.

According to the National Alliance on Mental Illness, more than one in five adults in the U.S. experience mental illness, and more than one in 15 experience both a substance abuse disorder and mental illness. Unfortunately for many, treatments are limited and unaffordable.

Pulvinar Neuro, a UNC-Chapel Hill spinout company, offers a novel device that shifts brain activity patterns for patients suffering from mental illness and substance abuse. Founded by Flavio Frohlich, PhD, professor of psychiatry and director of the Carolina Center for Neurostimulation at the UNC School of Medicine, the company developed a breakthrough technology that has captured the attention of industry leaders and investors alike.

Pulvinar offers a device that delivers high-quality, non-invasive brain stimulation: transcranial alternating current stimulation (tACS). In March 2022, the company was acquired by Electromedical Products International, Inc. (EPI), a leading medical device company that uses patented, FDA-cleared non-invasive brain stimulation technology to treat anxiety, insomnia, depression, and pain.

"Our goal is to translate our proprietary non-invasive brain stimulation technology into the clinic," says Leah Townsend, PhD, CEO of Pulvinar Neuro. "Like EPI, we're bringing hope to patients and their families who otherwise might not be aware of the benefits of brain stimulation."

Known for his pioneering work in targeting brain activity, Frohlich wants to transform how psychiatric illnesses are treated.

"About 10 years ago, I discovered that the electric fields generated by the brain act as a feedback signal to enhance brain rhythms," says Frohlich. "Our team has worked hard to translate this discovery into the next generation of brain stimulation."

"What's unique about Pulvinar's technology is that we can apply different wave forms to potentially treat different conditions," says Townsend. "And just like depression, substance use disorder and PTSD are all different conditions with different symptoms, there are different underlying brain signals to target for each."

WE'RE BRINGING HOPE TO PATIENTS AND THEIR FAMILIES WHO OTHERWISE MIGHT NOT BE AWARE OF THE BENEFITS OF BRAIN STIMULATION.

Leah Townsend, PhD, CEO, Pulvinar Neuro

GeneVentiv Therapeutics

UNIVERSAL HOPE FOR HEMOPHILIA


Photo courtesy of UNC Gene Therapy Center

A research associate professor of pediatrics, Chengwen Li, MD, PhD (right) leads a research lab based at the Gene Therapy Center.

For most people, a small cut on the hand or foot isn't a big deal. But for those with hemophilia, even the smallest cut or bruise can lead to severe bleeding and other health issues. Caused by a mutation of genes that provide the ability to make clotting proteins, hemophilia occurs in about one of every 5,000 male births. Although rare, it can occur in females as well.

Current gene therapies for hemophilia — while exciting — are limited because they are only for patients who don't experience immune response issues — called inhibitors — after receiving a therapeutic infusion. Most therapies are designed to work for patients who have either hemophilia A or B without inhibitors, which are complicating factors that limit the ability of medications to create the desired clot.

UNC-affiliated startup GeneVentiv Therapeutics is developing the first universal gene therapy for all types of hemophilia.

"These patients suffer from tremendous problems, including neurological problems, gastrointestinal problems and joint deterioration, which reduces the quality and the duration of their lives," says Damon Race, CEO of GeneVentiv. "Until now, there's a group of patients that had no hope of benefiting from exciting gene therapies that are in development. We're giving these patients new hope with a first-in-class gene therapy that can treat all types of hemophilia, delivering patients from these problems and rescuing them from a lifetime of weekly infusions or repeated injections."

GeneVentiv's treatment is based on research from Chengwen Li, MD, PhD. A research associate professor of pediatrics, Li leads a lab at the UNC Gene Therapy Center.

Current treatment for hemophilia patients is a weekly infusion with the patient's missing clotting factor, but roughly a third of patients will develop an inhibitor as a result.

For patients, GeneVentiv's therapy is designed to offer a long-awaited and lasting answer: a single, curative infusion that works for life.

