



**Georgia Tech**  **Parker H. Petit Institute for  
Bioengineering & Bioscience**

## **2014 IMPACT REPORT**

***Discover. Innovate. Collaborate.***



## ***Discover. Innovate. Collaborate.***

These three simple yet powerful words describe the Parker H. Petit Institute for Bioengineering and Bioscience at Georgia Tech where discoveries are feeding innovation in a collaborative research setting.

This report showcases our impact to the bio-community and how we have discovered, innovated, and collaborated in the past year. With over 150 faculty and 17 research centers, we are proud of the strong community we continue to build within Georgia Tech and our partner institutions for catalyzing, cultivating, and deploying interdisciplinary research and education in bioengineering and bioscience.

World-class researchers at the Petit Institute work together to translate scientific discoveries into game-changing solutions to solve real world problems. Inside this report, we highlight how RNA can be used for DNA repair, how brain circuits can multitask, cancer discoveries, microneedle technology that allows self-administered vaccines, and more. We also spotlight our faculty, which has tripled in size in the last 10 years.

In 2014, we held over 100 seminars, workshops, symposia, and special events bringing together over 5,600 individuals from around the country, universities, government, and industry to learn and share the latest discoveries within the bio-community. We have over \$24 million invested in our state-of-the-art research facilities, and in 2015 the new Engineered Biosystems Building will be opened on Georgia Tech's campus helping meet the demand of our growing bio-community.

Thank you for all your support this past year. It is exciting to be a part of such a unique, collaborative, and entrepreneurial environment that is truly focused on making a difference.

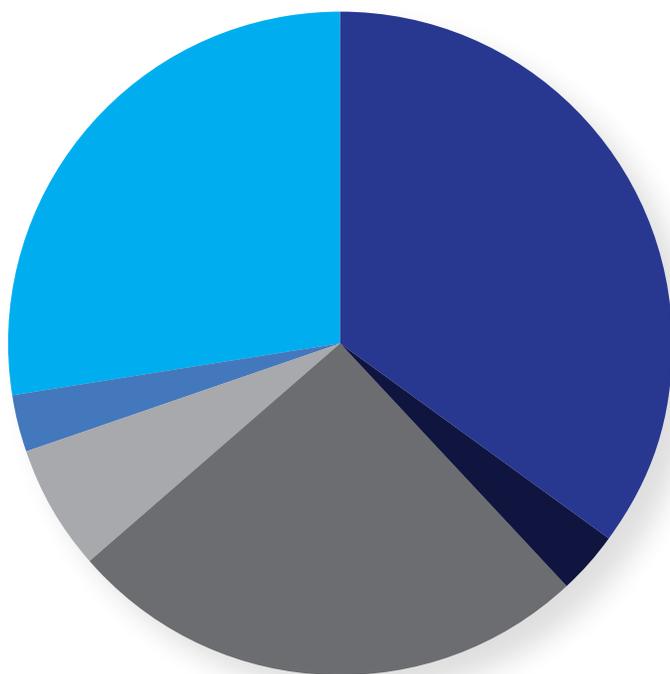
A handwritten signature in black ink, appearing to read "Robert E. Guldberg". The signature is stylized and cursive.

Robert E. Guldberg, Ph.D.

Executive Director

Parker H. Petit Institute for Bioengineering and Bioscience

# Petit Institute Research Funding | FISCAL YEAR 2014



NIH	35.2%
DOD	3.1%
NSF	25.4%
Industry	6.2%
NASA	2.8%
Other	27.3%

**TOTAL**  
**\$58.2 million**

## Petit Institute Reach in 2014



### Faculty

**tripled** IN SIZE

**50** IN 2004 **159** IN 2014



### Reach

**> 100** EVENTS

**> 5,600** ATTENDEES



### Research

**9** FOCUS AREAS

**10** CORE FACILITIES

**17** RESEARCH CENTERS

WITH OVER **100** PIECES OF LAB EQUIPMENT

Sometimes, discoveries are accidental, sudden, or an epiphany. Other times, they are the result of a dedicated search by scientists and engineers to understand the unfathomable. For two decades, the Petit Institute has served as a catalyst for discoveries that can be leveraged to solve real world problems.

