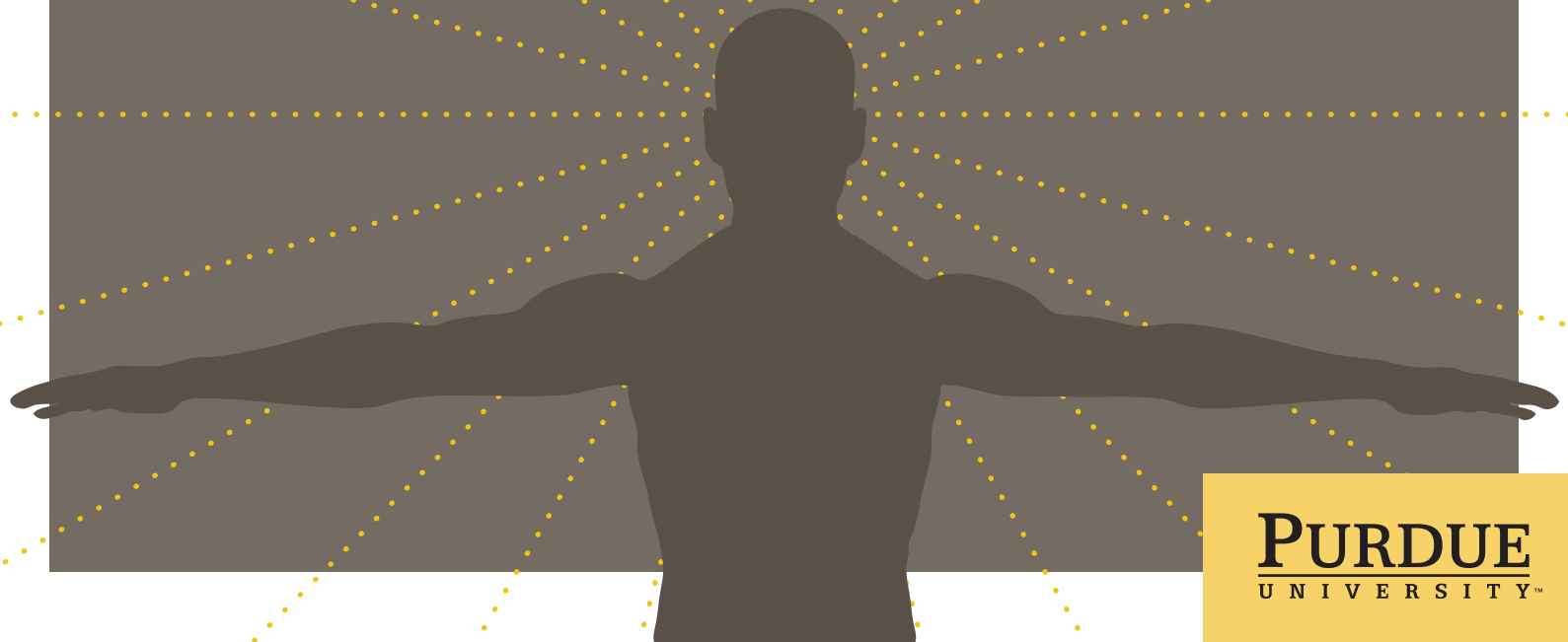
2013 | 2014

Executive Vice President
for Research and Partnerships

ANNUAL REPORT

smell taste sight sound touch
SENSORIUM



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Excerpts and complete poems throughout this report are the work of Marianne Boruch, professor of English, 2013 Kingsley Tufts award winner and recipient of the 2014 Purdue University Research and Scholarship Distinction Award.

AWARDS

THE BODY

has its little hobbies. The lung
likes its air best after supper,
goes deeper there to trade up
for oxygen, give everything else
away. (And before supper, yes,
during too, but there's
something about evening, that
slow breath of the day noticed: oh good,
still coming, still going...) As for
bones--femur, spine,
the tribe of them in there--they harden
with use. The body would like
a small mile or two. Thank you.
It would like it on a bike
or a run. Or in the water. Blue.
And food. A habit that involves
a larger circumference where a garden's
involved, beer is brewed, cows
wake the farmer with their fullness,
a field surrenders its wheat, and wheat
understands I will be crushed
into flour and starry-dust
the whole room, the baker
sweating, opening a window
to acknowledge such remarkable
confetti. And the brain,
locked in its strange
dual citizenship, idles there in the body,
neatly terraced and landscaped.
Or left to ruin, such a brain,
wild roses growing
next to the sea. The body is
gracious about that. Oh, their
scent sometimes. Their
tangle. In truth, in secret,
the first thing in morning
the eye longs to see.

Marianne Boruch

Equipped with his five senses,
man explores the universe around him
and calls the adventure Science.

Edwin Hubble

smell taste sight sound touch

SENSORIUM

Perched on a tower high above a canopy of old-growth trees, an ecologist steadies a microphone, listening to cicadas hum and geckos bark as the sun rises in the Borneo rainforest. A horticulturist bites into a brilliant red tomato, its juicy sweetness bursting in her mouth as its citrusy fragrance fills her nostrils. A surgeon in dark glasses gestures toward the patient projected in front of him, prompting a robotic arm 50 miles away to hand a curved titanium scalpel to his counterpart in a rural surgical suite.

Our senses — the traditional five and countless debatable others — allow us to gather information about the world around us, and also serve as the basis for much of scientific inquiry. We sense. We perceive. We know. We evolve. Join us as we examine the sensorium through the lens of world-class researchers.

BRINGING AROMA AND FLAVOR BACK TO TOMATOES

The smell of oak, soaked that way vaguely sweet and bitter, nothing like pine …

Marianne Boruch
The Luxor Baths

The day Natalia Dudareva walked into her lab and smelled the tomatoes her postdoctoral research associate, Michael Gutensohn, was slicing, she knew they had achieved a milestone.

"It was incredible. Such aroma. Right away I could see the difference," says Dudareva, distinguished professor of biochemistry and distinguished professor of horticulture. And that aroma made her want to taste the tomatoes.

The secret wasn't the sun, the soil or garden location, although those were ideal; the tomatoes were grown in a Purdue horticulture greenhouse. Nor was the secret an agriculturist's breakthrough of some kind; this was the work of a biochemist. The secret was the plant's monoterpenes — a class of volatile compounds that determine smell and taste — which her team increased through metabolic engineering. Their work was done with collaborators in Israel and at the University of Michigan.

From flavorless to flavorful

Dudareva's research addresses a common consumer complaint about commercially grown tomatoes. "In the old days, tomatoes had flavor and aroma," she says. "When they were bred for a long shelf life, flavor was bred out."

She began pondering the scent-taste problem. "And I also asked basic scientific questions," she says. "I think everybody likes to smell and enjoy flavors and not have synthetic fruits and vegetables."

Easier to eat veggies

In this case, aroma and flavor can be improved, as well as the likelihood that people will eat their veggies because they again can appeal to their senses.

"People have to eat more tomatoes. They are one of the most important foods to eat because of their phytonutrients," says Dudareva, who has received nearly $11.5 million in grants for her tomato work and other research. "The trend has been to eat fewer vegetables, and people are not getting enough phytonutrients. Making tomatoes tastier and more aromatic will make people want to eat them and help people get their dietary nutrition."

Dudareva and her collaborators detailed their findings in the cover story of *The Plant Journal* in August 2013.

One challenge addressed, she's now focusing on increasing those phytonutrients in tomatoes. So every bite will not only smell and taste great, but also count more in nutrient value. That is her passion, she says — "discovering new things completely unknown and using these for plant improvement, for added value." | K.M.

PHOTO BY VINCENT WALTER

Natalia Dudareva

PHOTO BY VINCENT WALTER

Savory Results for Wine Aroma Research

With 1,000 bottles of aged wine in Purdue's Enology Library for education and research use, Christian Butzke and former graduate student Alyssa Beatty had the perfect material for their research. They removed minute samples through the wine corks, keeping the bottles intact and unopened, then analyzed the aromas and published an expanded Savory Wine Aroma Wheel.

"We are interested in what happens as wine ages over long periods of time," says Butzke, a professor of enology and a winemaker, who is researching ways to replicate aromas and tastes of old wine without requiring the aging time.

Their new descriptors go beyond traditional terms, such as bacon, soy sauce and beef broth, to include nontraditional scents. Among them: grilled red beets, potato chips and wasabi.

"Our next step is to determine the precursors that cause those savory aromas," says Butzke. "Every winery wants to make more complex, and thus more valuable, wines, so understanding the mechanisms is very important," he says. "Ours is applied research, with true economic impact." | K.M.

Christian Butzke

Byunghoo Jung

PHOTO BY VINCENT WALTER

Arming Cockroaches for Disaster Duty

The lowly cockroach, one of the most reviled insects, could become the world's next hero. Outfitted with tiny sensor backpacks, the cockroaches could be deployed in a swarm to sniff out toxic chemicals or communicate with and locate victims of a nuclear disaster.

A team led by Byunghoo Jung, a professor of electrical and computer engineering, has developed and tested a high-sensitivity, low-power wireless transceiver for insect-based wireless sensor networks. The stout and tank-like roaches — lugging a microcontroller, sensor, antenna and wireless transceiver — can either send data directly to a base station or pass data to other roaches closer to the station.

The project originated as an assignment from the systems company OpCoast to develop a wireless sensor node for the U.S. Army Research, Development and Engineering Command. "Based on the successful development of the prototype, the work is taking steps toward commercialization, led by OpCoast," Jung says. | L.T.

Sniffing Out Danger in Everyday Chemicals

How do the chemicals you're exposed to every day in your environment — like the pungent-smelling herbicides sprayed on crops and lawns — affect your risk of getting cancer? That's the question at the heart of research by Jennifer Freeman.

"This is a very important problem in public health," says Freeman, an associate professor of toxicology. "There is a great lack of knowledge on if and how the large number of environmental chemicals to which we are exposed everyday may influence cancer and other diseases."

Focusing on the herbicide atrazine along with lead and radiation, Freeman and her team are investigating the molecular mechanisms by which adverse health effects occur in both adults and children.

"Most of our studies are focused on early developmental exposures since this is one of the most sensitive life stages," she says. "We study the immediate effects and the potential impacts later in life." Ultimately, she says, that could lead to new disease-prevention measures. | A.R.

Jennifer Freeman

PHOTO BY VINCENT WALTER

J. Andrew DeWoody

PHOTOS COURTESY OF ANDREW DEWOODY

Understanding an Eagle's Sense of Smell

How keen is a bird's sense of smell? Probably much stronger than John J. Audubon once claimed. And when it comes to the golden eagle, whose numbers have been decimated in recent years in heavily populated areas, new findings by Purdue researchers could lead not only to a deeper understanding of their olfactory abilities but also new methods for tracking their survival.

Performing the first-ever genome sequencing of the golden eagle, J. Andrew DeWoody, a professor of forestry and natural resources and biological sciences, and Jacqueline Doyle, a postdoctoral associate, discovered dozens of genes associated with smell. Their sheer number indicates that smell could be more important to eagles than previously thought for activities such as finding prey.

