\JĒ-ˈNŌ-MIKS\

GENOMICS \JE-ˈNO-MIKS\:
THE STUDY OF THE STRUCTURE AND FUNCTION OF AN ORGANISM'S COMPLETE SET OF GENETIC MATERIAL, AND HOW IT DEFINES LIFE.

INSTITUTE FOR GENOMIC BIOLOGY

2013 Annual Report

\AS AN INSTITUTE ON THE FRONT LINE OF INNOVATION, WE EMBRACE CHANGE. FROM REIMAGINING THE TRADITIONAL LAB SPACE TO CREATING INTERDISCIPLINARY TEAMS, WE EMBODY FORWARD THINKING EACH DAY AS WE CONDUCT TRANSFORMATIVE RESEARCH.\

The past six years have taught us that while technologies and techniques may change, many aspects of this Institute will remain steadfast. Our commitment to advancing life sciences research and stimulating bioeconomic development. Our conviction in collaborative, interdisciplinary research. Our confidence in a thematic approach to tackling formidable problems facing our society.

This year, the Institute for Genomic Biology's (IGB) progressive work has redefined the applications of genomics and its potential to provide bountiful food and fuel, robust health, and a sustainable environment.

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A CELL CHANGES ITS SPOTS

SR-SIM - Four laser structured illumination system

Jingyi Fei
Taekjip Ha Lab

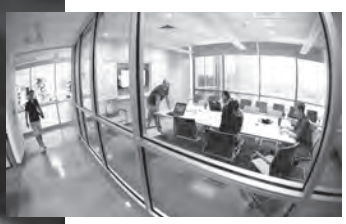
Research funded by the NSF Center for the Physics of Living Cells and the American Cancer Society

The best-known role of RNA is that of a messenger within the cell, carrying instructions for how to build proteins. However, RNA plays many other important roles, some of which are still being discovered. The bright spots that form the basis for this image were produced by labeling a long non-coding RNA (a recently described class of RNA) with a fluorescent dye. Imaging long non-coding RNAs will shed light on possible correlations between their organization in the nucleus and their potential function in coordinating gene expression.

Gene Robinson, Director

This year, we have found ourselves returning again and again to a deceptively simple question: what is genomics?

A technical definition–the study of an organism's complete set of genetic material–does not capture the excitement and dynamism of the field, the uniquely diverse range of genomic research, or the far-reaching societal implications of its findings. A complete answer should include the culture and philosophy of genomics.



The IGB provides large, communal spaces that encourage interactions among its members, from collaborations in the shared laboratories to conversations with colleagues in the meeting areas.

The Institute for Genomic Biology strives to exemplify all of these qualities. As we continue to grow and adapt in a world of fast-paced technological advancement and big data, we are mindful of how much diversity, flexibility, and community connections have contributed to our success.

The work we do at the IGB reflects the many facets of genomic research. In the past year, our members have continued to engage in path-breaking investigations. They have created strains of yeast that more efficiently convert biomass into fuel; discovered unexpected connections between the proliferative ability of a disease-causing parasite and the regenerative biology of its harmless relative; and used a novel and efficient method of DNA editing to uncover hidden natural products in a bacterial genome.

The inception of genomic research embodied a shift in the scientific community from considering single genes in isolation, to the attempt to understand the concerted actions and interactions among many genes. This intellectual framework parallels the growth of the genomic research community, a strong and complex network of groups representing a broad range of academic backgrounds and areas of interest.

Our community is a stellar example of this collaborative culture. The scientific questions driving IGB research are larger and more

"As the impact of genomics on society continues to grow, the need to make advances in genomic research accessible and comprehensible to the community at large is increasingly urgent."

complex than those traditionally pursued by a single laboratory group. Such questions invite a collaborative approach, one that can bring to bear the knowledge, tools and insights of multiple fields. Recently established projects within the IGB are bringing together computer scientists and neurobiologists, informaticians and engineers, to search for molecular origins of social behavior and to build novel analytical tools for large and complex data sets. Because of their involvement in these or other diverse partnerships and their allegiance to multiple units across campus, IGB members, like the research they conduct, defy simple categorization.

The IGB's network of partnerships and collaborations, not only within the Illinois community but across the world, has continued to thrive. In addition to its new and continued partnerships with institutions across the United States, we have strengthened relationships with researchers in India, Niger and China. These relationships bring us new perspectives, new techniques, and new opportunities to explore the ways in which our ideas and technologies can improve our global society.

As the impact of genomics on society continues to grow, the need to make advances in genomic research accessible and comprehensible to the community at large is increasingly urgent. One of the most exciting

A visualization of the future space of the CompGen Initiative (top); hosting an international exchange with students from China (middle); and unveiling our 3rd annual Art of Science gallery exhibit (bottom).

Dedicated to transformative research, the IGB pioneers advances in the life sciences through a vibrant and curious scientific community.

Hon. Heinz Rudolf extracts DNA from a strawberry in an IGB lab during the Genomics for Judges Program.

areas of growth the IGB has experienced this year is in our array of education and outreach efforts. We have established new programs, including a summer science camp for middle school girls, as well as continuing traditions such as Art of Science, an exhibit that uses images derived from research to blur the lines separating the technical from the aesthetic.

Our most ambitious new outreach project is a series of "Genomics for™" courses designed to help members of the public learn more about what a genome is, and what genomics means to them: how genomic research might impact their personal and professional life. Our first course, Genomics for™ Judges, was a rewarding experience for instructors and attendees alike. We will continue to expand the scope and scale of these and other outreach programs in the years to come.

In the past year, we have come to embrace the idea that genomics has become much more than a field of study; it is a tool that can be applied to solve a myriad of scientific challenges, a common language that facilitates connections between researchers with seemingly disparate academic backgrounds, and an opportunity to engage with and improve the wellbeing of our society. As we move forward, we'll continue to consider how we define genomics, not through words, but through our work and our vision for the future.

Gene E. Robinson

DIRECTOR, INSTITUTE FOR GENOMIC BIOLOGY

Illness. Hunger. Energy Crises. It's hard to imagine that the solutions to these colossal problems may lie inside a minuscule cell. Through the study of genomes, faculty at the Institute for Genomic Biology work to better understand organisms and biological processes that influence the human condition.

bit.ly/1dQBTHi

The IGB was established in 2003. Construction of the Institute's progressive building was completed in 2007. Using state-of-the-art equipment and shared lab spaces, the IGB's unique facility stimulates exciting discoveries and ongoing interdisciplinary collaborations among its world-class researchers.

The IGB brings together faculty, postdoctoral researchers, students, academic professionals, and volunteers who are committed to progressive research and community outreach. The IGB is a second academic home to more than 130 IGB faculty and affiliate members, who remain active in 30 departments at the University of Illinois at Urbana-Champaign. Their diverse backgrounds and technical skills contribute to the high funding rate and breadth of expertise at the Institute.

Since opening its doors, the IGB has garnered more than $186 million from federal and private sources as well as unique industry partnerships. These funds support a variety of research projects related to health, energy, agriculture and the environment.

Unified by common interests, IGB faculty work on both independent and shared research projects within eight research themes and two strategic industry partnerships.

IGB Research Themes

Biocomplexity (BCXT): Exploring the origin of life and behavior of biological systems.

Biosystems Design (BSD): Using engineering concepts to guide the study, design and construction of biological systems.

Business, Economics and Law of Genomic Biology (BioBEL): Examining the financial and legal issues related to genomics.

Cellular Decision Making in Cancer (CDMC): Working to better understand how cancer alters the inner workings of cells.

Genomic Ecology of Global Change (GEGC): Studying the intersection of genomics and global climate change.

Gene Networks in Neural & Developmental Plasticity (GNDP): Investigating how biological diversity is affected by the structure and function of gene regulatory networks.

Mining Microbial Genomes (MMG): Discovering metabolites (small molecules) that might provide new medical solutions.

Regenerative Biology & Tissue Engineering (ReBTE): Studying the replacement or regeneration of tissues and organs.

IGB Strategic Industry Partnerships

Center for Nutrition, Learning, and Memory (CNLM): Determining the impacts of nutrition on learning and memory in the human brain. In addition to the IGB, the Center partners with Abbott Nutrition and the Beckman Institute for Advanced Science and Technology.

Energy Biosciences Institute (EBI): Applying bioscience and biological techniques to address the global energy challenge through a unique public-private collaboration. The partnership, funded with $500 million over 10 years from the energy company BP, includes researchers from the University of California, Berkeley; the University of Illinois at Urbana-Champaign (housed within the IGB); the Lawrence Berkeley National Laboratory; and BP.

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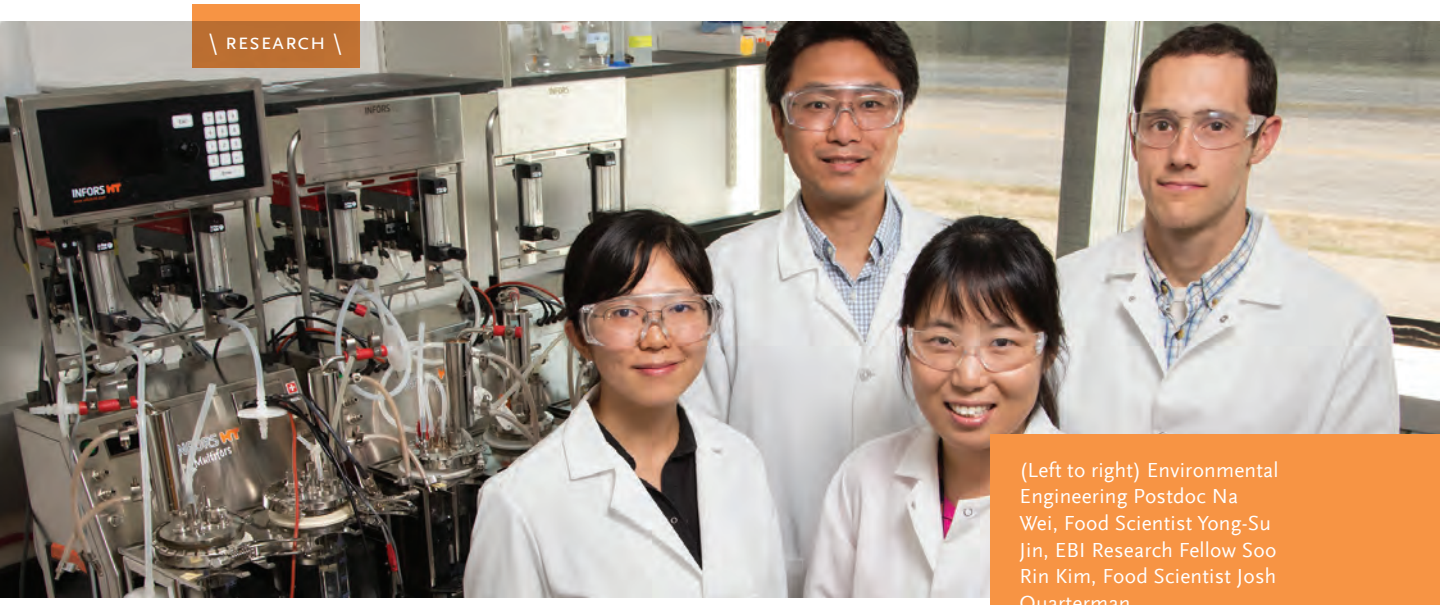
RESEARCH

: INVESTIGATION AIMED AT THE DISCOVERY AND INTERPRETATION OF FACTS, REVISION OF ACCEPTED THEORIES IN THE LIGHT OF NEW FACTS, OR PRACTICAL APPLICATION OF SUCH NEW OR REVISED THEORIES.

With state-of-the-art tools, cutting-edge techniques, and a passion for discovery, researchers at the IGB are tackling some of the most formidable problems facing society–24 hours a day, 7 days a week, 52 weeks a year. The IGB continually finds new ways to approach age-old problems and employ new technologies in pursuit of knowledge that will better the world.

Together, members of the IGB are working to better understand cancer and other diseases, provide abundant and nutritious food, discover sustainable sources of energy, and address other societal challenges.

With more funding than ever before, the IGB's interdisciplinary research has positively impacted many fields of study from medicine and bioenergy to synthetic biology and taxonomy. In 2013, our researchers have discovered improved techniques to identify people with ovarian cancer; Established a single type specimen for Asian elephants; Advanced a top origin-of-life theory; Sequenced the genome of the sacred lotus; Developed a promising cancer drug; and proved that biofuels really can grow on trees.



(Left to right) Environmental Engineering Postdoc Na Wei, Food Scientist Yong-Su Jin, EBI Research Fellow Soo Rin Kim, Food Scientist Josh Quarterman.

Scientists Up the Ante For Biofuels

Food Science and Human Nutrition Professor Yong-Su Jin (BSD/EBI), EBI Fellow Soo Rin, and coauthors reported in *Nature Communications* that they have engineered yeast to consume acetic acid, a previously unwanted byproduct of the process of converting plant leaves, stems and other tissues into biofuels. The innovation, funded by the EBI, increases ethanol yield from lignocellulosic sources by about 10 percent.

Lignocellulose is the fibrous material that makes up the structural tissues of plants. It is one of the most abundant raw materials on the planet, and because it is rich in carbon, it is an attractive source of renewable biomass for biofuel production.

http://bit.ly/KVKthe

Researchers Unmask Centuries-old Elephant Imposter

Through state-of-the-art ancient DNA and protein research and an exhaustive investigation of historical literature, animal scientist Alfred Roca (GNDP) and other researchers have determined a 300-year-old type specimen for Asian elephants is actually an African elephant.

In the study, published in the *Zoological Journal of the Linnean Society,* they established a new specimen to represent the species. The new specimen is likely the remains of Hansken, the famous performing elephant from the 1600s. The United States Fish and Wildlife Service supported Roca's research by funding earlier studies that contributed to these discoveries.

http://bit.ly/1gp2DoS

Animal Scientist Alfred Roca (left) with Research Specialist Yasuko Ishida (right).

Slow and Steady: A Drug Delivery Implant that Folds–and Paces–Itself

Chemist and biomolecular engineer Hyunjoon Kong (ReBTE) and colleagues have developed a substance that engineers itself—an easily produced hydrogel that, when implanted in tissue or placed in a water-based solution, folds itself into a shape that resembles a jelly roll. This whimsical-sounding innovation has a practical purpose: its self-assumed shape can be used to control the rate and direction of release of hormones or other embedded drugs, such as chemicals that promote tissue repair. The work was reported in *Advanced Materials* and was funded by the CAS, NSF, and U.S. Army Telemedicine & Advanced Technology Research Center.

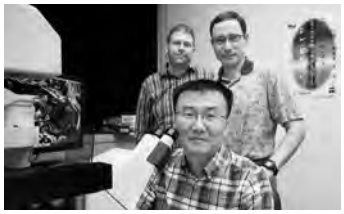
http://bit.ly/1d1e42u

Kong and his fellow researchers created a hydrogel with two layers comprising the same type of material, but made to differ in how each layer changes in shape when exposed to water. When placed in solution, the outer layer becomes longer relative to the inner layer, and the formerly flat gel rolls up into a tube. If a drug is loaded into the inner layer, the exposure of the drug-laden layer is very limited in the folded shape; this slows and prolongs the diffusion of the drug from the gel. The drug is also forced to diffuse mainly from the ends of the tube, directing release toward a particular area or tissue.

http://bit.ly/H0cRfJ

Scientists Work to Understand a Prolific Human Parasite

The schistosome, a parasitic flatworm, plagues millions of people across the world, causing roughly 250,000 deaths each year. Larval schistosomes are able to clone themselves thousands of times inside a snail host, with each clone capable of developing into an egg-producing adult inside human hosts.



IGB Fellow Bo Wang (front), Cell & Developmental Biology Postdoc James Collins (left), and Cell and Developmental Biologist Phillip Newmark (right) study the unique mechanisms that allow schistosomes' germinal cells to create thousands of clonal larvae that can then infect humans.

In a study published in *eLife*, cell and developmental biologist Phillip Newmark (ReBTE), IGB Fellow Bo Wang, and fellow researchers discovered schistosome germinal cells possess a molecular signature (a collection of expressed genes) similar to the molecular signature of neoblasts (adult stem cells), which allow planarians to regrow missing body parts. Among these genes, they identified some that are required for maintaining the germinal cell population.

