GROWING AS A COMMUNITY

ANNUAL REPORT 2013

Georgia Tech

Parker H. Petit Institute for Bioengineering & Bioscience

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

Interdisciplinary Efforts Expand Across Cam

Recently, I was asked to make some comments on the type of research that will be done in the Engineered Biosystems Building and the impact it will have on our broader bio-community at the ground breaking ceremony in August.

I started by reminding everyone that in the coming decades, our society will face the multifaceted challenges of providing energy, sustainable food sources, and cost-effective, accessible healthcare for nine billion people worldwide. The complexity of these challenges will require solutions that draw on research conducted at the intersection of the life sciences, the physical sciences, and engineering: a concept called convergent science that is currently being promoted at the national level by the National Academies and our White House Office of Science and Technology Policy.

Georgia Tech is poised to be a national leader in convergent science and technology and is already internationally recognized as a place that effectively brings together people from different disciplines to solve important problems. One way we do this is by recruiting faculty who are not just international thought leaders in their own area of expertise but also specifically come here

pus - New Building, New Research - A Community Growing

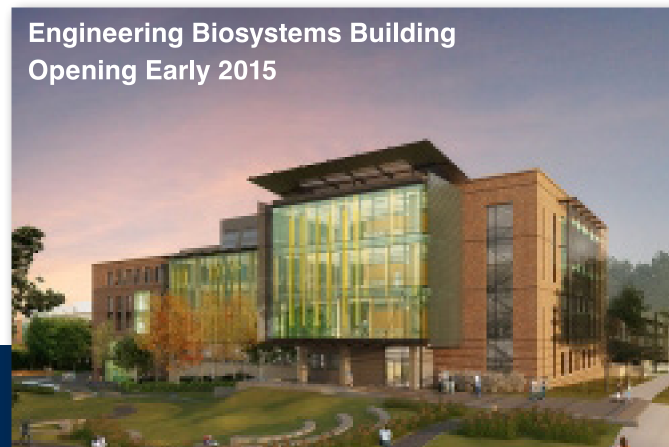
to collaborate with teams of researchers and amazingly talented trainees from other disciplines.

They are attracted to Georgia Tech by the strength of our academic programs and a strong commitment to building a collaborative culture through support of initiatives and facilities, such as the new Engineered Biosystems Building, that encourage team-based research, both within Georgia Tech and through our thriving partnerships with Emory & Children's Healthcare of Atlanta.

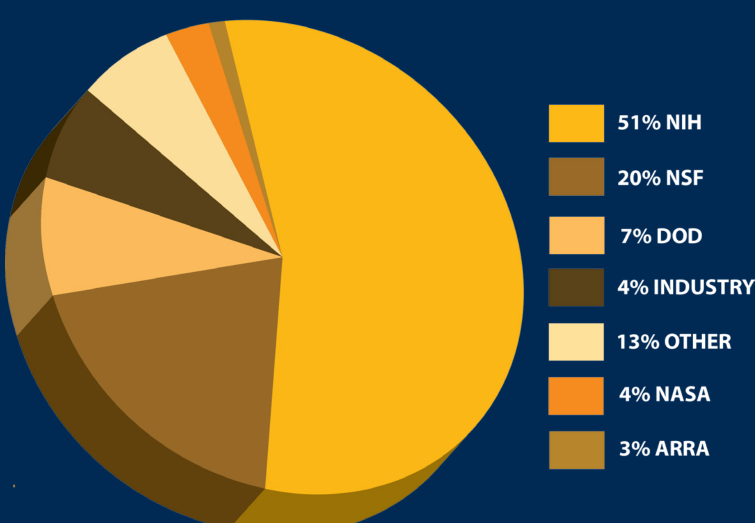
Talent is flocking to Georgia Tech to be a part of the culture we've established and the regional growth in integrated biosciences and bioengineering. The bio-community has soared to over 150 faculty in 15 short years and has expanded to over 1,000 graduate students from 10 different academic units. The Petit Institute has served as the heart of the bio-community during this growth, and the new Engineered Biosystems Building has been designed to expand this successful model by providing open labs and shared core facilities for new and exciting interdisciplinary research teams.

A few examples of expansion areas include immunoengineering, stem cell engineering and biomanufacturing, systems biology, chemical biology and molecular evolution. This new building, and plans for continued expansion in bioengineering and the biosciences over the next five years, will help ensure that Georgia Tech is at the forefront of the convergent science revolution and will undoubtedly quicken the pace of new discoveries and promote the commercialization and growth of biotechnologies in the State of Georgia to benefit human health and society in the years ahead.

Robert E. Guldberg, Ph.D.
Executive Director,
Parker H. Petit Institute for Bioengineering and Bioscience


Engineering Biosystems Building
Opening Early 2015

Fiscal Year 2013
Petit Institute Research Funding



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The content for the Petit Institute's Annual Report comes from contriubutions from communicators around campus.

NATIONAL LEA

Georgia Tech Researchers Attend White House Event Announcing New BRAIN Initiative

On April 2, 2013, President Barack Obama announced a $100 million commitment to fund research to map the activity of the human brain. Two researchers from Georgia Tech were invited by the White House to hear the announcement live. Robert E. Guldberg, Ph.D., executive director for the Parker H. Petit Institute for Bioengineering and Bioscience along with Craig Forest, Ph.D., assistant professor in mechanical engineering, were present to hear President Obama's pledge.

The goal of this grand challenge project is to develop new technologies that present, in real time, how brain cells and neural circuits interact to process information. The Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative will be launched with $100 million in the 2014 Budget.

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ADERSHIP

NIH Director Visits Georgia Research Community

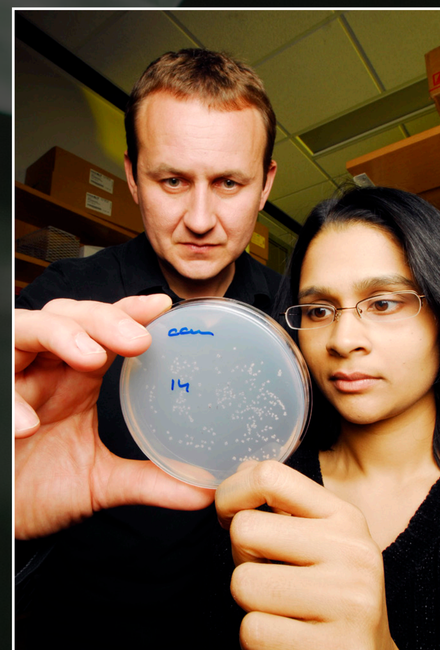
The Georgia university research community welcomed Francis Collins, M.D., Ph.D., director of the National Institutes of Health (NIH) on Thursday, May 30, 2013. On the heels of learning the specifics on how the sequestration will impact the NIH, Collins spent time with administrators and researchers from Georgia Institute of Technology, Emory University, University of Georgia, Georgia State University and Morehouse School of Medicine.

The group spent the morning highlighting NIH funded research. Scientists representing Georgia Tech included Robert Guldberg, Ph.D., executive director of the Petit Institute for Bioengineering and Bioscience and professor in mechanical engineering, who spoke to Collins about the Regenerative Engineering and Medicine Center, a partnership between Emory University and Georgia Tech focused on endogenous repair and healing of nervous, musculoskeletal, metabolic and cardiac applications.

Todd McDevitt, Ph.D., director of the Stem Cell Engineering Center and biomedical engineering associate professor, presented four projects funded with NIH dollars, including wound healing studies from a “Transformative Research Award,” a program developed to fund “high-risk, high-reward” science under the NIH’s Common Fund.

GAME CHANGI

Unusual Mechanism of DNA Synthesis Could Explain Genetic Mutations



Researchers have discovered the details of how cell repair breaks in both strands of DNA, a potentially devastating kind of DNA damage. When chromosomes experience double-strand breaks due to oxidation, ionizing radiation, replication errors and certain metabolic products, cells utilize their genetically similar chromosomes to patch the gaps via a mechanism that involves both ends of the broken molecules. To repair a broken chromosome that lost one end, a unique configuration of the DNA replication machinery is deployed as a desperation strategy to allow cells to survive, the researchers discovered.

The collaborative work of Kirill Lobachev, associate professor in the school of biology at Georgia Tech and Anna Malkova, associate professor at Indiana University-Purdue University Indianapolis, was critical in the advancement of the project. The group's research was published in the journal *Nature* and included additional collaborators, James Haber of Brandeis University and Grzegorz Ira of the Baylor College of Medicine.

Lobachev used cutting-edge analysis techniques and equipment available at only a handful of labs around the world. This allowed the researchers to see inside yeast cells and freeze the break-induced DNA repair process at different times. They found that this mode of DNA repair doesn't rely on the traditional replication fork - a Y-shaped region of a replicating DNA molecule - but instead uses a bubble-like structure to synthesize long stretches of missing DNA. This bubble structure copies DNA in a manner not seen before in eukaryotic cells.

Study Finds Substantial Microorganism Populations in the Upper Troposphere

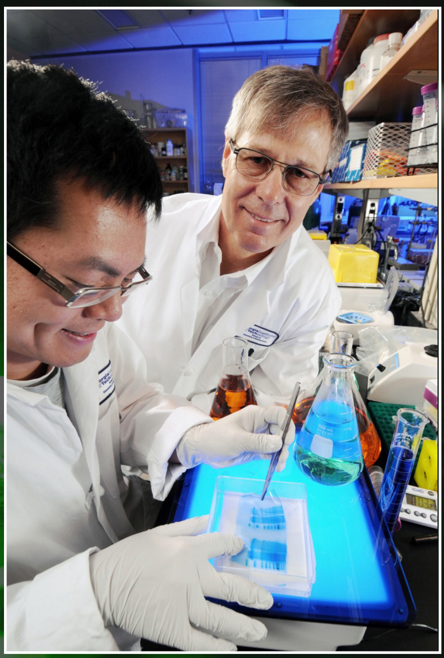
In what is believed to be the first study of its kind, researchers used genomic techniques to document the presence of significant numbers of living microorganisms – principally bacteria – in the middle and upper troposphere, that section of the atmosphere approximately four to six miles above the Earth's surface.

Whether the microorganisms routinely inhabit this portion of the atmosphere – perhaps living on carbon compounds also found there – or whether they were simply lofted there from the Earth's surface isn't yet known. The finding is of interest to atmospheric scientists because the microorganisms could play a role in forming ice that may impact weather and climate. Long-distance transport of the bacteria could also be of interest for disease transmission models.

The microorganisms were documented in air samples taken as part of NASA's Genesis and Rapid Intensification Processes program by applied physiology assistant professor, Kostas Konstantinidis, Ph.D., and his colleagues, to study low and high altitude air masses associated with tropical storms. The sampling was done from a DC-8 aircraft over both land and ocean, including the Caribbean Sea and portions of the Atlantic Ocean. The sampling took place before, during and after two major tropical hurricanes – Earl and Karl – in 2010. The research, which has been supported by NASA and the National Science Foundation, was published by the journal *Proceedings of the National Academy of Sciences*.

