terra

A world of research & creativity at Oregon State University • Spring 2010

A MOVEABLE FEAST

SENSIBLE FOOD AND SPIRITED PLAY COMBAT CHILDHOOD OBESITY

Paying for Pavement
An alternative to the gas tax

Gene Stalker
Whale geneticist Scott Baker

Where Chemistry Meets Compassion
Sensitivity is in our genes

SURPRISE!

Scott Baker had no idea that when he agreed to participate in the making of *The Cove*, a documentary about a dolphin slaughter in Japan, the movie would win an Academy Award. Neither did he expect to find as much evidence of traffic in endangered whales when he analyzed DNA from purchases made in Asian meat markets. Science has led the associate director of Oregon State University's Marine Mammal Institute down unexpected paths.

Surprise is a constant companion for scientists on the frontier of their fields. In *A Feeling for the Organism*, her stirring biography of Nobel prize-winning geneticist Barbara McClintock, Evelyn Fox Keller wrote: "The miracle of life is that, despite the best grip we can get on reality, it continuously manages to surprise us. The beauty of science is that, notwithstanding all our tacit assumptions, these surprises can get through."

Keller reflects on the resistance and hostility that McClintock endured when she developed a theory to explain the appearance of new traits in corn plants. The conventional wisdom in the 1950s was that genes — poorly understood, much like the cosmological concept of "dark energy" today — were nevertheless stable, fixed in place, immutable. McClintock's idea that they could move from one chromosome to another during cell division was not understood or welcomed by others in her field.

How far we have come in plant genetics and biotechnology. We have complete genome sequences for rice, corn and a wild species known as *Brachypodium* (a model species that OSU geneticist Todd Mockler calls the fruit fly of plant genetics). Through the work of OSU scientist Jim Carrington and others, we know that plants and viruses engage in molecular fencing matches through mechanisms that silence genes.

New knowledge is emerging from biotechnology labs at OSU and other institutions at a dizzying pace, and plant breeders, farmers and educators need new tools to make use of it. The Gramene database (www.gramene.org) is a promising example. One of its architects, OSU molecular biologist Pankaj Jaiswal, describes Gramene as a bridge between those who study genes and breeders whose eyes are on the plants we'll need to avert food shortages in a changing world.

We still have a few things to learn about plants. Why does it take weeks for some species to go from seed to flower while others can take as long as 40 years? How can we benefit from disease resistance traits that plants have evolved through eons of evolution with microbes? No doubt, researchers will find plenty of surprises along the way. What an exciting time to be a scientist.

— Nick Houtman

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OSU is a leading public research university with more than $252 million in research funding in FY2009. 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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Hear from Scott Baker on what it was like to be the scientific adviser in the Academy Award-winning documentary, *The Cove*.
Test your sensitivity IQ. How many emotions can you get right by looking at these actors' eyes?
Listen to Stewart Trost talk about his work on childhood obesity.

Features

Romping in the backyard at Cozy Corners family childcare home, Avery and Lauryn are boosting their health by doing what kids do naturally — running, jumping and playing.

Teeny Little Steps

Small changes can pay big dividends for overweight kids

By Lee Sherman | Photos by Nancy Froelich

When the doorbell chimes, the toddlers instantly forget about the movie flickering on the giant TV screen. Scrambling over the plush sofa and scooting past the coffee table, the five preschoolers at Cozy Corners family childcare home cluster curiously by the door to see who's here.

These pintsized Albany residents have, after all, seen *Beverly Hills Chihuahua* before. What they haven't seen are the mysterious high-tech gadgets Oregon State University doctoral student Kelly Rice starts unloading from her backpack soon after childcare provider Michelle Hoyt ushers her in.

"What are they, what are they?" the kids clamor, crowding around.

"They're called accelerometers," Rice tells the wide-eyed boys and girls, who range in age from 2 to 5. "They tell us how much activity you guys are getting while you're here. Who wants to be first?"

"Me! Me!" Riley yells.

"OK, Riley, come on over here." She wraps a black elastic belt around Riley's waist and cinches up the Velcro. "We need to make it nice and snug because the last thing we need is a floppy accelerometer," she tells him.

The matchbook-sized electronic monitor on his left hip will keep track of activity levels (sedentary, light, moderate, vigorous) by recording the frequency and magnitude of movement. Riley and his playmates will wear the accelerometers for a week during Phase One of an OSU study led by Associate Professor Stewart Trost. This initial activity data will form a baseline, along with each child's body mass index (the ratio of height to weight, used to estimate the proportion of fat to lean tissue), for gauging progress at the study's end.

Cozy Corners is one of 60 Oregon childcare homes in seven economically diverse counties along the I-5 corridor that are participating in the Healthy Home Child Care Project. Half of the homes will use the obesity-combating techniques devised by Trost and his team. The other half will serve as a "control" group for comparison, as well as receive training in food allergies.

The program's premise: You don't need fancy jungle gyms or pricey cuisine to make kids healthy and keep them that way. Rather, ordinary household items like card tables and couch cushions can get kids moving, and small changes like switching to skim milk can add up to big benefits.

"We're making the intervention as simple as possible," says Rice, who is coordinating the study. "We're looking for really little things that can make a huge difference, things like giving kids balls and bats to play with, adding a couple of veggies to the lunch menu — teeny little steps."

Essentially, the program will plug into kids' innate love of running and jumping and introduce fun, fresh foods like fruit pizza to compete with the "bubblegum-flavored cereal" and "Hot Pockets" children see every day on TV, says Trost.

"Just like puppies and lambs and kittens, kids have a natural inclination to play," he says. "Active play is inherent to normal development. Yet our studies have shown that kids in family childcare settings are getting only about five minutes of physical activity per hour, on average."

Designer Diabetes Gear

The statistics are alarming. Nearly 30 percent of American kids are overweight or obese. Their parents are even heavier, with two-thirds tipping the scales at excessive numbers. If trends continue, fully 50 percent of kids born this year will end up with Type 2 diabetes in their lifetimes. Just imagine: Half of Americans soon could be tucking a diabetes testing meter (these days, they come in designer colors like "Tickled Pink" and "Purple Fusion") into their purse or pocket along with their iPod and cell phone.

It was these startling trends — along with her pediatrician's warnings about her own daughters' marginal BMIs — that inspired First Lady Michelle Obama to plant an organic garden at the White House and to launch a national campaign to curb childhood obesity. She has gone so far as to demonstrate how easy exercise can be by hula-hooping on the South Lawn. The changes she made in her own household — a ban on weekday TV, smaller portions, low-fat milk, water bottles and apple slices in lunchboxes, grapes on the breakfast table, brightly colored veggies for dinner — she described to *USA Today* as "very minor stuff."

A lack of activity and fresh foods contributes to the rising rate of childhood obesity, says OSU Professor Stewart Trost (Photo courtesy of Synergies magazine)

In Brief

THE ISSUE Daycare providers need help in responding to the rising threat of childhood obesity.

OSU LEADERSHIP Stewart Trost and his students are testing the effectiveness of a diet and exercise program in 60 Oregon home daycare businesses.

> "The surge in obesity in this country is nothing short of a public health crisis, and it's threatening our children, it's threatening our families, and more importantly it's threatening the future of this nation."
>
> — **First Lady Michelle Obama**

Simple play equipment generates high activity for Lauryn.

But the payoff was surprisingly big. "These small changes resulted in some really significant improvements," Obama reported.

These are just the kinds of practical strategies Trost and his graduate students are using in their program, which is built around the theme "Journey to Healthy Child Care Home." Kids will map their make-believe travels and send postcards to friends and family along the way. The program is funded by the National Institute for Food and Agriculture.

Participating childcare homes in Benton, Linn, Lane, Yamhill, Polk, Marion and Washington counties were identified through local "resource and referral" agencies ("R&Rs," which train providers and help parents find quality facilities). Assistant Professor Kathy Gunter is leading the program design and will train OSU county Extension faculty to use it. They, in turn, will train the providers.

"It's a train-the-trainers, capacity-building approach," says Trost. "Our goal is to translate research into practice in a sustainable, community-based way."

With these kinds of novel approaches, Trost has rocketed to prominence in his field. "Stewart has rapidly become one of world's foremost researchers of issues related to physical activity in children and youth," notes Professor Russell Pate of the University of South Carolina. "He has developed an international reputation for his work on measurement and promotion of physical activity in kids."

Getting Switched On

When he was fresh out of Oregon State University with a bachelor's degree in exercise physiology, young Stewart Trost took a job in his native Australia as a corporate fitness director. It didn't take him long to notice that the sparkling new gym — fully equipped and conveniently located at the Brisbane headquarters of Australian Mutual Providence Society, the country's largest insurance firm — was vastly underused. There was a pattern to the laxness. Each year just after January 1, employees spurred by New Year's determination would join an aerobic dance class or hit the weight room, only to drift away within a few weeks or months. What was tripping up these good intentions?, wondered Trost, a lifelong athlete who had attended OSU on a track scholarship.

He came back to his alma mater to find out.

"It's a really tough task to try and sell exercise to a sedentary adult," he discovered as he dug into the literature as a master's student. "By that time, exercise is viewed as drudgery. Look at *Biggest Loser*. On that show, weight-loss regimens are treated like basic training in the military."

FROM CELL TO SOCIETY

The steps to healthy weight may be simple on the surface — eat more veggies and fewer fatty foods, get off the couch, take up walking. But the biological, psychological, economic and cultural causes of obesity are complex and poorly understood. OSU researchers in a range of fields are investigating obesity and related health risks all the way from "the cellular to the societal," in the words of Tammy Bray, dean of the College of Health and Human Sciences. Here are a few highlights of the university's search for answers.