This evidence suggests that schistosome larvae may have evolved by adapting a developmental program used for regeneration in non-parasitic flatworms in order to rapidly increase their population—essentially giving schistosomes the opportunity to reproduce twice within their life cycle, once asexually inside snail hosts and once sexually inside human hosts. This work was funded by the National Institute of Allergy and Infectious Diseases.

http://bit.ly/18oUAlF

Creating a "Living Foundry" with Support from the Roy J. Carver Charitable Trust

Scientists at the IGB have built a "living foundry" where they can manufacture molecules and materials in an automated, scalable, and high-throughput manner using synthetic biology, a new discipline that uses engineering principles to design biological systems more quickly and efficiently.

With a $2 million grant from the Roy J. Carver Charitable Trust, an interdisciplinary group of researchers have purchased the research equipment needed to establish the new Biosystems Design (BSD) research theme, led by Centennial Endowed Chair of Chemical and Biomolecular Engineering Huimin Zhao (EBI/MMG/BSD Theme Leader).

The Carver grant has allowed for the design and construction of a comprehensive system that includes (among other components) liquid handlers, thermocyclers, incubators, plate hotels, plate readers, and a robotic arm.

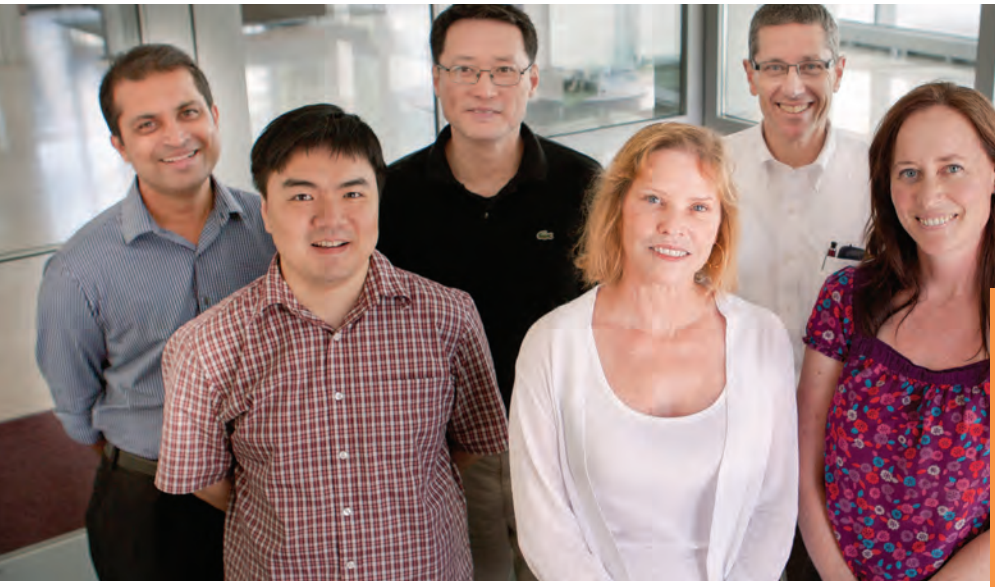
http://bit.ly/1eTiBUw

New Method of DNA Editing Allows Synthetic Biologists to Unlock Secrets of a Bacterial Genome

The genome of every bacterial species contains genes that can synthesize a diverse arsenal of natural products: antibiotics, antifungals, and other useful substances. Centennial Endowed Chair of Chemical and Biomolecular Engineering Huimin Zhao (EBI/MMG/BSD Theme Leader) and colleagues, in a study reported in *Nature Communications*, have demonstrated the use of an innovative DNA engineering technique to coax bacteria to reveal these functions, which are often hidden.

A bacterium will only express a subset of its genes at any given time: those that will help it thrive in its current environment. Zhao's group saw the challenge presented by the unexpressed, hidden genes as an opportunity to test a genetic engineering method they had recently developed. Their technique allows them to make many changes to DNA sequence simultaneously, rather than in the laborious series of steps that were previously necessary.

The genetic changes that Zhao's group made to the genome of *Streptomyces griseus*, a species of soil bacterium, directed the cell to express genes that usually remain silent. As a result, they were able to classify several previously unknown compounds belonging to a class of medically important natural products. The work is an important step toward creating a generalized, automated high-throughput method to make complicated changes to the genome of any organism; this is one of the major goals of BSD, the new research theme led by Zhao. The study was supported by the National Academies Keck Futures Initiative on Synthetic Biology, National Research Foundation of Korea, and NIH.



(Left to right) Computer Scientist Saurabh Sinha, Bioengineer Jian Ma, Cell and Developmental Biologist Fei Wang, Cell and Developmental Biologist Lisa Stubbs, IGB Director Gene Robinson, Animal Biologist Alison Bell, and Physicist Yoshi Oono.

IGB Biologists and Bioinformaticians Unite to Explore the Origins of Social Behavior

A $3 million grant from the Simons Foundation is funding a multidisciplinary effort to search for similarities in the ways that the brains of many different species, including our own, produce social behavior. The study, led by cell and developmental biologist Lisa Stubbs (GNDP Theme Leader), arose out of the common interests of the GNDP theme; theme members Alison Bell, Jian Ma, Yoshi Oono, Gene Robinson, Saurabh Sinha, and Fei Wang are co-investigators.

http://bit.ly/L0Tbe5

The study develops and implements new computational methods to compare gene interactions in the brains of bees, mice, and fish following an aggressive social encounter. Novel computational methods enable researchers to detect similarities in the way genes work together to direct social behavior in these three distantly related species. Such similarities would represent conservation of molecular mechanisms on a yet-unexplored level of analysis, the level of gene networks. Discovering deeply conserved mechanisms of social response will also further efforts to understand human brain function and social behavior.

Cracking How Life Arose on Earth May Help Clarify Where Else It Might Exist

Does life exist elsewhere or is our planet unique, making us truly alone in the universe? While many ideas about this fundamental

http://bit.ly/KgTDnT

Physicist Elbert Branscomb.

question exist, the real challenge is to move beyond speculation to theories.

A novel origin-of-life theory was first proposed more than 25 years ago by Michael Russell, a research scientist in Planetary Chemistry and Astrobiology at the NASA Jet Propulsion Laboratory. This potentially testable origin-of-life theory was further developed in a paper published in *Philosophical Transactions of the Royal Society B* by physicist Elbert Branscomb (BCXT), Russell, and Wolfgang Nitschke, from the National Center for Scientific Research in France.

The theory proposes that the transition to life was brought about by serpentinization, a geochemical process that closely resembles energy-making processes in living cells. Branscomb's work was supported in part by the NASA Astrobiology Institute.

http://bit.ly/141pcvk

Cancer Drug Tested in Pet Dogs Now Bound for Human Trials

Thanks to a $2 million investment from an anonymous donor, a drug that selectively destroys cancerous cells is on the road to human clinical trials. The compound, known as PAC-1, has so far proven to be safe and shown promising anticancer effects in early testing, including in pet dogs with spontaneously occurring lymphomas and osteosarcomas. Vanquish Oncology, a drug development startup company founded by Kenneth Rinehart Jr. Endowed Chair in Natural Products Chemistry Paul Hergenrother (CDMC) and Ted Tarasow, aims to move the promising drug from current early stages of development to eventual human clinical trials.

PAC-1 works by activating a signaling pathway that directs cells to self-destruct, a pathway that is easier to activate in many types of tumor cells. Hergenrother discovered PAC-1's anticancer capabilities in 2006 and has been refining and testing it ever since. After investigating the drug's efficacy in cell culture and mouse cancer models, he worked with Professor of Veterinary Clinical Medicine Tim Fan (CDMC) to examine PAC-1's ability to treat pet dogs from the community with naturally occurring cancers. The researchers noted that these tests, in addition to more closely resembling the medical challenge of human cancers, helped many sick animals that would not have received treatment otherwise.

http://bit.ly/13QuJDL

Innovation uses Adhesion to Combine Experimental Advantages of Silicones and Organic Materials

Microscale biotechnologies, including cell culture platforms and biochips, often rely on silicones as a component material. This is because of their advantageous properties: silicones are inert, elastic, biocompatible, and easy to work with. One major drawback of silicones is that their surfaces are extremely hydrophobic, meaning that they repel water—as well as aqueous solutions and some biological substances. Chemical modifications can be used to make the surfaces hydrophilic, but the results produced by these treatments are temporary.

A study led by chemical and biomolecular engineer Hyunjoon Kong (ReBTE) addressed this problem by developing a method to permanently modify a silicone polymer surface. Kong's group sought a way to "glue" an alginate hydrogel, a water-absorbing substance also used in food and medical industries, to a surface formed by a silicone polymer. They created a protocol to bond alginate, a component of the hydrogel, to the silicone surface. The reaction to produce the hydrogel can then take place directly on that surface.

The resulting hydrogel/silicone attachment formed by this process is stable for several months, can tolerate bending and repeated stretching, and is not

degraded by aqueous solutions. The hydrogel surface is friendlier to biological substances. “This method will greatly advance quality of cell culture platforms and microfluidic devices. It will further benefit design of novel drug delivery systems and cell transplantation devices,” Kong said. The work was reported in *Angewandte Chemie*, and funded by the CAS and NSF.

EBI Energy Farm, University of Illinois.

10-year Trials Show 10-ton Yields

Illinois researchers have reported results from a decade of Miscanthus field trials, conducted in the first research plots to be planted in the U.S. The average annual yield of miscanthus grown in seven Illinois locations over a period of eight to 10 years was 10.5 tons per acre, compared with 4.5 tons per acre for switchgrass grown in adjacent plots. The EBI, State of Illinois Council for Food and Agricultural Research, and Illinois Experimental Station provided funds to make the 10-year study possible.

http://bit.ly/1eGLIvY

Plant biologist Stephen Long (EBI/GEGC) recently reported the findings in the journal *Global Change Biology: Bioenergy*. Long and his colleagues calculated the total land area needed to produce enough miscanthus to meet the renewable fuel standard mandate for cellulosic ethanol production by the year 2022, finding that the targeted 16 billion gallon cellulosic volume would require 17 million acres of *Miscanthus x giganteus* or 39 million acres of switchgrass.

Study of Mitochondrial DNA Ties Ancient Remains to Living Descendants

Anthropologist Ripan Malhi (BioBEL/ReBTE) and other researchers report in *PLOS ONE* that they have found a direct genetic link between the remains of Native Americans who lived thousands of years ago and their living descendants. The team used mitochondrial DNA to track three maternal lineages from ancient times to the present.

http://bit.ly/1aWzvQs

The researchers compared the complete mitochondrial genomes of four ancient and three living individuals from the north coast of British Columbia, Canada. This region is home to the indigenous Tsimshian, Haida and Nisga’a people, all of whom have oral traditions and some written histories indicating that they have lived in the region for uncounted generations. Archaeological sites, some with human remains, date back several millennia. But until the current study, nothing definitively tied the current inhabitants of the area to the ancient human remains found there, some of which are 5,000 to 6,000 years old. The study was supported by the NSF.

http://bit.ly/1dtoL0q

Cracking the Sorghum Code

Although sorghum lines underwent adaptation to be grown in temperate climates decades ago, crop scientist Patrick Brown (EBI/GEGC) and his team have now completed the first comprehensive genomic analysis of the molecular changes behind that adaptation. They published their findings in *Genome Biology*.

Sorghum research crops, University of Illinois.

Having a complete characterization of the genomic locations (loci) affecting specific traits will speed up the adaptation of sorghum and other related grasses to new production systems for both food and fuel. This work was supported by the EBI.

http://bit.ly/L0Yme1

Synthetases as 'Key Interpreters'

Crop scientist Gustavo Caetano-Anollés (GEGC) and other researchers conducted an analysis of enzymes that load amino acids onto transfer RNAs–an operation at the heart of protein translation–that offers new insight into the evolutionary origins of the modern genetic code, as reported in *PLOS ONE*. The research was funded by grants from the NSF and the United States Department of Agriculture.

When protein is synthesized inside a cell, a molecular machine called a ribosome "reads" a strand of messenger RNA to determine what amino acid should next be added to the protein. Enzymes called aminoacyl tRNA synthetases play a crucial role in an earlier part of this process; the synthetases read the genetic information embedded in transfer RNA (tRNA) molecules and attach the appropriate amino acid to each tRNA. When the loaded tRNA encounters a ribosome, it is matched up with a section of the mRNA that corresponds with its own genetic code, and adds its amino acid to the growing protein.

Using an approach developed in the Caetano-Anollés lab, researchers set out to determine the relative ages of different protein regions in both the synthetases and the proteins they help to build. They found that the regions of synthetases that load amino acids onto the tRNAs are more ancient than those that read the genetic information of the tRNA. They also found that the most ancient regions of other proteins contained a disproportionately high amount of amino acids that are linked to tRNAs by the most ancient synthetases. This work has led researchers to the exciting hypothesis that ancient protein synthesis involved enzymes that looked a lot like today's synthetases, perhaps working in conjunction with ancient tRNAs.

http://bit.ly/1hUAJSG

Tracking Variability in Bacterial Populations

As a result of the variable nature of gene expression, genetically identical cells inhabiting the same environment can vary significantly in their numbers of key enzymes, which in turn results in strikingly different cellular behaviors.

Incorporating data from studies of gene regulation and protein distributions in single cells, chemist Zaida Luthey-Schulten (BCXT) was able to identify several cell behavioral subtypes within a modeled population. Luthey-Schulten's computer model predicts emissions of metabolic byproducts and molecular pathway selection to balance energy and protein costs as a function of growth. This research was published in the *Proceedings of the National Academy of Sciences* with support from the NSF to the Center for the Physics of Living Cells.

http://bit.ly/L8SmAH

Heads or Tails?

Cell and developmental biologist and Howard Hughes Medical Institute investigator Phillip Newmark (ReBTE) may not always be able to call "heads or tails" on a coin toss, but he can on a planarian–and not just for an anatomy exam. Newmark has discovered how to make a planarian, a type of non-parasitic flatworm, regrow a head from a fragment of its tail.

Some species can do this naturally, but Newmark found that other species of planarians can as well if a specific gene is repressed.

It may be that the last common ancestor had the ability to regenerate, a trait that was lost or inhibited over time in many species. According to the study, published in *Nature*, Newmark was able to "reverse the evolutionary loss of regenerative potential in planarians." Newmark's work was supported by the National Institute of General Medical Sciences.

Chemical and Biomolecular Engineering Postdoc Sara Pedron (left) and Chemical and Biomolecular Engineer Brendan Harley (right) found a way to adjust the malignancy of brain cancer cells in a newly developed polymer gel that mimics conditions in the brain.

Researchers Develop New Approach for Studying Deadly Brain Cancer

Human glioblastoma multiforme, one of the most common, aggressive and deadly forms of brain cancer, is notoriously difficult to study. Scientists need a method of growing cancer cells that allows them to observe the way tumors develop, spread, and respond to treatments. Traditionally, cancer cells have been grown in expensive animal models, or in petri dishes, which have none of the properties of the brain tissues in which these cancers naturally grow.

http://bit.ly/O6F0WA

Chemical and Biomolecular Engineering Professor Brendan Harley (ReBTE), along with a team of engineers, has developed a three-dimensional hydrogel that more closely mimics conditions in the brain. The new hydrogel is more versatile than other 3D gels used for growing glioma cells in part because it allows researchers to change individual parameters–the gel's stiffness, for example, or the presence of molecular signals that can influence cancer growth–while minimally altering its other characteristics, such as porosity.

The researchers found that they could increase or decrease the malignancy of brain cancer cells in their hydrogel simply by adding hyaluronic acid, a naturally occurring carbohydrate found in many tissues, especially the brain. "If you have a material that allows you to selectively tune up or down malignancy, that will allow you to ask lots of questions about treatment methods for more malignant or less malignant forms of glioma," Harley said. The IGB, Department of Chemical and Biomolecular Engineering, and the Campus Research Board supported the work, which was published in *Biomaterials*.

A Gene that Helps Honey Bees Find Flowers (and Get Back Home)

Honey bees don't start out knowing how to find flowers or even how to get around outside the hive. Before they can forage, they must perform

http://bit.ly/1o7T7Lt

training flights, called orientation flights, to learn to navigate a changing landscape and orient themselves in relation to the sun. Once they do, they quickly become masters of navigation, yet little is known about how their brains support this ability or what changes occur during the orientation flights.