"The sequencing also has identified thousands of genetic markers that can be used for noninvasive DNA monitoring," DeWoody says. By using thousands of genetic markers together as a DNA "fingerprint," researchers could distinguish individual birds, follow them in a population and determine population size flux, parentage and genetic variation. | L.T.

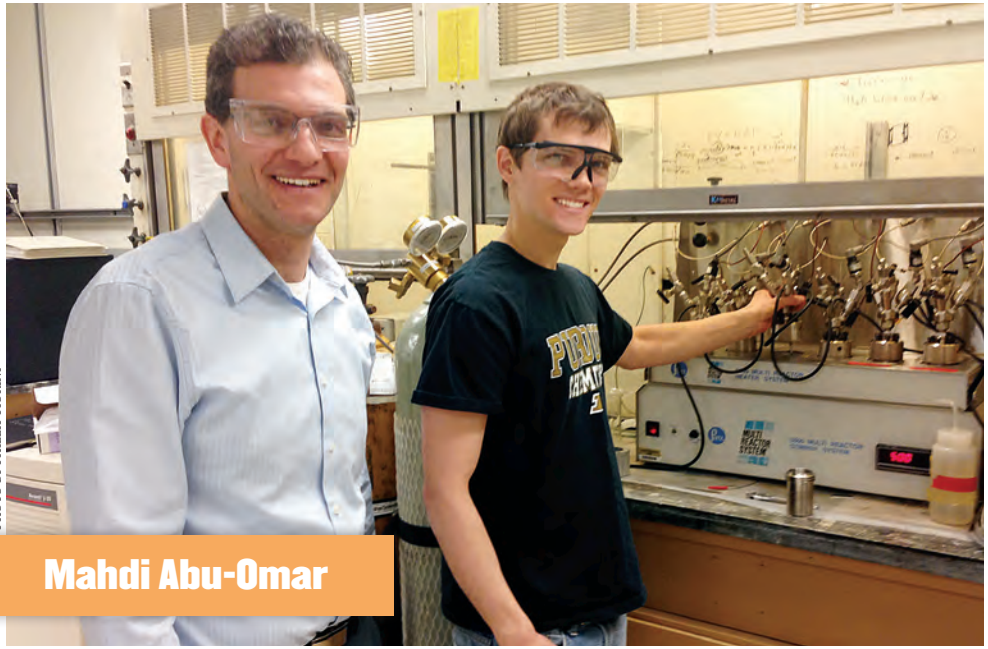


PHOTO BY PHILLIP FIORINI

Mahdi Abu-Omar

Mahdi Abu-Omar and Ian Klein, a doctoral student in Purdue's Department of Chemistry.

From Biofuels to Fragrances

An innovative process for advancing alternative energy from biofuels may have significant applications in the global flavoring and fragrance industry.

Spero Energy Inc., a company launched by Mahdi Abu-Omar, centers on novel catalytic processes for converting waste and lignin in wood biomass to liquid chemical products.

The method produces lignin-free cellulose that can be converted into fermentable sugars and sugar-derived, high-value chemicals.

The process focuses on delignifiying mechanically milled and shredded wood, converting it to methoxypropylphenols with a bifunctional catalyst under mild thermal conditions.

These so-called phenols, which currently are manufactured from petroleum feedstock, are high-value fragrance and flavor compounds, says Abu-Omar, the R.B. Wetherill Professor of Chemistry and Chemical Engineering and associate director of the Center for Catalytic Conversion of Biomass to Biofuels (C3Bio) in Discovery Park.

The family of eugenol and syringol-products Spero will make- high value aroma chemicals are used in the flavor and fragrance industry with global annual production of 47,000 metric ton and a market value of approximately $22 per kilogram. "The lignin-derived Spero products are expected to provide this new company an entry into the aromatic specialty chemicals market," Abu-Omar says. | P.F.

MAINTAINING BONE HEALTH WITH BLUEBERRIES

... your beauty
which is a kind of country.
I take my citizenship seriously.
I handle my passport with care,
your name as ready on my tongue
as body warmth and taste
is there ...

Marianne Boruch
Reasons

Blueberry smoothies, blueberry pancakes, blueberries with fresh whipped cream ... if the sound of these doesn't make mouths water, science might provide another incentive in the future to eat more blueberries, at least among middle-aged and older women: keeping bones healthy.

"We are taking a systematic, deep dive to learn if blueberries are helpful to counter menopause-induced and age-related bone loss," says Connie Weaver, distinguished professor and head of nutrition science. She is principal investigator on a $3.7 million grant from the National Institutes of Health's National Center for Complementary and Alternative Medicine.

Natural products research

"Human studies have not been done before, and this project also will look at what dosage levels protect bone. This is one of the most compelling avenues to pursue in natural products research because blueberries would be preventative and thus reduce the need for osteoporotic drugs and their side effects. "

Blueberries, from the family of vaccinium, are polypheolic-rich plant sources. Previous research in animal models and epidemiological studies show that polypheolics and flavanoids reduce age-related bone loss. Research on this topic is fairly new, with some of the first findings published in 2008.

Team effort

"How bioactive polyphenol metabolites from these berries protects bone is what we will try to answer, and it is our hypothesis that they help the immune system defend against bone loss," says Weaver, an expert in mineral bioavailability, calcium metabolism, botanicals and bone health.

Weaver is collaborating with Mario Ferruzzi, professor of food science and nutrition science. He is known for his work in bioactive food components and phytochemicals in food and assessing their bioavailability and distribution to body tissues. Other team members include George McCabe, professor of statistics, and Elsa Janle, an associate research professor in nutrition science. Investigators from Indiana University School of Medicine also are involved.

"This is a strong interdisciplinary team, and we have the capacity to look at the big picture, from profiling bioactive compounds to understanding the botanical aspects and connecting it all to bone health," Weaver says.

The first phase will focus on genetic screening. The researchers will be working with the Blueberry Genetic consortium who profiled 1200 lines of blueberries for polyphenolic content. We will study the five most different varieties and other varieties of vaccinium including white blueberries and cranberries to determine the most effective. The second phase will evaluate the most effective dosage levels in humans. | A.N.

PHOTO BY VINCENT WALTER

Connie Weaver

Kinam Park

PHOTO BY VINCENT WALTER

A Mocha Tablet for Your Mouth

You're driving down the highway late at night and desperately need something to stay awake. No rest stop in sight? No problem. Reaching for a Caffé Magia French vanilla cappuccino tablet, you dissolve it in your mouth, a burst of coffee flavor melting on your tongue along with 75 mg of caffeine.

The researcher behind this ingenuity is Kinam Park, the Showalter Distinguished Professor of Biomedical Engineering and professor of pharmaceutics. He focuses on transforming drugs, which are basically chemicals, into forms that are dissolvable in the mouth even without any water.

One creation Park already has commercialized is the Frosta fast-dissolving tablets that can melt in your mouth as quickly as 10 seconds, with pleasant taste. His coffee pill, along with a calcium tablet, flaxseed tablet, and a tablet that turns into toothpaste, are currently being made by his company Akina, housed in Purdue Research Park. The Frosta technology has also been used for headache, allergy and other medicines.

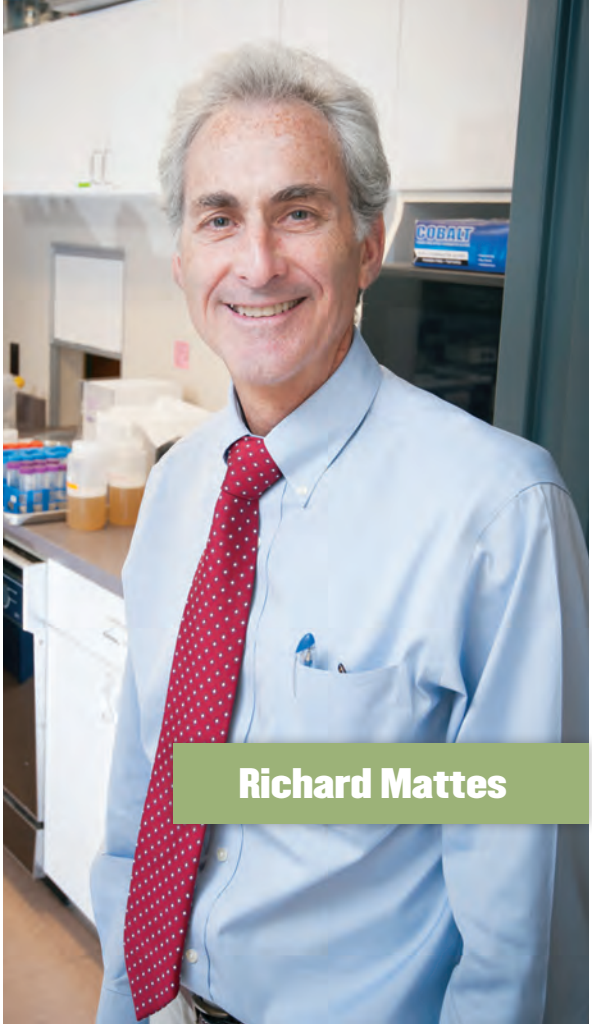
In addition to these fast-dissolving formulations, Park also is developing slow-release, injectable microparticles that can be administered under the skin and last up to six months. Applications range from treatment of macular degeneration to cancer.

"I want to make formulations that help human patients," he says. "When I started 35 years ago, it was the dark age in formulation science. It used to take weeks to make and test microparticles. Now it takes only hours with 3-D milling and 3-D printing devices." | L.T.

From Scab-resistant to Scrumptious

CrimsonCrisp, Pixie Crunch, GoldRush. Meander down to your local apple orchard, and you may discover one of the tasty varieties created by the PRI Apple Breeding Program. A decades-long collaboration between Purdue University, Rutgers University, and the University of Illinois, the program turned out dozens of varieties now popular worldwide for pies, fresh eating and cider.

"CrimsonCrisp, they really like it in Italy and France," says Jules Janick, the James Troop Distinguished Professor of Horticulture



Richard Mattes

PHOTO BY VINCENT WALTER

Examining Fat as a Taste

Is fat a distinct taste? Should it be added to the list of primary tastes: salt, sweet, bitter, sour and umami (savory)? Could the taste of fatty acids be a warning signal that something is rancid or unwholesome fat?

Those are questions Richard Mattes has been asking for two decades, examining the functions of fat taste in health and disease. He's a distinguished professor of nutrition science, co-founder and director of Purdue's Ingestive Behavior Research Center and director of the College of Health and Human Sciences' new public health program.

Once dietary fat is merely tasted, it mobilizes fat stored in intestinal cells from the previous eating event, rapidly elevating triglyceride levels. In one study, Mattes found that exposures of 10 seconds (one taste), 5 minutes (simulating a snack) or 20 minutes (simulating a meal) led to rapid triglyceride rises in 88 percent of participants. His work has also documented the novel finding that fatty acids are detected by the sense of taste (not just the olfactory and tactile senses).