## RNA Can Be Used for DNA Repair

The ability to accurately repair DNA damaged by spontaneous errors, oxidation, or mutagens is crucial to the survival of cells. This repair is normally accomplished by using an identical intact sequence of DNA. But a groundbreaking study in the Georgia Tech lab of Francesca Storici shows that a cell's own RNA can be used for DNA recombination and repair in yeast cells.

“Genetic information can flow from RNA to DNA in a homology-driven manner, from cellular RNA to a homologous DNA sequence,” said Storici, associate professor in the School of Biology, whose research was published in the journal *Nature*, and was supported by the National Science Foundation, the National Institutes of Health, and the Georgia Research Alliance.

The finding provides a better understanding of how cells maintain genomic stability, and if the phenomenon extends to human cells, could potentially lead to new therapeutic or prevention strategies for genetic-based disease.

## Brain Circuits Can Multitask

Research in the lab of Garrett Stanley found that neural circuits in the brain rapidly multitask between detecting and discriminating, offering important clues on how the outside world makes its way into our brains.

The study, published in the journal *Neuron*, may help scientists answer fundamental questions about how neurological disorders may disrupt brain circuits, and lead to insights that could result in better understanding of disease, new therapies, or methods to improve how the brain functions.

“This paper squarely goes after that link between what the brain is doing, how it's activated, and what that means for perception,” said Stanley, professor in the Wallace H. Coulter Department of Biomedical Engineering.



*Discover:* To see, find, or become aware of something for the first time, something hidden or difficult to see; often something surprising or unexpected.

### Dawson Lab Makes Cancer Discoveries

The lab of Michelle Dawson published two studies last year that showcased important new discoveries in the biomechanics of cancer.

Researchers identified how one important gene helps breast cancer cells break free from the primary tumor (90 percent of cancer-related deaths are caused by the spread of cancer cells from their primary tumor). Analysis of downstream signaling pathways of this gene, called SNAIL, could be used to identify potential targets for scientists who are looking for ways to block or slow metastasis.

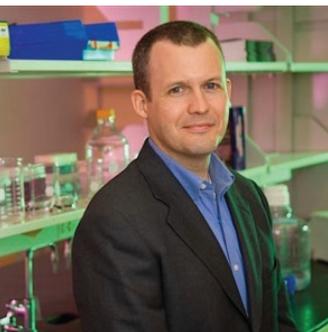
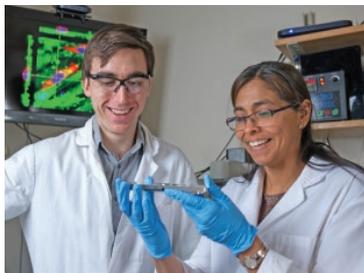
Previously, Dawson and graduate student Daniel McGrail published a study showing that ovarian cancer are more aggressive on soft tissues (such as the fatty tissue that line the gut), a finding that is contrary to what is seen with other malignant cancer cells that seem to prefer stiffer tissues.

### Evolution of Life's Operating System Revealed

The history of the ribosome, a large molecular structure found in the cells of all species, is a roadmap to the origin of life. In a NASA-sponsored study published last year, researchers were able to model the structures of primordial ribosomes, which use mRNA as a blueprint for building all the proteins and enzymes essential to life.

"We have worked out on a fine level of detail how the ribosome originated and evolved," said Loren Williams, professor in the School of Chemistry and Biochemistry at Georgia Tech, who called the ribosome's translation system, "the operating system of life."

"At its core the ribosome is the same everywhere," Williams said. "The ribosome is universal biology."



The world-class researchers at the Petit Institute are constantly exploring new frontiers in bioengineering and bioscience, working across multiple disciplines to translate scientific discoveries into game-changing, innovative solutions to influence human health and revolutionize healthcare delivery.

