

technology transfer

at **NC State**
2007 ANNUAL REPORT



Larval stage of the tick, carrier of the spirochaete bacteria that causes Lyme disease.

Research from NC State's Department of Entomology is combating this public health threat.

page 21

putting ideas to work

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3 **Year in Review** In FY07 NC State research resulted in 106 licensing agreements, 43 patents, 242 confidentiality disclosure agreements, 5 new startup companies, and top national rankings.

4 **NC State's Innovation Network** Meet the NC State network of units and services designed to support entrepreneurship and commercialization.

8 **Capital Ideas** Researchers disclosed 173 inventions and ideas culminating in intellectual property this year. Here's a closer look at the breadth and diversity of NC State's intellectual property portfolio.

14 **Is it Patentable?** This year the U.S. Patent and Trademark office issued 38 patents to NC State inventors, bringing the University U.S. patent portfolio to over 580 patents.

innovation. impact.

17 **Licensing & Commercialization** FY07 saw a 20 percent increase in number of licensing deals negotiated. The resulting partnerships maximize the potential benefits of NC State research to society.

20 **Products with Global Impact** NC State research has resulted in over 110 commercialized products improving quality of life, and benefiting the local and global economy.

22 **Startup Activity 2007** NC State consistently ranks among the nation's top universities for startups. It's not just the number that counts; it's the quality of those startups and the progress they're making that is truly significant.



MESSAGE FROM THE DIRECTOR

The pursuit of excellence in research at NC State continues to yield discoveries that have the potential of adding significant value to society. NC State intellectual property plays an important role in economic strategy and vitality. Most importantly, the intellectual property that the Office of Technology Transfer (OTT) shepherds reshapes the world we live in and improves the human condition. Our mission is to move academic discovery to the marketplace resulting in new products, processes, and companies while maximizing the impact of academic research and forging new partnerships to tackle 21st century issues.

Of the more than 170 new invention disclosures received in fiscal year 2007, five new startup companies were established, illustrating our efforts to contribute to local economic development. To date, NC State startups have created more than 2000 jobs in North Carolina and garnered more than \$250 million dollars in venture capital funding. Over 100 industry agreements were executed during fiscal year 2007 illustrating our commitment to identifying commercialization partners with the resources, expertise, and commitment to advance our discoveries. NC State was issued 38 U.S. patents in 2007 bringing NC State's patent portfolio to over 580 U.S. patents.

Our office strives to provide our faculty researchers with a wide range of professional and responsive services. As we begin our new fiscal year, we are committed to continued success and new initiatives. We will implement new outreach and educational programs designed to encourage innovation and engagement with our office.

This inaugural annual report presents data accompanied by success stories that illustrate how landmark discoveries, coupled with a strong technology transfer program, maximize the impact of NC State's research legacy.

A handwritten signature in black ink, appearing to read 'B. B. Houghtelng'.

BILLY B. HOUGHTELNG
DIRECTOR
NC STATE OFFICE OF TECHNOLOGY TRANSFER

FISCAL YEAR year in review 2007

QUICK STATS

DISCLOSURES

Invention Disclosures	144
Software Disclosures	3
Plant Variety Disclosures	18
Copyright Disclosures	8
TOTAL DISCLOSURES	173

PATENTS

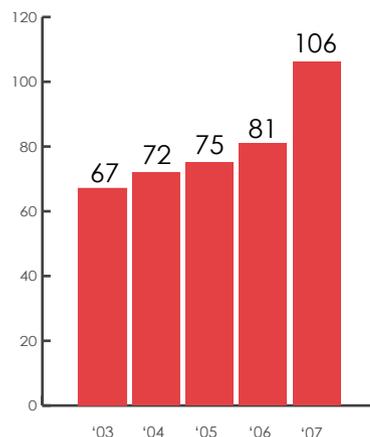
Patents Filed	115
US Patents Issued	38
Foreign Patents Issued	5
TOTAL ISSUED PATENTS	43

AGREEMENTS

Licenses/Options	106
Material Transfer Agreements	174
Confidentiality Agreements	242
Other IP Agreements	84
TOTAL AGREEMENTS	606

STARTUP COMPANIES

Agile Sciences, Inc.
DPoly Systems
AP Solutions, Inc.
ImagineOptics, Inc.
IntelliCATH Surgical Corporation



LICENSING INCREASE

Each year, hundreds of new inventions emerge from NC State laboratories. OTT transfers these inventions through licensing to the private sector for development that will benefit the public.

FY2007 saw a 20% increase in licensing activity, indicating our commitment to advancing technology commercialization.

TECHNOLOGY TRANSFER RANKINGS

9th **University Patent Pipeline Power**
IEEE Spectrum's National Patent Power Survey
November 2006

10th **Number of Cumulative Industry Licenses**
AUTM U.S. Licensing Survey. 2007

20th **International University Technology Transfer and Commercialization Index***
Milken Institute. Mind to Market: A Global Analysis of University Biotechnology Transfer and Commercialization
September 2006

* 1 MIT; 2 UCAL System; 3 CAL Tech; 4 Stanford; 5 UFL; 6 U of Minnesota; 7 Brigham Young; 8 U of British Columbia; 9 U of Michigan; 10 New York University; 11 Georgia Tech; 12 U Penn; 13 U of Illinois, Chicago, Urbana-Champaign; 14 U of Utah; 15 U of Southern CAL; 16 Cornell; 17 UVA Patent Fndtn.; 18 Harvard; 19 U of California, San Francisco; **20 North Carolina State University**; 21 SUNY; 22 W.A.R.F./U of Wisconsin; 23 McGill University; 24 U of Washington; 25 UNC Chapel Hill

the research works. now what?



INNOVATION NETWORK

OTT NC State innovators distinguish themselves as leaders in their respective fields through research and discovery.

NC State's Office of Technology Transfer (OTT) ensures that academic innovation reaches the public.

Through the protection and management of intellectual property resulting from research performed at NC State, OTT champions innovation to increase the transfer of knowledge and technology beyond campus boundaries. OTT offers services to protect and promote academic research including the negotiation and management of all intellectual property contracts required to protect, license, and share university discoveries.

For more info, visit <http://www.ncsu.edu/ott>

it takes a village

Innovation cannot exist alone, nor can it be cultivated alone. Innovation is the result of research and countless resources, collaborative efforts, prior work, support from friends and family, scientific methods, trial and error—the list continues. The successful innovator needs a successful network to maximize the impact of his or her research.

In today's highly competitive marketplace survival depends on a continuous stream of successful new technologies, new companies to bring those innovations to bear, and an infrastructure of support in place to help those companies get where they're going. NC State's innovative culture recognizes that the ongoing generation of breakthrough ideas with real-world application is vital to our mission of giving back to the public, and requires a campus-wide commitment.

The innovation network at NC State strives to support real-world processes to start and grow an initiative based on high value intellectual property. From idea management strategies to office space, shared facilities and networking opportunities, NC State provides service units and organizations designed to enable a culture of innovation.

NC State's innovation network includes the Office of Technology Transfer (OTT), the Technology Entrepreneurship and Commercialization (TEC) program, TEC's Accelerating the Commercialization of Technology (ACT) initiative, the Technology Incubator on Centennial Campus, the Economic Development Partnership (EDP), and the Small Business and Technology Development Center (SBTDC).

never before in history has innovation offered promise of so much to so many in so short a time. **Bill Gates**

TEC NC State's Technology Entrepreneurship and Commercialization Program (TEC) focuses on entrepreneurship and innovation education. TEC teaches scientists, engineers, and managers how to identify viable technologies, translate them into marketable products, and grow an entrepreneurial initiative based on the resulting innovation.

TEC disseminates this information through graduate and executive education programs. TEC has gained international recognition for the development of a technology commercialization process 'roadmap.' This roadmap, commonly referred to as the 'TEC Algorithm,' provides a teaching framework for technology commercialization and acceleration.

Using the TEC Algorithm, entrepreneurs and innovators learn

to analyze and develop solutions for more efficient commercialization processes and models for university-generated science and technologies specifically oriented towards new start-up ventures.