Now, in a new study, Mattes is collaborating with the Denver Museum of Nature & Science to investigate a possible genetic basis for the human ability to taste fatty acids. The study will enroll 3,000 participants over two years to better understand the individual variability in fat taste and how it relates to dietary fat intake and body fatness.

"Understanding the taste of fat will provide insights about our biological systems, how to develop food products to optimize health and improve public health recommendations about diet and chronic disease risk reduction," he says. | L.T.

PHOTO COURTESY OF JULES JANICK

Jules Janick

at Purdue. Other varieties — from the early-ripening, glossy-red Dayton to the late-maturing, deep-red Enterprise and Juliet — are produced by local growers worldwide, all from a program designed to combat the ubiquitous and costly apple scab disease. Organic apples have increased their appeal.

The PRI collaboration began in the mid-1940s with Illinois researchers crossbreeding apples with the naturally scab-resistant crabapple and Purdue screening the cultivars for scab. Janick, who has continued in his own hybrid research since the PRI program ended a few years ago, says that taste, texture and storage ability — not just disease prevention — have always been priorities.

"Apples are for eating, and in the final analysis, they have to be something you relish and enjoy," he says. | A.R.

The Not-So-Sweet Truth about Diet Soda

Ah, the sweet, syrupy taste of diet soda — all that zero-calorie goodness with no ill effects. But new research shows that this dieters' mainstay can actually cause difficulty with metabolism when foods with real sugar are eaten.

Moreover, says Susie Swithers, a professor of psychological sciences and a behavioral neuroscientist, "People drinking one diet soda a day are at increased risk for type 2 diabetes, metabolic syndrome, cardiovascular disease, hypertension and stroke. In some cases, the size of that risk is the same as people who drink one regular soda a day."

Swithers — who previously had discovered that rats occasionally given artificially sweetened drinks were more likely to overeat after a chocolate snack later — came to these conclusions after reviewing a dozen studies on diet soda and health outcomes.

"If you look over the long term, there are really no benefits to drinking diet soda," says Swithers, whose findings were published in a peer-reviewed opinion article in *Trends in Endocrinology & Metabolism*. So should everyone switch to regular soda? That's missing the point, she says: "Our diets have evolved to become unbelievably sweetened and we fundamentally need to cut back." | A.R.

Susie Swithers

PHOTO BY VINCENT WALTER

PHOTO BY VINCENT WALTER

Wayne Campbell

Making a DASH for Lean Pork in Diets

Pork is back on the menu, thanks to Wayne Campbell, professor of nutrition science.

Because of Campbell's research, individuals following the Dietary Approaches to Stop Hypertension (DASH) diet plan will now be able to reintroduce their palates to lean cuts of pork tenderloin, pork chops and all other pork products that contain less than 10 grams of fat and 4.5 grams of saturated fat.

The DASH diet, which limits sodium and red meat while emphasizing fruits, vegetables and fat-free dairy products, was developed for individuals with high blood pressure, diabetes or chronic kidney disease.

"Our research suggests that lean pork may also be a part of this healthy eating pattern," Campbell says.

Campbell's study challenges the recommendation that the DASH dieter should limit all red meat. After randomly assigning 19 overweight or obese adults to either the traditional DASH diet or one that included pork as its main protein source, Campbell determined that lean pork can be successfully included in the heart-conscious diet. | E.S.

CHINESE HERBS, ZEBRAFISH AND THE SEARCH FOR NEW VISION-LOSS TREATMENTS

It's over. Of course,
instantly. But the eye keeps on
seeing it there, the high
bright spill. Seeing it there,
and seeing it, what it was like,
that desire ...

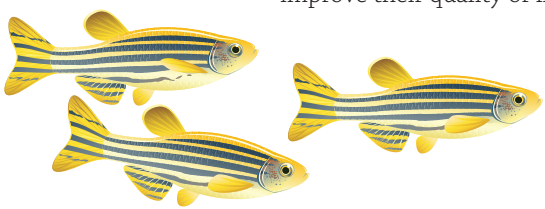
Marianne Boruch
Fireworks at New Year

In the 16th century, at the height of the Ming Dynasty, physician Li Shizhen penned *The Compendium of Materia Medica,* still considered the most comprehensive tome for diagnosing and treating patients using Chinese herbal medicine. In the 1950s, provincial health officials established a 3-D version of sorts of Shizhen's encyclopedic work, creating the Guangxi Medicinal Plants Botanical Garden in Nanning, China, to showcase, study and preserve more than 7,400 medicinal plants.

Yuk Fai Leung, professor of biological sciences, believes that this lush garden of 500 acres may hold a key to new treatments for retinal degeneration, an irreversible condition that affects millions of children and adults worldwide.

Intervention Window

"There are not many effective treatments, but the vision loss is usually a gradual process, which means there is a significant window for intervention," he says. "Drugs or therapies that could slow the progression of the disease could allow people to hold onto their vision longer and greatly improve their quality of life."



Now, an agreement between Purdue and the Guangxi Botanical Garden is giving Leung access to traditional herbs whose active ingredients could be extracted, replicated and turned into potential compounds. He's also working with the Eye Hospital at Wenzhou Medical University to build patient-specific, eye-disease models based on a mutation identified in Chinese patients. And he's leading a collaboration between Purdue, the Joint Shantou International Eye Center of Shantou University and the Chinese University of Hong Kong.

Purdue Lab

Together, they have established a laboratory at Purdue where researchers will use zebrafish to screen compounds that may have visual benefits.

"The partnership connects clinical and basic research so that we can identify a problem in patients, take it back to the laboratory for study, develop and test new therapies, and then bring back a solution to the patients," Leung says. "We hope to pinpoint the compounds in these traditional herbs that are influencing vision and use them as a model to create even more effective and safe compounds for treatment." | A.R.

PHOTO BY VINCENT WALTER

Yuk Fai Leung

PHOTO BY VINCENT WALTER

Zygmunt Pizlo

How to Get Robots to See Like Us

Students in Zygmunt Pizlo's undergraduate psychology class are replacing equations with online demos and animations, engaging in conceptual learning that complements the book he co-authored, *Making a Machine That Sees Like Us*, published by Oxford University Press.

"The book describes our recent work and provides our new view of human 3-D vision, its nature, how it should be studied, and implications for robot vision," says Pizlo, professor of psychological sciences and professor of electrical and computer engineering.

"Symmetry is central to human and robot 3-D vision, and could lead to new connections in math, physics, biology, psychology and even the arts," he says.

The book represents a major paradigm shift in developing robots with human-like sight and decision-making abilities, offering potential benefits for people with vision problems, surgeons and anyone performing risky tasks.

Two patents have been issued. The technology is available for licensing through Purdue Research Foundation's Office of Technology Commercialization. Pizlo also is developing a prototype through his company, Emulatus LLC, which has attracted interest from groups serving people who are blind. | K.M.

A Closer Look at Nanomaterials

Before Ji-Xin Cheng helped develop saturated transient absorption microscopy (STAM), no one could view objects smaller than 300 nanometers.

Now, with this innovative method that can break through the diffraction limit, researchers, clinicians and pathologists can get a closer look at live biological samples that are only nanometers in diameter.

Cheng, a professor of biomedical engineering and chemistry says, "It's a proof of concept and has great potential for the study of nanomaterials, both natural and synthetic."

Cheng was able to surpass the viewing capabilities of conventional optical microscopes by eliminating fluorescent labels. Instead, he uses variously shaped laser beams to highlight specific molecules.

The Trask Innovation Fund has awarded Cheng $50,000 to help commercialize the technology. The fact that researchers can now get their eyes on synthetic nanostructures and molecules could lead to advancements in fields such as medicine and nanoelectronics.

And this label-free technology may eventually allow researchers to view objects that are about 10 nanometers in diameter.

"We are not there yet," says Cheng, "but a few schemes can be applied to further increase the resolution of our system." | E.S.

PHOTO BY VINCENT WALTER

Ji-Xin Cheng

Illuminating Tumors in the Surgical Suite

Philip Low is lighting up cancer detection. Literally.

Low, the Ralph C. Corley Distinguished Professor of Chemistry and co-founder of On Target Laboratories LLC, has developed a new optical imaging technology that illuminates tumors during surgery, giving surgeons the ability to see a tumor 30 times smaller than standard techniques currently allow.

Low, who is also director of the Purdue Center for Drug Discovery in Discovery Park, has accomplished this by creating small-molecule ligands with the ability to seek out receptors that are over-expressed in cancers. These ligands are attached to proprietary fluorescent imaging agents, which cause the cells to emit light and be seen.

"These tumor-targeted probes could help surgeons remove more of the tumor than would have been otherwise possible," says Low.

Recognizing the potential impact of this research, the Pension Fund of the Christian Church and Tom Hurvis, founder of Old World Industries, have invested $15 million in OnTarget Laboratories to enable further development.

"By investing in this technology, we hope to make a contribution to the science that could result in a major step against cancer," says James Hamlett, president of the Pension Fund of the Christian Church. | E.S.

Philip Low

PHOTO BY VINCENT WALTER

Teaching STEM Skills with Exergames

Jumping between flashing lights, racing on scooter boards, hitting a ball against a target – for students in select Indiana and South Carolina schools, creating technology-based exergames that incorporate these activities are getting them to move more while also sharpening their STEM (science, technology, engineering and math) skills.

Called TECHFIT, an acronym for Teaching Engineering Concepts to Harness Future Innovators and Technologists, the program was created by two Purdue and two College of Charleston professors. It's funded with a $1.2 million grant from the National Science Foundation.

Looking at Wii Fit and other video games that rely on body movement, "We wondered how we could use something similar to get kids excited about our academic fields," says Brad Harriger, Purdue professor of mechanical engineering technology.

TECHFIT teacher workshops began in the summer of 2014. Participating teachers are now running 10-week afterschool programs that use technology to create fitness games. At the end of the program, participating teams will gather to show off their innovations.

"This is a unique and immensely beneficial way to address two big concerns — getting more kids to pursue STEM and getting people more physically fit," says Alka Harriger, professor of computer information technology. | K.M.

Brad Harriger

Alka Harriger

PHOTO BY MEAGAN HUGHES

PHOTO BY VINCENT WALTER

Darrell Schulze

Minerva Dorantes and Shams Rahmani

Seeing is Believing

Imagine holding a black-and-white paper map with squiggly lines denoting different soils and comparing that to the hills and valleys you're observing in the landscape.

Now, imagine having an iPad preloaded with aerial photography and maps, and with simple pinch-and-zoom flourishes of your hand, seeing how the wooded ridge you're standing on is part of an immense moraine formed 15,000 years ago when glaciers dominated the Earth.

Thanks to the Isee (Integrating Spatial Educational Experiences) project, the use of Geographic Information Systems (GIS) is revolutionizing how

future soil scientists, agronomists and environmental scientists learn how soils form and change across landscapes. "GIS is helping us teach concepts that would otherwise take students years of field experience to acquire," says Darrell Schulze, professor of soil science and principal investigator.