NG SCIENCE

RNA was Capable of Catalyzing Electron Transfer on Early Earth with Iron's Help



A research study, conducted by Loren William's lab, shows that RNA is capable of catalyzing electron transfer under conditions similar to those of the early Earth. Because electron transfer, the moving of an electron from one chemical species to another, is involved in many biological processes – including photosynthesis, respiration and the reduction of RNA to DNA – the study's findings suggest that complex biochemical transformations may have been possible when life began.

There is considerable evidence that the evolution of life passed through an early stage when RNA played a more central role, before DNA and coded proteins appeared. During that time, more than 3 billion years ago, the environment lacked oxygen but had an abundance of soluble iron.

Scientists may never be 100 percent sure what existed four billion years ago when a complex mixture of chemicals started to work together to start life. Their next goal is to determine whether the proto-RNA bases can be linked by a backbone to form a polymer that could have functioned as a genetic material.

The results of the study were published in the journal *Nature Chemistry.* The study was sponsored by the NASA Astrobiology Institute, which established the Center for Ribosomal Origins and Evolution (RiboEvo) at Georgia Tech.

Molecules Assembling in Water Hint at Alternative Theories into the Origins of Life

The base pairs that hold together two pieces of RNA, the older cousin of DNA, are some of the most important molecular interactions in living cells. Many scientists believe that these base pairs were part of life from the very beginning and that RNA was one of the first polymers of life. But there is a problem. The RNA bases don't form base pairs in water unless they are connected to a polymer backbone, a trait that has baffled origin-of-life scientists for decades. If the bases don't pair before they are part of polymers, how would the bases have been selected out from the many molecules in the "prebiotic soup" so that RNA polymers could be formed?

Nick Hud, Ph.D., and his team in the school of Chemistry and Biochemistry at Georgia Tech are exploring an alternate theory for the origin of RNA: they think the RNA bases may have evolved from a pair of molecules distinct from the bases we have today. This theory looks increasingly attractive as the Georgia Tech group was able to achieve efficient, highly ordered self-assembly in water with small molecules that are similar to the bases of RNA. These "proto-RNA bases" spontaneously assemble into gene-length linear stacks, suggesting that the genes of life could have gotten started from these or similar molecules. Hud's group knew that they were on to something when they added a small chemical tail to a proto-RNA base and saw it spontaneously form linear assemblies with another proto-RNA base. In some cases, the results produced 18,000 nicely ordered, stacked molecules in one long structure.

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GAME CHANGING SCIENCE

Making a Mini Mona Lisa

The world's most famous painting has now been created on the world's smallest canvas. Physics researchers at Georgia Tech have "painted" the Mona Lisa on a substrate surface approximately 30 microns in width – or one-third the width of a human hair. The team's creation, the "Mini Lisa," demonstrates a technique that could potentially be used to achieve nanomanufacturing of devices because the team was able to vary the surface concentration of molecules on such short-length scales.

The image was created with an atomic force microscope and a process called ThermoChemical NanoLithography (TCNL). Going pixel by pixel, the Georgia Tech team positioned a heated cantilever at the substrate surface to create a series of confined nanoscale chemical reactions. By varying only the heat at each location, Ph.D. candidate Keith Carroll, in Jennifer Curtis's laboratory, controlled the number of new molecules that were created. The greater the heat, the greater the local concentration. More heat produced the lighter shades of gray, as seen on the Mini Lisa's forehead and hands. Less heat produced the darker shades in her dress and hair seen when the molecular canvas is visualized using fluorescent dye. Each pixel is spaced by 125 nanometers.

Studying How Geometry Affects How Cells Behave

A fried breakfast food popular in Spain was the inspiration for the development of doughnut-shaped droplets that may provide scientists with a new approach for studying fundamental issues in physics, mathematics and materials. The doughnut-shaped droplets, a shape known as toroidal, are formed from two dissimilar liquids using a simple rotating stage and an injection needle. About a millimeter in overall size, the droplets are produced individually and their shapes maintained by a surrounding springy material made of polymers. Droplets in this toroidal shape made of a liquid crystal – the same type of material used in laptop displays – may have properties very different from those of spherical droplets made from the same material. Alberto Fernandez-Nieves, Ph.D., Dunn Family Assistant Professor in physics, believes the novel structures offer opportunities to study many interesting problems, from looking at the properties of ordered materials within these confined spaces to studying how geometry affects how cells behave.

Study Quantifies the Size of Holes Antibacterials Create in Cell Walls to Kill Bacteria

The rise of antibiotic-resistant bacteria has initiated a quest for alternatives to conventional antibiotics. One potential alternative is PlyC, a potent enzyme that kills the bacteria that causes strep throat and streptococcal toxic shock syndrome. PlyC operates by locking onto the surface of a bacteria cell and chewing a hole in the cell wall large enough for the bacteria's inner membrane to protrude from the cell, ultimately causing the cell to burst and die.

Research has shown that alternative antimicrobials such as PlyC can effectively kill bacteria. However, fundamental questions remain about how bacteria respond to the holes that these therapeutics make in their cell wall and what size holes bacteria can withstand before breaking apart. Answering those questions could improve the effectiveness of current antibacterial drugs and initiate the development of new ones.

Josh Weitz, Ph.D., assistant professor in the school of biology at Georgia Tech and collaborators at the University of Maryland recently conducted a study to try to answer those questions. The researchers created a biophysical model of the response of a Gram-positive bacterium to the formation of a hole in its cell wall. Then they used experimental measurements to validate the theory, which predicted that a hole in the bacteria cell wall larger than 15 to 24 nanometers in diameter would cause the cell to lyse, or burst. These small holes are approximately one-hundredth the diameter of a typical bacterial cell.

Understanding Early Development of Brain Structures

Sand-dwelling and rock-dwelling cichlids living in East Africa's Lake Malawi share a nearly identical genome, but have very different personalities. The territorial rock-dwellers live in communities where social interactions are important, while the sand-dwellers are itinerant and less aggressive. Those behavioral differences likely arise from a complex region of the brain known as the telencephalon, which governs communication, emotion, movement and memory in vertebrates, including humans, where a major portion of the telencephalon is known as the cerebral cortex. A study published by Todd Streelman, Ph.D., associate professor in the School of Biology, in the journal *Nature Communications* shows how the strength and timing of competing molecular signals during brain development has generated natural and presumably adaptive differences in the telencephalon much earlier than scientists had previously believed. Understanding subtle changes in brain structures earlier in the development process could provide better insight into how disorders such as autism and schizophrenia could arise during very early brain development.

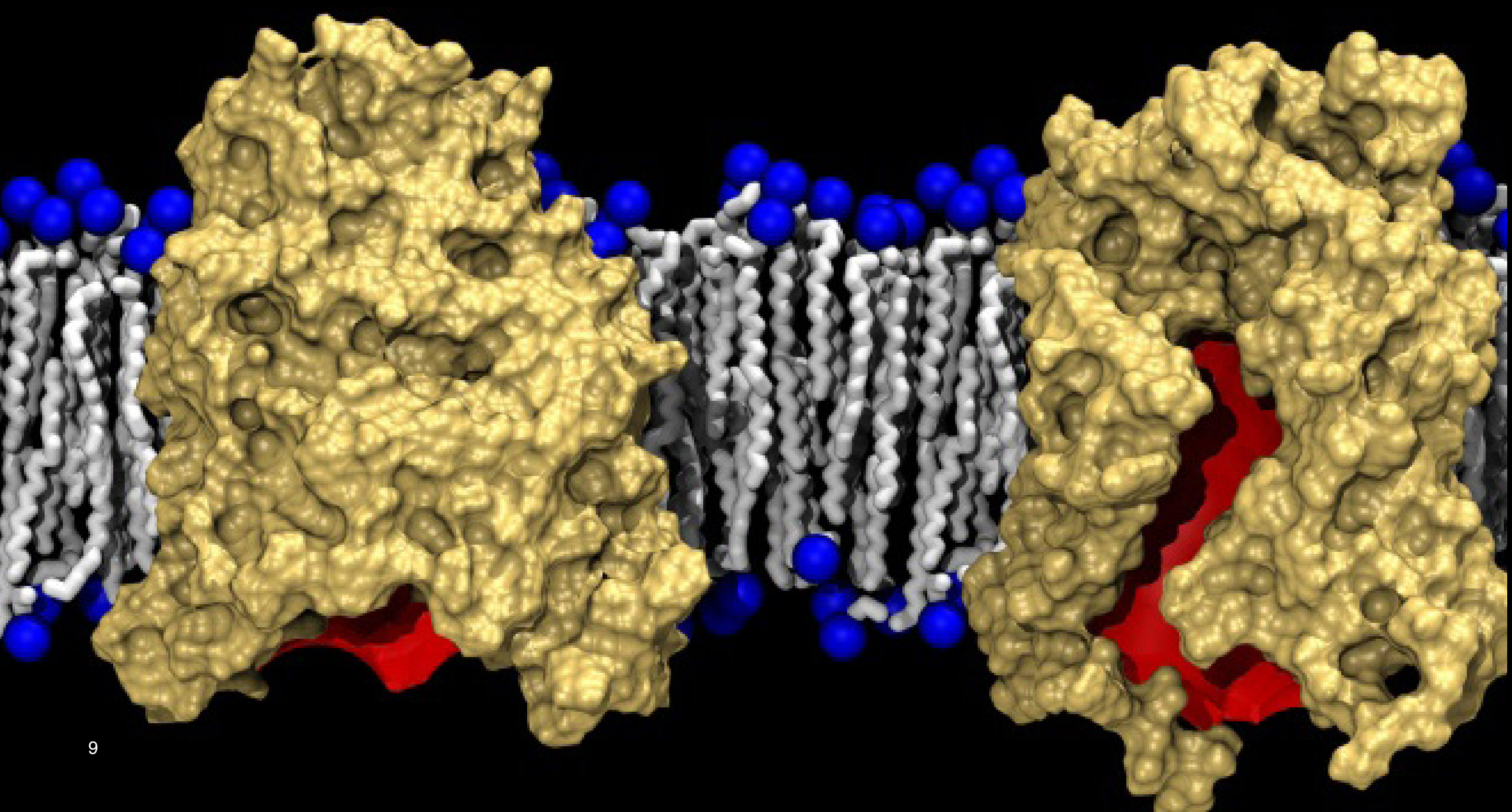
GAME CHANGING SCIENCE

Researchers Determine Protein Structure for New Antimicrobial Target

Growing concern about bacterial resistance to existing antibiotics has created strong interest in new approaches for therapeutics able to battle infections. The work of an international team of researchers that recently solved the structure of a key bacterial membrane protein could provide a new target for drug and vaccine therapies able to battle one important class of bacteria.

The research from J.C. Gumbart, Ph.D., assistant professor in Georgia Tech's School of Physics, determined the structure of BamA, a key component of the cellular machinery that controls insertion of beta-barrel proteins into the outer membranes of Gram-negative bacteria, organisms that cause a range of respiratory, gastrointestinal, urinary and other infections.