For more info, visit <http://mgt.ncsu.edu/tec>

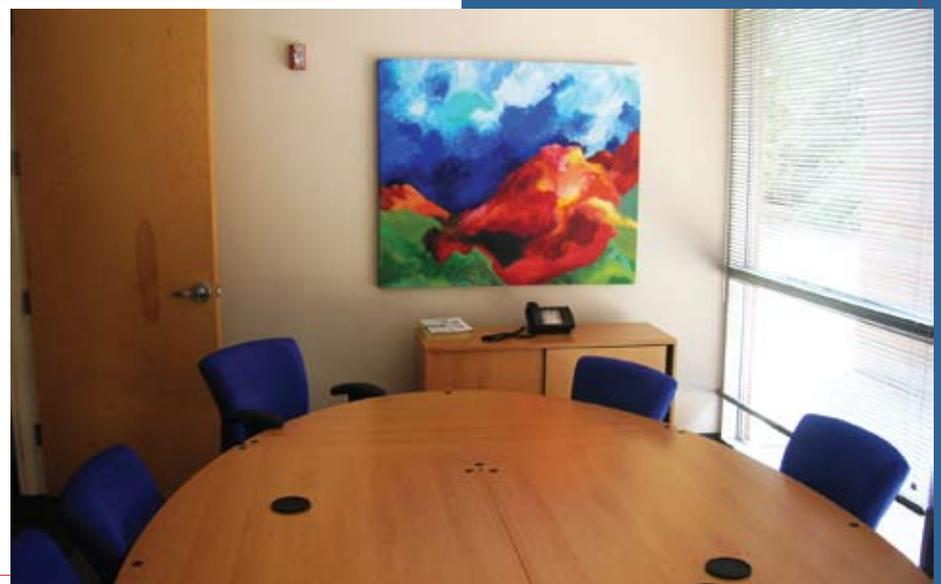
TECHNOLOGY INCUBATOR

The NC State Technology Incubator is located in the University's academic research park, Centennial Campus, and offers a truly collaborative blend of services and resources for the entrepreneur.

The Technology Incubator includes 48 individual Class A offices plus 10 wet laboratories. Incubator clients become part of a dynamic R & D neighborhood focusing on cutting-edge research with access to services such as funding opportunities, marketing strategies, and business planning. In addition to the wide array of support services and resources, clients are presented with the unique opportunity to partner with University departments, faculty, students, and research.

Entrepreneurs with products as diverse as specialized mold cultures, telecommunications applications, and biotechnology breakthroughs call the Technology Incubator their temporary home as they work toward commercializing their products and processes.

For more info, visit <http://techincubator.ncsu.edu>



Photos: Above left: Original painting displayed in the lobby of NC State's Technology Incubator. Right: Incubator shared facility conference room.

innovation is the ability to see change as an opportunity



INNOVATION NETWORK

EDP North Carolina needs and expects NC State to play a critical role in its economic transformation and in the accrual of economic benefits to all North Carolinians.

In 2003, NC State was the first North Carolina university to seize the opportunity to create an economic development office. Today, this Economic Development Partnership (EDP), informed by regionally organized strategies in high priority industry clusters, is leveraging university resources and expanding NC State's capacity to start, grow, retain, and recruit higher-skilled, higher-paying jobs and related corporate investments. Simultaneously, the EDP has successfully grown the University's research, education, and extension enterprises.

The EDP has successfully incorporated NC State programs into all aspects of economic development, from K-12 education to workforce development, technology commercialization, entrepreneurship, and community advancement.

For more info, contact
ruthann_cage@ncsu.edu

ACT With pilot funding from UNC General Administration, NC State's Technology Entrepreneurship and Commercialization Program (TEC) has developed a university system-wide program called Accelerating the Commercialization of Technology (ACT).

ACT supports the commercialization of intellectual property developed through the research activities of each UNC campus. Building upon the internationally recognized expertise of TEC, ACT expands NC State's technology transfer capabilities and commercialization assistance for the entire state.

The program is designed to evaluate technologies for commercial application, and to guide innovators in the development of appropriate strategies to bring those ideas to market.

SBTDC North Carolina's Small Business and Technology Development Center (SBTDC) helps entrepreneurs and those interested in forming a small company manage and plan for the future of their business.

The SBTDC has a presence on NC State's Centennial Campus and offers management counseling and educational services to small and mid-sized businesses throughout North Carolina. General business services range from management counseling and education to government contract procurement support and Small Business Innovation Research (SBIR) outreach.

For more info, visit
<http://www.sbtcdc.org>

\$1.4 billion

Government contracting represents a \$350 billion marketing opportunity that many small to mid-sized businesses have not explored. In 2006, the SBTDC helped client companies obtain over \$1.4 billion in government contracts, which helped support over 35,000 North Carolina jobs.

CENTENNIAL CAMPUS



INNOVATION NETWORK

we think a lot . . . alike

What's better than one innovative idea? An entire community of them. On NC State's Centennial Campus, collaboration is not just a good idea, it's the standard.

There is an increasing recognition that intellectual capital is of greater significance to the success of competitive entities than physical capital. A survey conducted by the Center for Entrepreneurial Development asked investors, "What is the key attribute in the Research Triangle that attracts you to making investments here?" 36% of respondents indicated that "knowledge capital" is the draw.

NC State's Centennial Campus operates as a unique, collaborative knowledge park designed to provide an environment for the region's best and brightest, cultivating a rich "knowledge capital" tradition through collaboration and increased opportunities for innovation.

Centennial Campus is an extremely visible manifestation of the entrepreneurship culture, offering benefits that are hard to find elsewhere. Centennial Campus offers shared equipment that might otherwise be cost prohibitive to smaller companies. There are opportunities to collaborate with graduate students and faculty. Leaders in cross-functional fields are able to

forge partnerships that work intellectually and logistically.

Spanning nearly 1500 acres, Centennial Campus is home to over 70 corporate and government partners and over 70 research centers, institutes, labs and academic units.

The Technology Incubator, the Office of Technology Transfer, the Technology Entrepreneurship and Commercialization Program and the Small Business Technology and Development Center are all located on Centennial Campus, making the amount of resources available to an entrepreneur comprehensive.

CAPITAL IDEAS

The process of technology development at NC State begins with the formal disclosure of an invention to the Office of Technology Transfer (OTT) describing the invention and its potential applications. In FY2007, NC State researchers disclosed 173 novel, innovative ideas to OTT demonstrating the multidisciplinary strengths, collaborative culture, and innovative climate of the NC State research community. This section of OTT's Annual Report highlights the breadth and depth of NC State's research tradition as evidenced by the intellectual property reported to OTT during FY2007.



green innovation leading biotech research before it was cool

Over the past 50 years researchers and scientists have rapidly begun to realize the advantages of biotechnology — namely the science of employing organic resources to solve human challenges. NC State has been doing just that for 120 years.

In 1887 legislation was passed establishing the North Carolina College of Agriculture and Mechanic Arts. Today NC State University continues that research and education tradition and is globally recognized for its core expertise in the fields of science, technology, engineering, textiles, and clinical sciences. Exactly the recipe for leading biotechnology innovation.

The Biotechnology Industry Organization, established in Washington DC in 1993 defines the biotechnology field as “science to benefit mankind by providing better healthcare, enhanced agriculture, and a cleaner and safer environment.”

Which is exactly what NC State researchers continued to do this year.

Unlocking a Tiny Mystery:

The study of small RNAs, especially those only 19~30 nucleotides (nt) in length, is gaining increasing attention. Researchers have demonstrated that such tiny RNAs are regulators and can control plant and animal gene expression, playing important roles in a remarkable range of biological pathways.

For example, one such class of these tiny RNAs — microRNAs (miRNA) — is thought to regulate at least one-third of all human genes and appears to be a potential biomarker for cancer related processes. But how do they do it?

Scientists need advanced tools to accurately and reliably detect miRNA and siRNA in biological samples.

this is the nature
of genius, to be
able to grasp the
knowable even
when no one else
recognizes that it is
present.