The Isee project — which also includes a publicly accessible interactive map of Indiana for education and decision-making — was originally created just for Indiana. Now it's being expanded into Wisconsin, Illinois, Kentucky, Ohio, West Virginia and Texas.

"Students in all these states will be able to develop a deeper understanding of soils in the natural environment and the impact that soils have on peoples' lives," Schulze says. |A.R.

PHOTO BY KEVIN DOERR

Vet student practices surgical skills with a video game.

Heather Towle Millard | Lyn Freeman

Linking Video Game Prowess with Veterinary Surgical Skills

Think the teenagers you know are spending too much time playing video games? They might unknowingly be preparing for careers in veterinary surgery.

Dr. Heather Towle Millard, clinical assistant professor of small animal surgery, and Dr. Lyn Freeman, associate professor of small animal surgery, both in Purdue's College of Veterinary Medicine, have found links between video gaming experience and the skills needed to perform laparoscopic surgery.

Typically, surgeons learn laparoscopic surgery techniques by practicing with box trainers constructed of PVC pipe and other inexpensive materials. The researchers decided to see how scores in carefully selected video games correlated with students' performance using the box trainers.

While there was no correlation between video game prowess and traditional surgical skills like suturing, students who scored higher on the test video games also scored higher on the laparoscopic box trainers. That's significant, since video games could help professors identify students with strong potential for minimally invasive surgery.

"A person can be super smart, but then hand-wise, speed-wise, efficiency-wise, they struggle, and it's hard to foster significant improvement in someone who just doesn't have those aptitudes," Millard says. |A.R.

CAPTURING THE VANISHING SOUNDS OF NATURE

Listen to the yard. One song builds and one unravels.

Marianne Boruch
Aubade

Click on the QR code with your mobile device to listen to the sounds of the rainforest, the city and the desert at
www.globalsoundscapes.org.

Purdue ecologist Bryan Pijanowski gained international attention for an Earth Day effort last April to capture soundscapes from citizen scientists. Now, he's leading a research center aimed at preserving the sounds of Earth and highlighting their bellwether role in alerting scientists to environmental habitat changes by species.

Center for Global Soundscapes

Through the new Center for Global Soundscapes in Purdue's Discovery Park, the forestry and natural resources professor and his team examine how animals interact — even across species — amid global habitat modification. They also are developing science-related K-12 education curriculum materials.

"There may be unique soundscapes around the world that, through normal human activities, could be lost forever," he says. "The environmental, social and economical stakes are extremely high, because missing or altered voices in our natural soundscapes tend to indicate broader environmental problems."

For the Record the Earth event on April 22, Pijanowski partnered with international collaborators and media to encourage citizen-researchers to capture natural sound recordings and upload them for preservation during Earth Day 2014.

Nearly 3,000 natural sounds have been uploaded from over 100 countries using mobile apps for iPhone and Android devices.

Sharing Sounds

The Discovery Park center also is collaborating with partners at Purdue and across the globe to advance the three-year-old research field by:

- Producing an IMAX show combining visual and acoustic elements recorded by Pijanowski and his fellow researchers.
- Launching a series of education modules, tablet course packs and online courses for students in grades 5-7 and their teachers.
- Creating an iListen website that will include links to related research, a growing library of soundscape recordings, and other tools for teaching and learning more about the field.

Already, Pijanowski has a library of 500,000 natural recordings from sites in Indiana, Costa Rica (La Selva Biological Station), Sonoran Desert (Arizona), Borneo (University of Brunei Darussalam Research Station), Maine (from the Wells National Estuarine Reserve) and elsewhere.

"All around us, at all times of the day and night, animals from ants, elephants and bats to baboons, lions and birds are participating in orchestration, a key measure of biodiversity," Pijanowski says. "We are using signals, like a detective, to discover what these sounds are all about, to identify species that we heard before and are now silent, missing or moved on. I call it the acoustic heritage of saving our planet." | P.F.

PHOTO BY STEPHEN YANG

Bryan Pijanowski

PHOTO BY VINCENT WALTER

Donna Fekete

Restoring Hearing through Biology

Cochlear implants are engineering marvels, but they come at a cost — a hefty price tag, a lengthy training period, and the chance that the implants either won't work or will destroy remaining hearing in the implanted ear.

Donna Fekete, a professor of biological sciences, wants to give people with hearing loss other options, and she's looking to zebrafish, chicken and mice for some answers. From her laboratory in Lilly Hall, she studies the molecular basis of inner ear development in these three model organisms.

Using direct injection into one-celled zebrafish embryos, Fekete and her team observed that an overexpression of particular microRNAs in zebrafish caused the formation of too many hair cells, the sensory receptors for the auditory system. When microRNAs were repressed, too few hair cells developed.

Once hair cells are gone, they can't be regenerated in mammals like us. So Fekete is examining whether these special microRNAs can be combined with a known hair-cell promoting gene, Atonal-1, to grow new hair cells in mice. The genes are delivered via viruses into the supporting cells, which remain when hair cells disappear. "If we could find exactly what would stimulate those hair cells to grow, the restoration of hearing might be much closer to normal than a cochlear implant," she says. | A.R.

Rap Music as Medicine

The sound of rap music already entertains millions. In the future, it could save the lives of thousands.

Babak Ziaie, a professor of electrical and computer engineering and biomedical engineering, is harnessing rap's driving bass rhythms to power a new type of miniature medical sensor, with potential applications ranging from monitoring incontinence to treating aneurysms.

Babak Ziaie

Ziaie's sensor, a microelectromechanical system (MEMS), employs acoustic waves from music to drive a vibrating device called a cantilever, generating a charge to power the tiny sensor.

Music within a certain range of frequencies, from 200 to 500 hertz, causes the cantilever to vibrate, generating electricity and storing a charge in a capacitor.

A plain tone can also be used, but Ziaie says that he thinks music — rap, classical, jazz, whatever fits the frequency — is more pleasant. | L.T.

PHOTO BY VINCENT WALTER

Joshua Alexander

PHOTO BY VINCENT WALTER

Aids for High Frequency Hearing Loss

Hearing aids have brought the world of sound to life for millions, but people with severe hearing loss still miss the highest frequencies and sounds that inhabit that range, including "s," "th" and "f" because the signal is weakest in that range. Joshua Alexander, an assistant professor of speech, language and hearing sciences, is on a quest to make those sounds audible to the millions of individuals afflicted with this type of hearing loss.

Alexander experienced firsthand the struggles these individuals face while completing a clinical fellowship at Boys Town National Research Hospital in Nebraska. After coming to Purdue, he developed a hearing aid simulator to investigate how sounds are perceived by and then amplified for people wearing hearing aids.

Using this simulator, he is able to manipulate the signals by lowering high-frequency sounds. His frequency-inversion process, driven by perceptual data, is patent-pending and could be adapted in various forms by hearing aid manufacturers.

To help test his hypotheses, Alexander has developed a mobile app that can wirelessly send altered sounds to someone's hearing aid.

"At the end of the day, what motivates my research is the patient. That is the greatest impact from this technology," Alexander says. | L.T.

Opening the Digital World to Sign Language Communication

It's easy for those who can hear and speak to talk to a GPS system or record audio notes on their tablets. "For those who primarily communicate through sign language, these innovations are not available," says Ronnie Wilbur, professor in the linguistics program, College of Liberal Arts, and speech, language and hearing sciences, College of Health and Human Sciences.

Technology, particularly automating tasks for sign-based dictation, is a high priority in her lab, the only Midwest sign language research center. Grants from the National Institutes of Health and National Science Foundation have furthered Wilbur's investigations into syllable structure, grammatical facial expression and word order and how to use those sign language components in digital innovations.

She earlier co-developed MathSigner, a PC-based tool using 3-D animated signers to teach students and parents sign language for K-4 mathematical concepts. She's also collaborating on an NIH project using computational techniques to perform automatic signed facial grammar recognition.

"We are focusing on investigating aspects of speech that remain unknown for sign languages," Wilbur says. "They include how signs are perceived by viewers and how they are produced by signers — both comparable to speech recognition — and the grammar that mediates between perception and production so messages are understood." | K.M.

PHOTO BY VINCENT WALTER

Ronnie Wilbur

Anne Smith | Christine Weber-Fox

What the Brain Can Tell Us About Stuttering

Clutching a toy polar bear, a 4-year-old wearing an elastic electrode cap watches an adapted clip from *Pingu the Penguin* as his brain waves (EEG) are being recorded.

While he's concentrating on the video, Christine Weber-Fox, Anne Smith and their graduate students wonder what his brain activity may tell them about stuttering in young children. With a new $3 million grant from the National Institutes of Health, they're searching for physiological signatures that could indicate which children are at greatest risk for developing a chronic stuttering problem. Their goal: to develop a screening tool so that speech therapists can better identify which preschoolers are not likely to recover and need therapy immediately.

PHOTO BY VINCENT WALTER

"Children whose stuttering persists also lag in development on speech sounds, speech motor coordination and brain functions for processing language, but more research is needed to identify how measures like these can serve as predictive factors," says Weber-Fox, a professor of speech, language and hearing sciences and a cognitive neuroscientist.

"Speech therapy resources are not necessary for every young child who stutters, but the let's-wait-and-see approach is missing children who could benefit from early intervention," adds Smith, a distinguished professor of speech, language and hearing sciences. | A.R.

Everyday Technology that Helps All Students

LeapFrog's brightly hued Tag reading pens — which sound out letters and words — give students with special needs a boost in reading abilities, confidence and social skills. Popular devices like these also eliminate divides among children with varying skill levels in classrooms, says Emily Bouck, associate professor of educational studies.

"Using socially desirable technologies as assistive technology, you reduce stigmatization," explains Bouck, who's co-authored papers on the subject for *The Journal of Special Education Technology* and *Preventing School Failure: Alternative Education for Children and Youth*.

Seeking popular innovations to repurpose, Bouck also has identified cell phone calendars, alarms and calculators; iPod audio and video prompts; response clickers; and educational apps, all with positive results.

Students can use cell phone calendars and alarms to remind them about homework, classroom activities and other things they need to remember. The audio or video prompting can give students a list of tasks, steps to be completed in the tasks or simple reminders. The clicker response systems are an avenue for self-monitoring.

The range of educational apps is ever-growing, with many providing visual, auditory and tactile learning opportunities, Bouck reports. Another potential aid is the smart pen, which records lectures and conversations while students also take notes. Apps, too, are available for smart pens.

PHOTO BY VINCENT WALTER

Emily Bouck

"When we implemented everyday technology in an elementary school, we had students who were not in special education ask to come to the resource room because they wanted to use the technology," Bouck says.

At another school, students with disabilities using popular devices have taught other students how to use them. "To me, that is empowering," she says. | K.M.