VITAMIN E Maret Traber of OSU's Linus Pauling Institute and Mark Levine of the National Institutes of Health are studying obese women with and without diabetes to see if their needs for vitamin E and vitamin C exceed those of normal weight women. Oxidative stress and inflammation are greater in the obese and may increase their antioxidant needs, as well as increase their risk for chronic diseases, such as heart disease, cancer and Alzheimer's.

TAX POLICY Taxes and government incentives could discourage consumption of unhealthy foods, argues Julie Elston, a professor of International Business at OSU-Cascades in Bend. During a Fulbright fellowship in Europe to study science's impact on policy formation, she focused on tackling obesity through tax policy. Revenues could be earmarked for obesity education or as subsidies for healthy foods, which could benefit struggling families.

PREMENOPAUSAL WOMEN Melinda Manore in Nutrition and Exercise Sciences is leading a project aimed at premenopausal, sedentary women with abdominal obesity. Called Losing Inches Through Exercise and Nutrition (LITEN Up!), the intervention compares the impact of two levels of dietary protein, along with moderate- to high-intensity exercise, on the tummy's fat levels and on other risk factors for metabolic syndrome.

LIVER DISEASE Non-alcoholic fatty liver disease has increased in the United States along with obesity. It can lead to hepatic inflammation, fibrosis, cirrhosis and cancer. Donald Jump in Nutrition and Exercise Sciences and the Linus Pauling Institute is studying how omega-3 fatty acids control fat build-up in the liver in two studies. One, funded by the U.S. Department of Agriculture, seeks clues to prevention of fatty liver disease. The other, funded by the National Institutes of Health, examines changes in liver metabolism accompanying diabetes and obesity.

BONE METABOLISM The hormone leptin, derived from fat cells, plays a role in appetite control. Inadequate leptin levels in the brain appears to be a factor in excessive weight gain. Urszula Iwaniec in Nutrition and Exercise Sciences, who studies obesity's complex effects on the skeleton, is investigating leptin's beneficial and detrimental actions on bone metabolism, specifically whether boosting leptin in the brain through gene therapy can restore leptin function, cure obesity and reverse obesity-related diseases without negatively affecting bone health.

LIMITED-INCOME OREGONIANS SNAP-Ed (Supplemental Nutrition Assistance Program-Education) outreach is a national U.S. Department of Agriculture program aimed at providing nutrition and physical activity education to limited-income children and adults. Oregon SNAP-Ed, led by Sally Bowman and taught by 110 Extension educators in 33 counties, focuses on healthy eating, stretching food dollars, food safety and physical activity for obesity prevention and good health.

RACE AND PERCEPTION The racial makeup of schools and the perception of weight for adolescents is the focus of a study by Stephanie Bernell in Public Health with colleagues from New York University. Her findings suggest that the body-mass index of minority adolescent girls is influenced by the norms of the social environment and the proportion of white to African American and Hispanic students.

Top: Peyten, John, Lauryn, Avery, Evan and Ashton are hard at play. Middle: John eats a healthful snack that's high in nutrients. Bottom: Peyten and John gear up for their play break

When Trost headed to the University of South Carolina for his Ph.D. in the mid-1990s, the nation's obesity problem was "just coming into the crosshairs" of public awareness, he says. The time, he realized, was primed for serious action. He returned to Corvallis once more — this time as a professor in the Department of Exercise and Nutrition Sciences — steeled by the conviction that solutions must take root in childhood. But today's fight against fat is gummed up with hurdles unimaginable just a couple of decades ago. Cable TV peddles hundreds of programs and millions of junk-food commercials to children. Videogames hook kids hard with eye-popping graphics and mesmerizing sounds. Moms and dads work longer hours to pay the bills, leaving their offspring alone after school with unfettered access to chips and soda. Stranger danger lurks, making romps in the woods risky. And schools, pressured to raise test scores in reading and math, have dropped PE and curtailed recess.

Trost knows we can't go back to the '50s and '60s. But he's waging a sustained research campaign to find a way forward for children's health, partnering not only with childcare workers but also with doctors.

"We have to work closely with health-care providers," he says. "By looking at the child's BMI, the physician knows immediately when the child is obese." Girded by knowledge of the medical risks of obesity, doctors can bring up children's diet and exercise choices more easily than can teachers or even parents. Trost sees the primary-care physician's office as the ideal forum for productive conversations about maintaining a healthy lifestyle.

Toward that end, he's working with Portland-area physicians to engage patients in brief motivational interviews — basically, lifestyle negotiations — that can begin an ongoing dialog and let the patient set the agenda based on his or her readiness for the message.

Schools, too, must play a pivotal role. With the Robert Woods Johnson Foundation's "Active Living Research" program, for instance, Trost is crafting a policy statement challenging the trend of cutting PE to boost instructional time. "There's not a single study that shows academic performance increases when you reduce time for physical activity," he notes. "On the other hand, there are a number of studies showing improved academic performance with increased activity during the school day. We also know there's a positive link between activity breaks and time on task in the classroom. When kids get activity breaks, they're more attentive in class, which facilitates better learning."

The evidence of benefit to brain power is compelling. "Aerobic exercise improves cognitive function," says Trost. Experiments ranging from sophisticated animal-based studies to functional MRIs on humans show that "exercise turns on the factors that promote greater cerebral blood flow and the growth of new brain cells," he says.

By playing harder and eating smarter, kids can not only learn better at school but also lay the foundation for vitality and longevity. In Oregon, at least, the trend may be heading in the right direction. A national study released in May by the U.S. Health Resources and Services Administration found that Oregon was the only state whose childhood obesity rate fell significantly from 2003 to 2007 — from 14 to just under 10 percent — giving it the nation's lowest proportion of obese kids. Trost's message is this: You don't have to take up mountaineering, compete in a decathlon, or eat only bean curd and baby spinach to prevent chronic disease and optimize health. In fact, the preventives are right in plain sight.

"Kids don't need a $150 inflated castle in the backyard," he says. "An obstacle course with lawn furniture or a fort fashioned from a blanket thrown over a card table can encourage both imagination and physical activity." terra

On the Web. Listen to a podcast with Stewart Trost at ***oregonstate.edu/terra***

The Mythbuster

Forestry graduate student digs into Wallowa County's history

On the 1,300-mile drive from Flagstaff, Arizona, to Corvallis, Oregon, Jesse Abrams took a detour. It was the summer of 2007, and he was pondering his upcoming Ph.D. in forest resources. He pulled into Enterprise, Oregon, the county seat for Wallowa County in the state's mountainous northeastern corner.

It was a homecoming of sorts. For his master's degree at Oregon State University, Abrams had worked here in 2003 for a nonprofit organization, Wallowa Resources, spending part of his time on the county's noxious weed program. Four years later, he had other ideas in mind. As a staff member of the Ecological Restoration Institute in Flagstaff, he had juggled the needs of the environment and community development. Now, he wanted to examine the socioeconomic and land-use changes afoot in resource-dependent rural places.

These concerns hit home in a place like Wallowa County, where 58 percent of the land is in public ownership and where farming, ranching and logging have sustained families for generations. In the 1990s, changes to federal forest management led to the closure of three local sawmills. Later, as retirees and vacation-home buyers moved in — drawn by spectacular scenery and what Abrams calls the "idyll of rural America" — land prices started to rise, making it more difficult for young families to get established.

Local Leadership

These and other trends led some to worry that the county's heritage was threatened and that its future was in the hands of outsiders, says Abrams. "Rather than having a community's fate decided by the federal government, special interest groups, the courts or corporations, I wanted to look at how local people can exercise leadership and determine their own future," he says.

So in Enterprise, the student who grew up in St. Petersburg, Florida, met with three Wallowa Resources representatives to discuss how his project might help the organization address some of the county's problems and develop local solutions.

"Century farms" and sawmills have defined much of Wallowa County's economy until recently. Changes in land ownership herald cultural shifts as well. (Photo: Jesse Abrams)

Abrams set out to define trends affecting the county's private lands: changes in ownership, road access, grazing by livestock, forest management, weed control, hunting rights and zoning. He interviewed landowners — both newcomers and long-time residents — and talked with public officials. He analyzed past land-use patterns, land sales records and demographic trends.

OSU forestry professor John Bliss advises Abrams and praises his ability to work hand-in-glove with local people. "He convened community leaders to help him get in touch with local concerns and provide feedback. It takes a mature researcher to maintain the necessary academic independence while engaging with such an advisory group, and Jesse has been extremely effective at it," says Bliss, holder of the Starker Chair in Private and Family Forestry.

Bliss calls Abrams a "mythbuster." Contrary to the view that before the 1990s, populations and land uses were stable and communities autonomous, Abrams has demonstrated that Wallowa County's economy and social networks have always been vulnerable to outside forces. "If you look at the county's history, what defines it is not continuity but change. From the Homestead Era on, land was not just a family asset. It was a commodity. People bought it, sold it, traded it and carved it up," says Abrams.

"What's happening now is new in some ways. It's the first time a significant proportion of private land in the county has been owned by people who don't depend on forestry or agriculture for their livelihoods," he adds.

Abrams hopes that information about past trends will contribute to efforts to manage the county's spectacular resources. He plans to finish his project in December 2010

–NICK HOUTMAN

On the Web: At ***oregonstate.edu/terra***, learn more about OSU students and faculty learning and serving in Wallowa County

Gene Stalker

DNA fingerprints reveal clues to ancestry and illicit hunting of cetaceans

By Lee Sherman | Illustration by Priscilla Wilson

For most Americans, eating a relative of Flipper or Keiko would be as unthinkable as dining on Lassie or Smokey Bear. But in some seafaring cultures, dolphins and whales are traditional foods, sold in supermarkets right alongside the fish fillets and beef cutlets.

