

# grow

Wisconsin's Magazine for the Life Sciences • Winter 2008

agriculture • food • health • environment

## Tracking Bears

**Following wildlife on the move in Wisconsin**



COLLEGE OF AGRICULTURAL & LIFE SCIENCES  
University of Wisconsin-Madison

DEBUGGING THE GYPSY MOTH

• THE NEW WHEY

• LISTENING TO PROTEINS









# grow

Wisconsin's Magazine for the Life Sciences

## 12 A WHOLE NEW WHEY

Once dumped down the drain, whey—the liquid byproduct of cheesemaking—is finding unprecedented value as a nutritious and surprisingly versatile ingredient in foods.

*By Nicole Miller MS'06*

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*By Michael Penn*

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A black bear's footprints mark the sand on Wisconsin's Stockton Island.

*Photo by Layne Kennedy/Corbis.*

FROM ABOVE, west-central Wisconsin resembles a patchwork quilt of forests and farms. More bears are navigating this carved-up terrain, and researchers want to know how (see story, page 18).



Dean Molly Jahn

## Investing in Our Future



**I**N 2007, WISCONSIN AGRICULTURE enjoyed one of its most prosperous years in history. As the new year opens, however, we find ourselves facing increasing uncertainty. Whatever our future holds, one thing is certain. In the long run, our ability to persevere and thrive through good times and bad will always depend on our commitment to invest in the future.

At CALS, one of the most powerful ways we do this is by investing in our students. Students—through the work they will do, the families they'll raise, the values they'll share and the communities they'll shape—define our very brightest hopes. Whatever our economic future may hold, our history teaches us that our students will make all the difference.

As you turn the pages of this issue of *Grow*, you'll notice many examples of this exciting potential. You'll read about students who are tackling challenges and partnering on and off campus to prepare for their futures and solve problems today. In each story and face, I hope you'll be able to feel, as I do, the vision, the energy and the optimism our students bring to our campus—and their commitment to your future.

**Each day, I share sidewalks and stairways with students who exceed every expectation. And they are just getting started.**

In the larger context of their lives, students spend such a brief time on our campus, critical though this period may be. We know there is so much to do in this short interval to prepare them for all the uncertainties they will face. We also know that much is expected of us during this critical chapter of their lives.

Parents send us their children because they expect that the skills and perspectives they gain here will help them succeed. Our partners in the private sector invest in us because they expect us to graduate bright, career-minded students who have the right skills to help industries thrive and communities prosper. Taxpayers expect that their investment in higher education will lead to a better quality of life through the generation of new knowledge and ideas and the creation of an educated citizenry.

The stories on these pages introduce you to achievements of just a few of our students and all those who stand with them. I hope you will find in them the same excitement and inspiration that I do. Each day, I share sidewalks and stairways with so many who exceed every expectation with their extraordinary knowledge, spirit and innovation. And they are just getting started. My confidence for our future lies in the knowledge that their best is yet to come.

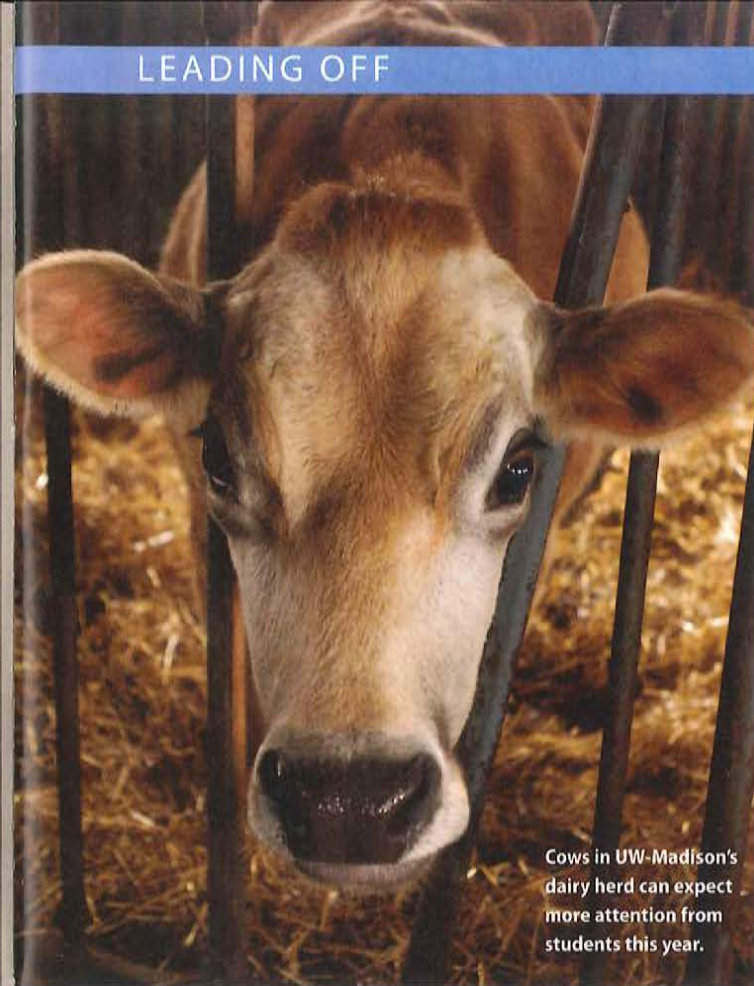
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Cows in UW-Madison's dairy herd can expect more attention from students this year.

## Greener Pastures

Dairy science gets personal to reverse enrollment trend.

It wasn't long ago that Ted Halbach's dairy cattle selection course—one of the first classes taken by new dairy science majors—felt a little too select.

"In 2005, I had six students," says Halbach, who has taught the class since 1999. "You don't have the diversity of opinion among students that you get with classes of 15 to 30 students."

These days, it's a different story. Halbach's class is full, buoyed by a bumper crop of 29 new dairy-science majors, more than triple its entering class from three years ago.

For one of UW-Madison's oldest and most traditional fields, that's a remarkable reversal of fortune. Since enrolling 189 undergraduate students in 1982, dairy science has seen a steady decline in popularity, and by 2004, fewer than 60 students were majoring in the field. That fall, just eight students signed on, raising concerns that dairy was falling off the modern student's radar.

"One of the ways we serve the dairy industry is by providing employees, and we weren't filling the pipeline," says department chair Ric Grummer BS'77. "There was a concern that maybe we

were letting down our clientele."

The department responded by overhauling its curriculum and revamping its public relations materials. It also changed its philosophy toward recruiting new students.