REVOLUTIONIZING RURAL SURGERIES WITH ROBOTS

... For now, it's daylight
and glare. And water run. To dip
a hand from the boat, a semisweet
stinging. The air's cut
through thousands of spruce
to get here and smell
like this ...

Marianne Boruch
The loon with two chicks

Highly specialized surgical expertise tends to collect in major medical centers and metropolitan areas, which is a problem if you're one of the millions of people not living in one. Industrial engineering assistant professor Juan Wachs and computer science associate professor Voicu Popescu considered this challenge of rural America as an opportunity. They proposed a new telementoring system using robotics and augmented reality to enable surgeons in rural areas to receive expert training in real-time without losing any benefits of an in-person, trainer-trainee relationship. It's called STAR (System for Telementoring with Augmented Reality).

Putting technology together

STAR combines Wachs' gesture recognition and robotics research, Popescu's augmented reality research, and trauma surgery guidance from Dr. Gerry Gomez, chief trauma surgeon at Eskinazi Health in Indianapolis. "All of this technology either exists or has been discussed in the industry, but nobody has put it together to create the experience," Wachs says.

In current systems, both the surgeon mentor and mentee use headsets and laptops to view and communicate. "It works, but it's not the most natural way for surgeons to work," says Wachs. STAR will use augmented reality to give the mentor a projected patient on a table. The mentee will use a tablet over the patient as a window, with the mentor's guidance appearing onscreen so his eyes are always on the patient. STAR includes the TAURUS robot, whose arms and hands will act as the mentor's hands in the operating room, assisting, pointing things out and handing tools, just as an in-person mentor would.

Far-reaching impact

Purchased from the Executive Vice President for Research and Partnership equipment grant and in collaboration with professors Howard Zelaznik, Bradley Duerstock, Eugenio Culurciello, Fabian Winkler, C.S. George Lee, Cheryl Zhenyu Qian and Heather Towle Millard, TAURUS' impact won't just be felt at home. It is also poised to revolutionize battlefield surgery, where time is of the essence and flying a patient to the nearest expert may be infeasible.

"This system means that surgeons can perform more specialized operations in the field because they can have access to real-time specialist guidance. TAURUS is also much smaller than many surgical robots, which makes it more practical for field hospitals," he says.

Wachs' team recently received a grant from the U.S. Armed Forces to make STAR a reality. They expect to spend three years developing the technology before beginning tests. | A.Z.

PHOTO BY VINCENT WALTER

Juan Wachs

PHOTO BY VINCENT WALTER

Karthik Ramani

Hands-on

Although perhaps begrudgingly, many artists have grown accustomed to pointing and dragging when using desktop design programs. But what if it were possible to use the same movements they'd use when drawing by hand to create art in three dimensions?

That's the premise behind the C Design Lab, where Karthik Ramani and his team have created zPots, which allows users to create polished, colorful and 3D print-ready pottery in minutes.

"The recent success of tablets and depth cameras is a direct example of the importance of using natural interactions to create simple and more interesting virtual experiences," says Ramani, the Donald W. Feddersen Professor of Mechanical Engineering and a professor of electrical and computer engineering (by courtesy). Leveraging such intuitive technology, his team also has developed skWiki, in which web users can collaborate on hand-drawn sketches; Juxtapoze, which allows users to combine pieces of clip art; and ChiRobot, in which children can build toys and quickly animate them using their hands.

Such technology can open up art to people who don't think of themselves as creative, Ramani says: "Everybody is a maker. By using more of these natural interactions, we can create more modalities of collaboration, and whatever comes out of it is totally new." | A.R.

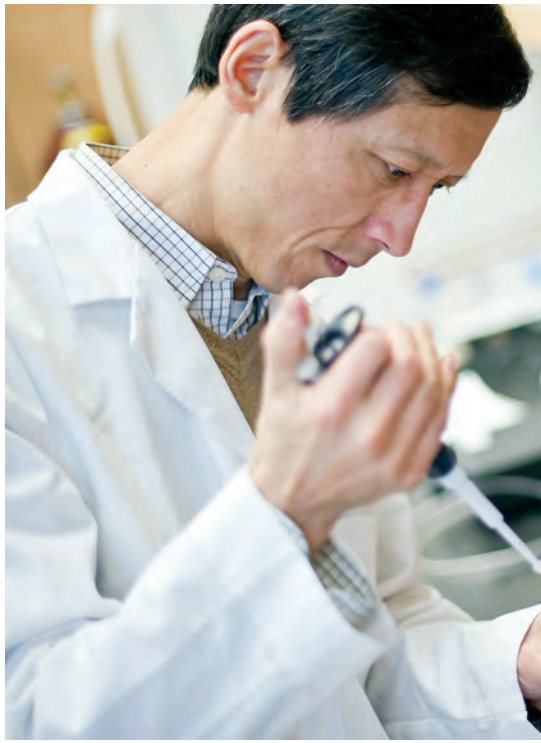
Graduate students use hand gestures and motions on a simple tabletop to input various commands into the computer at Purdue's C-Design lab directed by Professor Ramani. Infrared depth sensors (in the white bar on the table's far side) measure the position of hands and fingers in 3-D space. An image-processing algorithm tracks and interprets hand gestures and motions over time.

PHOTO BY MARK SIMON

Lessening the Pain of Touch

Paralysis can be difficult enough, but coupling that with chronic neuropathic pain can be agonizing.

"If you look at the quality of life of people with spinal cord injury, most people say that killing the pain is the No. 1 priority," says Riyi Shi, a professor of neuroscience and biomedical engineering in Purdue's Department of Basic Medical Sciences, College of Veterinary Medicine, and Weldon School of Biomedical Engineering. "In a chronic pain situation, a stimulus that ordinarily might feel pleasant, even just a little touch, could cause pain."



In collaboration with the Indiana University School of Medicine, Shi has discovered that when a traumatic injury occurs to nerve cells, the neurotoxin acrolein is produced in the body, triggering a cascade of biochemical events that appear to worsen the injury's severity. When laboratory rats with high levels of acrolein were given the hypertension drug hydralazine, however, their acrolein levels, and, subsequently, their pain, diminished.

Now, Shi has developed a patent-protected mechanism of action that identifies and lowers acrolein levels. "This could be promising news for millions of spinal cord injury victims who may suffer from debilitating pain," says Shi, who's founded the company Neuro Vigor LLC to conduct clinical trials and commercialize the innovation. | A.R.

Riyi Shi

PHOTO BY ANDREW HANCOCK

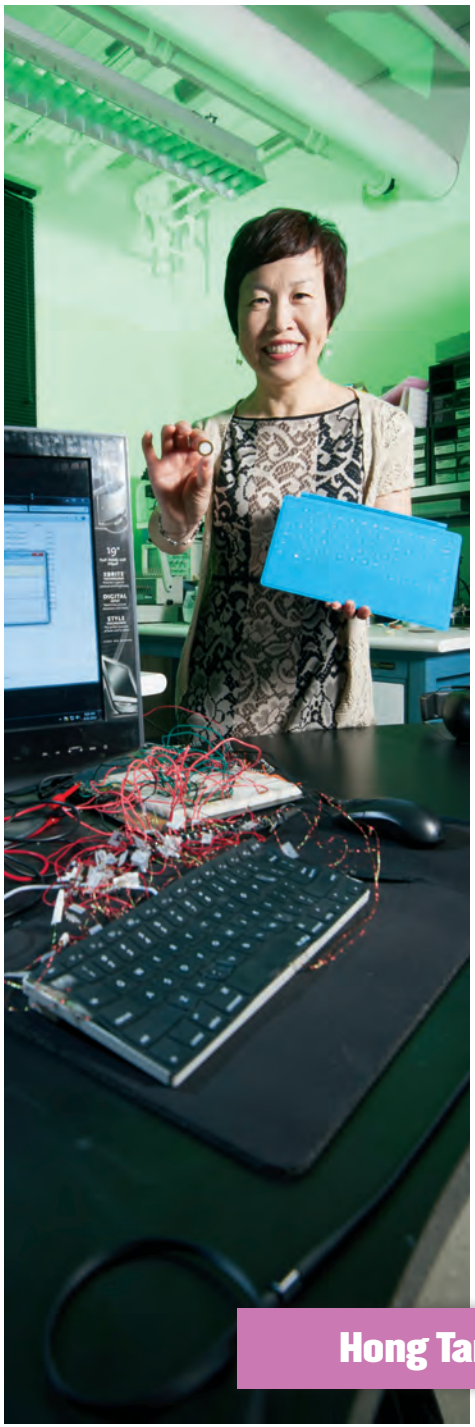


PHOTO BY VINCENT WALTER

Hong Tan

Haptics Research and the Virtual Touch

Imagine sending your loved one an intimate message with a secret touchpad stroke or sitting at home and touching the Mona Lisa painting. The world of virtual touch is at the heart of haptics research being undertaken by Hong Tan, a professor of electrical and computer engineering.

Tan, who is on a research leave with Microsoft Research Asia in Beijing, is developing technologies that let users feel a sensation on a piece of flat glass similar to what they currently feel when striking a movable key. Studies show that haptic keyclick feedback is more effective than other feedback mechanisms (for example, a sound) at increasing typing speed and decreasing error rate.

"We over-rely on our vision when we interact with computers, yet people are multisensory animals; we are used to experiencing the world through sight, sound, touch, smell and taste," Tan says. "By creating technologies that allow us to feel, in addition to touch, a computer screen, I hope that we can make human computer interaction a bit faster, more enjoyable, more natural and more graceful." | L.T.

Amanda Seidl

Learning Language through Touch

How do babies learn the words for body parts at such a young age when they can't identify where words start and end? Does touch from their caregivers affect how they learn and give meaning to words?

Amanda Seidl, professor of speech, language and hearing sciences, set out to answer these questions.

Seidl's student researchers played a continuous stream containing three-syllable, made-up "words" to young infants. While the infants listened to this string, they also received tactile stimulation from an experimenter. For example, for some infants, whenever "doh-be-tah" was played, they received a touch from the experimenter on their knee. When "lay-po-gah" was played the infants got touched once on their elbow, but all other elbow touches occured during different syllable sequences. Thus, touch with "doh-be-tah" was more reliably linked with the sequence of syllables than touch with "lay-po-gah".

Afterward, when tested on their language preferences, almost all of the infants recognized "doh-be-tah," but they failed to show a similar recognition of "lay-po-gah."

"We take this to mean that babies can use tactile cues and they can use them in a way that is contingent upon speech that they are hearing," Seidl says. | S.A.

PHOTO BY VINCENT WALTER

Marie Elizabeth Grávalos

PHOTO BY REBECCA BRIA

Researching Ancient Andean Textiles

Grasping a piece of thousand-year-old fiber with a gloved hand, anthropology doctoral student Marie Elizabeth Grávalos prepares to analyze it under a microscope. Through several trips to the mountainous Ancash region of Peru, Grávalos has unearthed textiles that reveal "many rich and diverse art styles."

