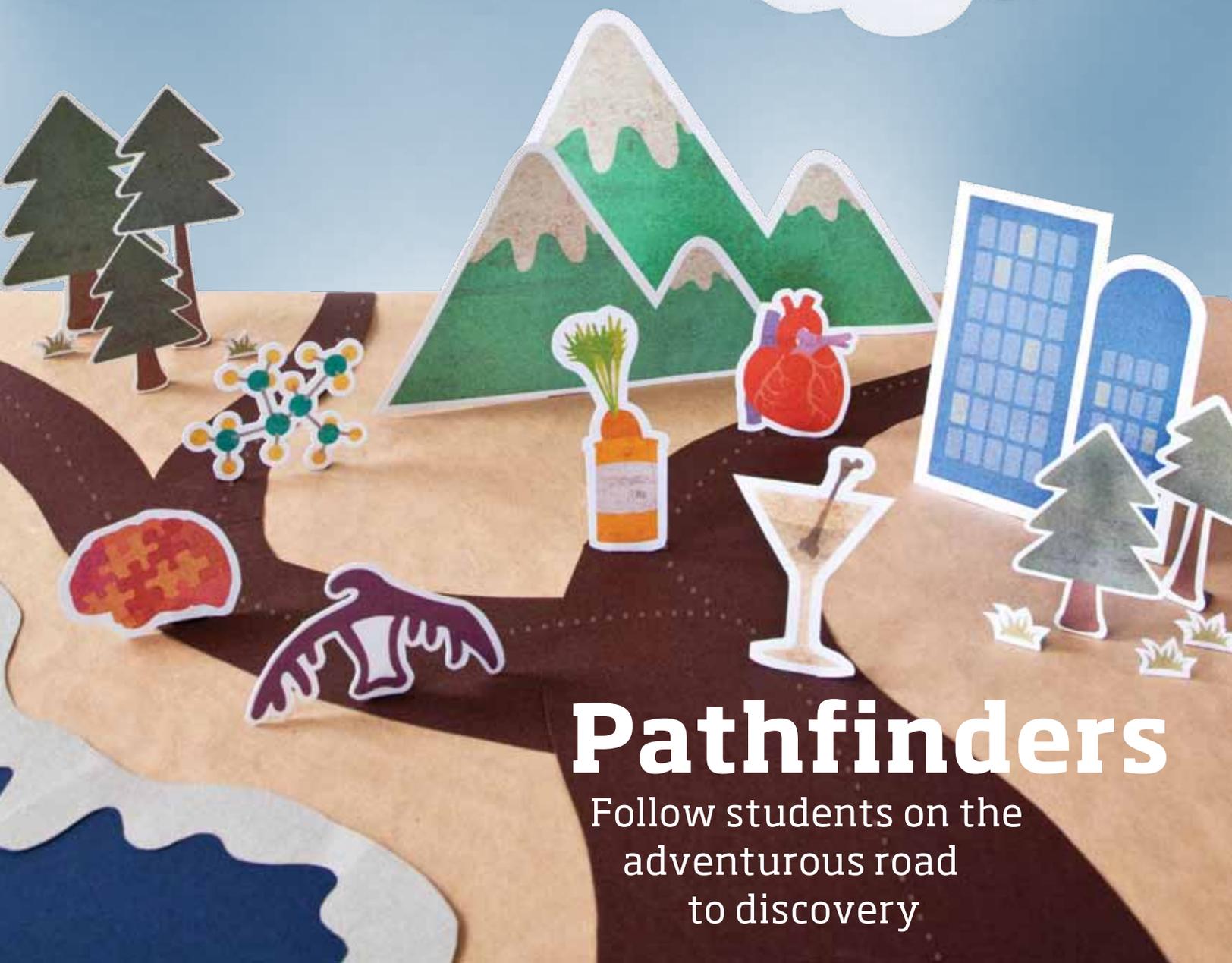


# terra

A world of research & creativity at Oregon State University · Spring 2011



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adventurous road  
to discovery

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For our story about undergraduate research, a student team in OSU's Studio 208 graphic design group came up with a playful take on the journey through new scholarly terrain.





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OSU is a leading public research university with more than \$275 million in research funding in FY2010. Classified by the Carnegie Foundation for the Advancement of Teaching in its top category (very high research activity), OSU is one of only two American universities to hold the Land-, Sea-, Sun- and Space-Grant designations. OSU comprises 11 academic colleges with strengths in Earth systems, health, entrepreneurship and the arts and sciences.

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## THE "WHY?" SWITCH

Some people just can't help it. They ask questions as though their "Why?" switch got stuck in the "on" position when they were children. Take Don Pettit. The NASA astronaut and OSU chemical engineering alum ('78) from Silverton joined three different labs during his undergraduate years in Corvallis. He learned how to photograph fluidized bed coal combustion, studied asexual reproduction in plants that live on insects and measured gas adsorption on the surface of a solid.

Pettit says professors "roped" him into their labs because he kept asking questions. In exchange, he got a first-hand look at how research was done.

His switch is still wide open. Today he works in a lab that you can see from home. Just look up on a clear night. As an astronaut, he does fundamental physics experiments in the International Space Station. In his online "Saturday Morning Science" videos from space, water forms a glistening sphere in a wire loop, antacid tablets generate frothy bubbles that circulate in a watery world and CD players demonstrate the principles of a gyroscope. These phenomena aren't just curiosities; they have direct application to engineering in the space environment. Pettit is scheduled to return to the station in December.

Pettit may be in the vanguard of space science, but his enthusiasm echoes in today's undergrads. They show the same thirst to solve problems and make discoveries. At OSU's Celebrating Undergraduate Excellence forum in May, 56 student teams presented their research in a range of fields — forestry, biochemistry, agriculture, psychology, nutrition, geology, biology, engineering and the arts.

Talking to these students is like getting a tour of new worlds. They gladly share their insights. They talk excitedly but with conviction, and I often come away with an overwhelming feeling: My own "Why?" switch is open, and I'd love to join them on their journey.

I hope you get that feeling as you read through some of their stories in this issue of *Terra*.

— Nick Houtman

Editor



## Better Bridge Inspections

THE MINNEAPOLIS BRIDGE COLLAPSE OF 2007 might have been prevented if an innovative Oregon State University technology had been available.

The 1950s-era bridge failed because a steel plate connecting trusses gave way, even though the plate had been visually inspected. Now, bridge inspectors have a new tool to help detect these kinds of structural weaknesses. A computerized system developed by OSU civil engineers uses digital imaging and "machine vision" — extracting data by analyzing images — to essentially see inside connecting plates, where older bridges are most vulnerable.

In OSU's Structural Engineering Research Laboratory, Professor Chris Higgins and his research team tested the system last fall with a replica of the failed connector that brought down the Minneapolis bridge. The system is being deployed by consultants and transportation agencies around the country.

"It's the connectors where most bridge failures occur," says Higgins. "The failure of a single critical connection can bring down an entire bridge, just like it did in Minneapolis." (See "Fear and Loading," [oregonstate.edu/terra/2008/09/fear-and-loading](http://oregonstate.edu/terra/2008/09/fear-and-loading))



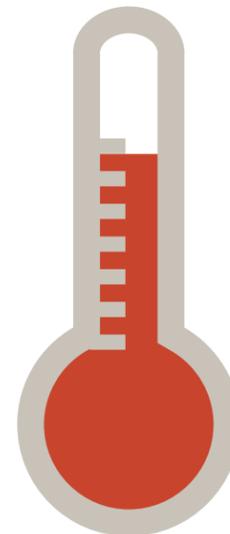
## Temperature Surge

OREGON STATE UNIVERSITY IS POISED for explosive growth in environmental data collection, thanks to a new-generation fiber-optic instrument, one of only five in the world. The device senses temperatures remotely and is 15 times faster than earlier systems, according to OSU environmental engineer John Selker.

"We just got the best tool ever made to understand our environment," says Selker, a professor in the Department of Biological and Ecological Engineering. "This provides thousands of times more data than we used to have" (see "Wired Watershed" in *Terra*, winter 2009, [oregonstate.edu/terra/2009/01/wired-watershed/](http://oregonstate.edu/terra/2009/01/wired-watershed/)).

OSU has retooled the technology, originally developed for the oil industry, for environmental monitoring across a vast range of landscapes and features, from streams and lakes to glaciers, aquifers, mines and soils. Already it's being used for salmon restoration projects in Eastern Oregon's John Day River. Selker expects the technology to open new opportunities in fields such as irrigation. Inquiries are already coming in from the Middle East.

Acquired with support from the National Science Foundation and the American Recovery and Reinvestment Act, the instrument is undergoing research to further ramp up its capabilities.



## Effective Science Communication

DAWN WRIGHT'S RESEARCH HAS TAKEN her to coral reefs, mid-ocean ridges and undersea volcanoes. This year, it will take her to Washington, D.C., where she will join 19 other environmental scientists for training in a critical challenge: communicating scientific findings effectively to media, policymakers, business leaders and communities.

Wright, a professor of geosciences at Oregon State University, has been chosen as a Leopold Leadership Fellow for 2011. The program, funded by the David and Lucile Packard Foundation, has OSU roots. It was created in 1998 by the university's prominent marine ecologist Jane Lubchenco, currently serving as director of the National Oceanic and Atmospheric Administration.

"These 20 outstanding researchers are change agents engaged in cutting-edge research," says Pam Sturner, executive director of the fellowship program based at Stanford University's Woods Institute for the Environment. "Through our program, they will gain new skills and connections to help them translate their knowledge into action at the regional, national and international levels." (See "Great Blue Engine," [oregonstate.edu/terra/2007.07.great-blue-engine](http://oregonstate.edu/terra/2007.07.great-blue-engine))



## Free-Choice Science

Study confirms benefits of learning centers, museums



The touch-tank at the Hatfield Marine Sciences Center Visitor Center in Newport captivates Noah Goodwin-Rice, left, and his mom Cait Goodwin. (Photo: Jim Folts)

**IN A WORLD CONFRONTED WITH** greenhouse gasses, emergent diseases, energy shortages, natural disasters, habitat loss, species extinctions and a thousand other urgent issues, public understanding of science is more essential than ever. Now, an OSU study reveals a powerful vehicle for enhancing science literacy in local communities: science museums.

Science museums like the Oregon Museum of Science and Industry in Portland aren't new. But the strength of their impact surprises even museum expert and advocate John Falk, a professor of science education and renowned proponent of "free-choice" (beyond school) learning.

"Overall, the results were staggering — much more positive than I could have imagined," says Falk, who led the multi-year study of visitors to the California Science Center in Los Angeles.

Not only did thousands of visitors and their children report learning a lot about science and technology from the museum, but they also got a big boost in long-term interest. Many of them could even define the term "homeostasis" after viewing an exhibit where a 50-foot-tall animated puppet named Tess explained the biological process.

One of the takeaway messages: Classrooms are only one source of science learning.

"It has long been assumed that formal schooling is the primary mechanism by which the public learns science," explain Falk and his coauthor Mark Needham in the *Journal of Research in Science Teaching*. "But in recent years there has been a growing appreciation for the fundamental role played by the vast array of non-school science education institutions."

Hard data on the role museums play in science learning gives momentum to the growing free-choice movement. Museums and other programs outside the K-12 system exist as "launching points" that inspire people to seek more understanding and explore on their own, says Falk.

"Many people have believed that such institutions could do this," he adds. "But this study provides some of the first definitive evidence that it works."

## The Motion of Oceans Marine energy center gets new leader

**CAPTURING THE IMMENSE POWER OF** ocean waves and tides is among the most promising prospects on the green-energy horizon. The Northwest National Marine Renewable Energy Center — one of only three such centers in the nation — brings together researchers from Oregon State University and the University of Washington to help lead innovation in this burgeoning field.

In July, the center will move forward under new leadership from OSU's Belinda Batten, who currently heads the School of Mechanical, Industrial and Manufacturing Engineering.

"It's clear to me that marine energy has a great potential to contribute significantly to the nation's renewable energy portfolio," says Batten.