## Researchers “Move” Brain Tumors

Malignant cells from brain tumors spread to new locations by following nerve fibers and blood vessels, making treatment difficult.

But researchers have learned to hijack this migratory mechanism, so instead of invading new areas, the migrating cells latch onto specially-designed nanofibers and follow them to a location – potentially outside the brain – where they can be captured and killed.

“We have designed a polymer thin film nanofiber that mimics the structure of nerves and blood vessels that brain tumor cells normally use to invade other parts of the brain,” said Ravi Bellamkonda, chair of the Wallace H. Coulter Department of Biomedical Engineering, and lead investigator of the research team, which included the Children’s Healthcare of Atlanta and Emory University.

## Self-Administered Flu Vaccine Patch May Be Feasible

Microneedle technology from the lab of Mark Prausnitz could change the way people protect themselves from the flu. Results of a study published in the journal *Vaccine* suggest that self-administered vaccine microneedle patches may soon be feasible.

“Our dream is that each year there would be flu vaccine patches available in stores or sent by mail for people to self-administer,” said Prausnitz, a Regent’s professor in the School of Chemical and Biomolecular Engineering.

The study also found that use of a patch might increase the rate at which people vaccinate against influenza, while significantly reducing the overall cost and relieving the burden on health care professionals.



*Innovate:* To do something in a new way; to have and develop new, transformative ideas about how something can be done.

### Synthetic Platelet-like Particles Slow Bleeding

A new class of synthetic platelet-like particles could enhance natural blood clotting for the emergency treatment of traumatic injuries, while giving doctors a new option for limiting surgical bleeding.

“If EMTs and medics had particles like these that could be injected and then go specifically to the site of a serious injury, they could help decrease the number of deaths associated with serious injuries,” said Ashley Brown, Georgia Tech research scientist and first author of the paper that appeared in the journal *Nature Materials*, the result of a collaborative effort between Georgia Tech, Emory University, and Children’s Healthcare of Atlanta.

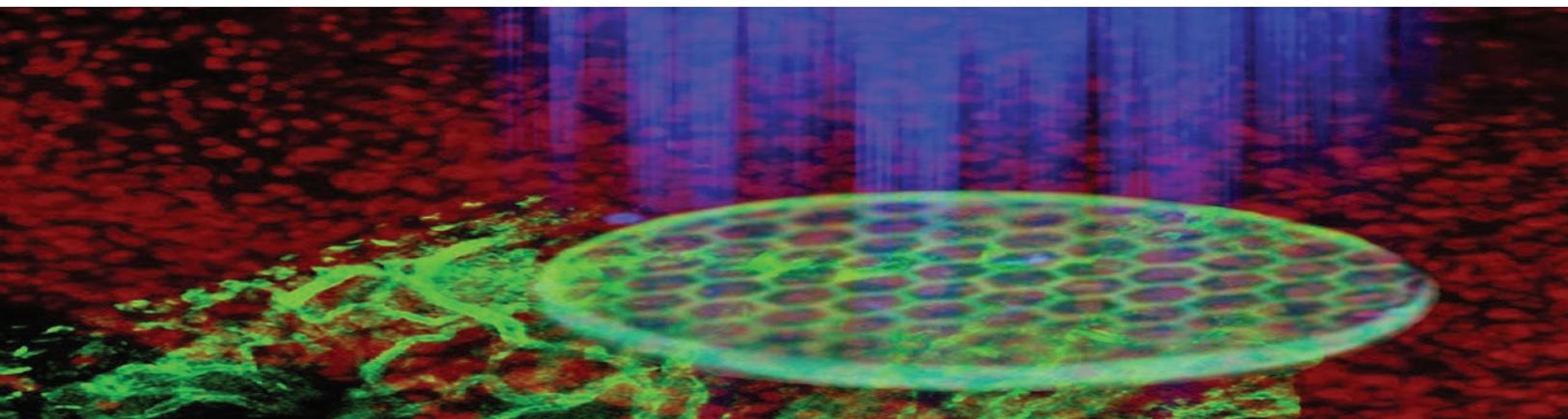
The particles, triggered by the same factor that initiates the body’s natural clotting processes, may also help physicians address some blood clotting disorders without the need for natural platelet transfusion, which can be costly and difficult to obtain.