"I think the thing that clicked for me was that it's about what kind of experience a student can have here," says Halbach, who coordinates the department's recruiting. "While our rankings are nice, kids don't make their decisions based on how we're ranked. They want to know what their lives will be like if they come here."

When talking to students, Halbach now trumpets the campus and its location in "the heart of dairy," as the department's new materials describe it. More important is how he delivers those messages. As a youth extension specialist, he travels regularly to shows and fairs to talk one-on-one with prospective students. At last year's state FFA convention, for instance, he enticed more than 200 students to fill out information sheets by entering them in

a drawing for an iPod.

"Our booth looked like a riot scene," he says. "I had to recruit my daughter to help hand out forms."

Other factors have contributed to the comeback, including a significant bump in scholarship money and a change in UW-Madison's admissions policies, which speeds decisions for qualified students interested in agricultural fields. An improving climate for agriculture also helps. Nationally, student membership in FFA is up, eclipsing a half million for the first time since 1978.

But ultimately, the most significant thing Halbach and his colleagues have done to reverse the enrollment trend is to take it personally, winning the recruiting battle one student at a time.

"Ted has made heroic efforts to seek new students and get them to commit to the UW-Madison dairy science program," says Robert Ray, associate dean for undergraduate programs at CALS. "Dairy science is reaching potential students who are in some cases in middle school."

—MICHAEL PENN

## Number Crunching

**991**

CALS dairy science graduates living in Wisconsin.

**1,245,000**

Dairy cows living in Wisconsin.

**159,212**

People employed by the Wisconsin dairy industry in on-farm milk production and dairy processing.

**30**

Percent of cheese produced in the United States that is made in Wisconsin.

**45**

Percent of the nation's butter made in the state.

**\$20.6 billion**

Dairy's annual impact on the state's economy.



## To Kill a Caterpillar

A surprising strategy for combating gypsy moths.

For a time last summer, Wisconsin's cherished camping season fell to the mercy of an insect. Gypsy moth caterpillars—voracious, prolific pests that hatch and feed on deciduous trees—broke out in huge numbers, causing extensive tree damage and turning campsites into a fuzzy, squirmy mess. At Wisconsin's Rocky Arbor State Park, the infestation was so extreme that managers shut down the park for two weeks in an attempt to keep them from spreading.

Officials are having to resort to such measures partly because other weapons—namely the bacterial insecticide Bt—have proved less than ideal in stemming the gypsy moth's march across the northern United States. While applications of Bt have helped slow the moth's spread, they have hardly stopped it. Last year, the insects defoliated 23,000 acres in Wisconsin alone. Experts predict conditions will favor another outbreak this summer.

New research, however, is beginning to explain why Bt may not work as well as hoped. In one landmark study, a group of CALS scientists has overturned one of the central assumptions about how Bt works—that it kills insects directly by causing the equivalent of blood poisoning—potentially opening the door to new ways to improve Bt's potency.

In the laboratory, the team removed microbes that live naturally in a gypsy moth caterpillar's gut and then administered Bt. Without other microbes to contend with, they expected the bacterium to be more lethal. Instead, they found that it didn't work at all, suggesting Bt kills by teaming up with a microbe



Gypsy moth caterpillars were responsible for defoliating 23,000 acres of Wisconsin forest last year.

already present in the caterpillar's gut.

"Ultimately, this is a very simple story," says bacteriology professor Jo Handelsman, one of the lead investigators. "You need two bugs to kill an insect instead of one."

Although researchers don't yet understand how the two microbes interact to kill gypsy moths, the finding implies that insecticides could be made more effective by combining Bt with other microbes. It also creates a surprising new path for future research to explore.

"We didn't believe it at first because it was so antithetical to what we were imagining was going on," she says. "When your hypothesis is so wrong the opposite is true, you just have to laugh. But those are the moments we love in science, because the bugs are always more interesting than our imaginations."

—NICOLE MILLER MS'06



Genetics researcher Ahna Skop observes the earliest stages of life with an artist's eye.

## The President's Cell Call

**WHEN AHNA SKOP PhD'00** got a letter from the White House in fall 2006, she first thought it was a prank. "It said they needed information for an FBI security check, and it asked for my Social Security number," says the assistant professor of genetics. "That kind of makes you suspicious."

Skop complied anyway, and she's glad she did. This past Novem-

ber, she was a guest at the White House to accept a Presidential Early Career Award in Science and Engineering, one of the top prizes given to young researchers. This year, 58 scientists were tabbed for the honor, which carries five years of federal research support—and a nice photo op with President Bush.

Skop earned the recognition for her pioneering work on cell division,



## Too Many A's?

Prenatal vitamins may deliver more than baby needs.

When a woman becomes pregnant, one of her doctor's first actions is to prescribe prenatal vitamin supplements to stimulate the healthy development of her baby. But could those supplements be delivering too much of a good thing?

Nutritional scientist Sherry Tanumihardjo worries this may be the case for vitamin A, a compound commonly included in prenatal supplement formulas and vitamin-fortified foods. While important to fetal development and healthy lactation in breast-feeding mothers, vitamin A can become toxic in higher doses—and there's little data about how much of it is enough for a developing fetus.

"The high intake of vitamin A from supplements and fortified foods worldwide has caused us to be concerned," says Tanumihardjo.

With colleagues at the Wisconsin Regional Primate Research Center, Tanumihardjo is trying to establish the proper balance. In one recent study, her team found that when pregnant monkeys consumed foods fortified with vitamin A, higher levels of the vitamin showed up in their fetuses' livers during early gestational stages, a sign that they were passing on more of the substance than their babies can handle.

While developing monkeys store the excess vitamin A in a benign form that seems to protect them from harmful effects, researchers aren't yet sure that humans have the same defenses. And even if they do, Tanumihardjo says future research may point to a better formula for prenatal supplements that ensures mother and baby get just what they need—and not more.

—MICHAEL PENN

a fundamental but still little-understood process by which all living things grow. Her lab has identified nearly 100 proteins involved when cells divide, which could aid the treatment of birth defects or cancer, where cells often fail to divide properly.

She also won praise for an unconventional approach that unites art and science. The daughter of a

sculptor and an art teacher, Skop has a ceramics degree and creates spectacular works of scientific art. Her brightly colored images of cells have been shown at international conferences. Currently, they decorate the walls of the genetics building.

"I think it is important for the public to see how beautiful what we work on is," she says.

## how to study the smell of cheese

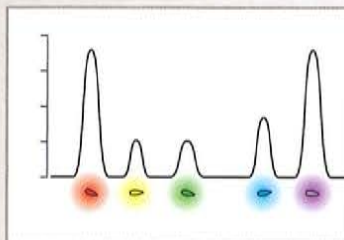
**So you're well along in developing this great new Cheddar.**

You sample a piece from a trial run, and you notice this funny aroma. Kind of reminds you of gym socks. Can this Cheddar be saved? Here's how researchers in UW-Madison's food science department tackle the problem.



