periodiCALS
THE MAGAZINE OF CORNELL UNIVERSITY'S COLLEGE OF AGRICULTURE AND LIFE SCIENCES
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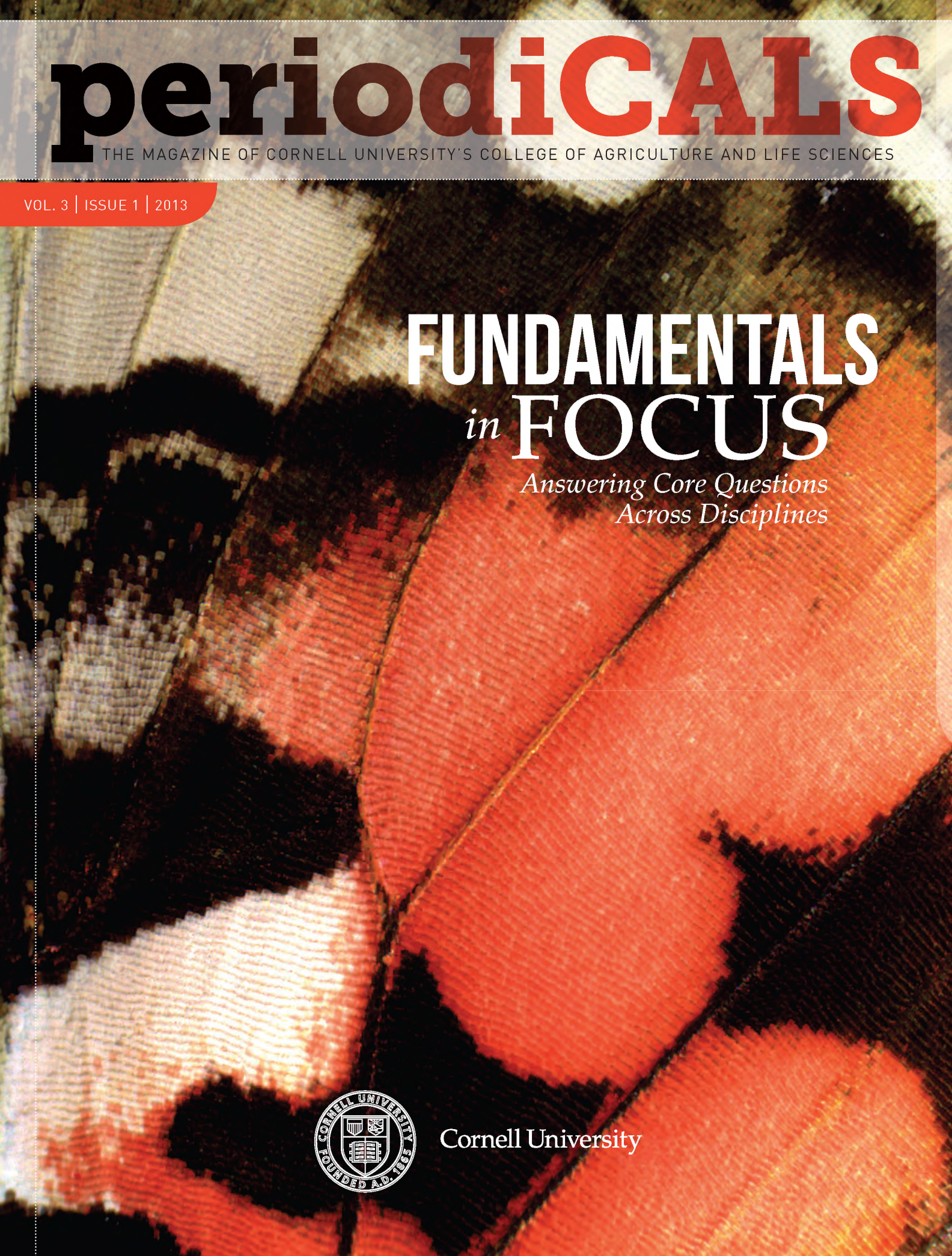
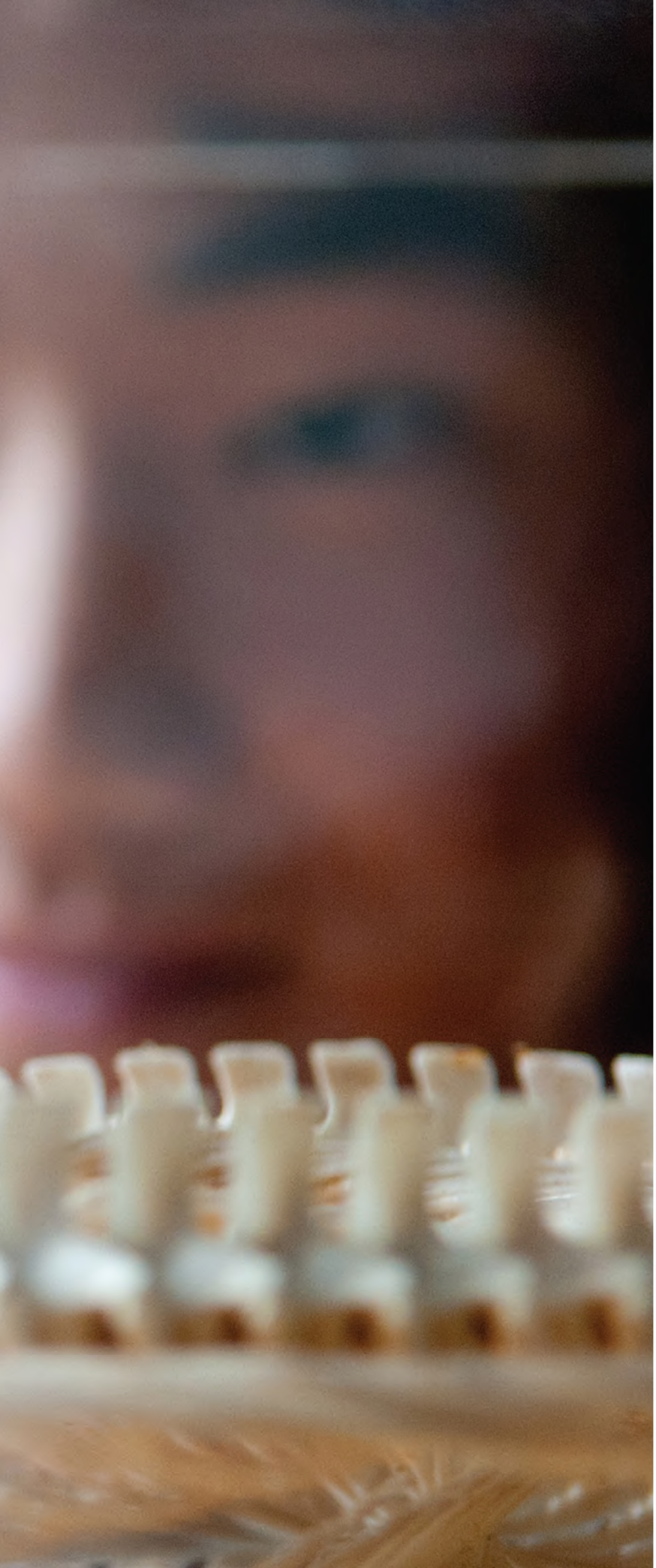


FUNDAMENTALS *in* FOCUS

Answering Core Questions Across Disciplines

Cornell University



inside

[VOLUME 3 | ISSUE 1 | 2013]

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ON THE COVER: A high magnification image of a Painted Lady (*Vanessa cardui*) butterfly wing. Butterfly wing patterns are micromosaics of thousands of tiny colored scale cells. The scales are arranged in perfect overlapping rows, much like shingles on a roof. The Robert Reed lab in Cornell's Department of Ecology and Evolutionary Biology is working to understand the evolution and developmental genetic basis of wing pattern diversity in butterflies. For more, see page 24. Photo: Robert Reed

INSIDE: Michael Yuan '14, ecology and evolutionary biology, examines a Gaboon viper (*Bitis gabonica*). Among the largest venomous snakes, the Gaboon viper is native to Africa and eats small antelopes and other mammals. The specimen is from the Cornell University Museum of the Vertebrates. Learn about it and other collections on page 18. Photo: Robyn Wishna

dean's message

As a scientist, I'm often asked questions about the applicability of my research: What exactly do you do? Why is it significant? How will it help me?

These are valuable and important questions–and I'm gratified when people ask them! I believe it is a part of the job of every scientist to communicate the value of their work to the general public, who, after all, fund much of the research we do through their tax dollars.

In my case, the answer to these questions can be summarized succinctly: I am a microbiologist who investigates factors that affect the presence and persistence of certain microorganisms that can make people sick, with a focus on microbes transmitted through foods.

Photo: International Rice Research Institute

Jean O. Loyola, director of the Office of Institutional Linkages Office at the University of the Philippines, Los Baños, welcomed Dean Kathryn Boor during a visit to the Philippines last November. For more on her visits with alumni in the Philippines and Mumbai, India, see page 32.

While it is easy for most people to relate to food, not all science intersects with our daily lives. In some instances, the practical value of a particular discovery may be unforeseen, or may take years or decades to be recognized. Isaac Newton certainly wasn't trying to put satellites in orbit when his work revealed the laws of motion, but NASA engineers relied on those very laws to do so centuries later.

In other instances, there may never be tangible applications that result from a body of research. But this does not mean such science is inconsequential. Quite the contrary, in fact, for so-called "fundamental research" is just that: fundamental to advancing our basic understanding of the mechanisms that regulate life and underpin the natural world around us.

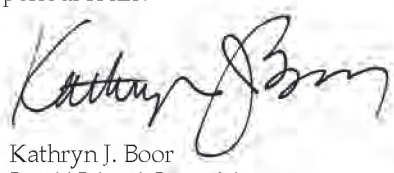
The primary goal of fundamental research is to generate knowledge for the sake of knowledge. This kind of science is the starting point from which all innovation eventually arises. It is focused on discovery as a core human aspiration.

Fundamental research is driven by human curiosity. It alerts us to questions we didn't even know to ask and suggests answers we may not have otherwise recognized as possible. Moreover, it is foundational to the principles that guide the education and training of all young scientists.

In these pages, you'll be introduced to several astonishing CALS life scientists. In some instances, their work has resulted in practical innovations that have impacted the lives of countless people. In other cases, it has not. Yet what they all share in common is the passion to unlock the secrets behind some of the key mysteries of life.

In CALS, we have long endeavored to create an environment where fundamental researchers like these have the freedom to satisfy their innate curiosity by following the trails ignited by their own discoveries. That's why my predecessor, Dean Charles Palm, petitioned the state legislature to change the name of the college from the College of Agriculture to the College of Agriculture and Life Sciences in 1971. And like Dean Palm, I, too, believe that discovering knowledge for the sake of knowledge serves the greatest of public purposes, for it enriches the sum total of our understanding of who we are and where and how we live.

I am so proud of our faculty, students, staff and alumni working today in the fundamental life sciences, and I'm thrilled to celebrate their inspiring and path-breaking research in this issue of periodiCALS.



Kathryn J. Boor
Ronald P. Lynch Dean of the
College of Agriculture and Life Sciences

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The College of Agriculture and Life Sciences has sustainability as a core value. This magazine was printed regionally using soy-based inks, on post-consumer fiber paper certified by the Forest Stewardship Council, in an eco-friendly process that recycles virtually all chemical, paper, and metal waste.

CONTEST HARVESTS NAMES FOR NEW WINE GRAPES

By Kate Frazer

After a naming challenge drew 1,100 suggestions from around the world, a Cornell breeder has revealed the secret identities of two new wine grapes: Arandell and Aromella.

Arandell—a mash-up of "arandano," the Spanish word for blueberry, and the "ell" from Cornell—is the first grape released from the New York State Agricultural Experiment Station's "no-spray" vineyard.

Horticulture professor Bruce Reisch (pictured) hopes its hint of blueberry will attract wine lovers, while its high level of natural disease resistance will appeal to growers interested in sustainable or organic production systems.

Aromella, an aromatic muscat white wine grape, ranks high for winter hardiness and productivity. Reisch says its release is timely given the growing popularity of muscat wines.

The competition emerged almost accidently when Anna Katharine Mansfield, assistant professor of enology, suggested emailing colleagues to introduce two varieties ripe for naming. As news of their appeal spread through the proverbial grapevine, it attracted coverage from outlets including NPR's Morning Edition and Bon Appétit.

Photo: Joe Ogrodnick

Family tributes were a popular theme. Many submissions had Cornell associations, like Big Red (Cornell's mascot), A.D. White (Cornell's first president), and Llenroc (Cornell spelled backwards). Others, like Genevieve, were inspired by the grapes' birthplace in Geneva, N.Y.

"One thoughtful person asked if I had a grape named for me and suggested 'Breischling,'" Reisch said.

Perhaps the most creative offering came from four different entrants who suggested comedians Stephen Colbert and Jon Stewart be the namesakes. "Colbert Red and Stewart White do have the essence of great grape names but are already associated with existing vineyards," Reisch said.

But grape naming is serious business. With 7,000-plus varieties on the market, new grapes face an uphill battle.

"The trickiest part is ensuring the name isn't trademarked or already used in the industry," Mansfield said. Once the list was pruned to 120 suggestions, Reisch researched each name, then gathered opinions on 19 finalists from growers and winemakers.

GREENING IN THE RED ZONE

Extensive research supports the value of green space in urban contexts and of nature in helping people with a variety of disorders. Keith Tidball, Ph.D. '12, a senior extension associate in the Department of Natural Resources and an Army veteran, wondered what restorative powers nature and outdoor recreation might hold for soldiers and other trauma victims. "Greening in the red zone," as Tidball calls this concept, includes such activities as tree planting, community gardening, hunting and fishing, and time alone in nature. He is researching the validity of the concept as principal investigator for an $85,600 federal grant, "Returning Warriors: A Study of the Social-Ecological Benefits of Coming Home to Nature." Among others, Tidball is working with Cornell Cooperative Extension associations, veterans' organizations and the Army's Fort Drum in northern New York to promote greening practices. "There's no 'magic green pill,' but this is clearly an untapped, important resource," Tidball said.

REAPING SUCCESS IN WAR-TORN MALI

Despite being entrenched on the front lines in an embattled West African nation, 70 rice farmers in seven villages were able to increase their yields by an average of 86 percent this past season, thanks to use of the System of Rice Intensification (SRI) method.

With technical support from the Cornell SRI-Rice program and a grant from the non-profit SRI Global, Mali-based self-help association 3A-Sahel taught local farmers how to increase productivity of rice and other crops by 20-100 percent while reducing the amount of seed, water and chemical fertilizer needed—simply by changing how the plants, soil, water and nutrients are managed.

Photo: Hamidou Guindo

Malian farmers using SRI methodology collected yield data on 70 farms despite jihadists' occupation of the area

Project leader Hamidou Guindo had to grow a beard and try to blend in with locals in order to avoid suspicion by armed jihadists who occupied the area. He managed to finish his work unharmed, training farmers, conducting comparison trials, and collecting biophysical and socioeconomic data.

Guindo and his team now hope that by the beginning of the next growing season they will be able to take SRI to more farmers.

SIGNIFICANT RESPONSE TO SUPERSTORM SANDY

When "Superstorm" Sandy struck the New York coast, Cornell Cooperative Extension (CCE) was able to mobilize its network to reduce the impact of the natural disaster. Thanks to lessons learned from previous hurricanes Irene and Lee, CCE and the Extension Disaster Education Network (EDEN) were prepared with a system-wide set of standard operating procedures. Drills and table-top exercises over the past year meant a Disaster All-hazards Response Team (DART) was ready to jump into action when activated for the first time in a live incident days before Sandy made landfall in October 2012. Direct linkages to the National Weather Service, the New York State Emergency Operations Center and other state government agencies allowed for close monitoring of the storm's path and intensity, and extension associates throughout the state kept in close contact to share reports about impacts and responses. Disaster education resources were compiled for rapid dissemination via traditional and social media outlets, and a special Hurricane Sandy resource page was developed.

"Extension has a long history of pitching in during times of emergency and disaster, and the ongoing work of CCE NY EDEN during and after Hurricane Sandy is no exception. The entire CCE EDEN team is proud to be of service to the citizens of New York in this way."
-Keith Tidball, state program leader for CCE NY EDEN

TXT UR Q 2 PROF?

Professors tired of fighting the battle against students texting and posting on Facebook during class are finding ways to embrace technology and use it as a learning tool. Deborah Streeter, the Bruce F. Failing Sr. Professor of Personal Enterprise in the Charles H. Dyson School of Applied Economics and Management, is leading Flip the Switch workshops around the country to help educators engage students in classrooms through technology, such as cell phone polling, in-class texting and mobile apps that complement their coursework.

PLANT BIOLOGY MARKS 100 YEARS

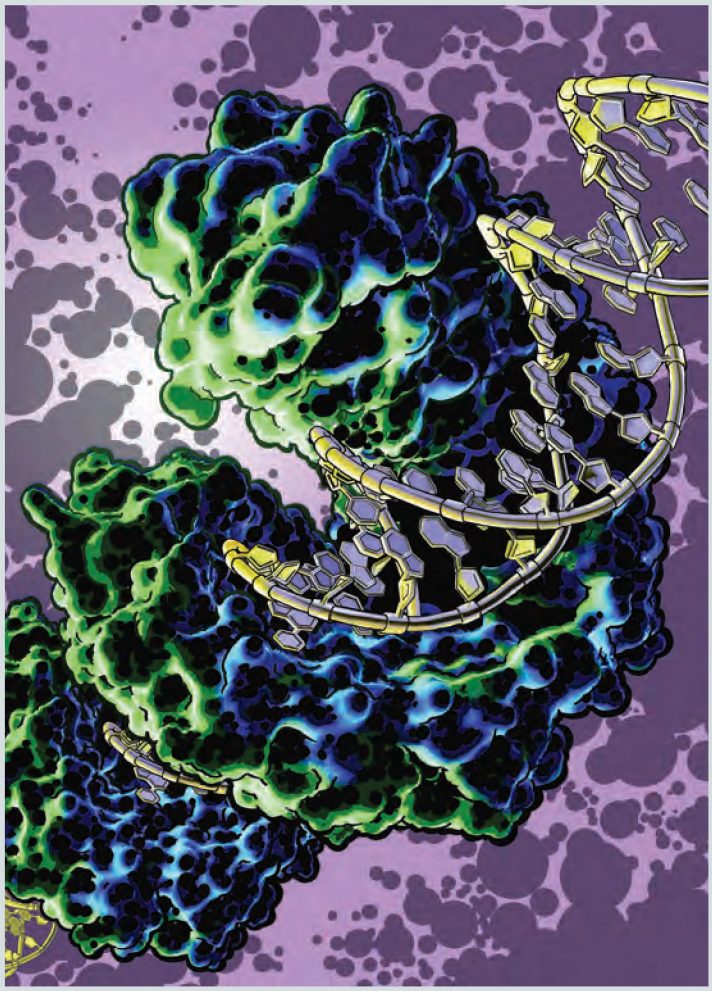
For the past 100 years, it has been home to Nobel Prize winners, members of the National Academy of Sciences and intrepid plant explorers. It has been ahead of the times in educating women and minorities in the sciences. On June 28-29, the Department of Plant Biology will mark its centennial with a special symposium for alumni and friends.

"The department has a rich and storied history, which we will celebrate during the symposium," said William Crepet, professor and department chair. "As we look to the future, as has happened repeatedly in the past, we see that what has been 'basic' research will be crucial to solving complex 'applied' problems facing society on a number of fronts. Principal among these, perhaps, is climate change which creates an unprecedented threat to biodiversity maintenance and agriculture at the very time when population growth places great demands in both these areas."