### Growing Blood Vessels With Light

Researchers at Georgia Tech have demonstrated for the first time how biological signals presented on biomaterials can be activated by light through the skin of a living animal. If it can be made to work in humans, the technique could provide more precise timing for processes essential to regenerative medicine, cancer treatment, immunology, stem cell growth, and a range of other areas.

The research team developed molecular “hats” for peptides (a compound that launches many biological processes) as a disguise to sneak biomaterials into living animals. So, when the team shines an ultraviolet light on the peptides, the disguise comes off, and the body’s cells and other molecules interact with them.

“Until now, we haven’t had control over the sequence of events in the response to implanted materials,” said Andrés García, principal investigator in the research, which was presented in the journal *Nature Materials*. “But with this technique, we can deliver a drug or particle with its signal in the ‘off’ position, then use light to turn the signal ‘on’ precisely when needed.”



# COLLABORATE

Research collaborations have been at the heart of the discoveries and innovations that have emerged from the Petit Institute, which has served for 20 years as a foundation for catalyzing and facilitating interdisciplinary collaborations. Because tackling complex research problems is not a solo act. It takes a team.

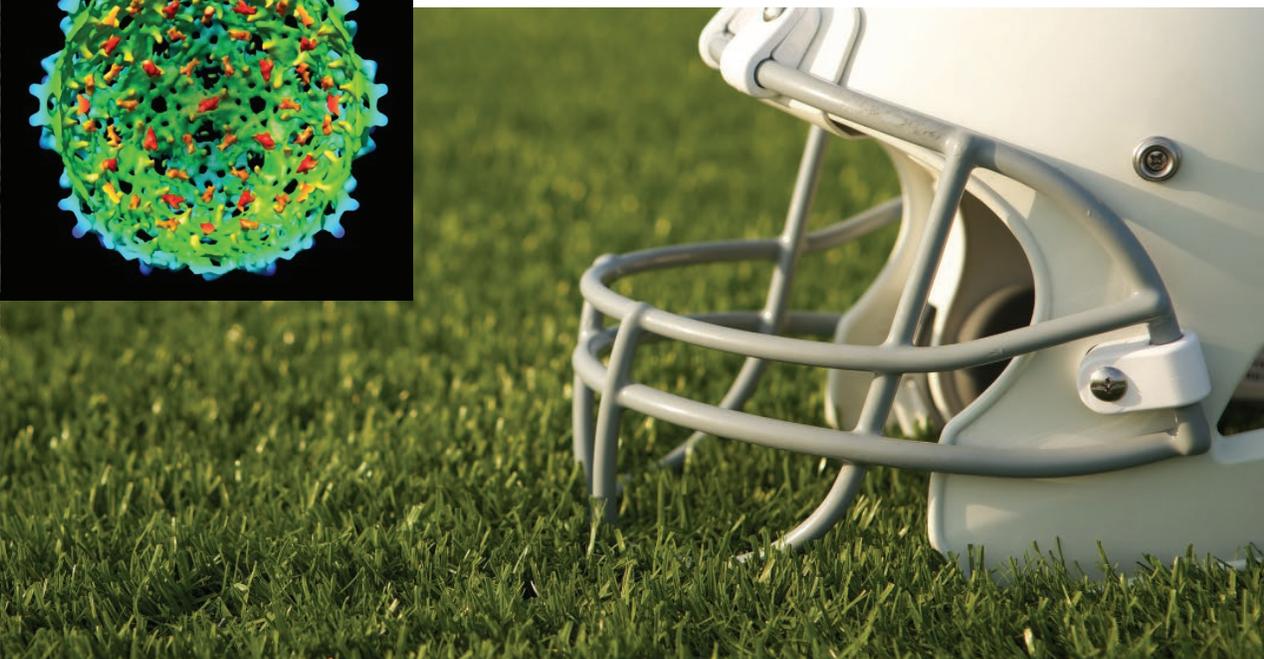
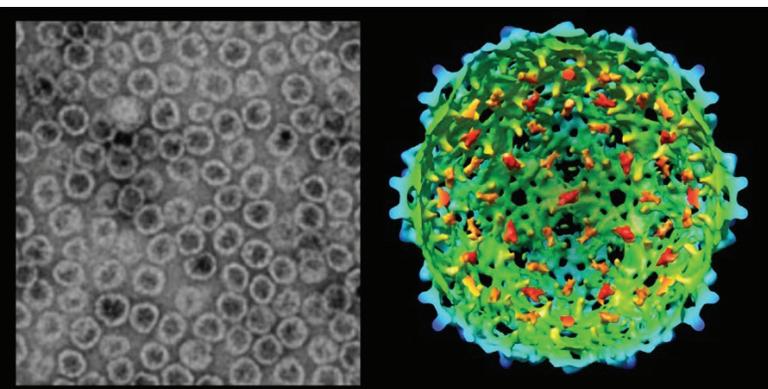
## Emory Partnerships Advance Research