Deepak Chopra

INTELLECTUAL PROPERTY

Quantifying Small RNAs

NC State researchers, Dr. Vincent Chiang and Dr. Rui Shi, from the Department of Forest Biotechnology, have developed a one-step RT-PCR method for the detection and quantification of miRNA and siRNA.

RT-PCR (reverse transcription-polymerase chain reaction) is a technique for producing millions of copies of specific parts of the genetic code of an organism so that it may be readily analyzed. The technique is often used to help in the identification of an infectious agent.

The proprietary method developed by Dr. Chiang and Dr. Shi readily lends itself to high throughput applications.

Fruits of Labor: FY07 Plant Varieties

With one of the richest agricultural traditions in the nation, NC State's team of plant breeders and horticultural scientists continued to advance plant technology to address disease resistance, global crop improvements and market variety.

The impact of NC State's plant breeding program is far reaching, affecting not only our gardens and produce shelves, but also our economy:

The field and horticultural crops produced in North Carolina are worth nearly \$3 billion annually. If American growers are to continue to raise crops profitably, to compete against global competition, not to mention their ancient foes, disease and insect pests, they need an edge.

N.C. State University's College of Agriculture and Life Sciences (CALS) boasts a long and productive history of plant breeding and of developing new varieties of various crops that are designed to make growers in North Carolina and beyond more productive.

Breeders conduct research, cultivar and parental line development, and germplasm enhancement in departments including the Department of Crop Science, the Department of Horticultural Science, and the Department of Forestry. Other departments such as Plant Pathology and Entomology have faculty who are extensively involved in breeding programs for field crops, horticultural crops and trees.

To date, N.C. State University plant breeders have released for public use 641 cultivars, germplasms and parental lines. NC State breeders have developed 458 field crop cultivars, germplasms and parental lines and 183 horticultural crop cultivars, germplasms and parental lines.

plant cultivar class of 2007

Switchgrass (*Panicum virgatum* L.) - BoMaster
Switchgrass (*Panicum virgatum* L.) - Performer
Wheat: NC06BGTAG13
Wheat: NC06BGTAG12
NC-Stella (NC-302 x NC-306 F1) Melon: (*Cucumis melo* L.) NC302
NC-Sparta (NC-301 x NC-304 F1) Melon: (*Cucumis melo* L.) NC301
NC-Sapphire (NC-303 x NC-309 F1) Melon: (*Cucumis melo* L.) NC303
NC-Star (NC-302 x NC-305 F1) Melon: (*Cucumis melo* L.)
Melon: (*Cucumis melo* L.) inbred lines: (NC-301 — NC-306, NC 309)
NC 2000 LC Burley Tobacco
NC 2002 LC (ms) Burley Tobacco
NC BH129 LC (NC638 x TN 86 F1) Burley Tobacco
NC3 LC (NC1209 cms x NC DH19 F1) Burley Tobacco
NC4 LC (NC1246-11 x NC1426-17 F1) Burley Tobacco
NC5 LC (NC174 cms x NC821 F1) Burley Tobacco
NC6 LC (NC1209 cms x NC325 F1) Burley Tobacco
NC7 LC (NC775-5 cms x NC645 F1) Burley Tobacco
NC 103 Flue-cured Tobacco Hybrid



CAPITAL IDEAS

Photos this page: Landscape and paper factory paper roll. Opposite page upper: Spheroid of a human colorectal cell line. Lower: MEMS Accelerometer case and PDA designed by Biomedical Engineering Senior Design Team.

Energy. Economy. Environment.

According to a 2006 report by PriceWaterhouseCoopers — Global Forest, Paper and Packaging Industry Survey — the high energy consumption rate of current technologies used by the paper industry is impacting U.S. earnings. China has become the world's second largest producer of wood and paper products after the U.S. In order to retain a global share of the market, we must search out competitive advantage.

NC State researchers from the Department of Wood and Paper Science are researching advanced technologies that would not only reduce energy costs associated with the pulp bleaching process, but also reduce environmentally damaging waste discharge, while maintaining a high quality paper product.

Pulp bleaching is the process of chemically treating wood pulp fibres before papermaking to reduce or remove lignin and resin. Bleaching results in finished paper that has clean, white, bright characteristics with the ability to withstand degradation. This bright white paper ends up in our copy machines, laser printers, legal tablets, etc.

Certain currently used chlorination techniques that facilitate pulp bleaching can produce toxic chlorinated organic compounds and chlorides as waste. While such effluents have previously been discharged to streams and lakes, environmental statutes now regulate such pollutant containing discharges.

NC State's proprietary oxygen delignification method would reduce levels of pollutant discharge, reduce energy required to refine the oxygenated pulp, and produce final pulp products having desired physical characteristics.

Development and commercialization of this method has the promise of significant environmental, economic, and energy sustainability impact.



all truths are easy to understand once they are discovered; the point is to **discover** them

Galileo Galilei

Biomedical Engineering Innovative by Design

The Joint Department of Biomedical Engineering unites two prestigious university traditions: NC State's College of Engineering and UNC-CH's School of Medicine. Established in 2003, the concept itself is innovative. The intellectual property developed from this merger is even more impressive.

Biomedical research depends on sophisticated diagnostics and clinically progressive technologies. Researchers at NC State are taking up that challenge and advancing the architecture of biomedical microdevices.

In FY2007, NC State researchers developed a concept for an improved microfluidic device for spheroid cultures.

Biomedical researchers use microfluidic devices for DNA analysis, cell manipulation, cell separation and clinical diagnostics.

Dr. Glenn Walker observed the disadvantages of the current method of culturing spheroids using a culture dish and shaker. This traditional method introduces multiple cells into a relatively large volume of medium, which can result in spheroid fragmentation and re-aggregation.

Dr. Walker's microfluidic system solves this problem by culturing single spheroids in a chamber, the diameter of which is slightly larger than a single spheroid (~300µm). Because spheroids are inherently self-limited in their growth, they can be maintained at a constant size indefinitely within the chamber.

The microfluidic connections to the culture chambers allow the spheroids to be gently perfused with medium or exposed to arbitrary challenges. Spheroids can also be visualized *in situ* which allows them to be monitored continuously during experiments.

Dr. Walker's innovation paves the way for biomedical researchers to manipulate and observe spheroids in ways not possible with current technology.

While faculty members lead advances in biomedical research, they are also charged with NC State's core education mission. Enter Biomedical Engineering's Senior Design class.

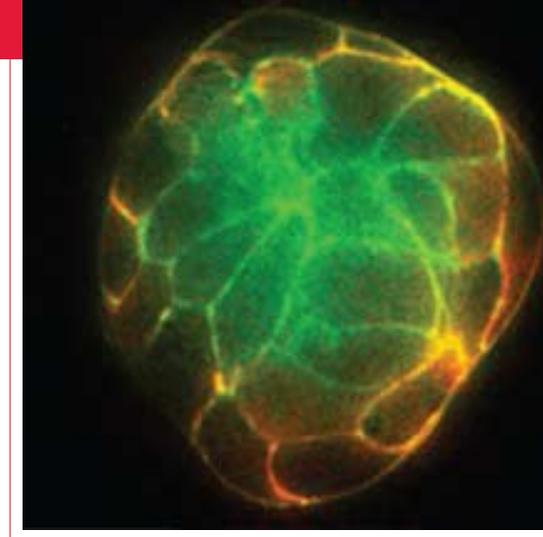
Andrew DiMeo, Biomedical Engineering Program Director for Industrial Relations, leads groups of undergraduate seniors through product development from concept to reality. Implementing industry standard design control processes, students learn the strategic skills necessary to find unmet needs and develop innovative solutions.

When Jennifer Boyd, Jennifer Hawthorne, Eric Rush, and Tabitha Staniszewski learned that 1 in 200 Americans use a wheelchair, they identified a need for a stationary

rehabilitation setting and developed their senior design project: a variable resistance treadmill for use with a manual wheelchair.