In a new study, led by IGB Director Gene Robinson, researchers found that a regulatory gene known to be involved in learning and the detection of novelty in vertebrates also kicks into high gear in the brains of honey bees when they are learning their way around a novel environment. Activity of this gene, called *Egr*, quickly increases in a region of the brain known as the mushroom bodies whenever bees try to find their way around an unfamiliar environment.

"This discovery gives us an important lead in figuring out how honey bees are able to navigate so well, with such a tiny brain," said Robinson. "And finding that it's *Egr,* with all that this gene is known to do in vertebrates, provides another demonstration that some of the molecular mechanisms underlying behavioral plasticity are deeply conserved in evolution." Robinson and coauthor Claudia Lutz (GNDP, now IGB Communications), reported their findings in *The Journal of Experimental Biology*. The work was supported by the NIH.

http://bit.ly/1iHQ4Eq

Cellular Tug-of-War Reveals Strength of Molecular Forces

Living cells rely on communication with their environment—neighboring cells and the surrounding matrix—to activate many cellular functions, including differentiation of stem cells into distinct cell types, cell-cell adhesion, and migration. Receptors extending through the cell membrane are activated when they form a bond to specific molecules on the surface of a neighboring cell, creating a physical pull that is felt, and translated into an internal molecular signal, by both cells involved.

Researchers have tools that allow them to quantify some types of molecular forces, but until now, no one has been able to measure the molecular force required to mechanically transmit function-regulating signals within a cell. Physicist Taekjip Ha (CDMC Theme Leader), along with postdoctoral researcher Xuefeng Wang, have innovated a new technique that uses DNA strands to precisely measure these forces. The method, which was reported in *Science*, has made it possible to quantify the mechanics of the interaction by which cell receptors are activated.

In the method, named the tension gauge tether (TGT) approach, Ha and Wang converted DNA strands into tethers for cell surface molecules to test the tension required to activate cell adhesion via receptors. The receptor bonds to the tethered molecule, and adhesion is activated only if the DNA tether does not rupture. By varying the strength of the DNA strand used, it is possible to infer the force exerted on the activated receptor. This research was funded by the NSF through the Physics Frontiers Center Program.

http://bit.ly/1m7N5nS

Hitting the Spot: New Innovation Directs Stem Cell Therapy to Damaged Tissue

Stem cells could eventually be a magic bullet that heals tissues damaged by injury or disease. One obstacle to achieving this type of therapeutic application is the difficulty of delivering stem cells to the affected tissue and keeping them there. Research in this area has concentrated on selecting molecules that will be attracted to proteins that are commonly found in the target tissue, and attaching those molecules to the surface of stem cells—a process that risks damaging the stem cells.

Chemical and Biomolecular Engineering Professor Hyunjoon Kong (ReBTE) and colleagues, including Vice President for Research and Gutgsell Professor

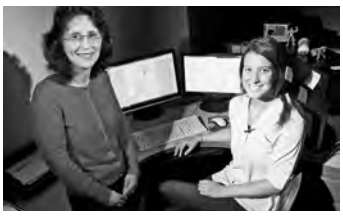
of Animal Sciences Lawrence Schook (BioBEL/ReBTE), have found an elegant and effective solution. They created a large molecule that acts like a bur, attaching itself both to the membrane of a stem cell and to inflamed tissue lining unhealthy blood vessels. The molecule is based around a central compound with many long branches, from which two types of "bur hooks" project: long carbon chains that are attracted to the lipid layer of cell membranes, and peptides that bind to inflamed vascular tissue.

A major strength of the Kong group's method is that it self-assembles; when the molecule is added to stem cells, the long carbon chains insert themselves into the stem cell membranes. When these pre-loaded stem cells were tested in an artificial microfluidic system, the presence of the linking molecule doubled the number of stem cells attached to the target tissue. With the use of different bonded peptides, this system could potentially be used to direct systemically injected therapeutic stem cells to a variety of tissues. The study was published in *Journal of the American Chemical Society* and funded by the NIH.

Finding the 'Inside Track' for Diagnosis

http://bit.ly/1aHkRPj

According to the American Cancer Society, an estimated 22,240 women will be diagnosed with ovarian cancer in 2013, and 14,230 will die of the disease; this makes ovarian cancer the fifth most common cause of cancer death in women.



Animal Scientist Sandra Rodriguez-Zas (left) and Animal Science Postdoc Kristin Delfino (right) identified biomarkers that are used to determine ovarian cancer survival and recurrence and showed how the interactions between these biomarkers affect these outcomes.

Animal scientist Sandra Rodriguez-Zas (GNDP) led a study, published in the journal *PLOS ONE*, that helped identify biomarkers that are used to determine ovarian cancer survival and recurrence, and showed how the interactions between these biomarkers affect patient outcomes.

The team was able to confirm the association of 21 microRNAs with ovarian cancer. They also found 838 target genes and 12 transcription factors associated with ovarian cancer survival and 734 target genes and eight transcription factors associated with ovarian cancer recurrence. This work was supported by the National Cancer Institute, the National Human Genome Research Institute, and the National Institute on Drug Abuse.

New Technique May Yield Better Drugs

http://bit.ly/1kmw4Yq

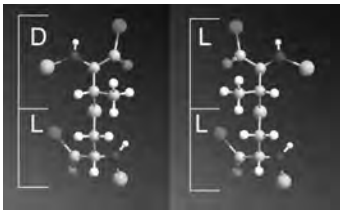
Paul Hergenrother (CDMC), the Kenneth Rinehart Jr. Endowed Chair in Natural Products Chemistry, and his team discovered a new way to create collections of compounds that may be better candidates for new drugs than those discovered by previous methods. Those approaches tested libraries of molecules that are often not as complex and functional as natural products.

In fact, 41 percent of anticancer and 65 percent of antibacterial drugs are derived from natural products. Instead of taking the traditional route by building more complex molecules out of smaller molecules, Hergenrother is tweaking the molecular structure of naturally produced chemicals to create complex and diverse sets of related compounds. The next step will be to compare the medical efficacy of these compounds to that of their synthetic counterparts produced by former methods. This research, published in *Natural Product Reports*, was supported by the Office of Naval Research, NSF, and Illinois.

Scientists discover never-seen-before protein structure

http://bit.ly/1dtK3uJ

While working out the structure of a cell-killing protein produced by some strains of the bacterium *Enterococcus faecalis*, researchers stumbled on a

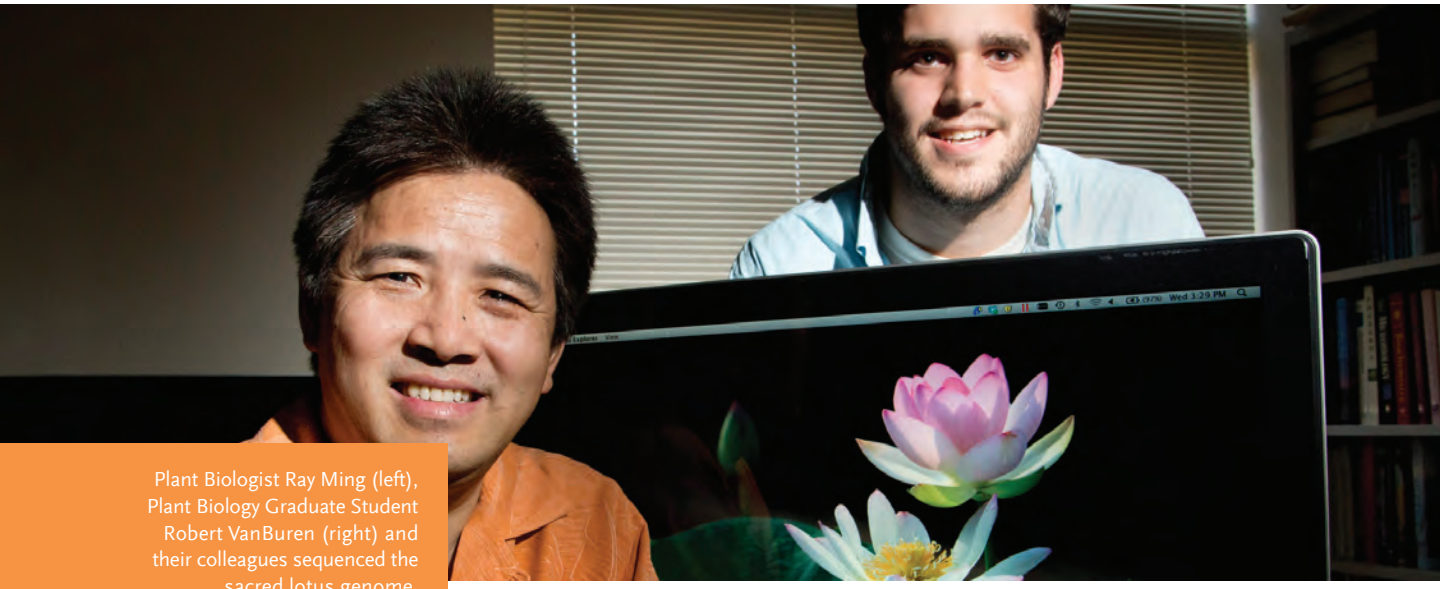


One enzyme shapes the components of a bacterial protein into rings with right-handed (D) and left-handed (L) stereochemistries.

bit of unusual biochemistry. Chemist Wilfred van der Donk (MMG) found that a single enzyme helps form distinct, 3D ring structures in the protein, one of which had never been observed before.

The new findings, reported in *Nature Chemical Biology*, should help scientists find new ways to target enterococcal cytolysin, a protein that, once assembled, attacks other microbes and kills mammalian cells. Enterococcal cytolysin belongs to a class of antibiotic proteins, called lantibiotics, which have two or more sulfur-containing ring structures.

In a series of experiments, the researchers found that one ring on each of the proteins adopted a (D-L) stereochemistry that is common in lantibiotics (see image). But the other rings all had an unusual (L-L) configuration, something van der Donk had never seen before. This work was supported by the NIH.



Plant Biologist Ray Ming (left), Plant Biology Graduate Student Robert VanBuren (right) and their colleagues sequenced the sacred lotus genome.

http://bit.ly/1m7N5nS

Scientists Sequence Genome of the Sacred Lotus

Plant biologist Ray Ming (EBI/GEGC) and other researchers reported in the journal *Genome Biology* that they have sequenced the lotus genome. The sequence revealed that of all the plants sequenced so far–and there are dozens–the sacred lotus bears the closest resemblance to the ancestor of all eudicots, a broad category of flowering plants that includes cacti, melons, soybeans, and sunflowers, among many others.

Although it lacks the 100 million-year-old triplication of its genome, seen in most other eudicots, the sacred lotus experienced a separate, whole-genome duplication about 65 million years ago, the researchers found. A large proportion of the duplicated genes (about 40 percent) have been retained.

By looking at changes in the duplicated genes, the researchers found that the lotus has a slow mutation rate relative to other plants. These traits make the lotus an ideal reference plant for the study of other eudicots. Funding for this study was provided by the University of California, Los Angeles; the Chinese Academy of Sciences; and Illinois.

Crop Scientist Gary Kling shows students and faculty a black locust tree during a tour of the EBI Energy Farm.

Bioenergy may Actually Grow on Trees

Crop scientist Gary Kling (EBI) and other EBI researchers evaluating the biomass potential of woody crops are taking a closer look at the black locust (*Robinia pseudoacacia*), which showed a higher yield and a faster harvest time than other woody plant species that they evaluated.

http://bit.ly/1aD828p

As part of the initial study, two-year old seedlings were planted in the spring of 2010, grown over the summers of 2010 and 2011, and were then coppiced in the winter of 2011-2012. Kling explained that the process of coppicing the plants, that is, cutting the plants back to a single stem just a few inches from the ground, allows the plants to grow back with multiple stems coming from the base and shoots coming up from underground root systems.

"*Robinia pseudoacacia* is showing great potential as a biomass crop for Midwestern energy production, out-yielding the next closest species by nearly three-fold," Kling said. "We picked the best crops and moved those forward. Other crops may catch up, but black locust was the fastest out of the gate." These findings, made possible with support from the EBI, were published in *Ecosphere*.

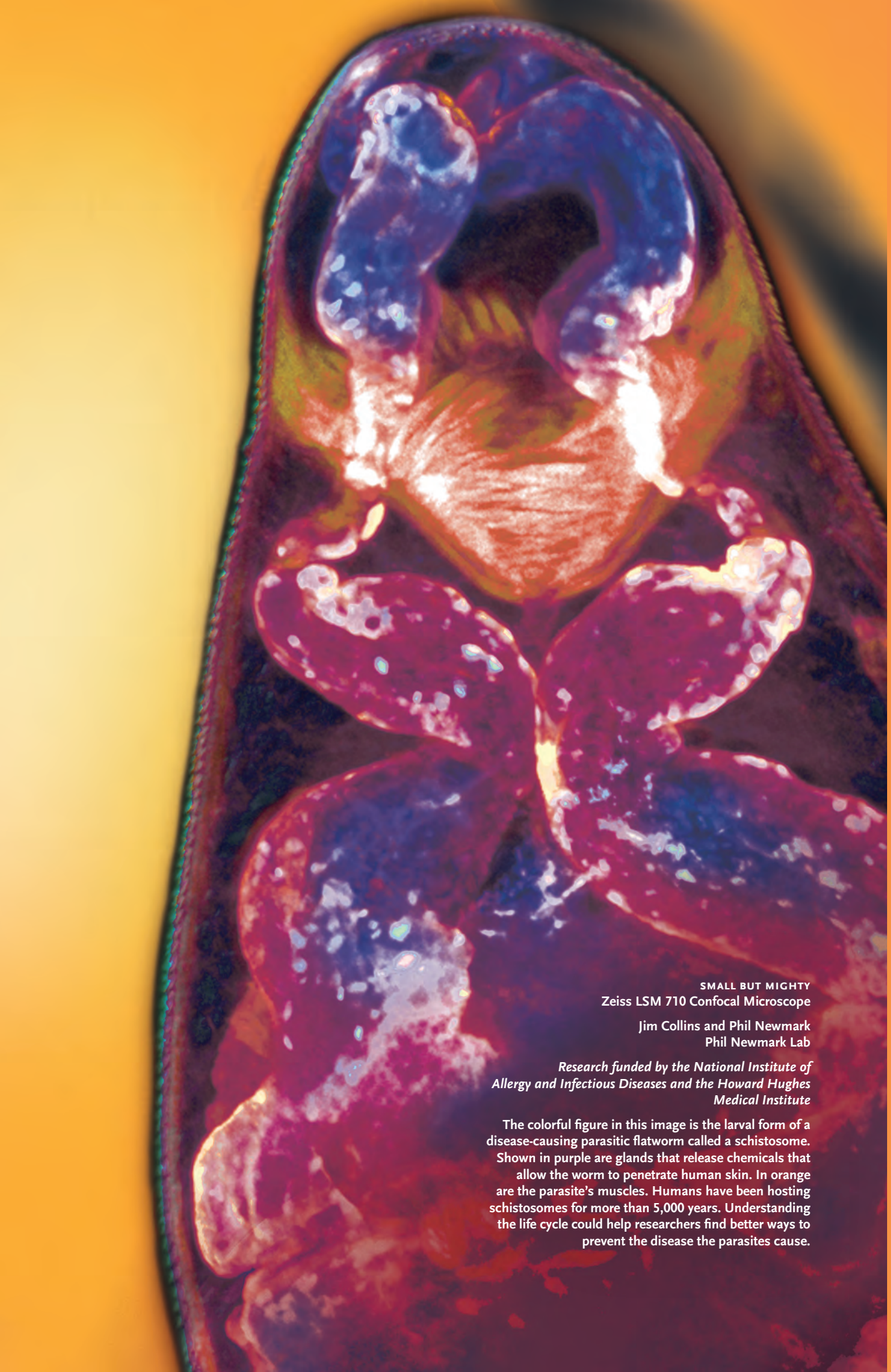
A Change of Heart

Duchenne muscular dystrophy (DMD) is a genetic disorder that causes muscle weakness and heart problems. Comparative Biosciences Professor Suzanne Berry-Miller (ReBTE) and other researchers have shown that transplanting stem cells derived from normal mouse blood vessels into the hearts of DMD mouse models prevents the expected decrease in heart function.

http://bit.ly/1kAC9Ut

The researchers injected stem cells known as aorta-derived mesoangioblasts (ADM) into the hearts of mice deficient in dystrophin, a protein that helps muscles function and whose loss causes DMD. The ADM stem cells have a working copy of the dystrophin gene.