Beta-barrel membrane proteins transport substrates ranging from small molecules to large proteins into and out of the Gram-negative bacteria. These transport proteins help maintain the structure and composition of the outer membrane. Responsible for the virulence of pathogenic strains, the proteins are also essential to the viability of the bacteria – making them of interest for the development of new therapeutics.

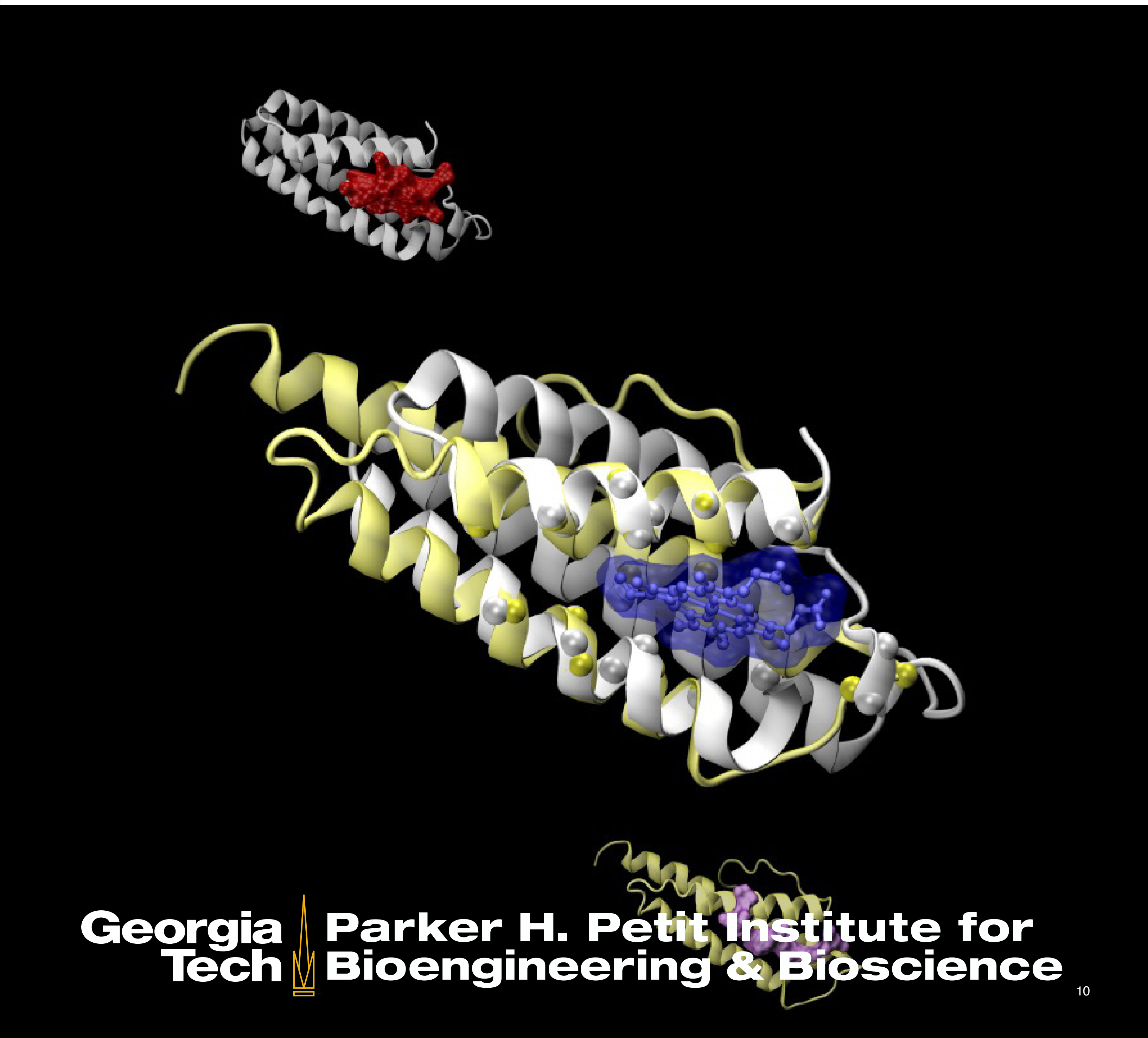


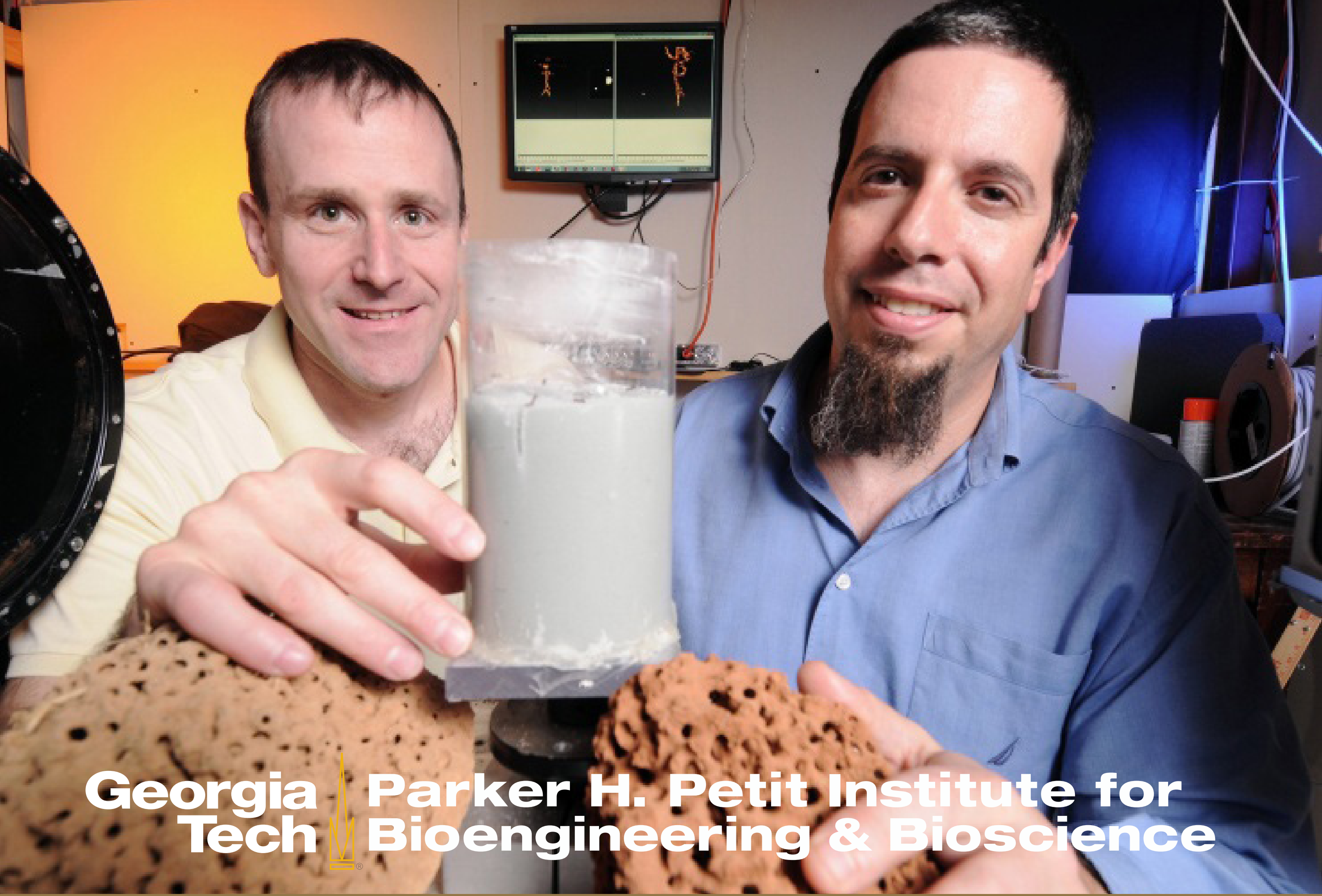
Study Suggests Drug Side Effects Inevitable; Basic Physics Enabled Early Biochemistry

A new study of both computer-created and natural proteins suggests that the number of unique pockets – sites where small molecule pharmaceutical compounds can bind to proteins – is surprisingly small, meaning drug side effects may be impossible to avoid. The study also found that the fundamental biochemical processes needed for life could have been enabled by the simple physics of protein folding.

Studying a set of artificial proteins and comparing them to natural proteins, researchers at Georgia Tech have concluded that there may be no more than about 500 unique protein pocket configurations that serve as binding sites for small molecule ligands. Therefore, the likelihood that a molecule intended for one protein target will also bind with an unintended target is significant, said Jeffrey Skolnick, professor in the School of Biology.

Research on the binding pockets was published in the journal *Proceedings of the National Academy of Sciences*. The research was supported by the National Institutes of Health.





Principles of Ant Locomotion Could Help Future Robot Teams Work Underground

Future teams of subterranean search and rescue robots may owe their success to the lowly fire ant, a much despised insect whose painful bites and extensive networks of underground tunnels are all-too-familiar to people living in the southern United States.

By studying fire ants in the laboratory using video tracking equipment and X-ray computed tomography, Dan Goldman, Ph.D., from physics and Michael Goodisman, Ph.D., from biology, have uncovered fundamental principles of locomotion that robot teams could one day use to travel quickly and easily through underground tunnels. Among the principles is building tunnel environments that assist in moving around by limiting slips and falls and by reducing the need for complex neural processing.

Among the study's surprises was the first observation that ants in confined spaces use their antennae for locomotion as well as for sensing the environment. Researchers believe that the ants are creating their environment in just the right way to allow them to move up and down rapidly with a minimal amount of neural control. The environment allows the ants to make missteps and not suffer for them. The hope is that the ants can teach us some remarkably effective tricks for maneuvering in subterranean environments.

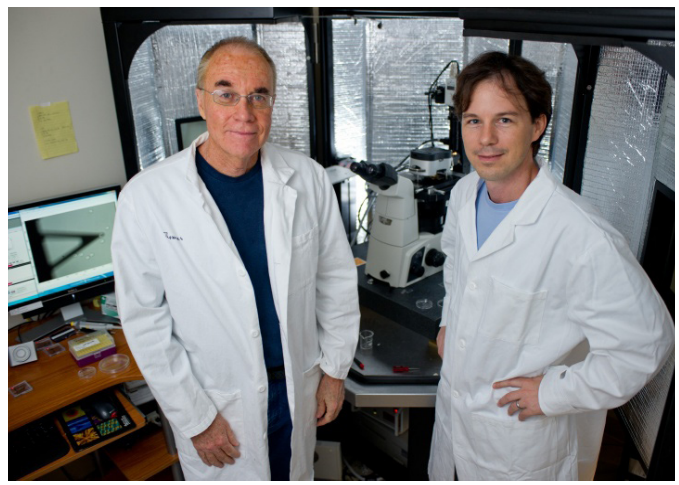
TEAM SCIENC

Petit Institute Seeds Innovative Teams

The Petit Institute awarded $50,000 to three interdisciplinary teams under its Bioengineering and Bioscience Collaborative Seed Grant program, which was created to support early-stage innovative biotechnology research. Proposals were submitted by teams comprised of two Petit Institute faculty with appointments in different academic colleges. Funding for the new seed grants comes chiefly from the Petit Institute's endowment as well as contributions from the College of Sciences and the College of Engineering. Each team will receive $50,000 a year for two years; however, the second year of funding will be contingent on submission of an external collaborative grant proposal. "The purpose of the program is to catalyze new collaborations that will tackle problems that require an interdisciplinary approach," said Robert E. Guldberg, Ph.D., executive director of the Petit Institute.