In FY2007, Senior Design Teams submitted seven invention disclosures to the Office of Technology Transfer. These innovations range from physical therapy devices, to wireless communication components, to a Sudden Infant Death Syndrome (SIDS) Intervention Device. The innovations are as diverse as the needs identified by each team.

The contributions of intellectual property made by the Department of Biomedical Engineering are significant. Disclosures received from the department and senior design teams account for 10% of all innovations reported this fiscal year.





CAPITAL IDEAS

Spotlight on Medical Devices

The development of specialized retraction devices is a key element in continued improvements to mitral valve repair and replacement surgeries. The mitral valve lies between the left atrium (upper heart chamber) and the left ventricle (lower heart chamber), such that a retractor device is used to gain efficient visibility and access to the mitral valve.

Dr. Gregory Buckner from NC State's Department of Mechanical and Aerospace Engineering recognized that current retractor devices used for mitral valve procedures tend to slip during surgery and may provide sub-optimal retraction. His team of researchers developed a progressive retraction device that improves exposure and visibility of the mitral valve through its reduced size and decreases slipping errors through a suctioning technology.

This innovative retractor, measuring only 3 inches in length, adheres to the surface of the exposed wall using a suctioning technology, allowing the surgeon to position the atrial wall for maximum operative field visualization.

In patients with isolated valve disease, minimally invasive procedures may be appropriate. A minimally invasive surgical approach includes a 2-3 inch right chest approach or a 2-3 inch mid-sternal approach. Dr. Buckner's device is smaller than currently used retractors, making it appropriate for minimally invasive surgeries.

Dr. Buckner's research team also developed a left atrial appendage clamp and hyper redundant active catheter in FY 2007.

Over 2 million patients in the US suffer from atrial fibrillation which is associated with the formation of thrombi in the left atrial appendage (LAA). To remove the threat of embolic events, the LAA is isolated from the left atrium. LAA closure is performed through minimally invasive surgery using suturing or surgical staples, which do not always perform the closure satisfactorily, and can cause tissue damage. Dr. Buckner's advanced technology prevents blood flow to the LAA with reduced risk of damage to delicate atrium tissues.

The clamp device utilizes a shape memory alloy (SMA) to spread the halves during installation. When the clamp is positioned correctly, the clamp closes to prevent blood flow to the appendage.

Shape memory alloys are also employed in Dr. Buckner's advanced catheter device. Current catheterization procedures can perforate delicate tissue during navigation through the vessel, exerting stress throughout the insertion process. The high-mobility active catheter conforms to a path, using a hyper-redundant structure, providing more flexibility and active control of the structure.

this nation has said there are no dreams too large, no innovation unimaginable and no frontiers beyond our reach

John S. Herrington

NC State's Center for Translational Research and Comparative Medicine (CTRCM) focuses on the comparative study of animal and human diseases as an initiative of the College of Veterinary Medicine.

Recognizing the interdependence of animal and human health and that each relies on a common store of medical and scientific knowledge, the CTRCM champions the concept of "One Medicine."

The phrase "One Medicine" is credited to Sir William Osler (1849-1919), the founder of the medical residency program, the first chief of staff at Johns Hopkins Hospital, and the father of essential features of comparative medicine, including veterinary pathology.

Schematic drawing of a novel medical device for positioning the mitral valve during surgery.

As part of CTRCM's mission, the Center leverages recent advances in biomedical research for the benefit of all animal species.

The interdisciplinary faculty involved with the Center include experts in fields as far ranging as oncology, biomaterials, and structural biochemistry. Capitalizing on clinical expertise in multiple areas and collaborating with scientists at UNC Chapel Hill, Duke, U.S. Environmental Protection Agency (EPA) and National Institute for Environmental Health Sciences (NIEHS) enhances the discovery potential of this working group.

The CTRCM's cross-laboratory approach provides a unique training experience and an environment of innovation facilitates the development of novel approaches to the diagnosis and treatment of disease.

The Center's core research areas include: Allergic Diseases; Biostatistics; Clinical Genomics; Emerging and Zoonotic Diseases; Mucosal Pathophysiology; and Oncology.

The center identifies the most appropriate animal model for specific areas of study that will benefit both human and animal health.

The oncology core, for example, concentrates on improving the understanding of the pathogenesis and treatment of cancer through collaborative research on induced and spontaneous models of cancer. Areas of focus include cancer genomics, cytogenetics, manipulation of tumor physiology, signaling and cell cycle control/differentiation, clinical diagnosis and treatment.

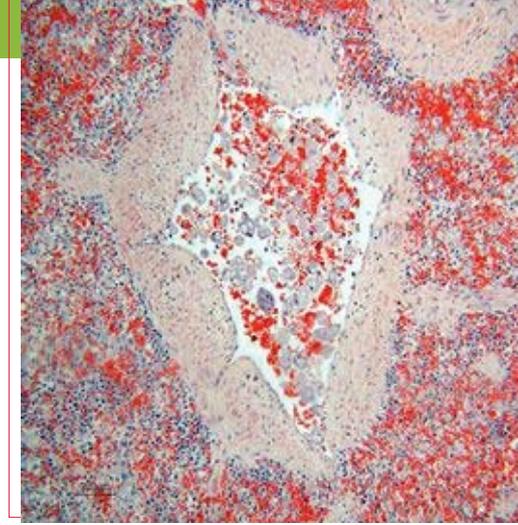
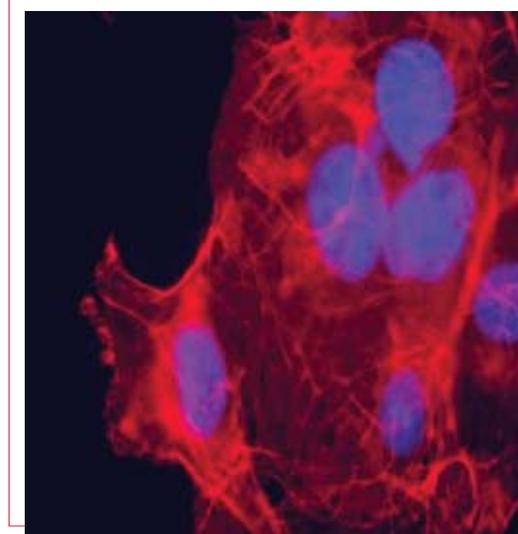
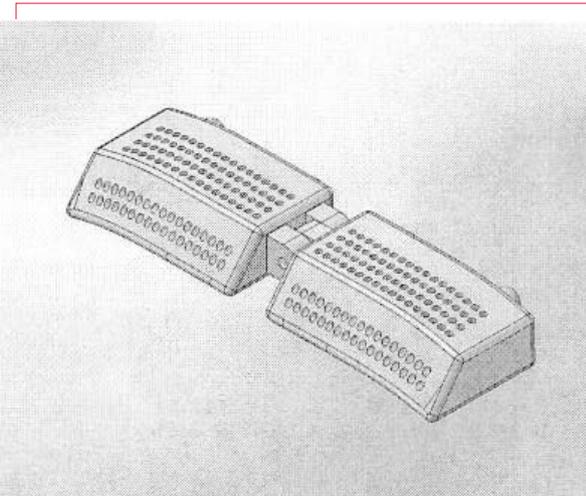


Photo above and below: Slides from CTRCM's Oncology Research Core and Emerging and Zoonotic Diseases Research Core.



tradition of innovation



IS IT PATENTABLE?

Industry partners capable of developing, producing, and marketing promising innovations often require that ideas are protected by patents before making the substantial investment required to further develop and commercialize academic discovery.

The US Patent Act of 1952 categorizes subject matter that qualify for patent protection as processes, machines, manufactures and compositions of matter. An invention must also satisfy the requirements of being new, useful and non-obvious to qualify as patentable subject matter.

To date, NC State's patent portfolio consists of 582 U.S. patents. NC State was issued 38 U.S. patents in 2006.

582 U.S. Patents

The issue of a U.S. patent indicates that one's work has been deemed novel, useful and worthy of protection under United States patent law.