This stem cell therapy prevented or delayed heart problems in mice that did not already show signs of the functional or structural defects typical of Duchenne muscular dystrophy, the researchers report. Their findings, supported in part by funds from the Illinois Regenerative Medicine Institute, appear in *Stem Cells Translational Medicine*.



SMALL BUT MIGHTY
Zeiss LSM 710 Confocal Microscope

Jim Collins and Phil Newmark
Phil Newmark Lab

Research funded by the National Institute of Allergy and Infectious Diseases and the Howard Hughes Medical Institute

The colorful figure in this image is the larval form of a disease-causing parasitic flatworm called a schistosome. Shown in purple are glands that release chemicals that allow the worm to penetrate human skin. In orange are the parasite's muscles. Humans have been hosting schistosomes for more than 5,000 years. Understanding the life cycle could help researchers find better ways to prevent the disease the parasites cause.

\'pärt-nər-ships\

PARTNERSHIPS

: THE RELATIONSHIPS BETWEEN INDIVIDUALS OR ENTITIES ASSOCIATED WITH EACH OTHER, ESPECIALLY IN ACTION.

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Feeding the world. Treating cancer. Improving learning and memory. We can solve these problems together. Experts from many disciplines join forces to inspire new strategies and solutions for the Institute's research endeavors. The IGB's unique partnerships bring together the best people for the job, whether they are housed within one of its research themes or in laboratories across the world.

The IGB's industry partners recognize the value of joint efforts, which serve as a catalyst for innovative solutions. Through formal collaboration agreements, the Institute is able to pool its resources with other institutions and companies in pursuit of common goals. Together, we advance life science research.

This year, the IGB's ongoing partnerships have helped the Institute continue to reach new heights, while blossoming alliances hold promise for future achievements. In 2013, world-renowned scientists gathered at the IGB for the first External Advisory Board meeting. HPCBio began a collaboration with Niger scientists to revolutionize malaria research. The IGB's ongoing EBI partnership yielded its first patent. Biologists and computer scientists embarked on a project to revolutionize how DNA is analyzed. A partnership between an IGB scientist, engineer and doctor may save thousands of infant lives.

Chancellor Phyllis Wise (top left) and Vice Chancellor for Research Peter Schiffer (middle) joined IGB leadership for the first ever meeting of the IGB External Advisory Board (EAB).

The External Advisory Board gives IGB top marks

In October, External Advisory Board (EAB) members from across the U.S. and points beyond gathered at the IGB for the first-ever EAB meeting with IGB leadership and top university members, including Chancellor Phyllis Wise, Provost Ilesanmi Adesida, and Vice Chancellor for Research Peter Schiffer.

http://bit.ly/1dzktVl

The EAB found the quality of research at the IGB was "outstanding" with "great evidence of interdisciplinary efforts and successes throughout the IGB." They recognized the themes as being very successful in developing productive, multidisciplinary groups that perform excellent research and provide novel training opportunities. They were pleased to learn of ongoing and new efforts to increase interactions between themes, and encouraged more.

The EAB was also very impressed with the IGB's unique research partnerships with BP, Abbott, and the Gates Foundation. They recognized these partnerships as being extremely important to providing a diverse research portfolio and a great way to enhance the visibility of the IGB at the national and international levels. They were supportive of the IGB's efforts in commercialization and technology transfer and encouraged additional efforts, where appropriate.

"This is the first evaluation of the IGB by an external advisory board, and I think we can all take great pride in the results," said Director Gene Robinson in an email to IGB members. "It is a great honor and pleasure to be your director, and I look forward to working with you to take the IGB to even greater heights."

EBI Earns First Patent

Research on improved sugar transport for biofuel production has been recognized with the first patent to be granted to the EBI since the collaboration's establishment in 2007. The breakthrough discovery optimizes sugar conversion yields by yeast to produce bioethanol.

http://bit.ly/1aaJplt

The U.S. Patent No. 8431360 is titled "Methods and Compositions for Improving Sugar Transport, Mixed Sugar Fermentation, and Production

of Biofuels." The application for the patent was filed in July 2010 and the award was granted April 30, 2013—a fairly short processing period for biotechnology inventions.

Among the inventors of the patented process are scientists from BP, Illinois, and the University of California, Berkeley.

http://bit.ly/1kYdFCn

HPCBio Supports Malaria Research in Niger

Through a new malaria research project, HPCBio is collaborating with the Centre de Recherches Médicales et Sanitaires. The collaboration is studying the genetic diversity of the parasite that causes malaria by collecting blood from malaria patients across Niger, an African country that is a little larger than Texas.

HPCBio helped develop the project's experimental design and has sequenced more than 600 samples. This project has already created a unique partnership that extends across the Atlantic. In 2013, HPCBio Director Victor Jongeneel had the opportunity to visit the Institut Pasteur while a Niger scientist used HPCBio's expertise and the IGB's state-of-the-art equipment to analyze data that he had collected in the field.

This project is supported by an Illinois Strategic International Partnerships award and by AVEVA, a global software engineering company.

http://bit.ly/1daReSu

IGB Hosts BGI for the Summer Institute in Evolutionary Genomics

In the spirit of learning and development, the IGB held the second in a series of learning and discussion workshops with BGI, formerly known as the Beijing Genomics Institute.

BGI members get a close-up view of a honeycomb at the University of Illinois Bee Research Facility.

From May 19 to May 24, 2013, the IGB hosted 12 students from BGI. The EBI Deputy Director Isaac Cann, Roy J. Carver Biotechnology Center Director Bruce Fouke, HPCBio Director Victor Jongeneel, and other IGB members presented their research methodologies, tools, and findings.

They also treated the group to a small taste of the Midwest. During their weeklong stay, the BGI students toured Chicago museums, explored Starved Rock State Park, viewed the Blue Waters supercomputer, visited the EBI Energy Farm, and bowled at the Illini Union.

http://mayocl.in/1nmUJzL

Alzheizheimer's Disease: From Genotype to Phenotype

With help from HPCBio, Mayo Clinic in Florida is comparing the genomes of people with and without Alzheimer's disease to uncover the relationship between genotypic polymorphisms and phenotypic expression.

HPCBio is helping researchers analyze the expression of 24,000 genes in 400 people (200 with dementia, 200 with normal cognition) to find novel genetic loci or epistatic mutations that may influence gene expression in the brains of patients with dementia. HPCBio has worked with Mayo to develop an experimental design, ensure that their software runs efficiently on the Blue Waters supercomputer, and conduct benchmarking.

This project is supported by the IGB, Mayo Clinic, the National Center for Supercomputing Applications, and the Mayo-Illinois Strategic Alliance for Technology-Based Healthcare, a partnership between Illinois and the Mayo Clinic that facilitates collaborative research between these two institutions. This research is being led by Nilufer Taner, an associate professor of neurology and neuroscience at Mayo Clinic.

Illinois Initiative Creates Futuristic Facility

Through the CompGen initiative, the IGB has partnered with the Coordinated Science Laboratory in the College of Engineering to bring together top faculty in genomic and computational sciences to develop new technology for genomic research.

http://bit.ly/1dNpxpQ

Illinois researchers believe this facility, with its state-of-the-art hardware and software coupled with innovative algorithms, will make analyzing DNA more accurate and efficient even as technology advances and researchers are able to sequence larger and larger amounts of data.

With financial support from the Office of the Provost and the OVCR, CompGen gathers new faculty members as well as computer science and engineering students to address these computational challenges.

To maximize on CompGen's efforts, Illinois researchers are also partnering with more than 15 companies and institutions, including IBM, Abbott Laboratories, Mayo Clinic, Baylor College of Medicine, Microsoft, and the Tata Institute of India, which recently worked with Illinois to co-host a "Computing for Genomics" workshop in Bangalore.

Core Facilities Continues to Employ New Technologies

In 2013, IGB Core Facilities acquired the Elyra S1 system, a state-of-the-art Zeiss super resolution microscopy setup. This imaging system sets a new standard for fluorescence imaging resolution available in campus facilities, from 250nm to 120nm, through the use of Super Resolution-Structured Illumination Microscopy (SR-SIM). The system is equipped with four laser lines (405nm, 488nm, 561nm and 633nm) and provides super resolution imaging capabilities using the same fluorophores that are typically used to label samples for confocal microscopy.

The Elyra S1 system, one of several cutting-edge microscopes available to campus researchers through the Core Facilities at the IGB.

Structured Illumination Microscopy is based on wide-field imaging, illuminating the whole sample as in traditional light microscopy but with a near diffraction grid (patterned light) projected onto the sample. The interaction between the grid and the sample allows the microscope to capture details of the sample's structure that would otherwise be undetectable. Data for a single image are collected by imaging the sample with the grid in five lateral positions (phases) and five rotations for a total of twenty five images.

"The Elyra S1 system moves our optical imaging ability from the size of cell organelles to the scale of large molecules," said Glenn Fried, Director of Core Facilities. "This increase in resolution opens new worlds of exploration that were not possible a few years ago."

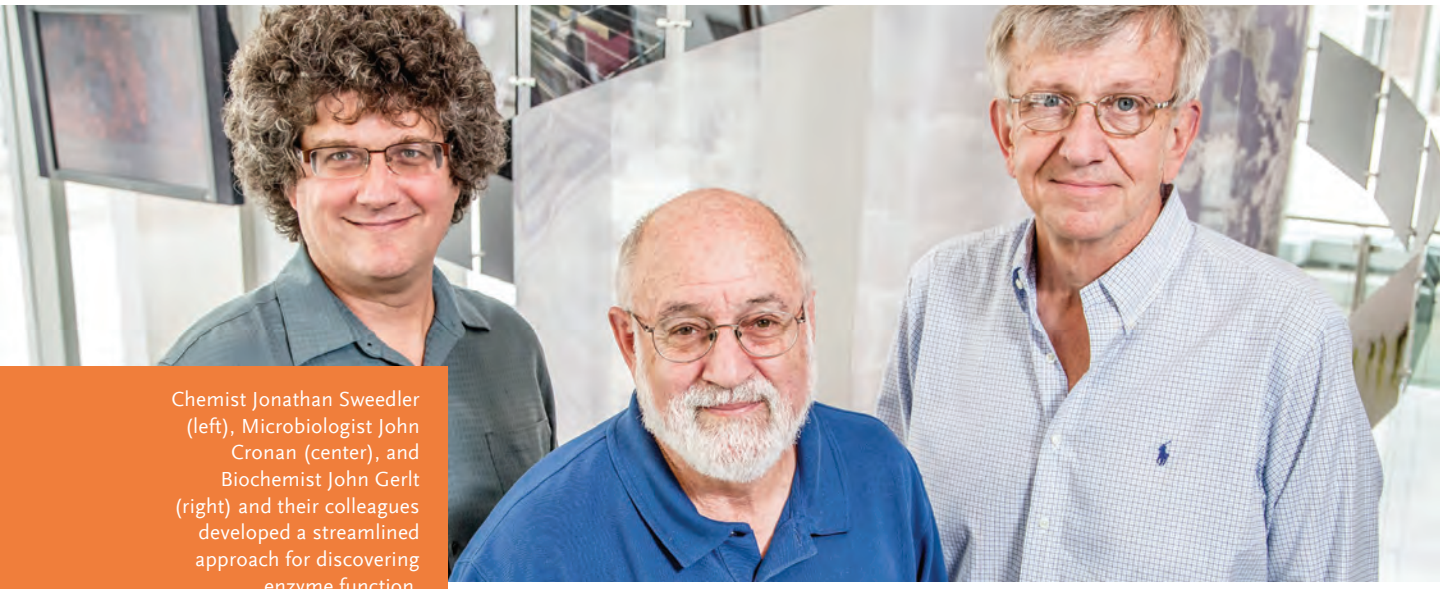
Victor Jongeneel Startup Proof of Concept Funding via Office of Technology Management

Reza Farivar (HPCBio), formerly of the Illinois Computer Science program and currently a postdoctoral researcher at the IGB, had been researching ways to improve analysis of DNA sequence data as a side project. With no background in biology and with no plans to become an entrepreneur, he underwent an unexpected journey leading to his current position as cofounder of his own startup company, Accelerated Genomics Inc.

As a graduate student in Computer Science Professor Roy Campbell's lab, Farivar developed software that could align DNA sequences—finding matches between short sequences and a genome database—much faster and more accurately than existing programs. An IGB Proof of Concept Award supported

the work needed to develop the research-grade code into user-friendly software. Now, Farivar, Campbell, and HPCBio Director Victor Jongeneel have formed a corporation, allowing them to apply for an NSF Small Business Innovation Research grant that could help them bring the software to market.

Farivar reflected that the development and incorporation processes have required him to become familiar with "three different worlds–the world of computer science, the world of biology, and the world of business." The latter two were foreign to him when he began the project. He spoke highly of the campus resources that have guided him: his involvement in HPCBio and CompGen, and the support of the Technology Entrepreneur Center and Office of Technology Management.



Chemist Jonathan Sweedler (left), Microbiologist John Cronan (center), and Biochemist John Gerlt (right) and their colleagues developed a streamlined approach for discovering enzyme function.

It Takes A(n Academic) Village to Determine Enzyme's Function

http://bit.ly/1hvsqde

Scientists have sequenced the genomes of nearly 7,000 organisms, but they know the functions of only about half of the genes that encode protein products within those genomes. Now, a multidisciplinary effort involving 80 scientists from nine institutions has begun chipping away at this mystery–in a big way. The Enzyme Function Initiative (EFI), according to co-principal investigator and Gutgsell endowed biochemistry professor John Gerlt (MMG), aims not simply to identify the function of specific proteins, but to forge a new way to tackle the vast and growing body of sequence data for which functional information is lacking.

To achieve this goal, researchers in five different core working groups within the EFI are using a combination of computational and experimental methods to establish a systematic workflow for discovering a protein's function. Once the process has been optimized, they hope to share it with other researchers, and provide resources to support its use. The initiative is funded by the National Institutes of General Medical Sciences, and its principal investigators also include Head of Microbiology John Cronan (MMG) and James R. Eiszner Family Chair in Chemistry Jonathan Sweedler (MMG).

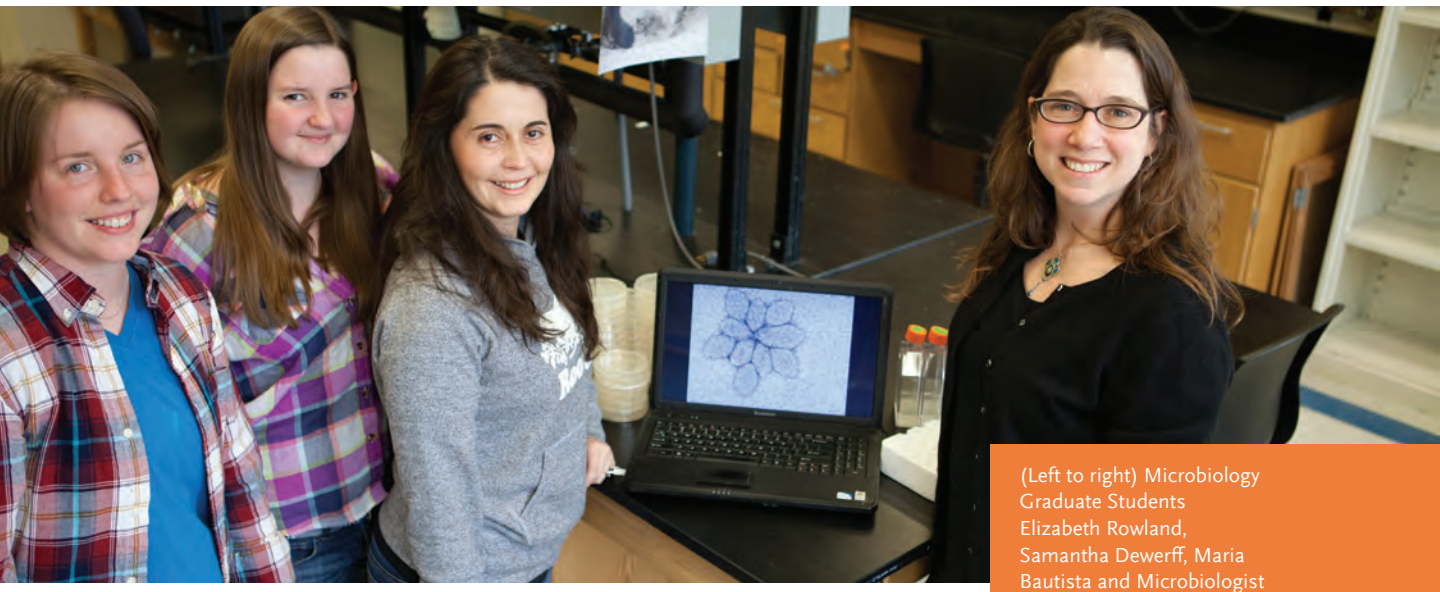
http://bit.ly/1g7uXab

New method for DNA analysis holds promise for improved cancer diagnostics A research effort has yielded a technological breakthrough that could lead to improved cancer diagnostics. The project was led by Electrical and Computer Engineering Professor Rashid Bashir (ReBTE).