Georgia Tech and Emory University have long been research partners in the Petit Institute. The partnership added a number of highlights in 2014, including establishment of the Georgia ImmunoEngineering Consortium (GIEC). The GIEC will bring researchers and clinicians together to focus on cancer, infectious diseases, autoimmune and inflammatory disorders, and areas of regenerative medicine including transplantation, bone and cartilage repair, and treatments for spinal cord injuries.

Meanwhile a team of physicians and engineers from Emory University and Georgia Tech was recognized by the National Football League (NFL) as winner of the Head Health Challenge II, a competition for new

innovations intended to speed diagnosis and improve treatment for concussions. The Atlanta-based team helped by Petit Institute faculty member Michelle LaPlaca won \$500,000 for iDETECT, a rapidly deployable, easily administered, comprehensive system designed to improve neurologic assessment following mild traumatic brain injury.

Also, researchers from Georgia Tech and Emory University partnered with researchers from Princeton University in a study that identified a gene expression profile associated with an elevated risk of cardiovascular death, which could help identify patients that might benefit from personalized treatment and counseling.



*Collaborate:* To work with another person or group in order to achieve something, working together, especially in an intellectual endeavor.

### Stem Cell Consortium Launched

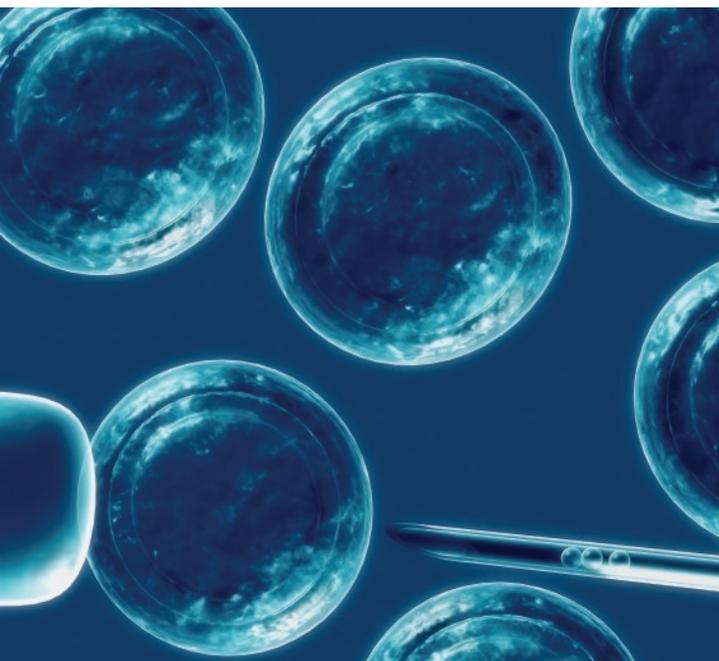
The Georgia Research Alliance (GRA) is leading a partnership that includes Georgia Tech, the University of Georgia, and seven other institutions (from academia and industry) from across the country that have formed the Cell Manufacturing Consortium.