The center's work in research, testing, monitoring, education and outreach is supported by the U.S. Department of Energy, the state of Oregon and the Oregon Wave Energy Trust, among other private and public agencies.

## Water World

Envisioning the Willamette River basin's future

**HAVING JUST ENDURED ONE OF** the wettest springs on record, Oregonians may find it hard to imagine a water shortage. Yet even in the rain-drenched Northwest, water supplies will come under increasing pressure as the population grows and the climate warms, scientists warn.

To help policymakers, resource managers, city planners, farmers, tribes and local communities predict and prepare for water issues in coming decades, OSU researchers have joined scientists at Portland State University and the University of Oregon to peer into the future of the Willamette River basin. Their window onto this uncertain outlook is an OSU-created software program called Envision. By plugging in possible variables — temperature, precipitation, snowpack, demand, usage, management, policy — researchers will create a range of water scenarios for the basin. These models can then guide decision-making, not only for the Willamette River basin but for river basins everywhere.

"How climate change will conspire with population growth to affect water quality and quantity in basins around the world is the defining issue of this century," says lead investigator Jeff McDonnell, who heads OSU's Institute of Water and Watersheds.

The five-year project is funded by a \$4.3 million National Science Foundation grant.



## Biotech Partnership

Focus on flowering genes

**RESEARCH INTO TREE BIOTECHNOLOGY HAS** gotten a boost through a new agreement between Dow AgroSciences LLC and Oregon State University. The wholly owned subsidiary of The Dow Chemical Company will make its EXZACT™ Precision Technology available to Steve Strauss, distinguished professor of forest biotechnology in the College of Forestry.

EXZACT™ provides a versatile and comprehensive toolkit for targeted genome modification, according to the company, and has already been licensed for use in research elsewhere on algae, maize and other plants.

As part of the agreement, Strauss and his team will make modifications to essential genes for flowering and reproduction. Dow AgroSciences is providing its technology as well as access to intellectual property; to validated, high-quality compounds known as zinc-finger reagents; and to scientific expertise.

"Tree biotechnology is an exciting new field for agriculture and represents an important opportunity for both traditional industries like lumber and paper and newly emerging bioenergy companies," says Kay Kuenker, vice president for new business at Dow AgroSciences.



## On the Web

[oregonstate.edu/terra](http://oregonstate.edu/terra)

### TERRA FOR KIDS

What child doesn't worry when a pet dog or cat gets sick? When it's cancer that strikes, the worries mount. At OSU's Small Animal Clinic, pets receive care and treatment, but through research, they also contribute to improved health care for people. In a video with OSU doctors Stuart Helfand and Bernard Séguin in OSU's College of Veterinary Medicine, see how researchers combine science with respect for the bond between people and their pets. On Terra for Kids, teachers will also find lesson plans to help students investigate veterinary medicine.



### KEN HEDBERG ON LINUS PAULING

Ken Hedberg, emeritus professor of chemistry, has Linus Pauling to thank in part for 55 years as a member of the OSU faculty. In a video interview with *Terra* editor Nick Houtman, Hedberg reflects on the events that brought him to OSU in 1956 and on his journey through the science of molecular structure.



### UNDERGRADS ON CAMERA

Student researchers filled the Memorial Union ballroom in May for the annual Celebrating Undergraduate Excellence Forum. Listen to students who received "best in show" awards for work on coral reefs, nutrition for kids, the effects of spilled oil on sea turtles and other topics.

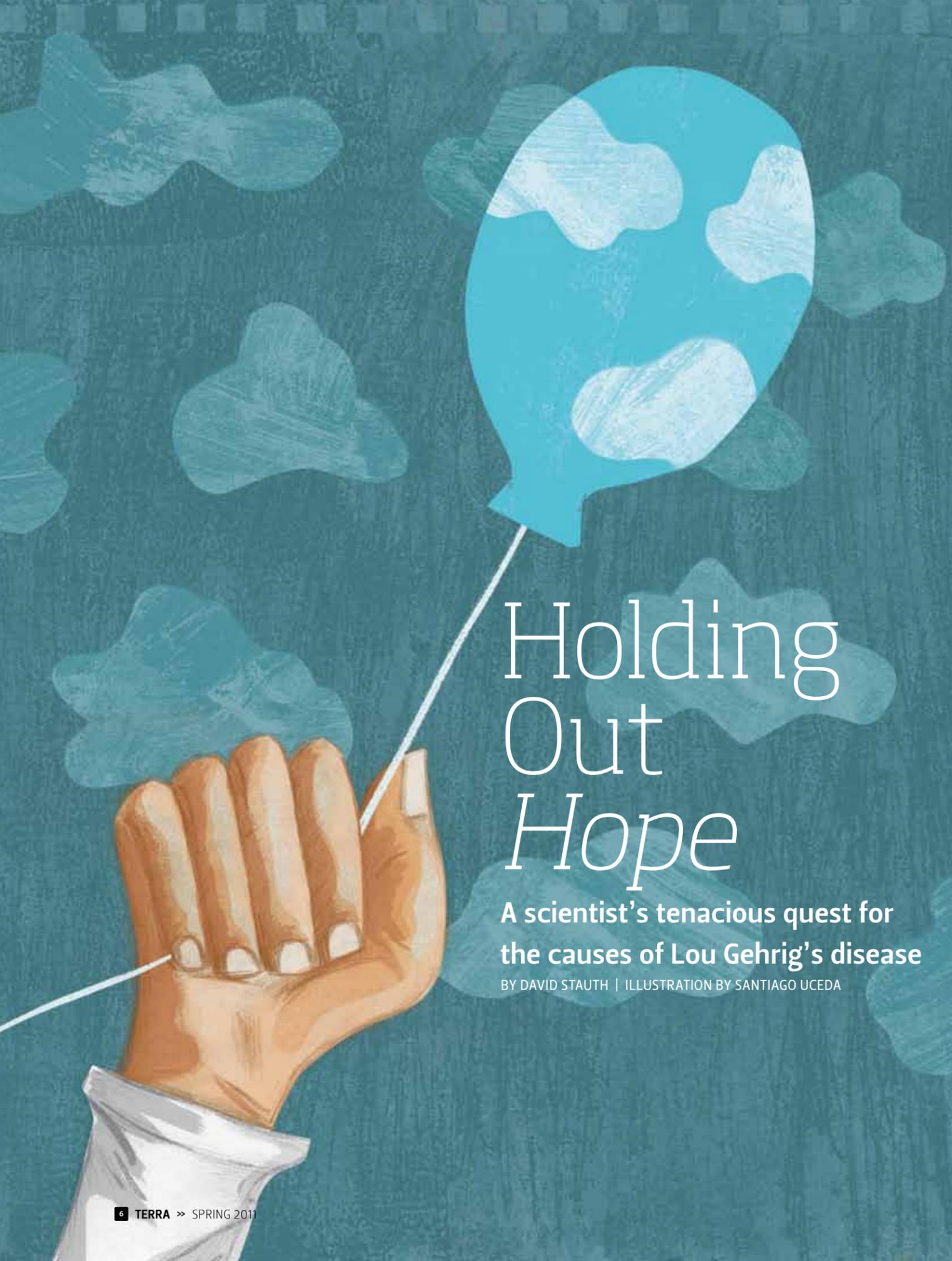


### BIRDS OF KING ISLAND

OSU anthropologist Deanna Kingston and wildlife biologist Kim Nelson have combined to offer a guide to the seabirds of King Island, Alaska. Their illustrated listings include Inupiat names, locations on or near the island and descriptions of habitat and bird song. See a link to the guide on the *Terra* blog.

There's a lot we can do for people who are stricken with this horrible disease. We can't cure it yet, but we can provide hope.

— Joe Beckman, holder of the Ava Helen Pauling Chair in the Linus Pauling Institute



# Holding Out Hope

A scientist's tenacious quest for the causes of Lou Gehrig's disease

BY DAVID STAUTH | ILLUSTRATION BY SANTIAGO UCEDA

He hit .295 with 29 home runs and 114 RBIs that last year in 1938 — a season most baseball players could only dream about.

They called him the “Iron Horse” because he was known for his durability. But even in 1938, he was feeling tired by mid-season. And for him, a season like that was considered mediocre.

The next year started off much worse. “I think there is something wrong with him,” one sports reporter wrote. “Physically, I mean. I have seen ballplayers ‘go’ overnight, but they were simply washed up as ballplayers. It’s something deeper in this case.”

The reporter was right. Seventy years earlier, a French doctor named Jean-Martin Charcot had described a strange disease called amyotrophic lateral sclerosis (ALS), and in the seven decades since, very little had been learned about it. It was only in 1939 that ALS burst onto the world consciousness when Lou Gehrig, one of the greatest baseball players who ever lived, announced he was suffering from the disease, retired and died just two years later.

ALS would evermore be known to most people as Lou Gehrig's disease. Unfortunately, when World War II was just starting in Europe in 1939, they didn't know much about it.

Unfortunately, after another seven decades has passed, that's still true.

## Still No Cure

Doctors do not know for sure what causes ALS. They don't know how to slow its progression. They certainly don't know how to cure it. Researchers debate among themselves and trade theories in science literature. Dedicated doctors, nurses, therapists, aides and especially

family members work to reduce suffering and treat symptoms, but the disease is debilitating, progressive and terminal.

In the middle of this quandary is Joe Beckman, an Oregon State University professor of biochemistry, holder of the Ava Helen Pauling Chair in the Linus Pauling Institute and director of the widely recognized OSU Environmental Health Sciences Center.

Major research programs are under way, and Beckman has been laboring in them for 18 years. The goal is a therapy or cure for ALS. But this disease is not simple. If it were, very smart scientists would have figured it out a long time ago, and that hasn't happened.

“This is complex, and it's not certain yet where the right answer lies,” Beckman says.

The complexity, from one perspective, is about whether to restore zinc, remove copper or stabilize “superoxide dismutase” (an enzyme that protects cells from damage). If you think that sounds complicated, consider that Beckman has a stack of scientific studies on his desk about a foot thick, at risk of toppling to the floor, that address this and a lot of other issues.

But if the OSU researchers are right — and they think they are — then at least some research programs may be on the wrong track, and their efforts to stabilize a certain biological function are misguided. Instead of helping, these approaches may lead to the death of motor neurons and progression of the disease. As it progresses, ALS causes lost motor function, paralysis and usually death within a few years.

Beckman and his long-term collaborator Alvaro Estevez, a former

OSU researcher now at the University of Central Florida, last year published what they believe is an important study that summarizes more than a decade of findings and helps make the case for their theory.

The work was funded by the National Institutes of Health, the Amyotrophic Lateral Sclerosis Association and other agencies. And it's been facilitated by the sophisticated mass spectrometry facilities at OSU, which allow detailed questions to be asked at levels never before possible.

## Copper May Be Key

Therapies that could remove copper atoms from superoxide dismutase (SOD), the OSU team believes, would allow it to die and be naturally eliminated. In the process, they could form the basis for a treatment for ALS. Researchers say this could stop the progression of the disease, while others in the science community continue to argue that copper is irrelevant.

“With the approach we're using, we can already remove copper atoms in cell cultures and stop the death of motor neurons,” Beckman says. “We haven't done this yet in animals, and some researchers who disagree with us point to certain experiments that they say show this won't work. But I think this issue is more complex than many understand and those experiments are flawed.”

“The devil is in the details,” he adds.

Complexity is a word that keeps coming up in discussions about ALS. That's the sometimes painful process of science, which rarely yields simple findings and unchallenged facts. With ALS, some things are known. The disease results from the death of nerve cells in the brain and spinal

cord. It's less clear what starts that process, how it could be slowed or stopped, and there's no known way to detect it before it begins.

Which brings back the discussion about copper-zinc SOD, an antioxidant that helps rid cells of free radicals, which can be toxic. A genetic mutation in the SOD gene leads to a zinc-deficient form of this compound. Some people with the mutation are far more likely to get ALS.

"In healthy people, superoxide dismutase compounds sort of partner together, fighting back-to-back to make each other stronger and help protect other cells," Beckman says. "In ALS patients, for genetic or other reasons that are not clear, this process breaks down. Zinc-deficient SOD proteins begin to lose their shape and function, and the end result is dead motor neurons."