One mechanism that cells use to control gene expression is DNA methylation. Altered DNA methylation near certain genes can be used to diagnose or even predict the severity of many types of cancers, but until now, detecting methylation has been a labor-intensive process.

Bashir and colleagues from Illinois and the Mayo Clinic developed a method of detecting methylation by using an electrical field to pull strands of DNA through a nanopore, a microscopic hole in a silicone membrane. When the strands were mixed with a modified protein fragment that attaches only to methylated DNA, the methylated strands became bulkier. Researchers could then distinguish between the passage of these strands, and the slimmer unmethylated strands, through the nanopore. Future work will aim to refine the method so that it detects not only the presence of methylation, but what locations on a given DNA fragment are methylated.

This project was supported by the NIH and Mayo-Illinois Strategic Alliance for Technology-Based Healthcare, a partnership between Illinois and the Mayo Clinic that facilitates collaborative research between these two institutions. The new technique was described in a publication in *Scientific Reports*.



(Left to right) Microbiology Graduate Students Elizabeth Rowland, Samantha Dewerff, Maria Bautista and Microbiologist Rachel Whitaker.

http://bit.ly/1fCVuMg

What Won't Kill You, *Might* Make You Stronger

Despite the fact that viruses are practically everywhere and affect every living thing, scientists know very little about their potential for positive impact on their hosts. Researchers now believe that some viruses may protect hosts from competitors and help them survive.

The NSF awarded a five-year, $2 million grant to microbiologist Rachel Whitaker (BCXT) and an interdisciplinary, multi-institutional team to explore the idea of viruses and their hosts coevolving together in the lab in the model system of hot springs at Yellowstone National Park.

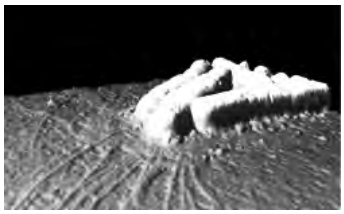
Through laboratory experiments, Whitaker's team studies host-viral interactions, including the costs and benefits of chronic infections. Mark Young, a professor of virology at Montana State University, studies these interactions in a natural hot spring using a device developed by Sascha Hilgenfeldt, a professor in the Department of Mechanical Science and

Engineering at Illinois. Associate Professor of Biology Joshua Weitz from Georgia Tech University will use Whitaker and Young's findings to develop a theoretical and computational eco-evolutionary model of how viruses and microbes interact.

http://bit.ly/1lucxTQ

Exploring the Mechanics of Teamwork

Former Professor of Physics Gerard Wong moved on to a new position in the Departments of Engineering and Chemistry & Biochemistry at the University of California at Los Angeles, but his connections to Illinois remain strong. Like the soil bacterium they study, *Myxococcus xanthus*, Wong, Illinois Professor of Physics Karin Dahmen (BCXT) and colleagues work together to get ahead. In a study recently published in *Proceedings of the National Academy of Sciences*, they uncovered mechanics of bacterial movement that led to a better understanding of how these bacteria travel together.



Myxococcus bacteria (white) in motion.

The group examined the forward progress of crawling bacteria on the scale of tenths of a second. They found that a bacterium, rather than oozing forward at a constant rate, moves jerkily. The bacterium alternates between pauses when it is captured by the friction of the surface and surges forward when it overcomes that friction, in the same pattern of fits and starts with which tectonic plates move past each other.

The study showed that a secretion produced by the bacteria, once thought to act only as a glue, also acts as a lubricant. This lubricant is important for the bacterial group movement; when *M. xanthus* bacteria move in tandem, one bacteria acts as the "locomotive," pulling another behind it, and the lubricating properties of their secretion keeps their movements coordinated. The work was funded by the Center for the Physics of Living Cells at Illinois, NSF, and NIH.

A Partnership to Discover Food for Thought

From college students cramming for an exam to retirees hoping to keep their minds nimble, many people are interested in "brain food." Will eating a banana or a handful of nuts really lead to a boosted test score or better memory recall? The scientific rationale to support such claims is mixed and difficult to interpret at best. What is needed are studies that examine not only what foods or supplements support brain function, but how they do so.

The Center for Nutrition, Learning, and Memory (CNLM), a collaboration between Illinois and Abbott Nutrition, is working to revolutionize the understanding of how nutrition affects cognition. The Center, now in its third year, supports interdisciplinary research investigating how the foods we eat as infants, as adults or in old age may improve learning and memory. Currently, over 86 faculty, postdoctoral researchers, research scientists, and graduate students from 15 departments and six colleges are involved in this work.

CNLM partners with the IGB, as well as the Beckman Institute for Advanced Science and Technology. The IGB makes valuable genomics resources, such as the HPCBio group, available to CNLM researchers. In addition, several IGB members are involved in CNLM research: IGB Director Gene Robinson is a critical member of the Center's Executive committee, and work by IGB faculty, including cell and developmental biologist Fei Wang (BSD/GNDP/ReBTE) has already yielded exciting results.

Animal Scientist Matthew Wheeler (left) displays a 3D-printed splint (right) like the one used to treat a critically ill infant.

Collaboration Creates 3D-printed Splint that Saves Infant's Life

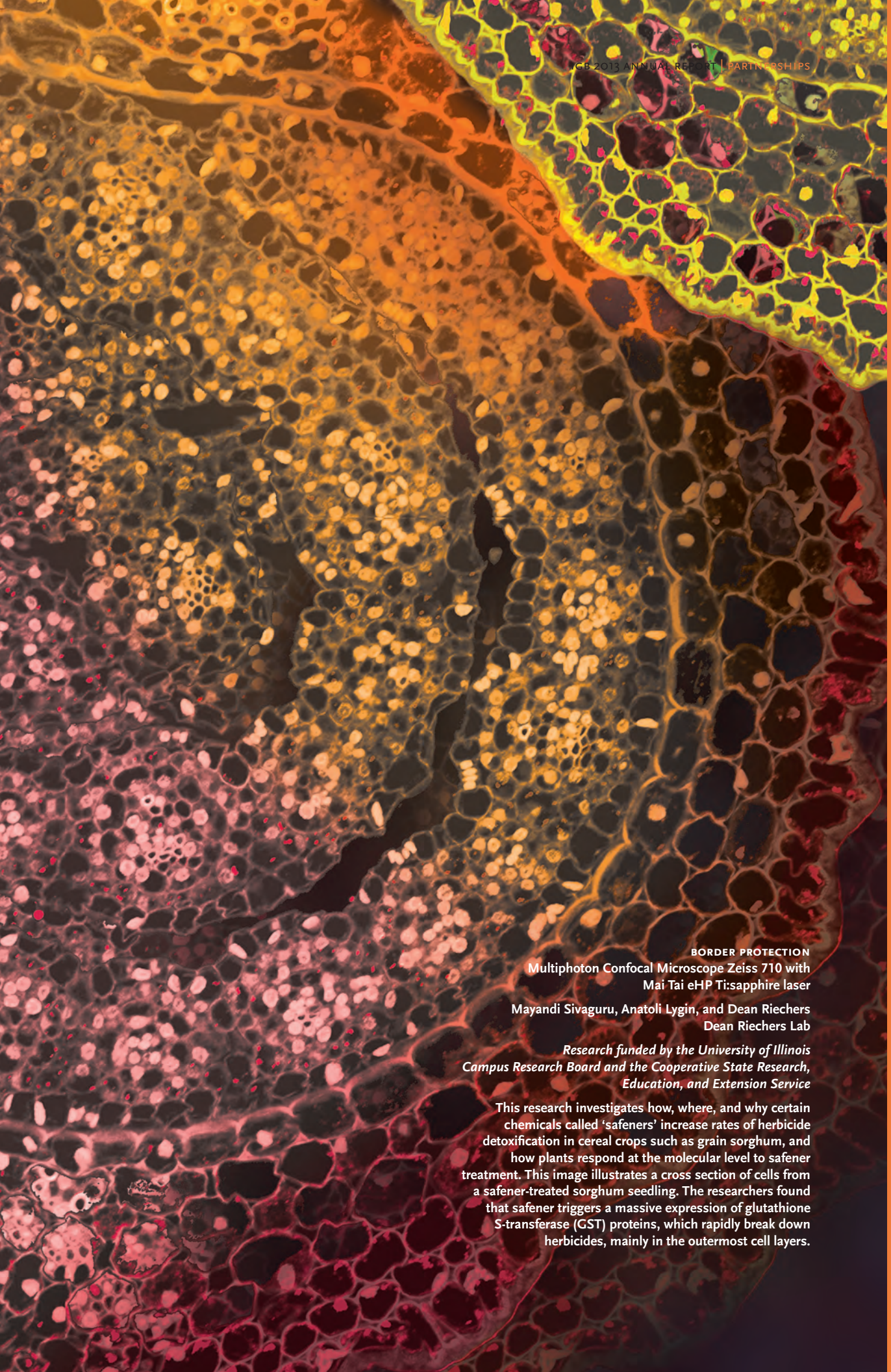
Animal scientist Matthew Wheeler (ReBTE) said all of his work is "physician inspired." Doctors and surgeons have a problem and turn to Wheeler to engineer and test a cure. Currently, he is working with a team of researchers to test a 3D-printed, bioresorbable airway splint in swine experimental models. This splint has already saved the life of an infant born with severe tracheobronchomalacia, a birth defect that causes the airway to collapse.

http://bit.ly/1hTGNuK

Kaiba Gionfriddo, 20 months, was treated with a printed splint. Over roughly three years, the splint will be reabsorbed by the body.

Wheeler sent a CT scan of a pig's trachea to Scott Hollister, a professor of biomedical engineering at the University of Michigan. Hollister used the CT scan and a 3D CAD program to design and print the splints. Next, Wheeler developed a strategy to implement the device, and U-M associate professor of pediatric otolaryngology Glenn Green carried out the surgical procedure. After surgery, the pigs' tracheobronchomalacia symptoms disappeared.

More data from Wheeler's large animal trials will be essential to show the long-term viability of this procedure before it can be used to save the lives of other children born with this disorder. In future trials, Wheeler plans to add stem cells to the splint in order to accelerate healing. The NIH supported this work, which was published in the *Journal of the American Medical Association (JAMA) Otolaryngology–Head & Neck Surgery.*



BORDER PROTECTION
Multiphoton Confocal Microscope Zeiss 710 with Mai Tai eHP Ti:sapphire laser

Mayandi Sivaguru, Anatoli Lygin, and Dean Riechers
Dean Riechers Lab

Research funded by the University of Illinois Campus Research Board and the Cooperative State Research, Education, and Extension Service

This research investigates how, where, and why certain chemicals called 'safeners' increase rates of herbicide detoxification in cereal crops such as grain sorghum, and how plants respond at the molecular level to safener treatment. This image illustrates a cross section of cells from a safener-treated sorghum seedling. The researchers found that safener triggers a massive expression of glutathione S-transferase (GST) proteins, which rapidly break down herbicides, mainly in the outermost cell layers.

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EDUCATION

: THE ACT OF IMPARTING INFORMATION OR KNOWLEDGE, OR THE KNOWLEDGE AND DEVELOPMENT RESULTING FROM AN EXPERIENCE.

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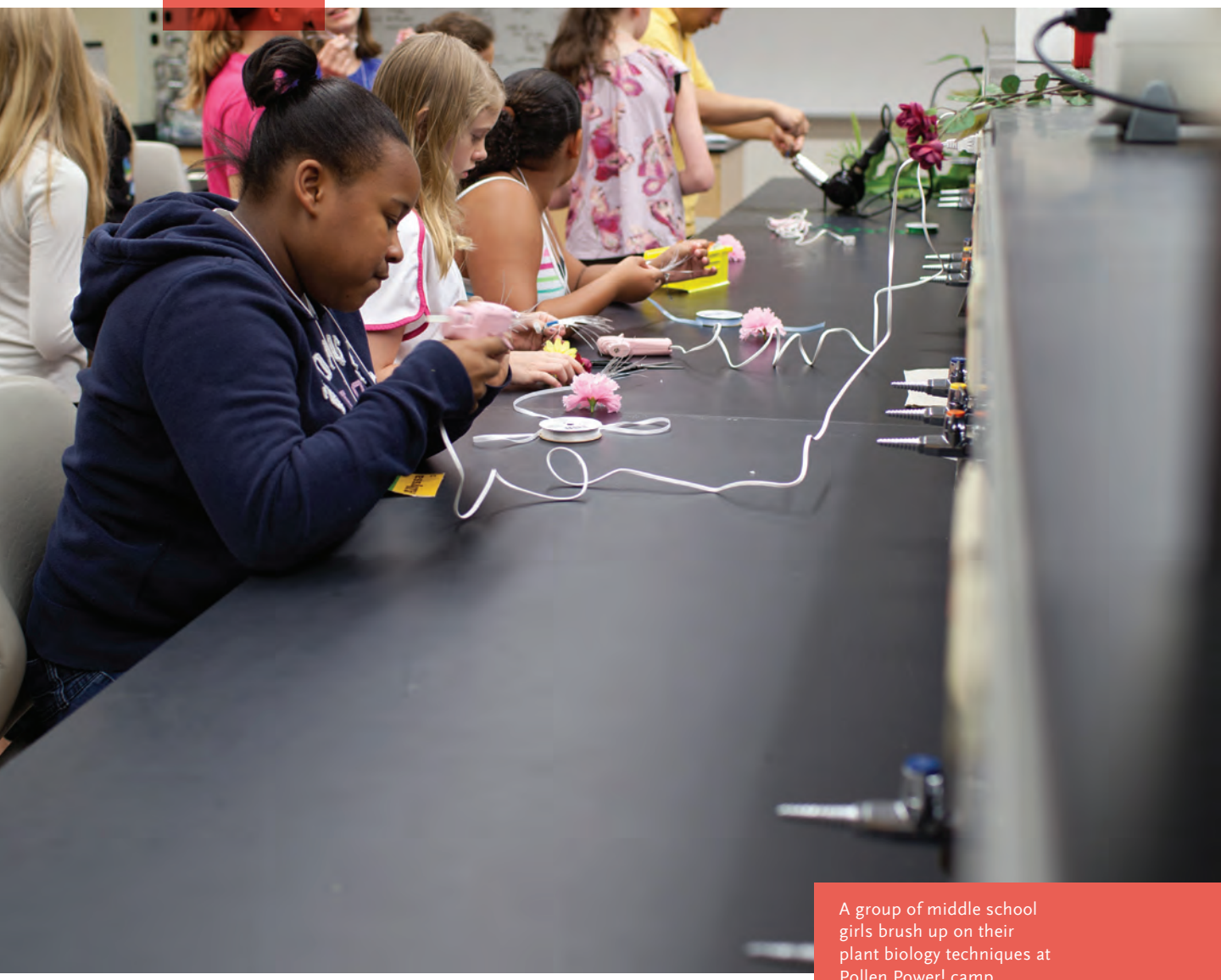
Education is an intrinsic part of the IGB's mission. Despite their many backgrounds and disciplines, members of the IGB are united by their enthusiasm to learn and expand humanity's body of knowledge.

The IGB is committed to seeking out and providing educational opportunities for its members as well as its geographic and scientific communities. The IGB stimulates learning through training grants, education-oriented competitions, special certifications and user instruction programs.

The IGB's collaborative research environment creates copious opportunities to learn from one another and grow intellectually. Each day, IGB faculty, students and volunteers learn something that they, or the world, didn't know before. Special workshops and symposia hosted by the IGB help members add breadth and depth to their scientific knowledge. The IGB encourages faculty to broaden their impact through activities such as planning conferences and giving lectures.

In 2013, the IGB created new opportunities to educate a large and diverse audience. As part of ongoing education efforts, the IGB held a genomics workshop for Native Americans. The IGB also hosted the first-ever Pollen Power! summer camp, a weeklong science day camp for middle school girls. Through the novel "Genomics for™ Judges" program, the IGB educated judges about DNA and genes to prepare them for cases that deal with DNA sequencing and analysis.