The two-day celebration will feature talks on botanical medicine, department history and a vision for the future, as well as tours of plant biology labs and the Liberty Hyde Bailey Hortorium. For more information on the celebration, visit http://plantbio.cornell.edu/.

ENTOMOLOGIST NAMES NEW BEETLES

Over the past 20 years, he's discovered nearly half of the 400 total known *Mecyclothorax* species of beetles. Now entomologist James Liebherr, M.S. '74, is in the process of adding 37 more formally named species to the list. Liebherr, professor and curator of the Cornell University Insect Collection, travelled to Tahiti and Moorea in the Society Islands in 2006 to study the small predatory beetles and their evolution. Liebherr said he often names new insects based on certain attributes that stand out, while *Mecyclothorax perraulti* was named after French entomologist Georges Perrault.



Graphic: Jon Bogdanove

TAL effectors, shown here in an illustration by comic book artist Jon Bogdanove, are DNA-targeting proteins that plant pathogenic bacteria use to alter gene expression in their hosts.

HOLY SMOKES! SUPER SCIENTIST AWARDED FOR MAJOR BREAKTHROUGH

An innovation that allows life scientists to precisely edit genomes for applications including gene therapy was named a runner-up for Science magazine's 2012 Breakthrough of the Year.

Adam Bogdanove, Ph.D. '97, professor of plant pathology and plant-microbe biology, made the breakthrough in 2009 while he worked as a plant pathologist at Iowa State University. He identified the mechanism by which pathogen proteins called TAL effectors bind to specific sequences in their host plant's genome. He later showed that TAL proteins could be used to carry an enzyme that slices DNA, creating molecular machinery—called a TALEN—capable of landing in a precise location in the genome and cutting the DNA.

Now widely available, TALENs also allow researchers to replace existing genes with new ones, opening the door for medical applications including gene therapy.

"Depending on the nature of a genetic defect, researchers may soon be able to extract a patient's cells, remove the genetic mutation, replace that sequence with healthy code, and reintroduce the cells to the patient," Bogdanove said. "Plant breeders may also be able to use TALENs to sidestep traditional breeding of crops by inserting new, site-specific genetic information."

in the marketplace

STOCKING HALL AUDITORIUM NAME WILL HONOR PEPSICO

By Amanda Garris, Ph.D. '04

The Department of Food Science is recognizing a proven supporter and advocate for food science excellence at Cornell with the naming of one of the premier educational spaces in the renovated Stocking Hall. Next fall, students in several large food science courses will attend classes in the newly designated PepsiCo Auditorium.

"PepsiCo has initiated innovative research projects, supported undergraduate education in food science, and is our partner in developing programs to retool the workforce in New York State and around the world," said Dennis Miller, Ph.D. '78, professor and chair of the Department of Food Science. "We are pleased to recognize their generosity by naming the auditorium in honor of the company."

The 124-seat auditorium will be used for large classes, department seminars and special events, such as scientific conferences. Its design caters to specialized sensory learning; for courses where eating or drinking are often required, the space will be equipped with technologies that allow students to electronically register responses to their sensory perceptions and see the data analyzed in real time.

"PepsiCo is proud to support Cornell, as it is home to one of the country's premier food science departments that is doing cutting-edge research to better understand food, nutrition and agriculture in ways that will lead to important new discoveries," said Greg Yep, the senior vice president for long-term research at PepsiCo.

PepsiCo has many ties to Cornell. Two of its scientists, alumni Kirk Kealey, M.S. '78, Ph.D. '85, director of raw material food safety, and Jonathan Licker, M.S. '98, Ph.D. '99, senior manager for research and development in snack seasonings and flavors, are currently serving on the Cornell Institute of Food Science Advisory Council. The company is also a significant supporter of the Food Science Excellence Endowment Fund and numerous sponsored research programs that cut across several CALS departments, including food science.

"Support for the Excellence Fund is particularly meaningful because the endowment structure will help sustain the department over the long term," Miller said. "It will provide critical support for the department as we grow and enhance our programs in teaching, research and extension."

Mitchell|Giurgola Architects, LLP

STOCKING HALL RENOVATION UPDATE

The first phase of the Stocking Hall renovation will conclude in June with completion of the wing facing Tower Road, home of the Stocking Hall Dairy Plant and the Dairy Bar. The PepsiCo Auditorium joins two other named spaces in the renovated building:

- The TIC Gums classroom, named for the Whitemarsh, Md.-based company, a long-time supporter of the Food Science Summer Scholars Program and a global leader in advanced texture and stabilization solutions for the food and beverage industry.
- The International Food Network (IFN) Seminar Room, named for the Ithaca-based product development company. A major employer of Cornell Food Science alumni, IFN is also a supporter of the Summer Scholars Program.

GLOBAL EXCHANGES

Cornell has global aspirations, and working with a global company like PepsiCo is enabling CALS to build its expertise abroad, including new ties to the Russian dairy industry.

A team of six scientists and extension specialists led by Carmen Moraru, associate professor of food science, was dispatched in January to help PepsiCo assess the operational efficiencies of a key dairy facility located just outside of Moscow. Their purpose was to help PepsiCo align production quality and measurable standards with an overarching aim of assessing areas for continuous improvement.

This fall, associate professors of animal science Tom Overton '91 and Mike Van Amburgh, Ph.D. '96, along with Daryl Van Nydam, DVM 1997, Ph.D. '02, associate professor of population medicine and diagnostic sciences in the College of Veterinary Medicine, will welcome Russian dairy farmers to campus for workshops on dairy production.

"This collaboration with PepsiCo is a great opportunity to strengthen the global reach of Cornell's expertise, and we value the opportunity to share our experience," Overton said.

WORKFORCE DEVELOPMENT

PepsiCo employees closer to home are also benefitting from joint efforts in workforce development with a training program for workers at the new Muller Quaker yogurt facility in Batavia, N.Y. Led by Cornell's Food Science Dairy Extension Team, a comprehensive training program has been developed in partnership with a regional alliance including the Genesee County Economic Development Center, Ecolab, Inc., the New York State Department of Agriculture & Markets, and the Food Processing Cluster Initiative from Rochester's Institute of Technology. The curricula being shared with PepsiCo and the resulting increase in dairy expertise among the workforce is playing an important role in the continuing economic development of the Upstate region.

"Dairy is one of the most regulated industries, and many of the regulations will be new to workers recruited from other manufacturing sectors," said Tristan Zuber '08, dairy processing specialist with Cornell Cooperative Extension's regional Harvest New York project. "This holistic program will cover everything from basic micro and food safety regulations to make sure the processing will result in a safe and high quality product."

PepsiCo also continues to be a supporter of the Food Science Summer Scholars Program, which brings top undergraduates from around the country to Cornell for an intensive research and mentoring program designed to cultivate the next generation of food scientists.

Industry leaders, researchers, government officials and the media tour Cornell's new Stocking Hall Dairy Plant. Photo: Robyn Wishna

"PepsiCo has been one of the major supporters of the Summer Scholars program, and they continue to hire graduates of the program," said Martin Wiedmann, Ph.D. '97, professor of food science. "It's a classic win-win situation."

"There is no finer example of a public-private partnership than what the College of Agriculture and Life Sciences has with PepsiCo," added Joseph Vinciquerra, director of corporate and foundation relations. "The intersection of academic research, economic and workforce development, and critical support through philanthropy is the very definition of a mutually beneficial relationship between industry and university."

CALS AWARDED FUNDS FOR REGIONAL ECONOMIC DEVELOPMENT

Cornell expertise has driven economic growth for more than 150 years. Grant funds awarded through New York's Regional Economic Development Councils will soon boost Cornell's economic impact by expanding job-creating infrastructure on the Ithaca campus.

A $500,000 grant will equip a specialized mini-manufacturing facility within the Food Processing and Development Laboratory (FPDL) in the Department of Food Science, which is already a statewide center for workforce training and product development.

"This will significantly expand our capability to support regional dairy plants, especially with artisan cheese and yogurt products," said Rob Ralyea, M.S. '98, dairy extension specialist. "The new equipment will allow the FPDL to produce marketable, packaged products, an essential step in helping new processors establish themselves in the marketplace."

A $350,000 grant will fund construction of a state-of-the-art 8,000-square-foot research greenhouse with 16-foot-high side walls. The height, unique among Cornell greenhouses, will facilitate studies of taller crops important to Southern Tier growers, including corn, trellised peas and biofuel grasses.

"The research performed in Cornell greenhouses creates local jobs and strong agricultural communities," said Mike Hoffmann, director of the Cornell University Agricultural Experiment Station. "Projects lined up for the new greenhouse include breeding new field crops, vegetable varieties and biofuels adapted to New York, as well as developing recommendations for pest control and weed management needed to keep our farmers competitive."

Cornell's Tech campus on New York City's Roosevelt Island also received an award of $870,030 to design a 150,000-square-foot LEED (Leadership in Energy and Environmental Design) Platinum "net-zero energy" building, which will harvest as much energy from the site as it consumes.

The Regional Economic Development Councils and Awards are the core of the New York Governor Andrew Cuomo's strategy to harness a community-based approach to job creation.

"The small-scale processing facility and the new greenhouse will help us keep pace with the needs of New York growers and manufacturers," said Kathryn Boor, the Ronald P. Lynch Dean of the College of Agriculture and Life Sciences. "We are pleased to be partnering with the state and region to build infrastructure that will yield jobs for decades to come."

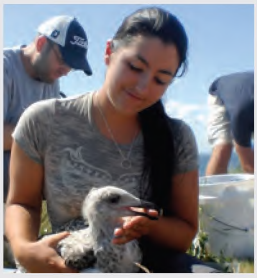
Photo: Robyn Wishna

Assistant professor of plant breeding and genetics Michael Mazourek plants peppers with Ph.D. student Lindsay Wyatt.

WILD KINGDOM: UNIQUE UNDERGRADUATE SCHOLARLY PURSUITS

By Amanda Garris, Ph.D. '04

The Hunter R. Rawlings III Cornell Presidential Research Scholars program funds independent research by outstanding undergraduates across the university. Since its establishment in 1996, hundreds of Presidential Scholars have pursued original research, including these three CALS seniors who have followed their inspiration into lab and field to explore sound, size and speed in the animal world.

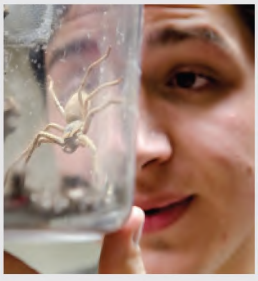


CALLING THE GULLS **Sarah MacLean '13,** Natural Resources

Curiosity about how birds identify potential nest predators led Sarah MacLean to the rocky outcroppings of Cornell's Shoals Marine Laboratory, where gulls nest by the hundreds. With guidance from Lab of Ornithology assistant director of Citizen Science David Bonter and professor of natural resources Janis Dickinson, she serenaded nesting gulls with a specialized avian playlist: the call of the bald eagles, warning cries of two gull species, the familiar call of the local song sparrow and the novel call of the Western scrub-jay, as well as a person reading from a book. The most alarming sounds to the gulls? The human voice and the bald eagle. MacLean found that gulls not only distinguished among the different sounds, they also reacted with a gradient of agitation behaviors that suggest gulls use a finely tuned system for categorizing different types of threats.

SIZING UP DOMESTICATION GENETICS **Julian Homburger '13,** Biology

An avid equestrian since childhood, Julian Homburger traded the stable for a lab bench to study the process of domestication in horses. Working with Nate Sutter, an assistant professor of clinical sciences in the College of Veterinary Medicine, and animal science professor Samantha Brooks, Homburger analyzed the high-resolution genomic fingerprints of 30 horse breeds to uncover the genetic relationships among them. As in many domestic animals, size in horses has been a target of selection by humans, resulting in heights ranging from the under-a-meter-tall American Miniature to Percherons twice that height. His research showed that size differentiation occurred early in the horse lineage and that there has been relatively little inter-mating between small and large horses since, even during the creation of breeds. The evidence suggests that horse height was an important trait for breeders well before modern times.



CHASING SPRINTING SPIDERS **Jacob Hurst '13,** Entomology

Jacob Hurst was ensnared in a silken thread as a first-year student in Linda Rayor's spider biology course. In Rayor's lab, Hurst's research has focused on the intersection of size, gender and speed in the Australian huntsman spider. They are friendly with their kin, but speed is key to outrunning predators and capturing more prey. Although juvenile males and females are the same size, at sexual maturity the males have legs that are up to 20 percent longer than females of the same size, and Hurst evaluated the effect of this difference on their running speed. He ran a series of miniature time trials in a short acrylic tube and measured velocity, body weight and leg length in juvenile and mature males and females. Though smaller overall, sexually mature males had much longer legs, ran faster and were more "on edge" than their female counterparts, a potential advantage in escaping predators—and aggressive females.

CLUB HELPS KEEP CORNELL CURRENT

By Jennifer Pierre '13

In the era of news alerts on email and on smartphones, it seems like keeping up to date with what's happening around the world couldn't get any easier, but a trio of business-minded juniors in the Charles H. Dyson School of Applied Economics and Management have taken things one step further.

In the fall of 2012, Rich Horgan '14, Kwesi Acquay '14 and Vinay Ramprasad '14 founded Cornell Current, a new student organization focused on keeping students up to date and informed on current events.

"We want students to be aware of stories that have global and personal impact," Horgan said. "During job interviews, a lot of students get tripped up on the question, 'So what's going on in the world these days?' The Cornell Current will hopefully help give them a competitive edge."

The group's website, cornellcurrent.com, covers current events from Cornell campus news to top global stories in five sectors: politics, technology, international news, and science. Each sector has a head news analyst who aggregates the different news stories into cohesive articles.

Horgan noted that the group has significant integration with faculty and alumni. Some examples include the "Expert Insight" sections on the website and alumni Skype sessions during weekly meetings.

GIVING HUNGER A HUMAN FACE

By Rebecca Harrison '14

We know the statistics regarding global hunger, about the lack of food and the infrastructure needed to distribute that food. We are proficient in debating the use of technology in agriculture. Nothing, however, is as powerful an education tool and motivator as looking into the faces of parents forced to beg in order to feed their children.

In January, I was among a group of 24 Cornell graduate and undergraduate students who traveled to western India with students from other American and Indian universities as part of the International Agriculture and Rural Development (IARD) course Agriculture in Developing Nations.

The class was divided into three thematic groups—agricultural systems, rural infrastructure and development, and value addition. As part of the value addition group, I toured research and development programs and food processing facilities that produce products from American cheese singles to wine and fruit juices. It was a valuable introduction to the challenges and opportunities for value-added products in a developing nation.

A trip to a soybean processing plant and the market where the owner purchases some of his raw materials highlighted some blatant inefficiencies in the Indian food system, including massive amounts of food waste and corrupt middlemen who profit on unregulated commission. We also saw examples of success, such as research and development that adds nutritional and monetary value to soybeans through a variety of processing methods, such as making flour substitutes.

This year marks the 50th anniversary of International Programs in Cornell's College of Agriculture and Life Sciences. Our class, which has been held yearly since 2002, is just one example of how International Programs exposes students to life beyond the Ag Quad. This trip was my first experience in a developing country; it humanized everything I have studied back on The Hill.

Indian student Srishti Kaushik visits a vineyard as part of the IARD 4020 trip. Photo: Srishti Kaushik

Graduate student Gregory Bernard interacts with village children. Photo: Ashish Kumar

Jennifer Weidman '13, environmental engineering, gets some hands-on field experience on an Indian farm. Photo Jennifer Weidman

STUDENT SPURS BAN ON NUTRITIONAL SUPPLEMENT IN NEW YORK

By Tina Cormier

A student's troubling experience with weight loss and muscle-building supplements is influencing the regulation of a chemical stimulant in New York.

On Jan. 17 in Manhattan, CALS student Gregory Maller '14 stood with New York Sen. Jeffrey Klein as Klein introduced an amendment to the public health law that would prohibit the sale of products containing dimethylamylamine (DMAA), a stimulant more potent than the now-banned Ephedra. It works like a rush of adrenaline to boost metabolism, narrowing blood vessels and elevating blood pressure, which can result in shortness of breath, rapid heartbeat and headaches.

Maller, who is pursuing a major in communication with a minor in nutritional sciences, approached the senator after his own experience with DMAA. After being diagnosed with fatty liver disease and asthma at the age of 13, Maller shed 80 pounds by joining the wrestling team, but it left him emaciated and weak. Although supplements promised quick results in muscle mass and athletic performance, adverse side effects and parental concern led him to delve deeper into what was in the drugs. By the summer of 2012, Maller had gathered enough information to approach Klein, then chair of the standing committee on Alcoholism and Substance Abuse.

Inspired by nutritional sciences professor David Levitsky, he also co-founded the Cornell Health and Nutrition Society with fellow CALS undergraduate Renan De Souza '14 in 2011. The group is dedicated to investigating and informing the public of the links between health, nutrition and athletic performance.

"I want to promote knowledge about this—what you're really putting in your body and what the effects could be," Maller said.

Gregory Maller '14 and Sen. Jeffrey Klein (D-Bronx/Westchester) introduce an amendment to the public health law that would prohibit the sale of any products containing the stimulant dimethylamylamine. Photo: Anna Durrett, Office of State Sen. Jeffrey D. Klein

around the affiliates

Photo: Tim Laman

VIRTUAL TICKET TO PARADISE *By Pat Leonard*

Thirty-nine of the most extraordinary birds in the world are flying into living rooms and classrooms through the new Birds-of-Paradise Project website from the Cornell Lab of Ornithology. The world's most spectacular examples of evolution by sexual selection, birds-of-paradise can transform themselves from plain to psychedelic in the blink of an eye, with displays that include bright colors, unique feathers, shape-shifting poses and dance steps, all the in name of attracting a mate. The site offers more than two hours of never-before-seen footage, plus images, sounds and interactive features that explore the unique set of rules that guided these birds' evolution. Visit the website at birdsofparadiseproject.org.

COOLER COLLABORATION

A popular library study hub has been transformed with major improvements in high-tech functionality, work space efficiency, comfort and pizzazz.

Updates to Mann Library's Bissett Collaborative Center include four collaborative work stations that combine computing equipment, a display screen and comfortable seating with built-in privacy screens. Beanbag chairs, ottomans, mobile white boards, portable LCD screens, a PC and a Mac docking station, and whiteboards with plenty of available markers make the space ideal for group work.

The renovations mark the 25th anniversary of the death of the center's namesake Kenneth L. Bissett '89, a CALS communication major who was killed in the bombing of Pan Am flight 103 over Lockerbie, Scotland.

"The Bissett Center puts the best collaborative research and writing tools at students' fingertips," said academic technology / public computing librarian Sara Wright. "We hope it will foster precisely the kind of cross-disciplinary perspectives that characterized Ken's own studies at Cornell."

LANDSCAPE FOR LIFE

Does your garden work with nature or struggle against it? A new certificate program offered by Cornell Plantations is teaching homeowners how to make nature an ally, whether they have a patio garden, a suburban backyard or a 20-acre farm.

Landscape for Life is an offshoot of the Sustainable Sites Initiative, a national program of benchmarks for landscape designers. Over five weekly sessions, participants in the Plantations' Landscape for Life workshop will learn about sustainability in the home landscape, develop plans for their own site, and get better acquainted with their soil, plants and water while learning to integrate features such as bird habitats or rain gardens to slow down water runoff.

"If a homeowner captured every single inch of rain that fell on the roof of a 1,600-square-foot home in Ithaca, it would add up to 33,000 gallons of water a year."
—Joshua Whitney

"It is amazing what can be accomplished on a small scale," said course instructor Joshua Whitney, a staff gardener at the Plantations. "We're not out to change the world, but small things can add up to something pretty significant."