PORTRAY Device

DENTAL X-RAYS IN 3D

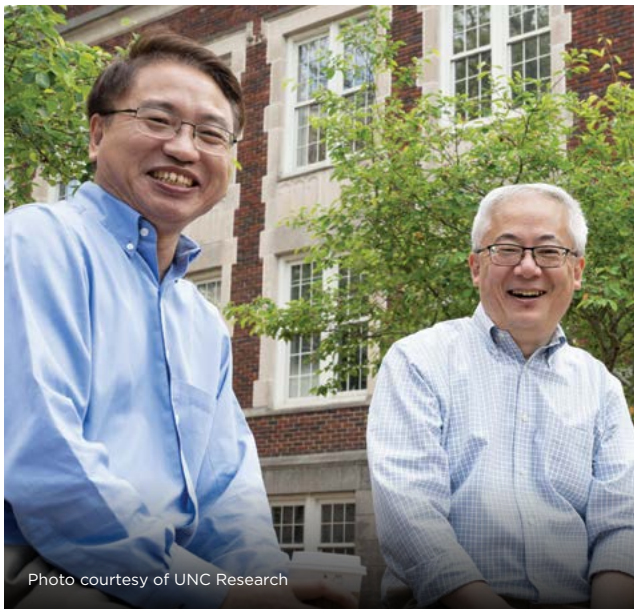


Photo courtesy of UNC Research

Carolina physics professors Jianping Lu, PhD, and Otto Zhou, PhD, have worked together for 20 years on a technology that makes X-ray machines smaller, faster, safer and sharper.

A novel 3D X-ray technology developed via a collaboration between scientists in the Department of Physics and Astronomy and the Adams School of Dentistry can identify dental issues earlier with more detail — and less radiation.

UNC-Chapel Hill professors Otto Zhou and Jianping Lu have spent 20 years refining an X-ray source technology that uses carbon nanotubes to make X-ray machines smaller, faster, safer and sharper. And their perseverance has paid off. The U.S. Food and Drug Administration (FDA) approved a 3D X-ray device called PORTRAY enabled by Zhou and Lu's novel technology.

With the FDA clearance secured, a company named Surround Medical Systems located in the Research Triangle Park plans to make the device available to dental professionals.

"This 3D technology offers a better way to identify dental disease earlier," says Zhou, David R. Godschalk Distinguished Professor of Physics and Astronomy. "For the patient, this means you can start treatment earlier, improving the quality of dental care."

PORTRAY's transformative technology allows dentists to capture more detailed imaging for identifying cavities and other dental diseases. Along with Zhou, a team of researchers from UNC-Chapel Hill's Department of Physics and Astronomy, the UNC/NCSU Joint Department of Biomedical Engineering, and the Adams School of Dentistry's Department of Diagnostic Sciences Section of Oral and Maxillofacial Radiology worked to develop and patent the technology.

"It's very gratifying," says Zhou. "It's rare you see a new technology that you envision from basically a rough sketch on a piece of paper 20 years ago, after going through a lot of ups and downs, to move to the clinic and now benefit patients. That's a big accomplishment for everyone involved in this process."

Although Zhou has achieved the FDA clearance milestone, he is not slowing down. He and his collaborators are already exploring other avenues and areas of medicine that can benefit from the technology. These involve brain imaging and mammography as well exploring the security industry, including scanners for luggage inspections in airports.

> **THIS 3D TECHNOLOGY OFFERS A BETTER WAY TO IDENTIFY DENTAL DISEASE EARLIER.**
>
> Otto Zhou, PhD,
> Professor of Physics and Astronomy

Carolina Graduate Certificate in Innovation for the Public Good

MORE THAN A MINDSET

Nine of the first 82 students to enroll in the Carolina Graduate Certificate in Innovation for the Public Good (top left to right): Thomas Persico (public administration), Asia Carter (public health), Matt Gannon (journalism and media), Chloe Coletta (public health), Marcellos Allison (public health), Austin Wang (computer science), Carly Lappas (public administration), Snigdha Peddireddy (public health), Irene Manning (chemistry).

Magnifying. Adaptive. Powerful. These are just a few of the words students in the Carolina Graduate Certificate in Innovation for the Public Good (CIPG) use to describe their experiences in the program. Launched in 2020 for UNC-Chapel Hill graduate students, the interdisciplinary certificate program teaches students about modern changemaking. It helps them hone the skills they need to collaborate with others, partner with government, nonprofits, businesses and communities, and lead with agency to tackle challenges in new ways.