Innovative capacity is one of the key drivers of a prosperous future. Last year, 33 NC State innovators confirmed that our University's innovative capacity is flourishing. Their work was recognized by the US Patent and Trademark Office (USPTO) as novel, useful and worthy of patent law protection, resulting in 38 new U.S. patents issued to NC State researchers. As of September 2007, NC State's current patent portfolio consists of 582 U.S. patents.

In April of 2007, the Office of Technology Transfer recognized those researchers whose innovations are resulting in new products, effective diagnostics, the preservation of our environment, the management of human diseases, and an improved standard of living.

Photo: Patent recipients gather in the Chancellor's Reception of the Alumni Center during the Annual Inventors Awards Ceremony & Banquet hosted by the OTT.

U.S. Patent Recipients

US 6,985,483	Methods and systems for fast packet forwarding Dr. Paul D. Franzon, Electrical & Computer Engineering
US 6,987,182	Process for producing cold-gelling hydrocolloids Dr. Christopher R. Daubert, Food Science
US 6,987,189	Short synthesis of pyridine-based pharmaceutical intermediates Dr. Daniel L. Comins, Chemistry
US 6,994,782	Apparatus for removing phosphorus from waste lagoon effluent Dr. Philip W. Westerman, Biological & Agricultural Engineering
US 6,995,265	Synthesis of nicotine derivatives from nicotine Dr. Daniel L. Comins, Chemistry
US 7,004,620	Method and system for conservative evaluation, validation and monitoring of thermal processing Dr. Josip Simunovic, Food Science Dr. Kenneth R. Swartzel, Food Science Mr. Eric J. Adles, Food Science
US 7,005,072	Method for removing phosphorus from waste lagoon effluent Dr. Philip W. Westerman, Biological & Agricultural Engineering
US 7,005,237	Method of making information storage devices by molecular photolithography Dr. Jonathan S. Lindsey, Chemistry
US 7,010,340	Methods, systems, and associated implantable devices for dynamic monitoring of physiological and biological properties of tumors Dr. H. Troy Nagle, Biomedical Engineering
US 7,015,471	Surface plasmon resonance systems and methods having a variable charge density layer Dr. Stefan Franzen, Chemistry
US 7,022,862	Scalable synthesis of dipyrromethanes Dr. Jonathan S. Lindsey, Chemistry Dr. Masahiko Taniguchi, Chemistry
US 7,035,317	Single-user decoder metrics for subtractive interference cancellation detectors in code-division multiple-access (CDMA) communication systems with time dependence variance residual multiple-access interference (RMAI) Dr. Alexandra Duel-Hallen, Electrical Engineering
US 7,040,157	Variable depth automated dynamic water profiler Dr. JoAnn M. Burkholder, Plant Biology, Center for Applied Aquatic Ecology Dr. Robert E. Reed, Center for Applied Aquatic Ecology
US 7,060,344	Three-dimensional deep molded structures with enhanced properties Dr. Behnam Pourdeyhimi, Nonwovens Cooperative Research Center, Textile & Apparel Technology & Management Dr. Trevor J Little, Textile & Apparel Technology & Management
US 7,063,839	Continuous method and apparatus for separating polymer from a high pressure carbon dioxide fluid stream Dr. George W. Roberts, Chemical & Biomolecular Engineering
US 7,067,672	Regioselective halogenation of nicotine and substituted nictotines Dr. Daniel L. Comins, Chemistry

We rely on inventors to improve our lives . . . unbridled invention is one hallmark of our legacy of freedom. If we foster this freedom and disseminate it around the world, there is no end to what we can accomplish.

James E. Rogan
Under Secretary of Commerce
for Intellectual Property and
Director of the US Patent and
Trademark Office 2003

U.S. Patent Recipients

US 7,074,507	Structures including perovskite dielectric layers and variable oxygen concentration gradient layers Dr. Jon-Paul Maria, Material Science & Engineering Dr. Angus Ian Kingon, Material Science & Engineering
US 7,091,293	Stereoregular polar vinyl polymers and methods of making the same Dr. Bruce M. Novak, Chemistry
US 7,095,062	Methods of fabricating gallium nitride semiconductor layers on substrates including non-gallium nitride posts, and gallium nitride semiconductor structures fabricated thereby Dr. Robert F. Davis, Material Science & Engineering
US 7,099,215	Systems, methods and devices for providing variable-latency write operations in memory devices Dr. Eric Rotenberg, Electrical & Computer Engineering Mr. Ahmed S. Al-Zawawi, Electrical & Computer Engineering
US 7,105,118	Methods of forming three-dimensional nanodot arrays in a matrix Dr. Jagdish Narayan, Material Science & Engineering
US 7,110,420	Integrated circuit devices having on-chip adaptive bandwidth buses and related methods Dr. Ralph K. Cavin, III, Electrical & Computer Engineering
US 7,112,678	Regiospecific synthesis of nicotine derivatives Dr. Daniel L Comins, Chemistry
US 7,112,954	Methods, systems, and devices for evaluation of thermal treatment Dr. Josip Simunovic, Food Science Dr. Kenneth R. Swartzel, Food Science Dr. Kandiyani Puthalath Sandeep, Food Science
US 7,115,385	Media and methods for cultivation of microorganisms Dr. Edward B. Breitschwerdt, Clinical Sciences
US 7,119,254	Endoglucanase gene promoter upregulated by the root-knot nematode Dr. Eric L. Davis, Plant Pathology
US 7,122,060	Phosphate fluorosurfactants for use in carbon dioxide Dr. Joseph M. DeSimone, Chemical & Biomolecular Engineering
US 7,128,848	Photoluminescent fibers and fabrics with high luminance and enhanced mechanical properties Dr. Behnam Pourdeyhimi, Nonwovens Cooperative Research Center, Textile & Apparel Technology & Management Dr. Trevor J Little, Textile & Apparel Technology & Management
US 7,132,545	Synthesis of nicotine derivatives from nicotine Dr. Daniel L. Comins, Chemistry
US 7,144,213	Method for controlling flow of process materials Dr. Gary Dean Cartwright, Food Science
US 7,148,023	Immunoglobulin E detection in mammalian species Dr. Bruce Hammerberg, Population Health & Pathobiology
US 7,148,361	Synthesis of phosphono-substituted porphyrin compounds for attachment to metal oxide surfaces Dr. Jonathan S. Lindsey, Chemistry
US 7,153,975	Boron complexation strategy for use in manipulating 1-acyldipyrromethanes Dr. Jonathan S. Lindsey, Chemistry Dr. Marcin Ptaszek, Chemistry

Patents not listed indicate donated intellectual property.



commercial partners **Licensing** and **Commercialization**



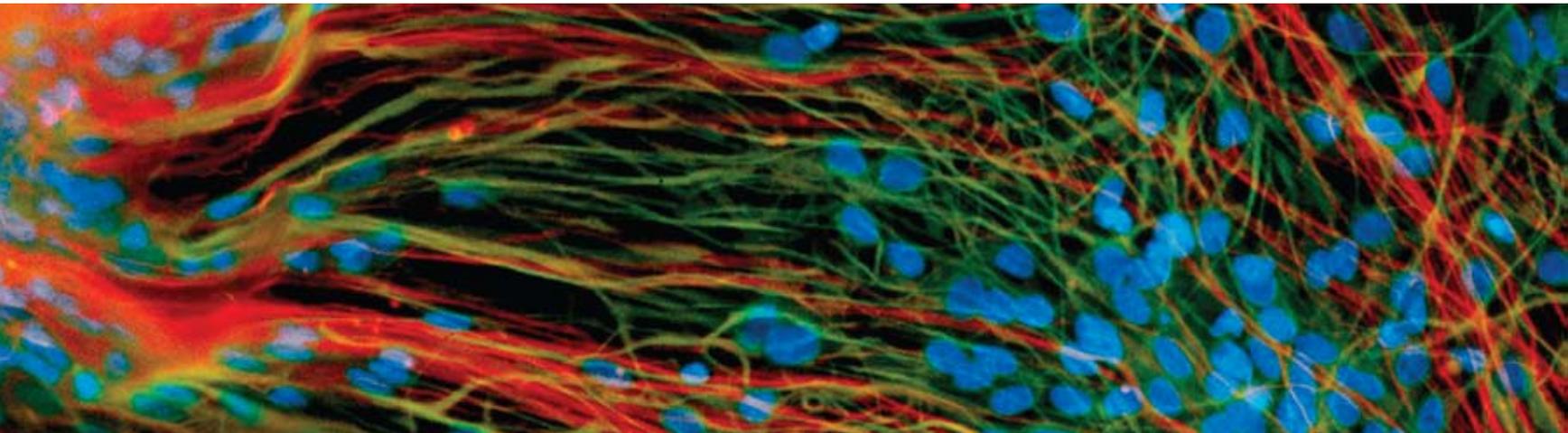
From green technology for high performance renewable biofuels to a proprietary methodology for vaccine development, NC State research is making its way through the commercialization corridor by teaming up with industry partners.