**Extract the flavor molecules.** Cheese aromas are created by the release of volatile compounds within the cheese. To identify which of those compounds might be causing an offensive smell, you have to capture them for study. The first step is to grate a pound of cheese and soak it in diethyl ether to create a solution.

**Separate the volatile compounds from the milk fat and solid parts of the cheese.** There are several ways to do this. A common one, a solid phase micro extraction (SPME) fiber system, acts kind of like flypaper for volatile compounds. You condition the fiber so that certain types of volatile chemicals adhere to it, leaving the parts of the cheese that have nothing to do with its aroma behind.

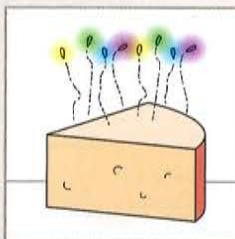


**Identify the individual compounds in the aroma.** A cheese might contain dozens of different compounds that contribute to its aroma. Scientists sort them out by sending volatile compounds down a long tube inside a gas chromatograph. Because each

compound has a unique molecular weight, the compounds arrive at the other end of the tube in a specific order. The chromatograph then compares each compound's molecular fingerprint to a database of 130,000 known volatile compounds to identify and label it.

**Run each of these compounds past a human nose.**

At the same time, a researcher takes a big whiff of each compound as it arrives at the end of the tube. This human "sniffer" uses a joystick and microphone to describe the intensity of the aroma. Scientists can then compare the sniffer's report to the chromatograph record to pin down the source of any offending aromas.



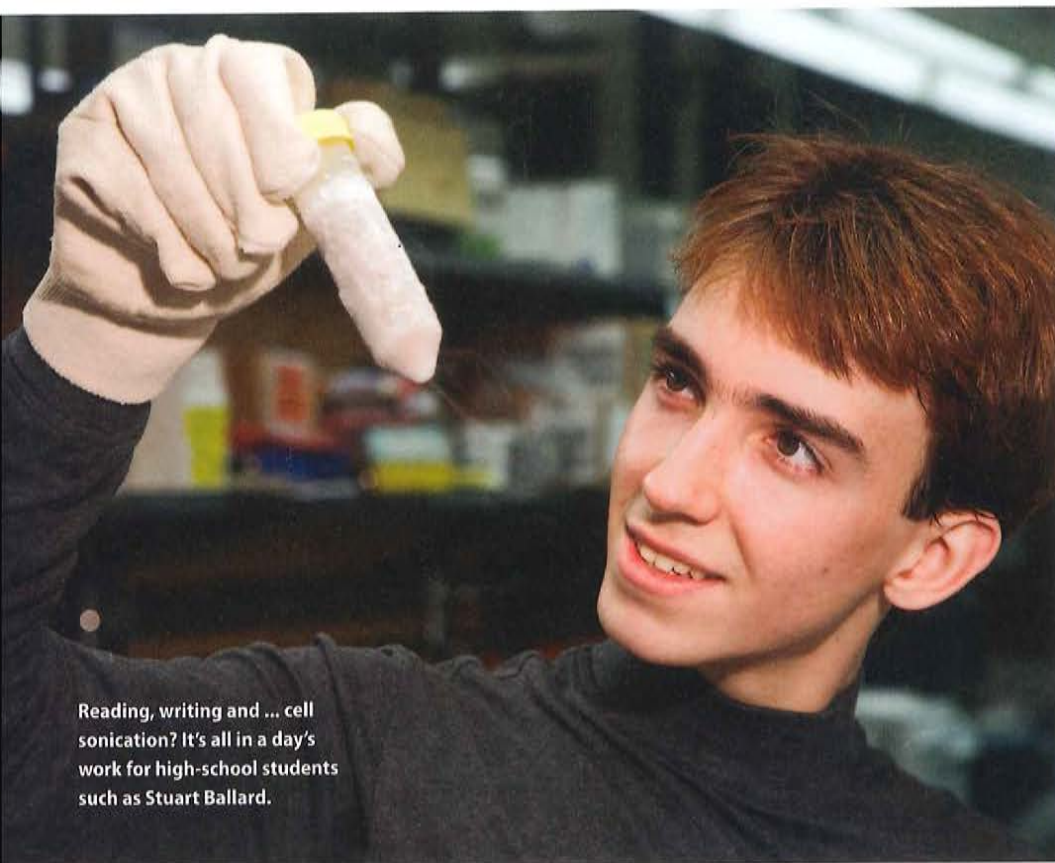
**Go back to the cheese.** Most often the culprit can be traced to the presence of spoilage bacteria, yeast or mold in the system, perhaps due to poor milk quality or poor handling techniques. On the other hand, these same techniques can be used to identify pleasing aromas that can be amplified in the cheesemaking process.

ILLUSTRATIONS BY H. ADAM STEINBERG



## Youth Movement

High-school students tackle real science in CALS labs.



Reading, writing and ... cell sonication? It's all in a day's work for high-school students such as Stuart Ballard.

As a lab assistant in CALS' Center for Eukaryotic Structural Genomics, Stuart Ballard performs tasks typical of an upper-level graduate student: sonicating cells, cleaving proteins and running gas chromatography trials.

But Ballard isn't a graduate student. He's a senior at Madison West High School who's still shy of his 18th birthday.

Baby-faced researchers such as Ballard are becoming a common sight around UW-Madison, which increasingly is trying to cultivate budding young scientists before they even arrive on campus. Through arrangements such as the Youth Apprenticeship Program, a state-run project that matches promising high-school students with practical experiences in their desired careers, CALS labs have employed dozens of science-minded high-school students the past decade.

For students such as Ballard, who is enrolled in YAP's biotechnology thrust, the program offers a taste of working science that high school just can't replicate.

"Working in the research lab is amazing," says Ballard, who plans to pursue both an M.D. and Ph.D. after college. "It's meaningful. In high school, you do your labs and it's not contributing to human knowledge in any way."

Students in the program attend weekly evening training sessions to master basic lab techniques such as using pipettes, running gels and handling biohazardous material. Once paired with a professional mentor, they spend 10 to 15 hours per week working in the lab. They get paid for their labor, which involves much more than washing dishes.

"They get a bench just like everybody else," says entomology professor Que Lan, who has had youth apprentices in her lab for seven years. "They get the same treatment as my graduate students. I work with them one on one. I help them solve problems."