The new team of Raquel Lieberman, Ph.D., associate professor from the School of Chemistry and Biochemistry, and Ross C. Ethier, Ph.D., Gellerstedt and Georgia Research Alliance Professor from the Wallace H. Coulter Department of Biomedical Engineering, have proposed to lay the foundation for a new treatment for glaucoma by testing a new hypothesis for the molecular basis of disease. Glaucoma is the second leading cause of blindness affecting approximately 70 million people worldwide.

"The grant will expand our understanding of the role of myocilin, a protein closely linked to certain forms of glaucoma," said Ethier. "Further, we will develop animal models to support our long-term goal of developing a novel small molecule therapy for glaucoma.



"In parallel, we are taking a chemical biology approach to develop tailored new reagents to identify myocilin amyloids that could be adapted for a therapy," Lieberman added. "We have already discovered several promising lead compounds."

Another team that was awarded was John McDonald, Ph.D., professor from the School of Biology and Todd Sulchek, Ph.D., assistant professor in the George W. Woodruff School of Mechanical Engineering. They will be developing a new class of anticancer agents, or bead-size molecules, that will recognize and activate the immune system against them. "Cancer cells frequently display proteins or other molecules on their surface that are not present on the surface of normal cells. Inducing the production of antibodies against these cancer-specific surface molecules or antigens is the key to cancer immunotherapy," said McDonald. "We propose to generate a new class of synthetic micro and nanobeads that will enhance the exposure of the immune system to these cancer antigens."

Facilitating the exposure of the natural immune response to diseased cells is a strategy that may be applied to combat many cellular sources of disease in addition to ovarian cancer. "By combining the capability to selectively target cancer cells while stimulating the immune system, we hope to create an environment that can overcome immuno-evasive or -suppressive strategies by cancer cells," Sulchek explains. "This innovative approach of targeted immune activation could lead to drugs capable of treating a variety of diseases."

The third team to be awarded was, Tom Barker, PhD, associate professor in the Wallace H. Coulter Department of Biomedical Engineering and Alberto Fernandez-Nieves, PhD, Dunn Family Assistant Professor from the School of Physics, who proposed the development of a new class of deliverable biomaterials. "One of the primary challenges in the regenerative medicine field is the development of biomaterials that are robust when delivered but that can also enable rapid cell invasion," explains Fernandez-Nieves. "Currently researchers have been able to optimize one property (mechanics) or the other (cell migration), but optimization of both simultaneously represents a significant hurdle."

To address this problem the team will take a new approach; incorporating a colloidal assembly, or a system which has highly deformable, "squishy", microscopic hydrogels that partition into discrete large pockets rather than dispersed consistently throughout a dense fibrin-based."To our knowledge the specific approach used here has not previously been explored. The findings thus far could not have been predicted which leads to the uniqueness of the system," Barker said. "The long term strategy for this project is to be able to assist better with healing and tissue regeneration."

TRANSLATION

Mechanical Forces Control Assembly and Disassembly of a Key Cell Protein

Researchers have for the first time demonstrated that mechanical forces can control the depolymerization of actin, a critical protein that provides the major force-bearing structure in the cytoskeletons of cells. The research, conducted by the laboratory of Larry McIntire, Ph.D., from the Wallace H. Coulter Department of Biomedical Engineering, suggests that forces applied both externally and internally may play a much larger role than previously believed in regulating a range of processes inside cells.

Using atomic force microscopy (AFM) force-clamp experiments, the research found that tensile force regulates the kinetics of actin dissociation by prolonging the lifetimes of bonds at low force range, and by shortening bond lifetimes beyond a force threshold. The research also identified a possible molecular basis for the bonds that form when mechanical forces create new interactions between subunits of actin.

Found in the cytoskeleton of nearly all cells, actin forms dynamic microfilaments that provide structure and sustain forces. A cell's ability to assemble and disassemble actin allows it to rapidly move or change shape in response to the environment. The research was reported March 4 in the early online edition of the journal *Proceedings of the National Academy of Sciences* and the work was supported by the National Institutes of Health.

Nanotechnology Research Study Turns Brain Tumors Blue Helping Detection

Researchers from Georgia Tech and Children's Healthcare of Atlanta have developed a technique that assists in identifying tumors from normal brain tissue during surgery by staining tumor cells blue. The technique could be critically important for hospitals lacking sophisticated equipment in preserving the maximum amount of normal tissue and brain function during surgery. Published in the journal *Drug Delivery and Translational Medicine*, the research was led by Barun Brahma, M.D., Children's neurosurgeon and biomedical engineer, and Ravi Bellamkonda, Ph.D., chair of the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University.

Brahma initially approached the Georgia Tech-based laboratory of Bellamkonda to see if it would be possible to manually distinguish a tumor from normal tissue during surgery without using complex equipment that might be unavailable to some health facilities. Bellamkonda's lab developed a nanocarrier made of fat that carried a clinically approved dye called Evans Blue. The team demonstrated that these nanocarriers leak out of blood vessels in the tumor margin and stain brain tumors blue. Using tumor cells injected into a rat brain, the team proved nanocarriers are able to find their way to the brain tumor and selectively dye it blue while excluding normal brain tissue. The findings are significant for hospitals worldwide that lack machines to help guide tumor removal, such as an intraoperative MRI machine. This new technique could help neurosurgeons remove brain tumors in children more accurately all over the world, the researchers said.

AL RESEARCH

Biomaterial Shows Promise for Type 1 Diabetes Treatment

Researchers have made a significant first step with newly engineered biomaterials for cell transplantation that could help lead to a possible cure for Type 1 diabetes, which affects about 3 million Americans. Georgia Tech engineers and Emory University clinicians have successfully engrafted insulin-producing cells into a diabetic mouse model, reversing diabetic symptoms in the animal in as little as 10 days.

The research team, which included Georgia Tech's Andrés García, Ph.D., from mechanical engineering, engineered a biomaterial to protect the cluster of insulin-producing cells – donor pancreatic islets – during injection. The material also contains proteins to foster blood vessel formation that allow the cells to successfully graft, survive and function within the body.

New Evidence that Cancer Cells Change While Moving throughout Body

For the majority of cancer patients, it's not the primary tumor that is deadly, but the spread or "metastasis" of cancer cells from the primary tumor to secondary locations throughout the body that is the problem. That's why a major focus of contemporary cancer research is how to stop or fight metastasis. Previous lab studies suggest that metastasizing cancer cells undergo a major molecular change when they leave the primary tumor – a process called epithelial-to-mesenchymal transition (EMT). As the cells travel from one site to another, they pick up new characteristics. More importantly, they develop a resistance to chemotherapy that is effective on the primary tumor. But confirmation of the EMT process has only taken place in test tubes or in animals.

In a new study, published in the *Journal of Ovarian Research*, John McDonald, Ph.D., biology professor, has direct evidence that EMT takes place in humans, at least in ovarian cancer patients. The findings suggest that doctors should treat patients with a combination of drugs: those that kill cancer cells in primary tumors and drugs that target the unique characteristics of cancer cells spreading through the body. The researchers looked at matching ovarian and abdominal cancerous tissues in seven patients. Pathologically, the cells looked exactly the same, implying that they simply fell off the primary tumor and spread to the secondary site with no changes. But on the molecular level, the cells were very different. Those in the metastatic site displayed genetic signatures consistent with EMT.

Designer Blood Clots

When it comes to healing the terrible wounds of war, success may hinge on the first blood clot – the one that begins forming on the battlefield right after an injury. Tom Barker, Ph.D., a biomedical engineer, who has been exploring the complex stream of cellular signals produced by the body in response to a traumatic injury believes the initial response – formation of a blood clot – may control subsequent healing. Using that information, they're developing new biomaterials in collaboration wtih chemistry professor Andrew Lyon, Ph.D., including artificial blood platelets laced with regulatory chemicals that could be included in an injector device the size of an iPhone. Soldiers wounded in action could use the device to treat themselves, helping control bleeding, stabilizing the injury and setting the right course for healing. Formation of "designer" blood clots from the artificial platelets would be triggered by the same factor that initiates the body's natural clotting processes. In animal models, the synthetic platelets reduced clotting time by approximately 30 percent, though the materials have not yet been tested in humans.

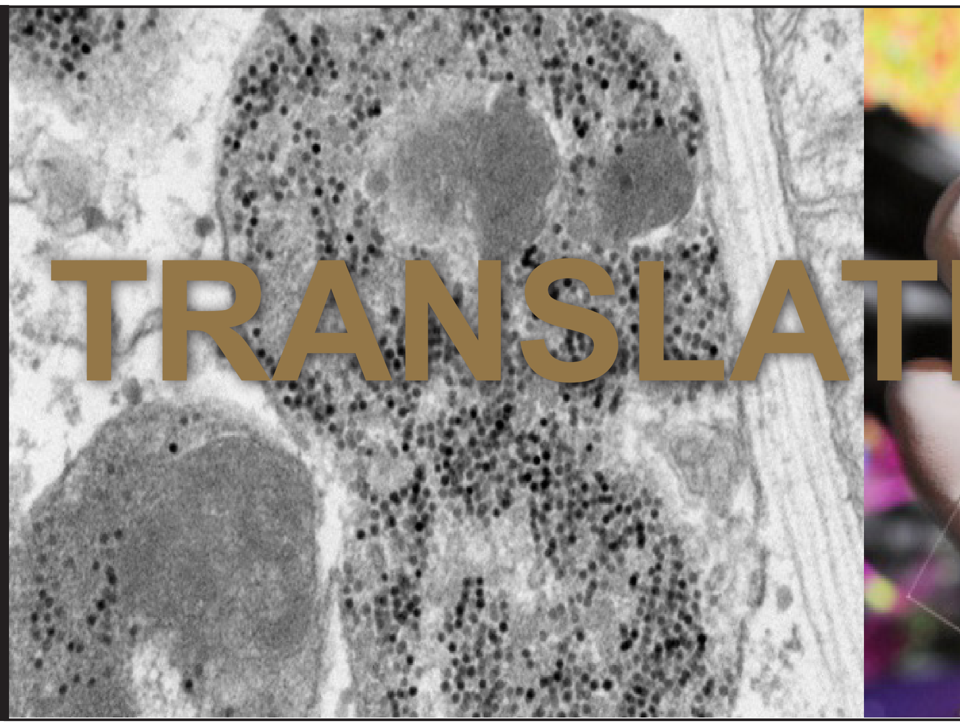
Sticky Cells: Cyclic Mechanical Reinforcement Extends Longevity of Bonds Between Cells

Research carried out by scientists at the Georgia Institute of Technology and The University of Manchester has revealed new insights into how cells stick to each other and to other bodily structures, an essential function in the formation of tissue structures and organs. It's thought that abnormalities in their ability to do so play an important role in a broad range of disorders, including cardiovascular disease and cancer.