Together, we're putting ideas to work.

Over the last five years, NC State has invested nearly \$1.5 billion in research and development, averaging \$300 million in total research expenditures annually. The breadth of NC State's innovation and invention activities, ranging from nanotechnology to biomedical engineering, is reflected in our Technology Licensing Portfolio, consisting of over 2500 innovations.

The Office of Technology Transfer promotes University inventions to industry partners to facilitate further development and commercialization. The commercial appeal of an innovative idea often depends upon the patentability of the technology and the presence of a potential market to justify investment in development, manufacture, and marketing.

In FY2007, 106 industry agreements were negotiated by the OTT on behalf of the University. The OTT managed 71 individual company partnerships based on the added value NC State research brings to bear for their enterprise. ►



LICENSING & COMMERCIALIZATION

Vivalis (NYSE-Euronext : VLS)

In August of 2007, French biopharmaceutical company, Vivalis, exclusively licensed a method of producing undifferentiated avian cell cultures using primordial germ (PGC) cells from NC State. The new cell culture technology is based on the research of Dr. James N. Petitte of NC State's Poultry Science Department and works in concert with two related cell culture technologies Vivalis previously licensed from NC State in 2002.

The platform technology — U.S. Patent #6,333,192, "*Method of producing an undifferentiated avian cell culture using avian primordial germ cells*" — describes a novel method by which primordial germ cells are collected from an avian embryo and introduced to a growth medium in order to produce an embryonic stem cell phenotype.

The addition of NC State's intellectual property secures a market niche for Vivalis in advancing avian stem cell line research. Pharmaceutical companies including Novartis and GlaxoSmithKline have research agreements with Vivalis to study the company's stem cell lines for potential vaccine and therapeutic protein development.

IMS

In January of 2007, Industrial Microwave Systems (IMS) licensed technology from NC State that supported development of the company's Cylindrical Heating System. The system employs an aseptic process created through the joint efforts of IMS, NC State's Department of Food Science, and the USDA.

The Heating System enables pumpable foods and beverages to be uniformly and volumetrically heated in a continuous flow while processing. The uniform spatial and temporal delivery of high-intensity thermal energy solves the problem of "hot spots" encountered during traditional thermal processing.

Aseptic processing has gained favor by the food processing industry for its ability to provide safe food while maintaining the product's natural nutrients, texture and flavor. Market researchers predict that by the year 2015, 30 percent of U.S. food supply will be aseptically processed.

Life is trying things to see if they work

Ray Bradbury

Diversified Energy Corp.

NC State research coupled with the industry expertise of Diversified Energy Corporation (DEC) — a biotech company specializing in the development of advanced alternative and renewable energy technologies — led to a cost-effective, “green” method to produce high performance biofuels this year.

NC State researchers from the College of Engineering developed a “green technology” that has the potential to turn virtually any fat source – vegetable oils, animal fat, cuphea, algae – into biofuels.

Because of the flexibility of the process, virtually any lipid-based material with a fat source can be converted into virtually any biofuel.

In January of 2007, the Office of Technology Transfer managed the licensing arrangements to grant DEC the rights to further develop the technology with a goal of scale-up and ultimately, commercialization.

DEC has trademarked the process Centia,[™] derived from the Latin *crudus potentia*, — green power.

The process consists of a first stage hydrolysis reaction, where fats and oils are converted into free fatty acids. In a second stage, a carbon dioxide molecule is removed from these free fatty acids, yielding a long, straight chain hydrocarbon. These long straight chain molecules are then isomerized, cracked, and/or aromatized, yielding a wide range of

molecular sizes and structures. The final recipe of iso-alkanes, aromatics, and cycloalkanes can be adjusted to yield the desired octane number.

Existing transportation fuel infrastructures and gasoline engines have the potential to use DEC’s biogasoline without modification since the biofuel has equivalent chemical, physical, and combustion characteristics to traditional petroleum-derived gasoline.

Because the fuel is derived from renewable resources, net implications to greenhouse gases and other emissions are reduced as compared to traditional gasoline production.

Dr. William Roberts, Professor of Mechanical and Aerospace Engineering and Director of the Applied Energy Research Laboratory at NC State, developed the biofuels process with NC State’s Dr. Henry Lamb, Associate Professor of Chemical and Biomolecular Engineering; Dr. Larry Stikeleather, Professor of Biological and Agricultural Engineering; and Tim Turner, Mechanical and Aerospace Engineering graduate student.



MoreSteam

In April of 2007, NC State educators and experts in their respective fields from the College of Textiles and Industrial Extension Service partnered with MoreSteam.com to provide eLearning modules through the Six Sigma Program.

Six Sigma training and tools provide process improvement strategy and education in an online learning environment. The Office of Technology Transfer negotiated the licensure of University intellectual property for use by MoreSteam.com. MoreSteam.com is headquartered in Ohio and provides Six Sigma online courses globally.

The NC State modules offer a menu of classroom training and certifications related to Six Sigma methodologies in addition to corporate implementation support.

PRODUCTS WITH GLOBAL IMPACT

More than 100 commercially-available products have moved from NC State labs, benches and development environments to our daily lives and are playing a role in a healthier, safer and more convenient world today.

According to the latest Association of University Technology Managers (AUTM) survey, 527 new products were introduced into the market in 2005, with a grand total of 5,171 since AUTM began tracking university research-based products in 1980.

NC State's product development pipeline continues to grow, having resulted in over 100 products to market to date. The pipeline includes both breakthrough innovations and new indications for existing, well-understood methods and products that have the potential to impact lives and improve the human condition.

Here, we share several successful commercialization stories that represent how NC State research is truly impacting the greater public good.

SmartFresh®

Fruits and produce often don't make it to market due to rotting in transit or while in storage. NC State researchers developed a breakthrough innovation that safely protects apples and other produce from ethylene – a natural ripener – so the freshness, quality, flavor and nutrition of ethylene sensitive fruits are maintained and consumers can enjoy fresh produce throughout the year.

This ripening-process breakthrough has been commercialized as SmartFresh® and allows fruit and vegetable crops to arrive safely to market throughout the world.

This work was developed in the department of Biochemistry, College of Agriculture and Life Sciences and licensed to Rohm and Haas Company by NC State through the Office of Technology Transfer.

For more info, visit <http://www.smartfresh.com>



All good things that exist are the fruits of originality.

John Stuart Mill



BioUD™

Perhaps the biggest product launch based on University research in FY 2007, BiteBlocker with BioUD™ has burst onto the market as a natural alternative to DEET.

In March of 2007, the US EPA officially approved BioUD™ as a safe active ingredient in insect repellent for direct skin application with no child restrictions.

HOMS, LLC — the North Carolina-based biotech company that licensed the technology from NC State — began distribution plans immediately to match demand.

Dr. Michael Roe, William Neal Reynolds Distinguished Professor of Entomology, discovered that a naturally occurring compound found in wild tomato plants effectively repels a wide variety of insects. His research suggested that a “green technology” could be developed with efficacy levels that would challenge DEET. After patenting the discovery, the Office of Technology Transfer managed the licensing agreement with HOMS.