The sale of meat from whales and dolphins accidentally drowned in fishing nets or left over from "scientific" whaling operations is allowed in some countries as "exceptions" to the international moratorium on commercial whaling. Trouble is, neither customers nor enforcers eyeing the packages of fresh or frozen steaks or stew meat can distinguish a minke whale taken in the scientific whaling program from, say, an illegally killed gray or humpback whale.

That's where Scott Baker comes in.

The OSU conservation geneticist is one of the world's foremost experts in using DNA to identify specific populations of cetaceans — whales, dolphins and porpoises — and thereby detect the unlawful sale of protected species. Baker travels frequently to Japan and South Korea, where he holes up in cramped hotel rooms in Tokyo or Seoul with his portable genetics lab, listening for a knock at the door. When the secret code is tapped out, he cracks open the door and a local collaborator, who has been covertly trolling grocery stores and sushi bars, furtively passes him a bagful of bloody meat for analysis.

This cloak-and-dagger science was documented in the Academy Award winning eco-thriller *The Cove*, in which Baker was cast (see sidebar).

"No scientist has contributed more to our understanding of cetacean genetics than Scott," says Phillip Clapham, a cetacean scientist with the National Oceanic and Atmospheric Administration. "In particular, his innovative use of genetic analysis to detect and track illegal or unreported trade in whales and other wildlife has given scientists and managers a powerful tool to assess the extent of this traffic and its impact on populations. He's been one of the major players in the field of whale biology worldwide."

Catcher in the Bay

Height, as everyone knows, is an advantage in basketball games and presidential elections. But in marine science? Surprisingly, it can be — at least at New College of Sarasota, Florida. For a pioneering dolphin study launched while he was a student there, Baker's 6-foot-4-inch stature gave him an edge over his shorter classmates. That's because he could stand in the shallow waters of Sarasota Bay, his head well above the surface, while helping to use a seine net for the capture and release of wild dolphins.

"The researchers tended to enlist tall undergraduates for the hard work," Baker says, laughing.

As a kid in Alabama, Baker vacationed on the Gulf Coast every summer with his dad (an electrical engineer and decorated veteran of

In Brief

THE ISSUE Marine mammal populations are rebounding, but some species still face threats from human activities, such as hunting and habitat loss.

OSU LEADERSHIP Scott Baker, associate director of OSU's Marine Mammal Institute, uses molecular biology and genetics to monitor marine mammal hunting and to determine where whales, dolphins and other species migrate. He is working with international organizations to apply the latest findings and solve problems.

Scott Baker's investigations of whale and dolphin DNA have taken him from the frigid waters of Alaska's humpback feeding grounds to the black market of Korea's illegal marine mammal trade and to the big screen of an Academy Award–winning documentary. (Photo: David Baker)

Omaha Beach and the Battle of the Bulge) and his mom (an activist and humanitarian in the nuclear freeze movement and many other causes). "When you live in a place like Birmingham, the Gulf of Mexico is sort of like paradise — except for the mosquitoes and sand flies and jellyfish," he says, grinning. The Gulf was where he first became intrigued by dolphins. But it was in that shallow Florida bay as he wrapped his arms around individual bottlenoses to process them for the study — weighing, measuring, tagging, drawing blood, taking tissue samples — where the animals etched a deeper impression on his psyche.

"Those kinds of things change your life," says Baker, who left New Zealand's University of Auckland in 2006 to become associate director of OSU's Marine Mammal Institute. "How many people get to have an experience like that — capturing and releasing wild dolphins for a groundbreaking scientific study?" He adds, "We caught a *lot* of dolphins."

Describing himself as "not terribly sentimental," Baker nevertheless admits to being charmed by the *joie de vivre* of dolphins. Whales, on the other hand, are hard to relate to. He calls them "extremophiles," a term borrowed from deep-ocean biologists who apply it to such exotic creatures as cold-seep tubeworms and giant hydrothermal vent clams — organisms that live in Earth's most extreme environments. Not only have whales shed such basic mammalian characteristics as hind limbs during their evolutionary history, they can dive as deep as 5,000 feet, live as long as 200 years and travel as far as 6,000 miles during annual migrations.

"Whales are so alien," Baker says. "They're fascinating and magnificent animals, but it's hard for us to imagine their world. Dolphins are much more like humans."

Brain Train

During discussions of cetacean genetics, Scott Baker's train of thought passes through a hundred switches, side rails and branch lines, diverging down one surprising aside after another. For him, everything in biology is connected to cetacean genetics.

Ask him about genetic diversity among whales, for instance, and he'll tell you a story about cheetahs — a story with an Oregon angle, no less — from a *Scientific American* article that strongly influenced his early career. At Southern Oregon's zoological park, Wildlife Safari, cheetahs were mysteriously dying of a common feline virus that causes only sniffles in housecats, suggesting a weakness in the big cats' immune systems. The resulting gene-pool study by U.S. National Cancer Institute scientist Stephen O'Brien piqued Baker's curiosity about the impact of genetic "bottlenecks" (large die-offs in a population caused by natural or human forces, such as the intensive whaling during the 19th and 20th centuries) on long-term species survival among the great whales.

Ask Baker about the human bond with wild animals, and he'll engage you in an exploration ranging from the philosophy of Descartes to the methods of Jane Goodall to the quantifiable self-awareness of pigs, chimps, crows and (of course) dolphins. If you venture into the topic of evolution, you'll dive with him into the Eve Hypothesis (the theory that all humans share DNA traceable to the emergence of *Homo sapiens sapiens* in Africa about 200,000 years ago), take a detour into Mendel's peas, then veer from Darwin's (mistaken) hunch that whales evolved from bears to the current scientific thinking: Today's oceanic behemoths had a hoofed, hippo-like ancestor. If you're still with him, you'll careen around a hairpin turn, returning to the origins of modern humans to look in on the late pioneer of molecular evolution Allan Wilson of UC Berkeley, who discovered the "molecular clock" (using genetic mutations to date evolutionary changes).

By this point in the conversation, your brain will probably verge on overload. But Baker is just getting warmed up. As he talks, he frequently jumps up from his seat

SECRET SLAUGHTER

Oscar-Winning Movie *The Cove* Casts OSU Dolphin Researcher

In the seaside village of Taiji, Japan, there's a jarring juxtaposition: Jolly-looking tour buses shaped like happy dolphins putter up and down the streets by day, while by night fishermen secretly slaughter hundreds of panic-stricken dolphins in a nearby inlet and sell them as meat.

This sinister irony permeates the Academy Award-winning movie, *The Cove*, produced by the Ocean Preservation Society. Scientific adviser and cast member Scott Baker is delighted by the accolades, not because they widen his fame outside science circles but because recognition from the Critics' Choice Movie Awards and the Sundance Film Festival means broader exposure for the movie, which critics have characterized as an "eco-thriller." That, in turn, means more international pressure to end the carnage.

"There has been tremendous resistance to the movie in Japan," says Baker, a leader in international efforts to uncover black-market trade in products from protected species of whales and dolphins. "The Tokyo International Film Festival initially turned down the film, but under pressure from American actors like Ben Stiller, they agreed to allow one showing outside the formal festival. The international press was relegated to the back of the auditorium."

Baker, associate director of OSU's Marine Mammal Institute, acts as the film's scientific voice on dolphin biology and the health risks to humans who eat dolphin meat, which is high in mercury (mercury levels are concentrated in organisms that are, like dolphins, high up in the food chain). As the world's first scientist to use DNA to identify whale species being butchered for human consumption, Baker appears in the movie both as an expert "talking head" and as a DNA detective, hunkered over a portable genetics lab in a Tokyo hotel testing samples purchased, covertly, in Japanese fish markets.

"We spent *days* filming in that hotel room — a room not much bigger than my office," recalls Baker. He describes director Louie Psihoyos as "visionary but meticulous," shooting "tons of film" to tell the story of the annual killing of more than 1,200 dolphins in Taiji.

Baker's science-based scenes of DNA identification and his comments on the threat of mercury contamination in dolphin meat are a counterpoint to the movie's main storyline: An intrepid team of cinematographers and activists (including the dolphin trainer of the 1960s TV series *Flipper*), wearing camouflage and night-vision goggles, risk arrest and even death to capture video and underwater acoustics during the slaughter.

(Photo: Oceanic Preservation Society)

Besides being a gripping piece of filmmaking, the movie highlights a heartbreaking issue of massive proportions: the international black market in wildlife. From elephant tusks and rhino horns to bighorn sheep antlers and panther pelts, the illegal trade in endangered animals is worth an estimated $5 billion to $8 billion a year worldwide. Cetaceans are lucrative commodities in that grisly enterprise. In Japan or Korea, for instance, a whale killed in coastal fishing nets can sell for more than $100,000 wholesale. Dolphins, too, bring in fat cash: Aquariums pay $150,000 for a live animal.

But it's the dead ones that most worry Baker, a longtime delegate to the International Whaling Commission (IWC). Despite the IWC's 1986 moratorium on whaling, Japan, Korea, Iceland and Norway continue the hunt, either under the guise of science or under an "objection" (basically, a rejection of the commission's authority to regulate whaling). Loopholes in the commission's 1986 moratorium, it turns out, are big enough for a whale to swim through — and die in. A "scientific whaling" loophole allows a limited number of whales to be killed for research and the remains to be sold. A "bycatch whaling" loophole allows fishermen to sell whales and dolphins that become entangled in fishing nets. Hundreds of protected animals die unreported each year because of the laxity of IWC rules and regulations, Baker says. "The continued sale of 'legal' whale products acts as a cover for other illegal, unreported and undocumented hunting," he argues.