Photo: Sonja Skelly

SHOALS GREEN GRID TO EXPAND

Ross Hansen has an ambitious goal: To power the Shoals Marine Lab with renewable energy sources instead of a diesel generator, using a green grid that is fed by solar panels, an 80-foot wind turbine, and perhaps someday a wave generator. This summer, with a grant from the National Science Foundation, a new building will be constructed on the island campus to house a 300-kWH battery bank that will be charged in part by solar and wind power, making Appledore Island quite a "green" place to be.

"Island inhabitants do their part to keep the facility sustainable by taking limited showers and composting almost everything," said Hansen, assistant director for island and coastal operations. "The new battery bank will eventually allow us to store enough solar and wind power during the day to get through the night without using the diesel generator."

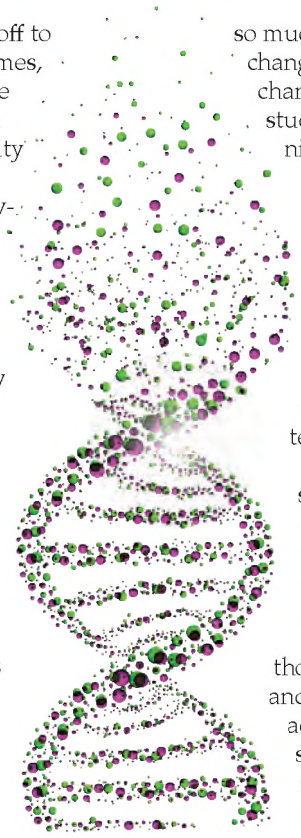
The building design, from its roof angle to its square footage, was developed with help from a team of four sustainable engineering interns in 2012.

MOLECULAR MECHANICS

By Amanda Garris, Ph.D. '04

At first glance, a leaf, a yeast cell and a human hair follicle are convincingly unique. But journeying past cell walls, through microscopic membranes, and into the workings of the nucleus, one might be forgiven for confusing one for the other.

From the switches for turning genes on and off to the micromachinery for copying chromosomes, the mechanics of DNA are similar across the tree of life. This is the not-so-secret weapon of fundamental research: an underlying unity that allows discoveries made in fruit flies to generate cancer treatments for humans. Here we look at discoveries made by CALS researchers who are "molecular mechanics," tinkering with genes and proteins to unlock the hidden workings of DNA.



HEAD STARTS

Is it hot in here? A cell silently answers yes by quickly producing proteins to protect itself, and John Lis, the Barbara McClintock Professor of Molecular Biology and Genetics has been dissecting the mechanics of the cell's rapid response to environmental changes for more than three decades.

Heat shock proteins become crucial in hard times, when cells are stressed by heat, toxins or water deprivation. They function as cellular chaperones that keep proteins on good behavior, preventing them from unraveling or contorting and thus losing their function.

"The heat shock proteins are common to all organisms—in a fly in a hot field or in a person with a feverish flu, heat shock proteins are activated," Lis explained. "In the beginning I was not so much interested in heat stress per se. Because the changes in their expression occur within minutes of a change in temperature, they were a great system to study the process of gene expression in a synchronized way."

To appreciate Lis' work requires a quick review of basic biology. DNA encodes for genes, and when a gene is turned on, the information is transcribed into RNA, which cellular machinery uses as instructions to build proteins. Or, as Nobel Laureate Marshall Nirenberg said, "DNA makes RNA makes protein." It was generally assumed that if a protein was needed, the first step was to recruit the platform of proteins to transcribe genes into RNA.

Lis made the surprising discovery that the heat shock genes had a head start. Even before the first hint of heat, the cellular machinery of gene expression was not only physically tethered to the start of these genes, it had precociously produced a short piece of RNA transcript.

For decades, this "proximal pausing" was thought to be restricted to Lis' heat shock proteins and a few other genes. Only in the mid-2000s did advances in genomic technology allow other researchers to realize that it was occurring at thousands of other genes in the genome, in organisms ranging from the fruit fly to humans. In other

words, it was a fundamental process.

"If you look at genes that are paused, many respond rapidly to signals to grow or communicate," Lis noted. "Although we don't fully understand its functional importance, it may be a fundamental step to allow genes to turn on rapidly and synchronously."

Lis' quest to dissect how genes are turned on and off has required him to become a tool-maker. He's developed ways to visualize nanoscale processes (see box) and devised tiny molecular wrenches, not for tightening up molecules but to throw into the works of proteins and see what happens.

He is currently using a system called RNA aptamers, short strands of RNA that can interfere with a protein's ability to interact with other proteins or with DNA. It starts with making huge libraries of random RNA sequences—about 10 quadrillion molecules, each 70 RNA bases long.

"It's like having a room full of keys and looking for the key that locks a specific door," Lis said. "In this case we are looking for a molecule that can disable a particular protein, and we use successive rounds of selection to narrow that huge pool down to 1,000 candidates to test against a specific protein."

And here is where fundamental research on gene expression merged onto the cancer research superhighway.

"Expression of one of the aptamers that interferes with the master regulatory protein of the heat shock response selectively kills human cancer cells," Lis explained. "It turns out that cancer cells rely on the heat shock response because they are quite stressed—they are growing quickly, with low oxygen, and very crowded compared to normal cells—and they need heat shock proteins to chaperone proteins."

In other words, without functional heat shock proteins, the imperfections in the cancer cell's machinery become exposed. For Lis, it's a testament to the potential impact of fundamental research.

"Pursuing basic research has had more practical applications than I might have expected at the start of my career," he noted. "In many ways, it's analogous to dealing with polio. At the height of the epidemic, it was very important to build a better iron lung, but the solution—a vaccine—came from an unexpected approach rooted in another field."

A HITCHHIKER'S GUIDE TO THE GENOME

Transposons are among the most skilled hitchhikers in the biological world. These short pieces of DNA are not technically alive, yet they code for one to a handful of genes that allow them to jump from spot to spot within a genome. Associate professor of microbiology Joseph Peters has made it his goal to understand just how they propagate themselves in the promiscuous world of microbe biology.

"Transposons are the ultimate pathogen because they are within our DNA," Peters said. "The human genome is littered with the shrapnel from inactivated transposons, but only in rare cases do they cause disease."

In microbes, however, transposons claim partial credit for their diversity and impressive tolerance of environmental extremes. Peters studies a particular transposon called Tn7, which is widespread in the bacterial domain. It's been found in the genomes of bacteria in an amazingly broad array of environments, including deep sea vents, polar ice caps, searingly acidic mine drainage, pastoral farmland and our own digestive tracts, to name a few.

In addition to acting as a quite unobtrusive guest, the presence of Tn7 can be advantageous, because in addition to the five genes it needs to jump, it also contains a cargo area of sorts that can carry up to 50 genes, including genes for antibiotic resistance, disarming harmful chemical compounds and many whose functions have not yet been identified.

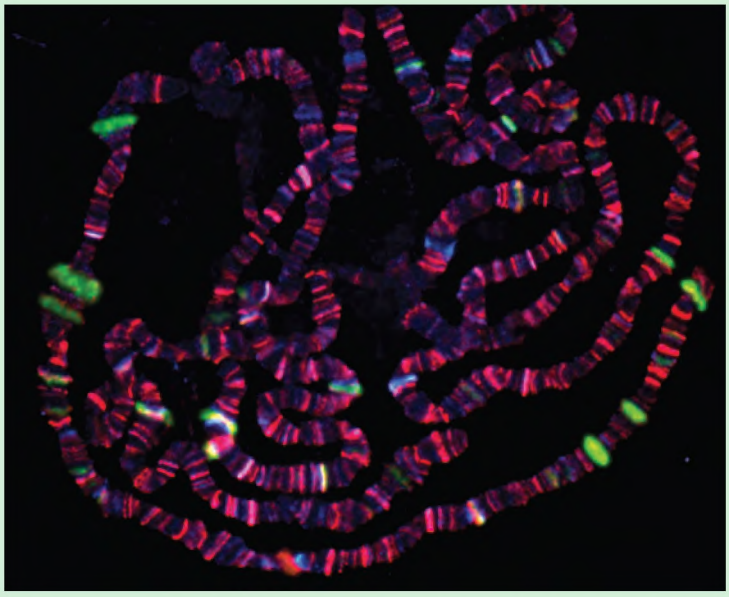
"What's interesting about this is that you cannot catch a cold from your family dog—because most pathogens tend to be very specific to a given species—yet bacteria that diverged millions of years ago can 'catch' Tn7 from each other," Peters said.

How did it travel so far? Peters' research assigns the credit to two clever tricks. First, Tn7 is a polite genomic guest and always inserts into a specific site in the host genome where it won't disrupt a gene. Second, it preferentially inserts into the most promiscuous type of bacterial DNA, "extra" circular DNAs called plasmids, which are capable of mobilizing between bacteria, often regardless of species.

Peters has been working to understand just how Tn7 knows to make their move when plasmids are present.

"It turns out, Tn7 is more clever than we thought," he said.

To produce new cells, a first step is to duplicate the entire genome so the



TOOLS OF THE TRADE: POLYTENE IMMUNOFLUORESCENCE

To conveniently visualize proteins on DNA, one approach used in professor of molecular biology and genetics John Lis' lab utilizes special chromosomes found in the secretory glands of the fruit fly (Drosophila melanogaster), called polytene chromosomes, in which hundreds of strands of DNA are perfectly aligned to form conglomerates large enough to view with a microscope. For the image above, fruit fly larvae were heat shocked for only two and half minutes, and the chromosomes from the salivary glands were prepared and spread for fluorescent staining. Red indicates the presence of the master regulator of heat shock genes; green shows the regions where the machinery of gene expression—RNA polymerase II—is attached, and locations with an additional regulatory enzyme fluoresce blue. "What's particularly evident is RNA polymerase II in large regions that are in the process of having their transcription repressed (shown as green above) and the purple fluorescence of triple staining at heat shock gene loci that are beginning to be activated," Lis explained. A drive to see the process of genes being turned on and off in real time led Lis in collaboration with the labs of Watt Webb and Warren Zipfel at Cornell to develop imaging techniques to view specific gene loci in polytene chromosomes in living salivary glands. Movies that show proteins recruited to "turned-on" genes can be found on Lis' web site http://mbg.cornell.edu/cals/mbg/research/lis-lab/images.cfm.

daughter cells will each have a full copy of the chromosomes. The process of copying—or replicating—the DNA requires that two complementary strands of the double helix unwind so that that each strand becomes a template for DNA replication.

Replication on one of the two DNA strands is like travel on a transcontinental rail line: once the engine of DNA replication clamps on, it can travel uninterrupted for long distances. The other strand proceeds more like a climber rappelling down the face of a cliff—clamp, hop, clamp, hop—this discontinuous process requires many molecular clamps. And at one stage of their lifecycle those circular, promiscuous plasmids replicate solely by the discontinuous process.

"One of our main discoveries was that the clamp involved in DNA replication is recognized by the transposon," Peters said. "Because the plasmids—the transposon's 'bus ticket' out of the cell—use a lot of clamps, they tip off the transposon to their presence."

Now that he understands Tn7's strategy at the molecular level, he is starting to look at ways it could be harnessed as a tool.

"Tn7's preference for a particular site in the genome apart from other genes means that it can be used to engineer bacteria to do all sorts of things without disrupting functions essential to their wellbeing," Peters said. "We can turn the tables on Tn7 by using it to insert genes we're interested in, for example a gene that can break down plastic or a pollutant into the organism of our choice."

Peters' lab is also capitalizing on the ability of Tn7 to target the discontinuous portion of DNA replication. This work is providing insight into how to better manipulate all regions of the bacterial chromosome for research and development.

"Tn7 appears to have identified the 'Achilles heel' of otherwise high-fidelity DNA replication that shows incredible promise for altering the genetic code of bacteria in a more surgical way," Peters said.

UNZIPPING A CAUSE OF CANCER

It happens every time a sunburn heals and every day in hair follicles: A cell makes a full copy of its chromosomes before dividing into two daughter cells, each with a complete set of genes. It sounds routine, the stuff of biology 101.

> "Cancer is many different diseases, each of which gives rise to cell proliferation. Yeast is a perfect model to bridge mutation and mechanism."–Bik Tye

"It's actually the most dangerous time in a cell's life cycle and therefore very strictly regulated," said Bik Tye, professor of molecular biology and genetics. "If mistakes occur in the process of copying the DNA, the errors become permanent and are passed on to all future cells."

Mistakes in DNA lead to many diseases, perhaps most notoriously to cancer. Tye, who joined the Cornell faculty in 1977, has made a career of identifying the genes that regulate DNA replication and understanding how they work and how they fail.

During this fundamental process in the life of a cell, humans and yeast have a lot in common, and Tye prefers to work with the "useful and simple" yeast. Her focus is the first step in the process of DNA replication, in which the double helix of DNA is melted into separate strands to form two templates for chromosome duplication.

Studies of mutant yeast with defective DNA replication pointed to helicase, a six-protein ring of enzymes named for its ability to unzip the double helix of DNA, and a class of enzymes called MCM proteins. More than ten MCM proteins have been identified to date—some of which form the helicase ring—and Tye is currently particularly interested in two: MCM10 and MCM4.

When the genome is prepped for duplication, helicase rings are recruited to thousands of sites along a chromosome, but only a fraction are used during cell division.

"The extra helicase rings become obstacles if they are not removed, and we discovered that MCM10 is the protein responsible for dissociating them," Tye said. "Yeast without a functional MCM10 end up with DNA damage throughout the genome where the active helicase 'tripped' over the unused helicase rings."

MCM4 is another gene that, when mutated, has dire implications for genome stability. Tye's Jackson Laboratory colleague John Schimenti, now professor of genetics at Cornell's College of Veterinary Medicine, identified a mutation in MCM4 that caused a high incidence of aggressive mammary cancer in mice.

"We wondered, what would happen in a simple organism, one without even breast tissue?" Tye said.

It resulted in yeast populations rife with large-scale genomic rearrangements: extra chromosomes, missing chromosomes, and counterfeit

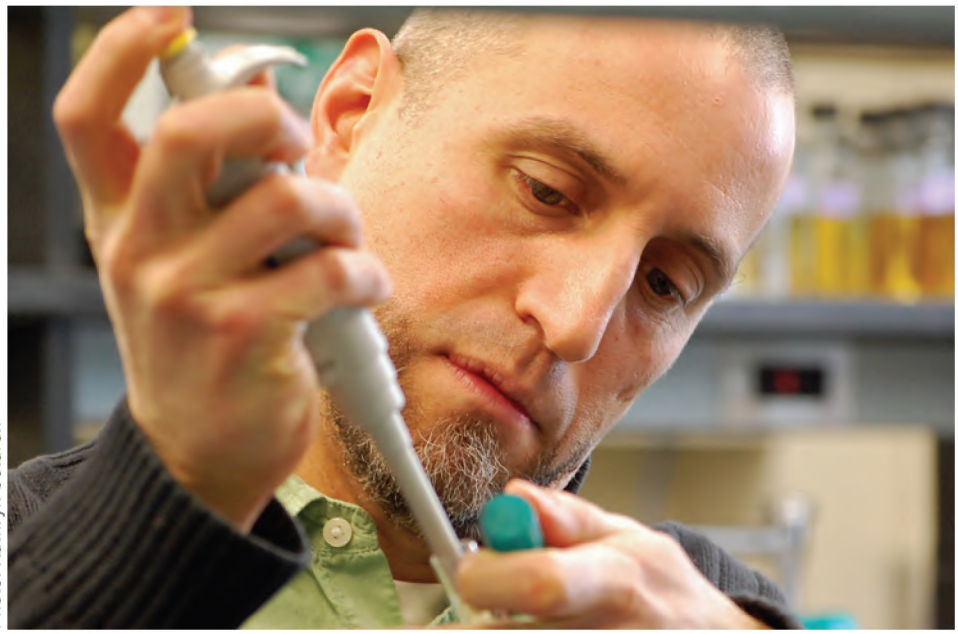


Photo: Kathryn Coldren

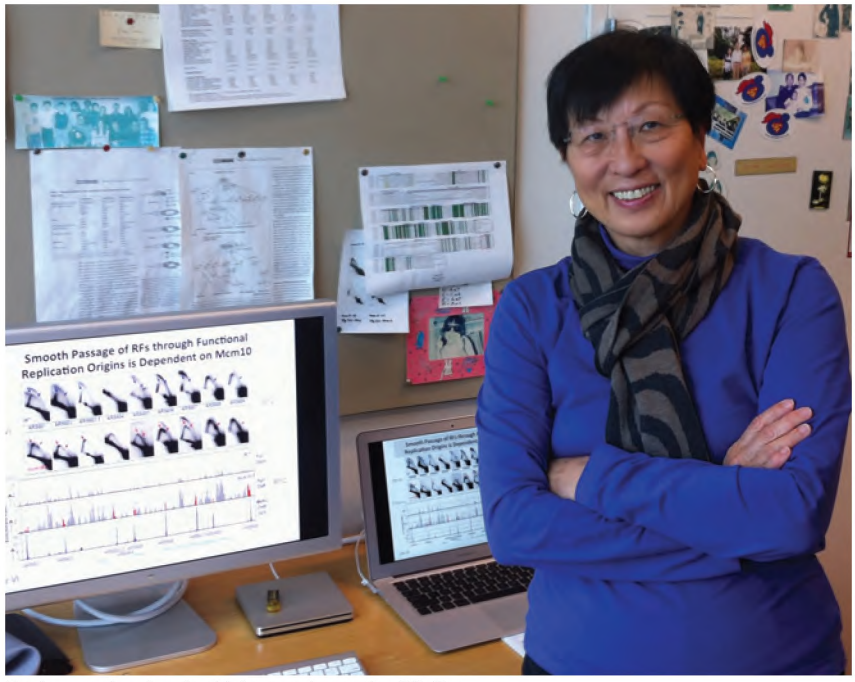
Associate professor of microbiology Joseph Peters finds microbes intriguing because they evolve in a different way than most other organisms. "Now that genome sequencing is less expensive, we are able to appreciate that microbe evolution is driven by a lot of swapping of genetic information between different microbes," he said. "This is key to their ability to degrade anything made on the planet. They can quickly get new combinations of genes via swapping."

copies of particular genes or segments of chromosomes. In other words, echoes of the genetic hallmarks of cancer. In addition, many of the mutated yeast strains reproduced more quickly, like tumors.

"We demonstrated in a follow-up study that the excessive growth was not linked to the chromosomal rearrangements themselves, but rather a faulty MCM4 gene can be thought of as a 'cancer susceptibility' gene," Tye explained. "It causes an uptick in the incidence of small mutations, which do lead to cancer."

Armed with proof of principle that a complex disease can be dissected in a simple model organism, Tye hopes that yeast can help guide the search for cancer genes.

"Cancer is many different diseases, each of which gives rise to cell proliferation," Tye said. "A common approach now is to sequence tumor genomes. But researchers find thousands of mutations, making it difficult to separate the signal from the noise, and impossible to provide proof, only guilt by association. Yeast is a perfect model to bridge mutation and mechanism."



Professor of molecular biology and genetics Bik Tye.

FROM DNA TO CELLS AND GELS

While many researchers focus on DNA as genetic material, professor of biological and environmental engineering Dan Luo values the molecule as a generic material, a Lego for building new polymers. He is tapping its potential to construct materials with novel properties that could revolutionize disease diagnostics, therapies, and even computing.

As a Ph.D. student, Luo studied DNA topology and the enzymes that regulate it. As a postdoctoral associate, Luo hunted for synthetic polymers appropriate for delivering DNA within the body for gene therapy and vaccines.

"I realized that DNA itself is a polymer," Luo said. "And its chemical, physical and biological properties could potentially outperform existing polymers."

As a molecule, DNA has several biologically-friendly characteristics. It's soluble in water, very stable at hot or cold temperatures, and biodegradable and biocompatible.

"That last point is very important for pharmaceutical applications," Luo said. "The body can degrade it easily, and it's non-toxic—we eat DNA every time we eat anything, from salad to sushi."