A group of middle school girls brush up on their plant biology techniques at Pollen Power! camp.

Middle School Girls Gained Real-world Science Skills at Pollen Power! Camp

Middle school girls learned that pollen does a lot more than help flowers reproduce at the first Pollen Power! Camp, a weeklong summer camp hosted by the IGB. From July 8–12, nearly 30 campers used pollen to study past and future plant responses to climate change, toured state-of-the-art campus research labs and facilities, conducted real-world pollen research, and created video presentations using a green screen and teleprompter.

http://bit.ly/13Hi5W2

2013 Pollen Power! camp participants and counselors.

"This camp is a one-of-a-kind opportunity for girls of this age group to gain first-hand experience working in a research environment alongside female mentors and role models," plant biologist Lisa Ainsworth (GEGC) said. "These girls tackled real-world projects related to real-world issues, including rising CO2 and O3 levels' effects on the climate and plants we depend on for food, fuel and fiber." The camp, which is funded in part by a grant from the NSF, will be held again in July 2014.

http://bit.ly/1adFKDq

IGB Hosts Second Summer Internship for Native Americans in Genomics

On August 4–11, more than a dozen students from across North America attended the Summer Internship for Native Americans in Genomics (SING) workshop at the IGB to discuss the potential, as well as the risks, of genomic research in Native American communities.

Marcus Briggs-Cloud was one of over a dozen attendees at the 2013 SING workshop.

During the weeklong workshop, thirteen participants learned not only about recent Native American genomic studies and genetic legal cases, but also the skills that are required to conduct real-world genomic research, from DNA extraction to DNA sequence analysis.

"In the past, biological anthropology has generally had a poor relationship with minority groups and indigenous communities," said Tsimshian Alaskan Native Alyssa Bader, of Snohomish, Washington. "I wanted to find out about how other indigenous people are regarding the research that's going on in genomics, and in general, so I can find ways in my own research to be more sensitive to those ideas."

Throughout the workshop, Bader and the other participants explored the benefits and risks of conducting genomic research in Native American communities. They discussed the intricacies of conducting such research, including the difference between community and individual consent and the complexity of interactions between indigenous communities and non-indigenous scientists. Support for the workshop is provided by the NIH (including the National Human Genome Research Institute) and NSF.

http://bit.ly/1lecHEq

Educating Illinois Judges On How Genetic Information Can Impact Court Decisions

Genomic research will eventually uncover a complete picture of how our genetic information, acting in concert with our experiences, influences our health and behavior. When considering whether an individual's genetic inheritance can be blamed for criminal behavior, or how information on disease predisposition should be used, who is qualified to testify, and what kinds of knowledge are needed to make sound judicial decisions?

The Honorable Kathleen Kauffman, Illinois Judicial Conference Committee on Education member, at the IGB.

The Supreme Court of Illinois and its Administrative Office of the Illinois Courts (AOIC), in coordination with members of the Illinois Judicial Conference Committee on Education, appointed by the Supreme Court, are responsible for facilitating educational resources for Illinois judges, including those pertaining to sciences in the law. The IGB had the unique opportunity to work with the AOIC in offering a new seminar, "Genomics for™ Judges," that was designed to prepare judges to grapple with legal questions involving DNA sequencing and analysis, as well as related technologies, in the courts today and in the future. The two-day course was also supported by the OVCR and the College of Law.

Forty-eight judges and justices from around Illinois participated in the workshop, which included sessions on the structure and function of DNA, how gene function is influenced by the environment, and how genome sequences are analyzed. Inspired in part by the success of the Genomics for™ Judges program, the IGB is now planning to offer similar genomics workshops to a variety of professional groups.

HPCBio supports educational opportunities

http://bit.ly/1nYc8ha

True to its mission to support computationally intensive genomic research, HPCBio provides many opportunities for the campus and greater science community to learn more about biological computing. In 2013, Technical Lead for User Support and Training Radhika Khetani (HPCBio) organized six workshops, including an Introduction to UNIX, Gene Expression Analysis Using R, and Genome Browsers workshops. Some classes had nearly 50 participants, and it wasn't unusual for a participant to attend several workshops.

"The goal of these workshops is to make bioinformatics more accessible to biologists, whether they are already involved in genomic biology or looking to get into more big data, high-throughput analysis biology," Khetani said.

In addition, computer scientist Saurabh Sinha (GNDP) helped organize the weeklong Mayo-Illinois Course on Computational Genomics workshop, which was held at the IGB. A majority of the workshop instructors were affiliated with the IGB and HPCBio. This workshop was supported by the Mayo-Illinois Strategic Alliance for Technology-Based Healthcare, a partnership between Illinois and the Mayo Clinic that facilitates collaborative research between these two institutions.

In the fall of 2013, HPCBio also held the first Genome Technologies Seminar Series. Presentations by HPCBio staff, university faculty, and others focused on emerging technologies in genomics and bioinformatics. Discussions are the heart of the seminar series, promoting collaborations between biologists and computational scientists. This seminar series, the first at Illinois to unite these academic groups, attracted more than 50 participants, including faculty, postdoctoral researchers, and graduate students. "I thought this seminar did a good job of tapping into the experimental and computational expertise within HPCBio but also across campus," said postdoctoral researcher Clare Rittschof (GNDP). The ongoing seminar series is supported by the OVCR.

Illinois Undergraduates Participate in International Engineering Competition

A team of undergraduates from Illinois participated in the 2013 International Genetically Engineered Machine (iGEM) Foundation competition. The iGEM competition is dedicated to education, advancement of synthetic biology, and the development of open community and collaboration. The Illinois team is composed of undergraduate students from a variety of colleges, including Bioengineering and the School of Molecular and Cellular Biology, led by mentors at the IGB who conduct synthetic biology research.

Finding clues to ancient human dispersal inside genomes

http://bit.ly/1ne9IdG

Anthropologist Ripan Malhi (BioBEL/ReBTE) is analyzing DNA to tell the story of how and when humans first arrived in the Americas, and what happened to them afterwards. Malhi shared some of his findings before the Royal Society in London in late 2013.

Anthropologist Ripan Malhi works with Native Americans to collect and analyze their DNA and that of their ancestors.

Through study sites throughout the Americas, he is helping to find long-sought answers to the big, debated questions addressing the who, when, and where of the first Americans and the dynamics of their spread and activity across the Americas. By cooperating with members of the Tsimshian Nation on the northwest coast of British Columbia, for example, he found a direct ancestral link between ancient human remains in the Prince Rupert Island area and the native peoples living in that

region today. The research Malhi discussed was supported in part by the NSF, and recently reported in *PLOS ONE*.

Students with Science Skills Become Business Savvy Begun in 2007, the Certificate in Entrepreneurship and Management (CEM) program educates graduate students and postdoctoral associates in engineering, life sciences, and related disciplines about business, economic, and legal issues in scientific and technological start-up ventures. The program is a collaborative effort between the College of Business and the IGB.

The curriculum is divided into FastTrac TechVenture sessions and lectures on business fundamentals. In addition, students create sustainable business plans and develop an entrepreneurial spirit through teamwork. Teams are coached to create a business plan around a topic of their choice and provide a 10-minute pitch.

The CEM program embodies the interdisciplinary nature of the IGB. Students represent many departments, including animal sciences, microbiology, biochemistry, and others. Students can reach multiple levels of achievement, depending on their personal goals; students who complete the program receive a certificate in Enterpreneurship and Management, with the option to complete the FastTrac TechVenture sessions or to earn a business certificate.

2013 International Symposium on C4 and CAM Plant Biology held in Illinios.

http://bit.ly/1f8Cs3k

International Symposium on Photosynthesis Addresses Food Security The goal to sustainably feed a growing worldwide population could be significantly advanced by better understanding two types of plants that photosynthesize more efficiently than others.

From August 6–9, about 175 plant scientists from 17 countries discussed how to improve crop performance through photosynthesis in C4 and CAM plants at the 2013 International Symposium on C4 and CAM Plant Biology, held at Illinois.

"This symposium is a really great example of bringing together groups of people from different disciplines to work on a common problem facing society," said plant biologist Andrew Leakey (EBI/GEGC), who helped organize

the event. "The participants include leaders in the genomics, evolution, ecology and ecophysiology of C4 and CAM plants."

Throughout the four-day conference, speakers and attendees talked about how C4 and CAM plants have evolved many times in diverse ways; the studies working to piece together the "genetic tool kit" that C4 and CAM plants use for photosynthesis; and current efforts to apply this knowledge to enhancing photosynthesis in C3 plants. Sponsors of the conference included Illinois, the IGB, NSF, U.S. Department of Energy, LI-COR, and two journals: *Journal of Experimental Botany*, and *Plant, Cell & Environment*.

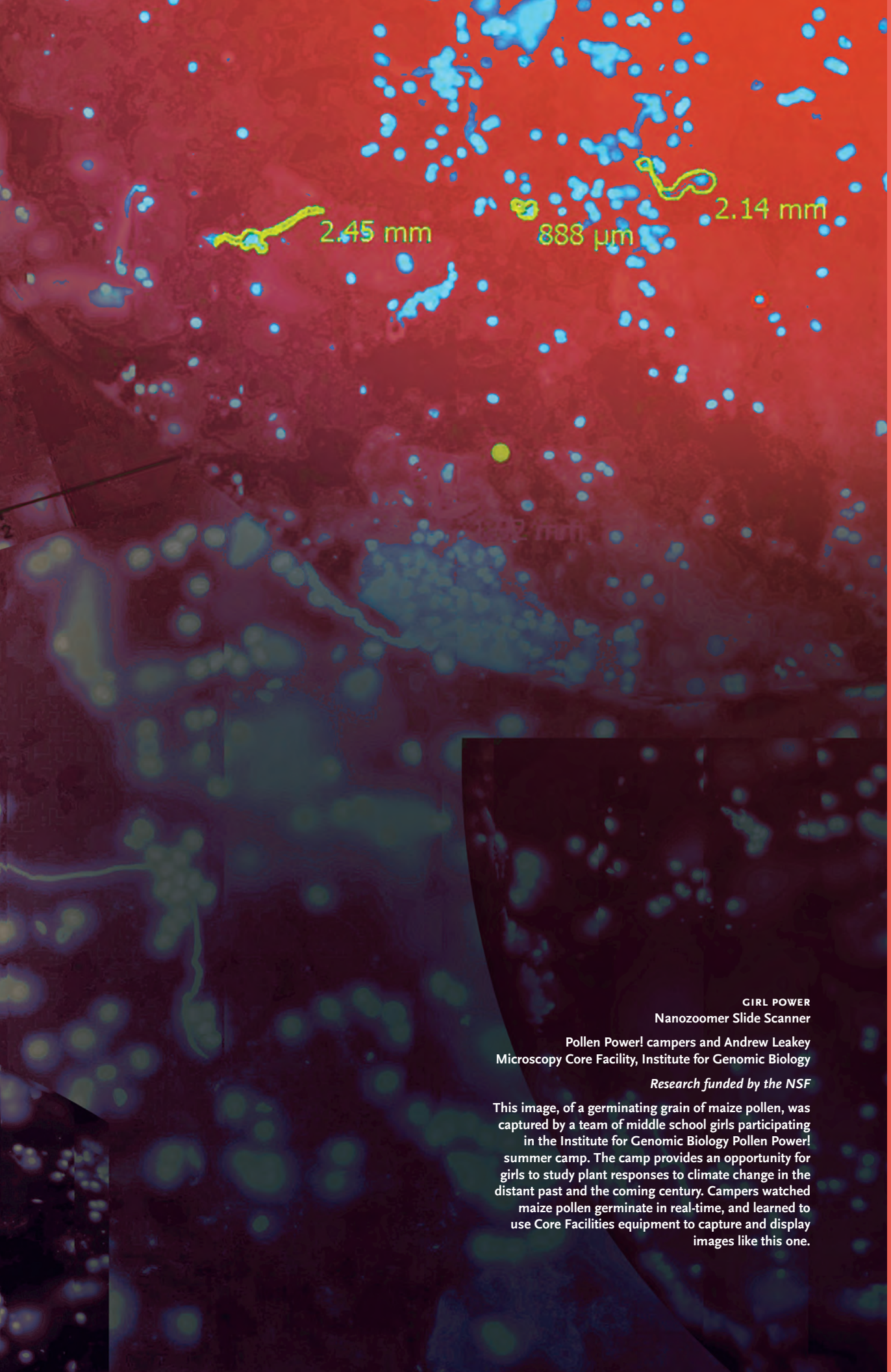
Genome Day 2013.

Genome Day Makes Science Hands-on for Kids–and Their Parents

In November 2013, more than 480 children, parents, and friends of the IGB attended the second annual Genome Day, an afternoon of learning about genomes, genes, DNA, and evolution at the Orpheum Children's Science Museum in Champaign. More than 100 volunteers helped run 14 child-friendly activities related to genetics, including learning how organisms relate to each other on the Tree of Life, constructing their own models of DNA and cells, and extracting strawberry and banana DNA to make necklaces. Volunteers from SACNAS (Society for Advancement of Chicanos and Native Americans in Science) provided bilingual volunteers for the event.

Genome Day is part of the IGB's mission to engage K-12 students, as well as the broader East Central Illinois community, in learning about the biology that underlies its research and technology development.

http://bit.ly/T8bUcs

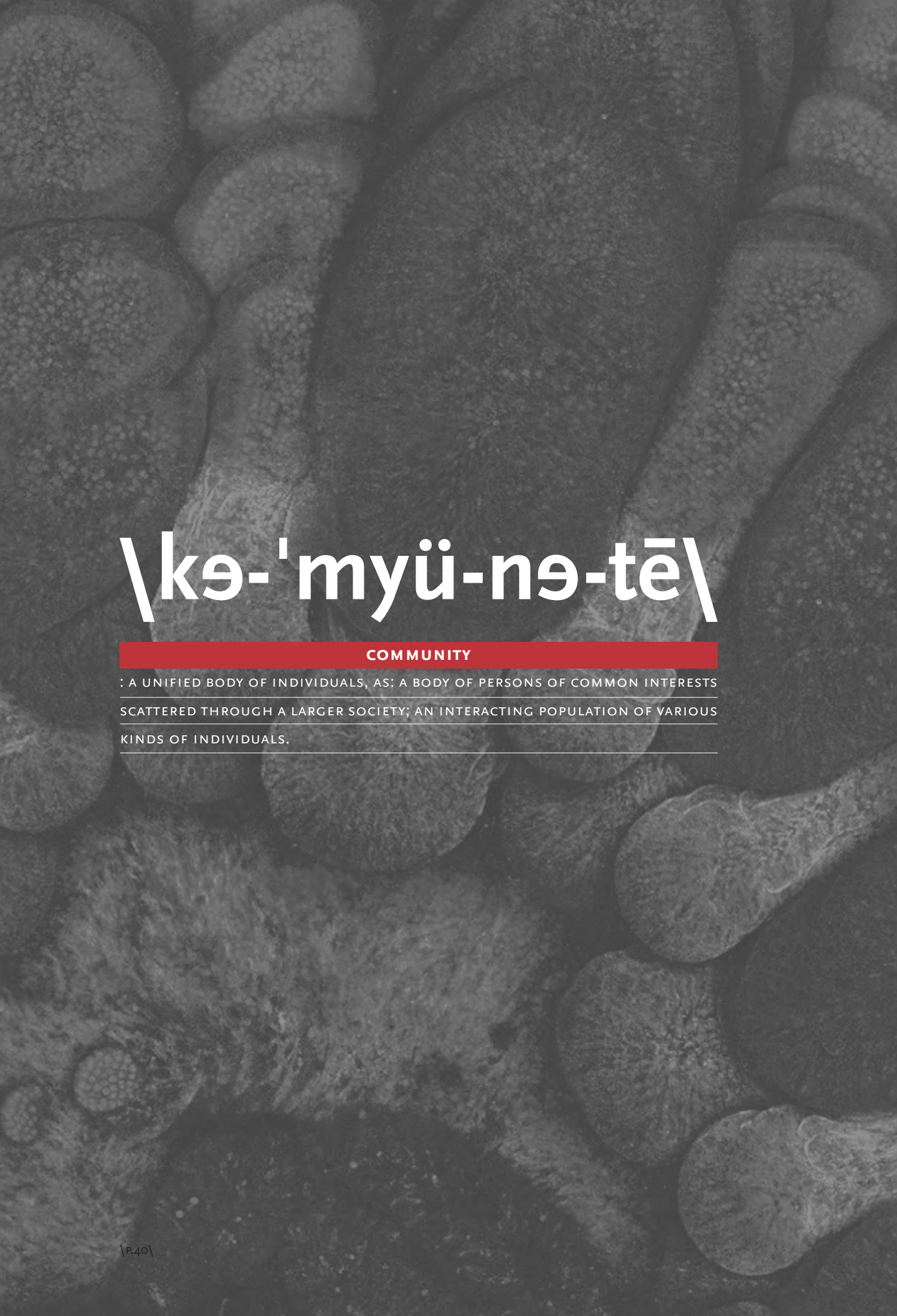


GIRL POWER
Nanozoomer Slide Scanner

Pollen Power! campers and Andrew Leakey
Microscopy Core Facility, Institute for Genomic Biology

Research funded by the NSF

This image, of a germinating grain of maize pollen, was captured by a team of middle school girls participating in the Institute for Genomic Biology Pollen Power! summer camp. The camp provides an opportunity for girls to study plant responses to climate change in the distant past and the coming century. Campers watched maize pollen germinate in real-time, and learned to use Core Facilities equipment to capture and display images like this one.