The study's findings, conducted by Cheng Zhu, Ph.D., a biomedical engineer, in collaboration with mechanical engineering Andrés García, Ph.D., and Martin Humphries from the University of Manchester, are outlined in the journal *Molecular Cell* and describe a surprising new aspect of cell adhesion involving the family of cell adhesion molecules known as integrins, which are found on the surfaces of most cells. The research uncovered a phenomenon termed "cyclic mechanical reinforcement," in which the length of time during which bonds exist is extended with repeated pulling and release between the integrins and ligands that are part of the extracellular matrix to which the cells attach.

Magnets Steer Stem Cells

Magnets could be a tool for directing stem cells' healing powers to treat conditions such as heart disease or vascular disease. By feeding stem cells tiny particles made of magnetized iron oxide, scientists at Emory University and the Georgia Institute of Technology can then use magnets to attract the cells to a particular location in the body after intravenous injection. Scientists were able to load the cells with nanoparticles with a unique coating and were able to show that the cells were not harmed meaning there was no change in viability or other characteristics of the stem cells, such as their capacity to differentiate. This was essentially a proof of principle experiment. Ultimately, they would like to possibly target an abnormal blood vessel or even the heart.



Adhesive Differences Enable Separation of Stem Cells to Advance Potential Therapies

A new separation process that depends on an easily-distinguished physical difference in adhesive forces among cells could help expand production of stem cells generated through cell reprogramming. By facilitating new research, the separation process could also lead to improvements in the reprogramming technique itself and help scientists model certain disease processes.

The reprogramming technique allows a small percentage of cells – often taken from the skin or blood – to become human induced pluripotent stem cells (hiPSCs) capable of producing a wide range of other cell types. Using cells taken from a patient's own body, the reprogramming technique might one day enable regenerative therapies that could, for example, provide new heart cells for treating cardiovascular disorders or new neurons for treating Alzheimer's disease or Parkinson's disease. But the cell reprogramming technique is inefficient, generating mixtures in which the cells of interest make up just a small percentage of the total volume. Separating out the pluripotent stem cells is now time-consuming and requires a level of skill that could limit use of the technique and hold back the potential therapies.

To address the problem, researchers at Georgia Tech have demonstrated a tunable process that separates cells according to the degree to which they adhere to a substrate inside a tiny microfluidic device. The adhesion properties of the hiPSCs differ significantly from those of the cells with which they are mixed, allowing the potentially-therapeutic cells to be separated to as much as 99 percent purity.

New Technology That Sorts Cells by Stiffness May Help Spot Disease

Sorting cells according to their stiffness might one day help doctors identify certain diseases in patients. The mechanical properties of cells are often an indicator of disease. Cancer cells are typically soft and squishy. When the malaria parasite is inside a red blood cell, for example, the cell is stiffer than normal. Sickle cells also vary in stiffness. Research into the stiffness of diseased cells is lacking, in part due to limits in technology. Todd Sulchek, Ph.D., assistant professor in the George W. Woodruff School of Mechanical Engineering, has developed a new technology to sort human cells according to their stiffness. Sulchek hopes that their technology might one day aid doctors in the field to rapidly and more accurately diagnose disease. Using new technology cells are injected into a microfluidic channel on one side of the device. As the cells move through the channel, they are forced to squeeze over a series of ridges that are fabricated at an angle to the channel. If the cells are very flexible, they will easily squeeze over the ridges and follow the fluid stream. But if the cells are stiffer, when they hit a ridge, they will slide along the angled ridge before squeezing over, causing the cells to move to one side, separating them from the softer cells. These ridges eventually separate a single stream of cells into two streams depending on the cells' stiffness, which in some cases can be an indicator of a disease.

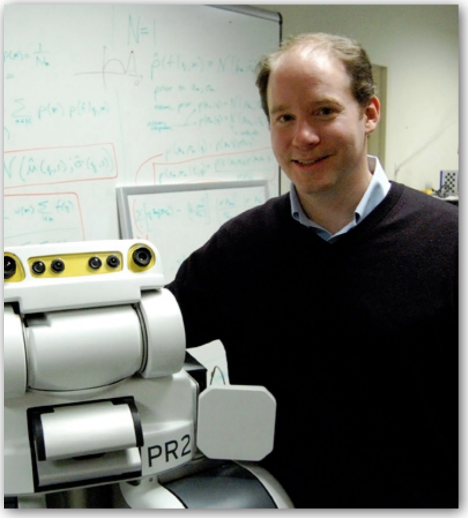
Microparticles Create Localized Control of Stem Cell Differentiation

Before scientists and engineers can realize the dream of using stem cells to create replacements for worn out organs and battle damaged body parts, they'll have to develop ways to grow complex three-dimensional structures in large volumes and at costs that won't bankrupt health care systems.

Todd McDevitt, Ph.D., and his laboratory, are now reporting advances in these areas by using gelatin-based microparticles to deliver growth factors to specific areas of embryoid bodies, aggregates of differentiating stem cells. The localized delivery technique provides spatial control of cell differentiation within the cultures, potentially enabling the creation of complex three-dimensional tissues. The local control also dramatically reduces the amount of growth factor required, an important cost consideration for manufacturing stem cells for therapeutic applications.

The microparticle technique, which was demonstrated in pluripotent mouse embryonic cells, also offers better control over the kinetics of cell differentiation by delivering molecules that can either promote or inhibit the process, thus demonstrating that by creating three-dimensional structures from stem cells they can reduce the use of growth factors. Based on research sponsored by the National Institutes of Health and the National Science Foundation, the developments were reported in the journal *Biomaterials*.

NEW DIRECTIC

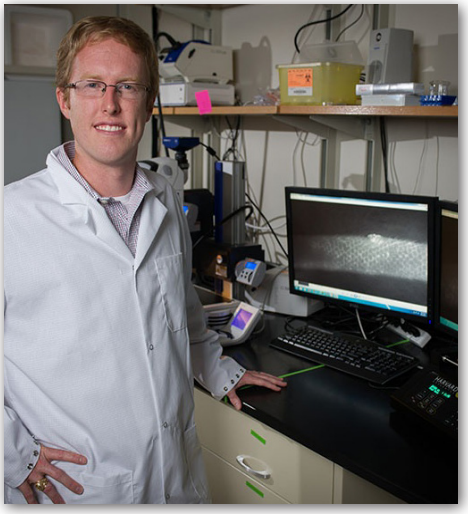


Georgia Tech Researchers Study Aging with Disabilities

Imagine the obstacles a blind person who relies on sound will face if he loses his hearing as he ages. Or the difficulty a long-term wheelchair user will confront as she develops arthritis in her shoulders with age. People with long-term disabilities and chronic conditions will encounter a unique set of challenges as they get older. But that doesn't mean they can't age successfully and safely. The Georgia Institute of Technology has received a five-year $4.6 million grant to increase understanding of the aging process for people with disabilities and use data gleaned from the study to develop technologies that will benefit them and others. The team includes Petit Institute faculty member, Charlie Kemp, Ph.D., associate professor in biomedical engineering. The grant from the National Institute on Disability and Rehabilitation Research in the Department of Education will support the interdisciplinary Center on Technologies to Support Successful Aging with Disability (RERC TechSAge).

$2M NSF Grant to Study Dimensions of Biodiversity

The National Science Foundation has awarded a 5 year grant of approximately $2 million to fund a collaborative group of scientists: Mark Young from Montana State, Joshua Weitz, Ph.D., from Georgia Tech and Rachel Whitaker, Ph.D., from University of Chicago-Urbana Champaign, to study the role of viruses in shaping genetic, taxonomic and functional diversity. The team will investigate a new hypothesis about how viruses may control the structure and function of microbial communities. The traditional view of viruses is that they negatively impact the fitness of infected hosts. In other words, they are viewed strictly as pathogens, in which the host tries to eliminate the virus. This project will explore an alternative hypothesis: that chronic viral infections contribute positively to host fitness, increasing the success of the virus-host pair by protecting their hosts from infection by even more pathogenic viruses.

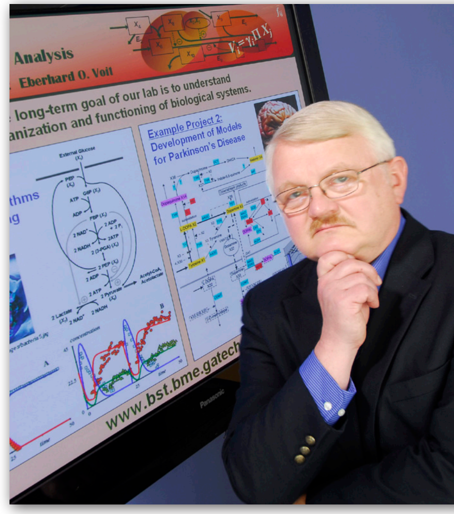


NIH Awards $2 Million For Engineering Approach to Understanding Lymphedema

The National Institutes of Health has awarded Georgia Tech a $2 million research grant to unravel the mechanical forces at play in lymphedema, a poorly understood disease with no cure and little hope for sufferers. Lymphedema develops when the body fails to circulate lymphatic fluid, a mixture of immune cells, proteins, and lipids. This fluid builds up in the arms, legs and genitals — sometimes causing extreme swelling and permanent remodeling of the tissue. The mechanisms involved in the progression of the disease are unclear, therefore professor J. Brandon Dixon's lab will use an engineering approach to studying the disease. This innovative methodology could lead to new technologies to test and treat lymphatic disease.

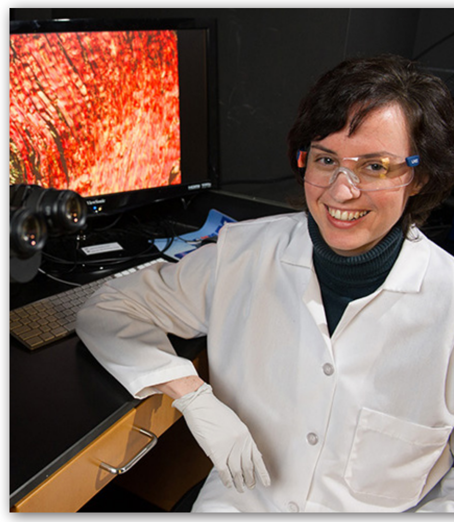
ONS

Atlanta Team Receives First Human Exposome Center Grant



Investigators at Rollins School of Public Health at Emory University, along with partners at the Georgia Institute of Technology, have received a $4 million grant over four years to establish the HERCULES Center (Health and Exposome Research Center: Understanding Lifetime Exposures). The grant is the first exposome-based center grant awarded in the U.S. Exposome research looks at the holistic view of the human body's exposures, how the body responds to those exposures, and their combined effects. It is proposed to be the environmental equivalent of the human genome and includes lifetime exposures to environmental pollutants in food, water, physical activity, medications, homes and daily stressors. Scientists believe that when coupled with a growing understanding of genetics, the exposome will help uncover the causes of many complex diseases and disorders. Petit Institute faculty member, Eberhardt Voit, Ph.D., a biomedical engineering professor, is part of the research team.