It's also an engineer's dream material. The molecule's length can be controlled with sub-nanometer precision, its composition can be synthesized to a researcher's specification using the four types of DNA letters, and it can be precisely manipulated—cut, rejoined and edited—with more than 4,000 enzymatic tools. In addition, it can be either rigid or flexible depending on its length, like a cooked spaghetti noodle.

What was not an engineer's dream was DNA's molecular shape. In nature, DNA is found primarily in only two topologies: circles and straight lines. One of Luo's first graduate students, Yougen Li, M.S. '03, was able to coax DNA into Y-shaped trees, after which the Luo group used an enzyme to link DNA trees together to form networks. They are engineering these networks into a host of new, useful materials, including a new way to produce proteins without cells.

"Normally when you need a lot of a protein, you have to engineer bacteria or cells to produce it, which they do quite unwillingly," Luo said. "We can engineer a gene right into a hydrogel made of networked DNA, supply it with wheat germ extract, and the protein will be produced."

According to Luo, the advantage of the cell-less system is not just higher quantities of protein. The approach can be used in conditions that finicky microbes can't tolerate, such as in extreme pH, or to make products that would be toxic to them, like antimicrobial peptides.

In the December issue of Nature Nanotechnology, Luo and his group published results of a new meta-gel that had surprising properties. By using a special enzyme with a clever design of self-replication, the DNA that formed the gel is a 3-D entangled network that flows like a liquid, but when placed in water it returns to the shape of the container in which it was formed, reminiscent of the T1000 material in the movie Terminator II.

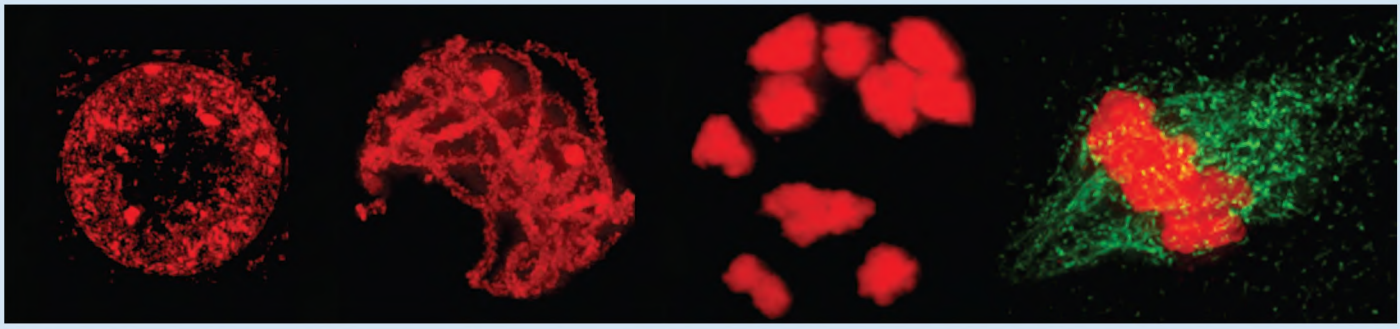
"In combination, these properties could be immensely useful in situations where drug delivery can be enhanced by shape," Luo explained. "For example, to kill remaining cancer cells after removal of a tumor, the gel could flow to the cavity and be triggered to fill the open space and maximize contact."

Binding the DNA polymer to other materials offers many opportunities for invention. Luo and his group are currently developing new, highly portable "point of contact" disease diagnostics with funding from the Bill and Melinda Gates Foundation. Inside the portable diagnostic, the DNA polymer will bind to specific pathogen targets and self-amplify without any enzymes.

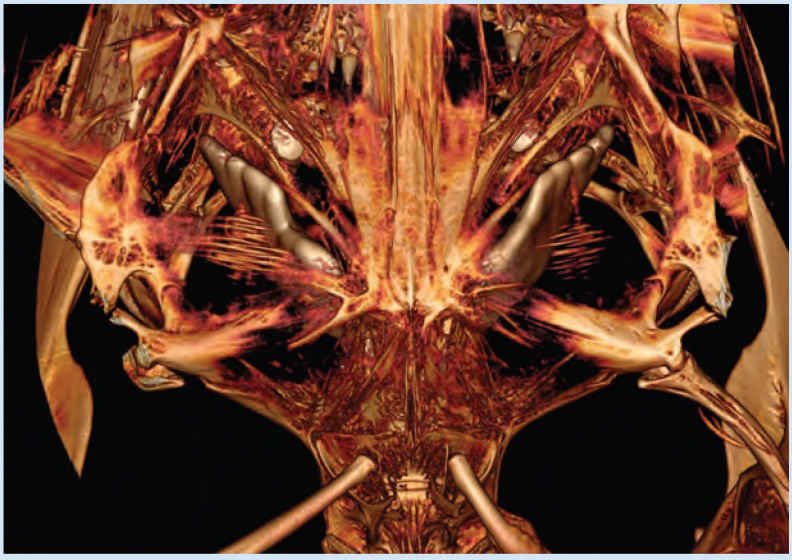
"This would bring diagnostics out of the lab and to the bedside and battlefield," Luo said. "The impact could be particularly significant in resource-limited environments."

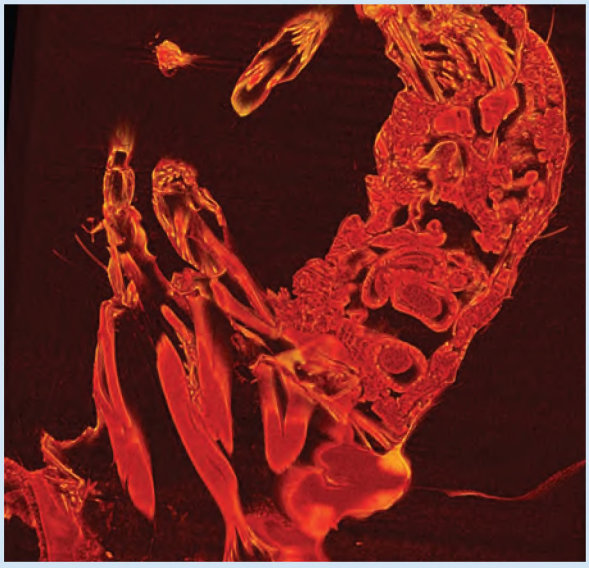
By combining Luo's DNA polymers with nanoparticles, sized between 1 and 100 nanometers (less than one tenth of a millionth of an inch), researchers are able to create new materials for many engineering applications, such as nanowire, nanosheets and nanocrystals where DNA provides the organization structure. For example, plasmonics, the manipulation of electrons with light or "light on a wire," using DNA-nanoparticle structures could eventually land on a desktop near you.

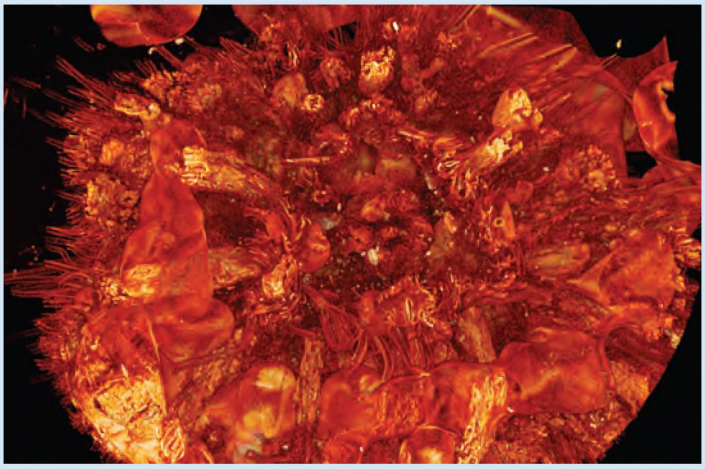
TOOLS OF THE TRADE: INSIGHTS FROM IMAGING

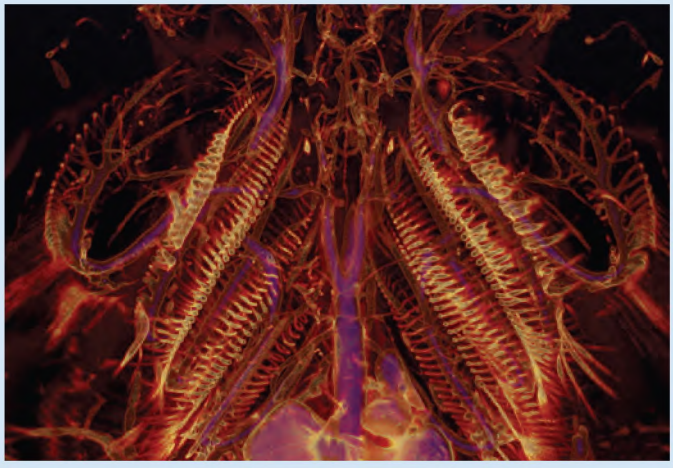


Associate professor of plant breeding and genetics Wojtek Pawlowski studies the choreography of inheritance during meiosis, a specialized type of cell division that leads to production of sperm and eggs. The resulting cells have half the normal number of chromosomes, and each chromosome is a unique mosaic of genes from mom and dad. Pawlowski watches the behavior of chromosomes during meiosis using a method called three-dimensional deconvolution microscopy. For each image, chromosomes are stained with a fluorescent dye (red) that binds to DNA, and several optical sections are combined to make a three-dimensional representation of the cell. Shown from left to right above, DNA is mostly dispersed and unorganized at the beginning of meiosis; it condenses into long threads that consist of matching chromosomes from mom and dad wrapped around each other; then the chromosomes compact to form small round bodies. Finally, chromosomes from mom and dad separate, pulled apart by a filamentous protein called tubulin (green). "In this type of research, seeing really is believing," said Pawlowski's graduate student Samantha Mainiero. For more on Pawlowski's work, see page 17.









Cornell's CT Imaging Facility in the basement of Weill Hall is extending the boundaries of what's possible in the realm of 3D non-invasive X-ray CT (computed tomography) imaging. From the head of a great white shark to a fruit fly, research engineer and facility director Mark Riccio, B.S. Eng. '92, M.S. Eng. '99, uses two state-of-the-art machines—the GE CT120 and Xradia VERSA XRM-500, acquired in 2008 and 2011— to help researchers conduct studies that were previously impractical without the use of a synchrotron, or simply impossible without destroying the sample or specimen. The machines can image objects less than 10 mm in size, with resolution as fine as 600 nanometers (1/50th the width of a human hair). The X-rays can be set weak for soft tissue or strong enough to penetrate materials, rocks and fossils. Images created for CALS researchers include: the interior of a midshipman fish to understand three-dimensional internal structures for Andrew Bass, neurobiology and behavior (pictured, top left); fruit fly torsos to study infectious disease for Angela Douglas, the Daljit S. & Elaine Sarkaria Professor of Insect Physiology and Toxicology (pictured, top right); a 70,000,000-year-old flower trapped in amber for William Crepet, plant biology (pictured, bottom left); and the vascular system of a sturgeon to study evolutionary forces in anatomy for Amy McCune, ecology and evolutionary biology (pictured, bottom right). "CT scanners are transforming the questions we can ask—and answer—in research," Riccio said.

MODEL BEHAVIOR

Simplicity is an ally for researchers studying the mechanisms of fundamental biological processes. Some of our diminutive domestic companions—bakers' yeast, the fruit fly, the mouse and the weedy arabidopsis—may mean big breakthroughs for CALS scientists tapping into their potential as model organisms.

By Sarah Thompson • Photos: Kent Loeffler

MUS MUSCULUS (THE HOUSE MOUSE)

Mankind and mouse are inextricably linked. Nearly every gene in the mouse genome has a counterpart in that of humans, and our organs and bodily systems work in similar ways. Like humans, mice are social mammals who care for their young, can learn, and are flexible in their behavior. They also develop diseases, such as hypertension and type 2 diabetes, in a similar way to humans. But what makes mice so indispensable for human biological research is how easily and precisely they can be genetically manipulated, with the resulting effects studied in the context of a whole living organism.

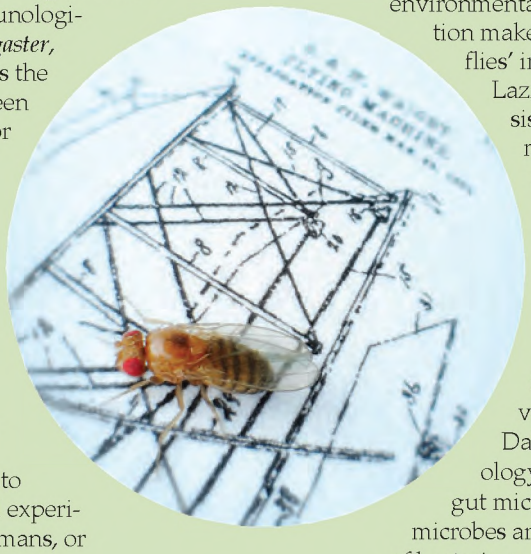
David McCobb, associate professor of neurobiology and behavior, uses mice to study animals' stress response and how it interacts with sex and species differences. Chronic stress can adversely affect every system in the body. According to McCobb, the problem is that humans' stress response evolved to trigger emergency reactions to acute threats. "But because we live longer and are less likely to be devoured by lions, our well-being is related more to how we deal with chronic threats, real or imagined," he said.

McCobb has found that cells in the adrenal gland of female mice are equipped to secrete adrenaline at higher rates than those of males, likely because females have higher levels of glucocorticoids, or stress steroids. But in male mice, more habitual aggressive behavior is probably driven by noradrenaline, a less intense relative of adrenaline. "In humans under chronic stress with elevated stress steroid levels, elevated adrenaline secretion—similar to that seen in female mice compared to males—may contribute to depression. These studies are part of the bigger picture of learning how to regulate our stress response better on a day-to-day basis," McCobb said.

Robin Dando, assistant professor of food science, is using mice to study how obesity changes animals' sensitivity to certain tastes. To do this, Dando will test different genetic strains of obese mice, each exhibiting different obesity-related

DROSOPHILA MELANOGASTER (FRUIT FLY)

Be careful which fly you swat. It could hold the genetic keys to unlocking the secrets of tissue regeneration or chronic metabolic and immunological diseases. *Drosophila melanogaster*, commonly called the fruit fly, is the one you should spare. It has been used as a model for research for more than a century, mostly because of its small size, fast development, and ability to lay thousands of eggs per year. Today, genetics and developmental biology researchers are attracted to the fruit fly's compact and easily manipulated genome, as well as its extensive genetic resources. Most importantly, the fruit fly allows researchers to conduct mechanistic biological experiments that can't be done in humans, or even in mice.

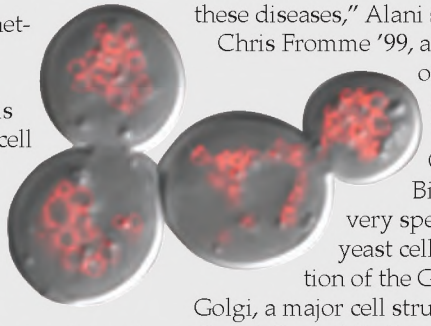


Brian Lazzaro, associate professor of entomology, understands the benefits of these insects in studying the genetic basis of immune system performance. Lazzaro has found that flies vary greatly in their ability to fight infection, due to both genetic and environmental reasons. High-sugar diets and nutrient deprivation make flies more susceptible to infection, while female flies' immunity drops significantly after mating. The Lazzaro lab is interested in deciphering the genetic basis for such unexpected interactions, many of which may also hold true in other animals, including humans. "This is where model systems really have an advantage," Lazzaro said. "Through these studies we're getting at mechanisms, including possible hormonal linkages among traits."

Our microbiota—the bacteria living in and on our bodies—affect our health and wellness. However, these relationships are difficult to study in complex organisms with highly diverse and variable microbiota. This led Angela Douglas, the Daljit S. and Elaine Sarkaria Professor of Insect Physiology and Toxicology, to turn to *Drosophila* to study how gut microbes affect nutrition. She found that fruit fly gut microbes are more stable and less diverse, with just five types of bacteria accounting for 90 percent of the total. When she grew germ-free flies, Douglas got a surprise: The flies weren't terribly

BAKER'S YEAST

Saccharomyces cerevisiae, or baker's yeast, is a cheap date. This single-celled fungi is low maintenance, microscopic, reproduces in under two hours, and has a small, completely sequenced genome.



Eric Alani, professor of molecular biology and genetics, is using it to help him answer a fundamental biological question: What is the role of genes in how a cell behaves? He is studying yeast cell "spell checker" proteins, which monitor cell reproduction and DNA replication, identify errors, and remove them before they become permanent after cell division. According to Alani, these highly conserved proteins—seen in bacteria, yeast, and humans—play a major role in maintaining genome stability. Defects in spell checker proteins have been identified in hereditary forms of colorectal and endometrial cancer. "However, there remain inherited colorectal cancers for which the underlying genetic defects are not known. Part of my lab's work is to identify the mutations associated with these diseases," Alani said.

Chris Fromme '99, assistant professor of molecular biology and genetics in the Weill Institute for Cell and Molecular Biology, generates very specific mutations in yeast cells to study the function of the Golgi apparatus. The Golgi, a major cell structure, is the cell's Grand Central Station–sorting proteins out to different locations in the cell. Mutations in Golgi proteins give rise to many human diseases. Fromme has identified a positive feedback loop by which different proteins interact to regulate the master molecular switch that turns the Golgi on and off.

"These same proteins in yeast cells are found in humans, so the assumption is this works the same in humans," Fromme said.

Assistant professor Marcus Smolka, another member of the Weill Institute, developed a new technology to better study how certain signaling proteins, called DNA damage checkpoint kinases, prevent cells with damaged DNA from dividing. Smolka identified one particular protein, Slx4, that kinases regulate in yeast cells. Initially thought to exist only in yeast, Slx4 has now been found in humans. It appears to have a major impact on the development of Fanconi anemia, a cancer predisposition syndrome. "If you are addressing a fundamental biological mechanism, it will eventually have an impact on humans," Smolka said.

symptoms, to find molecular evidence for these changes in the taste bud itself. For Dando, mice are ideal surrogates for the study of human feeding. Like humans, they are drawn to sweet, salty and protein-rich food; if fed a steady diet of these, mice—just like us—will get fat. But they can also slim down by exercising more and eating less. "However, a mouse will reach maturity in a matter of weeks, thus giving us access to a whole lifetime of data in a fraction of the time the study would take in humans," Dando said.

sick, but they had very high blood sugar and fat levels—the same traits seen in people with insulin resistance. Douglas is continuing experiments to see which of the fly's five main gut microbes are important for controlling fat and blood sugar levels.

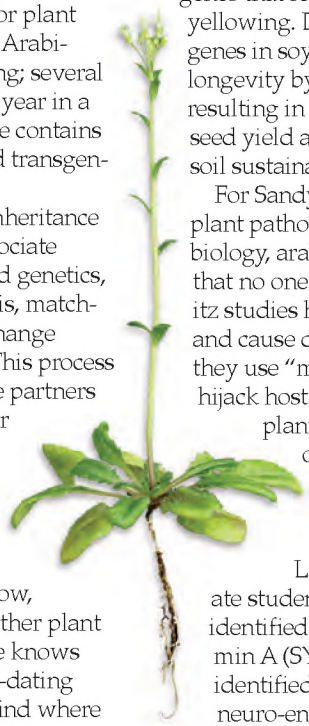
Nicolas Buchon, assistant professor of insect immunology, also uses the fruit fly to study how the gut controls its own microbes, both good and bad, and how microbes affect the gut. Buchon found that bacterial infection changed the rate of cell turnover in the gut, which is powered by stem cells—specialized cells that can generate new cells of different tissue types. Buchon discovered that stem cell growth was ten times higher in infected flies, a clear demonstration that microbes can impact the division rate of stem cells, which could in part explain how microbes affect cancer initiation and progression.