"The CIPG brings together diverse groups of students and challenges them to think through how to increase the impact of their work and make it more meaningful, even beyond their time at Carolina," says Liz Chen, PhD, CIPG inaugural director, assistant professor in the health behavior department at the Gillings School of Global Public Health and design thinking lead at Innovate Carolina.

Each CIPG student is matched with a community partner to help them solve a real challenge. Examples of partners include UNC Chatham Hospital (a 25-bed critical access hospital located in Siler City, NC), iRT (a behavioral sciences research company) and Girls on the Run Triangle (an organization that uses experience-based curriculum and running to inspire girls to be joyful, healthy and confident).

"Working with the design thinking students was a rewarding experience for both Chatham Hospital staff and community members," says Keith Stinson, the emergency department director and emergency preparedness coordinator at UNC Chatham Hospital. "Hospital staff had the opportunity to learn new process improvement methods, and the community members reported feeling connected to both the hospital and UNC students. The program design was supportive, informative, and provided recommendations on improving a process at Chatham Hospital."

"I'm interning in health care technology, and I've already been able to use some of the tools I've learned in class," says Lianza Reyes, a master's student in the School of Information and Library Science. "My work has benefited greatly from some of the frameworks I've learned, like creating a journey map and forming empathy for users."

WORKING WITH THE DESIGN THINKING STUDENTS WAS A REWARDING EXPERIENCE FOR BOTH CHATHAM HOSPITAL STAFF AND COMMUNITY MEMBERS.

Keith Stinson,
Emergency Department Director and Emergency Preparedness Coordinator, UNC Chatham Hospital

Innovate Carolina developed CIPG in partnership with three sponsoring academic units — the Gillings School of Global Public Health, the Department of Public Policy and the School of Education — which administer the certificate on a rotating basis.

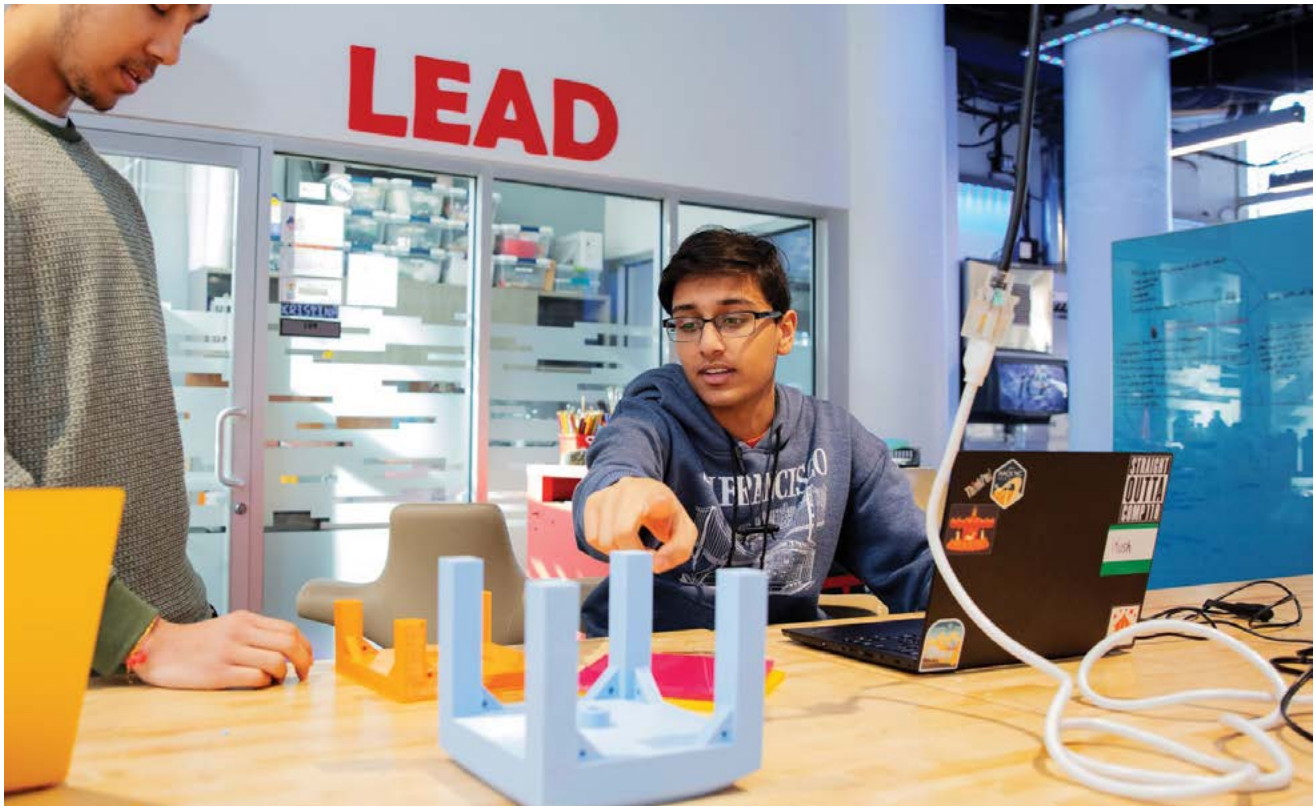
CIPG emphasizes evidence-based and creative problem-solving approaches, along with team-oriented, customer/community discovery methods that students use to develop solutions that address pressing human concerns. During the certificate's first two years, 81 students from 18 different schools and departments enrolled in the program. The diversity of students and academic interests reflects how valuable the lessons and experiences are for a wide range of graduate students who are researching and solving all types of interconnected problems.