Engineering an Injectable Therapy for Rotator Cuff Injuries



A research team is attempting to engineer an injectable therapy for the shoulder's supraspinatus tendon, a rotator cuff tendon that is commonly torn in sports. When the tendon is damaged, the body makes things worse by activating enzymes that further break down the tendon. The scientists hope to develop an injectable compound that would deliver an inhibitor capable of blocking these enzymes, thereby reducing the severity of the injury or even healing the tissue. This work is supported by a $1 million grant from the National Institute of Arthritis and Musculoskeletal and Skin Diseases for five years of research, which began in September 2013. Collaborating with Johnna Temenoff, Ph.D., on the research is Manu Platt, Ph.D., an assistant professor in the biomedical engineering department. Temenoff's previous work on tendon injuries, which focused on quarterbacks in football, was sponsored by the NFL Charities.

Assistant Professor Receives Ellison Medical Foundation New Scholar in Aging

Patrick McGrath, Ph.D., assistant professor in the School of Biology, has been chosen as an Ellison Medical Foundation New Scholar in Aging to study how complex genetics can influence the aging process in the small nematode C. elegans. McGrath joined the School of Biology in 2012. In humans, lifespan is a heritable trait, meaning that differences in our genes influence how fast we age. The McGrath lab plans to identify new signaling pathways controlling aging that are preferentially modified by combinations of natural polymorphisms segregating within a population. The foundation's New Scholar awards provide support for new investigators to help establish their labs.

INDUSTRY PAR

RTNERS

Innovation and Entrepreneurship

The vision of the Petit Institute's industry program is to serve as a catalyst to enable leading-edge research and translation of results into actions that advance economic development and societal impact. To realize that vision and address critical innovation challenges, the Petit Institute fosters interdisciplinary research, builds and sustains institutional partnerships and industry collaborations, and connects faculty and students with Georgia Tech's entrepreneurial resources with the goal of addressing critical innovation challenges.

The results of these efforts are novel cutting-edge technologies, industry collaborations and faculty and student initiated startup companies that help advance new products with the potential to impact human disease, quality of life and the economic health of our state and nation.

Start-up LymphaTech Develops Detection for Lymphedema

LymphaTech is an early-stage startup that has developed an innovative optical diagnostic to detect lymphedema, a side effect of breast cancer surgery, which affects nearly 50% of all breast cancer survivors. Lymphedema causes dramatic and irreversible arm swelling, subsequently leading to pain, depression, and reduced quality of life. There is currently no technology on the market that can detect the onset of lymphedema before permanent tissue damage has already occurred. Lymphatech's diagnostic can detect lymphedema before symptoms begin, which will allow doctors to begin therapy and prevent permanent tissue damage, thus dramatically improving the standard of care for breast cancer survivors. The startup company is based on technology developed in the lab of Brandon Dixon, Ph.D., assistant professor in the George W. Woodruff School of Mechanical Engineering. The founder of the company is fourth-year Georgia Tech bioengineering Ph.D. candidate Mike Weiler. The company formed through the joint Georgia Tech-Emory TI:GER program (Technological Innovation: Generating Economic Results) which is a program that joins teams of Ph.D., M.B.A. and J.D. to commercialize university research technologies.

Startup Launched from Georgia Tech-Emory University Research Receives $7.9 Million

Clearside Biomedical, Inc. an Atlanta-based ophthalmic pharmaceutical company launched from research at Emory University and Georgia Tech, has received $7.9 million in funding to continue drug and technology development for treatment of ocular diseases. Santen Pharmaceuticals Co., Ltd in Osaka, Japan, will fund Clearside's technology development, and has also entered into a research collaboration agreement for posterior ocular diseases. Santen, along with new investor Mountain Group Capital and its affiliates, joins current investors Hatteras Venture Partners in Durham, N.C., the Georgia Research Alliance Venture Fund, and the University of North Carolina's Kenan Flagler Business School Private Equity Fund.

Clearside Biomedical is developing microinjection technology that uses hollow microneedles to precisely deliver drugs to a targeted area at the back of the eye. If the technique proves successful in clinical trials and wins regulatory approval, it could provide an improved method for treating diseases including age-related macular degeneration and glaucoma, as well as other ocular conditions related to diabetes. The technology was developed in a collaboration between the research groups of Henry Edelhauser, Ph.D., professor of ophthalmology at Emory University School of Medicine, and Mark Prausnitz, Ph.D., a Regents' professor in Georgia Tech's School of Chemical and Biomolecular Engineering. The National Institutes of Health sponsored research leading to development of the technology.

Startup AbbyMed Focuses on Intractable Cancers

AbbyMed, LLC, was incorporated to develop and commercialize novel therapies for intractable cancers. The company's technology comprises a class of novel small molecule NADPH oxidase inhibitors, called triphenylmethanes (TPMs). The TPM compounds and novel compositions are based on technologies developed by Jack Arbiser M.D., Ph.D., professor of Dermatology at Emory University and Ravi Bellamkonda, chair of the Wallace H. Coulter Chair of Biomedical Engineering at Georgia Tech and Emory. Arbiser designed the TMP compounds, but to overcome the challenge of the compounds low solubility, a novel nano-encapsulation method invented Bellamkonda was employed to increase bioavailability. Abby Med's initial clinical target is glioblastoma multiform (GBM) the most common and deadly malignant primary brain tumor. GBM has been designated an orphan disease, which opens the door to expedited development. Pre-clinical data with lead composition, nano-IB, showed safety and efficacy in animal models of GBM. AbbyMed recently closed on $1M in a Series A Preferred offering and is currently raising additional funding to support product development. AbbyMed's CEO is Stephen Snowdy, PhD, a venture capitalist and serial entrepreneur.

MiMedx and Georgia Tech Partnership

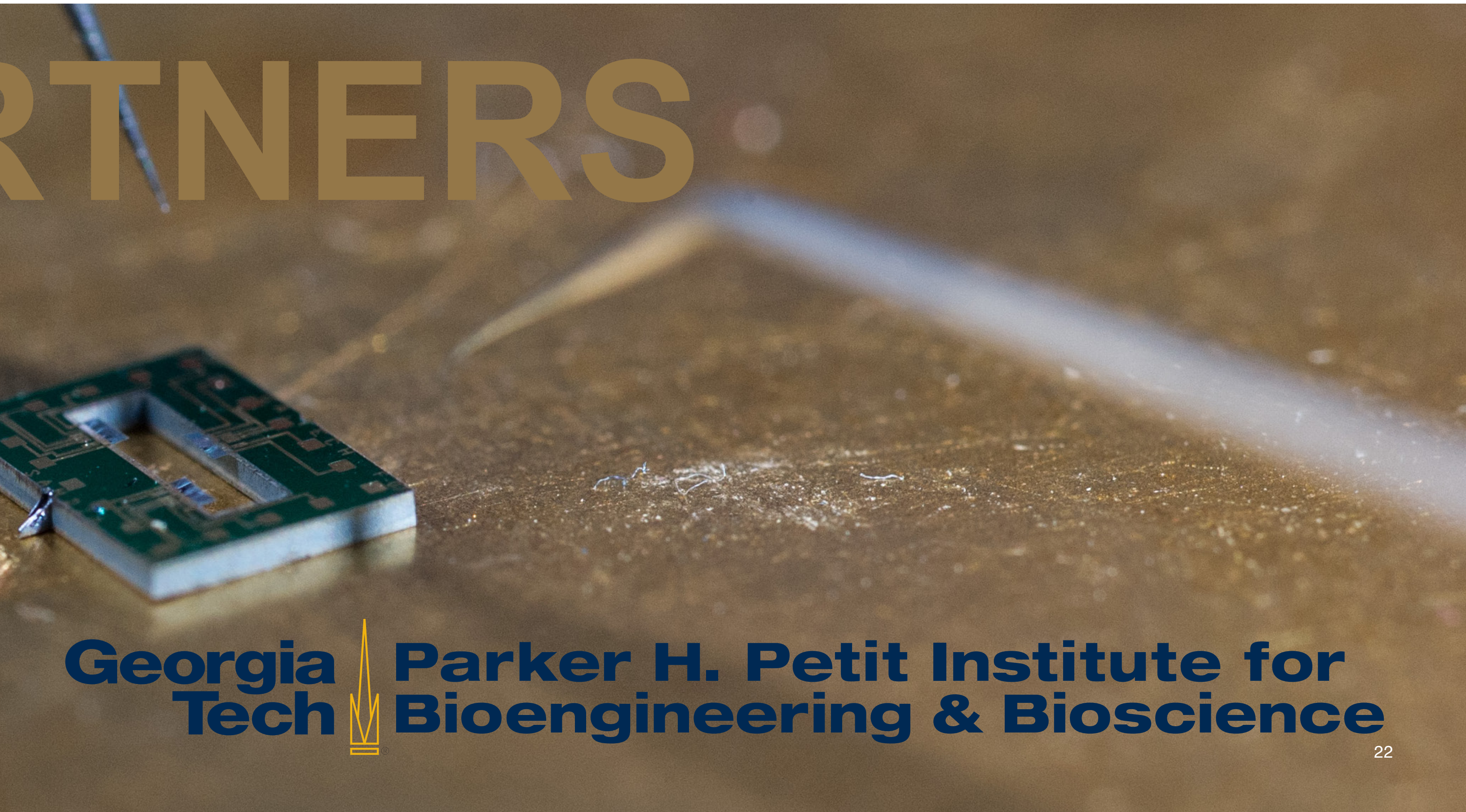
MiMedx Group is a publicly traded Marietta, Georgia-based regenerative biomaterials company and a Petit Institute industry partner. The Company's Chairman and CEO is Parker H. "Pete" Petit and they focus on delivering technologies that can be used for a wide range of medical applications, including ocular surface repair, gum repair, wound care, nerve and tendon protection, spine surgery, burn treatment, and many other types of procedures that require the repair of a patient's integumental (native) tissue. Product offerings utilize the Company's proprietary PURION® process, and include their AmnioFix® and EpiFix® dehydrated human amnion/chorion membrane (dHACM) allografts.

The partnership between MiMedx® and the Petit Institute is a natural one and gives this Georgia-based company access to research capabilities and expertise, state-of-the-art equipment and services, as well as hiring Georgia Tech trainees.

In addition, research collaborations have emerged, including projects in partnership with Johnna Temenoff, Ph.D., associate professor in the Wallace H. Coulter Department of Biomedical Engineering. The Temenoff lab has demonstrated that EpiFix® allografts retained biologically-active growth factors as well as factors capable of stimulating and recruiting stem cells that are instrumental in the wound healing process.