Published research shows that BioUD™



outperforms DEET and the eucalyptus compound found in Off Botanicals in testing against mosquitoes.

In fact, BioUD™ demonstrates 100 percent repellency against mosquitoes up to three hours after application and 99 percent repellency up to 4.5 hours in forest and marsh conditions.

BioUD™ has also demonstrated efficacy which rivals DEET against ticks. BioUD™ has been tested against American Dog Ticks, carriers of Rocky Mountain Spotted Fever, and Deer Ticks, carriers of Lyme disease.

For more info, visit <http://www.bioud.com/>

YorkTest

YorkTest Veterinary Services Ltd., provides allergy and intolerance testing products and services for the companion animal industry. YorkTest licensed technology from the College of Veterinary Medicine's Department of Population Health and Pathobiology for incorporation into its proprietary Canine Food Allergy Test. The company has since expanded its portfolio to include

a range of food and environmental allergy tests for dogs, cats and horses.

For more info, visit <http://www.animal-allergy.com>

YSI Vertical Profiler

Whether reservoir management concerns relate to surrounding land use or plant efficiency, having baseline data is a critical component in informed decision making. YSI licensed water quality technology from NC State's College of Agriculture and Life Science, Department of Plant Biology, to develop their Vertical Profiling System.

The vertical profiler provides continuous water quality data, typically once an hour, throughout the water column.

The profiler monitors total algal biomass that can be used to improve filter run times, identifies blooms, and monitors vertical migration of algae. The system also detects turnover events, and monitors the impacts of storms and land use on water quality.

For more info, visit <http://www.ysi.com>



NC STATE STARTUPS

In August of 2007, NC State startup BioMarck Pharmaceuticals, raised a \$4 million private investment round enabling the company to take a treatment for respiratory ailments into the second phase of proof-of-concept clinical study.

The treatment under development addresses diseases caused by hyper secretion of mucus and inflammation such as COPD, asthma, chronic rhinitis, sinusitis and cystic fibrosis.

Founded in 2002, BioMarck is based on scientific concepts developed by researchers of cell biology at NC State.

Working on things that matter

NC State has spun out 68 companies based on University discoveries, ensuring a vibrant economic climate for the region. While much of the business takes place within our state, the resulting technologies are of impact globally.

Intellectual property (IP) is crucial to a startup company in order to gain competitive advantage and market differentiation. According to a start up survey conducted in 2006 by Roeder-Johnson Corporation, unique technology is also significant in gaining investor interest and attention in the fundraising process.

Thus, academic intellectual property portfolios are natural resources for startup initiatives. According to the latest Association of University Technology Managers (AUTM) survey, 628 new startup companies were created in 2005 based on university technology platforms. That's 1.7 new companies each day!

NC State consistently ranks in the top 20 universities nationwide for startup companies formed each year. In fiscal year 2007, five new startups emerged, bringing the total number of NC State startups licensing university IP as their platform technology to 68.

The formation of a startup company illustrates how academic research and creative work are tied to the economy and competitiveness. These entities create new jobs and opportunities for North Carolinians, increase our region's funding influx and serve to keep our region's economic climate healthy.

The majority of NC State's spin-outs are headquartered in North Carolina contributing to the statewide job market. Biolex Therapeutics, headquartered in Pittsboro, has received over \$100M in venture capital and created over 100 jobs in the state. Nitronex has received \$77M in venture capital and created over 50 new jobs.

A vibrant economic development strategy is vital to ensuring North Carolina's competitive edge and prosperous future. These 68 companies are building on academic discovery to create real world solutions for the region, the state, the nation, and the world.

class of 2007

Agile Sciences, Inc. (PAMS) – Developing compounds inhibiting biofilm (communities of bacteria) formation. The virulence and persistence of drug-resistant bacteria is dependent on the ability to form biofilms. Products will treat surfaces where bacteria are common.

DPoly Systems (COE) – Developing new plastics recycling technology that offers faster, lower cost conversion of commonly recycled plastics into purified, reusable resin for new products. www.dpoly.com

AP Solutions, Inc. (COE) – Commercializing turn-key Plasma Application Systems and pioneering techniques including surface preparation, green manufacturing, novel material synthesis, and materials characterization. www.aplasmasolution.com

ImagineOptics, Inc. (COE) - Developing a revolutionary projection display technology that is low cost and light efficient. This technology will enable the development of projection devices the size of a PDA that have higher resolution, contrast, and light intensity than conventional display technologies.

IntelliCATH Surgical Corporation (COE) - Developing innovative products to improve human health. Initial product development efforts are based on two NC State technologies, a Kyphotic Spinal Immobilizer and a MEMS-based Adjustable Stiffness Catheter.

Micell Technologies

Micell Technologies, Inc. — an NC State biomedical startup — closed on \$7M in venture funding in August of 2007.

Founded in 2001, Micell develops product therapies in the cardiovascular, orthopedic, and drug-delivery areas.

The company is currently advancing a surface modification innovation employing supercritical fluid technology. Micell's technology involves the electrostatic capture of micro and nanoparticles of polymers and drugs onto the surface of a medical device followed by polymer gelling and sintering utilizing supercritical fluid.

Through electrostatic capture of the nano and microparticles of the drug and polymer, all intricate surfaces of the device can be coated. In addition, the distribution of drug in the coating can be manipulated.

Micell's supercritical fluid methods provide opportunities for independent placement of multiple drugs into discrete microenvironments within the surface coating of a medical device, eliminating any potential chemical interactions and providing a potential mechanism for controlling discrete therapeutic effects.

NC STATE STARTUPS

Biolex Therapeutics

In August of 2007, Biolex Therapeutics filed with the U.S. Securities and Exchange Commission (SEC) for an initial public offering of its common stock.

In November of 2006, Biolex Therapeutics was named the Top Venture Capital Invested Company of the Year, having received over \$60M from investors.

Headquartered in Pittsboro, NC with over 100 employees, the company's platform technology is based on proprietary research from NC State. The biopharmaceutical development method uses duckweed to replicate human therapeutic proteins, which can be converted into medicines.

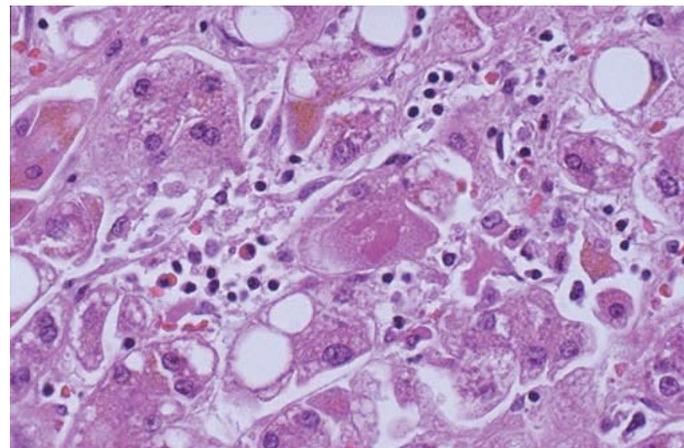
Biolex utilizes its patented LEX System™, a complete set of technologies and capabilities demonstrated to significantly enable faster, less-expensive development and production of proteins (such as peptides and cytokines) and antibodies.

Biolex Therapeutics' lead product, Locteron™, entered Phase 2a clinical trials in January of 2007. Locteron™ is being developed as a treatment for chronic Hepatitis C, a virus infecting more than four million people in the US. The Phase I study demonstrated fewer and less severe side effects over PEG-INTRON®, the currently marketed interferon that served as the control. Participants receiving Locteron™ also demonstrated biomarker levels that were equal to or greater than the participants receiving the control. Further, Locteron™ requires dosing once every two weeks, a substantial improvement over currently marketed pegylated interferons that require dosing every week.

Incorporated in 1999, Biolex Therapeutics is founded upon a proprietary platform technology developed in NC State's Department of Forestry. The company calls the Triangle region home employing local professionals and contributing to the economic development of the region.

Photos this page: Above: Lemnaceae, commonly known as 'duckweed,' grows in still or slow-moving fresh water.