One significant finding is from the complex woven textiles excavated at the site of Hualcayán. "These were recovered from mortuary contexts and dated approximately 1 to 1000 CE," she says. Using technical attribute analysis, she found that single communities of weavers tended to produce relatively homogenous textiles.

Grávalos, who presented her research at the 2014 Society for American Archeology conference, attributes the commonalities to shared technical knowledge and uniformity in textile production.

"Archeology allows us to consider the activities of individuals who lived in the past, something that is of critical importance for the development of new technologies, innovations and forms of social and economic organization."

With that in mind, she plans to conduct community outreach with "local contemporary weavers to develop alternative economic resources for agrarian communities, particularly women." | K.M.

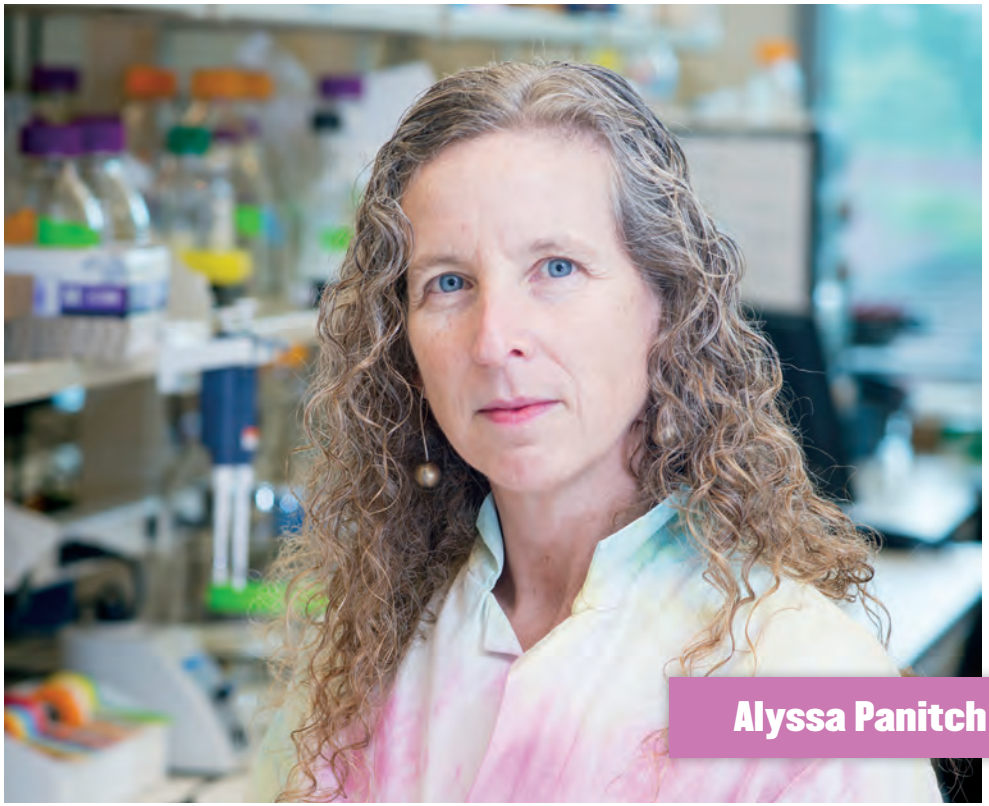


PHOTO BY VINCENT WALTER

Alyssa Panitch

Slowing the Progression of Osteoarthritis

Osteoarthritis (OA) affects over 27 million Americans and millions of others around the world. It's characterized by the breakdown of the protective molecule aggrecan, a protoeglycan which helps to cushion joints. When that cushioning is lost, inflammation, pain and stiffness can occur, ultimately making it difficult to do everyday activities like taking a short walk or bending over to tie your shoes.

But while physicians can treat OA with anti-inflammatory pills, joint injections and knee replacement surgery, little progress has been made in slowing or reversing its progression.

That's where biomimetics — synthetic materials that mimic biomolecules — could help. Alyssa Panitch, the Leslie A. Geddes Professor of Biomedical Engineering, has developed a biomimetic proteoglycan that, in the laboratory, resists cartilage degradation and interrupts the inflammatory cycle of osteoarthritis. She's licensed the therapy to San Francisco-based SYMIC Biomedical.

"We really want to add to the knowledge that creates something to improve human well-being," says Panitch. Up next for her: formulating the peptidoglycans for delivery to injured joints. | L.T.

AWARDS


Marianne Boruch


Jay Melosh


Ei-ichi Negishi


Jan Allebach

Poet Honored with Purdue's 2014 Research and Scholarship Distinction Award

English professor and award-winning poet **Marianne Boruch**, who developed and directed the master of fine arts program in creative writing from its inception in 1987, until 2005, is the recipient of the 2014 Purdue University Research and Scholarship Distinction Award.

The Research and Scholarship Distinction Award is the most prestigious research honor outside the natural sciences given by Purdue University. The award recognizes Boruch for her considerable contributions to the school of American poetry, for bringing national and international recognition to Purdue through her work, and for advancing poetry as an artistic, philosophical and spiritual force.

Boruch came to Purdue in 1987 as an English professor, to teach and to direct the new graduate program in creative writing. Her work includes eight collections of poetry, two books of essays on poetry and a memoir. She has been published in such places as *The New Yorker*, *Poetry*, *The Nation*, *Poetry London*, *The Paris Review*, *American Poetry Review* and *Poetry 180*. Her most recent book of poems, *Cadaver, Speak,* was released in April.

As the 2014 award recipient, Boruch delivered the keynote address at the Purdue Research and Scholarship Distinction Distinguished Lecture.

"I'm surprised and grateful to have been chosen for this award by my colleagues. More importantly," Boruch said. "I am pleased the University has honored liberal arts on campus in this way – and poetry, in particular."

Crater Expert Selected as Purdue's 2014 McCoy Award Winner

Jay Melosh, internationally known for his work on impact cratering, planetary tectonics, and the physics of earthquakes and landslides, is the 2014 recipient of the Herbert Newby McCoy Award, the most prestigious research honor in the natural sciences given by Purdue University.

Melosh, a distinguished professor in the College of Science's Department of Earth, Atmospheric and Planetary Sciences, also has professorship appointments with the Department of Physics and Astronomy and the School of Aeronautics and Astronautics.

Melosh's research focuses on numerical modeling of the physics and chemistry of impacts at scales ranging from the Deep Impact event on comet Tempel 1 to the Mars-size object that impacted the Earth 4.5 billion years ago and created our moon. He also studies the exchange of microorganisms between the planets and the origin of life. His recent research includes studies of the K/T impact that extinguished the dinosaurs and the ejection of rocks from their parent bodies.

"I'm certainly honored and humbled to join the fraternity of past McCoy Award winners at Purdue University who share a love of research and celebrate those days in the laboratory with our students when we realize we might be onto something that will provide a deeper understanding of our universe," Melosh said.

Purdue Professor and Nobel Laureate Elected to National Academy of Sciences

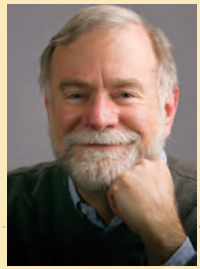
Purdue University Nobel laureate **Ei-ichi Negishi** has been elected into the National Academy of Sciences, one of the highest honors given to a scientist or engineer in the United States.

Negishi, the Herbert C. Brown Distinguished Professor of Chemistry and Teijin Limited Director of the Negishi-Brown Institute, was elected to the academy as a foreign associate in recognition of his distinguished and continuing achievements in original research. He will be inducted into the academy at its next annual meeting.


Gebisa Ejeta


Robert Geahlen


Ananth Grama


Jeffrey Lucas

Negishi, a citizen of Japan, won the 2010 Nobel Prize in chemistry for his palladium-catalyzed cross coupling technique to link carbon atoms and synthesize molecules. In addition to its use in the development of the painkiller naproxen and the cancer treatment taxol "Negishi coupling" is estimated to be used in more than one-quarter of all chemical reactions in the pharmaceutical industry. The technique also has been used in fluorescent marking essential for DNA sequencing and in the creation of materials for thin LED displays.

National Academy of Engineering Elects Purdue Professor

Jan Allebach, the Hewlett-Packard Distinguished Professor of Electrical and Computer Engineering has been elected to membership in the National Academy of Engineering (NAE).

Election to the NAE is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made outstanding contributions to "engineering research, practice or education, including, where appropriate, significant contributions to the engineering literature" and to the "pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering or developing/implementing innovative approaches to engineering education."

In its announcement of his election and that of 66 other new members and 11 foreign associates, the NAE cited Allebach's work in developing algorithms for digital image half-toning for imaging and printing.

Ejeta Appointed to U.N. Scientific Advisory Board

Distinguished professor of agronomy and World Food Prize laureate **Gebisa Ejeta** has been appointed to a newly created United Nations Scientific Advisory Board.

The appointment by U.N. Secretary-General Ban Ki-moon places Ejeta as the only agricultural scientist on the 26-member board. It is composed of internationally renowned scientists representing various fields of natural, social and human sciences.

The board will provide advice on science, technology and innovation for sustainable development to the secretary-general and executive heads of relevant United Nations organizations. Some key objectives will be to strengthen the link between science and policy and to ensure that the latest scientific findings are reflected in high-level policy discussions within the U.N.

"It is a great honor and responsibility to have the chance to work at the highest level of global science policy and diplomacy," Ejeta said. "I will try to be a good ambassador of agricultural sciences to uphold the indispensability of food and agriculture, and to impart that feeding humanity sustainably in the foreseeable and unforeseeable future is the ultimate responsibility of all nations. I hope to make a difference."

Three Purdue Professors Elected as AAAS Fellows

Three Purdue University professors were awarded the distinction of fellow from the American Association for the Advancement of Science, the world's largest general scientific society.

The distinction recognizes their notable work to advance science or its applications, and fellows are elected by peer members. The fellows from Purdue are:

Robert Geahlen, distinguished professor of medicinal chemistry for distinguished contributions to the field of receptor signaling;

Ananth Grama, professor of computer science, for distinguished contributions to the field of high-performance computing and computational science; and

Jeffrey Lucas, professor of biological sciences, for distinguished contributions to animal behavior, optimality modeling, and animal communication.

These new AAAS members bring Purdue's total to 57.

AWARDS

President Barack Obama with PECASE award winners including Jeffrey D. Karpicke and Tamara Moore

Peter Kissinger

Researchers Honored with Presidential Early Career Awards

Jeffrey D. Karpicke, the James V. Bradley Associate Professor of Psychological Sciences, and **Tamara Moore**, an associate professor of engineering education, are among the 102 recipients that were honored by the White House in 2014 with Presidential Early Career Awards for Scientists and Engineers.

The award, also known as PECASE, is the highest honor bestowed by the U.S. government on science and engineering professionals in the early stages of their independent research careers.

Karpicke, who was nominated by the National Science Foundation and the Department of Education, is a cognitive scientist whose research has shown that students who use retrieval practice, which is a form of self-testing, retain the information longer and learn better, compared to students who reread their notes.