\kə-ˈmyü-nə-tē\

COMMUNITY

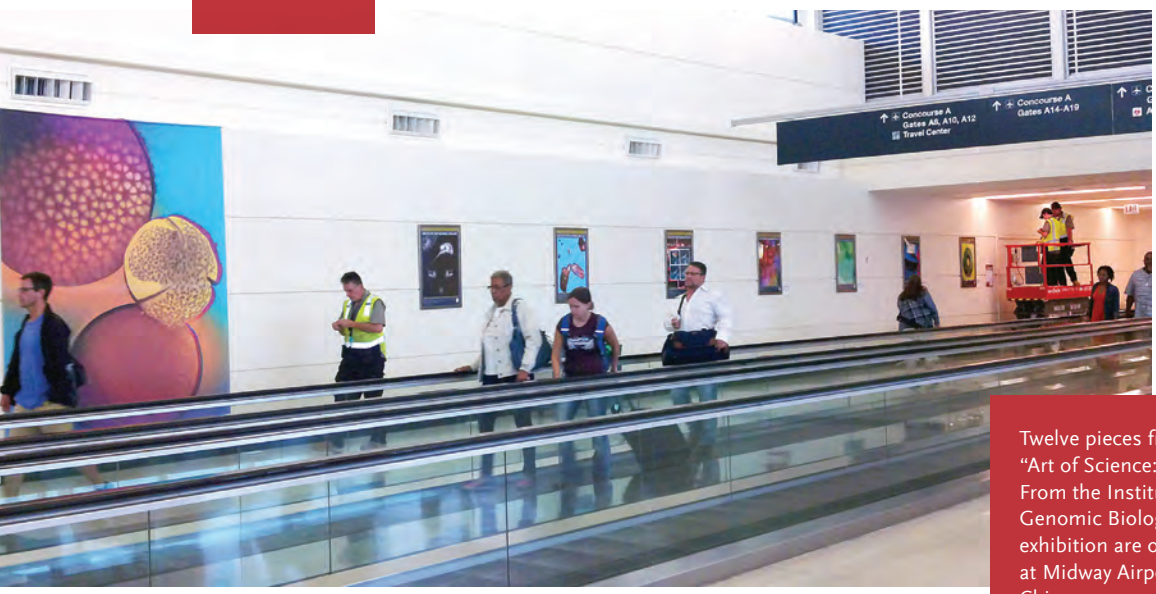
: A UNIFIED BODY OF INDIVIDUALS, AS: A BODY OF PERSONS OF COMMON INTERESTS SCATTERED THROUGH A LARGER SOCIETY; AN INTERACTING POPULATION OF VARIOUS KINDS OF INDIVIDUALS.

The IGB embodies its motto: Where Science Meets Society. Through site visits, workshops, art exhibits, and other events, the IGB helps people learn about and appreciate science.

The IGB's innovative outreach and education programs expose people to transformative research, research that is helping to solve preeminent problems faced by local and global communities. These meaningful interactions remind IGB faculty, students and staff what motivates their research, while helping the public understand the work that goes into modern, cutting-edge research and the results that come out of it.

The IGB believes that community knows no borders, that learning has no age limit, and that there is no telling what we can discover together.

In 2013, the IGB continued to reach out to its community through lectures, programs, exhibits and more. The community had the chance to see the beauty of science firsthand at Art of Science exhibits. On tours of the EBI Energy Farm, they learned about growing biomass and producing bioenergy. They also learned about sorting truth from fiction in health news from an IGB event featuring a New York Times reporter. Through a citizen scientists program, they experienced real-world research first hand.



Twelve pieces from the "Art of Science: Images From the Institute for Genomic Biology" exhibition are on display at Midway Airport in Chicago.

Looking Through the Lens of Research to Find Beauty

Microscopic images of coral polyps, kidney stones, and human colon cancer cells were among the images displayed at a four-day art exhibit at the Indi Go Artist Co-op from April 12-21, 2013. The "Art of Science 3.0: Images from the Institute for Genomic Biology" art exhibit included 21 images used in innovative research at the IGB, some of which have been artistically enhanced.

"These images represent much more than art," said Glenn Fried, Director of Core Facilities, which helped researchers capture these images with their biological microscopy and image analysis resources. "They represent scientific breakthroughs and discoveries that will impact how we treat human diseases, produce abundant food, and fuel a technologically-driven society."

Pieces from the 3.0 exhibit were also featured at the I Hotel and Conference Center and Willard Airport. Since July, Midway Airport passengers have been able to experience Art of Science works during an ongoing exhibit in Concourse A.

"Art is a really cool way to learn and jump-start conversations about research," said IGB design specialist Kathryn Faith Coulter, the exhibit's managing artist. "By sparking a natural curiosity through these vibrant images, we hope people will discover how the research conducted at Illinois relates to their families, friends, and communities."

http://bit.ly/19CmcHn

IGB Director Gives Congressional Testimony on Value of Brain and Behavior Research

In July of 2013, IGB Director Gene Robinson served as one of five witnesses who gave testimony at the House of Representatives Subcommittee on Research and Technology Hearing in Washington, D.C. on the subject "The Frontiers of Human Brain Research." He spoke in support of President Obama's BRAIN initiative, a new research effort to better understand the brain and reveal new methods for treatment and prevention of brain disorders such as Alzheimer's, schizophrenia, autism, and epilepsy.

http://bit.ly/1pByGlC

Gene Robinson, Director of the IGB, Washington, D.C..

Robinson's research background and prior experience with public outreach led to his selection to represent the NSF at the hearing. In his testimony, he used his laboratory's work on the molecular basis of honey bee brain function and behavior as an example to demonstrate the value of basic neuroscience research, and how it leads to the development of applications in areas such as human health.

A major goal of Robinson's presentation was to stress the importance of basic research on behavior as well as the brain, the study of diverse animal models, and interdisciplinary collaboration. In response to a question from a representative about the applicability of knowledge gained from animal models to human biology, he pointed to the contributions of neuroscience research in bees to the understanding of how childhood adversity affects human development.

OLLI Citizen Scientist Albert Himoe, in the cell and developmental biology lab he's been a part of since 2011.

IGB Offers Lifelong Learning

Through the Osher Lifelong Learning Institute (OLLI) at Illinois, the IGB welcomes community members 50 years or older into their labs–and not just for a tour or week-long workshop. These OLLI members are integrated into the IGB as part-time research assistants who contribute to innovative research.

In 2011, the IGB partnered with the Beckman Institute to create the OLLI Citizen Scientist program, which pairs OLLI members with research projects that relate to their personal interests or life experiences. Citizen Scientists are trained by graduate students or postdoctoral researchers and work alongside them in pursuit of discoveries. This mutually beneficial relationship illustrates the IGB's commitment to collaborative research and community involvement.

OLLI is a member-centered community of adult learners that is supported by the Bernard Osher Foundation, the Illinois Office of the Provost, and the generous donations of OLLI members and community partners.

http://bit.ly/1dCz0zz

Bryan White Presents at Science Café Meeting

Local Science Café meetings help connect scientists with community members in public forums to discuss their research. "Meetings like this give the audience an opportunity to ask scientists questions about their work in an informal setting," said Beckman Institute Postdoctoral Fellow Joe Toscano, who brought Science Café to the area. "We hope this helps people to be more interested in science and better understand what scientists do."

In September, animal scientist Bryan White (BCXT) had the opportunity to talk about the human microbiome at a Science Café meeting at the Champaign Public Library. "I think it's an important activity because it is part of our outreach mission in translating for the public and community what we do and how it affects everyday life," White said. "That's why I enjoy these opportunities."

During his talk, White discussed what a microbiome is, how it is associated with health, and how medical interventions can effectively treat disease associated with the microbiome. "In the last few years, we have realized that we are more microbial than we are human," he said. "There are 10 times more microbial cells in your body than there are human cells."

Illinois journalism class visits IGB

This fall, the IGB hosted a freshman discovery journalism class for students interested in science and political writing. IGB Media Communications Specialists Claudia Lutz and

Claire Sturgeon, along with Multimedia Design Specialist Kathryn Faith Coulter, talked about their jobs and experiences in communications. The students also heard from postdoctoral researcher Jim Collins, from the lab of cell and developmental biologist Phillip Newmark (ReBTE). Collins discussed his research on human parasites. In addition, Director of Development and Outreach Melissa McKillip provided tours of the building.

New York Times Science Writer Gina Kolata discusses how members of the community can critically evaluate health news and information.

New York Times Journalist Gina Kolata Visits Illinois

On November 15, *New York Times* journalist Gina Kolata presented a special seminar, entitled "How to Misread the Science of Health," at the Alice Campbell Alumni Center. During her talk, Kolata encouraged faculty, students, and community members not to fall for anecdotes about health trends, but instead to rely on peer-reviewed research. Earlier that day, she heard about research projects from members of the IGB and talked to a class of journalism students. Kolata's visit was supported by the College of Law, OVCR, College of Media, CAS, and IGB.

http://bit.ly/1g7xiSn

Gina Kolata from *New York Times*

Energy farm Tour Reveals Bioenergy Crops' Sustainability

On a crisp fall day, students, faculty and staff learned about ongoing research projects at the EBI Energy Farm as they walked among towering plots of prairie grasses and woody plants. The farm tour was part of the Fourth Annual Sustainability Week, a weeklong celebration of the ongoing efforts by Illinois to create a more sustainable campus and community. Farm tours are a "fantastic way" for students to learn about the diversified research at Illinois said Jenny Kokini, who helps run the Center for a Sustainable Environment (now the Institute for Sustainability, Energy, and the Environment) that hosted the event. Among the researchers who presented on the tour were crop scientists D.K. Lee (EBI), Gary Kling (EBI), and Tom Voigt (EBI), and postdoctoral researchers Candace Smith (EBI) and Ilsa Kantola (EBI).

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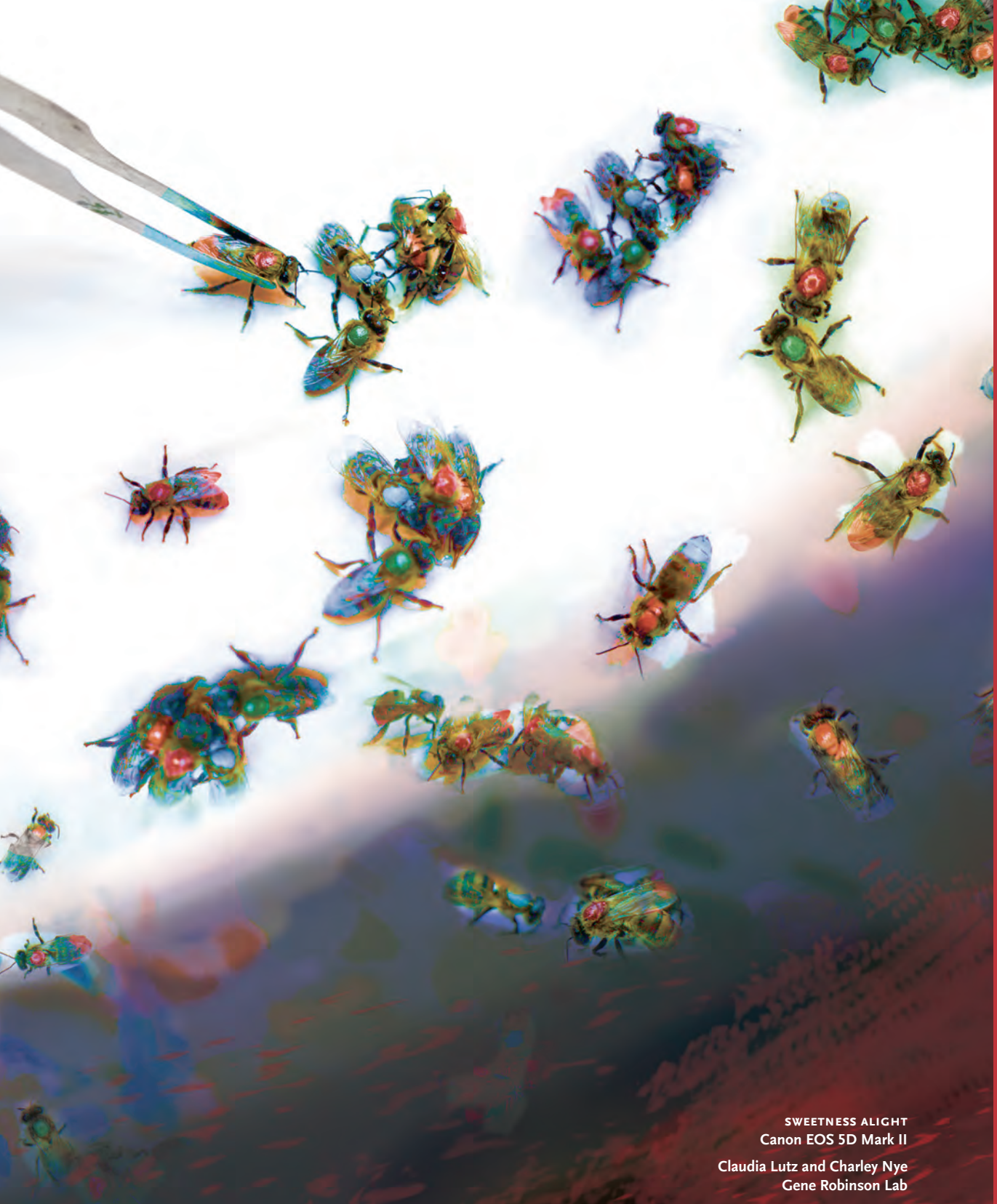


SWEETNESS ALIGHT
Canon EOS 5D Mark II

Claudia Lutz and Charley Nye
Gene Robinson Lab

Research funded by the NIH

Researchers doing behavioral experiments with honey bees sometimes use paint or enamel to give individual bees distinguishing marks. The elaborate social structure and impressive learning and navigation abilities of bees make them an ideal model for behavioral and neurobiological research. Since the sequencing of the honey bee genome, published in 2006, bees have been used increasingly for research into the molecular basis for social interaction and other complex behaviors.

\'biz-nəs\

BUSINESS

: PURPOSEFUL ACTIVITY; AN IMMEDIATE TASK OR OBJECTIVE; A COMMERCIAL OR INDUSTRIAL ENTERPRISE.

To remain at the forefront of innovative research, IGB members continually assess their investments of time, energy and resources. As passions and interests evolve, we reimagine how to employ the strengths of faculty and affiliates through new projects and proposals.

In 2013, this forward thinking and self-evaluation led the IGB to create a new research theme, Biosystems Design (BSD), to investigate the application of engineering principles to the design and construction of improved or novel biological systems.

This new vein of research is one of many at the IGB that addresses formidable problems in health, food, energy, and environmental research. But it's not enough to have cutting-edge equipment, expert scientists, and innovative ideas. In order to conduct essential research, the IGB relies on crucial support from federal and private funding sources as well as unique partnerships with the private sector.

Despite a challenging economic environment, including government sequestration, the IGB's funding increased by more than 20 percent. These financial resources are vital to help the IGB attract the best and brightest, acquire new technologies, and remain competitive with other institutions. Investors and vanguards of scientific leaders have helped the IGB redefine the applications of genomics and its potential.