ARABIDOPSIS THALIANA

Arabidopsis is a small unassuming plant, but it has power in numbers. In the past 20 years, scientists have rallied around arabidopsis as a main model for plant biology and genetics research. Arabidopsis is small and fast growing; several generations can be grown in a year in a small space; its concise genome contains almost no repetitive DNA; and transgenics and mutants abound.

To better understand how inheritance works, Wojtek Pawlowski, associate professor of plant breeding and genetics, studies meiosis. During meiosis, matching pairs of chromosomes exchange parts before recombination. "This process of finding correct chromosome partners is extremely important in order for inheritance to work," Pawlowski said. In meiosis, the genome does what Pawlowski describes as "a rock-and-roll dance," where chromosomes mix together. Now, by studying arabidopsis and other plant species, Pawlowski believes he knows why: "We think this is a speed-dating protocol for chromosomes to find where their appropriate parts are. We have evidence that this is in fact what's happening during meiosis."

Susheng Gan, associate professor of horticulture, is interested in how leaves are programmed to die. Since their main function is photosynthesis, the longer leaves stay green, the more sugars and other nutrients the plant can synthesize to fill seeds, store as biomass, or help root nodules live longer to fix more nitrogen in the soil. Using arabidopsis strains lacking certain genes, Gan identified several genes that regulate senescence, or leaf yellowing. Disabling one of these genes in soybeans increased leaf longevity by more than one week, resulting in a 44 percent increase in seed yield and significantly increased soil sustainability.



For Sandy Lazarowitz, professor of plant pathology and plant-microbe biology, arabidopsis opened doors that no one knew existed. Lazarowitz studies how viruses infect plants and cause disease, specifically how they use "movement proteins" to hijack host cell pathways to cross plant cell walls and infect other cells. While investigating the host proteins that work with these movement proteins, Lazarowitz and her graduate student Jenn Lewis, Ph.D. '05, identified one protein, Synaptotagmin A (SYTA), that had only been identified in animal brain and neuro-endocrine cells.

"When we identified SYTA in plants, people's reaction was, 'But plants don't have brains!'" Lazarowitz said. "Further studies revealed that SYTA regulates the cell-to-cell spread of a variety of plant viruses from diverse families. We now have the potential to engineer broad-based resistance to quite different, distinct plant viruses."

The COLLECTORS

The 16th century Wünderkammer ("wonder chamber"), known also as a cabinet or room of curiosities, was the progenitor of the modern museum, a way for those fascinated by the wonders of the natural world to collect and codify such marvels. The College of Agriculture and Life Sciences is home to a number of extensive teaching and research collections, many of which benefitted from such personal collections, and all of which are inspiring and informing scientists today. These stylized images pay homage to the history of several of these magnificent collections while the accompanying text explores their modern-day missions. Discover more at periodicals.cals.cornell.edu.

IN THE CABINET:

Top to bottom and left to right: *Attacus atlas* (atlas moth); the network view of the protein interactome in the budding yeast *S. cerevisiae*; *Ectopistes migratorius* (passenger pigeon); *Carcharhinus limbatus* (blacktip shark) from the Bimini Islands; *Ganoderma tsugae* (a conk fungus); book selections from the E. F. Phillips Beekeeping Collection and Isabel Zucker Language of Flowers Collection; *Letharia vulpina* (wolf lichen); cycad leaf (Eocene period); book selection from the James E. Rice Poultry Collection; Rhacophyton (Devonian period); *Lodoicea maldivica* (Coco de Mer); *Daedalea quercina* (a shelf fungus); and an early 1950s Magnemite 610E reel-to-reel recorder.

TINA CORMIER & ELLEN LEVENTRY '95 • PHOTOS BY ROBYN WISHNA

CORNELL UNIVERSITY INSECT COLLECTION

The Cornell University Insect Collection is the largest collection of its kind at a land grant institution and dates back almost as far as the university itself. In 1871, John Henry Comstock started the collection in his room in the tower of McGraw Hall while teaching entomology classes as a sophomore. Today, the 7-million-specimen repository resides in a modern, temperature- and humidity-controlled facility in Comstock Hall. • While the current collection benefitted greatly from the adventures of H.H. Smith, a 19th-century professional bug wrangler, it is also the direct beneficiary of the global travels of Cornell's professors—just one example of the university's early engagement as land grant to the world. The collection is home to specimens from every continent, excluding Antarctica, with roughly 20 percent of the world's described insects—200,000 species—represented. The holdings also include about 8,000 "type specimens," priceless archetypal examples that serve as permanent references for species. Collection manager Jason Dombroskie described the collection as "a library of corpses in a lot of drawers"—16,500 drawers, to be exact. • Professor James Liebherr, M.S. '74, the curator and self-proclaimed "mother hen" of the collection, emphasized its historical and contemporary significance as a permanent repository of biological information. "This is long term, this is culture, this is a catalogue of life on Earth," Liebherr said. It's a catalogue that includes several significant extinct species such as the Rocky Mountain locust, the pest responsible for a plague that effectively eclipsed the sun for five days over parts of the Midwest and Great Plains in 1875. • Given the worldwide coverage of the collection, it has gained prominence for insect identifications of all kinds, especially invasive species and agricultural pests. Each year, interested citizens send in hundreds of samples for identification; a member of the public even submitted the first recorded Asian longhorn beetle in New York.• While Dombroskie and Liebherr disagree on their favorite insects (small moths and ground beetles, respectively), they do agree on the privilege of carrying on Comstock's legacy and the importance of taking the collection out of its four walls and making it available to everyone via the web.

James Liebherr and Jason Dombroskie

PLANT PATHOLOGY HERBARIUM

Thanks to a series of complex extrapolations, scientists believe that 95 percent of fungi are yet to be named. Of the scant five percent of lichen, mushrooms, molds and other fungi that have been documented, Cornell University's Plant Pathology Herbarium has more than 400,000 specimens, including at least 7,000 "type specimens"—the first of their kind ever described. • Founded in 1907, it is one of the largest mycological collections in North America. According to curator Scott LaGreca '91, one of its strongest assets is its long history of documenting fungi that destroy agricultural crops and have a huge impact on the economy. "Today's scientists can track the spread and spatial patterns of plant disease going back to the 1800s," he said. This historical record provides invaluable data for those studying the evolution of plant pathogens, and it aids ecologists in their study of climate change. Mushroom fruiting is highly sensitive to subtle changes in the ecosystem, and climate scientists can look at mineral deposition in lichens to identify pollution patterns. • The collection also has a lot of "little treasures," according to professor of mycology and director Kathie Hodge, M.S. '93. Ph.D. '98. Her favorites include those collected by a group of Cornell geology students who joined arctic explorer Robert Peary during his 1896 expedition to Greenland and some fungi that prey on insects. "They turn ants into zombies," she enthused. • The collection's staff work to open up the mysterious world of fungi to everyone through activities such as educational walks and fungus identification contests. They also enjoy identifying specimens that are sent in by the public. Blurry cell phone photos accompany questions like "Can I eat this?" or "My dog just ate this, is it poisonous?" • Hodge and LaGreca, like other CALS collectors, are undertaking an epic effort to digitally database and photograph the entire archive of dried and pressed fungi. "We've been sitting on a vast warehouse of data. Until now, only specialists could really get at it," Hodge said. She expects the collection to be online within the year and is excited to see generations of work by her predecessors become widely accessible.

Scott LaGreca

CORNELL UNIVERSITY MUSEUM OF VERTEBRATES

The Cornell University Museum of Vertebrates' (CUMV) four miles of shelves are enough to hold only part of the 1.3 million individual fish, 58,000 bird, 37,000 mammal, and 52,000 reptile and amphibian specimens in the worldwide collection. Known for its extraordinary breadth, the collection holds over half of the world's known bird species in addition to its other assets. As collections manager Charles Dardia '92 likes to quip, "If it has a backbone, you can probably find it here." • Housed at the Imogene Powers Johnson Center for Birds and Biodiversity along with the Lab of Ornithology, the museum's roots date back to the founding of the university in 1865. It began as a combination of specimens brought back from global expeditions and gifts of personal collections such as that of Louis Agassiz Fuertes, famed American ornithologist, illustrator and artist. • Visiting scientists, Cornell students and scholars at other institutions use the collection to address myriad mysteries and answer questions about evolutionary and ecological shifts and leaps. A bat's fur can shed light on migration patterns; a salamander's spots can provide an indication of pollution levels; a bird's feathers can reveal information about its diet decades after it has died. The U.S. Geological Survey currently uses the collection to track the spread of invasive species. • "Museums are not dead places that should be forgotten–they are active and alive," Dardia said. And the CUMV is more vital than ever thanks to constant innovation in technology. Unlike in the collection's earliest days when only a skull and pelt were kept for physical examination, multiple tissue samples and complete skeletons are preserved for DNA analyses. Now even the oldest specimens can reveal new information. "When specimens from the 1800s were collected, methods for molecular-level genetics did not exist," explained Kim Bostwick '92, a research associate in ecology and evolutionary biology and the collection's curator of birds and mammals. "Yet because of this collection, we can ask these questions 200 years later. Centuries from now, we'll be able to answer questions we can't even begin to fathom today."

Kim Bostwick and Charles Dardia

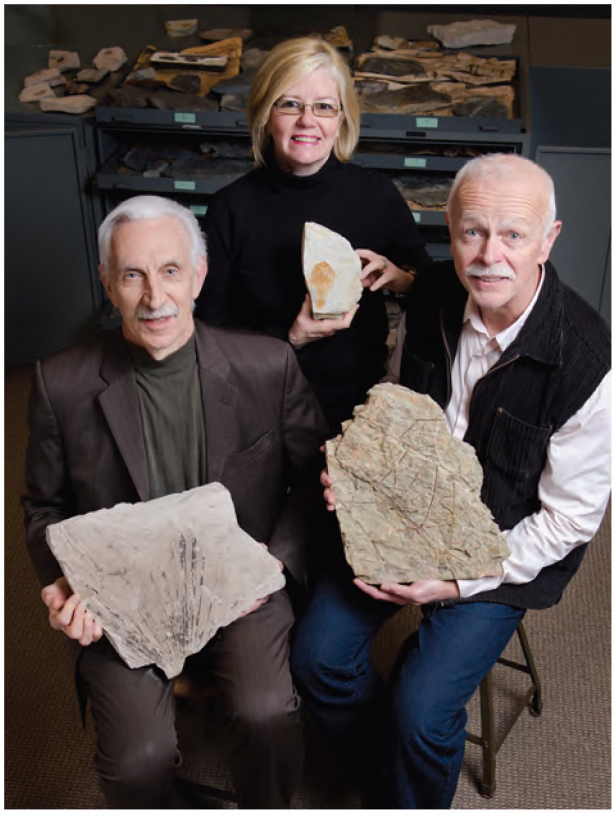
MACAULAY LIBRARY

Seventy-five-hundred hours: that's almost an entire year and, according to ornithologist and director Michael Webster, Ph.D. '91, the time it would take to listen to all of the Macaulay Library's online recordings of birds, bugs, and most anything with a backbone. • Part of Cornell's Lab of Ornithology, a CALS affiliate, the archive is the world's oldest and largest collection of wildlife sounds, with more than 225,000 audio and video recordings of insects, mammals, fish and frogs, as well as 75 percent of the world's bird species. "What's really incredible is that it represents the voices of the world, carefully catalogued for the next generation," said curator Greg Budney. • The collection has amassed recordings of almost 10,000 species through a long-standing collaboration between the scientific community and amateur animal observers, demonstrating the invaluable role of citizen-scientists in discovery. The holdings even include video and audio of extinct species, like the imperial woodpecker and the golden toad. "People can actually listen to and watch animals that are no longer with us—a glimpse into the past. It's an amazing thing," Webster said. • One of the oldest collections on campus, it is now a technological pioneer thanks to what Webster calls "Macaulay 2.0," an initiative to build a global digital network to collect recordings and make them instantly accessible to the world. "What was once only on our shelves is now online—80 years of expertise from some of the finest field biologists of our age," Budney added. • They are also building advanced tools for seeing sounds. Developments in sound visualization software "turn sounds into numbers, and when you can do that, you can analyze them," Webster explained. • While nearly 600 scientific publications have utilized the library's recordings, the collection has a wide range of uses beyond the ivory tower. Teachers, conservationists and general enthusiasts visit the repository repeatedly and regularly. Even Hollywood has come a-calling: the scream of Fawkes the phoenix in *Harry Potter and the Chamber of Secrets* came from the Macaulay Library.

Greg Budney and Mike Webster

PALEOBOTANICAL COLLECTION

The specimens in Cornell's Paleobotanical Collection are as old as the hills—in many cases older. The collection's oldest fossils, curated by Liberty Hyde Bailey Professor of Plant Biology Karl Niklas, date back 300 million years to the Devonian period, when land plants first evolved. The younger specimens, 50- to 90-million-year-old Cretaceous and Tertiary flowering plants from North America and parts of South America, were gathered by William Crepet, chair of Plant Biology and founder-director of the collection, and Alejandra Gandolfo, senior research associate in Plant Biology. • To date, the Cretaceous collection contains more than 80,000 charcoalified and amber fossils from the time when flowering plants first began to dominate the Earth; fossilized flowers make up 75 percent of the collection. • "In terms of importance, flowering plants are dominant in species numbers by almost an order of magnitude amongst terrestrial plants," Crepet explained. "They are critical to medicine, agriculture, maintenance of the climate, and anchor the land-based food chain. We can't exist without these plants." • Yet the circumstances of their origin and rise to dominance are still mysteries. Answers may lie in the fossil record, and it may be the flowers that provide those answers. Until recently, flowers from those eras were thought to be so rare that scientists focused mainly on fossils of leaves, which have fewer informative features. Crepet and a team of Cornell researchers turned that idea on its head when they discovered scores of fossilized flowers—including early relatives of oaks, melons, arabidopsis, pitcher plants and magnolias—in an abandoned clay mine in Sayreville, N.J., once a tropical forest. • CALS scientists and students analyze the collection to answer questions not only about the evolutionary origins of flowering plants, but also to discover important linkages among ancient and modern species, and to provide insight into how past, present and future climate change may affect Earth's flora and fauna. And they are leveraging modern technologies to do so. Using CT scans and software that creates three-dimensional models by digitally stacking two-dimensional, cross-sectional images, they are able to pull new information out of the geologic gems (See page 15). • Many of the images are available through the collection's online database.



William Crepet, Alejandra Gandolfo and Karl Niklas

LIBERTY HYDE BAILEY HORTORIUM

Where on campus can you see exotic flora from Captain Cook's first voyage to the South Pacific and an aquatic plant collected by poet Henry David Thoreau? The Liberty Hyde Bailey Hortorium, one of the largest collections of cultivated plants in the world and home to wild plants from every continent, specializing in palms, sedges (grass-like plants), bryophytes (nonvascular land plants) and oaks. • The word "hortorium" means "things of the garden." Liberty Hyde Bailey, the first dean of the College of Agriculture and Life Sciences, coined the term in 1935 when he gave his dried plant collection and horticulture library to Cornell. • It now boasts nearly one million specimens, and it is the premier collection of oaks in the world and one of the two great collections of palms in the world. Naturally, a collection of its size includes a few adored oddities, such as the unexpected coconut received in the 1930s. It came in the mail without box or wrapping, a stamp affixed to the shell and a hand-painted address made out to "Chief Palmist." Unusual packaging, perhaps, but not an unusual occurrence. • One way the Hortorium serves Cornell's land grant mission is by identifying rare species, weeds and toxic plants for the public, said curator Kevin Nixon, professor of plant biology. In fact, the local hospital has summoned Nixon to identify a toxic plant eaten by a child, and the College of Veterinary Medicine has called on Anna Stalter, associate curator and extension botanist, to identify seeds from the stomach of a sick cow. • The collection also supports scientific inquiry of many types, including the use of specimens, literature and images, explained Peter Fraissinet, assistant curator and librarian. Researchers, students, scientific illustrators and even amateur botanists can be found poking around the 900 cases of pressed plants. Nixon credited the collection's popularity with its breadth: "We have connections with so many areas of science—agriculture, ecology, taxonomy, horticulture, wild edible plants, invasive species, genetics, and the list goes on." In an effort to share its treasures with an even broader public, the Hortorium is in the process of digitizing and photographing its entire repository for online access.

Anna Stalter, Kevin Nixon and Peter Fraissinet

MANN LIBRARY SPECIAL COLLECTIONS

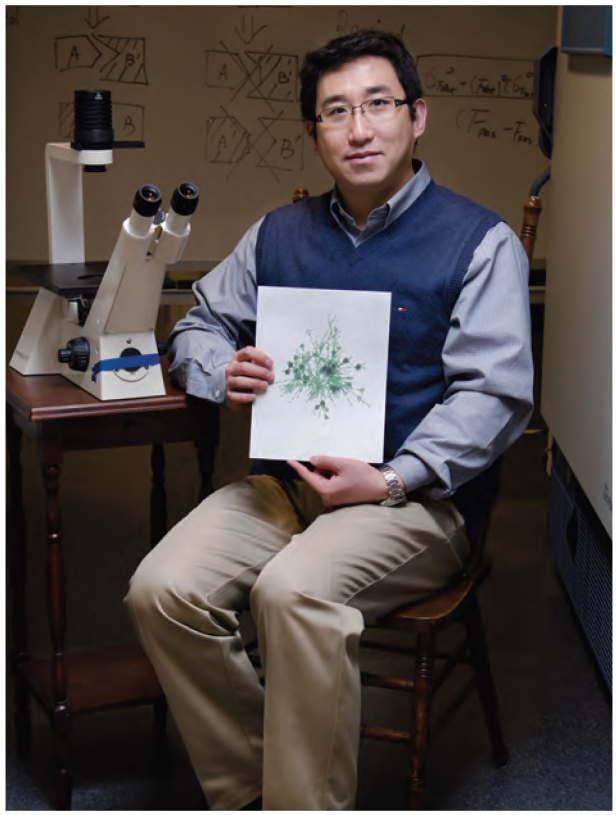
Deep in a vault within Mann Library reside some of the oldest, rarest and most valuable books in its collection, which is particularly impressive considering Mann is the largest academic agricultural and life sciences library in the United States. These time-honored treasures—the earliest dating back to the 1500s—provide history, culture and insight on topics ranging from entomology to fly fishing. • The E. F. Phillips Beekeeping Collection, established in 1925, is the most famous of Mann's special collections and the world's largest repository of books, journals, manuscripts and other documents on bees and beekeeping. Truly grassroots in origin, former Cornell professor Everett Franklin Phillips asked each New York beekeeper to donate the profits from one hive to finance the collection. • The Rice Poultry Collection, also considered the premier collection of its kind, contains more than 800 pre-1900 volumes on poultry science and game birds. Named after Cornell professor James E. Rice, the first professor of poultry husbandry in the U.S., the collection's books are extremely rare and beautiful, with elaborate illustrations

Linda Stewart and Frank Brown

of exotic-looking birds. • A favored collection of librarian Linda Stewart is Language of Flowers, which contains more than 170 books from Victorian-era Europe. Browsers can learn how the lilac, with its short-lived but beautiful blooms, symbolized the first emotions of love. "The use of flowers to express emotion is a fascinating custom," Stewart said. • Many of the materials in the special collections are considered part of the public domain, meaning they were published before 1923 and can be digitized and put online without violating any copyrights. Such efforts are currently under way for many of the often-requested volumes. • But it's not just the information contained within their pages that make the tomes within the special collections valuable to researchers. Many of the more than 14,000 volumes contain handmade paper, leather bindings, ornate engravings and hand-colored illustrations. Book conservation technician Frank Brown often finds that the artistry in a book's construction tells an important story of its own. "Each of these elements is like a view into another world," Brown said.