Many researchers believe that stabilizing these mutant proteins would help prevent the progression of ALS. "Some neuropathologists look through a microscope at damage from ALS, and they see the tangled globs of misfolded proteins that are hallmarks of the disease," Beckman says. "They find SOD associated with that, and think that's the cause of ALS, and believe preventing that damage, preventing that unfolding, is the way to a therapy."

Beckman's findings are just the opposite. They suggest the SOD damage is just a step in the process and an early one at that.

"We believe that keeping this dysfunctional superoxide dismutase around just makes things worse, creates a situation that is even more toxic to motor neurons and leads to the disease," Beckman says. "Our studies indicate the best thing is to just let the zinc-deficient SOD go ahead and unfold, fall apart and be naturally eliminated."

Scientists have found that removing copper atoms from this zinc-deficient SOD allows just that.



*Finding a way to eliminate, not repair, mutant nerve cells could lead to treatments for Lou Gehrig's disease, says Joe Beckman. (Photo: Karl Maasdam)*

The SOD is eliminated and does not create a toxic environment. In cell cultures, this has been shown to stop the death of motor neurons.

Therapies that would do this effectively don't yet exist, but Beckman says they could. It would probably be a drug that helps remove the right amount of copper in cells in the right places, a metabolic balancing act that may be tricky but possible. "The real cure to defective superoxide dismutase is not to try to stabilize it; it's to get rid of it. Removing copper is a way to do this, and we believe in that direction may lie a cure for ALS."

### Hope for Today

While this work goes on, 30,000 Americans have ALS at any given time, and Beckman provides what relief he can while he makes progress on the research front.

"Joe is a brilliant scientist, but he can also explain these very complicated topics in ways that others can understand," says Lance Christian, executive director of the ALS Association of Oregon. "He regularly meets with our support groups to help explain the latest research findings. And he's very patient, never rushed. Even though the science is so narrow and focused, Joe will answer every question, and he understands the

larger issues of real people dealing with this disease."

Beckman says that's important, and he gets upset when he hears stories about people being told "nothing can be done."

"There's a lot we can do for people who are stricken with this horrible disease," Beckman says. "We can't cure it yet, but we can provide hope. And we can make sure that patients get all of the special help they may need to watch their nutrition, communicate, breathe, reduce their stress levels. That can improve both the quality and length of their life."

ALS affects everything from swallowing to maintaining weight, breathing, and in some cases, cognition. Fatigue and depression are common. Most people die from respiratory failure or pneumonia within a few years of diagnosis.

"ALS is such a difficult disease that it not only can kill individuals but can destroy families, with the constant struggles and demands for 24-hour care," Beckman says. "We have to do everything we can to help people until we can finally figure out exactly what is causing this disease."

"And when we do that, I really believe we can find a therapy for it, at least a way to slow or stop its progression. We'll see the day when ALS is no longer a terminal illness."

**terra**

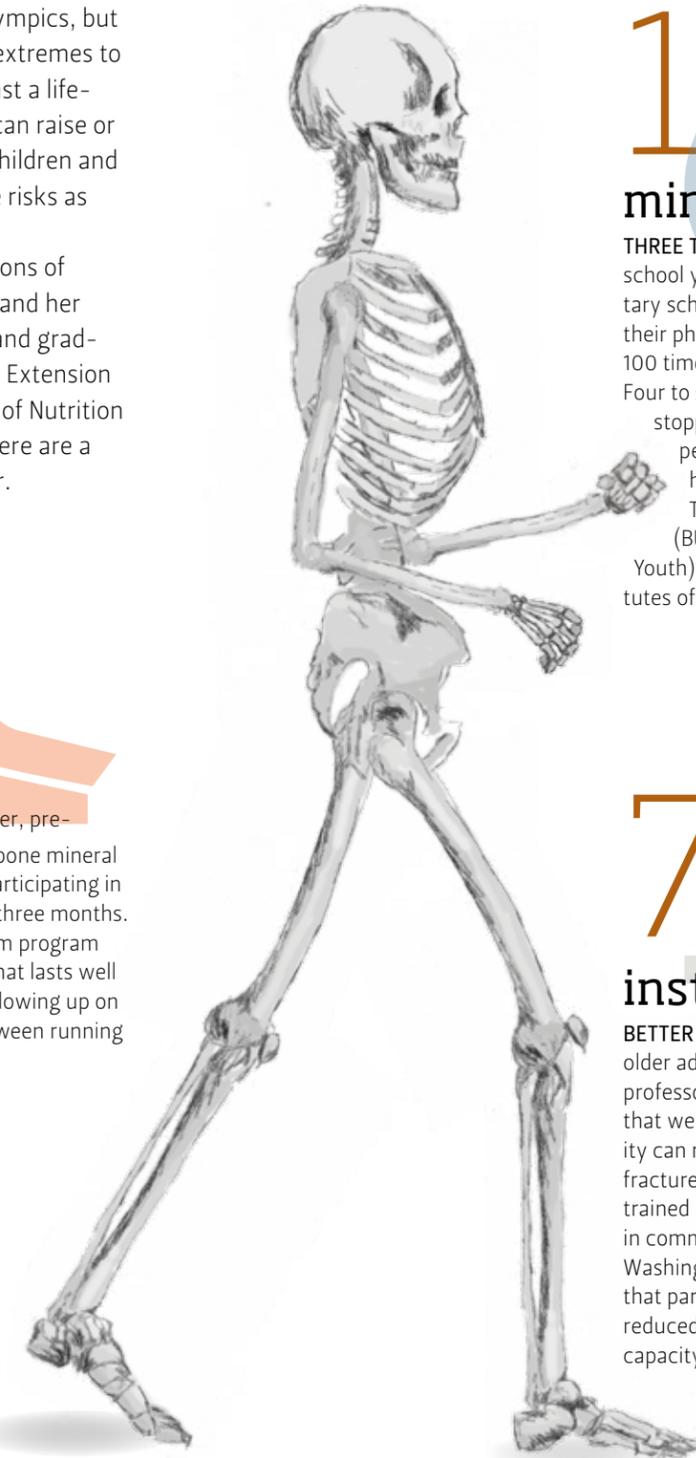
## Bone Builders step.run.jump.lunge.

IT MAY SOUND LIKE THE Olympics, but you don't have to go to extremes to get benefits that could last a lifetime. Regular exercises can raise or maintain bone mass in children and adults, reducing fracture risks as they age.

Those are the conclusions of studies by Kathy Gunter and her team of undergraduate and graduate students in the OSU Extension Service and Department of Nutrition and Exercise Sciences. Here are a few numbers to consider.

### 31 runners

IN A RECENT STUDY BY Gunter, pre-adolescent girls had higher bone mineral content in their hips after participating in Girls on the Run for at least three months. The international self-esteem program may promote bone health that lasts well into adulthood. Gunter is following up on the positive association between running and bone mass in girls.



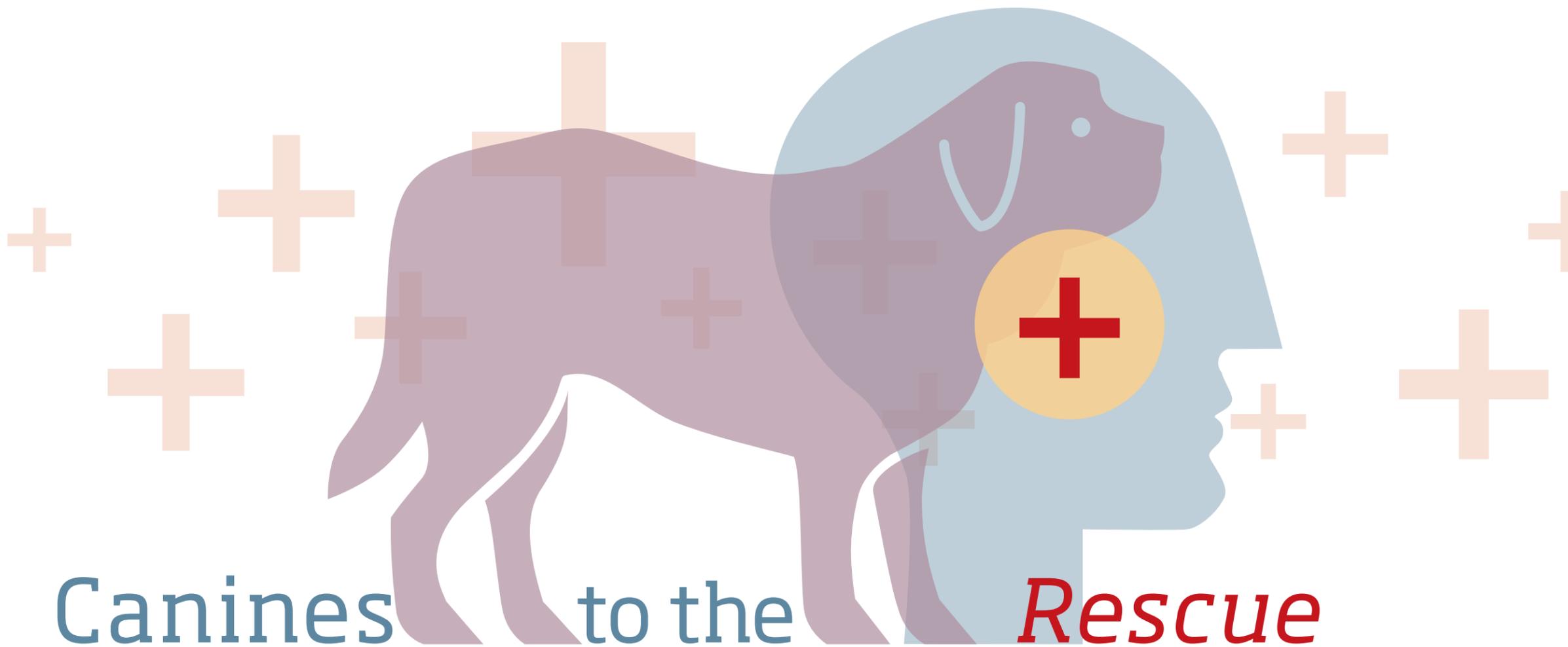
### 15 minutes

THREE TIMES A WEEK FOR an entire school year, more than 300 elementary school-aged children spent part of their physical education period jumping 100 times off a two-foot high platform. Four to seven years after the exercises stopped, jumpers had 3 percent to 8 percent more bone mass in their hips, compared to control groups. The project known as BUGSY (Building the Growing Skeleton in Youth) was funded by the National Institutes of Health.

### 75 instructors

BETTER BONES AND BALANCE IS for older adults. Gunter and former OSU professor Christine Snow demonstrated that weight-bearing physical activity can reduce the risk of osteoporotic fractures in older women. Gunter has trained instructors to deliver the program in communities throughout Oregon, Washington and California. Data show that participants have greater bone mass, reduced fall risk and better functional capacity than those in control groups.

ON THE WEB: See more about Joe Beckman's research at [lpi.oregonstate.edu/staff/beckbio.html](http://lpi.oregonstate.edu/staff/beckbio.html).



# Canines to the *Rescue*

Dogs with cancer point scientists to treatments for people

BY MARK FLOYD | ILLUSTRATION BY AMY CHARRON

The similarities are uncanny. Bone tumors, whether from a teenager's leg or the paw of the teen's pet dog, look virtually identical. If you biopsy those tumors and examine them under a microscope, you'd be hard pressed to tell one from the other.

That's why oncology research at Oregon State University's College of Veterinary Medicine is attracting the attention of researchers at medical schools, including Oregon Health & Science University.

"Canine cancer often mimics human cancer," says Stuart Helfand,

who came to OSU in 2005 to begin the college's oncology program. "But I'm a big believer in looking at cancer holistically; it's not about humans on one side and dogs on another. It's about studying and treating cancer. And there are ties between human and animal health, just as there is a

bond between people and their pets."