Lan says nearly all of her apprentices have gone on to study science as college students, a reward that compensates the time mentors invest working with the young students.

"Kids always associate science with either (being) very smart or very nerdy," she says. "I think I'm trying to show them, 'Yes, you can have a career; yes, you can have a family; and yes, you can have fun.'"

"It's been a very nice program to be involved in," adds biochemistry professor Brian Fox, who is mentoring Ballard and three other apprentices. "Once they get comfortable with the techniques, they turn out to be very helpful employees."

Under Fox's tutelage, Ballard has learned how to purify proteins while formulating ideas for his own future research. He has helped train undergraduate students as lab assistants, and he was recently offered an opportunity to work as a volunteer in a second lab on campus.

While those commitments can make for a demanding schedule—Ballard is only at his high school for a single weightlifting class—he says the experience is incomparable. Asked if he feels like he's missing out on a normal high-school experience, he laughs, "Not at all, not at all."

—KATE TILLERY-DANZER



## jorge escalante

## Making Links

Meat lab gives students a taste of the industry.

So you've got an RV full of Packers fans on their way to your place for a tailgater. You need meat, and fast. Where do you turn?

Here's an option that may surprise you: UW-Madison's Meat Science and Muscle Biology Laboratory. Opened in 1931, the lab operates much like a small-scale meat-processing plant, where white-coated staff and students harvest animals, process meat and prepare steaks, chops and sausages. Though primarily geared for research and training students, the lab began selling its products to the public last year, opening a small store in a converted spice room. Now students produce and sell everything from top sirloin to Polish sausages, all while closing the loop on their educational experience.

"Students are extremely responsible and intelligent," says Kurt Vogel BS'06, who manages the lab's 10 student employees. "It takes a lot to get into this school, and my feeling is that we should let them use their skills."

A case in point arose this fall, when students Jordan Matthews and Clayton Wohlk approached Vogel about changing the lab's recipe for sausage sticks. "We didn't like the flavor of the stuff we were making," says Wohlk, a junior dairy-science major, "so we changed some things around and added peppers." Vogel liked the result so much that he had the students prepare a batch to sell in the store. They even designed a product label.

"The biggest thing is that now they can take something home to their family and say, 'Look what I did,'" says Vogel. And rarely has homework tasted so good.

—MICHAEL PENN



## Rotten Luck

**FOR POTATO GROWERS**, a good harvest doesn't always mean a good year. Spoilage in storage claims 8 to 9

percent of the nation's annual potato crop—a \$16 million loss of potatoes in Wisconsin alone. But a new test developed by CALS plant pathologists may help farmers weed out those potatoes destined to go bad before they get into storage lockers. Offered by Pest Pros, Inc., a Wisconsin plant diagnostics company, the test employs a technique known as PCR to screen potato samples for the presence of microbes responsible for diseases such as late blight, pink rot and fusarium. Potatoes shown to have a high risk of spoiling in storage can still be filtered out and processed immediately, explains Zahi Atallah, a postdoctoral researcher who developed the test. "So instead of storing the good with the bad," he says, "now growers can do triage."



- **job** Ira L. Baldwin Professor of Bacteriology
- **lab** Located on the sixth floor of the Microbial Sciences Building
- **team** 13 graduate students, five undergrads, one high-school student and one research specialist
- **what we study** The metabolic processes of bacteria

**What's the research question on your mind right now?** What are the means a cell uses to take advantage of its environment so it can survive and grow? In other words, we study metabolism—how bacterial cells extract energy from their environments.

**Is work in the lab 9-to-5 or 24/7?** The clock is not our master. Sometimes students must stay all night to finish an experiment, checking the growth of bacteria at regular intervals. They routinely come to the lab on the weekend, which proves to be extremely difficult on football Saturdays because of the lack of parking. I face this problem, too!

**What piece of equipment in your lab is used most often?** We use every toy we have with almost the same frequency, but I would probably say that the protein purification devices are at the top of the list.

**What's playing on the lab radio?** Music is not allowed in the lab. It prevents people from concentrating, and it is difficult to play music that pleases everyone's taste.

**Which is better: starting a new project, or finishing one?** Starting a project demands focus and the ability to prioritize. A new project is like a space shuttle—we spend more than 90 percent of our energy just getting it off the ground.

**Clean desk or messy desk?** Good question. I can only say ... I try.

**Eat out or brown bag?** Even in my old age, I stick to the old grad student habit of bringing lunch and eating it while I work.

**Any personal items in the lab?** Family pictures—although I love this job, I never forget where my real priorities lie.

**What's your desktop picture?** I have two pictures of my daughter, one when she was hours old and one of her dressed up for high school junior prom. There are also photos of my son and my wife.

**What's your favorite way to recharge the batteries?** I love deep-sea fishing. My son is my fishing buddy.

**What's the coolest thing you've learned by doing research?** That it never ends. Research is constantly challenging me intellectually, and that's why I keep doing it.



# Go Figure

By blending biology and computational logic, **Julie Mitchell** is helping make math the next microscope.

**J**ULIE MITCHELL, an assistant professor of biochemistry and mathematics, builds computational tools that help biologists analyze and predict changes to protein structures that will alter their function—information that can help scientists design novel drugs and disease-fighting agents. Describing herself as a liaison between the logic-driven world of math and the chaotic realm of biology, Mitchell has collaborated with researchers working on everything from cancer to better processes for making ethanol.

**Grow:** How different are mathematics and biology anyway?

*Mitchell:* In many ways, mathematics and biology are almost logical opposites. Mathematics is more of an art: You create rules for some geometric or algebraic space, and then you see what you can prove about it. In biology, we can't even figure out what some of the basic rules are. There are no theorems. Everything has a little asterisk that says: except in these following cases. And so, as a mathematician, if you want to go into biology, you have to be able to accept that and not allow it to drive you insane.

**Grow:** Is that how you came into this field, as a mathematician?

*Mitchell:* Yes, I graduated with my math degree in 1998 from UC-Berkeley.

**Grow:** What was it that attracted you to biology and proteins?

*Mitchell:* My background is in geometric analysis, so what drew me to proteins in the first place was their interesting shapes. Some people look at proteins mainly as strings of amino acids, and when they think about what we call a point mutation—a change to a single amino acid—to them that's a change in the linear sequence. I don't quite think that way. To me, that's a structural change, a geometric change, as well as a change in the protein's biochemical properties.

Now for a long time, I think I translated chemistry into mathematics through physics. You know, everything is a bunch of atoms, here are the forces on the atoms, and so on. That can be a starting point, but ultimately you have to begin thinking a bit more like a biochemist—which takes a lot of time.