Still, whales are afforded at least some measure of protection by the IWC. Dolphins, on the other hand, have none at all from the IWC or other international conventions (although many individual nations have outlawed dolphin killing).

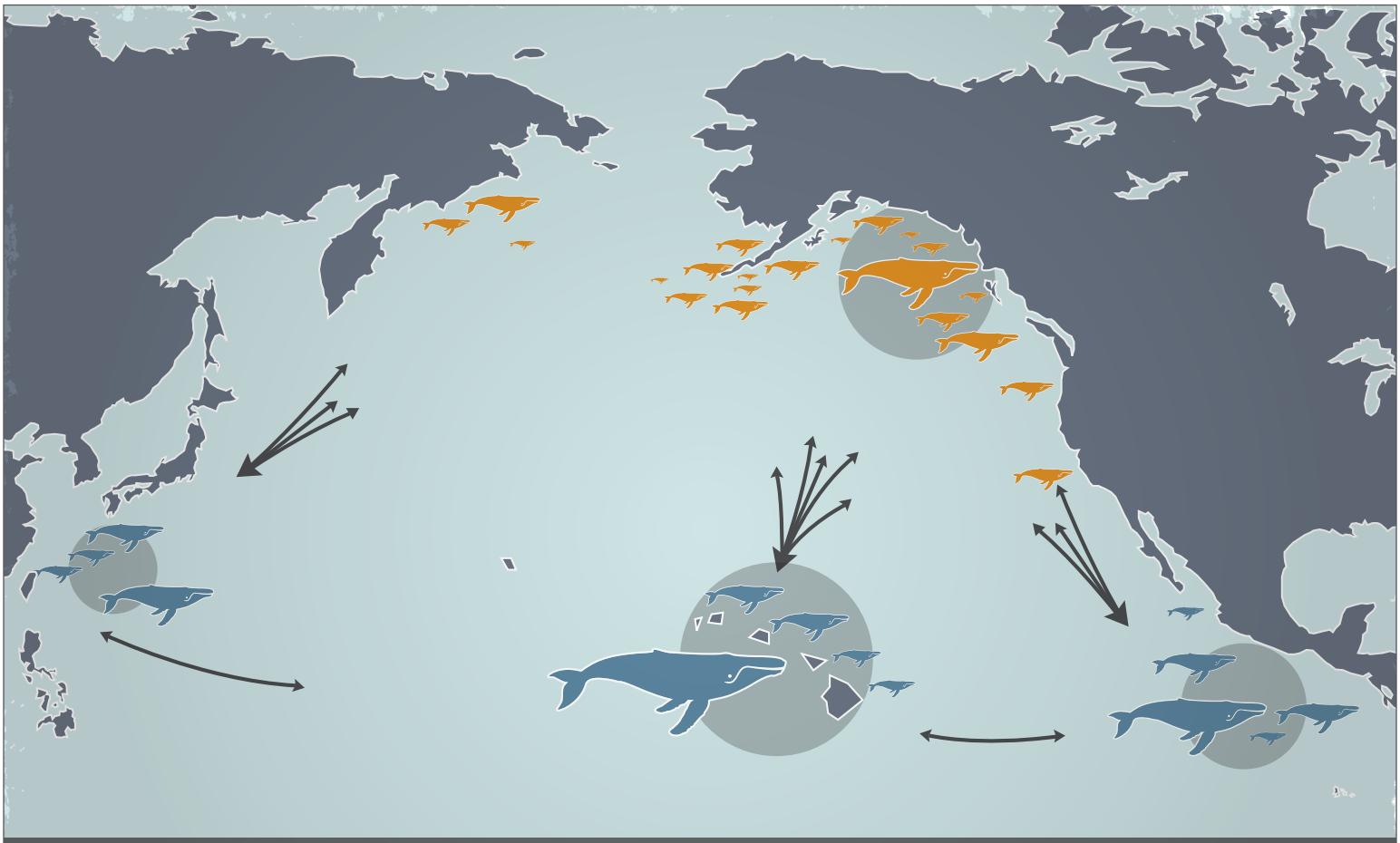
Forensic genetics is a potent weapon in the fight to save wildlife. Baker's technique — a method of quickly amplifying segments of DNA called a polymerase chain reaction (PCR) — is the same one used by crime-scene investigators to match "perps" to body fluids, hair and other tissue they leave behind. PCR is used for all sorts of investigations, from nabbing moose poachers to detecting cystic fibrosis in eight-celled human embryos. Indeed, Baker and his Ph.D. student Merel Dalebout were using PCR in 2002 when they discovered a new species of beaked whale, the first new whale species in 15 years and the first to be described primarily by DNA.

to scan his bookcase for a relevant article, or swivels to his computer screen to pull up a DNA barcode or digital map showing worldwide distribution of humpbacks, which he has studied since his years as a Ph.D. student at the University of Hawaii.

He's at his most animated when talking about those early discoveries — such as one stunning, predawn revelation in a darkroom where he was developing "autoradiographic" images of humpback whale DNA. These were some of the first "DNA fingerprints" derived from small skin samples, which Baker had collected with a biopsy dart fired from an inflatable research boat in Southeast Alaska's Inside Passage and Central California's coastal waters, as well as in Hawaii and the Gulf of Maine. (Previously, whales and dolphins had been ID'd photographically by natural markings on their fins, flukes and flippers.) The finding he made that night in 1988 was a breakthrough in the just-emerging field of molecular ecology — using molecular markers for clues to relationships among individual whales and the ancestry of populations.

"I remember pulling out the first autorad that showed samples from feeding grounds in Southeast Alaska side-by-side with samples from California, and there was no overlap between the two populations," he says. "All individuals from Southeast Alaska had one pattern, and not one individual from California had that pattern. It was like, wow!"

These population-level variations in DNA, which geneticists call "fixed differences," pointed to ancient migration pathways swum again and again and again over tens of thousands of years. The black-and-white barcode he stared at that night supported his hypothesis that migratory routes from winter calving to summer feeding grounds had persisted for hundreds of generations — in other words, across evolutionary time. Biologists call this enduring continuity "maternally directed fidelity," that is, patterns taught from mother to calf and



Studies of humpback DNA worldwide have revealed a complex picture that includes a few "pure" stocks — such as the one shown here migrating between Hawaii and Southeast Alaska and another between Oregon/California and Central America — along with a larger number of "mixed" stocks (distinct breeding populations that share feeding grounds with other breeding groups).

(Illustration by Truen Pence)

reflected over eons in mitochondrial (maternally inherited) DNA, which scientists denote as mtDNA.

"This was one of the first discoveries we made using molecular methods," he says. "What we were seeing in whales was a very distinct population substructure. The markers showed that despite their mobility, despite their ability to travel 12,000 miles roundtrip on each migration, these animals keep returning to the same place year after year, generation after generation. They don't wander around. It was puzzling, because these aren't terrestrial animals isolated by canyons and rivers and mountains — they're out there in the ocean with no obvious barriers. Who would have thought the ocean would be so subdivided? Who would have thought whales would treat the ocean the same way bears treat their habitat, inheriting their mothers' home range and returning there each year?"

Megafaunal Migrations

In the two decades since, Baker's research has confirmed, in convergence with the work of other scientists, that these patterns are shared by many marine megafauna (animals that range from big to gigantic).

"Our original work with these 84 individual humpbacks, along with the early sea turtle research of Brian Bowen and John Avise, was some of the first really clear evidence of these strong patterns of maternal fidelity," he says. "The humpbacks turned out to be very much like the sea turtles. Since then, we've analyzed more than 5,000 samples and seen maternal fidelity again and again and again. Dolphins, sharks, even manta rays, all show the same kind of migratory behavior."

Although the patterns show up in the mtDNA of geographically related whales, Baker cautions that the routes themselves aren't inherited genetically. Rather, they're taught from mother to calf.

"I think of it as a kind of cultural inheritance," he explains. "Whales are not genetically determined to go back to those places; they've learned to go back, and these learned patterns track the evolution of the maternally inherited DNA, which changes by random mutation over many hundreds of generations."

Baker's earliest humpback work is being greatly expanded in a pair of international studies called SPLASH (Structure of Populations, Levels of Abundance and Status of Humpbacks) in the North Pacific and SORP (the Southern Ocean Research Partnership) in the South Pacific. Cetacean geneticists worldwide are loading up their crossbows and veterinary capture rifles with state-of-the-art biopsy darts, collecting skin samples from humpbacks in every ocean. They're seeking deeper insight into humpbacks' complex population structures and substructures. If science can reveal whales' molecular mysteries, Baker says, conservationists can make more compelling cases on behalf of fragile populations.

The Antarctic minke whale debate is one such conservation issue now under scrutiny. The controversy centers on some of the smallest and some of the largest ocean life forms: tiny crustaceans called krill and baleen whales that feed on them by the billions. Some scientists argue that mass slaughter of blues, fins, humpbacks and other giant filter-feeders during the commercial whaling era left a teeming surplus of krill, particularly in the Southern Ocean. With less competition from behemoths like the 100-ton blues, they suggest that the relatively diminutive 10-ton minke has experienced a population explosion. But Baker and his colleagues recently questioned this "krill surplus" hypothesis. An analysis of genetic diversity suggests that in fact, today's 600,000 global minke population has remained relatively stable over deep ecological time. The finding, published in *Molecular Ecology* earlier this year, should help counter pressure from pro-whaling countries to "cull" minke, Baker says.