In another study, MiMedx partnered with Robert Guldberg, Ph.D., executive director of the Petit Institute, and investigated whether EpiFix® Micronized product had positive effects in an industry-standard preclinical model of osteoarthritis. After injecting EpiFix® Micronized into the affected areas, outcomes of cartilage degeneration were measured using quantitative 3-D imaging by contrast enhanced micro-CT. EpiFix® Micronized was found to have a protective effect on the cartilage in the OA disease model; proteoglycan loss was attenuated, incidence of erosion sites was reduced, and lesion formation was completely prevented. Although further testing is needed, the results of these preliminary studies suggest that injectable micronized dHACM has the potential to be an effective clinical therapy for patients with degenerative joint disease.

MiMedx is traded on the NASDAQ Stock Market under the ticker symbol "MDXG."



APPOINTMENT

Goldbart Named Dean of Colleges of Sciences

Following a national search, Georgia Tech's College of Sciences has a new leader. Paul Goldbart, Ph.D., professor and chair of Georgia Tech's School of Physics, would assume the responsibilities of College of Sciences dean. Having spent the past 35 years as a physicist and teacher, Goldbart acknowledges a "lifelong romance" with science and mathematics.

Nerem Honored at International Conference for His Lifetime Achievements

Robert M. Nerem, Ph.D., has been selected for the Lifetime Achievement Award by the Tissue Engineering and Regenerative Medicine International Society America's chapter annual meeting for the over forty years that he has dedicated to the bioengineering community. Nerem has lead several national efforts throughout his career and this awards was given in recognition of all of his service.

New BME Chair Selected

The Georgia Institute of Technology and Emory University have selected Ravi V. Bellamkonda, Ph.D., a prominent biomedical scientist and engineer, to chair their joint Georgia Tech and Emory University department of biomedical engineering. Bellamkonda's appointment concludes a national search begun last year to fill the position, which is responsible for overseeing the department's academic and research programs.

DeWeerth Appointed as the New Associate Dean for Research & Innovation

Steve DeWeerth, professor in the Wallace H. Coulter Department of Biomedical Engineering, has been appointed as the new Associate Dean for Research & Innovation in the Dean's Office of the College of Engineering. DeWeerth is professor and founding chair of the Department of Biomedical Engineering at Khalifa University of Science, Technology, and Research in Abu Dhabi. As associate dean, he will focus on enabling engineering faculty members to develop and sustain excellence in scholarship and research.

García Named as Regents Professor by the University System of Georgia Board of Regents

A Regents' Professorship title represents the highest academic status bestowed by the University System of Georgia and it is meant to recognize a substantial, significant and ongoing record of scholarly achievement that has earned high national esteem over a sustained period. Andrés García was recognized for his excellence in research, teaching and service, and his leadership role in bioengineering education on campus and biomaterials research around the world.

AIMBE Names Bellamkonda President-Elect

The American Institute for Medical and Biological Engineering (AIMBE) has named Ravi Bellamkonda, Ph.D., as the organization's president-elect. Headquartered in Washington, D.C., AIMBE provides leadership and advocacy in medical and biological engineering. Bellamkonda represents the fourth Georgia Tech bioengineer elected to serve as president of the prestigious organization, reflecting the Institute's leadership in biological and medical engineering.

McDevitt Named as One of Georgia Trend's 40 Under 40

Georgia Trend Magazine has selected a group of 40 Georgians under the age of 40 who they consider the state's "Best and Brightest" across different sectors, including business, government, politics, nonprofits, arts, finance and the military. Todd McDevitt, Ph.D., associate professor in the Wallace H. Coulter Department of Biomedical Engineering (BME) at Georgia Institute of Technology and Emory University, was chosen among this year's selections.

Researchers Selected for the Department of Energy's 2014 Community Science Program

Kostas Konstantinidis, Ph.D., Carlton S. Wilder Assistant Professor in Civil and Environmental Engineering; has been selected for the Department of Energy's 2014 Community Science Program. The program provides high-throughput DNA sequencing resources to support genomics research of relevance to urgent energy and environmental challenges.

Gaucher Receives Young Professor Award from DuPont

Eric Gaucher, Ph.D., associate professor in the School of Biology, was named as one of 14 young faculty from seven nations to receive an early career grant from DuPont. The DuPont Young Professor program is designed to help promising young and untenured research faculty begin their research careers. The $75,000 award will allow Gaucher to explore new research directions.

TS & HONORS

Lu Named as AAAS Fellow

The American Association for the Advancement of Science (AAAS) named Hang Lu, Ph.D., professor in the School of Chemical and Biomolecular Engineering to its 2013 class of fellows. Lu was honored for her distinguished contributions to the field of engineering systems for high-throughput quantitative and systems biology. AAAS is the world's largest general scientific society and fellows are recognized for meritorious efforts to advance science or its applications.

Ragauskas Honored at American Chemical Society Meeting

Art Ragauskas, Ph.D., professor in the School of Chemistry and Biochemistry was honored with the 2014 American Chemical Society Award for Affordable Green Chemistry. His research focuses on converting lingocellulose, a kind of plant matter, into biofuels as well as biobased chemicals and materials that can be used in applications ranging from health care to packing material. Using plant materials to take the place of plastics can have a large impact on the environment as it lessens our demand for petroleum and creates products that are biodegradable.

Thomas Honored with Young Investigator Award from National Society

Susan Thomas, Ph.D., assistant professor in the George W. Woodruff School of Mechanical Engineering, has been named the 2013 Rita Schaffer Young Investigator by the Biomedical Engineering Society (BMES). Recognized for her pioneering work in the field of immune-bioengineering, she continues to investigate the role of biotransport processes in regulating immune-regulated pathologies, in particular cancer.

BME Faculty Appointed Carol Ann and David D. Flanagan Faculty Professorships

The University System of Georgia Board of Regents has approved the appointment of Krish Roy, Ph.D. and Todd McDevitt, Ph.D. to Carol Ann and David D. Flanagan Faculty Professorships in the Wallace H. Coulter Department of Biomedical Engineering. These appointments, generously endowed by the Flanagans in 2011, serve to recognize and reward faculty that are conducting high impact research and are exemplary citizens of the department and Georgia Tech.

OUTSTANDING RECOGNITIONS

Julie Champion, Ph.D. - CETL/BP Junior Faculty Teaching Excellence Award
Suman Das, Ph.D. - Morris M. Bryan, Jr. Chair in Mechanical Engineering for Advanced Manufacturing Systems
Michelle Dawson, Ph.D. - Georgia Tech 2013 Excellence in Teaching Award
Craig Forest, Ph.D. - Engineer of the Year in Education by Georgia Society of Professional Engineers
Craig Forest, Ph.D. - Georgia Tech 1940 Roanne Beard Outstanding Teacher Awards for his teaching
Craig Forest, Ph.D. - Georgia Tech 1934 Outstanding Innovative Use of Education Technology Award
Bob Guldberg, Ph.D. - Roundtable member for the Biomedical Engineering Materials and Applications (BEMA)
David Hu,Ph.D. - Sigma Xi Best Faculty Paper Award
David Hu Ph.D. - National Science Foundation CAREER Award
Nick Hud, Ph.D. - Georgia Tech Outstanding Achievement in Research Program Development Award
Michelle LaPlaca, Ph.D. - DETECT device named as one of Atlanta Magazine's groundbreaking technologies
Raquel Lieberman, Ph.D. - Georgia Tech Junior Faculty Outstanding Undergraduate Research Mentor Award
Todd McDevitt, Ph.D. - Best Advisor, Bioengineering Graduate Program
Bob Nerem, Ph.D. - Georgia Tech Gold & White Honorary Alumnus Award
Manu Platt, Ph.D. - Petit Institute Interdisciplinary Research & Educational "Above & Beyond" Award – Junior Faculty
Steve Potter, Ph.D. - Top 20 Science & Engineering Professors in Georgia
Todd Streelman, Ph.D. - Petit Institute Interdisciplinary Research & Educational "Above & Beyond" Award – Junior Faculty
Mark Styczynski, Ph.D. - National Science Foundation CAREER Award
Susan Thomas, Ph.D. - Georgia Tech 2013 Class of 1969 Teaching Fellows Program
Younan Xia, Ph.D. - 2013 Nano Today Award

WORKSHOPS

Regenerative Engineering and Medicine Workshop at Hilton Head

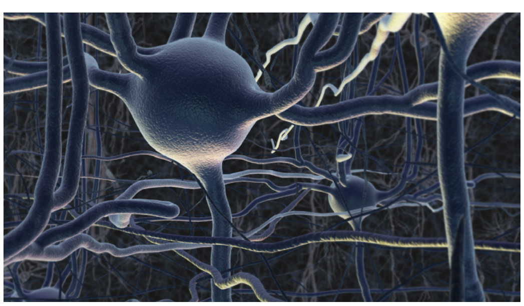
The 17th Annual Hilton Head Workshop, “Regenerative Medicine: Technologies Enabling Novel Therapies,” was held on Hilton Head Island in South Carolina and co-organized by the Georgia Tech and Emory Regenerative Engineering and Medicine Center (REM) and the University of Pittsburgh. With another “sell-out” crowd in attendance, the goal of the 2013 workshop was to bring together academic and corporate scientists and their trainees working at the cutting edge of regenerative medicine technologies and provide an intimate forum for sharing the latest insights and discoveries in this rapidly progressing field.

Pediatric Workshop Hosted to Create New Synergies

Pediatric Medicine + Engineering Workshop for Diagnostics, Devices and Delivery brought together investigators interested in pediatric research from Georgia Tech, Children’s Healthcare of Atlanta, Emory, and Morehouse. The goals were to identify areas of potential synergy and collaboration to develop improved diagnostic, device, and delivery/therapeutic technologies for pediatric clinical therapies. Hosted by the Petit Institute in October, over 85 faculty and trainees attended and new research partnerships were formed.

2013 Suddath Symposium - Inorganic Chemistry and Biology

The 21st Annual Suddath Symposium was held to honor the life and contribution of F.L. “Bud” Suddath by discussing the latest developments in bioengineering and bioscience. The 2013 Suddath Symposium, “The Inorganic Face of Life: From Metalloproteins to Cells and Whole Organisms,” was devoted to illuminate the rich tapestry at the intersection of inorganic chemistry and biology, traditionally thought of as two separate disciplines with little common ground. The presentations covered a broad and diverse set of topics, ranging from the movement of electrons in redox processes to exploring the function of metalloenzymes, from unraveling the role of metal ions in the evolution of life to chasing their trafficking pathways and regulation in developing organisms and disease, and from tracing gasotransmitters in cell signaling to resolving complex gene regulatory processes. Christoph Fahrni, professor in the school of chemistry and biochemistry, was the symposium’s organizer.



Brain Workshop: Enabling Health through Neurotechnologies

On the heels of President Obama’s announcement to dedicate $100 million to brain mapping, the Petit Institute hosted a workshop around the topic in October. The goal was to bring together industry and science innovators in the field to explore and discuss leading issues such as sensing and measurement; controlling and modulation; and neural circuits, coding and modeling. Over 65 researchers attended and the evening concluded with a well attended poster session.