"Our students develop a deeper, better understanding of how to engage others in different disciplines who may think or see the problem and potential solution differently," says Melissa Carrier, CIPG advisory board chair and professor of the practice in the Department of Public Policy. "We know how critical this training is because the challenges these students are trying to solve cannot be solved by any single approach or sector."

Carolina public health graduate students Sharita Thomas (center) and Hiba Fatima (right) compete in the global Map the System competition at Oxford University. Their research focuses on improving health equity and reducing maternal mortality rates.

INNOVATION IN ACTION

What does Carolina-driven innovation look like? Across campus and in our communities talented problem solvers and university partners put their ingenuity and entrepreneurial grit to work in all kinds of inventive ways. Their passion is finding answers to tough challenges that people care about — by turning knowledge, research and ideas into new products, technologies, services and ventures. For the good of North Carolina and the world, Tar Heel innovation looks like innovation for all.



Students Kush Jain (right) and Harshul Makwana (left) work in a UNC makerspace to build a prototype for a device that uses UV light to sanitize water bottles. Jain and Makwana are two of the co-founders of QUVI, a startup based on their device. QUVI represented Carolina as the University's top student innovation team at the 2022 ACC InVenture Prize competition hosted by Florida State University.

Mireya McKee, PhD, director of KickStart Venture Services, and Kelly Parsons, PhD, director of technology commercialization, were both named to new leadership positions in 2022. Their hires reflect Innovate Carolina's efforts to further enhance the strategy and support it provides to entrepreneurial researchers who wish to build startups or license their technologies.

Research scientist Marcus Williams of Enzerna Biosciences works in Innovate Carolina's KickStart Accelerator, which is part of the UNC Institute for Convergent Science. The 7,500-square foot accelerator provides research-based startups with wet lab facilities, advanced equipment, and office space conveniently located in the heart of Carolina's health sciences corridor.

David Lee, a doctoral student and co-founder of startup Exsto Bio, a startup focused on personalized medical cannabis treatments; and Oliver Pau, founder/owner of alt-protein food venture DoJo Fresh. Their companies were two of nine to pitch during Launch Chapel Hill's spring 2022 Demo Day, which featured the accelerator's 20th cohort since 2013.

Members of the Innovate Carolina team tour the construction site of the new innovation hub. Once opened in 2023, the hub will offer numerous services from Innovate Carolina along with a variety of workspace options, including floating desks and co-working areas, private offices, conference rooms, a training room, business center, and event and networking areas.

Biomedical engineering professor Rahima Benhabbour, PhD (center), shares her experience launching a life science startup during a panel discussion with Chief Innovation Officer Michelle Bolas (left) and Chancellor Kevin Guskiewicz (right) at the Institute for Convergent Science.

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