Moore was nominated by the NSF for work done at the University of Minnesota. She joined the Purdue faculty in 2013. Her research and teaching interests are centered on integrating the STEM (science, technology, engineering and mathematics) fields in K-12 classrooms.

"The impressive achievements of these early-stage scientists and engineers are promising indicators of even greater successes ahead," President Barack Obama said. "We are grateful for their commitment to generating the scientific and technical advancements that will ensure America's global leadership for many years to come."

Commercialization Award Affirms Lifetime of Innovation

Peter Kissinger, a professor of analytical chemistry, received the Outstanding Commercialization Award for Purdue University Faculty for 2013.

The award is given annually to a faculty member in recognition of outstanding contributions to, and success with, commercializing Purdue research discoveries. It was established with an endowment gift from the Central Indiana Corporate Partnership Foundation.

Kissinger is the founder of Bioanalytical Systems Inc., which he led from 1974-2007. BASi manufactures instrumentation for pharmaceutical research and carries out contract bioanalytical, pharmacological and toxicological research for pharmaceutical and biotechnology companies. It has headquarters in West Lafayette and operations in Evansville, Ind.

"I am delighted to be recognized in this way, but the ventures I've been involved with would have been impossible without the great people we have here in Indiana as employees, collaborators, vendors, investors and friends," Kissinger said.

Three Honored for Excellence in Teaching, Research, Engagement

Three Purdue faculty members were honored with Morrill Awards in 2014 for demonstrated excellence in teaching, research and engagement missions. They are **Rakesh Agrawal**, the Winthrop E. Stone Distinguished Professor of Chemical Engineering; **Philip Low**, the Ralph C. Corley Distinguished Professor of Chemistry; and **Edward Delp**, the Charles William Harrison Distinguished Professor of Electrical and Computer Engineering and professor of biomedical engineering.

Agrawal's research has made a series of long-lasting contributions to energy harvesting, including its transformation and use. He has established a world-class solar research lab at Purdue, and his research group has attained the world's second-highest power conversion efficiencies for solution processed solar cells. An acclaimed teacher, he has created several research teams at Purdue that have secured multimillion-dollar grants for wide-ranging projects.


Philip Low


Rakesh Agrawal


Edward Delp


Michael Ladisch

The director of Purdue's Center for Drug Discovery, Low has more than 340 publications and 50 active patents to his name. More than 70 of his laboratory students have received Ph.D.s from Purdue, and he is known for guiding his students and inspiring them to advance their research. Low also is known for his pioneering tumor-targeting technologies that allow delivery of both imaging and therapeutic drugs selectively into cancer cells. Applications of these novel technologies currently in the clinic include agents for the treatment and fluorescence-guided surgery of lung, ovarian, kidney, prostate and endometrial cancers.

A Purdue faculty member since 1984, Delp has achieved worldwide acclaim for his work related to image and video processing. He was one of the first researchers to investigate multimedia security and he is a sought-after expert who has worked with the U.S. Department of Defense, U.S. Department of Homeland Security and other federal and state agencies. He has developed 12 courses related to the subject at Purdue and has received numerous teaching awards.

Distinguished Professor Honored by BioCrossroads

BioCrossroads has honored **Philip Low**, the Ralph C. Corley Distinguished Professor of Chemistry, with the 2013 August M. Watanabe Life Sciences Champion of the Year Award.

The prestigious honor named in tribute to BioCrossroads' late first chairman is given annually to an individual or organization that has made or enabled unique achievements in the development and promotion of Indiana's life sciences research, educational or economic advancement.

Low has received several national and international awards, including a National Institutes of Health MERIT Award and Purdue University's award for outstanding research. In addition to his work at Purdue University, Low also has guided the discovery and development of seven drugs that are currently in human clinical trials for imaging and therapy of various cancers and has founded two companies (Endocyte Inc. and On Target Laboratories LLC) focused on commercialization of these and other targeted drugs. He also has been involved in two other Indiana startup companies.

"Phil Low has the remarkable combination of being a success in the academic halls, the research lab and the entrepreneur's office. His passion for bringing scientific discoveries to the market to improve health and well-being has enabled him to start companies here in Indiana and to develop breakthroughs in the treatment of cancer," said David Johnson, president and CEO, BioCrossroads.

Two Profs Named Fellows of Inventors' Organization

Two Purdue professors have been named fellows of the National Academy of Inventors (NAI):

Rakesh Agrawal, the Winthrop E. Stone Distinguished Professor in the School of Chemical Engineering, and **Michael Ladisch**, Distinguished Professor in the Department of Agricultural and Biological Engineering and Weldon School of Biomedical Engineering and director of Purdue's Laboratory of Renewable Resources Engineering (LORRE).

They are among 143 new members who were recognized during an NAI induction ceremony on March 7 at the U.S. Patent and Trademark Office headquarters in Alexandria, Va.

Agrawal holds 120 U.S. patents and has authored 138 technical papers. In 2011 he received the National Medal of Technology and Innovation from President Barack

AWARDS


Liping Cai


Makarand Hastak


Jon Harbor


Ali Shakouri

Obama. In 2013 he was elected to the American Academy of Arts and Sciences, one of the nation's oldest and most prestigious honorary societies.

Ladisch is author of two textbooks, 225 journal papers and book chapters, and 20 patents. He is a member of the National Academy of Engineering, received the Charles D. Scott Award in 2009, elected fellow of ACS and AAAS in 2011, and is on the Board of the Foundation for Food and Agriculture Research. His research is in bioprocess engineering, bioseparations, biofuels and pathogen detection.

Three Gain Leadership Skills as ACE Fellows

Three professors are undertaking studies relevant to Purdue — multicultural learning, innovative financing and summer/year-round study — as American Council on Education (ACE) Fellows.

Liping Cai, associate dean of the College of Health and Human Sciences and a 2013-2014 fellow, is examining international faculty and students as resources in advancing students' global and multicultural learning. He has interviewed representatives at Georgia State University, his host institution. At Purdue, Cai also is a professor and director of Purdue's Tourism and Hospitality Research Center.

Makarand Hastak, civil engineering professor, head of the Division of Construction Engineering and Management and a 2013-2014 fellow, is applying his construction management skills to help Purdue identify alternate strategies for budget streamlining, deferred maintenance and other finance strategies. He has met with senior leaders at several universities to learn their approaches.

Expanding summer/year-round study is the focus of 2014-2015 fellow **Jon Harbor**, a professor of earth, atmospheric and planetary sciences. He is eyeing efficient, effective summer use of campus resources and a possible year-round calendar for Purdue.

ACE fellows participate in a concentrated year of retreats, interactive learning, campus visits and other opportunities to help their home institutions with specific projects and to prepare them for senior leadership.

Shakouri Receives THERMI Award

Developing and commercializing high-resolution thermal imaging systems and researching nanoscale heat and current transport in semiconductors, micro refrigerators and waste-heat recovery all contributed to **Ali Shakouri** joining the elite cadre of THERMI Award winners.

He received the annual award, the 24th ever bestowed, at the 2014 Thermal Measurement, Modeling & Management Symposium.

As the Mary Jo and Robert L. Kirk Director of Discovery Park's Birck Nanotechnology Center and a professor of electrical and computer engineering since 2011, Shakouri coordinates activities of more than 300 faculty, staff and graduate students from 36 Purdue schools and departments who are advancing research in nanoscale science and engineering.

THERMI award winners are selected by earlier recipients and the current general chair of the SEMI-THERM Educational Foundation, which provides educational opportunities and resources worldwide.

Shakouri previously served on the faculty at the University of California, Santa Cruz, and co-founded Microsanj, a semiconductor business.

Pastakia Earns Pharmacy Award for Exemplary Leadership

Seeking someone likely to emerge as a major leader in pharmacy — and with fewer than 10 years in the profession — the Phi Delta Chi Pharmacy Leadership and Education Institute found the perfect candidate at Purdue University: **Sonak Pastakia**.


Sonak Pastakia


Adam Wasserman


Wayne Campbell


Eugene Spafford

An associate professor of pharmacy practice who earned his doctorate of pharmacy in 2004, Pastakia received the Albert B. Prescott Pharmacy Leadership Award in 2014, announced at the American Pharmacists Association annual meeting.

In his role with the Purdue Kenya Partnership since 2007, he has helped provide and expand access to previously unavailable healthcare services for some 3.5 million people in Kenya. He works alongside Kenyan providers to expand their professional roles well beyond dispensing medications to implementing novel models of contextualized care for rural patients.

Pastakia chose William Ogallo, a graduate of the Purdue Kenya Partnership, to give the annual meeting lecture.

Wasserman Receives Sloan Research Fellowship

Early-career scholars "representing the most promising scientific researchers working today" win Sloan Research Fellowships. In 2013, **Adam Wasserman** was one of only 126 chosen from the United States and Canada.

An assistant professor of physical/theoretical chemistry, Wasserman is interested in understanding the role that electron-electron interactions play in chemistry, and in developing new theoretical tools to help guide and interpret experiments in which electron correlations are essential. He also focuses on extending density functional methods to be applicable to larger systems and longer times, and he is studying the foundations of chemical reactivity theory.

Wasserman earned his doctorate in 2005 at Rutgers University and was a postdoctoral fellow for three years at Harvard University.

A philanthropic, grant-making institution, the Alfred P. Sloan Foundation is dedicated to supporting original research and broad-based education in science, technology, engineering, mathematics and economic performance. It has been awarding fellowships since 1955.

Campbell Helps Set New Dietary Guidelines

Whether a pyramid, a plate or another creative visual will illustrate the next U.S. Dietary Guidelines for Americans is not yet known. Whatever the choice, the guidelines will reflect the work of **Wayne Campbell**, a Purdue professor of nutrition science.

Campbell is one of 14 scientists chosen in May 2013 to serve on the committee preparing the 2015 edition of the guidelines, which are evaluated every five years. Its charge: review current scientific and medical knowledge and make recommendations.

"I'm very impressed with the rigor of the scientific reviews, reliance on systematic reviews of literature and consistent transparency of the process," Campbell says. "It's important in guiding nutrition programs."

He brings expertise in evaluating the impact of protein, carbohydrate, energy intakes and exercise on macronutrient metabolism, body composition, and muscle strength and function, as well as research in food form, portions and dietary patterning on appetite and weight control.

Spafford's Cyber Security Success Hailed

Two announcements put **Eugene H. Spafford**, the Center for Education and Research in Information Assurance and Security (CERIAS) and Purdue University in the spotlight in 2013.

The first named the computer science professor and CERIAS executive director to the National Cyber Security Hall of Fame as among "the best and the brightest" who "helped define an industry and secure a nation," says Mike Jacobs, chairman. Spafford was one of five chosen from 250 nominations.

AWARDS

Chris Greene

Jonathan Wilker

Spafford also received the Harold F. Tipton Lifetime Achievement Award from (ISC)², a nonprofit organization that educates and certifies information security professionals. It recognizes his years of achievements. "His work has propelled us light years ahead of where we would be without his contributions," awards committee chair Corey Schou says.