Frontiers in Bioengineering Workshop

The Frontiers in Bioengineering Workshop brought together leaders of bioengineering to discuss the cutting-edge research in the field, with a focus on bio-imaging, biomaterials and cellular/molecular bioengineering, and to identify critical issues, challenges and future directions. Speakers from around the world presented their latest research and spoke about future trends in their research area. In addition to the line-up of speakers, over twenty young investigators from visiting universities from around the world were selected through a competitive process, to attend and present a poster. The workshop was co-organized by Gang Bao, professor, Wallace H. Coulter Department of Biomedical Engineering, and Robert M. Nerem, professor emeritus, George W. Woodruff School of Mechanical Engineering.

& EVENTS

Nobel Laureate, Cech, Gives Distinguished Lecture

Each fall at the Petit Institute hosts a special speaker for its Distinguished Lecture Series which brings nationally and internationally recognized bioengineering and bioscience leaders to the community to give their perspective on the future of biotechnology. The 2013 speaker was Thomas R. Cech, Ph.D., who spoke to the audience about his discovery that ribonucleic acid (RNA) is not only an informational molecule, but can also catalyze biochemical reactions, a finding which led to the Nobel Prize in Chemistry in 1989.

Specifically his group found that Tetrahymena, a single-celled pond organism, cut and rejoined chemical bonds in the complete absence of proteins. Thus RNA was not restricted to being a passive carrier of genetic information, but could have an active role in cellular metabolism. This discovery of self-splicing RNA provided the first exception to the long-held belief that biological reactions are always catalyzed by proteins. In addition, it has been heralded as providing a new, plausible scenario for the origin of life; because RNA can be both an information- carrying molecule and a catalyst, perhaps the first self-reproducing system consisted of RNA alone.

During his presentation, he spoke about his discovery and reviewed the chemical mechanism and structure of the original ribozyme (catalytic RNA molecule). He then went on to present some of his more recent work, including the genome-wide analysis of a human protein, FUS, that binds long non-coding RNAs, and the possible implications of the research for understanding the neurodegenerative disease Amyotrophic lateral sclerosis (ALS).

New Direction for Tissue Engineering and Regenerative Medicine

Georgia Tech, along with university partners, Cedars-Sinai, University of California at Berkeley, University of Maryland and the University of Wisconsin, hosted a two-day workshop in July on the topic “New Directions for Tissue Engineering and Regenerative Medicine” with a focus on stem cell research and its emergence as a technology and the role of engineering. The goal of the workshop was to stimulate creative, original, and potentially transformative new ideas and concepts and to identification of future directions in the field of tissue engineering and regenerative medicine, particularly the role of engineering in the field of stem cells.

Forty leaders representing both academia and industry participated in organized presentations and working groups. The discussion at the workshop focused on the underlying scientific and technological issues and challenges and potential broader impact of engineering on the stem cell field. Tissue engineering and regenerative medicine is an interdisciplinary field that integrates engineering and the life sciences towards the advancement of commercial applications and clinical therapies. These fields have gone through major transformations since the early 1990’s. Over the last decade, stem cell research has emerged as a major component of the field boosting tissue engineering and regenerative medicine into new and promising directions.

OUTSTANDING

Petit Institute Announces its 2013 Class of Petit Scholars

The Petit Institute for Bioengineering and Bioscience announced its 2013 class of Petit Undergraduate Research Scholars. The “Petit Scholars” are top undergraduate students from Atlanta-area universities chosen from a highly competitive selection process to conduct independent research projects for a full year at the Petit Institute. Each of the 16 scholars will be mentored by a graduate student or postdoctoral fellow in a Petit Institute laboratory for an entire year. During this period, the scholars will work to develop their own research projects which they themselves have selected after a thorough interview process with potential mentors. Research is conducted within the areas of cancer biology, biomaterials, drug design, development and delivery, molecular evolution, molecular cellular and tissue biomechanics, regenerative medicine, stem cell engineering and systems biology. Many scholars will have made enough progress in their research by the end of the year to contriubute to scientific publications and present at conferences. The class of 2013 is represented by students from Georgia Tech, Emory University, Morehouse College and Agnes Scott College.

Petit Institute “Above and Beyond” Award Winners Announced

The Parker H. Petit Institute for Bioengineering & Bioscience announced the winners of its annual “Above and Beyond” awards given annually to staff, a junior faculty member, a senior faculty member, a staff member, and, for the first time in 2012, to three trainees. The trainee awards were given to graduate students, Ashley Allen, Stacie Gutowski and Jenna Wilson for their dedication to the broader community through graduate student group activities as well as volunteering. Allen, from the lab of Bob Guldberg, PhD, was recognized for her numerous volunteer activities over the years. She served as chair and member of Bioengineering Graduate Student Association (BGSAC) for two years, and as chair of the outreach committee for the Bioengineering and Bioscience Unified Graduate Students (BBUGS). Gutowski, who also gives generously of her time to volunteering in many capacities, has been very active in BBUGS, serving as the organization’s co-chair for two years as well as the co-chair for the education and outreach committee. She was the co-chair for the biotechnology career fair and served as a trainee and then a mentor for the Graduate Leadership Program (GLP) on campus. Gutowski’s adviser, Andres Garcia, PhD, nominated her for the award. Wilson, a doctoral student in the lab of Todd McDevitt, PhD, is another standout amongst Petit Institute trainees. She served as event chair of BGSAC, volunteered for numerous outreach activities with BBUGS, was a leader for the IGERT mentoring meetings, a mentor for Georgia Tech’s Women in Engineering and served on the graduate recruitment committee for BMES.

2013 Suddath Symposium Award Winners

The Parker H. Petit Institute for Bioengineering & Bioscience awarded the 2013 Suddath Symposium Awards to three graduate students for their grand achievements in biological or biochemical research at the molecular or cellular level.

The first place award was given to Melissa Kinney who is pursuing her PhD in biomedical engineering in the lab of Todd McDevitt, PhD. Kinney was selected from numerous submissions in the most competitive selection process to date for the award. Her research is focused on understanding the complexity of embryonic stem cell interactions within three dimensional microenvironments in order to control spatial and temporal aspects of pluripotent cell fate and morphogenesis and ultimately enable the derivation of complex, functional tissues for the replacement or regeneration of damaged tissue.

Berkley Gryder received the 2nd place award for his research in bioorganic chemistry, biochemistry and drug design in the lab of Yomi Oyelere, PhD. He has developed gold nanoparticle conjugates to target prostate cancer, novel proteasome inhibitors for treating cancers and M. tuberculosis infections, triazole-based histone deacetylase inhibitors for cancer and antimalarial treatment, and duel-acting conjugates that bind hormone receptors for drug delivery.

James Kratzer, a doctoral student in the school of Biology, was recognized for a 3rd place award for his leadership in the lab of Eric Gaucher, PhD, where he conducts research in the field of evolutionary synthetic biology, protein engineering, ancestral sequence reconstruction and directed evolution.

BioEngineering Graduate Program Announced 2013 Awardees

The 2013 BioEngineering Graduate Program awards were announced during the poster session which was held to welcome potential new recruits to the program. This is the second year that the program has honored graduate students with the Best Thesis and Paper awards and a faculty advisor whose dedication advising and mentoring graduate students in the program goes above and beyond.

Sarah Sharpe, a Ph.D. candidate in Dan Goldman's laboratory, was awarded the Best Paper Award for a journal article featured in the Journal of Experimental Biology entitled, "Environmental interaction influences muscle activation strategy during sand-swimming in the sandfish lizard Scincus scincus." Sarah's work has been ground breaking because while there has been a lot of work looking at organisms swimming in fluids, flying, and running on relatively flat rigid hard ground, there has been much less work done on the movement of organisms on and within materials like sand that can behave as fluids and solids.

Catherine Rivet, a Ph.D. candidate, supervised by Melissa Kemp, Ph.D. and Hang Lu, Ph.D., received the Best Thesis Award for her dissertation entitled, "Impaired Signaling in Senescing T Cells: Investigation of the Role of Reactive Oxygen Species Using Mircrofluidic Platforms and Computational Modeling." This research resulted in five publications and Rivet was also named as the 2012 Suddath award winner.

COMMUNITY

Stem Cell Engineering IGERT Heads into 4th Year

Georgia Tech's IGERT (Integrated Graduate Education Research Training) program announced its fourth class of PhD student trainees which includes graduate students from a wide variety of disciplines including the School of Chemical and Biomolecular Engineering, the Wallace H. Coulter Department of Biomedical Engineering, and the School of Materials Science and Engineering.

This NSF-funded IGERT program in Stem Cell Biomanufacturing was originally awarded to Georgia Tech in 2010 to educate and train the first generation of PhD students in the translation and commercialization of stem cell technologies for diagnostic and therapeutic applications. The field of stem cell research continues to offer a unique opportunity for engineers to contribute significantly to the generation of robust, reproducible, and scalable methods for phenotypic characterization, propagation, differentiation and bioprocessing of stem cells. The IGERT program supports incoming Georgia Tech PhD students for their first two years of graduate school and offers a core curriculum in stem cell engineering and bioprocessing paired with elective tracks in advanced technologies, public policy, ethics, or entrepreneurship. The $3 million award will train over 30 graduate students in the first five years of the program and has been tremendously successful to date.

IGERT trainees have gone on to publish in top journals, as well as win prized fellowships and numerous awards, with Douglas White recently winning the Medtronic Excellence in Modeling Award and Alison Douglas receiving an American Heart Association Predoctoral Fellowship. IGERT students also devote large amounts of time to campus events and community outreach, participating in Buzz on Biotechnology and Girls Summit. Trainees are also afforded opportunities to meet with leading experts in the field through the Stem Cell Engineering Center seminar series and the annual Stem Cell Engineering workshop, and to interact with representatives from leading companies during Georgia Tech's annual Bio Industry Symposium.

Petit Institute Hosts Annual Buzz on Biotechnology High School Open House

On Saturday, October 26th, the Parker H. Petit Institute for Bioscience & Bioengineering hosted its annual open house for high school students to come and learn more about the cutting-edge world of biotechnology at Georgia Tech. A capacity crowd of over 400 students, parents and teachers came from over 40 Atlanta area schools to take part in engaging, hands-on scientific demonstrations, tours of state-of-the-art Petit Institute laboratories and biotechnology-focused seminars. They even had a visit from Buzz the Georgia Tech mascot!

The program was first created in 2003 by the Petit Institute's graduate student group, the Bioengineering & Bioscience Unified Graduate Students (BBUGS), to expose young people to biotechnololgy and get them excited about science. Some of the innovative science and engineering demonstrations included "Ribosomal Evolution," "Stem Cell Separation," "The Cardiovascular System," "Hold a Human Brain," "Fun with Liquid Nitrogen," "Cabbage Acids and Bases," "Protein Folding," "Functional Finger" and "Viscoelasticity."

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