FY13–265 papers published, six in *Science* and *Nature*

SCIENCE PAPERS

"Carl R. Woese (1928-2012)"
Goldenfeld, N.; Pace, N.R.
Science, 2013;339(6120):661.

"Defining single molecular forces required to activate integrin and notch signaling"
Wang, X.; Ha, T.
Science, 2013;340(6135):991-994.

"Evidence that the fosfomycin-producing epoxidase, HppE, is a non-heme-iron peroxidase"
Wang, C.; Chang, W.-C.; Guo, Y.; Huang, H.; Peck, S.C.; Pandelia, M.E.; Lin, G.-M.; Liu, H.-W.; Krebs, C.; Bollinger, J.M.
Science, 2013;342(6161):991-995.

Science magazine, published by the American Association for the Advancement of Science (AAAS) since 1880, remains one of the world's top scientific journals.

NATURE PAPERS

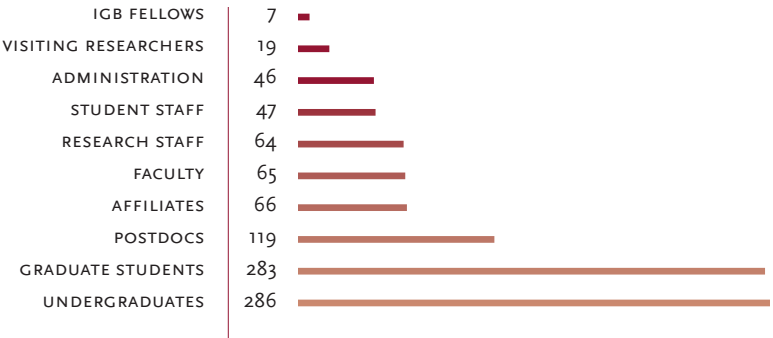
"Adult somatic stem cells in the human parasite *schistosoma mansoni*"
Collins III, J.J.; Wang, B.; Lambrus, B.G.; Tharp, M.E.; Iyer, H.; Newmark, P.A.
Nature, 2013;494(7438):476-479.

"Biochemistry: Positive and radical"
Peck, S.C.; van der Donk, W.A.
Nature, 2013;496(7443):34-35.

"Discovery of new enzymes and metabolic pathways by using structure and genome context"
Zhao, S.; Kumar, R.; Sakai, A.; Vetting, M.W.; Wood, B.M.; Brown, S.; Bonanno, J.B.; Hillerich, B.S.; Seidel, R.D.; Babbitt, P.C.; Almo, S.C.; Sweedler, J.V.; Gerlt, J.A.; Cronan, J.E.; Jacobson, M. P.
Nature, 2013;502(7473):698-702.

Nature, the leading international weekly journal of science, was founded in 1869 and focuses on the publication of original, interdisciplinary research.

PEOPLE



TOTAL	1,002

The IGB houses nearly 1,000 faculty, postdoctoral researchers, students, staff, and other personnel. IGB faculty are drawn from a broad range of disciplines that span seven colleges and 30 departments at the University of Illinois.

FY13 ECONOMIC DEVELOPMENT

By the end of FY13 the IGB had 86 total disclosures, including 31 from the EBI, and 47 patent applications, of which 13 were from the EBI. Of the nine total patents, one was granted to the EBI.

DISCLOSURES	7	86 TOTAL
PATENT APPLICATIONS	8	47 TOTAL
PATENTS ISSUED	3	9 TOTAL
LICENSES OPTIONED	–	5 TOTAL

PATENTS ISSUED FY13

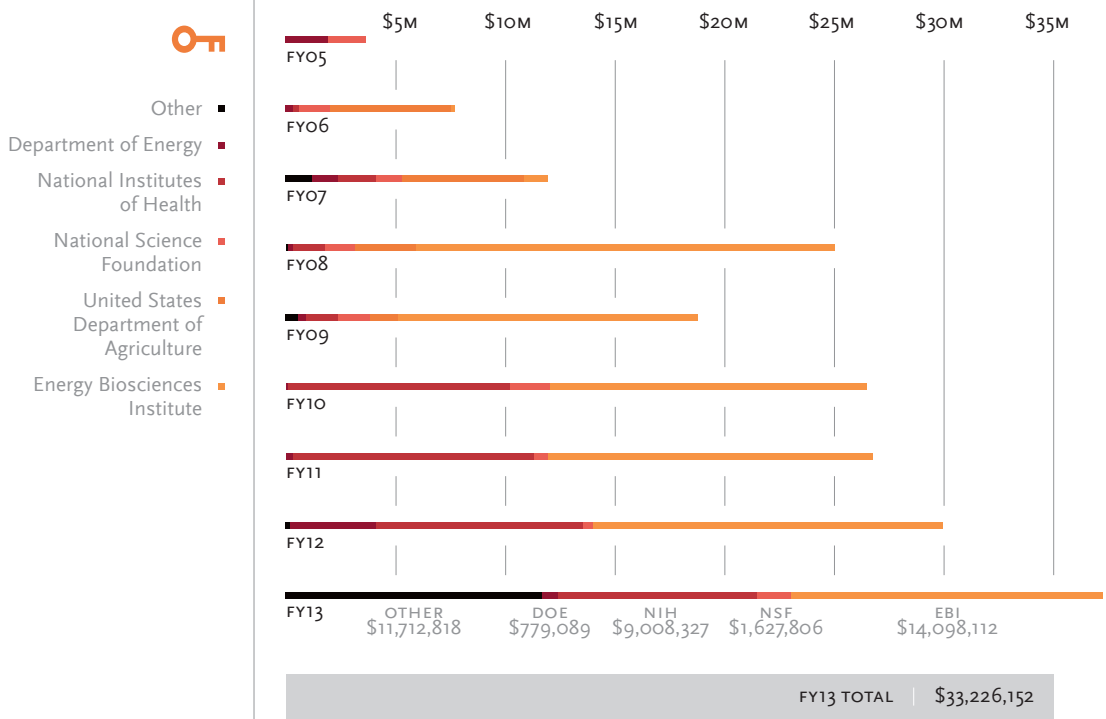
TF09115 **"Discovery and Characterization of Novel Pentose-Specific Transporters for Biofuels Production"**
William Beeson, Jin Choi, Jing Du, N. Louise Glass, Suk-jin Ha, Yong-Su Jin, Soo Kim, Sijin Li, Chaoguang Tian, Huimin Zhao

TF09153 **"Genes for the Biosynthesis of Antibiotics Rhizocticins Bacillus Subtilis ATCC 6633"**
Svetlana Borisova, Benjamin Circello, William Metcalf, Wilfred van der Donk, Jun Zhang

TF10025 **"Thermostable Enzyme Mix for Hydrolysis of Mannan Containing Polysaccharides"**
Isaac Cann, Dylan Dodd, Yejun Han, Roderick Mackie, Satish Nair

IGB CORE FACILITIES USAGE | 105 RESEARCH GROUPS (282 ACTIVE USERS)

FUNDING



FY13 TOTAL | $33,226,152

LISA AINSWORTH (GEGC) was selected to join the American Society of Plant Biologists Executive Committee as an elected member.

Department of Plant Biology, College of Liberal Arts and Sciences

CARL BERNACCHI (EBI/GEGC) was selected as a 2014-2015 Helen Corley Petit Scholar; this endowment funds development of the scholarship and teaching of LAS college members early in their career.

STEPHEN BOPPART (REBTE) was named a Fellow of the American Association for the Advancement of Science.

BRIAN CUNNINGHAM (MMG) was elected a Fellow of the Optical Society of America for the "invention, development, and commercialization of biosensors and detection instrumentation based upon nanostructured surfaces, and the development of biological applications."

Department of Electrical and Computer Engineering, College of Engineering

BRUCE FOUKE (BCXT, EBI) received the 2013 Campus Award for Excellence in Undergraduate Teaching and the 2013 LAS Dean's Award for Excellence in Undergraduate Teaching.

Departments of Geology and Microbiology, College of Liberal Arts and Sciences

NIGEL GOLDENFELD (BCXT) was named a CAS Professor, one of the university's highest academic honors.

Department of Physics, College of Engineering

BRENDAN HARLEY (REBTE) was selected to receive the 2014 Young Investigator Award from the Society for Biomaterials. This award is given to recognize an individual within ten years of their terminal degree who has demonstrated outstanding achievements in the field of biomaterials research.

Harley was also awarded a 2013 NSF Faculty Early Career Development (CAREER) Award. These grants are among the most prestigious given to the best young university faculty, in a highly competitive annual program. They recognize the outstanding efforts of these individuals and their leadership in the integration of education and research.

Department of Chemical and Biomolecular Engineering, College of Engineering

PAUL HERGENROTHER (CDMC) was selected by Illinois as the Kenneth L. Rinehart Jr. Endowed Chair in Natural Products Chemistry.

Department of Biochemistry, College of Liberal Arts and Sciences

VICTOR JONGENEEL (HPCBIO) was appointed to the PubMed Central Advisory Committee of the NIH. The committee advises the NIH on the content and operation of the PubMed Central repository, and also establishes submission criteria and ensures that PubMed Central evolves and remains responsive to the needs of its users.

Department of Bioengineering, College of Engineering

PAUL KENIS (REBTE) from the was selected by Illinois as the William H. and Janet G. Lycan Professor of Chemistry.

Department of Chemical and Biomolecular Engineering, College of Engineering

HYUNJOON KONG (REBTE) was named a Centennial Scholar by the College of Liberal Arts and Sciences.

STEPHEN LONG (EBI/GEGC) was elected to the Fellowship of the Royal Society. The Royal Society is one of the oldest and most eminent honorific scientific academies in the world and election to its ranks is one of the highest awards a scientist can receive.

Long was also named a CAS Professor, one of the university's highest academic honors.

Department of Plant Biology, College of Liberal Arts and Sciences; Department of Crop Sciences, College of Agricultural, Consumer and Environmental Sciences

School of Molecular and Cellular Biology, College of Liberal Arts and Sciences

WILLIAM METCALF (EBI/MMG) was named by Illinois as the G. William Arends Professor in Molecular and Cellular Biology.

Department of Bioengineering, College of Engineering

SUA MYONG (CDMC) received the National Medical Scholars Program's 2013 Outstanding Advisors of the Year Award.

GENE ROBINSON (DIRECTOR) was chosen to receive the iBIO Institute's 2013 iCON Innovator Award. This award recognizes excellence in biotechnology teaching and scholarship in Illinois.

Department of Entomology, College of Liberal Arts and Sciences

Robinson was also appointed to the National Advisory Mental Health Council (NAMHC) of the National Institute of Mental Health (NIMH). The NAMHC advises the Secretary of Health and Human Services, the Director of the NIH, and the Director of the NIMH on all policies and activities relating to the conduct and support of mental health research, research training, and other programs of the Institute.

Department of Chemical and Biomolecular Engineering, Department of Chemistry, and Department of Materials Science and Engineering, College of Engineering

Furthermore, Robinson was elected by the Animal Behavior Society as the 2013 Distinguished Animal Behaviorist. One of the Society's most important marks of recognition, this award is granted for outstanding lifetime achievement in research.

CHARLES SCHROEDER (BSD) was named a CAS 2014-2015 Fellow.

Department of Computer Science, College of Engineering

SAURABH SINHA (GNDP) was selected for the Dean's Award for Excellence in Research from the College of Engineering (formerly the Xerox Awards for Faculty Research). This award honors faculty members on an annual basis for outstanding research. Sinha was recognized based on his research, accomplishments, and publication record during the past five years.

Department of Chemistry, College of Liberal Arts and Sciences

JONATHAN SWEEDLER (MMG) received the American Chemical Society (ACS) Award in Analytical Chemistry, recognizing "outstanding contributions to the science of analytical chemistry" for his pioneering development of methods to detect extraordinarily small quantities of neurotransmitters.

Sweedler was also named a CAS Professor, one of the university's highest academic honors.

College of Business

MADHU VISWANATHAN (BIOBEL) received a 2013 Campus Award for Excellence in Public Engagement. These awards recognize faculty members, academic professionals and students who have consistently applied their knowledge and expertise to issues of societal importance for the public good.

Postdoctoral Fellow, IGB

BO WANG (REBTE) received a Career Award at the Scientific Interface by the Burroughs Wellcome Fund, designed to support those seeking to merge their education in engineering, computation or mathematics with an academic career in the biological sciences.

Department of Chemical and Biomolecular Engineering, College of Engineering

HUIMIN ZHAO (BSD) was selected to receive the 2014 Gaden Award. Named in honor of Elmer L. Gaden, Jr., the founding editor of the journal *Biotechnology & Bioengineering*, the award recognizes an outstanding published paper from the journal in the last year.

Thank you to all the individuals, foundations, corporations, and organizations that have supported the Institute for Genomic Biology. All gifts received to the Institute for Genomic Biology from July 1, 2012, to June 30, 2013, are included in the Honor Roll. Gifts may include any of the following: cash, stock, matching gifts, grants, bequests, planned gifts, gifts-in-kind, real estate, and paid life insurance.

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Great care was taken to ensure the accuracy of the Honor Roll listings. We would appreciate you alerting us to any errors or omissions. Please direct your inquires to Melissa McKillip, IGB Development & Outreach Director, at mmckilli@illinois.edu or 217-333-4619.

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The Institute for Genomic Biology overlooks the Morrow Plots, the oldest experimental field in the United States.

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Where science meets society

Use this flap as a reference for the acronyms and words (highlighted in white or orange) that are used throughout the report.

ABBREVIATIONS AND ACRONYMS

IGB RESEARCH THEMES

BCXT	Biocomplexity
BSD	Biosystems Design
BioBEL	Business, Economics and Law of Genomic Biology
CDMC	Cellular Decision Making in Cancer
GEGC	Genomic Ecology of Global Change
GNDP	Gene Networks in Neural & Developmental Plasticity
MMG	Mining Microbial Genomes
ReBTE	Regenerative Biology & Tissue Engineering

IGB STRATEGIC INDUSTRY PARTNERSHIPS

EBI	Energy Biosciences Institute
CNLM	Center for Nutrition, Learning and Memory

OTHER ABBREVIATIONS AND ACRONYMS

Inside the University of Illinois:

CAS	Center for Advanced Study
HPCBio	High-Performance Biological Computing
OVCR	Office of the Vice Chancellor for Research

Outside the University of Illinois:

NIH	National Institutes of Health
NSF	National Science Foundation

GLOSSARY

Biomarker A molecule, such as an RNA strand or protein, the presence of which can be quantified, that can be used to detect or predict the occurrence of disease or other biological processes of interest.

Biomass The matter that makes up living or once-living organisms. Plant biomass is now being explored by many groups as an alternative energy source.

Bioresorbable Capable of being broken down, and the resulting components reabsorbed, by the body.

DNA A biological molecule, shaped like a long, twisted rope ladder, found inside almost every living cell. The "rungs" of the ladder structure form a code that can be read by the cell, and carry genetic information.

DNA methylation A biological process in which small molecules called methyl groups are attached to the much larger strand of DNA in specific places. Methylation changes the ability of proteins to bind to DNA, and can therefore change the level of expression of nearby genes.

Fluorophore A chemical that generates and re-emits fluorescent light when light is shined on it.

Gene To grow and function, cells need to make many different types of proteins, which act as building blocks and participate in or control chemical reactions needed for life. A gene is a region of DNA that holds the information to make one type of protein.

Gene networks A model or description of how interactions among genes impact the expression levels of those genes.

Genome The entire set of genetic information contained in all the DNA found in a cell. All the genes in the genome, along with regions of DNA in between that help to control when different genes are used to make protein, interact with each other to produce life.

Germinal cells Specialized cells within an organism that divide to produce reproductive cells--either eggs or sperm.

Glioma A tumor that arises from glial cells, cells found in the nervous system whose normal function is to support and protect neurons.

Microbiome The ecological community of microbial species that live inside our bodies; sometimes referring to the subset of microbes that live within a single organ or tissue type.

Mitochondrial DNA Genetic information outside the genome that is passed from mother to offspring through her eggs.

O3 The chemical symbol for ozone, a pale blue gas that has harmful effects if inhaled, but whose presence in Earth's upper atmosphere protects life on our planet from excessive UV radiation.

Synthetic biology The design, construction, and characterization of improved or novel biological systems using engineering design principles.

Type specimen A specimen that exemplifies the defining features of a species.