"Some stakeholders argue to allow for an increase in minke whale catch, in part to aid in the recovery of other whale species," wrote Baker, with first author Kristen Ruegg (Stanford) and co-authors Jennifer Jackson (OSU), Eric Anderson (NMFS) and Steve Palumbi (Stanford), summarizing their findings in the January 2010 *Lenfest Ocean Program Research Series*. "The study does not support the proposition that an unusually large population of minke whales is competing with other whale species for a limited supply of krill."

Even without an official OK for taking more minkes, whale hunters and fishermen already are killing hundreds of protected animals under the radar, Baker has found. DNA taken from whale meat samples purchased in Korea over a five-year period recently revealed that 800-plus individual minkes were butchered and sold — nearly twice as many animals as were reported to the IWC by the South Korean government. Most were members of an endangered coastal population.

A February 2010 *New Scientist* article on whale genetics cites recent worldwide findings, including Baker's minke work, and concludes that although "the new ecological perspective on the past abundance of whales is controversial ... the ever-growing body of historical evidence is siding with the DNA." As writer Fred Pearce puts it, conservation geneticists like Baker now believe that "even the most 'recovered' of today's whale populations are mere ghostly reminders of their former dominance." terra

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Online, listen to an interview with Scott Baker at ***oregonstate.edu/terra***

Paying for Pavement

Vehicle mileage fee could replace the gas tax

By Nick Houtman

Praise the gas tax. For every gallon pumped into pickups, SUVs and miserly subcompacts, Oregonians put 24 cents into the state highway fund and another 18.3 into the federal. On top of that, two Oregon counties (Washington and Multnomah) and 21 cities add their own levies for local roads. In 2005, about 80 percent of Oregon's road revenues depended on fuel taxes.

Since 1919, when Oregon became the first state in the nation to levy a gas tax, the revenue stream has been as reliable as winter rain in Portland. Today, it generates about $400 million annually, but in the near future, with the push for energy independence and electric cars in particular, paying for pavement may become more difficult. Fewer gallons in our vehicles will mean less money to keep roads, highways and bridges safe and in good repair.

As Nissan, General Motors and other manufacturers continue to develop electric vehicles, there is still only one demonstrated alternative to a gas tax in the nation: Oregon's vehicle mileage fee concept. In a pilot test organized by the Oregon Department of Transportation and completed in 2007, Oregon State University engineers showed that such a system is technically viable.

When the project began four years earlier, monitoring mileage was a new venture for OSU's Mobile Technology Solutions Laboratory. Director David Porter specializes in data capture and analysis, and, although colleague David Kim worked for General Motors for 10 years before coming to OSU, he and his team simulated production line efficiencies (they were honored in 2005 for saving GM more than $2 billion). Nevertheless, ODOT had decided to create an electronic data collection system, says agency manager Jim Whitty, and was attracted by the engineers' expertise in combining on-the-fly detection (laser scanning, bar coding, radio frequency identification) with communications and data management.

In a presentation to an ODOT task force (the Road User Fee Task Force, also known as "rough-tough"), Porter and Kim reviewed a range of technology options for recording mileage electronically and transmitting data to computer-equipped gas pumps. "ODOT saw we had expertise in evaluating technologies, what potentially would work for the requirements given by the Legislature," says Porter. The engineers wrote the technical specifications and administered a technology pilot test for ODOT in Portland.

Testing, Testing

It wasn't the first technology test for Porter and his team. In an evaluation of flat-bed scanning technologies for PSC Corporation of Eugene (now Psion Teklogix, an international mobile computing company), they

had built and operated a supermarket check-out stand. For the U.S. Post Office, they had tested an invisible-ink labeling system to speed the processing of magazines and catalogs. They had done projects for the U.S. Army, Symbol Technologies and Wavelink Corporation.

Nevertheless, the Portland test was an eye-opener. Porter and Kim had tried out the mileage tracking devices in their own cars in Corvallis, but in Portland, they worked with 285 motorists and two eastside independent gas stations. They compared two different mileage monitoring systems, one based on GPS (global positioning system) technology and the other on a diagnostic device, standard equipment in cars made after 1996.

Just getting equipment installed turned out to be more difficult than planned, but a custom electronics manufacturer, MegaTech of Corvallis, stepped in to finish the job. Other problems cropped up as the pilot test proceeded: dead car batteries, stolen GPS units and unreliable data links.

Fortunately, those were the exceptions to a system that worked smoothly. For most participants, the mileage monitoring devices recorded and transferred data to gas station billing systems without missing a byte. In its final report, ODOT concluded that "using existing technology in new ways, a mileage fee could be implemented to replace the gas tax as the principal revenue source for road funding."

Privacy Concerns

The project spurred plenty of comment on news media websites, most often about motorists' privacy. "We always do our best to avoid putting that element at risk," says Porter. "We feel confident that we will be able to protect privacy to a very high level." Still, he agrees, some people might oppose the technology regardless of engineered safeguards.

At the federal level, Oregon congressman Earl Blumenauer has proposed legislation (HR 3311) that calls for continued research and pilot tests for a nationwide Road User Fee Pilot Project. Such a system would have to address concerns such as privacy, public acceptance, ease of compliance and administrative cost.

Meanwhile, Porter and Kim are working with ODOT on another intelligent transportation technology, which will deliver near real-time travel time data to Web-accessible traffic maps, in hopes to help drivers avoid congestion as they plan their routes. A test is slated later this year for U.S. Highway 99W near Portland. terra

WHO PAYS MORE?

OSU ECONOMIST B. STARR MCMULLEN HONORED FOR HER ANALYSIS

Nothing gets a conversation started like a proposal for a new tax or a user fee. OSU economist B. Starr McMullen discovered that when she gave public presentations about vehicle mileage fees. "This is the one topic I've done in my career where everyone has an opinion," says McMullen, an expert in transportation economics.

In a study funded by the Oregon Transportation Research and Education Consortium (OTREC) and the Oregon Department of Transportation (ODOT) in 2006, she led the development of three models to examine the effects of mileage fees on how much people drive, how the fees would be distributed among rural and urban motorists and how the tax change would affect different income groups.

Using data from a 2001 national transportation survey, McMullen found that shifting from the gas tax to a mileage fee made little difference in how much motorists would actually pay and thus had little or no effect on how much they drive. She also showed that mileage fees would be slightly more regressive than the gasoline tax. That is, motorists with the lowest incomes would pay a small increase, less than 1 percent of their income, under a mileage fee program. However, that pales in comparison to the more than 5 percent increase that occurred when gasoline prices roughly doubled from 2001 to 2006.

Comparing urban and rural residents, McMullen found that rural drivers would pay slightly less under mileage fees. Even though rural motorists tend to drive more miles, they also tend to have more pickups and other vehicles that get lower fuel mileage. Owners of fuel-efficient vehicles would pay slightly more under a mileage fee system.

A lack of car sales data prevented McMullen and her team from evaluating the impact of mileage fees on vehicle purchasing preferences.

OTREC honored McMullen with its first Researcher of the Year Award in 2009 for her leadership in the analysis. In March 2010, she was elected president of the Transportation Research Forum, an international independent organization of researchers and other professionals.

Her report, *Techniques for Assessing the Socio-Economic Effects of Vehicle Mileage Fees*, was published in 2008 and is available at http://www.otrec.us/reports.php

Living on the Fault

Picture of a collision foreshadows disaster

In one of the Earth's most active fault zones, OSU geoscientist John Nabelek and colleagues are defining the forces that created Mt. Everest and threaten millions of people. (Photo courtesy of John Nabelek)

On a computer generated diagram of seismic profiles from Nepal and Tibet, John Nabelek traces a thin blue line. "That's the interface between the Indian and the Eurasian tectonic plates," he says. The earthquake-prone, mountainous terrain above it is home to an estimated 40 million people.

"It is very steep. In earthquakes, landslides come tumbling down," says Nabelek, an associate professor in Oregon State University's College of Oceanic and Atmospheric Sciences. "Construction is not up to par, so there, you're looking at a huge disaster."

With support from the National Science Foundation (NSF), Nabelek leads an international team of scientists on a quest to understand the underlying geology of the Himalayas. In 2009, they created the most complete seismic image of the Earth's crust and upper mantle in the region and discovered some unusual geologic features that may explain how it has evolved. The study is known as Hi-CLIMB, Himalayan-Tibetan Continental Lithosphere during Mountain Building.

"The research took us from the jungles of Nepal, with its elephants, crocodiles and rhinos, to the barren, wind-swept heights of Tibet in areas where nothing grew for hundreds of miles and there were absolutely no humans around," Nabelek says. "That remoteness is one reason this region had never previously been completely profiled."

Waterbed Geology

A lack of scientific consensus on how two continental plates collide has led to competing theories about the Himalayas. Some researchers have proposed that the heat generated by the collision has melted so much rock that the Tibetan plateau floats above it as though on a waterbed.

"There could be small pockets of fluid, but our study shows there are not large amounts of fluid here," says Nabelek. "The building of Tibet is not a simple process. In part, the mountain building is similar to pushing dirt with a bulldozer, except in this case, the Indian sediments pile up into a wedge that is the lesser Himalayan mountains."

The interface between the subducting Indian plate and the upper Himalayan and Tibetan crust is the Main Himalayan thrust fault, which reaches the surface in southern Nepal. The new images show that it extends from the surface to mid-crustal depths in central Tibet, but the shallow part of the fault sticks, leading to historically devastating mega-thrust earthquakes.

"The deep part is ductile and slips in a continuous fashion. Knowing the depth and geometry of this interface will advance research on a variety of fronts, including the interpretation of strain accumulation from GPS measurements prior to large earthquakes," Nabelek adds. The study is continuing with funding from NSF and the Air Force Research Laboratory.