**Grow:** How did you begin to do that, to think more like a biochemist?

*Mitchell:* (laughing) I think trial by fire. When I first switched fields, the most helpful thing I did was not to take classes or read books, but to attend a lot of professional meetings and go to the talks and, especially, the



poster sessions. That's where the graduate students and postdocs are representing their papers, and you feel a little less intimidated saying, "I know this is a really dumb question, but what does that mean?"

Not being afraid to ask a dumb question is very important. You have to be very brave and humble, in a way, to admit when you don't know something. At the same time, you have to be very good at—how shall I say this?—pretending to know what you're talking about when you half-don't (laughing).

**Grow:** It truly does sound like trial by fire. Why go through it?

*Mitchell:* When I was finishing up my Ph.D., I really loved mathematics, but I didn't feel a tangible connection between the work I was doing and the real world. Mathematics was beautiful, it was fascinating, but I felt like I wanted to have a more immediate impact.

Eventually, I was pointed toward the protein-folding problem, and so I got on the Internet and typed in "protein folding." And then I pulled up pictures of these fabulous proteins, with all of these interesting coiled structures, all wrapped up into a compact little ball. And there were partial differential equations and dynamical systems that went along with these fascinating geometric structures, and from that point on, that's what I was doing.



## “Mathematics and statistics can help uncover patterns in biological systems.”

As a mathematician, Julie Mitchell was first drawn to proteins because of their interesting geometry. Now, she uses math as a tool to study protein function.

**Grow:** Did you have any grasp of the biological significance of proteins back then?

*Mitchell:* I had no clue. Honestly, before I started on this quest, I didn't know there was more than one kind of protein, such as antibodies or enzymes. Protein was something on the back of the box in the grocery store—it was this generic, singular thing. Since then, I've come to understand the diversity of the world of proteins and all the important functions they perform.

**Grow:** So what can math reveal about proteins?

*Mitchell:* Mathematics can be many things, but one of the fundamental capabilities of math lies in recognizing and characterizing patterns. Within the realm of biology, math and statistics can help uncover patterns in biological systems, like proteins, that aren't immediately obvious, or may only be obvious to an expert.

For example, the predictions made by our computational tool, called the KFC server, are certainly possible for a trained structural biologist to make, but the analysis might take hours rather than seconds, and it can't be automated. Computational mathematics makes the prediction process faster, more statistically non-specialist.

**Grow:** What specifically have you been trying to understand about proteins?

*Mitchell:* Well, there are many different questions we've posed. One of them is protein docking. Given two structures of proteins, can you predict how they come together? It's a bit like solving a three-dimensional puzzle, only a lot harder.

Now, the KFC server solves a somewhat different problem. If we already know how two proteins come together, can we identify, among all the amino acids in the interface between them, which ones are most important in the sense that if you change them, the proteins won't bind as well anymore? Then there's a

somewhat harder problem, which is can you predict mutations that are going to improve the binding?

Fundamentally, we want to provide tools to experimental groups, particularly to people who aren't necessarily used to computational tools or who don't usually give a lot of thought to protein structure. How can we help them identify the structurally important features of their protein systems?

**Grow:** Is that why you've chosen to offer your tools on a server over the Web, because you're targeting non-mathematicians?

*Mitchell:* Yes, the beauty of doing things with a server is that nobody has to download code, or run an application. Everybody, including your grandma, can work the Internet. Well, maybe most people's grandmas.


My philosophy is that you should be able to run a problem using very few parameters. You also don't want people to waste a lot of time typing in commands when you can automate things for them with a check box or a drop down menu, or something else that's going to allow them to very quickly get at the information they need. That's really the goal of the KFC server: to make it very simple for people to interact with protein-protein interfaces and to highlight the important features of those interfaces in a way that's intuitive and simple to use.

**Grow:** Where do you see yourself going from here?

*Mitchell:* Since I've come here, I've become interested in bioenergy applications. The most important problem in the world right now—by far the most important problem—is climate change and energy.

I feel that in the last decade there has been so much emphasis on medical science and medical advances—it's fabulous. On the other hand, if you increase everybody's life span by 20 percent—just to throw a number out there—you're increasing the impact of each individual on the planet by 20 percent. Therefore, you have to balance medical advancements with advances in agriculture and energy science, and so on. So to be able to have any impact on that at all, is just ... it would be an honor, if that makes sense.

**Grow:** So can math save the planet?

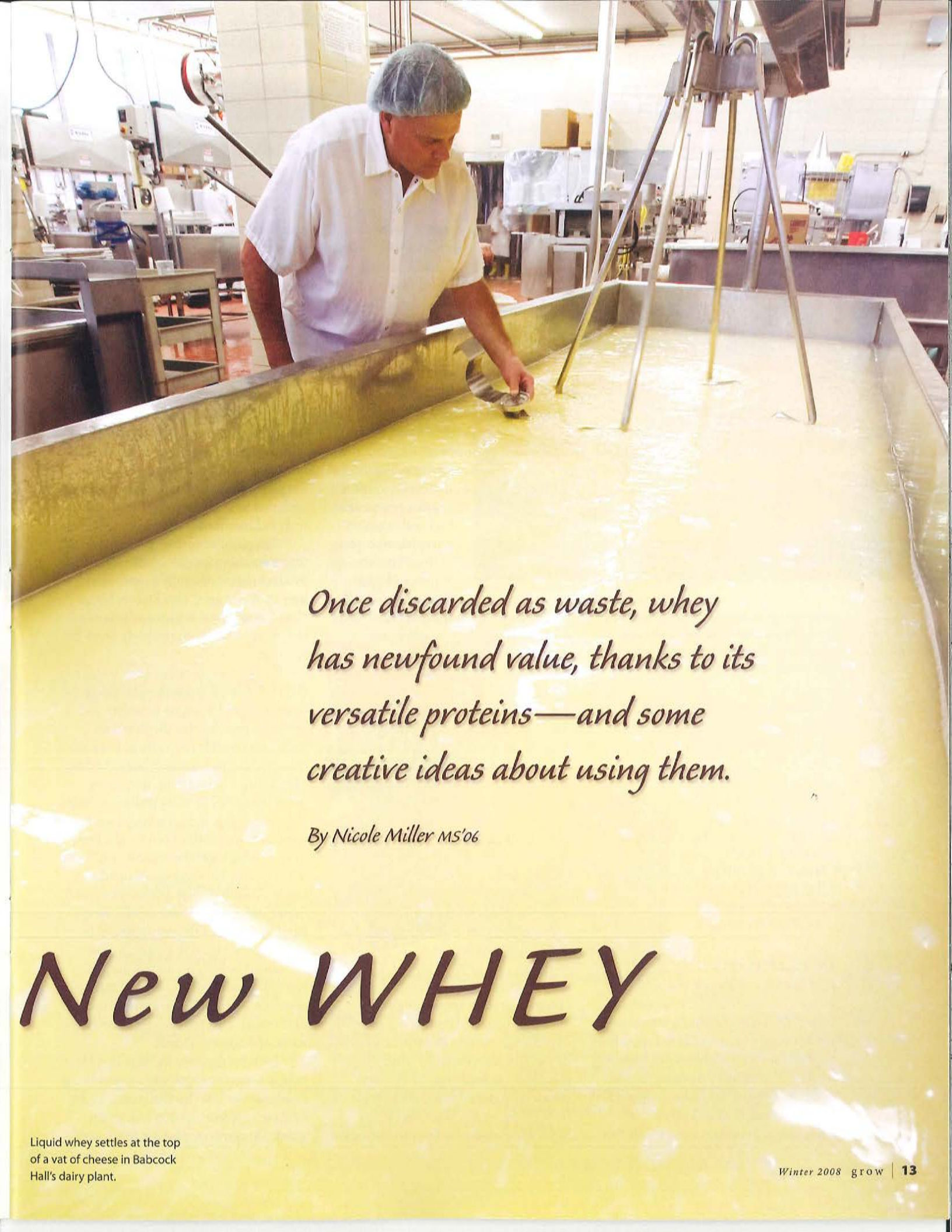
*Mitchell:* (laughing) Well, we'll do our best. 