If OSU's animal health clinic is the public face for the College of Veterinary Medicine, its research laboratories are the legs. Here is where Helfand and his colleagues study how cancer works in dogs and cats and what treatments may kill, or at least slow down, deadly cancer cells. Helfand's interest in cancer research began in immunotherapy, which seeks to boost the immune system to fight cancer. Through this portal, his interests have expanded in a number of research directions.

"I was trained as a clinician but came to realize that there were many questions we could not answer in the clinic alone," he says. "This attracted

me to research in the laboratory with an eye toward learning things that could be brought back to our patients in the clinic, so-called translational research."

A particularly aggressive form of cancer in dogs, known as hemangiosarcoma, drew Helfand's attention because it has resisted attempts to find a cure. In cell cultures, it can be used to investigate angiogenesis, the process through which growing tumors develop a blood supply. Helfand is also studying proteins that act as chemical messengers, telling cells to reproduce and regulating other cellular activities. One type, an enzyme known as tyrosine kinase, serves as an "on" or "off" switch and

also plays a role in human cancers.

"This field has expanded rapidly, and our laboratory is focused on learning how to exploit abnormal tyrosine kinases in several cancers that affect dogs and cats," Helfand adds. "Through these efforts, we are hopeful we can improve care for animals while helping to establish these tumors as models for human cancer and contributing to improvements in human health." Results from Helfand's research have now begun to find their way into his clinical oncology practice.

Dogs are an attractive model for human cancers for two reasons: genetics and a shorter lifespan. People often live 75 years or more

and may not develop cancer until late in life. Dogs, on the other hand, go through generations much more quickly and have distinct breeds with unique genetics, making them ideal for looking at the mechanisms leading to cancer. Why, for example, does bone cancer in humans affect teenagers at a disproportionate rate, and in dogs, primarily strike large breeds like Rottweilers, Saint Bernards, Irish wolfhounds and Great Danes?

## A Surgeon's Best Friend

Bernard Séguin, a small-animal surgeon with the college, discovered just how difficult it can be to have a pet stricken with cancer when his Rottweiler mix, George, developed bone cancer. He operated on the dog himself and helped extend his life several more months before the tumor made a fatal return.

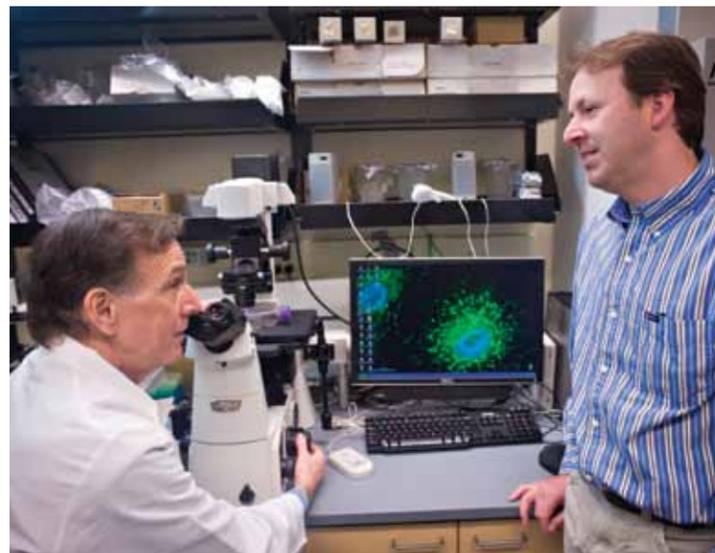
"Large-breed dogs are at great risk for bone cancers," says Séguin, a native of Montreal who came to OSU from the University of California-Davis. "We aren't quite sure why. Teenage humans also are at greater risk, and medical doctors want to know why. So we are working together."

Séguin is teaming with Dr. Charles Keller, an OHSU pediatric oncologist, on a joint study of bone cancer they hope will help both dogs and humans. And in the surgical suite, sometimes under extraordinary circumstances, Séguin is applying what Helfand and others are learning in the laboratory.

Last year, Holly, a greyhound, was referred to the OSU clinic with a tumor in her humerus bone. The tumor was in an unusual location, in the middle of the bone, rather than at the tip, which is much more

common. The usual course of action for such tumors is to amputate the leg, because the surgery is so invasive and the tumor can spread. But as OSU researchers learn more about cancer, they are looking at other protocols.

In the first operation of its kind anywhere, Séguin and his colleagues removed the diaphysis, or the long shaft of the humerus, and replaced it with a section of Holly's ulna, then performed microvascular surgery to



Doctors Bernard Séguin and Stuart Helfand collaborate in treating animals and delving in the mechanisms of cancer in the oncology research laboratory and in OSU's Small Animal Veterinary Teaching Hospital. (Photo: Karl Maasdam)

connect tiny blood vessels, giving blood to the new bone structure instantaneously.

"We are able to push the envelope here in part because we have the technological capability," Séguin says. "We have the best CT scanner in veterinary medicine that allows us to do things we never dreamed of, and we have an operating microscope that few teaching hospitals have. We can match equipment with most vet colleges in the country."

### Regional Resource

Helfand has a vision of creating a regional cancer program at the college that would serve as a

clinical resource for Northwest veterinarians, and that, as a leading research facility, would collaborate with medical researchers. What is missing, he says, is a building, endowed faculty positions and a linear accelerator for providing radiation treatment.

Radiation therapy, he says, has both curative and palliative benefits for animals.

"When you remove a tumor surgically, the challenge is to get all the cancer tissue out," Helfand says. "To be safe, you often remove some of the surrounding tissue. But soft-tissue sarcomas frequently occur on the legs, where there isn't a lot of soft tissue, which is why amputations frequently are the course of action. Radiation could help reduce amputations as well as reduce the animals' pain.

"It's all about increasing the quality of life for the animals," he adds.

When Helfand leaves the clinic floor en route to his research laboratory, he frequently walks by what he calls his "Wall of Heroes," photos of animals treated for cancer at OSU. Most are dogs; some recovered from their disease, others did not. Each of them, he says, has a story.

"We had one dog, brought in by a gentleman who told us: 'This is my son's dog. My son just died, and this is our last link to him. You must save him,'" Helfand explains. "That was emotional. In most cases, our lifespan exceeds that of our pets, and when you get a pet, you need

to accept that you will experience heartbreak.

"Sometimes," he adds, "it works out the other way."

At the other end of the spectrum from heartache is hope, and the OSU oncology program is creating that for a growing number of visitors. Research advances, diagnostic and surgical skill and sophisticated technology are making the term "cancer" slightly less frightening.

Just ask Lucky. The 1-year-old golden retriever was training for hunting competitions when she developed a large aggressive tumor along her spine. It looked like her life would be cut short. In 2007, her owner, Rod Kraher of Salem, brought Lucky to OSU where Helfand and Séguin collaborated on a treatment of chemotherapy and surgery.

"I am happy to report," Kraher wrote in a recent email to Helfand and Séguin, "that all is great four years post-op!!! There has been little effect from the surgery. She lost some range of motion when turning her head (neck) to the right, but compensates with no problems. Lucky has achieved her Master Hunter title and will be working towards an invitation to the Master National Hunt Test (the Super Bowl of retriever games) in Maryland this year!"

"That," says Séguin, "is what we live for." **terra**



Lucky recovered from a life-threatening cancer to qualify for national competition. (Photo: Rod Kraher)

## The Birth-Weight Factor

Small babies may face lifelong problems metabolizing meds

BY LEE SHERMAN

AMONG THE QUESTIONS YOU MAY be asked someday by doctors who prescribe your medications is one that few people can probably answer: What was your birth weight?

Research by Ganesh Cherala of the Oregon State University College of Pharmacy suggests that when physicians prescribe drugs ranging from Tylenol to cancer chemotherapies, they may need to factor birth weight along with body weight into dosing decisions for their patients.

In tests with laboratory rats, Cherala found that the kidneys of underweight animals born to mothers that were fed low-protein diets during pregnancy and nursing had significantly less ability to process and transport drugs than animals whose mothers had adequate protein. His results suggest that low birth weight may hinder the body's ability to process therapeutic drugs, thereby jeopardizing their effectiveness.

The culprit appears to be a protein called a "drug transporter," says Cherala, an assistant professor who has a joint appointment with Oregon Health & Science University.

"These transporters, which sit on the cell membrane, grab the drug molecules from the blood and put them into the cell," Cherala explains from his laboratory overlooking Portland's waterfront. "Then a second set of transporters grab the drug from the cell and dump it into the urine."

In the low birth-weight animals, the transporters Cherala looked at — OAT 1 (Organic Anion Transporter) and Pgp (P Glycoprotein) — were anywhere from two to 50 times less prevalent than in the normal birth-weight animals, depending on age and transporter type. The gap showed up across genders, although females showed a greater deficit over time.

Fewer kidney transporters mean that less medication can be excreted out



To help doctors and pharmacists optimize dosages and personalize dosing regimens for their patients, researcher Ganesh Cherala is investigating the impact of birth weight on drug metabolism. (Photo: Dennis Wolverton)

of the body, according to Cherala. The harmful results can range from toxic buildup of drugs in the blood to inadequate therapeutic benefits from the medication prescribed.

There are several ironies in this finding. First, scientists know that low birth weight increases risks for diabetes in humans, as well as for cardiovascular disease and metabolic syndrome (high levels of cholesterol, blood sugar and blood pressure). Thus, low birth-weight patients are more likely than normal birth-weight people to need medication during their lifetime. Yet these same subjects may be less able to process the drugs they need.

Second, researchers have found a link between low birth weight and adult obesity in humans. Because current weight is a major determiner of drug dosages (along with height, age and gender), obese patients typically get higher doses from their doctors than non-

obese patients. But if a patient's obesity stems from low birth weight, the higher dose may be more than his or her body can process.

"Let's say I'm low birth weight, and because of that I become obese," says Cherala. "If you dose me because of that higher body weight, you're actually compounding the problem. You're making the assumption that if you're higher body weight, you have more transporters. Actually, it's exactly the opposite."

Health-care professionals have long known that underweight babies can face a lifetime of health problems. By factoring birth weight — and its impact on drug metabolism and transport — into health-care decisions, pharmacists and physicians may help mitigate some of these risks down the road.

"The main goal of our lab is to discover how we can use birth weight to optimize the dose and personalize the dosing regimen," Cherala says.

# Path finders

Creativity and scholarship flourish for undergraduates in the field, at the bench and in the studio

BY NICK HOUTMAN

Robert Johnson gets a lot of strange looks when he tells his friends what he does in Ken Hedberg's lab. The senior from Salem and another student, Luke Costello from Corvallis, shoot electrons through clouds of gasses and use the results to analyze molecular structure.

"People ask 'why?'" says Johnson. "I just say, 'because it's interesting to me.' It's so simple," he adds, as though he were taking snapshots at the beach, "but you get a lot of information out of it about the molecules."

For Johnson and Costello, there's more to it than personal interest and curiosity. They're solving problems — troubleshooting equipment, puzzling over data with Hedberg, running numbers, reporting results

— on their way to bachelor's degrees in chemistry at Oregon State University. They both plan to attend graduate school and to pursue research full time, Johnson in chemistry and Costello in material science.

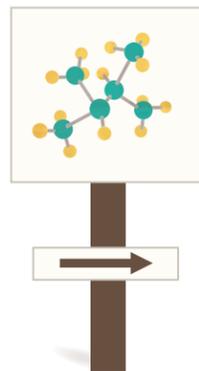
Every good coach, whether in baseball or chemistry, focuses on

the fundamentals. Hedberg shows his students how to transform solid materials into gasses, generate and guide an intense electron beam the width of a human hair through the gas, record the resulting "diffraction pattern" and use the results to calculate the distances between atoms that define the size and shape of the molecule. To get on base, Costello and Johnson run samples to make sure the machinery is working properly. Convincing evidence of the shape of a complex molecule is a home run.

Hedberg, an OSU alumnus (Chemistry, '43) and emeritus professor, explains further: "The energy of the electron beam we use is so great that it

passes right through the atoms, looks at the nucleus and gets bent around the nucleus. And as these electron waves pass through, they interfere with each other and create a diffraction pattern. That diffraction pattern is what we analyze to determine the structures of the molecules in the gas phase."