BINARY INTERACTOME DATASET

Some collections are evolving to digital and some are born digital. Haiyuan Yu, assistant professor of biological statistics and computational biology (BSCB), has been curating the Binary Interactome Dataset for the past decade, developing computational tools to mine it for the protein signatures of both human health and disease. • The human body has more than 20,000 proteins at work, and no protein is an island: they function within an extended network, the interactome, physically partnering with other proteins or binding to DNA to function. Missed connections due to changes in a protein's topography or chemical properties can result in disease. • Yu doesn't simply work with large datasets, the next wave of collecting. Like many of the other curators featured here, his work requires time and labor-intensive tissue sampling. A recent study of yeast cells required them, with help from their robots, to perform 36 million individual experiments. In humans, exploring such relationships means testing 400 million pairs of proteins to determine if they bind together. As Yu and his team of researchers map the interactome, they begin with



Haiyuan Yu

computerized models that prioritize which mutations are most likely to disrupt the network and result in a specific disease. They subsequently test misfit protein pairs in the lab to determine if the model-predicted outcome actually occurs. In one breakthrough, Yu's approach identified a small set of mutations that lead to higher likelihood of colorectal cancer. He said, "I'm not a doctor, but I'm much closer than just trying to solve some equations about the dynamics of protein interaction–down the line, our results can help people." • Yu looks to the future and how understanding the interactome can lead to new drug therapies and cures for disease. "Today, pharmaceuticals are sort of disconnected from molecular biology – most drugs are based on history and experience," Yu explained. In the coming years, he hopes to see more therapies harness the power of prediction developed from a molecular biology foundation. • The first and only collection of its kind in the world, the dataset will eventually be open to the public and prove an invaluable resource for biological and medical researchers.

CODE BREAKERS

By Krisy Gashler

What can a pattern tell us, or what it is trying to hide? From the scales of a butterfly wing to the words we use online, CALS researchers are deciphering patterns in evolution, growth and communication.

From iridescent blue stripes to rippling, startling eyespots, a butterfly's wings help it communicate with the world around it: go away, bird; come closer, potential mate.

Robert Reed, an associate professor in the Department of Ecology and Evolutionary Biology, and his graduate students go four-wheeling across the Andes and hiking through the Amazon, chasing butterflies. Some they pickle and use to extract DNA. Others are captured live and brought back for breeding and behavioral studies.

Their goal: to find the actual genes that have driven wing pattern diversification over the past several hundred million years.

"We have known for a long time that variation initially arises through genetic mutations, and that evolution is essentially a process of these mutations being sorted out in nature. What we know less about is exactly which genetic changes are responsible for which evolutionary innovations," Reed said. "Most mutations are just junk or worse—so what's the nature of the few mutations that end up being useful?"

In the lab, Reed's group uses gene expression screening and crossbreeding inheritance studies to pinpoint the exact DNA sequences that underlie evolutionary change in wing patterns.

They have made some astonishing discoveries. Although there are probably hundreds or thousands of genes involved in creating a butterfly's wing pattern, much of the dramatic variation that has arisen over the past 20 million years can be linked to just three genes.

"There are lots of different mutated copies of these genes floating around that have extensive, complex wing pattern effects," Reed said. "This begs the question: Why is it only these three genes, over and over and over again? What is so special about these genes? Why do they seem to encourage such rapid evolution?"

Reed is chasing those questions and others. How exactly do color pattern evolution genes work? How can single genes exert so much influence on complex patterns? How do some butterflies change their wing patterns according to season?

"Really, who would have thought that there would be so much to learn from butterfly wings?" Reed said. "It's serious science, but it's also seriously beautiful science."

NOISE AND NUCLEOTIDES

Alon Keinan mines data to find his patterns, which lie hidden in the vast diversity of the human genome. In doing so, the Robert N. Noyce Assistant Professor of Life Science and Technology in the Department of Biological Statistics and Computational Biology is making discoveries that expand our knowledge about human history and the process of evolution, as well as our understanding about genetic risk factors in modern complex diseases.

The human genome contains more than three billion individual nucleotides, coding for more than 20,000 genes that shape our identities, our morphologies and even our risk of Alzheimer's. Keinan mines the data from the genomes of tens of thousands of individuals and develops complex statistical methods to look for the signatures of something unusual, such as evidence of natural selection or deviations from a typical background level of diversity.

Keinan, a self-described "genetic historian," has used this approach to look all the way back to our human beginnings, to the evolution and eventual migration of *Homo sapiens* out of Africa more than 100,000 years ago.

"While history has only been able to bring us 4,000 years back, genetics allows us to look much, much farther back, into the evolution of our species and other species related to us," he said.

Comparisons between the X chromosome and the rest of the genome have provided particular insight. It carries genes for male and female traits, and studying the differences between sex-linked chromosomes in living people from different populations led Keinan's lab to discover that modern non-Africans have unexpectedly lower genetic diver-

"Really, who would have thought that there would be so much to learn from butterfly wings? It's serious science, but it's also seriously beautiful science." -Robert Reed

sity on their X chromosomes. Keinan suspects this is because more men than women left Africa; men carry a single X chromosome, but women carry two X chromosomes, giving them greater genetic diversity on chromosome X than men.

"Contrasting the level of genetic diversity on chromosome X with the rest of the genome points to the migration out of Africa being male-driven," Keinan said.

Keinan also investigates the patterns of genetic variation and mutation to gain insights into the way the human population has grown and spread. One of his recent articles in Science concluded that the explosion of human growth since the development of agriculture 10,000 years ago has left the current human population with far more genetic variation than previously believed—which could have implications for our risk of disease.

"This huge excess of genetic variation results in many mutations being unique to a few individuals or families," Keinan said. "In evolutionary terms, these mutations are so recent natural selection has not really had time to weed out the detrimental ones, so they are more likely than random mutations to increase our risk of developing certain diseases."

The sheer randomness and amount of variation in the human genome can obscure the genetic patterns that influence everything from disease onset to body type.

For example, height in humans is considered by many to be a simpler trait than disease risk, due to its high heritability: up to 80 percent of height difference is determined by genes. However, the almost 200 genes associated with height only explain variation of a couple of inches in the population, but adult human height can vary by feet.

"So the question is, where is the rest of the genetic contribution?" Keinan said. "This has been dubbed 'missing heritability,' the dark matter of heritability. We know height is supposed to be heritable, why don't we find all of the genetic factors? This is what motivates much of my research."

Keinan is working to separate the signal from the noise by offering solutions based on his background in statistics and computer science. His next investigation will involve a return to sex-linked chromosomes, this time with an eye toward understanding the patterns of gender disparity in aging-related, autoimmune and cardiovascular diseases.

Photo: Kathryn Coldren

The work of Alon Keinan, the Robert N. Noyce Assistant Professor in Life Science and Technology in the Department of Biological Statistics and Computational Biology, views modern human health through the lens of human evolution. "We are basically genetic historians, if you'd like, using DNA as a book," he said. "While history has only been able to bring us 4,000 years back, genetics allows us to look much, much farther back, into the evolution of our species and other species related to us." In 2012, Keinan was awarded New Scholar Award in Aging from the Ellison Medical Foundation for his outstanding promise in aging research.

PULSING PATTERNS

Irby Lovette has his finger on the pulse of patterns of genetic diversity, studying the evolutionary history of birds and other animals.

The associate professor in the Department of Ecology and Evolutionary Biology had his interest sparked at a young age while holding a bird as a nine-year-old. Now he has his hands in history and his sights on the future, aligning patterns of the past with modern ecology.

"Historically, ecologists studied present-day things, and evolutionary biologists studied the past, and they didn't talk to each other much," he said. "But we know that a bird's present behavior is a combination of the forces acting upon it right now as well as all the evolutionary forces that have molded it."

One goal of Lovette's research is to disentangle whether a behavior is a response to current environmental forces or an echo of natural selection over the eons.

For example, a walk in the woods around Ithaca can bring a bird watcher within range of six to seven distinct species of warblers, all using the same area in slightly different ways. Some feed on insects caught mid-flight, others on sap or insects on the trunk. Their preferred nesting sites can vary from the treetop to the forest floor.

If one of those species were to leave an area, Lovette would wonder whether it was because of changes to its current habitat or because it was so ecologically similar to another nearby species.

In most cases, evolution occurs slowly, but some species arise in a sudden burst of genetic creativity. These explosions of diversity are often triggered by an opportunity that unleashes many new species in a short time, such as the colonization of a new continent or expansion into a newly available habitat. Normally, the more species that already exist in a group, the less likely it is that they'll produce more.

In his studies of New World warblers, Lovette discovered that the small, insect-eating birds native to North, Central and South America were much older than first believed.

"This group of warblers pulsed twice: 15 million years ago, and again five to six million years ago," Lovette said. "This means that they are five million years older than we previously thought, with the first pulse predating the last Ice Age." These species therefore diversified long before North America resembled its current conditions, and the behaviors of these birds involves a relatively ancient evolutionary legacy.

Lovette is also contributing to the National Science Foundation's Tree of Life project, which is attempting to link together all the world's organisms into one complete evolutionary tree. His group linked together 850 species of birds, sampling DNA from wild birds and museum collections.

In addition to clarifying evolutionary relationships, the ambitious collaborative project will allow the experts to test evolutionary hypotheses about complex behaviors and traits, such as the commonly observed combination of drab plumage and ground nesting, and pinpoint when they arose in evolutionary time.

LEAFY LOGIC

From a daisy's ring of petals to the five points of a maple leaf, plants produce a diversity of patterns choreographed by genetic instructions and realized cell by cell. Professor of plant biology Michael Scanlon and assistant professor of plant biology Adrienne Roeder are probing the fundamental processes that drive plant patterning, including cell identity, cell size and spatial arrangement.

"Diversity is one of the main attractions of biology," Scanlon said. "How do plant species achieve the same goals using different mechanisms, and which genes have enabled plants to generate such diverse morphology?"

Scanlon analyzes the genetic similarities and differences across species to understand how plants have developed such similar functions, focusing on the stem cells that give rise to every organ in the plant.

For example, in order for plants to capture light most efficiently, they need to develop leaves—flattened surfaces with two distinct sides. In plants like tomatoes, stem cells work to initiate leaves, and from the very beginning, the cells have to pick a team: top or bottom. In moss, which evolved 400 million years ago, the plant achieves the exact same functional purpose, but with only a single cell layer.

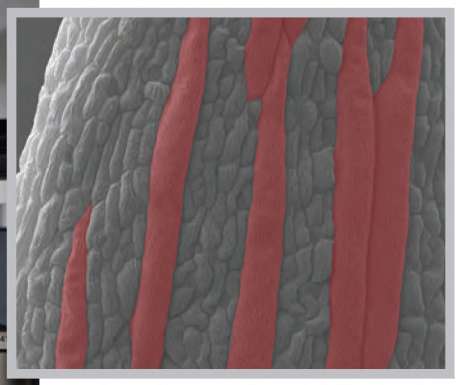
"Moss leaves are only one-cell thick, but they accomplish the same purpose as a tomato leaf," Scanlon said. "They use very different structures, but are they using the same genes? Or different genes? It's looking like a little bit of both."

Mutants—created in the lab or naturally occurring—are a valuable tool for Scanlon's team. Because they harbor genetic errors that disrupt the typical organization of the leaves, mutants can be exploited to identify genes and processes behind plant patterns. One mutant, called narrow sheath, disrupts the normal process that instructs cells to form leaves, resulting in a plant with extremely narrow leaves. It's a useful tool to identify genes involved in initiating leaf formation.

Adrienne Roeder focuses on an often-overlooked plant organ that is itself an ancient adaptation from the leaf: the sepal. These typically green, leaf-like structures protect the flower bud and form a collar below the open flower, and Roeder thinks they may hold clues to the genetics of identity and architecture in other plant organs as well.

"The sepal contains two types of

Photo: Kathryn Coldren



To understand the basics of cell identity and spatial arrangement, assistant professor of plant biology Adrienne Roeder looks to the sepal, the typically green, leaf-like structures that protect the flower bud. The scanning electron micrograph above shows a sepal with the giant cells, which can be 30 times larger than the small cells, colored red.

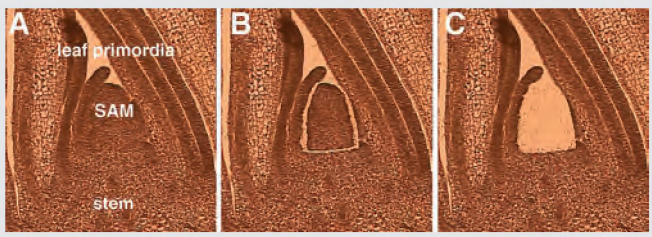
TOOLS OF THE TRADE: LASER CAPTURE MICRODISSECTION

Professor of plant biology Michael Scanlon works with plant stem cells within the shoot apical meristem, a structure the size of the ball in a ballpoint pen. A key tool for Scanlon and other CALS biologists is laser capture microdissection (LCM), a technology that affords researchers exquisite precision in their analysis of tissues and cells.

"We take very thin sections of our plant sample, place them on a slide, and the laser cuts the tissue and catapults the target off the slide and into a collection vessel," Scanlon explained. "It allows us to 'eavesdrop' on the RNA, proteins and metabolites in this tiny structure."

In January, Cornell's Biotechnology Resource Center added additional LCM capacity to its array of state-of-the-art instruments and services, including DNA sequencing, computational biology and advanced imaging (for more, see page 15).

"Researchers working with a range of multicellular organisms were clamoring for access to LCM," said Jocelyn Rose, director of the Cornell Institute of Biotechnology. "It's of interest to colleagues across the university, including many in CALS, because it allows us to ask questions at the cell and tissue level, and it's a 'front end' technology that can be followed up with isolation of the DNA, RNA, proteins or metabolites from tiny amounts of tissue."



cells, giant cells and small cells," Roeder explained. "The giant cells can be more than 30 times larger than the small cells, which allows us to ask both how does a cell know which type to become and how do they know where to form to create the pattern of giant and small cells?"

Her first breakthrough came as a postdoctoral scholar at The California Institute of Technology, where a rigorous protocol of sleepless nights examining living, growing cells under the microscope—every six hours for several days—paid off. She found that the giant cells simply weren't following the same rule as the small cells, which follow the traditional pattern of DNA doubling followed by cell division.

"The giant cells undergo a special type of cell cycle: they replicate their DNA, but they don't divide into two new cells, again and again," Roeder said. "They ended up much larger and with 16 times the amount of DNA."

Her work at Cornell has followed up on this finding, using mutants to identify genes involved in this unusual cycle. According to Roeder, sepals are not the only plant organ practicing DNA duplication without cell division.

"This also occurs in endosperm, the nutritive tissue inside a seed for the plant embryo, which is also the nutrition for us, since it makes up the bulk of a kernel of corn or a seed of wheat," Roeder said. "This process would be hard to study in the endosperm, but we hope research using the sepal will uncover basic principles that will be highly translatable."

READING BETWEEN THE LINES

The patterns within the language we speak can reveal our assumptions, biases and even criminal tendencies. Associate professor of communication Jeffrey Hancock studies our lies, from the fibs people tell on social media sites, to the language of psychopaths.

Hancock's interest in studying deception was sparked when he worked as a customs officer in Canada.

"For someone interested in deception, communication and psychology, the job was a voyeur's dream," Hancock said. He quickly learned not to trust stereotypes. "One little old lady I stopped had a box of Bibles in her trunk—with five handguns at the bottom, one of them loaded."

According to Hancock's research, if you want a window into someone's soul, don't look at their eyes, look at their Facebook profile.

In face-to-face interaction, people are only able to detect deception 54 percent of the time, mostly because there is no single cue that always indicates deception. In text-based communications, people are less distracted by non-verbal cues, and they have a written record to reference.

"On Facebook in particular, you can get caught up in a web," Hancock said. "You may have told one person one thing and another person something else, so you can get caught by someone else in your group."

For his studies on deception and psychopathy, Hancock works with Mike Woodworth, an associate professor of psychology at the University of British Columbia. Using computational linguistic analyses, Hancock and Woodworth analyzed word-use patterns in convicted psychopathic and non-psychopathic murderers.

They concluded that psychopaths give themselves away by their linguistic narcissism. Psychopaths use personal pronouns more than most people, and when describing heinous crimes, they spend a great deal of time talking about mundane personal details, such as what they ate and drank.

Hancock hopes this work will help law enforcement officials identify and interrogate suspects more effectively and with less bias.

"The people who are most confident in their ability to detect deception tend to rely on stereotypes and make a lot of mistakes," Hancock said. "The best way for a police officer to tell if someone is lying is by writing down what they say and then going out and checking on whether the statements are true or not, by checking with other witnesses or finding related facts."

Eric Baumer is interested in a different kind of dialogue: the national conversation about political issues carried out daily in media outlets and political blogs.

"How we think about political issues shapes the ways that we talk about those issues and the words we use," said Baumer, postdoctoral researcher in the Interaction Design Lab. "Analyzing the way we talk about contentious issues can provide insights into how we think about them and how that changes with time and context."

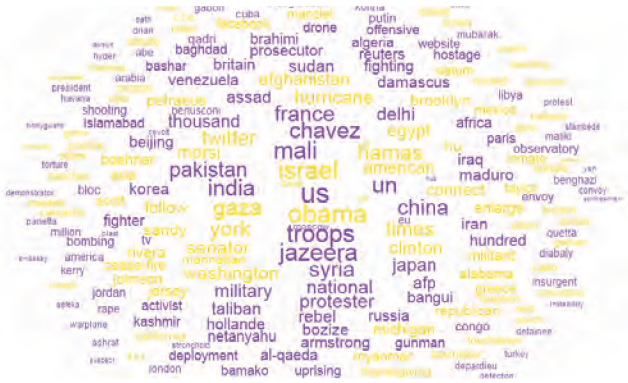
His free, online tool, Reflext, analyzes 40 news sites and blogs and creates visualizations that illustrate associations between words.

For example, Reflext shows the change in language associated with "warming" before and after Superstorm Sandy devastated the East Coast in late October 2012. On Sept. 22, "warming" was associated with words like "independent," "consider," and "suggest." By Nov. 10, it was associated with terms like "contribute," "amount," and "hoax."

A user can also see how words are being used in the context of specific issues. For example, in the context of health care, the term "contraception" is associated with terms like "provide," "cover," and "afford," which relate to insurance coverage. But in the context of abortion, "contraception" is associated with terms such as "ban," "oppose," and "deny," which emphasize ethical and moral aspects.

"It's about reading not just the words in front of you but what's being said between the words and behind the words. And what's said in repetition? Not just in word counts, but associations between words?" Baumer said. "Seeing the patterns in our language will hopefully move us towards a more holistic discussion of our politics."

"It's about reading not just the words in front of you but what's being said between the words and behind the words. Seeing the patterns in our language will hopefully move us towards a more holistic discussion of our politics." –Eric Baumer



Reflext allows users to visualize patterns in the language used in political coverage in major media and blogs. This word cloud compares Al Jazeera English (purple) and The New York Times (yellow). The size of a word corresponds to its frequency in the selected media.

generations & innovations

ROBERT C. BAKER '43

He's often called the "Thomas Edison of poultry," and his Cornell chicken barbecue recipe has delighted American presidents as well as thousands of New York State Fair visitors. The ubiquitous chicken nugget owes its existence to him. Yet the legacy of the late Robert C. Baker, a Cornell professor of food science who passed away in March 2006, is as much a story of mentoring and outreach as it is of chicken.

Photo: Division of Rare and Manuscript Collections, Cornell University Library.

"Bob nurtured his graduate students. He was creative and generous with his time, strongly encouraging us to present research findings at professional conferences so we could network with industry, government and the scientific community. I'm not sure a lot of people did that at the time," said Robert Gravani, M.S. '69, Ph.D. '75, professor of food science and a former student of Baker.

In the late 1950s, Baker began developing a series of processing steps to create more ways to use poultry meat, eggs and, later, seafood. He believed that consumers would eat more if they had more convenient alternatives to whole chickens and shell eggs.