Nabelek also studies the Cascadia subduction zone, in which the relatively dense Juan de Fuca plate dives beneath North America. "The advantage of working in Tibet is that you can get on top of it. You can work on it. With the Cascadia, most of the mega-thrust is offshore about 100 miles."

His emphasis in Cascadia is in the southern portion of the Juan de Fuca plate offshore from the Oregon-California border, a region known as the Gorda Deformation. Scientists don't yet know why so much seismic activity occurs in this area. Most of the Juan de Fuca plate is relatively calm.

In another project funded by the NSF-EarthScope program, Nabelek will use the crustal imaging techniques employed in Nepal and Tibet to study the Earth's crust under parts of Nevada. That project is scheduled to start this summer.

— NICK HOUTMAN

Tools of the Trade

Gramene database spurs quiet revolution in crop genetics

To find the genes that enable a crop — ryegrass or wheat, for example — to resist disease or tolerate drought can mean endless searching, not through one haystack but through many. And success is only the beginning of time-consuming breeding trials. Now scientists, farmers and plant breeders who feed the world have a new scientific resource at their disposal to help them cut through the DNA clutter.

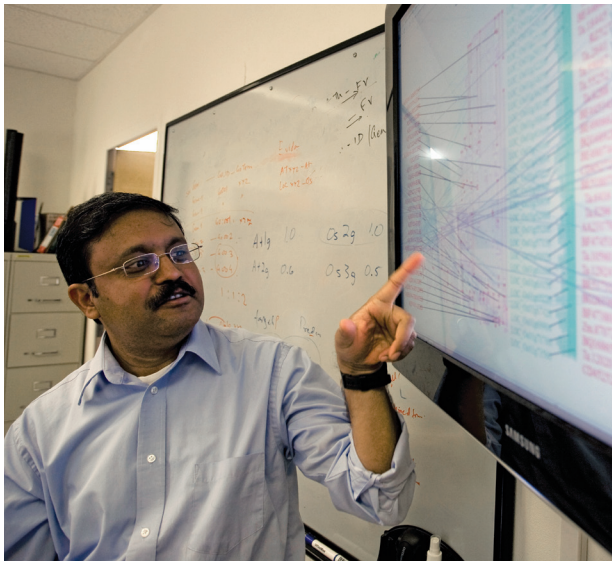
An online gold mine known as the Gramene database is really a library of datasets, says one of its creators, Pankaj Jaiswal, assistant professor in Oregon State University's Department of Botany and Plant Pathology and a faculty member in the Center for Genome Research and Biocomputing. While a post-doctoral scientist at Cornell University, Jaiswal helped to create the database, research tools and educational information that are revolutionizing the application of genomics to crop development. He continues to be one of Gramene's principal investigators with colleagues at Cornell and the Cold Spring Harbor Laboratory in New York.

Supported by grants from the U.S. Department of Agriculture (USDA) and the National Science Foundation (NSF), Gramene focuses on grasses (family name: *Gramineae*), including wheat, corn and rice, which collectively provide about half of the world's calories.

"What's unique about Gramene," says Jaiswal, "is that it builds relationships between scientists who work from a purely genetics and breeding perspective and the people who work from the molecular and biochemical perspective. It tries to bridge the gap between these two." To develop crops with desirable characteristics, crop breeders can identify genes that are associated with specific traits, such as cold hardiness, disease resistance or flowering time.

And by providing genetic information about multiple species, the database bridges genomes that have been fully sequenced and are relatively well described, such as corn and rice, and those that are less well known, such as wheat and ryegrass. Commonalities between different genomes can generate important clues for breeders of new plant varieties.

Scientists use Gramene for basic science — understanding evolutionary relationships among different species, for example — as well as for studies that seek innovations in plants for biofuel production or disease resistance. In 2008, USDA and university scientists, including Reed Barker of the Agricultural Research Service in Corvallis, used Gramene to identify likely candidates for disease resistance genes in perennial ryegrass, a mainstay of Oregon's grass seed industry. The close similarities with disease resistance genes in rice, which had been studied and described in detail, led them to suggest that the ryegrass genes might have the same function.



Pankaj Jaiswal is a co-creator of the new Gramene database that helps plant breeders develop new crop varieties (Photo: Truen Pence)

Judging by the traffic on its website, Gramene has been a global hit. In the last year alone, its data files have been downloaded or viewed in more than 140 countries by about 220,000 visitors. Scientists have cited it as a model for an emerging plant knowledge system, says OSU plant geneticist Todd Mockler. Mockler's lab participated in the recently completed sequencing of a small grass plant, *Brachypodium*, whose genome is now stored on Gramene. *Brachypodium* is a promising model for grass genomics studies.

Jaiswal, an acknowledged leader in developing standardized vocabularies (what scientists call "ontologies") for the rapidly expanding plant genome sciences, also trains breeders and farmers to use Gramene. "We try to avoid too many scientific terms," he says with a nod to the technical language of his profession, "but we can't do that all the time."

— NICK HOUTMAN

On the Web, see ***www.gramene.org*** to learn about the natural history and genomics of grasses

Where Chemistry

Examining the biological roots of empathy

By Lee Sherman

OSU neuropsychologist Sarina Rodrigues (Photo: Karl Maasdam)

You don't think of voles as paragons of virtue. Yet one species of these drab mouse-like creatures is loyal to its mate for life, helps around the den, cuddles its young, and generally exhibits what humans would call "family values." Meet the true-blue prairie vole.

Its cousin the meadow vole, however, is a cad. Despite being 99 percent genetically identical to the prairie vole, the meadow vole is profligate in its ways — sleeping around, shirking nest-building and abrogating pup-rearing.

It's not moral rectitude that makes the difference in voles' domestic behavior but rather a couple of compounds called oxytocin and vasopressin. Doubling as hormones and neurotransmitters, these neurochemicals are major players in how animals, including humans, relate to each other both romantically and socially. They may even help to explain worldview differences among liberals and conservatives.

Scientists think that animals like the prairie vole, whose cerebral reward centers have evolved to associate vasopressin with pleasure, get more positive reinforcement for pair bonding and therefore seek it out. But exactly how these hormones function in the body and the brain is still largely unknown. Teasing out oxytocin's and vasopressin's precise mechanisms drives Rodrigues' research as an assistant professor in the Department of Psychology.

"Oxytocin," says OSU neuropsychologist Sarina Rodrigues, "is just such a marvelous, amazing and elegant hormone. It's related to generosity, trust, empathy, mating, pair bonding, parenting. It facilitates social behaviors."

Stress, Actually

This "elegant hormone" influences stress as well as love, not only strengthening pair bonds and social attachments, but soothing the mind and calming the body when faced with difficult or dangerous situations. Thus, along with the related compounds serotonin, vasopressin and dopamine, it has earned the designation "neuromodulator" — basically, a social lubricant and a brake on stress reactions.

"It dampens how much stress hormone our body releases," Rodrigues explains. "It curbs our brain's response to emotional stimuli and even how much our heart freaks out during stress."

Inspired by her Ph.D. adviser at New York University, Joseph LeDoux, author of *The Emotional*

Meets Compassion

Brain and the Synaptic Self, Oregon-born Rodrigues started her career dissecting both human and animal brains to map emotions at their source, in a part of the brain known as the amygdala. As a postdoctoral scholar at Columbia University, she studied the brains of psychiatric patients, looking for biochemical clues to mental illness. From there, she headed to Stanford to work with Robert Sapolsky, who discovered that brain cells shrink and die under severe stress. Before joining the faculty at OSU, Rodrigues did yet another postdoc, this time at Berkeley's Greater Good Science Center, a move she laughingly describes as reflecting her "hippy-dippy" idealism. "Berkeley was my bridge from neuroscience to social psychology," she says.

Although she sees herself as a "geek" at heart ("I *love* microscopes and pipettes and test tubes and all that sort of stuff"), she has veered from the merely molecular to the more broadly social. Whether seeking the physical loci of emotions in gray matter or exploring chemical responses to stress, she hopes her neurological knowledge will ultimately benefit the human condition.

"How can we use this information to make people's lives better?" she wonders. "If we can better understand how people process emotions, we can create tools for dealing with feelings more effectively."

The Mind's Eye

Rodrigues' most recent study, published in the November 2009 *Proceedings of the National Academy of Sciences*, has broken new ground in the field for a couple of reasons. One, it's the first simultaneous investigation of empathy and stress on a hormonal level. And two, it's the first to link a specific gene to both empathy and stress reactivity. "This was the first study that really looked at how one gene can affect our social behavior and our stress reactivity in tandem," Rodrigues says.

If you think of oxytocin molecules as boats floating through the human body, you can think of oxytocin receptors as the docks where the boats tie up. Rodrigues calls these docks "targets."

"Oxytocin has targets all over our body and brain," she says. The heart and the spinal cord, even the uterus, have oxytocin docks. It's not surprising, then, that the hormone affects such maternal functions as uterine contractions and breast-feeding.

Genetic variations in these receptors affect how people respond to hormonal signals from the brain. In her two-pronged experiment, Rodrigues tested the DNA of 200 college students grouped by genotype. Group A had a genetic variation associated with low levels of empathy and social affiliation (emotional bonds with others) and high levels of

In Brief

THE ISSUE Neurochemicals such as oxytocin influence behavior in ways that scientists still don't understand. Revealing the interplay between genes and behavior can benefit psychological health.