Since he came to OSU in 1956, Hedberg and his students have explored a library of compounds: halides and butadienes, diboranes and cyclohexanes. In 1993, he and his team were the first to confirm and publish the structure of a newly discovered soccer-ball shaped molecule that had made the headlines: carbon 60, aka the "buckyball." Hedberg's analysis of carbon 60 in the gas phase turned out to



"Ken Hedberg's a great guy to work for," says Luke Costello, right. Hedberg, center, instructs Costello and Robert Johnson on setting up the electron diffraction apparatus in his lab. (Photo: Karl Maasdam)

be more accurate than studies of its solid form.

In past generations, you would have been hard pressed to find undergrads doing this kind of work. Original research — studies that push the edge of current theory and practice and contribute new knowledge — used to be the domain of graduate students, post-doctoral researchers and the faculty. Undergrads had to get through the basics before they were admitted to the inner sanctum of the lab.

At OSU, as at colleges and universities around the country, Johnson and Costello are part of a movement of undergrads who conduct independent research and original creative work as part of their academic programs. It's not learning by listen and repeat-after-me. It's about jumping in with both feet, curiosity-based inquiry under the guidance of people who have been there and remember the thrill of creating something new. In the process,

students learn about themselves — their skills, personal goals and career interests — as much as about atoms, the arts, the environment, human health, technology and other fields.

"Independent research teaches you how to work things out yourself and not have somebody hold your hand the whole way," says Costello, who nevertheless appreciates the supportive, close-knit atmosphere he's found in the OSU chemistry department. "I have friends who are in big labs elsewhere and end up watching other people's experiments or doing total grunt work. They're not doing the actual experimental work."

And besides, he says, "Ken Hedberg's a great guy to work for."

Independence and ownership — what Susie Brubaker-Cole, associate provost for academic success and engagement, calls "a feeling of agency" — define this activity. So does mentorship. In teams or one-on-one, faculty members instruct

and guide undergrads through the process of asking questions, designing experiments, analyzing data and creating presentations. This “learning community” of undergraduate and graduate students, post-doctoral researchers and faculty members can become a student’s family away from home, adds Brubaker-Cole. And the faculty link today’s students to academic tradi-



Ken Hedberg’s National Science Foundation grants now go toward the support of undergraduates, like Robert Johnson, right, and Luke Costello. (Photo: Karl Maasdam)

tions and culture. In Hedberg’s case, that legacy includes another stellar OSU alumnus, Linus Pauling.

### Job on the Home Front

Hedberg grew up in southern Oregon and graduated from Medford High School. In 1943, with an OSU chemistry degree in hand, he went to work for the research arm of the Shell Oil Co. in California on aviation gasoline, synthetic rubber and penicillin extraction, projects deemed crucial to the war effort.

After earning his Ph.D. in physical chemistry and working as a post-doctoral researcher at Caltech, Hedberg came to OSU with strong encouragement from Pauling. OSU

Chemistry Professor Earl Gilbert had made a second job offer to Hedberg that spring (Hedberg turned him down the first time), and the young chemist sought Pauling’s advice. One evening, on the veranda of Pauling’s Pasadena home, the Nobel Prize winner urged Hedberg, already an expert in the analysis of molecules by electron diffraction, to accept.

With nearly continuous National Science Foundation (NSF) support for his research since 1962, he depended largely on graduate students to help him with studies in molecular structure. Although he retired in 1987 and turned 91 in February, Hedberg continues to work nearly every day in his office and plays an occasional game of tennis. “My wife Lise says she is retired and knows it and that I am retired and don’t know it,” he says with a slight grin.

Meanwhile, his NSF grants have shifted to support for undergraduates like Costello and Johnson, who are learning structural

## Linus Pauling Science Center

Researchers in the Department of Chemistry and the Linus Pauling Institute will share new laboratory space next fall. The 105,000-square-foot Linus Pauling Science Center, supported by private donations and public funds, is scheduled for completion in August and will feature classroom and lab space for students and faculty.

chemistry from one of the pioneers in the field. “They are doing much the same kind of work that my graduate students used to do. It’s lots of fun. These kids are bright, and for the most part, they have been quite interested and productive,” he says.

In 2005, Hedberg received one of the highest honors in his field: the International Barbara Mez-Starck Prize, given to scientists who have made outstanding contributions to structural chemistry.

At OSU, student opportunities have grown along with the university’s research portfolio, which has more than doubled in the last decade. Little university-wide data is available (monitoring student participation is left to each faculty member, department and college), but the following stories show how personal discoveries are shaping today’s undergraduates in ways their parents could hardly have imagined.

## Natural Defense

### Plant-based diabetes treatment shows promise

“I’m not one that is easily deterred,” Anneke Tucker says with a disarming smile. It’s a good thing. The 23-year-old Oregon State University senior from Lakeview, Oregon has fixed her sights on nothing less than improving health care in rural communities.

And along the way, she might throw in a new treatment for one of the nation’s most serious health threats, Type 2 diabetes.

Last winter, judges in a national competition, *The Journal of Young Investigators’* Second Annual



Anneke Tucker has demonstrated the power of natural plant products to reduce glucose levels in people with Type 2 diabetes. (Photo: Frank Miller)

Virtual Poster Session, recognized her skills and ambition when they awarded her first place for a video presentation on research with scientists in OSU’s Linus Pauling Institute (LPI). It was Tucker’s second presentation to a scientific audience.

The University Honors College student grew up in a ranching community and, inspired by her participation in Future Farmers of America, came to OSU to study animal science. But instead of healthy cows, it was healthy people that drew her attention, so she switched her focus in the College of Agricultural Sciences to BioResource Research. Intent on getting into a lab, she searched for a mentor and applied for undergraduate research funding from OSU’s Howard Hughes Medical Institute program and from the OSU Office of Research.

Then she met Balz Frei and Meltem Musa. The LPI scientists were planning to test plant extracts — grape-seed, Japanese knotweed and white and green tea, among others — for their ability to treat Type 2 diabetes. In addition to laboratory studies, they planned to do human trials. Tucker was hooked. “Since I was the only student working with Dr. Musa and Dr. Frei on that particular project, it allowed me to have a greater understanding of the overall goal of the research,” says Tucker.

She focused on two enzymes —

alpha amylase and alpha glucosidase — that play a key role in diabetes by breaking carbohydrates down into glucose molecules. Glucose is vital since it powers our cells, and most people keep blood glucose levels within a healthy range.

But in those with Type 2 diabetes, blood glucose can rise to harmful levels. The disease has an unknown cause, and its symptoms are devastating: increased risk of Alzheimer’s Disease, stroke, heart attack, high blood pressure and osteoporosis. In the United States alone, 23.6 million people have been diagnosed with Type 2 diabetes, and another 54 million are thought to be pre-diabetic.

Working closely with Musa, Tucker compared the effectiveness of plant extracts to a prescription medication that carries a high price tag and has serious side effects. Her results were mixed. She found that several of the plant extracts are more effective than the drug in reducing the activity of one of the enzymes, alpha glucosidase. For the other enzyme, alpha amylase, the drug was more effective.

“Ultimately,” she says, “I would love to open a clinic in a rural and underserved community (which is where my fiancé and I come from) and offer medical services and education regarding women’s health and life-long nutrition and health.”

## Blood Lines

Ishan Patel found his niche in biomedical engineering

It wasn’t the most elegant way to enter a lab. Ishan Patel had just met his mentor for the summer of 2009,

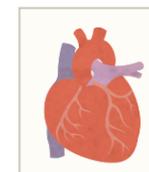
Dr. Owen McCarty at Oregon Health & Science University. The OSU bioengineering student wanted to make a good impression, and when McCarty told him to go across the hall and meet his research team, Patel confidently tried the doors, only to trip the alarm just as a

security guard and another person were leaving. “There was lots of confusion about who had set off the alarm,” Patel laughs.

Patel had walked into a facility shared by OHSU researchers studying optics, stem cells, neurology and blood chemistry. For the first-year student aiming for a career in medical research, it was a thrill just to be there. Once McCarty arrived and introduced Patel to the other members of his team, Patel received his marching orders: build a table-top device that would allow liquid to flow under the force of gravity from a reservoir through a capillary tube into a reservoir.

Patel recalls his exact words. “He said: ‘I don’t know how you’re going to do this. Here’s a catalog book to find parts. If you need anything, you can order what you want. Just get it done.’” The device would provide a model for McCarty’s studies of blood clot formation.

After three weeks and several attempts, which involved burning small holes in plastic Petri dishes and applying glue to silicon tubing, Patel was testing a prototype when



McCarty came into the lab. “He saw it and said: ‘That looks good. Let’s add some blood.’ So we pipetted some blood through a syringe, and it flowed right through into the capillary and into the bath. No leaks, nothing.”

That was the first success for Patel, who is also a student in OSU’s University Honors College. Since then he has worked on a mathematical model of blood flow in the device to make sure it is physiologically relevant to human arteries and veins. In 2010, he returned to McCarty’s lab to study the influence of cancer cells on blood coagulation. He is listed as a co-author on four peer-reviewed papers on blood chemistry and coagulation.

Patel credits OSU engineering professor Willie “Skip” Rochefort with encouraging him and helping him to earn a Pete and Rosalie Johnson Scholarship during his internship at OHSU. “When I came to OSU, I really wanted to start

doing research,” says Patel. “I came from a small town, Redmond, and I never expected to be able to get into a research lab right away and start producing results that quickly.

“The fact that I get to spend my four years with the same people, that I develop relationships with my peers and professors — that provides a really good education environment.”

Patel advises fellow students who are considering research to be persistent and open to opportunities. “Try anything and everything you want,” he adds. “Keep your goals in mind. If you want to go on to grad school, avoid getting sidetracked by distractions.”

This spring, Patel learned that he had received a Barry M. Goldwater Scholarship, one of the nation’s most prestigious awards for undergraduate researchers. In July, he plans to present a paper to the International Society of Thrombosis and Haemostasis in Kyoto, Japan.



In support of his work on blood chemistry and clotting factors, Ishan Patel was awarded a Barry M. Goldwater Scholarship. (Photo: Jan Sonnenmair)

## Cultural Designer

Contemporary images respect Ojibway traditions

Neebinnaukzhik means “summer evening” in the Ojibway (also known as Chippewa)



language of the Great Lakes region. When Neebinnaukzhik Southall was growing up, she made handcrafts — friendship bracelets, dream catchers and beaded

animal shapes — and sold them to family and friends. She called her business Summer’s Specials.

Today, the senior in OSU’s Graphic Design Program and the University Honors College goes by Neebin and is combining her passion for line, texture, color and pattern with an exploration of her own story and heritage. “Graphic design is about bringing beauty to little things, elevating them in some way,” she says. “I see a cultural reclamation going on, and I feel like graphic design can be a part of that.”

Despite the emerging pride that she sensed in Native communities, Southall was concerned with what she found in her studies. In preparing for her senior project, she saw that Native Americans were poorly represented in professional associations and other parts of the graphic design world. “It’s a voice that seems lacking. I wondered why. When I started my research, I didn’t know any big designers who are Native Americans,” she says.

Through her exploration, she discovered the work of Victor Pascual (Navajo and Mayan), Mark Rutledge (Ojibway) and the Buffalo



Neebinnaukzhik Southall wants to use graphic design to further the cultural reclamation under way in Native American communities. (Photo: Frank Miller)

Nickel Creative, cofounded by Ryan Red Corn (Osage). She also found work by white designers that presented Native cultures in a sensitive and powerful way.

Inspired by these examples, she has set out to combine contemporary design with traditional motifs in her own work. For her senior project — Then and Now: Asserting Anishinabek Identity Through Indigenized Apparel — she is creating designs for clothing (T-shirts and hoodies) that echo traditional symbols from her mother’s people, the Chippewas of Rama First Nation in Ontario, Canada. Anishinabek is the collective name for Native people of the region, and the thunderbird and underwater panther carry powerful meanings for them. These symbols appear in Native beadwork and quillwork. Her immediate goal is to respectfully integrate such images with modern forms that appeal to a young generation.