*F*OR JESSICA ZIMMERMAN, a fifth-grader at Northside Elementary School in Middleton, Wis., lunch is the most trying meal of the day. Because of a rare genetic condition that makes protein act like poison inside her body, Jessica can't eat most of the things fifth-graders eat: no hot dogs, no chicken strips, no eggs, milk or cheese. If she were to eat any of these foods, an amino acid called phenylalanine would collect in her bloodstream and travel straight to her brain, where it would cause her to lose concentration on her studies and play havoc with her emotions. ☀ Instead, Jessica follows a prescribed diet stricter than any vegan's. A typical packed lunch includes a sandwich of artificial cheese on homemade, protein-free bread, a piece of fruit and mineral water. But the really awful part is what she must drink: a foul-smelling, milky-white beverage that provides virtually all of her dietary protein. Blended fresh daily by her mother, Ann, the beverage is a cocktail of amino acids specially designed for people with Jessica's condition, known as phenylketonuria, or PKU. Jessica drinks this concoction three times a day, even though she hates the way it tastes and how it makes her breath smell. ☀ At school, kids sometimes teased her for drinking "baby formula," and now she refuses to drink it there, opting to wait until she gets home. But without her mid-day dose of amino acids, Jessica's mind drifts in afternoon classes.

*A Whole*



A man wearing a white short-sleeved button-down shirt and a grey hairnet is leaning over a large, rectangular stainless steel vat. The vat is filled with a thick, yellow liquid whey. He is using a small metal tool to stir or skim the surface. In the background, there is a dairy processing facility with various pieces of equipment, including a large metal frame structure and other workers in the distance.

*Once discarded as waste, whey  
has newfound value, thanks to its  
versatile proteins—and some  
creative ideas about using them.*

*By Nicole Miller MS'06*

# *New WHEY*

Liquid whey settles at the top  
of a vat of cheese in Babcock  
Hall's dairy plant.





**Strawberry pudding made with a protein from whey brings a smile to 10-year-old Jessica Zimmerman, whose diet is severely restricted by a genetic condition known as PKU.**

"Controlling Jessica's phenylalanine levels poses constant dilemmas no kid should have to face," Ann Zimmerman says. "A small Rice Krispie treat or a small order of French fries is a rare delight, which requires Jessie to be extra diligent that day. She never gets a day off. Not on her birthday, not on Halloween, not on Christmas."

It's unfair, Ann thinks, that food could be so cruel.

*IN A LABORATORY-CUM-KITCHEN* in Babcock Hall, Kathy Nelson, a researcher at the Wisconsin Center for Dairy Research, measures ingredients on a digital scale before throwing them in a mixing bowl. She's making a batch of strawberry pudding, her favorite in a line of foods she designed for Jessica Zimmerman and others with PKU. These items may soon be the first

protein-rich foods Jessica ever eats.

The reason? Nelson's foods contain a secret ingredient: a unique protein derived from whey, the liquid byproduct of cheesemaking.

For the 15,000 people in the United States with PKU, protein is usually a problem because their bodies lack the enzyme responsible for breaking down phenylalanine, one of the 20 major amino acids that form proteins. All

of the proteins we eat in everyday foods contain phenylalanine, and because of that, diet is a chore for people with PKU. A little phenylalanine is essential. But excess amounts can stay in the body indefinitely and interfere with brain function. Too much phenylalanine leads to "an inability to concentrate and focus," says Sally Gleason, a nutritional counselor and case manager who works with individuals with PKU at UW-Madison's Waisman Center, one of the nation's premier centers for PKU research. "They also face emotional problems and depression." The only solution for Jessica is to heavily supplement her diet with the amino-acid shake, which is specially formulated to exclude phenylalanine.

In the late 1990s, however, CALS food scientist Mark Etzel found another option: a protein known as glycomacropeptide. GMP turns out to be the only dietary protein in nature that doesn't contain phenylalanine. And the only place you can find GMP is in whey, which is produced when milk curdles to form cheese curds. Working for the WCDR, a largely farmer-funded organi-

zation dedicated to supporting the dairy industry, Etzel developed a method to isolate and purify large quantities of GMP from whey, some 22 billion pounds of which are generated by Wisconsin's cheese plants every year. In fact, for every one pound of cheese, dairy plants end up with nine pounds of whey.

Despite seemingly limitless quantities of it, the protein in liquid whey is too dilute to be of significant nutritional value as is. It's also full of fats, sugars and minerals that are less than ideal for human consumption, Miss Muffet aside. For years, cheesemakers have done little with this haul other than throw it on their fields or feed it to pigs.

"The point of (Etzel's project) was to find something special in whey, a waste product that we literally have tons of here in Wisconsin," says Denise Ney, a CALS nutritional scientist who studies the effect of GMP on the body. "And he found it."