OSU LEADERSHIP Sarina Rodrigues in the Department of Psychology has demonstrated for the first time that a gene linked to oxytocin is associated with empathy and response to stress. She emphasizes that behavior is complex, that how we act can also influence our genes.

stress reactivity (jumpiness). Group B, in contrast, had genes associated with strong empathy and low stress reactivity. Each student was then tested for empathy by measuring his or her score on an instrument called "Reading the Mind in the Eyes Test," which asks subjects to guess which emotion (such as "hateful, jealous, arrogant or panicked" for one image and "playful, irritated, comforting or bored" for another) is revealed in a photograph of a pair of human eyes. Stress reactivity was gauged by measuring the students' heart rates after unexpected bursts of noise in a headphone.

The findings were strong and clear: Students in Group A were nearly 25 percent more likely to make an error on the facial expression test, and were also more jumpy on the stress test.

"It does seem that we are biologically hardwired," Rodrigues says. "We do have a lot of inborn tendencies."

She cautions, however, that our destinies aren't ordained by biology. "We are this huge slurry of both nature and nurture, of genes and upbringing and experience," she says. "It's our social connections that really chart which trajectory we will go down."

Rodrigues' discovery adds to the growing scientific understanding of why some people are more tuned in to the feelings and needs of others. It even bolsters a growing body of literature pointing to oxytocin receptors as possible culprits in autism, which has been associated with the same low-empathy, high-stress variation in Rodrigues' Group A.

"You can't change your genes," Rodrigues points out. "But you can change how genes are expressed." Extreme loneliness, for example, can weaken genetic defenses against germs. She likens our genetic inheritance to a bottle. Its shape and composition are set. But by capping or uncapping it, by replacing a twist top with a cork, a glass stopper with a funnel, the bottle can be opened or closed, made more receptive or less receptive to new input, turned on or turned off.

Uber-Gooey Group

For young Sarina Rodrigues, it all started with a mystery experiment in her Portland high school chemistry class. "We had no idea what we were making," she recalls. The blending of sucrose crystals, 3M glucose, protein pellets, solidified mixed esters, 4-hydroxy-3-methoxybenzaldehyde, sodium chloride, sodium bicarbonate and water yielded something a teenager could appreciate: peanut brittle. An apprenticeship at a neuroscience lab arranged by the same St. Mary's Academy chemistry teacher set her on her current path.

She recently got a shock after testing her own DNA. To her astonishment, she found that she was born with a genetic predisposition for low empathy, high stress reactivity.

"At first I wanted to keep it a secret," she confesses. "I like to think that I'm a very caring person with empathy for others. But In fact, 75 percent of the people in our study were in the low-empathic, high stress-reactive group. The uber-gooey, lovey-dovey, very empathic, low stress-reactive people were a really small proportion of our sample. Many of us have to really work at forming social bonds and not freaking out." terra

THE SALIVA DIARIES

You've heard of scout camp, church camp, even fat camp. But spit camp? That's where scientists like Sarina Rodrigues go to study the practical applications of using saliva in the lab. A company called Salimetrics, a spin-off from Pennsylvania State University, offers workshops on using oral fluids as biological specimens for the behavioral, social and health sciences.

"It's a boot camp on how to study biomarker fluctuations in people's saliva — the best way to collect it, best time of day, best way to store it, best way to measure it — so I can get it just right," she explains. "These are tricky things to get from saliva."

Rodrigues signed up for the Salimetrics Spit Camp because, in her quest to unravel the mysteries of oxytocin, saliva has several advantages over blood ("I don't want to be pricking people") and cadavers ("I don't want to be in the business of collecting fresh human brains"). First, needles aren't needed. Second, subjects must be alive. And third, people can spit in a cup anytime, anywhere, making it handy and practical.

Saliva diaries are another tool Rodrigues is sharpening up for her research program. She wants to track biochemical changes occurring during varying emotional states. "I want people to take a little saliva sample when they feel really depressed and when they feel really warm and fuzzy to see how that might correlate how the body and brain react to various emotions."

Biases and Barriers

Pharmacist battles myths about chronic pain

(Illustration: Scott Laumann)

Bi-Mart seems an unlikely springboard for social change. Yet tucked away in a corner of a store on the edge of Springfield, pharmacist Kathy Hahn is waging a militant campaign against pain.

"I'm kind of an activist," she says, leaning close to her listener and whispering the word "activist" as if confiding a dark secret. "When I see something that's wrong all day every day, I'm the type that says, 'I'm going to do everything in my power to change that.'"

What she's changing is the way chronic pain is managed in Oregon. In her 20 years as Bi-Mart pharmacy manager, she has seen legions of patients — combat veterans, fibromyalgia sufferers, accident victims, people with auto-immune disorders and degenerative diseases — who suffer needlessly because their pain is poorly controlled. The twin fears of patient addiction and illegal drug trafficking scare doctors away from prescribing opium-based medications for many of the 76 million Americans living with chronic pain, Hahn explains. And pharmacists often behave judgmentally when patients come to the counter with high-dose prescriptions for opioids.

"Many pharmacists think people who use Vicodin or Percocet are all potential addicts, and they treat them horribly — horribly! — whispering to the technician, looking at the patient with suspicion," she says. "A pharmacy that does not understand pain management can be the biggest barrier in the health-care chain."

Far from being content with just filling "scrips," Hahn teaches in OSU's College of Pharmacy as an affiliate faculty member, chairs the Oregon Pain Management Commission (the first of its kind in the United States) and serves as Oregon co-leader for the American Pain Foundation. She also is active in Death with Dignity, Oregon's first-in-the-nation assisted suicide law.

Listening to Patients

From a curtained consultation room overlooking the Bi-Mart pharmacy counter, Hahn keeps a sharp eye out for patients who might need her expertise or just a cheerful "hello." When Vietnam vet Richard Ketter shuffles up, bent low over a shopping cart, his hat decorated with buttons and pins — including a purple heart — Hahn calls out to him.

"Hi, Mr. Ketter, how are you today?"

"Good. Gettin' ready to go prospectin' for gold out in Arizona."

The news is nothing short of miraculous. Injuries suffered during a helicopter crash in Vietnam left the 65-year-old Ketter with a painfully damaged leg. Unable to get the meds he needed through Veteran's Affairs, he searched online for a new doctor and was steered to Hahn. She in turn referred him to Dr. Martin Klos, who accepts patients like Ketter whom "no one else will touch."

"Kathy and Dr. Klos saved my life," says Ketter, who admits to nearly giving up on life before finding help. "They're the only people who seem to care."

Passing the Torch

As the chair of the 17-member Oregon Pain Management Commission, Hahn helps set policies and guidelines to improve the lives of patients. One controversial issue is medical marijuana.

"The commission understands that marijuana can have tremendous medical value," she says. "It is a travesty that more money has not gone into investigating and developing it. I believe that its niche is going to be neuropathic pain, and neuropathic pain — if you look at the whole spectrum of pain — is the monster. It is the one that is most difficult to treat."

As a teacher and mentor, Hahn is passing the torch to a new generation of pharmacists, raising awareness and providing guidance during students' six-week rotations at Bi-Mart. "What the students have to learn is that it takes a village to take care of a pain patient," she says. "I want them to do a paradigm shift before they leave here. I want them to become advocates."

— LEE SHERMAN

Preview of Coming Attractions

After Chile, Oregon prepares for Big One

MARCH 15, 2010: *"The Bridge Team's goal for today was to determine the geographical extent of bridge damage from the Chilean earthquakes. We did this by driving nearly 450 miles south along Route 5 (the Pan American Highway) from Santiago to Temuco, keeping along the outer edge of the zone of strong shaking (about 50 miles or so inland). To put this into Pacific Northwest context, it would be very similar to driving from Seattle to southern Oregon along I-5 after a Cascadia Subduction Zone earthquake off the Oregon/Washington coast."*

— BLOG POST FROM OSU CIVIL AND CONSTRUCTION ENGINEER SCOTT ASHFORD

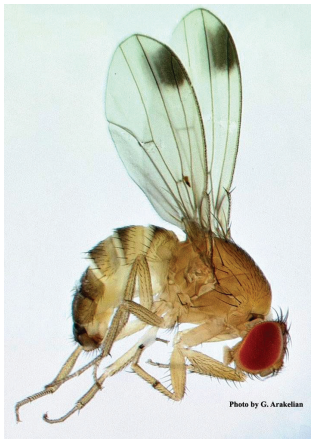
Ashford visited Chile as a member of the international Chile Earthquake Reconnaissance Team sponsored by the Earthquake Engineering Research Institute. The quakes that have devastated Chile and Haiti in recent months, he notes, are reminders that Oregon, too, sits poised for heavy shaking. The Cascadia Subduction Zone shifts abruptly every 300 to 400 years or so, and the next time it does, experts predict destruction and dislocation from the Pacific shoreline inland to Portland and the Willamette Valley. A tsunami could follow in the earthquake's wake.

To help Oregonians prepare, Oregon Sea Grant outreach specialist Patrick Corcoran is working with coastal communities. "We may have as little as 15 minutes' warning for a potential tsunami, and the damage from an earthquake could be immediate," says Corcoran, who coordinates the Coastal Storms Program at OSU. "We all need to be prepared to help ourselves."

Ashford and Corcoran are among more than a dozen OSU faculty who are sharing their expertise in engineering, geology, communications and marine sciences with Chilean colleagues.

More information on tsunami preparedness is available at: ***http://extension.oregonstate.edu/clatsop/coastal-hazards/tsunami-preparedness***

Fending Off a Fruit Menace



It's a pest not much bigger than the head of a pin. But for Oregon farmers, the tiny fruit fly has the potential to take a giant bite out of yields — and profits.

The spotted wing *Drosophila* has made its way to Oregon from its native Southeast Asia, turning up first in wine grapes late last summer and then invading berries, cherries, plums, peaches and other fruit crops across 13 counties. Willamette Valley growers lost up to 20 percent of their blueberries and raspberries and as much as 80 percent of their late-season peaches.