“Neebin approaches every project with a fire and intensity,” says Andrea Marks, associate professor in the Department of Art’s graphic design program and Southall’s mentor. “She’s very proud of her heritage, and she has brought that with her from the beginning. It’s been interesting to see how she threads that into her projects.

“I can see the passion she has for her culture and wanting to give something back and empower young people. She is very secure in who she is,” Marks adds.

In addition to Chippewa on her mother’s side, Southall traces her ancestry to Iroquois and European cultures from her father. Being of mixed ethnicities has been both a struggle and a gift, she says, since she has felt a need to clarify her personal identity and to bring people together despite their differences. And she recognizes that design inspiration for Native people has come from other cultures (European religious art, Persian rugs) as well as indigenous experience.

Southall hopes to bring her spirit and design skills to the Chippewa of Rama First Nation tribal center or to another organization that promotes Native American culture, such as the Smithsonian Institution or a Native American educational foundation.

“I have a heart,” she says, “for moving forward in a positive way and strengthening people.”

## Growth Factors

High alcohol consumption inhibits bone healing



Feeding the rats was just the beginning. To get to the bottom of questions about the effects of alcohol consumption on bones, Cyndi Trevisiol learned how to remove the living cells from a femur and a tibia (purchased frozen from a biological supply house). She then removed the minerals — calcium, iron, magnesium, zinc, silicon — leaving behind a tube of seemingly lifeless collagen, the bone’s own skeleton, so to speak. She implanted the tube under the skin of a rat and watched something miraculous: On the protein skeleton, new bone started to form. Cells

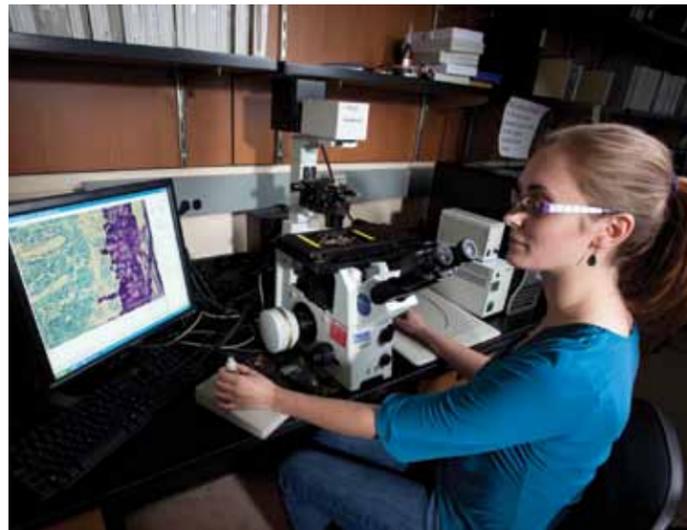
migrated into the area. After only six weeks, the lifeless shell had become a small sample of mature bone.

As a freshman, she learned all that, along with how to feed and care for the rats, in her first summer in OSU’s Skeletal Biology Laboratory.

Under the guidance of OSU professors Russell Turner and Urszula Iwaniec, Trevisiol produced results that led to a paper in *Bone*, one of the major peer-reviewed journals

in the field. “It was hard, and I made mistakes,” she says. “But Russ and Urszula were always so open and willing to listen to my concerns and interests. And tell me where I had made an error in my thinking.”

In 2006, the graduate of West Albany High School had come to OSU with interests in animals and tissue engineering. With financial support



Research grabs student interest and keeps them inspired, says Cyndi Trevisiol, who worked in OSU's Bone Research Lab. (Photo: Frank Miller)

from OSU's Howard Hughes Medical Institute program, Trevisiol became the first undergrad in the new skeletal biology lab in the College of Health and Human Sciences. “She set the standards for everyone else,” says Iwaniec. “I would present Cyndi with a project, and she would take it from start to finish and make it her own. In a lot of cases, she went beyond it, looking at what was asked of her and finding alternative methods for data collection.”

In that first year, Trevisiol demonstrated that the process in which broken bones repair themselves was impaired in rats fed a diet high in alcohol. Physicians have long known that bones don't heal well in human alcoholics, but Trevisiol's research was the first to demonstrate the mechanism that inhibits bone fracture repair.

“Undergraduates,” says Turner, “are capable of far more than simply obtaining a research experience. This is top-notch, first-line research in which undergraduates can make a very meaningful contribution in discovery processes.”

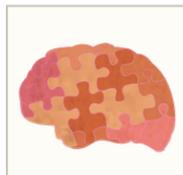
Using mass spectrometry and micro-computed tomography scanning, Trevisiol delved into proteomics, bone mineralization and growth factors. Her contributions led to her being listed as a co-author on three more papers (in *Bone*, *Osteoporosis International* and the *Journal of Mineral and Bone Research*) with Iwaniec, Turner and their colleagues.

“I hope a lot more freshmen get involved in undergraduate research,” she says. “It was valuable for me to start doing research

so early in my education. You start out a little unfocused, but if you're interested in what you're studying, and you're committed to learning, all of sudden school will come into focus.”

## Good Impressions

How do we size each other up?



Call it gut instinct, intuition, street smarts or sixth sense. Good poker players need it. Success in business, politics and athletics demands it. Psychologists call it emotional

intelligence, but unlike the myriad tests available to assess verbal and quantitative intelligence, a well-validated test for emotional intelligence has yet to be established, says Frank Bernieri, an associate professor in the OSU Department of Psychology.

For the last five years, Bernieri has led the Beaver Emotional Intelligence Project, which is identifying the basic components of emotional intelligence and attempting to validate the tests that measure them. What makes this project unusual is that it is run almost exclusively by undergraduates. For 10 weeks, research subjects socialize, take personality tests and get videotaped in interpersonal activities (acting, working, deceiving) that reveal their skills in both reading others and influencing them. Groups eat together, clean together, have debates and play games. The idea is to simulate all the important things we do with others that enable us to know them. And over the course of the term, they fill out personality scales about themselves and make judgments about the other members of their group.

“It's a really cool, unique experience,” says OSU master's student and Eugene native Jill Brown, who worked with Bernieri as an undergraduate to direct the project. She and two undergrads — Jordan Clark and Joshua Landin — manage a team of 13 students who schedule activities, collect data and keep their peers on track.

Emotional intelligence can be viewed as either an inherent personality trait or as something you can develop, Brown says. “It's like extroversion. It can be something you have, that is stable and inherent. Or it's something you can develop, like math ability.

“Some people are good at regulating their emotions, and some people aren't,” she adds. “Can you use them? Can you manage them? Can you perceive emotions in others?”

Unpublished results from the



Students run the Beaver Emotional Intelligence Project, a five-year effort to understand the basis for judging personality and behavior. Top left, Jordan Clark; middle, Joshua Landin; right, Jill Brown. (Photos: Frank Miller)



project don't settle those questions yet, but they do show that people are better at detecting some personality traits than others. It turns out, for example, that people can see whether a stranger is an introvert

or extrovert just by looking at them. However, it takes a full 10 weeks of working, socializing and traveling with someone before people can accurately determine how nice they are. This project will enable

researchers to figure out precisely when, where and how people discover these traits in others, and whether some are doomed to always be fooled.

Brown is working with Bernieri to prepare the first paper to emerge from the project, while Clark and Landin are pursuing their own related projects. Clark, a senior from Medford, is taking a look at a trait known as “self-monitoring.” A senior from California, Landin is evaluating a highly marketed test of emotional intelligence to see how well it predicts the ability to decode the nonverbal behavior and emotions of others.

“Our weekly lab meetings are a sight to behold,” Bernieri adds. “Imagine 13 undergraduates crammed into a conference room listening to one of their peers present research results and/or a proposal for a paper that is derived from the data set we are generating. It's pretty cool.” **terra**

## How Do You Know That?

BY RICK SPINRAD, VICE PRESIDENT FOR RESEARCH

As an undergraduate at Johns Hopkins University in the 1970s, I immersed myself in learning about my field of choice, oceanography. I spent plenty of time in class studying the leading texts of the day. But my real education came from first-hand research experiences. In fact, on my first scientific cruise, I probably learned more about the ocean by collecting real data than I had in my first year of study. Some of my most powerful lessons came from the unexpected, the data that didn't correspond to my expectations, the surprises that inevitably happen in science.

Today, I support increasing opportunities for undergraduates to conduct hands-on, extra-curricular research. There has been much talk in academia about helping students prepare for their future roles as society's leaders and contributors. First they need to become intimate with the science. We don't need merely good test-takers. At OSU, we strive to nurture people who question what we think we know

and people who can solve the world's real problems.

We also need scientists to be communicators. My parents wrote the Speaker's Lifetime Library, a resource for presenters, so communicating was always important to me. In my own career, I find myself having to make scientific information comprehensible to a diverse audience. I need to not only share information but also

to plead the case, justify the activities, inspire the funding — before the public, policymakers, legislators, potential sponsors and partners.

I am impressed that many OSU researchers use their passion and intellect to translate complex issues into meaningful, personal, memorable insights. I have heard Kathleen Dean Moore (Distinguished Professor of Philosophy) weave ethics into our understanding of the environment. On a research trip this winter, I listened to Bruce Mate (Director, OSU Marine Mammal Institute) talk passionately about the unknowns of whale migration.

Our students learn from scholars and researchers in studios and laboratories, on ships, in forests and on farms. And as undergraduates make discoveries that excite their curiosity, they also gain skills for life. They learn to think critically, to respond to assertions by their peers and others, not with a nod and a smile, but with a question: How do you know that?

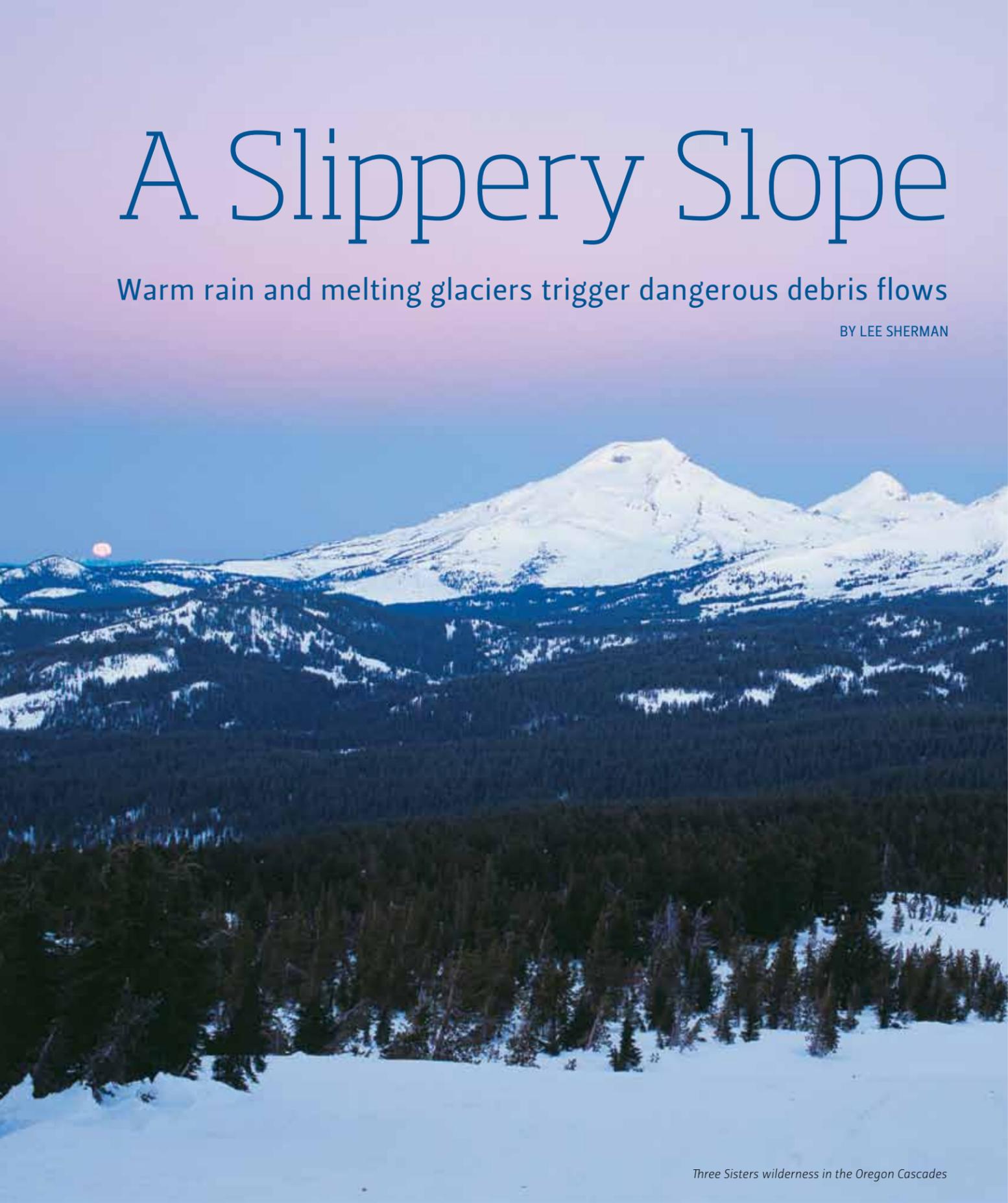


Rick Spinrad, right, on the R/V Wecoma.