Whey's rags-to-riches story traces to the 1970s, when researchers began perfecting the technologies to isolate and purify its proteins, for the first time making it possible to use them to enrich other foods. Bodybuilders were the first to catch on: in the 1980s, they recognized the utility of whey protein to help muscles recover from strenuous workouts, and their enthusiasm for the product helped it enter the mainstream. Soon, energy bars and sports drinks began including whey protein as a chief ingredient. One of those drinks, formulated by the WCDR and produced by the Babcock Hall dairy plant, is now consumed by athletes on the Badger football, basketball and hockey teams after workouts—a Wisconsin version of Gatorade that goes by the utilitarian name of Recovery Drink.

"It's been great for us," says Ben Herbert, assistant strength and conditioning coach for the UW football team. "A lot of these supplements don't taste very good. This gives us what we need, and



the guys really like to drink it.”

But whey protein is also present in an astonishing number of everyday foods, from ice cream to infant formula (see graphic, below). This proliferation of uses has, for the most part, been a boon for the dairy industry. Unprecedented global demand drove the price of dried whey to a record high of 78 cents per pound last April, more than triple its long-term average.

This increase has been a significant factor behind the rising price farmers receive for milk, says Brian Gould, a professor of agricultural and applied economics. “For every 10-cent increase in the price of dried whey, the class III milk price increases by 60 cents,” explains Gould. In Wisconsin, where a vast majority of the milk is class III

milk—the type used for making cheese—most farmers received a 20 percent raise over their 2006 earnings thanks to whey.

Etzel says one reason for the boom is the versatility of dairy proteins. “One of the nice things about dairy proteins is that because cows are mammals, like humans are, they have a lot of biological functions in humans that you wouldn’t find in a plant protein, like soy,” he says. Previously, he developed a method to purify lactoferrin, a protein found in whey and human breast milk that is known to boost immunity in children and cancer patients. To help find uses for GMP, “we have medical doctors, health care professionals, food-product developers, nutritional scientists and then me working on protein purification.”

It’s that broad approach that gave Etzel the opportunity to meet patients with PKU, which he says was a transformative moment in his career. “It’s so rare when you are doing basic science that you come in contact with people who are suffering that you can help,” he says.

*IN THE PAST*, babies born with PKU became mentally disabled before anything could be done to help them. Unable to process the proteins in breast milk, infants with PKU were inadvertently poisoned by their mothers’ milk practically from day one. With the advent of genetic screening in the 1960s, doctors are able to identify the condition with a simple blood test and

## FINDING the WHEY

*Whey protein shows up in all sorts of popular food items, including some that may surprise you. Here’s just a taste:*

**Kraft Fat-Free Ranch Salad Dressing**  
Whey, found fourth on the ingredient list, adds a creamy flavor and texture without adding any fat.

**MLO Sports Nutrition Bio Protein Double Chocolate Bar**  
Whey protein—listed first among its five types of protein—is packed inside to help build and repair muscle after workouts.

**Nestle Good Start Supreme Infant Formula**  
This baby formula’s packaging highlights its “comfort proteins,” meaning whey proteins that have been processed for easy digestion.

**Frito-Lay Doritos Nacho Cheese Tortilla Chips**  
Various forms of whey are listed seventh, 11<sup>th</sup> and 31<sup>st</sup> of 32 ingredients. It’s added to help the seasoning blend disperse over and adhere to the chips, while complementing the snack’s cheesy flavor.

**Nabisco Chips Ahoy Chocolate Chip Cookies**  
Third-to-last on the ingredient list, whey helps cookies turn a tantalizing baked-to-perfection brown while adding caramel-like flavors.







Bottles of Babcock Hall's Recovery Drink twirl around a conveyor. Created to help Badger athletes bounce back from workouts, the energy drink is made with whey protein from Wisconsin cheese plants.

quickly intervene. Breast-feeding is replaced by bottles of special formula—a baby's version of the amino-acid cocktail that Jessica Zimmerman drinks every day. "Jessica was born on a Saturday," recalls Ann Zimmerman. "She was on-diet the following Thursday."

To ensure that she is not getting too much phenylalanine, every item that crosses Jessica's lips must be measured and recorded in a food diary. In a culture that often revolves around food, she is a forced bystander. "Everywhere you go there's food," says her mother. "That's one thing you start to notice right away. For instance, if someone shows up at soccer practice with cupcakes, and I have nothing to give Jessie, she has to say, 'That's okay,' and then sit there and watch them all eat it. That is the hardest part, if you ask me, the total lack of spontaneity."

Ann Zimmerman is also concerned with her daughter's approaching teen years, when kids naturally rebel against rules. Just as their peers may feel the temptation of cigarettes or alcohol, PKU teens can succumb to the allure of illicit foods. Normally, going off-diet at this age causes only temporary problems, but on rare occasions, a teenager's indiscretions can lead to permanent brain damage.

And along with worries come daily hassles and headaches. To make Jessica's formula, the family must pack a blender, pitcher and special cup, as well as a large container of powdered amino acids. The latter always raises questions from airport security guards, even though the family carries a doctor's note explaining Jessica's condition. Being able to meet Jessica's needs with a pudding cup or granola bar made with GMP "would be

so welcome," says Ann Zimmerman. "It would really free people up and give them more independence." Short of a treatment or cure for the underlying condition, it's what parents like her want the most for their kids: to experience the pleasure of eating.

That's where Kathy Nelson comes in. Before joining the Wisconsin Center for Dairy Research, she spent ten years developing desserts at Pillsbury, and her role is to be part researcher and part foodie, creating new products that will be pleasing to consumers.

In 2001, Nelson turned her attention to improving the PKU diet. She began experimenting with GMP, but her first attempt at a GMP-fortified food, a loaf of bread, failed. "The more protein I added, the worse the bread turned out. The loaf would just collapse," she says.

During the next three years, however, Nelson created crackers, fruit leather, chocolate and strawberry pudding, and two types of drinks using GMP. A small sample of PKU patients are currently testing those foods, replacing their amino acid drinks with GMP foods for a four-day trial. Ten patients have completed the trials, and early results have confirmed that GMP foods are safe and well-accepted.

According to Denise Ney, the UW-Madison professor of nutritional science who heads up the study, the ultimate goal isn't to replace the amino acid drink entirely, but simply to develop some safe, tasty and convenient alternatives.

"I think GMP could replace about 50 percent of the amino acid drink," she says. "Most people take two to three cups per day. In the future, maybe they would only have to take one or two cups per day, and just have some GMP pudding instead."

Already, Cambrooke Foods, a Massachusetts company that manufactures low-protein foods for the PKU diet, is moving forward with the production of




two GMP-fortified snack items, including Nelson's chocolate pudding.