"This is an insect that, up to last year, had never been seen in the continental United States," says OSU research entomologist Amy Dreves.

In February, to help head off a crisis in the state's $500 million tree-fruit and berry industry, the Legislature gave $225,000 to a team of researchers from OSU and the state and national departments of agriculture for monitoring and controlling the fly. Among the team's tasks are sampling fruits to detect infestations, mapping outbreaks, testing traps, developing natural baits, doing outreach and training growers.

"It is crucial to find infestations of this pest as early as possible, when they can still be treated effectively," warns Dreves.

Oceanographer to Take Research Helm

Richard "Rick" Spinrad, who has overseen national research initiatives from leadership positions in the National Oceanographic and Atmospheric Administration (NOAA) and the U.S. Navy, will join OSU in July as vice president for research.

Spinrad earned his master's degree and Ph.D. at OSU in the 1970s and 1980s. He returns to Oregon with a wealth of experience tightly aligned with the university's research priorities in climate change and sustainability.

As NOAA's assistant administrator for research, he directed programs in oceanography, atmospheric sciences and climate, including the National Sea Grant College Program and Climate Program Office. In his previous NOAA post, he directed navigation services, including the National Geodetic Survey, the National Marine Sanctuaries Program and the Office of Coastal Resource Management. He also represented U.S. interests in the establishment of a global tsunami warning system.

Spinrad succeeds John Cassady, who retired in January.

Reserve for Rockfish

Policy and science in Port Orford

Redfish Rocks is home to a diverse collection of marine species — and to a unique collaboration among fishermen, university scientists and the Oregon Department of Fish and Wildlife. The jagged reef off the shores of Port Orford, one of two pilot sites in Oregon's developing marine reserve network, was established by coastal residents who wanted to "have a local say and carve out benefits" for their community. Those are the words of the Port Orford Ocean Resource Team, a grassroots nonprofit launched in 2008 to protect local fish stocks — particularly BOFFFFs (Big Old Fat Fertile Female Fish) — and to engage in scientific research.

That's where Tom Calvanese comes in. The OSU Marine Resource Management graduate student has studied fish in the Hawaiian and San Juan Islands and California's Channel Islands, but he also has a decade of experience in some of the grittiest territory in community organizing: mobilizing services for the homeless and for indigent HIV/AIDS patients.

The study of rockfish movements at Redfish Rocks that he is designing with his adviser Scott Heppell, assistant professor in the Department of Fisheries and Wildlife, will not only draw upon his undergraduate research at the universities of Hawaii, Washington and San Francisco State, but will also employ his skills working with disparate actors from multiple disciplines and perspectives.

"Marine reserves are a perfect storm of public policy and science — a contentious issue with a lot of complexity that this work will help to illuminate," says Calvanese, who recently received a $5,000 Oregon Lottery grant to help support his project. "I see conflict as an opportunity. If we can harness that conflict constructively, it enriches the process and leads to meaningful change."

OSU Scholars Archive Ranks Among World's Best

ScholarsArchive@OSU, a digital archive for scholarly writings, rates among the top institutional repositories in the world.

Achieving its highest ratings yet in January 2010, OSU came in fourth nationally and 16th internationally on Web-o-Metrics Institutional Repository rankings. Only three U.S. universities — MIT (which designed the repository software), Michigan and Tufts — outranked Oregon State.

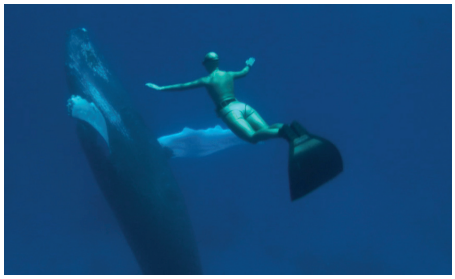
Last year alone, more than 3,500 items were added to ScholarsArchive@OSU, including Ph.D. dissertations and master's theses by OSU students, Extension and Experiment Station Communication technical reports and faculty articles. "This year, ScholarsArchive is on pace to add nearly 5,500 items," says Sue Kunda, OSU's digital production librarian.

In February, OSU's College of Oceanic and Atmospheric Sciences (COAS) became the first oceanography college in the world to implement an open-access policy. By the end of March, COAS articles had been downloaded more than 8,000 times.

Launched in early 2005, ScholarsArchive now attracts more than 2,500 visitors daily. "We get a surprising number from the third world — India, Africa, places where they're unable to access research if it's only available through journals," reports Michael Boock, head of Digital Access Services for OSU Libraries.

Find more information at ***http://ir.library.oregonstate.edu/jspui/index.jsp***

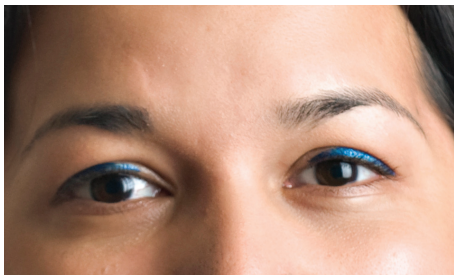
See Terra on the Web at Oregonstate.edu/terra



Scott Baker uses molecular clues to track the fate of whales worldwide. Listen to him discuss his role as science adviser in *The Cove*, the Academy Award-winning documentary about a dolphin slaughter in Japan.

Only about 30 percent of children meet minimum guidelines for daily physical activity. **Stewart Trost**, an expert in exercise and diabetes prevention, talks about why it's important to measure activity levels and what his research has shown.

Kids get a charge out of healthy eating and exercise in **Joanne Sorte**'s "Health in Action" program. See how it works in a video from Oregon State University's Child Development Center.



Sarina Rodrigues' research finds a correlation between emotional sensitivity and genes. Read her story and test your own emotional radar. See if you can correctly guess the feelings expressed in the eyes of movie stars.

Global Ocean

Sea levels are rising. Coral reefs are under siege. "Dead zones" are proliferating. From the poles to the Equator, Oregon State University marine scientists are tackling these and other problems in their quest to understand how oceans work, how ecosystems are responding and how we can manage them. With one of the largest concentrations of marine scientists in the nation, OSU's ocean research has gone global.

(Illustration by Jennifer Daniel)

Guarding Human Health

Diseases cross barriers from animals to people

Veterinarians, as everyone knows, care for dogs, cats and livestock. Less well-known is their role in safeguarding human health.

"It's important to point out the strengths and critical assets that veterinarians bring to public health," observes Cyril Clarke, Lois Bates Acheson Dean of Veterinary Medicine.

Clarke ticks off the key intersections of animal-human health one by one. First, the vast majority of emerging infectious diseases worldwide — swine flu, avian flu, HIV-AIDs and Ebola, to name a few — have animal origins. Next, 80 percent of pathogens that pose a national-security threat — infectious agents like anthrax, for instance — are transferred to humans from animals. And food-borne illnesses such as salmonellosis and *E-coli* infection, which sicken thousands of Americans each year, typically are traced to livestock.

"Veterinarians really are the guardians of a safe food supply," says Clarke, who grew up in South Africa and began eyeing a veterinary career during summers at his grandparents' farm near Kruger National Park. "They are responsible for investigating the causes of diseases linked to contaminated foods and for maintaining a healthy food supply."

Too, animal studies can reveal the causes of and cures for human illnesses. Researchers have developed more than 400 animal models of human disease, Clarke says. Studies with mice, for instance, have resulted in new understandings of tumor progression in lung cancer, as well as suggesting new diagnostic methods and therapies. Golden retrievers, which can carry spontaneous mutations in the dystrophin gene that causes a condition similar to Duchenne's muscular dystrophy, have shed light on this lethal childhood disease.

Investigating the link between human and animal health is a critical focus for Cyril Clarke, dean of OSU's College of Veterinary Medicine, as he leads the college in a new era of veterinary research. (Photo: Karl Maasdam)

Clarke's own research program at Oklahoma State University, in fact, was funded in part by the National Institutes of Health and other agencies that support human health studies. That's because his investigations of microbial pathogens in bovine respiratory disease — studies spurred by his initial professional interest in agriculture and livestock — illuminated principles of immune response and antimicrobial resistance that have applications in human health.

It is at this nexus of human-animal health where Clarke and his OSU colleagues in the human health sciences are laying the groundwork for a signature program that they hope will gain recognition nationally and internationally — what he calls an "area of critical mass and excellence." Clarke is working closely with fellow deans Tammy Bray (College of Health and Human Sciences) and Wayne Kradjan (College of Pharmacy) to design a multidisciplinary research and graduate program that will blend together and build upon OSU's strengths in the health sciences. Under the university's realignment plan, the three colleges are being folded into an overarching Division of Health Sciences.

"As we look to the future, the College of Vet Med will have a much larger research program — one that is overlaid and undergirded by an inter-departmental, cross-disciplinary graduate program in comparative (cross-species) health sciences," says Clarke. "We will also be enhancing our opportunities for outreach so that we can extend new knowledge to our stakeholders and constituents."

For information about supporting the College of Veterinary Medicine, visit ***CampaignforOSU.org*** or call the Oregon State University Foundation, 800-354-7281.

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A cracker with peanut butter is a tasty treat for Luke, a toddler at Cozy Corners in Albany. With help from him and children at 60 home-based daycares in Oregon, an OSU research team led by Stewart Trost is documenting the impact of exercise and healthy eating on childhood obesity. See "Teeny Little Steps," Page 2 (Photo: Nancy Froelich)

Listen to OSU researchers, follow their stories and see more photos, at **oregonstate.edu/terra**