# A Slippery Slope

Warm rain and melting glaciers trigger dangerous debris flows

BY LEE SHERMAN



Three Sisters wilderness in the Oregon Cascades

Grinding over ancient layers of lava and ash, the glaciers of the Cascade Range act like supersized sheets of shrink-wrap. Stretched taut across tons of pulverized rock, these blankets of frozen snow hold sand, gravel and boulders in place — that is, until they start to melt. Then the sediments, unlocked from the glaciers' icy grip, are vulnerable to gravity. The steeper the slope or gully, the more likely they are to break loose, especially when pounded by warm rainstorms blowing in from the sea.

That's what happened in early November 2006, says OSU geographer Anne Nolin. On virtually every Cascade peak from Mt. Rainier in Washington to Mt. Hood in Oregon, a "perfect storm" of driving rain, balmy temperatures and receding glaciers sent torrents of rock and mud tearing downhill.

"It was raining almost to the top of Mt. Hood," recalls Nolin, an internationally known expert in mountain hydroclimatology. On her laptop, she clicks open a photo of Mt. Hood with one of her graduate students standing beside a jumble of debris that had spewed out of Eliot Creek into a grove of evergreens during the storm, which dumped over 13 inches of rain on Mt. Hood in 36 hours.

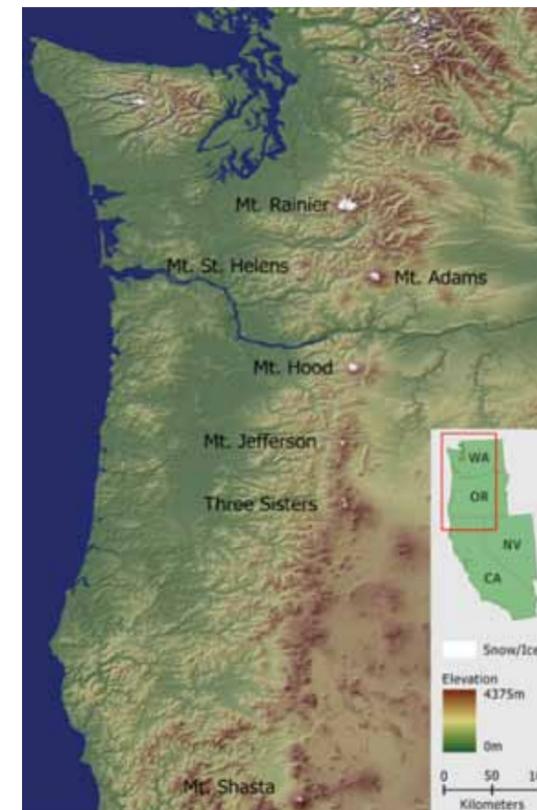
"This area used to be soft forest duff," Nolin explains, pointing to the photo. "Now it's full five

feet in boulders and logs."

Collecting data with sophisticated technologies (satellites, lasers and computer models), as well as traditional methods (boots on the ground), Nolin is leading an investigation that will more fully describe the forces energizing alpine debris flows.

"There's an enormous amount of sediment up there — pyroclastic debris from volcanoes, till ground up by glaciers," she says. "Once it's no longer held in place by the ice, it becomes unstable. Add water, and these unstable sediments are mobilized."

The study, funded by more than \$350,000 in National Science Foun-



## >> In Brief

**THE ISSUE** Melting mountain glaciers and warming rains drive debris flows, torrents of mud and rock that have damaged roads, closed recreational facilities and led to millions of dollars in clean-up costs in the Northwest. Climate change is likely to increase risks in the future.

**OSU LEADERSHIP** With funding from the National Science Foundation, OSU geographer Anne Nolin and geomorphologist Stephen Lancaster work with U.S. Forest Service hydrologist Gordon Grant to understand the debris-flow causes and to map vulnerable areas in the Cascades.

ation (NSF) stimulus funds, also will help foresters, park managers and mountain communities better predict events like the 2006 deluge, which washed out bridges, swept away campgrounds, closed roads and set the stage for future floods by choking river channels.

## Pineapple Express

Snow is Nolin's medium. Practically born with skis on her feet, she has plied the slopes from Killington Mountain in Vermont, near where her family has a home, to Mt. Hutt in New Zealand, where she spent three and a half months of her 2009-2010 sabbatical. The other eight months she lived (and skied) in the Vaud and Valais regions of Switzerland. (The Northern and Southern Hemispheres together gave her back-to-back winters — something only a lifelong snow lover would deem delightful.) While overseas, she gave



a flurry of presentations about debris flows, as well as conferring with fellow researchers at the University of Canterbury in Christchurch, the École Polytechnique Federale de Lausanne and the University of Zurich.

All of these scientists are seeing the same thing on their local mountaintops: a steady nibbling away of glacial edges. Satellite images of Hood and Rainier show glaciers shrinking by 14 percent between 1987 and 2005, Nolin reports. That's a loss of nearly 1 percent ice volume per year.

It is at this ragged glacial edge, where ice is fragmented and meltwater is leaking down the ultra-steep terrain of towering peaks, that most debris flows begin. Nolin and her team are trying to pin down the triggering mechanisms. One culprit could be the so-called Pineapple Express — those notorious storms nicknamed for the warm temperatures and monsoon-like quantities of rain they bring from

*The Cascades will see more rain, less snow and changing water flows as climate shifts precipitation patterns, says Anne Nolin of OSU's Department of Geosciences. In addition to analyzing debris flow risks, Nolin focuses on snowpack and water availability in the McKenzie River Basin. (Photo: Karl Maasdam)*

their origins in the tropical Pacific. They are examples of “atmospheric rivers” — airborne water plumes that shoot extraordinary amounts of vapor through the atmosphere. Nolin describes them as “laser beams of moisture,” which blast into the Northwest from time to time, including the 2006 storm that ranked as the decade's worst.

“We're trying to understand the character of these storms and their impact on mountain sediments,” she says. “Basically, we want to know how climate change affects rain-induced debris flows in the Northwest and other mountain regions worldwide.”

After Year One of the three-year study, Nolin and her team of colleagues and graduate students have found a clear link between debris flow events and unusually

high freezing levels, the elevation where precipitation falls as snow instead of rain.

“The freezing altitudes of nearly all the storms that caused debris flows are at least one standard deviation higher than other significant rainfall events occurring in the same season,” Nolin writes along with her co-investigators Stephen Lancaster, an OSU geomorphologist, and Gordon Grant, a courtesy professor in the U.S. Forest Service, in their annual report to NSF. “Further, nearly all debris-flow events were coupled with ... atmospheric river-like conditions.”

Yet because of the complex interplay of mountain systems, storm dynamics and debris-flow mechanics, Nolin says, “the conclusive story continues to elude us.”

## Upslope, Downslope

“Water flows downhill, but policy flows uphill,” Nolin told members of the international Mountain Research Initiative in Perth, Scotland, last fall.

On the “upslope-downslope continuum,” it's the big population centers in the valleys and on the coasts that pass the laws and set the agendas for timber harvest, land use, energy resources, air quality, water allocation and just about everything else that affects the highlands, she explained.

Policy isn't the only thing that rises. Greenhouse gases produced by cities and by fossil fuel users in the lowlands have caused temperatures to rise in the mountains. Research reveals that this warming is altering the foothills and forests of Oregon's Cascades in measurable ways. Spring is arriving a full month sooner than it did 50 years ago in some parts

of the H.J. Andrews Experimental Forest, Nolin says, citing the research of OSU atmospheric scientist Christoph Thomas. Winters' final frosts, he found, are falling ever earlier on the calendar. Water levels in the McKenzie River are dropping. Lower elevation snowpack — accumulated layers of snowfall that build up and compact during the winter — is disappearing.

“When snow melts earlier, we lose water storage,” says Nolin. “Snowpack is a reservoir for us.”

In Oregon's Hood River Valley, 50 percent to 80 percent of the water that irrigates crops comes from Mt. Hood's glaciers and snowpack. If early melting trends continue, that priceless meltwater is in danger of dwindling by early- to mid-summer, leaving farmers in short supply during the hottest months when they need it most.

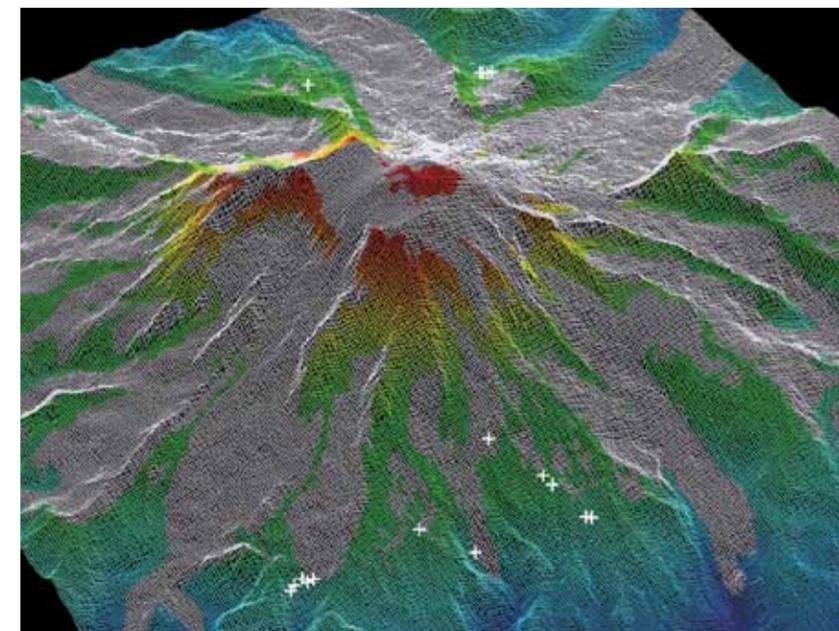
“Climate change,” Nolin says, “disproportionately affects mountain regions.” One reason is found in the physical properties of light and frozen  $H_2O$  — properties she studied along with satellite remote sensing as a Ph.D. student at U.C. Santa Barbara. After having previously worked as a soil and water scientist, she became entranced by the elegant physics of light interacting with ice particles.

“Soil and snow are both particulate, porous substances,” she says. “But snow is so much more simple and clean. Radiative transfer theory is a very straightforward way to monitor snow from satellites.”

In fact, the glittering white of snow and ice is what explains the vulnerability of mountains to climate change. Whiteness, Nolin explains, reflects sunlight back into the atmosphere. As light-reflecting snowcaps and ice sheets shrink, more sunlight gets absorbed into the earth instead of bouncing off. Melting accelerates as ever more light and heat are captured and held. Scientists call this phenomenon the “ice-albedo feedback.” As a vicious cycle, it causes temperatures to actually rise faster in ice-laden places than elsewhere on the planet.