The consortium, funded by a \$500,000 planning grant administered by GRA, is part of a national initiative to make the U.S. the world leader in biomanufacturing of cell therapies, projected to be a \$10 billion global industry within a decade. One potential goal would be to become an Institute for Manufacturing Innovation (IMI), a designation that has ensnared federal grants valued at \$30 to \$70 million for other manufacturing initiatives around the nation.

### UGA Joins Center for Regenerative Engineering and Medicine

The Center for Regenerative Engineering and Medicine (REM) grew in reach and potential last year when the University of Georgia (UGA) joined Georgia Tech and Emory University in this wide-ranging collaborative research effort. And the REM probably hasn't stopped growing yet, according to the Center's new co-director from Georgia Tech, Johnna Temenoff.

"The addition of UGA is significant, and I would like to see the Center grow even further," says Temenoff. Each participating university has an REM co-director – Ned Waller represents Emory and Steve Stice is at UGA's helm. "We have an opportunity to really turn this into a statewide initiative and perhaps garner even greater support for our work."



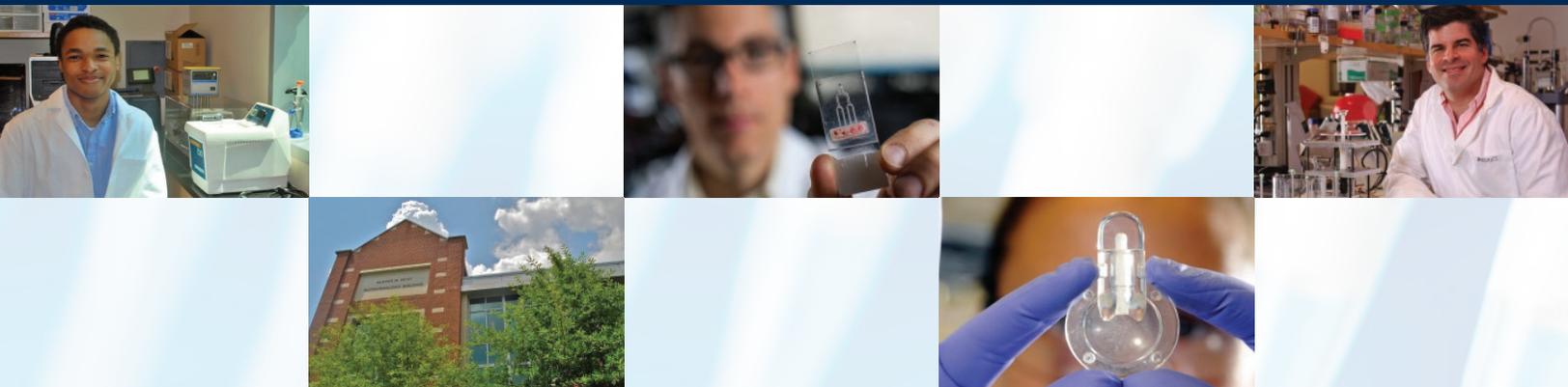
Georgia  
Research  
Alliance



The University of Georgia



“Research, like life, is a people business,” is a favorite maxim of Petit Institute founding director Bob Nerem. Innovative, collaborative discoveries only happen through the generosity and commitment of people who are routinely recognized for their cutting edge research and career achievements.



## BRAIN Power at Petit Institute

Petit Institute faculty members Craig Forest and Garrett Stanley secured \$1.5 million for their research in the first wave of NIH funding as part of the BRAIN Initiative (Brain Research through Advancing Innovative Neurotechnologies).