Baker's projects often resulted from work on basic and applied food science questions, and his innovative solutions were sometimes deceptively simple. Gravani recounted that Baker's solution for lowering cholesterol in an egg product was so simple and effective that an observer patented it immediately after seeing it in his lab.

Baker's most well-known innovations include chicken nuggets, poultry hot dogs and cold cuts, a process for making breading adhere to frozen nuggets during frying, and many egg products. He never patented any of these groundbreaking products; instead, after thoroughly market testing each one, Baker disseminated his findings widely to farmers and food professionals.

In 1970, Baker founded the Cornell Institute of Food Science and Marketing to foster greater collaboration between the food science department in Ithaca and its Geneva, N.Y.-based sister department.

Above all, Gravani said that Baker, in his mild-mannered, jovial way, dedicated his career to helping others succeed in the field of food science.

"Baker was a great role model for extension and outreach. He understood the science, had a good sense of the market, was an excellent networker, and was very likable. He had the whole package."

SARAH BELLOS '04

Eight years ago, Sarah Bellos moved to Nashville, Tenn., with a dream but not a job. Today, she's founder and president of Stony Creek Colors, a company that sources and extracts natural colorants for the textile industry.

The company evolved from Bellos' earlier business, Artisan Natural Dyeworks, a venture she and her sister launched several years ago to offer a fabric dyeing service using plant- and earth-based dyes. Their business grew as small and independent designers sought to meet emerging customer demand for natural and domestically sourced fabrics. Bellos also founded Southern Hues, which sells naturally dyed wraps and scarves.

"When we first started, our goal was to provide an artisan fabric dyed with natural colorants. Now, my goal is to move natural colorants out of a niche market and into the mainstream markets," Bellos said.

Last year, thanks to a Value-Added Producer Grant from the U.S. Department of Agriculture, Bellos moved forward. She is positioning Stony Creek's dye crops as a middle ground for farmers between high-value, higher risk cash crops—like tobacco—and lower value crops like soybeans. The company will create a market for these new crops while also helping farmers optimize growing plans and profits.

Stony Creek also makes dyes from waste products, like Osage orange trees. The common tree is cut for lumber or removal, but its heartwood yields vibrant yellow dye. Indigo is another major crop. U.S. manufacturers produce one billion yards of denim annually, and Bellos believes converting just two percent of this market to American-grown indigo can economically benefit farmers.

Bellos' belief in the science of sustainability flourished at Cornell. Several Resource Policy Management professors highlighted using market mechanics as an alternative to direct environmental regulation. Then, what Bellos saw during her junior year Cornell in

These creative members of the CALS community exemplify innovation, inventing dozens of products and coming up with sustainable solutions to pressing problems.

Washington internship drove home the point: The entities most able to affect change were those bringing business to the table.

"You want to both push the envelope and meet commercial customers and consumers where they are. It may take 15 years to create the next, more sustainable phase of the dye industry, but we have to start somewhere," Bellos said.

PAM MARRONE '78

As a child, Pam Marrone and her mother counted the dead bees, beetles and butterflies that littered the ground below an ancient dogwood tree outside their kitchen. These were the result of Marrone's father using a toxic insecticide to battle a gypsy moth infestation on the family's 40-acre Connecticut farm.

"I saw the moths devastate the forest, and I said to myself, we've got to control them," said Marrone, founder and CEO of Marrone Bio Innovations (MBI), a California-based biopesticide company. "My father switched to one of the first natural insecticides, but the perception was that they couldn't outperform synthetic chemicals. I was determined to find better ways."

This vision drew Marrone to Cornell's top-notch entomology program, where her professors and research assistants set the foundation for a career in scientific discovery.

"They had so much enthusiasm for what they did and for science. It was infectious," Marrone said.

For three decades, Marrone's love of science and business savvy have been transforming pest and weed management. At MBI, Marrone's third biopesticide start-up, scientists do classic natural product screening, analyzing samples from around the globe to find novel microbial or plant compounds that kill pests and weeds or improve plant health.

"More than half of our pharmaceuticals are derived from natural products, but only 11 percent of pesticides are derived from natural sources," Marrone noted. "We have a wide open field for new discoveries. We're just scratching the surface."

MBI has already developed the first environmentally safe biomolluscicide to kill invasive zebra and quagga mussels. The company plans to soon release a new insecticide and herbicide derived from a recently discovered bacterial species and featuring a new herbicidal mode of action, which is a very rare find.

Marrone's dedication to expanding undergraduates' career horizons is equally rare. For the past 15 years, Marrone has hosted externs in her home, her meetings and her boardroom.

"I want more students to see scientific entrepreneurship as an alternate, viable path for making a huge impact on the world," she said.

WILLIAM JEWELL

For the past 30 years, William Jewell, professor emeritus of biological and environmental engineering, has been up to his armpits in manure, studying and refining anaerobic digestion of farm waste.

"It's a magic technology. It produces natural gas from carbon, while leaving all humus materials," Jewell said. "You also make high-quality protein, in the form of bacteria that grow."

In 1973, Jewell came to Cornell to work on developing biological sources of energy from waste. That year was also the peak of the United States' first major energy crisis, and like others across the country, Northeast dairy farmers faced rising costs and energy challenges. Soon after, the U.S. Department of Energy approached Jewell and his team to see if it would be possible to develop a low-cost anaerobic digester for small dairy farms. Digesters use bacteria to break down manure in the absence of oxygen, producing methane gas as a byproduct.

His team succeeded: They developed a simple but highly effective digester using low-cost materials that are easy to use and replace.

"We were able to decrease the cost substantially, and we crossed a number of engineering barriers that were considered impossible," Jewell said.

Yet Jewell still wanted to attack the core problem for dairy farmers: eliminating waste completely. Jewell's Resource Recovery system was the first step. It separated the components in manure, using digestion and dilution to recover nutrients and proteins. A hydroponic system then harvested these nutrients to grow duckweed—a desirable, high-protein animal feed. Other valuable byproducts included biogas and a peat moss-like product.

"My approach is to jump into the cutting edge of a problem, the major obstacle to moving forward," Jewell said. "This means challenging engineering principles, as well as biological and chemical ones."

Jewell's patents cover all aspects of anaerobic digestion and energy conversion, and he is currently working on a residential biogas system as well as a method for digesting low-quality grass and brush clippings to produce energy. And at 71, Jewell remains guided by his vision: creating economically viable, innovative digestion solutions that allow small rural communities to become energy independent.

"I consider small farms the heart of Northeast agriculture. We are losing them because of pollution and energy concerns," he said.

Reunion 2013

JOIN CALS FOR REUNION WEEKEND: JUNE 6–9, 2013

THURSDAY, JUNE 6

Earth and Atmospheric Sciences Open House

10:00 a.m.-4:00 p.m., Snee Hall Atrium

Visit the Timothy N. Heasley Mineral Museum and inspect our mastodon and fossil exhibits while keeping an eye on the Earth's last rumblings at the Snee earthquake seismograph. Enjoy a stroll with the self-guided tour through the Engineering Quad Rocks.

FRIDAY, JUNE 7

CALS Admissions Information Session

Please visit website to check time and location.

Hear directly from a CALS student and receive helpful information about admissions and the CALS academic experience from an Admissions representative.

Visit http://cals.cornell.edu/admissions/visit/ to view the information session schedule and to RSVP online.

Earth and Atmospheric Sciences Open House

10:00 a.m.-4:00 p.m., Snee Hall Atrium

Visit the Timothy N. Heasley Mineral Museum and inspect our mastodon and fossil exhibits while keeping an eye on the Earth's last rumblings at the Snee earthquake seismograph. Enjoy a stroll with the self-guided tour through the Engineering Quad Rocks.

"More Mushroom Alumni" Lecture by Kathie T. Hodge, M.S. '93, Ph.D. '98

10:00-11:00 a.m., Room 160, Mann Library

Mushrooms are mum and mysterious things and won't tell their own tales. In this exhibit lecture, Professor Kathie Hodge, the director of Cornell's Plant Pathology Herbarium, will do the talking for them as she introduces an array of fascinating fungal specimens and the remarkable Cornellians who have shaped our understanding of fungi in all their wondrous forms. Among our cast of characters: A mushroom discovered on the Cornell campus in 1902, then never seen again; lost fungi collected during the Cornell Peary expedition to Greenland in 1896; an odd little fungus that subverts the sex drive of a moss; the world's most poisonous mushroom, named right here at Cornell; and some exotic-seeming fungi that grow in your own house and yard.

All-Alumni Lunch Extravaganza

11:30 a.m.-1:30 p.m., Barton Hall

Newly redesigned and packed full of energetic music, fabulous food, children's entertainment, a photo booth and wine tasting—you won't want to miss this destination event! Lunch tickets available on site.

Liberty Hyde Bailey Lecture

"Little Things, Big Consequences: Microbes, Micro-Nutrients, and Neurotransmitters"

1:00-2:30 p.m., Call Alumni Auditorium, Kennedy Hall

Small things make a big difference when it comes to human health. Neurotransmitters interact to connect what's on our tongue and our brain's perception of that taste; gut microbes determine exactly how many calories we are eating and how healthy we will be; nutrients like choline can reduce stress levels in utero and prevent hypertension later in life. Join this discussion about some big discoveries in the small scale.

Moderator: Jan Nyrop, CALS senior associate dean and professor of entomology

Panelists: Marie Caudill, professor of nutrition; Robin Dando, assistant professor of food science; and Ruth Ley, assistant professor of microbiology

Landscape Architecture Open House

1:00-3:00 p.m., 440 Kennedy Hall (Gallery)

The undergraduate landscape architecture degree is the only one of its kind in the Ivy League. Visit the studio and mezzanine, enjoy drinks and snacks, and chat with faculty, staff and fellow alumni.

Communication Department Open House

2:30 -3:30 p.m., Kennedy Hall, third floor

This reception is for alumni and friends of the Department of Communication. Connect with communication alumni who are returning to campus, mingle with current faculty and students, and learn about the exciting things happening in the department.

Olin Lecture

3:00-4:15 p.m., Bailey Hall

The Olin Lecture was established at Cornell in 1987 through a generous gift from the Spencer T. and Ann W. Olin Foundation. Each year, the Olin Lecture brings to campus an internationally prominent speaker to address a topic relevant to higher education and the current world situation. The lecture is free and open to the public.

Special Earth and Atmospheric Sciences Seminar

3:30-4:30 p.m., location TBD

A special seminar will be presented by Earth and Atmospheric Sciences faculty.

SATURDAY, JUNE 8

Reunion Run

7:30 a.m., Barton Hall, Garden Avenue entrance

Pre-registration required for the two- or five-mile courses.

CALS Reunion Breakfast and College Open House

8:00-10:00 a.m., Trillium, Kennedy Hall

Enjoy fellowship with Dean Kathryn Boor, alumni, faculty and friends of the college as the dean gives her annual Reunion welcome. Todd Wolleman '80, CALS Alumni Association president, will host the association's annual meeting. In addition to the buffet breakfast, CALS departments will host information tables for you to visit.

Cost is $15 per person, please submit reservation or contact Kristine Lange at ksk5@cornell.edu or (607) 255-8711.

Plantations Spring Plant Sale

9:00 a.m., Plant Production Facility, 397 Forest Home Dr. (across from Flat Rock)

Bring back some of our gardeners' top picks for your own home landscape.

Alumni Reception and Open House at Mann Library

9:30 a.m.-12:30 p.m., Mann Library

CALS, CHE and other Cornell alumni are cordially invited to explore the fusion of modern and classic that makes Mann Library, in the words of our students, "the best place to discover 10 million new ideas." Come explore our collaborative learning technologies, fresh study spaces, rich collections and summer exhibits showcasing early Cornell women in science and marvels from the mushroom kingdom. Guided tours will be available on request, and—in a grand departure from

library tradition just for the reunion occasion—mushroom-themed brunch treats and mimosas made with Finger Lakes sparkling wine will be served at the Mann circulation desk.

State of the University Address
10:30 a.m., Bailey Hall
Cornell University President David J. Skorton will deliver his annual Reunion State of the University Address. All registered Reunion attendees and their guests are welcome.

Landscape Architecture Brunch
11:00 a.m., Department Chair Peter Trowbridge's home
Enjoy the lush gardens and good company at this brunch for Landscape Architecture alumni. Please contact Kristie Oplinger to RSVP and for directions at klb28@cornell.edu.

All-Alumni Lunch Extravaganza
11:30 a.m.-1:30 p.m., Barton Hall
Newly redesigned and packed full of energetic music, fabulous food, children's entertainment, photo booth and a wine tasting—you won't want to miss this destination event! Lunch tickets available on site.

Biological and Environmental Engineering Alumni Gathering
11:30 a.m.-1:30 p.m., Room 105, Riley Robb
Enjoy a light lunch while visiting with fellow alumni and current and former faculty. Lab tours available.

Tour of the Cornell Insect Collection
1:00-3:00 p.m., Comstock Hall
Tour the world-famous Cornell Insect Collection, home to the most beautiful and bizarre insects in the world.

Wine Tasting
1:30-3:30 pm, Trillium, Kennedy Hall
Savor the flavor of New York state wines and meet winery owners at this very popular annual reunion event. Free admission to all alumni and guests, 21 years of age and older.

Guided Tour of The Museum of the Earth and its collections (affiliated with Cornell's Department of Earth and Atmospheric Sciences)
4:00-5:00 p.m., The Museum of the Earth, 1259 Trumansburg Road, Ithaca
Join a guided tour of The Museum of the Earth and its collections. A whale skeleton suspended in the atrium welcomes you to a beautiful museum in which you can follow the major transformations of life through the ages as displayed through fossils and videos. Observe the seismograph display and view research by EAS faculty and students. Collect fossils from the Devonian seas of Ithaca. Fun for all ages. Free admission is offered to alumni and families. Donations are appreciated.

Allan Hosie Treman '21 Memorial Concert
2:30-3:30 p.m., Jackson Grove in the F.R. Newman Arboretum (Flat Rock entrance)
Relax in the shade and enjoy this performance by The Hangovers, the popular a cappella subset of the Cornell Glee Club.
Bus will depart from Barton Hall at 2 p.m. and return after the concert.

Natural Resources Wine & Cheese Reception
3:00-4:30 p.m., Breezeway between Fernow and Emerson
Join us for wine tasting and light refreshments while you enjoy visiting with fellow Natural Resources alumni and former and current professors. There will be opportunities to share recollections of your days in Fernow and at field sites. Faculty will provide a brief update on the department and its programs. There will also be displays of our collection of historical photos, posters of recent faculty and graduate student projects, and information on programs at the Arnot Teaching and Research Forest.

Cornelliana Night
9:30 p.m., Bailey Hall
Join the Alumnae Chorus and the Alumni Glee Club in songs of Cornell. Reunion attendance and giving will be recognized. A real-time, live stream of Cornelliana Night at Bailey Hall will be available for viewing on a large screen at our overflow location in David L. Call Alumni Auditorium at Kennedy Hall.

Ongoing Weekend Events
****Check the reunion program or website for times**

Cornell Plantations
Explore Cornell's botanical gardens, arboretum and natural areas. The Nevin Welcome Center and Gift Shop will be open daily throughout Reunion, from 9:30 a.m. to 5 p.m. Shuttle vans will provide transportation on Friday and Saturday afternoons only, from 1 to 5 p.m., looping between Nevin Welcome Center, Barton Hall, West Campus and North Campus. Free parking is also available at the Welcome Center. Check our website for more information including the Reunion tour schedule: www.cornellplantations.org.

Mann Library Ongoing Exhibits:
8:00 a.m.-5:00 p.m.; Saturday, 9:30 a.m.-5:00 p.m. Thursday and Friday
Exhibit: Mann Gallery, second floor:
Focus on Fungus
Fungi are mysterious things that capture our imaginations with their weird, ephemeral beauty. Cornell's Plant Pathology Herbarium contains the stories of thousands of fungal species, as well as the stories of the generations of Cornell scientists and students who studied them. This exhibition celebrates these fascinating tales with photographs, specimens, and interactive stations. Join us for a rare look at the remarkable world of mycology that lives inside the Herbarium.

Exhibit: Mann Lobby, first floor
Pioneers: The Early Women Scientists of Cornell
This display explores the lives and work of some of the brilliant and fascinating women engaged in scientific research at Cornell in the late 19th and early 20th centuries. Archival images and other resources from our collections illuminate their stories, including ornithologist Elsa Guerdrum Allen's role in the re-discovery of the ivory-billed woodpecker, anatomist Susanna Phelps Gage's innovations in modeling the human embryo, and bacteriologist Alice Catherine Evans' pioneering work on brucellosis.

BREAKFAST REGISTRATION FORM

Register here or online at http://alumni.cals.cornell.edu/breakfast before May 31, 2013

Registrations are recorded on a first-come, first-served basis. Please note that your registration is not complete until the breakfast fee is paid. Name tags will be given to each registered guest upon arrive at breakfast.

Name (print exactly as to appear on name tag)

Class Year / Major

Address

City / State / Country / Zip

Phone Email

Reunion Year

Guests Class

Class

Membership Expiration Date

Number of Registrations

Total Amount Enclosed

Please make your check payable to CALS Alumni Association or pay with
☐ VISA ☐ MasterCard ☐ Discover Card

Expiration Date

Account #

Signature of Cardholder

Mail to: CALS Reunion Breakfast, Cornell University, 274 Roberts Hall, Ithaca NY 14853-5905;
Phone: 607-255-8711; E-mail: alsaa@cornell.edu; Fax: 607-254-4690
Must be received no later than May 31, 2013

CORNELL COMMUNITIES IN MUMBAI, INDIA & THE PHILIPPINES HOST DEAN BOOR *By Amanda Garris, Ph.D. '04*

A November trip to Asia by Kathryn Boor, the Ronald P. Lynch Dean of the College of Agriculture and Life Sciences, celebrated historical connections and the dedication of Cornell alumni in shaping the futures of their home countries.

Boor's first stop was Mumbai, India, where she was hosted by Cornell alumni and their families, including Shirish Rajendra Barwale '04 and Aashish Rajendra Barwale '06; Samir Somaiya '90, M.S. '92, MBA '93; Rajendra Mariwala, M.Eng. '86; Sanjaya and Nandana Mariwala, parents of Nihal Mariwala '14; Anuj Atul Bhagwati '91, M.S. '94; Viral Doshi '81; and Nandlal Pribhdas Tolani, Ph.D. '64.

"I learned how deep Cornell's roots are in Mumbai across the business and agricultural communities and how deeply invested our alumni are in making the world a better place," Dean Boor said. "As a group, they are remarkably philanthropic and are playing a vital role in helping India achieve the goals of the next generation."

Photo: IRRI

While in the Philippines, Dean Boor also visited the International Rice Research Institute (IRRI), hosted by IRRI Director General Robert Zeigler, Ph.D. '82, (right) with Ronnie Coffman, Ph.D. '71, director of international programs for CALS. "The tremendous work at IRRI over the past decades is fundamentally aimed at ensuring global food security," noted Dean Boor. "The incredible dedication of the staff in protecting the diversity of rice for posterity made an impression on me."

The Tolani family, for example, developed an educational campus in Adipur, an impoverished township in western India, into eight educational and research entities. The colleges of arts and science, commerce and pharmacy, as well as a maritime institute, an eye hospital and research center, and a center for the development of rural technology, now enroll more than 10,000 students.

"Across the board, the Cornell alumni I met in Mumbai were deeply invested in helping people live the best lives they can. It was incredibly inspiring," Boor said.

Boor next traveled to the Philippines, where she helped celebrate the centennial of the Cornell Club of the Philippines. Students from the Philippines first attended Cornell in 1902, in the Colleges of Law and Agriculture. The relationship was further strengthened after World War II, when the university played a significant official role in rebuilding the University of the Philippines in Los Baños, with more than 100 Cornell faculty and staff lending their expertise in research, teaching and extension.