Those ice-laden places include the North Atlantic island of Greenland, where as an early-career scientist, Nolin spent several summers studying polar climatology.

“It's flat and white as far as you can see,” she recalls. But if that sounds like a complaint about the frozen landscape, she quickly sets the record straight. “It glitters,” she says. “It's very pretty.” **terra**



*On Mt. Rainier, a “wire mesh” digital elevation model derived from airborne LiDAR data shows elevations (red is highest, blue lowest), glaciers and debris flow initiation sites. The gray areas are glaciers (as of 2008). Marked by white crosses, all debris flow initiation sites are just below glaciers in recently deglaciated areas. (Image courtesy of Anne Nolin)*

**ON THE WEB:** See more about OSU's Mountain Hydroclimatology Research Group at [www.geo.oregonstate.edu/~nolina/RESEARCH\\_GROUP/](http://www.geo.oregonstate.edu/~nolina/RESEARCH_GROUP/)



## One Less Child

Reproductive choices affect long-term carbon emissions

BY NICK HOUTMAN

ILLUSTRATION BY TERESA HALL

If you're concerned about sustainable living, you probably pay close attention to your "carbon footprint." We all have one: the amount of climate-changing carbon we emit to the atmosphere through our energy-intensive lifestyles. Some of us even calculate our household's footprint with one of the many carbon calculators available online.

It helps to have your old bills handy if you use the Household Emissions Calculator created by the U.S. Environmental Protection Agency (EPA). You'll need to enter how many kilowatt-hours of electricity and therms of natural gas or gallons of heating oil you've used in the past year. Add miles traveled in the car, whether or not you recycle your trash or turn down the thermostat at night and myriad other details, and the calculator will tell you how many tons of carbon emis-

sions you can call your very own. The per person average for 311 million Americans, according to the EPA calculator, is about 10 tons per year.

However, missing from these numbers is a factor that, in the long term, can overwhelm our efforts to live more lightly on the planet: the choice to reproduce.

"It's probably the most basic of all biological urges," Paul Murtaugh told a Corvallis audience in February. "To hint that there might be some benefit to controlling that urge is very controversial." Last year, Murtaugh personally found out just how strongly people feel about it.

### All in the Family

The Oregon State University professor of statistics and OSU colleague Michael Schlax published a paper in the journal *Global Environmental Change* describing an individual's "carbon legacy" — the amount of carbon likely to be emitted in the future by one's descendants. Parents, they reasoned, could be held accountable for one-half of their children's emissions, one-quarter of their grandchildren's and declining portions down through the generations.

Murtaugh and Schlax took a mathematical approach to understanding the consequences. They estimated how large a parent's carbon legacy might be by creating a model based on per capita carbon emissions and a country's population trends (fertility and mortality rates and average longevity). They used data from the Intergovernmental Panel on Climate Change and the United Nations to compare the carbon legacies of parents in 11 of the world's most populous countries.

Since family size and longevity vary widely even within the same population, they ran the model thousands of times country by country. Each time, the model chose a random parent with a specific number of descendants who lived and reproduced until the lineage ran

out. From those hypothetical examples emerged an average parent's carbon legacy for each country.

Murtaugh and Schlax didn't stop there. On top of these calculations, they added another factor: future changes in annual carbon emissions. While there are wide disparities between rich and poor countries, today's global average is about four metric tons (as carbon dioxide or CO<sub>2</sub>) per person. If new carbon-free energy technologies take hold, emission rates could drop. If not, they could stay the same or rise. So, looking forward to the year 2100, they used scenarios that were "optimistic" (drop to 0.5 tons), "constant" (stay at four tons) and "pessimistic" (50 percent increase to six tons).

The results were clear. "If you accept our method of accounting, a decision to have a child amplifies a single parent's lifetime emissions by three or four times in most countries, by virtue of the carbon legacy that perpetuates through generations," says Murtaugh. "Remember these emissions accumulate over hundreds of years and many generations."

### Lifetime Legacies

The effect was most dramatic in the U.S. On average, the additional emissions per child — about 9,400 tons under the "constant" scenario — was almost six times the amount of carbon emitted by a parent over his or her own lifetime. Not only that, it was 20 times more than the amount that could be saved over an 80-year lifetime by the energy conservation measures included in the EPA's emissions calculator.

Nevertheless, Murtaugh calls those short-term reductions essential. "It's not that we can solve the global warming problem by reducing the number of children that we have," he adds. "It will help immeasurably in the long term, but in the short term, it's essential that we reduce our per capita emissions right away." In fact, under the "optimistic" emissions

scenario, the drop in per capita emissions reduces future impact per child by almost 90 percent.

Slowing population growth can also help, but "the savings from these reductions in fertility aren't going to be that meaningful unless we get our per capita emissions under control," Murtaugh adds.

After the paper was published and featured in an OSU news release, news of their analysis splashed across international headlines and caught the attention of environmentalists, newspaper columnists and conservative bloggers. Some critics responded to a misperception that Murtaugh and Schlax had called for government policies to curb an individual's right to have children. "We said nothing in our paper about policies," says Murtaugh. "We just did the calculations and laid them out there for people to think about. But most of the people had obviously never seen the paper. We were called Nazis and eugenicists."

One individual phoned Murtaugh and suggested that he consider killing himself to reduce his own carbon emissions. The caller then proceeded to reach every member of the OSU statistics department demanding that Murtaugh be silenced. "I began to fear for my safety. Fortunately the blogs, calls and emails stopped after a few weeks," Murtaugh adds.

More than climate and reproductive rights are at stake. Rapid population growth affects other species (think ivory-billed woodpecker, passenger pigeon, blue whale and Fender's blue butterfly) and exhausts the planet's carrying capacity, Murtaugh says. At current levels of production, it has been estimated that it would take 1.4 Earths to maintain today's population into the future. "In other words," he concludes, "we're living off the capital now."

The United Nations Population Division expects the global population to reach 7 billion this fall. **terra**

## Building a Better Student

### One research project at a time

BY DANIEL ARP, DEAN, UNIVERSITY HONORS COLLEGE

WHEN UNDERGRADUATE STUDENTS DO HANDS-ON research with eminent professors on projects that matter, everyone wins. Students become better thinkers and citizens; the professors who mentor them become better teachers and researchers. Employers get access to employees with critical thinking, problem-solving and communication skills that are so important in an economy increasingly dependent on innovation and cross-cultural teamwork. Undergraduates who participate in research are prepared to contribute to their communities and to enter a globally competitive economic environment.

"Research" means more than laboratory science and engineering. It includes creative endeavors in the arts and humanities. And as dean of the University Honors College, I have found few experiences more fun and rewarding than getting to work with students on projects covering every imaginable subject. In the Honors College, we have made research the capstone of the undergraduate experience in the form of a senior thesis. My colleagues will probably agree with me that there is something special about being there at that "aha!" moment when students discover what an experiment is telling them or find their interpretive voice through a musical composition or literary work.

Chelsea Byrd (OSU B.S., Microbiology, 2001; Ph.D., Molecular and Cellular Biology, 2005) is a great example of a student who benefited from an undergraduate research experience. Chelsea works for SIGA, a Corvallis biotechnology company, where she designs countermeasures for infectious diseases. She discovered her passion for research as an undergraduate in my laboratory as she helped sort out how bacteria can degrade environmental pollutants. Chelsea also gives back to her alma mater by serving on the Board of Directors of the OSU Alumni Association.



Dan ARP chats with Chelsea Carnes, a junior in nutrition science with a chemistry minor and a student in the University Honors College. (Photo: Dennis Wolverton)

### Connecting the Dots

Few academic experiences have such long-lasting benefits. Studies, including the National Survey of Student Engagement (Indiana University), consistently reveal the positive effects of a research experience. For example, students who do research are more likely to stay in school, to experience diversity and to view their entire undergraduate experience more positively. They gain confidence and become better communicators. Classroom learning becomes more real as it gets put to use in the laboratory or in primary-source analysis. Research experiences have even greater impacts on members of underrepresented groups.

Research is one of the most effective ways to help students move from lower-order thinking skills — remembering, repeating, understanding — to higher-order skills — creating, analyzing,

evaluating. Students also learn to work independently but as part of a team; they learn to collaborate. These skills and experiences are increasingly vital to professional success. Graduate and professional schools expect that students will have had independent research experience, and employers are more likely to hire an individual equipped with the advanced skills developed in research.

Oregon State University provides many opportunities for undergraduates to do research. With more than 1,000 professors working in diverse disciplines, research at OSU is not just about white lab coats and test tubes. Our "laboratories" include estuaries and open seas, farm fields and forests, art studios and music practice rooms. Through these varied experiences, students learn about more than the world around them. Most importantly, they learn about themselves.



Abi Farsoni, right, and his graduate student, Abdulsalam Alhawsawi, discuss gamma and beta radiation waves visible on a computer screen. On the desk is the detector developed by Farsoni and colleague David Hamby. (Photo: Karl Maasdam)

## The Gamma and the Beta

### Nuclear detection invention improves monitoring

BY LEE SHERMAN

**FAST, ACCURATE, AFFORDABLE DETECTION OF** radiation — whether it's from Japan's damaged Fukushima plant, long-buried waste at Hanford's WWII weapons site, or secret underground testing by rogue nations — is a pressing need internationally.

Now, detection technology has taken a notable leap forward. A newly patented invention from the OSU Department of Nuclear Engineering and Radiation Health Physics uses "phoswich" technology (short for "phosphor sandwich spectrometer") to detect both beta particles and gamma rays simultaneously. Texas-based firm Ludlum Measurements has signed a contract with OSU's Office for Commercialization and Corporate Development to produce two of the detectors for engineering giant CH2M Hill for its Hanford cleanup project in Washington, where the U.S. government is spending hundreds of millions of dollars to remove radioactive soil. Ludlum also has expressed interest in licensing the detector for commercial production and sale. Eventually, the detector may find applications in nuclear energy and medicine, according to OSU researchers David Hamby and Abi Farsoni, who developed the device with funding from the U.S. Department of Energy.

A Corvallis-based spinoff called Avicenna Instruments soon will begin production of the device's electronic components. The fledgling company sees a ready market for the new technology in universities and laboratories, which currently make do with outdated analog equipment. "Detection systems that use digital spectrometers are more reliable, efficient and intelligent," says Farsoni.

Besides being an important advance on earlier technologies that measured only one type of radiation at a time, the device can be linked to a PC via a simple USB port, the researcher says.

To demonstrate, he fires up his computer and points to a bright red line pulsating across the screen. The line, which resembles the reading on a heart monitor, indicates background radiation — the levels that occur naturally in the environment. Then, picking up a nickel-sized capsule from the table, he holds it close to the detector. The red line reacts immediately. "See how the waves are going faster and faster?" he says. "This is a gamma source. It emits only gamma rays." Then, holding up a second capsule to the device, he says, "This is a beta source. See how the shape of the beta pulses is totally different from the gamma pulses?"

"With this new system," the researcher explains, "there's very little 'cross talk,' or interference, between the two types of radiation. It's very easy to separate the pulses."

Another plus: Test results can be processed at warp speed. The device, which runs on a small battery, takes a sample every five nanoseconds, giving users 1,000 samples in five microseconds, according to Farsoni. These mega-fast results can then go global instantly on the Internet.

"Now I can email pulses to my friends in India or Europe," Farsoni says.

Adds Hamby: "This system will be able to provide accurate results in 15 minutes that previously might have taken half a day. That saves steps, time and money."



Find more technology success stories at the Partnering with Industry website: [oregonstate.edu/research/partnering/](http://oregonstate.edu/research/partnering/)



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*The thunderbird appears in the art of the Neebinnaukzhik Southall, an OSU student in graphic design and a descendant of the Chippewa of Rama First Nation people. A member of OSU's University Honors College, Southall aims to use her design skills in support of Native American cultures. See "Pathfinders," Page 14. (Photo: Frank Miller)*

Listen to OSU researchers, follow their stories and see more photos, at [oregonstate.edu/terra](https://oregonstate.edu/terra)