The BRAIN Initiative is a \$300 million public-private program started by President Obama, to unlock the mysteries of the human brain.

## Nerem Gift to Fund Faculty Post

Bob Nerem, founding director of the Petit Institute, is helping to ensure the Institute's continued excellence. He and his wife, Marilyn, made an estate commitment to one day establish the Marilyn R. and Robert M. Nerem faculty chair of professorship in the Parker H. Petit Institute for Bioengineering and Bioscience.

The goal, Nerem said, is to enhance the Petit Institute's ability to attract and retain eminent teacher-scholars to this position of academic leadership.

## Training the Next Generation

In addition to being an influential hub of research and discovery, the Petit Institute serves as an incubator of new talent, an education center where new opportunities are created. Last year saw several milestones and highlights in several student-centered programs, such as:

- The Petit Undergraduate Research Scholars program celebrated 15 years with its largest class yet. More than \$50,000 was raised to support the program, which soared to support 20 new scholars to conduct independent research projects for a full year at the Petit Institute.
- Project ENGAGES more than doubled in size (from 10 students its first year, to 24 for the 2014-2015 school year). The ambitious program is designed to raise awareness of high school students in economically challenged, minority-serving public schools to the world of engineering, science, and technology.
- Petit Institute graduate students, having formed a new student chapter of the Society for Biomaterials, organized and hosted the first Biomaterials Day at Georgia Tech, when more than 160 students and faculty from a dozen universities descended on the Marcus Nanotechnology Building for a sold-out event that received rave reviews.

## Faculty Recognitions

**Dan Goldman** named one of 102 researchers to receive a Presidential Early Career Award for Scientists and Engineers

**Hang Lu** named 2013 American Association for the Advancement of Science (AAAS) Fellow

Petit Institute Interdisciplinary Education and Research “Above & Beyond” Awardees: **Julia Babensee** - Senior Faculty Award and **Christine Payne** - Junior Faculty Award

**Brandon Dixon** awarded 2014 National Science Foundation CAREER Award

**Jeff Skolnick** honored as Southeastern Universities Research Association’s (SURA) Distinguished Scientist

**Mark Prausnitz** receives 2014 Institute Award for Outstanding Achievement in Research Innovation at Georgia Tech

**Gang Bao** receives the 2014 Institute Award for Outstanding Achievement in Research Program Development

**Christine Payne** awarded the Vasser Woolley Faculty Fellowship

**Ronghu Wu** awarded a Blanchard Assistant Professorship

**May Wang** appointed a Distinguished Lecturer for 2014-2015 IEEE Engineering in Medicine and Biology Society

**Mostafa El-Sayed** named to President’s Committee on the National Medal of Science

**Ravi Bellamkonda** awarded National Clemson Award for Applied Research

**Ravi Bellamkonda, Ross Ethier, Todd McDevitt, and Krishendu Roy** recognized as top 20 Medical Researchers in the State of Georgia

**Andrés Garcia** named as Rae S. and Frank H. Neely Endowed Chair

**M.G. Finn** named Interim Chair of School of Chemistry & Biochemistry

**Pamela Peralta-Yahya** named to the 2014 Class of Dupont Young Professors

**Chris Rozell** awarded the James S. McDonnell Foundation 21st Century Science Initiative Scholar Ward in Studying Complex Systems

**Nick Hud** named International Astrobiology Society Fellow

**Hanjoong Jo and Cheng Zhu** named Biomedical Engineering Society Fellows

**Yunan Xia** named 2014 Fellow of the American Chemical Society

**Johnna Temenoff** named Co-director of the Center for Regenerative Engineering and Medicine

**Joshua Weitz** named Simons Foundation Investigator in Ocean Processes & Ecology



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315 Ferst Dr. NW  
Atlanta, GA 30332-0363

[petit institute.gatech.edu](http://petit institute.gatech.edu)