"It was an honor to celebrate the deep roots of Cornell and CALS in the Philippines," Boor said. "As a country they are in dramatic transition in agriculture, even evaluating whether their goal should be self-sufficiency, or if they should choose a different path within the global economy."

The future of agricultural and rural development in the Philippines was the focus of a special symposium, Philippine Rural Development and Cornell, which drew more than 100 attendees. The symposium addressed issues including global food security, water for agriculture, agriculture in emerging markets, higher education and the Philippine economy.

The program featured many Cornell alumni, including leaders in government, agriculture and education, such as Congressman Martin Romualdez '85, who is also the president of the Cornell Club; former president of the University of the Philippines Emil Javier '69; chair of the Commission on Higher Education, the Honorable Patricia Licuanan, M.A. '67, former director general of the National Economic and Development Authority Vicente Valdepenas, Jr., M.A. '64, Ph.D. '69; and former USEC, Department of Agriculture Orlando Sacay, M.S. '56, Ph.D. '61.

"I was very encouraged by the enthusiasm of the young people who will be shaping their country's future," Dean Boor said. "We aim to revitalize the bonds between Cornell and the Philippines, and we'll be looking for ways to collaborate with the University of Los Baños as they help the country transition over the coming decades."

IP•CALS
International Programs
College of Agriculture and Life Sciences
1963-2013

FIFTY YEARS OF SERVICE AND LEARNING

The project to rebuild the University of the Philippines in Los Baños after World War II was a major motivation in the establishment of the Office of International Programs at CALS (IP/CALS) in 1963. Now, 50 years later, the college is marking the occasion with a series of lectures and other events. The year-long celebration kicked off on Feb. 15, with a special reception to Dean Kathryn Boor, IP Director Ronnie Coffman, Ph.D. '71, Associate Director Sarah Davidson Evanega, Ph.D. '09, and Larry Zuidema, M.S. '64, who served as associate director from 1964 to 1995. For more information about upcoming events, visit http://ip.cals.cornell.edu.

EPIDEMIOLOGIST MINES INJURY DATA TO IDENTIFY DANGERS AROUND US

By Holly McIntyre Hartigan

What we don't understand can hurt us. Susan Baker '51 has made it her life's work to understand the dangers in our everyday lives, and her research has helped spur changes in policies like requiring automobile airbags and car seats for children. An epidemiologist and professor at the Johns Hopkins Bloomberg School of Public Health, Baker searches for patterns in data on human bodily injury. Those patterns help her understand the fundamental characteristics of what causes injuries.

Photo: Keith Weller

Seeing the need for changes in policy and our environment drives her research. "When I first was a faculty member at the School of Public Health there were some faculty members who thought researchers should not try to change policy," she said. "I felt very strongly that the people who understood those facts, and in some cases had discovered those facts, were the best people to put forth the arguments for how to prevent injuries."

Since beginning her career in the 1960s, Baker has pushed to make injury prevention a priority for public health. She said educating decisionmakers has been key.

"There certainly have been huge decreases in drowning, burn, and automobile and traffic related deaths over the last 50 years or so," she said.

Her work environment has evolved since the 1960s, too, and Baker credits Cornell with helping her overcome gender barriers as a young scientist. The ratio of men to women was about 5 to 1, but Baker, a zoology major, remembers then-university president Edmund Ezra Day stating his support for women and men working side-by-side.

"At the start of my career virtually all the people in highway safety were men. You'd go to a meeting and be the only woman there. I was perfectly comfortable being the only woman in a setting with a lot of men. I think that comfort and self-confidence was greater because of having gone to Cornell," she added.

Before diving into aviation research, Susan Baker got her private pilot license at age 56 to get a better understanding of what pilots do. Here she maps out her exploration of crash sites and dangerous passes near Aspen, Colo., the locus of her first paper on aviation crashes. Photo: Margaret W. Lamb

JCVI PRESIDENT LEADS RESEARCH ON THE HUMAN MICROBIOME

By Holly McIntyre Hartigan

Curiosity about genetic diversity has led Karen Nelson, Ph.D. '97, to research that may make disease diagnosis easier and faster.

Nelson, who became president of the J. Craig Venter Institute in October, is part of a project researching the microbial species in the human biome to discover how they impact health and disease.

"I think it's going to revolutionize how we practice medicine and how we interpret and diagnose diseases," Nelson said.

Human bodies send out microbial signatures very early in the disease process, and by looking for these signatures in urine or blood, for instance, doctors can diagnose diseases earlier and less invasively.

Nelson has worked for the JCVI, a world leader in genomic research, for 16 years. Before her recent promotion she served as director of the JCVI's Rockville, Md., office and leader of the Human Genomic Medicine Group, positions that she has retained as president.

With research groups focusing on human genomic medicine, infectious disease, plant, microbial and environmental genomics, synthetic biology and biological energy, bioinformatics, and software engineering, Nelson has to bridge many areas of scientific study. "I'm exposed to a lot more aspects of science right now. A lot of it has grown out of my education," she said. "It showed me how to work across different fields and different areas of research."

At Cornell, Nelson had experience in the animal science and microbiology departments, where she said professors encouraged curiosity and hard work.

"The students there are very driven. There were long hours in the lab. I think the dedication to accomplishing what you have to accomplish—some of that came out of those long hours in the lab," she said.

Curiosity has driven Nelson's career. She led the first metagenomics study on fecal material, which was published in 2006. This and her research on microbial ecology, genomics and physiology have influenced the direction of the current project on the human microbial biome. As genomic research evolves and the understanding of genetic diversity grows, Nelson said she and her colleagues have more knowledge and better technology with which to ask more questions about the natural world around them.

Photo: JCVI

alumni notes

ENDOWED NYSAES DIRECTORSHIP PAVES WAY FOR AGRICULTURAL INNOVATION

By Kate Frazer

The Goichman name has been associated with Cornell's enology and viticulture program since 2009, when businessman Larry Goichman '66 and his wife, Jennifer, endowed the first professorship of Enology and Viticulture at the New York State Agricultural Experiment Station (NYSAES) in Geneva. Now they have increased their commitment to the endowment and the Geneva station, enabling a Goichman Family Directorship of the New York State Agricultural Experiment Station.

From his first visit, Goichman said he was impressed by the station's vast research fields and its work to combat destructive beetles.

"It's amazing when a grower says, 'I have a problem, and I'm losing my crop,' and someone is listening who can respond," he said.

And he is quick to add that agricultural problems affect all people, not just farmers: "The world is getting crowded. We need more efficient, safer ways to produce food and to be in sync with a changing climate. Agricultural research is there to prevent the dust bowls and potato famines of the future."

The Goichman Family Fund, established in 1994, continues to provide support for Geneva faculty doing applied research. Goichman said his support of the station is as much about inspiring innovation as it is about addressing threats, and he also cites Thomas Burr, NYSAES director and CALS associate dean, as a major factor in his family's decision to endow the directorship.

Thomas Burr, the newly designated Goichman Family Director of the New York State Agricultural Experiment Station, with Larry Goichman '66.

"Tom is a big part of our willingness to do this. He's a great collaborator who encourages positive changes," Goichman said. "We've got to be smart about finding funding and pursuing critical research. The model today must be all hands on deck."

Goichman entered the College of Agriculture and Life Sciences with the intention of becoming a veterinarian, but his interests led him to graduate from the Charles H. Dyson School of Applied Economics and Management (then called agricultural economics). After earning an MBA from New York University, he worked for IBM, then established SCG Capital, an equipment leasing firm. He has served two terms on the CALS Advisory Council and is a member of the University Council and the NYSAES Advisory Council.

Both the Goichmans' children are Cornellians: Jesse Eisenberg, J.D. '02, MBA '02, and Samuel Goichman, '98, MBA '06.

"I feel very lucky to be able to make this contribution. I hope it will help others see they too can help Cornell in their lifetime," Goichman said.

FUND SUPPORTS NATURAL RESOURCES STUDENTS FROM ASIA

The Department of Natural Resources has received a $150,000 gift to establish the Cambodian, Laotian and Vietnamese Environmental Support Fund. Payout from the fund will support graduate students from the abovementioned countries who are studying conservation and biodiversity. Marianne Krasny '74, professor and department chair, noted that she is co-chairing a Ph.D. committee for a current graduate student from Laos who is on leave from his position with the Wildlife Conservation Society in Laos. "We are working to create a pipeline of students from these countries to come to Cornell at various levels. This gift allows us to recruit students who might not otherwise apply to Cornell," Krasny said. The gift was given by a couple who wishes to remain anonymous.

YOUNG ALUMNUS ENDOWS FIRST AMERICAN INDIAN PROGRAM FUND

By Sarah Thompson

Sam Scott '10 received an unusual wedding gift from his Zeta Psi fraternity brother Jason Kats '10: an endowed fund for Cornell's American Indian Program (AIP) in honor of him and his bride, Barrett.

The endowment will provide perpetual funding to cover expenses for Native American students to study abroad and participate in research, conferences, or internships. It is the first endowment for the AIP, which recently celebrated its 30th anniversary.

Photo: Provided

Sam and Barrett Scott

Kats said he made the gift to honor Scott, who is Native American on his father's side, as well as the people who created a supportive community for him at Cornell. He has quietly made two other endowment-level gifts to Cornell in the past year. He recognizes this is rare for a recent graduate, and he hopes that his generosity will spark more alumni to donate.

"For several years, I've been on this journey to discover how life's resources should be best apportioned and what I should do," Kats said. "Most people contribute in their 40s or 50s, when they feel they have enough materially. But the increase in utility of having an extra dollar decreases the more you have. I may lose money over five years, but that money goes into an endowment that will pay dividends over many years, so I derive much more utility from that money than I could just saving it."

By Claire Lambrecht '06

More than 150 Cornell alumni and friends gathered in SoHo on Jan. 31 to celebrate food products developed in conjunction with the College of Agriculture and Life Sciences or by CALS alumni at the first "From Furrows to Boroughs: A Taste of New York State in New York City" event.

Attendees had the opportunity to sample products from Acme Smoked Fish, Anthony Road Wine Co., Bedell Cellars, Brooklyn Brewery, Chobani, Cornell Dairy, Crown Maple, Flora-Tomatoes, King Ferry Winery, Mercer's Dairy, Murray's Cheese and Old Chatham Sheepherding Co.

"There is nothing more exciting than being in the midst of passionate Cornellians who continue to get together to enjoy not only each other, but the bounty of New York," said Kathryn J. Boor, the Ronald P. Lynch Dean of the College of Agriculture and Life Sciences.

The enthusiasm of attendees and the quality of food on display didn't surprise Beth Griffenhagen '94, marketing manager of Murray's Cheese Shop. "This is a big state, and there's a rich food heritage," she said. "There's a lot of land, there's a great entrepreneurial spirit and a lot of people supporting the different industries."

Assistance from Cornell has helped companies create new products and stay ahead of the competition. In 2005, for example, Mercer's Dairy launched a line of wine ice cream, the first of its kind in the world, with the help of Michele E. Ledoux, executive director of the Cornell Cooperative Extension of Lewis County. Today, Mercer's wine ice cream is available in six flavors: Cherry Merlot, Chocolate Cabernet, Peach White Zinfandel, Port, Red Raspberry Chardonnay and Riesling.

Cornell made a similar impact with Acme, particularly in the area of quality assurance.

"We've been working with Cornell for the last 12 years," said Gabriel Viteri '99, vice president of strategy and business development. "It's because of Cornell, and the relationship we've developed, that we've been able to stay ahead of our industry and keep up with technology."

Scott Boggs of Crown Maple Syrup.

Carol and Richard Girards, of Flora Nurseries.

Photos: Claire Lambrecht

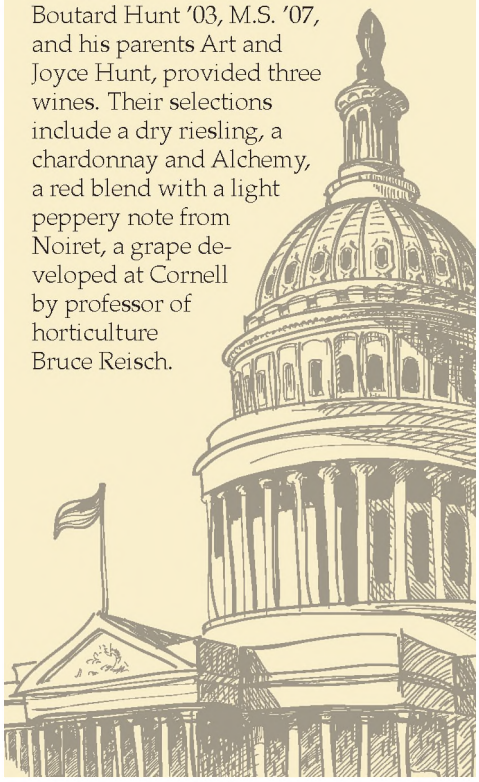
BIG RED TOASTS AT INAUGURAL CELEBRATIONS

When toasts were raised at inaugural celebrations for President Barack Obama and Vice President Joseph Biden, the wines of CALS alumni help put the cheer in the glass.

The 2009 merlot from Long Island's Bedell Cellars, where Trent Preszler, M.S. '02, Ph.D.'12, is chief executive officer and Rich Olsen-Harbich '83 is winemaker, was selected for the lunch for president, vice president, House and Senate leaders, Cabinet members and Supreme Court justices after the presidential inaugural, where it was paired with a bison steak.

"We were all incredibly honored for Bedell Cellars Merlot to be the first New York wine in history, along with a Finger Lakes riesling, served at a Presidential Inauguration," Preszler said. "We had a seat at the table at the most important power lunch in the world, and I believe that was a substantial advance for the broader, popular consumer acceptance of all New York wines."

Alumni wines were also included at other inaugural festivities, including the Green Inaugural Ball for which Hunt Country Vineyards, owned by Jonathan Hunt '04, his wife Caroline Boutard Hunt '03, M.S. '07, and his parents Art and Joyce Hunt, provided three wines. Their selections include a dry riesling, a chardonnay and Alchemy, a red blend with a light peppery note from Noiret, a grape developed at Cornell by professor of horticulture Bruce Reisch.

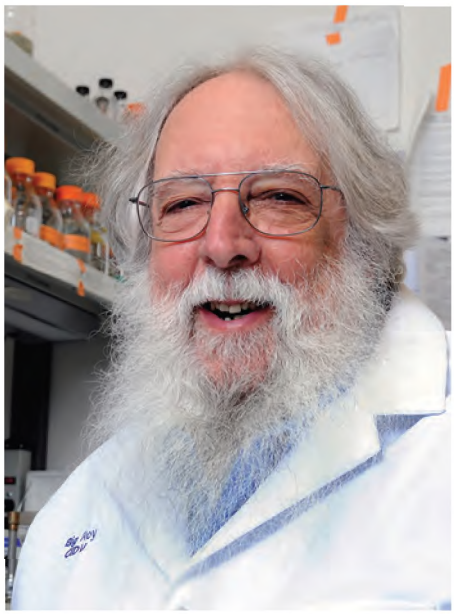


MY CORNELL STORY

Roy Curtiss III '56, Ph.D.

I've led a lucky life, and going to Cornell was one of my luckiest ventures, with a profound and lasting impact. It all began with the 4-H, and I like to think that its green four-leaf clover emblem has marked every turning point in my life.

My first visit to Cornell was for the New York State 4-H Congress in June 1947, when I toured the ag campus and attended lectures in Bailey Hall. I returned often throughout junior and high school. Some of the best experiences were in 1950 and 1951, when I visited my former 4-H leader, then a Cornell student, to attend Farm and Home Week. By the time I matriculated in 1952, most of my fellow freshmen thought I was an upperclassman since I knew my way around campus and all the eating establishments in Collegetown, as well as nuggets about many of the professors in the College of Agriculture.



Rice Hall, the home of the Department of Poultry Husbandry, became the center of my Cornell universe. In fact, thanks to my association with 4-H poultry extension leader Robert Ogle, I was able to move right into Room 403. This was a singular opportunity and afforded me the chance to work under the mentorship of all faculty members in the department. To earn my keep, I worked 16 hours per month for eight months for professors Gustave Heuser '15, M.S. '16, Ph.D. '18 and Leo Norris '20, Ph.D. '24, world authorities on poultry nutrition. I weighed chickens and the food they consumed in a study funded by Lederle Laboratories to investigate whether addition of chlortetracycline to poultry feeds improved feed conversion and weight gain.

I conducted avian embryology experiments with Alexis L. Romanoff '25, M.S. '26, Ph.D. '28, learned about embryonic lethals from professor Randall Cole, M.S. '37, Ph.D. '39, and studied avian genetics and genetic selection for resistance versus susceptibility to the avian leucosis complex with Cole and professor Frederick B. Hutt '54, LLB '56. I also got to work closely with the man dubbed "the Thomas Edison of the poultry food industry": Robert Baker (see page 28). I was TA for the two courses he taught and authored two papers with him, in addition to coaching the Cornell Poultry Team. I worked weekends with John Monroe to provide chicken barbecues for local groups, and as student chairman of Farm and Home Week in 1956 I developed and introduced turkey burgers at Professor Baker's suggestion.

In the fall of 1952, I got to meet Rice Hall namesake Jimmy Rice, the first professor of poultry husbandry in the United States. I skipped classes to attend the Eastern States Exposition in Harrisburg, Pa., as a member of the New York State 4-H Poultry Judging Team. There I sat down with the esteemed professor, then 84 and confined to a wheelchair. Our conversation was part interview, with me asking questions about his past and how he got started, and part sharing my experiences and describing how much I enjoyed and benefited from living in a building named after him.

Another significant opportunity occurred in 1955, when I spent the summer in St. Louis visiting Ralston Purina as a Danforth Fellow. There I met company founder William Danforth Sr., then 84 and in the last year of his life. Little did I know then that 27 years later his grandson, William Danforth, chancellor of Washington University in St. Louis, would be recruiting me to chair the Department of Biology.

There was also a vegetable and plant side to my Cornell life. In my plant physiology course, my lab partner was an agricultural missionary working in India, so we tackled (not too successfully) reclaiming alkaline soils for more productive plant growth. I became most impressed with Cornell's dedication to helping improve agriculture in the Philippines and Taiwan. Getting to know some of the visitors from these countries provided me with a lasting interest in global agriculture, which has led to my current efforts to develop vaccines to control infectious diseases of farm animals in the developing world.

Other aspects of Cornell life were influential. Social committees, leadership of the New York State and National Junior Potato and Vegetable Growers Associations... I even took lots of courses and graduated in 1956.

My life in science continues in the Biodesign Institute at Arizona State University, where I am director of the Center for Infectious Diseases and Vaccinology. Every day abounds with excitement, lucky events and successes, firmly based on a foundation of knowledge and tutelage from my years at Cornell.

Roy Curtiss III '56, Ph.D., is director of the Center for Infectious Diseases and Vaccinology in the Biodesign Institute at Arizona State University, as well as professor in the School of Life Sciences. He is a world-renowned geneticist engaged in developing attenuated *Salmonella* vaccines against agricultural and human pathogens. Since the 1970s, Curtiss and his research group have sought to define the biochemical bases and genetic controls by which bacterial pathogens cause tooth decay, gastroenteritis, typhoid fever, leprosy and pneumonia. He is a leader in the use of genetic and gene cloning approaches to elucidate bacterial virulence, and he pioneered the development of plant-based vaccines. Curtiss has worked at two national U.S. laboratories: Brookhaven and Oak Ridge National. He also formed two biotech companies, including Megan Health, Inc., which engaged in discovering, developing and marketing live, oral bacterial vaccines for animals and humans based on gene modification technologies. He holds an extensive list of 29 patents, three licensed vaccines, and more than 60 grant-funded research projects, and he has published 350 articles and research papers.

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