Right: Viral hepatitis C. 50% of cases lead to chronic liver disease.



Innovation is the specific instrument of entrepreneurship.

Peter F. Drucker

LaamScience

By June of 2007, LaamScience — a nanotech company spun out of NC State — had raised \$2M in investment, according to media reports. Incorporated in 2006, the company develops antimicrobial coatings which inactivate 99.9% of viruses and bacteria when exposed to visible light. Think hospital waiting room upholstery, surgical masks, daycare carpeting. Anywhere “germs” are the enemy.

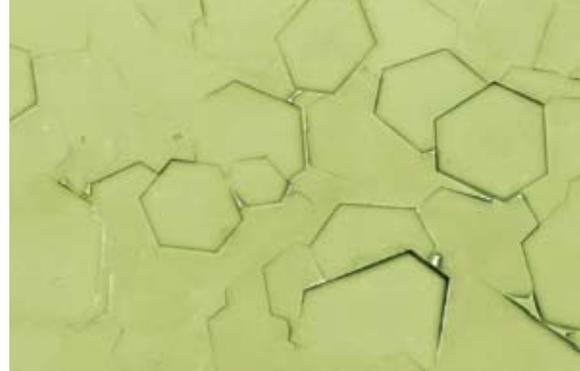
Pandemic disease and antibiotic resistant organisms are the focus of increasing worldwide concern. Avian influenza infections in humans now occur through direct contact with infected fowl, but health officials fear the H5N1 Flu will mutate into a more virulent, air-borne form which can spread through coughs and sneezes. The company plans to commercialize products that will protect against

influenza, cold and respiratory syncytial viruses, avian flu, SARS, West Nile virus, smallpox, and Ebola. Initial products will include surgical masks and face masks with subsequent applications to include hospital textiles such as gowns, divider curtains, bed linens, and air filters for planes, homes and commercial buildings.

LaamScience is built around the discoveries and science of Dr. Stephen Michielsen, Ph.D., Associate Professor of Textile and Apparel Technology and Management at NC State in collaboration with researchers from Microbiology & Immunology at Emory University.

Kyma Technologies

In January of 2007, the U.S. Department of Defense (DOD) awarded Kyma Technologies — an NC State startup company — a contract worth up to \$3.3M to further research and develop its gallium nitride (GaN) technology for advanced semiconductor chips. DOD is interested in using the GaN technology for its specialized high-power, high-performance, high-frequency military applications. The development focuses on achieving unparalleled reliability by



Gallium Nitride crystals.

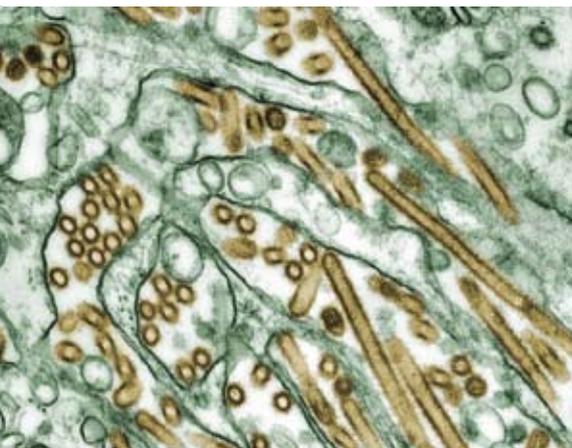
enabling a higher quality “device active region.” The company has received approximately \$7M in government contracts since 1998 and raised \$9.5M in venture capital.

Economics of Biopharma

Using plant tissues to express human therapeutic proteins demonstrates advantages over a chemical synthesis approach. Employing a renewable resource such as duckweed decreases manufacturing time, improves cost efficiency and production can be more easily expanded to provide larger quantities as demand increases. Production and cost advantages of biopharmaceuticals can allow more capital to be invested in research and development of new therapeutics, giving patients access to new drugs faster.

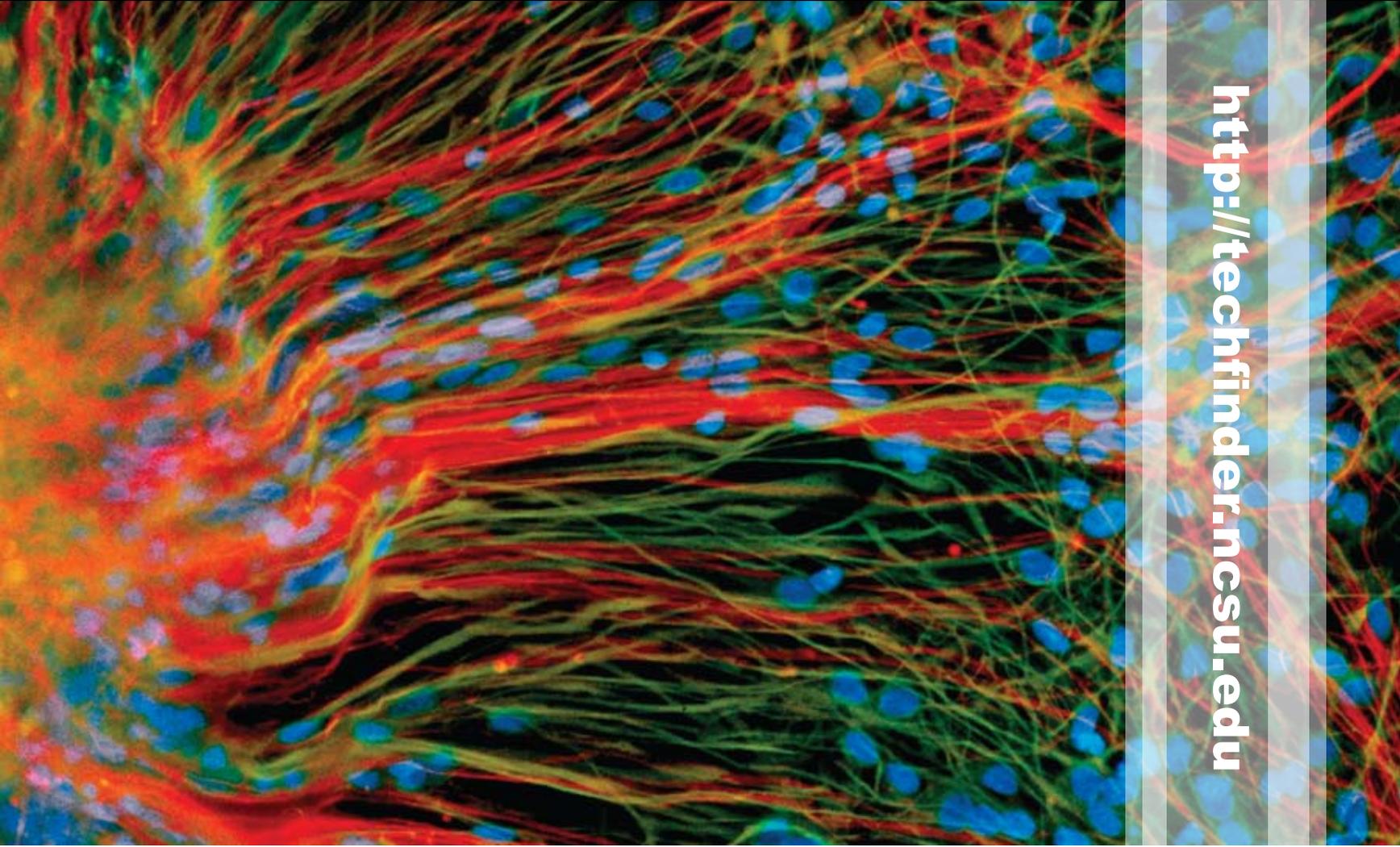
The global biopharmaceuticals market was estimated at US\$50 billion in 2005 with projected 10% annual growth rate. Revenues are expected to reach \$92 billion by 2011.

Avian influenza virus, also known as 'bird flu' now affects over 30 countries.



Every great advance in science has
issued from a new audacity of imagination.

John Dewey



<http://techfinder-ncsu.edu>

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