"For most of my 27 years at Purdue, I have been trying to increase our trust in computing systems deployed in critical situations and to improve the educational process to allow us to produce experts who can add to that trust," Spafford says.

"My efforts have been focused not only at Purdue, but in the community at large. It has not been a solo effort, but one that several others have joined in as an undertaking."

'Giant' Molecules Win Purdue Professor Hamburg Prize for Theoretical Physics

Chris Greene, the Albert Overhauser Distinguished Professor of Physics, has won the 2013 Hamburg Prize for Theoretical Physics for his work on "giant" molecules.

Greene was honored for his theory of an unusual binding mechanism in ultracold quantum gases and the existence of huge Rydberg molecules, electronically excited molecules that behave in unique ways and can exhibit exaggerated sizes. His prediction, published in 2000 with coauthors Alan Dickinson and Hossein Sadeghpour, helped to trigger the experimental discovery of these unusual Rydberg molecules in 2008.

The prize, which is jointly awarded by Joachim Herz Shiftung and the Hamburg Centre for Ultrafast Imaging (CUI), includes $53,444 and a research and teaching visit at the University of Hamburg.

"In being awarded the Hamburg Prize, Chris joins a very elite group of physicists who have made fundamental contributions to our understanding of quantum systems," says Andrew Hirsch, interim head of the Department of Physics at Purdue.

Purdue Professor Named PopTech Science Fellow

Jonathan Wilker, a professor of chemistry and materials engineering, was tapped last fall as an "ambassador of science" as one of the 2013 class of PopTech Fellows.

Wilker's research focuses on understanding and mimicking the adhesives produced by oysters, mussels and barnacles in order to create new materials including wet-setting adhesives for use in medicine and construction and materials to keep boat hulls clean without harming the environment.

"There's a lot of applications you might be able to think of for a biologically produced adhesive, something that can set in a wet environment and something that makes really strong bonds to a surface," says Wilker. He shared some of his ideas as a featured speaker at PopTech's annual conference last fall in Camden, Maine.

PopTech is a global community of innovators that helps promising scientists become more effective communicators and leaders. The science fellows program is designed to help promising scientists become more effective communicators, collaborators and leaders and to develop a corps of highly visible and socially engaged scientific leaders, according to PopTech.

Fellows are chosen through an invitation-only nomination process and selection by the program's advisory board, which includes science and communications leaders and working scientists.

FROM THE PRESIDENT

Purdue's researchers create knowledge and innovations on which the future of our state, country and world depend. Year in and year out, their discoveries lead to new jobs, prosperity and life opportunities for innumerable others.

Mitch Daniels, President

FROM THE PROVOST

Purdue is one of the finest higher education institutions in the world, thanks in large part to the exceptional research of our faculty, staff and students. Our university has an extraordinary past and an even brighter future.

Debasish (Deba) Dutta, Executive Vice President for Academic Affairs and Provost

FROM THE EXECUTIVE VICE PRESIDENT FOR RESEARCH AND PARTNERSHIPS

Our researchers work tirelessly to make the world a better place. Sensing, perceiving and interpreting, they create new windows on our universe, adding to our collective knowledge base and leveraging discoveries for the public good.

Suresh Garimella, Executive Vice President for Research and Partnerships

X-RAY VISION

is what my brother longed for, clipping out
his coupon from the screwy comic,
longed for and paid for, one solid
quarter beneath the cellophane tape.
Then he waited day and night
for sight. Right through clothes: oh monstrous,
miniature scope in the hand to set the eye
to all things in the world
delicious and forbidden, under something
vastly, boringly
not. Allow six weeks, he
kept intoning. Hope, not litany
though certainly it was prayer. (I can
see, cried the trembling
blind man in the movie for our Catholic
fifth grade, our teacher half
weeping as the projector
spit and smoked and nearly burned up....)

At home, it was simply
any mail? Week after week my brother
sailing through the door. Our poor mother
with her no aimed at his back,
exact. I said, could you see
through cats' fur? Through a door
of steel? Something quick like an eyelid,
quicker, like a bird,
like the wing, down to its bones
and glue? Anything, moron--he
forever patient, still
patient. O invincible
country, where childhood is,
and faith, a little
masterpiece.

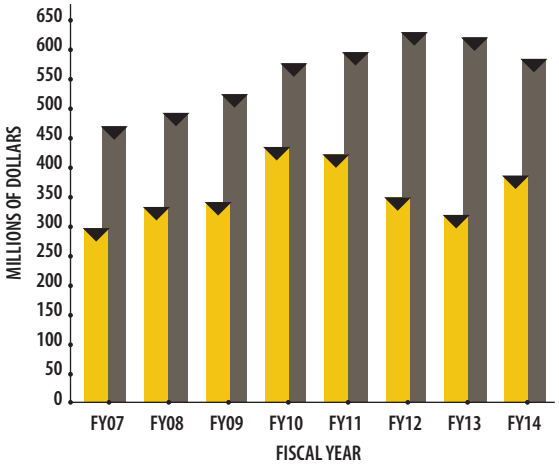
Marianne Boruch

METRICS

As a leading research university in the state of Indiana with a global reputation of excellence, Purdue is dedicated to maximizing our resources to build a research enterprise that supports impactful research that changes the world.

Committed sponsors partner with Purdue, enabling faculty and staff researchers to respond to grand challenges. During FY 2014, nearly $390 million in sponsored program awards were received.

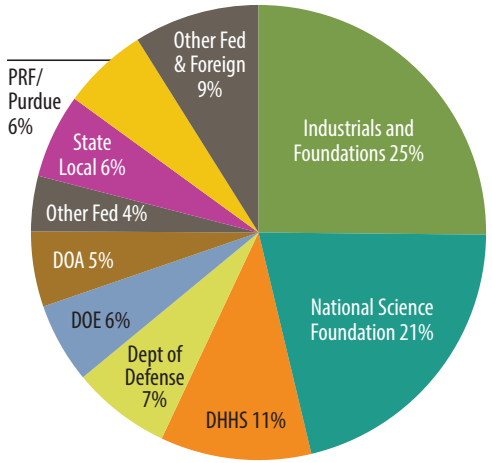
SYSTEM-WIDE SPONSORED PROGRAM AWARDS AND EXPENDITURES



Purdue University sponsored programs continue to land significant funding.

TOTAL AWARDS
TOTAL SUPPORT EXPENDITURES

MULTIPLE SOURCES



Sponsored Awards from Multiple Sources.

KEY:

DHHS	U.S. Department of Health and Human Services
DOE	Department of Energy
DOA	Department of Agriculture
Other	Other Federal including Dept. of Interior
PRF	Purdue Research Foundation
Other	Other Federal <$10M; NASA, Agency for International Development, Dept. of Transportation, Environmental Protection Agency, Dept. of Education, and Foreign Governments

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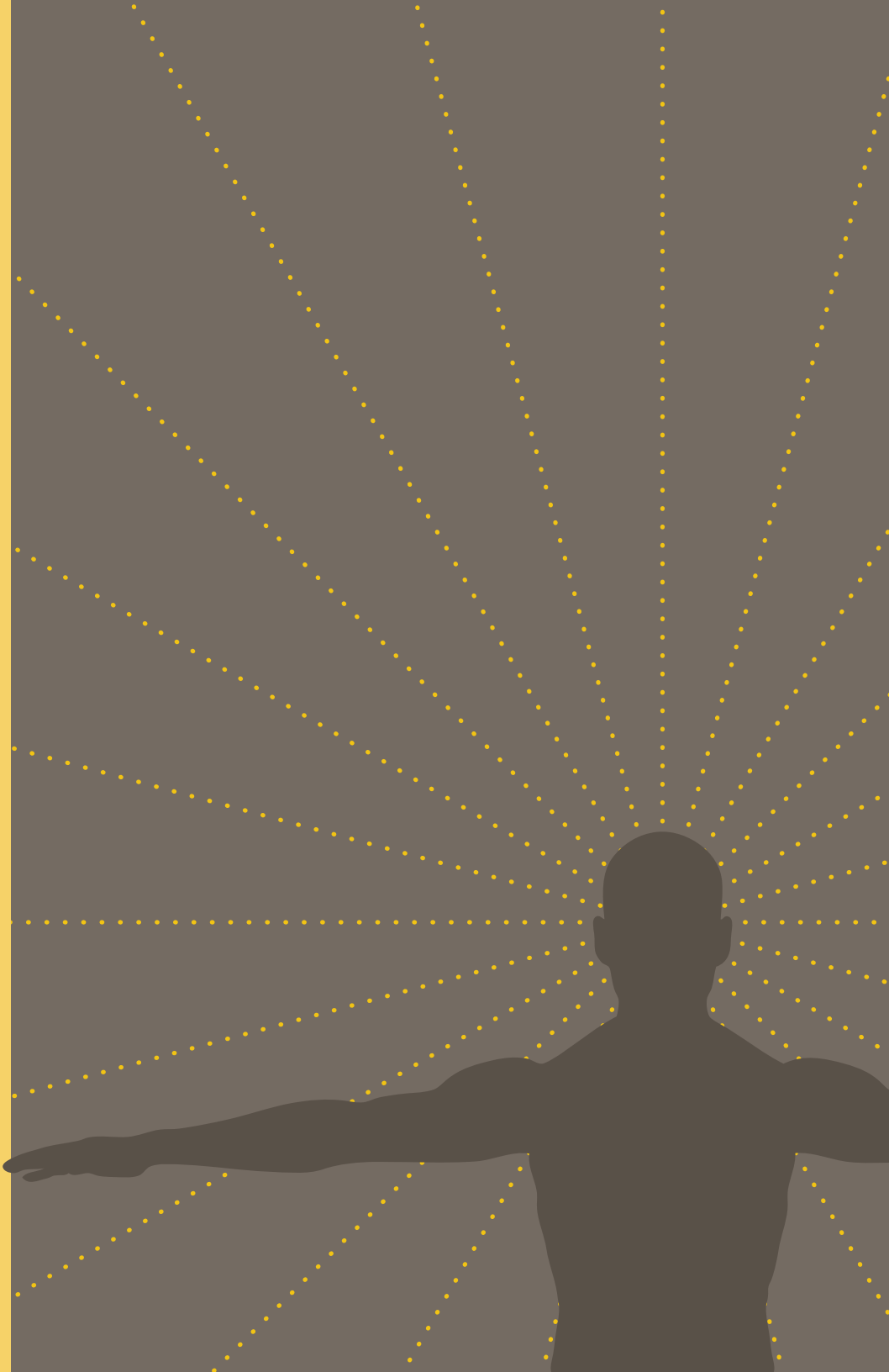

SENSORIUM

Far easier to say
what is beautiful to say, that
fields release their silence like a
scent, that any pasture fenced
and distant, haunts like some
pure creature out of Euclid.

Marianne Boruch
The Stairway