Meanwhile, longer-term research is exploring whey's role in fighting some of the country's biggest health problems. Recent scientific studies show that whey may help lower blood pressure, help patients with early-stage diabetes manage their glucose and insulin levels, and help dieters control their hunger. K.J. Burrington BS'84 MS'87, the WCDR researcher who formulated the Babcock

Recovery Drink for the Badger athletics team, sees a possibility that the same drink that bulks up football players could help trim America's ballooning waistline.

"It gives you a feeling of fullness," she says. "It also helps you maintain muscle mass while losing fat."

Beyond its food applications, whey also is proving to be a good feedstock for biofuel production. Its sugars can be turned into ethanol in a process that is

cheaper than making the fuel from corn kernels. In consideration of these emerging uses, some dairy economists have even speculated that whey could eventually become the most valuable part of cheese, meaning that one day cheese might be made for the prime reason of generating whey. That's a dramatic turnaround from the days of dumping the stuff down the drain. And for farmers, researchers and even a certain fifth-grade girl, that's the whey they like it. 

## Whey Good Business? Not Always.

**One year ago, Bill Hanson wasn't thrilled about the emerging uses for whey protein. Whey almost put him out of business.**

As owner of Arena Cheese, a small cheese plant in Arena, Wis., Hanson had plenty of whey around. But it was in liquid form, which sells at a fraction of the price of dried whey powder. Because Hanson didn't own the equipment to concentrate or dry his whey, he was forced to sell it at basement rates. So while he paid higher prices for milk—partly due to the surging value of its whey proteins—he wasn't recovering the value on the back end. In other words, he was getting squeezed by whey.

Last year, Hanson shared his financial woes with Randy Pittman, owner of nearby Mill Creek Cheese, who was facing the same tough reality. "We were both saying, 'We have to do something about this.' It was a survival thing," says Hanson.

The two decided to split the purchase of a second-hand ultrafiltra-



To recover value from whey, Arena Cheese owner Bill Hanson (left) went in with another cheesemaker to buy a second-hand ultrafiltration system (below) to concentrate whey protein.

tion system to concentrate their whey protein. Within seven weeks, they had launched a new company, called Whey To Go. Hanson's cheese plant was in the black the following month.

"We set the whole system up for less than half-a-million dollars," says Hanson. "But for a small company, even coming up with that kind of capital is a difficult thing to do. However, to survive, (other small cheesemakers) are going to have to do something like this."

John Umhoefer, director of the Wisconsin Cheese Makers Associa-

tion, a 117-year old trade group that represents a majority of Wisconsin's cheesemakers, confirms these are difficult times for small plants that don't process their own whey.

"I hate to sound negative. This is a great market because the world wants our whey," says Umhoefer. "However, I know of half a dozen companies expressing severe financial difficulty (due to the high price of whey)."

Fortunately, the price of dried whey has moderated somewhat since spiking last year. Experts predict it will settle somewhere around



double its historical price, which may give small cheesemakers a respite—or at least a chance to map out a way forward with whey.







# BEARING SOUTH



*With a growing population and expanding range, **Wisconsin black bears** are on the move.*

*CALS researchers are studying their path to figure out where they'll end up.*

*By Bob Mitchell BS'76*

**A** THOUSAND FEET ABOVE DUNN COUNTY IN WEST-CENTRAL Wisconsin, Karl Malcolm sits hunched in the cockpit of a Cessna Skymaster as it follows the curves of the Cedar River. Below, the landscape bursts with autumn color, but Malcolm isn't paying attention. His head is down, and his eyes are shut. His hands press headphones tightly to his ears. Long minutes pass as Malcolm, a graduate student in forest and wildlife ecology, is lost in silent concentration.

Suddenly his head comes up, eyes open now, scanning the ground below. "I've got one. To the left," he calls out. "Strong now. Right here."

Immediately the horizon tips on end as pilot Paul Anderson throws the plane into a steep turn to point the left wing, bristling





From the cockpit of a state-owned Cessna, Karl Malcolm listens for a signal from a radio collar worn by a young male black bear, which is wandering somewhere in the trees below (right). About every two weeks from spring through fall, Malcolm flies over northern and central Wisconsin to monitor the location of the bears he has collared, part of a project to learn how bears navigate Wisconsin's increasingly fragmented landscape. As the bear population in the Northwoods reaches capacity, pioneering black bears are venturing across the agricultural and developed terrain of west-central Wisconsin to find new habitat—a movement that could have consequences for bears and humans alike.



with antennae, straight down. The Cessna makes tight circles around a wooded hill, an island of trees among the cornfields. Somewhere in that woodlot, or the tall corn that surrounds it, a 20-month-old male black bear is finding its way through the most dangerous year of its life.

A male bear's life starts out pretty easy, but by the second year, it's anything but. His once-protective mother pushes him away, and if he stays in the vicinity of other bears, he's vulnerable to attack by

older, larger males. So he strikes out, looking for a piece of bear-free ground to call his own. The journey could take him hundreds of miles, during which he's likely to encounter houses, highways, hunters and countless other dangers.

A quarter century ago, Wisconsin bears didn't have to roam far to find their own turf. A report published in 1982 by the state's Department of Natural Resources estimated that Wisconsin had fewer than 5,000 bears, and the authors expressed concern that numbers were declining. The state no longer

had a resident bear population south of Highway 64, an east-west road that passes 20 miles north of Wausau, and many experts doubted it ever would.

Today, largely due to hunting restrictions enacted in 1986, Wisconsin has an estimated 12,500 to 14,000 bears. While most of them still reside in the upper third of the state, some 1,500 of them live south of Highway 64. Bears now thrive in Wisconsin's central forest, an island of oak and pine covering several million acres of Clark, Dunn, Juneau and Jackson counties. And they continue to push southward. Bears have





been spotted around Madison and other southern Wisconsin communities, and in 2005, a jogger ran across one in a park in Cedarburg, a 20-minute drive from downtown Milwaukee.

These aren't just wandering males, either. Sows with cubs have been spotted in several southern counties, says Mike Foy BS'79, a DNR wildlife manager for Rock and Green Counties, which lie near the Illinois border. "We've had some of these animals over-winter now," he says. "A female with cubs is an indication that we're on the way to having a resident bear population."

If you live around rural areas, the prospect of having bears in the neighborhood is more than just a curiosity. Some welcome the idea—real-estate ads for vacation properties often play up the chance to see bears. Others dislike the nuisance of sealing up garbage cans and taking bird feeders inside each night. But for farmers, bears can be a headache. A trampling, feeding bear can leave a cornfield looking like a crop circle. In 2006, Wisconsin farmers made claims of \$121,708 for damage done by bears. That same year, 19 bears were trapped on a single farm in Sawyer County.

Bear attacks on humans are very rare—often coming years apart, which is remarkable considering the thousands of times that humans encounter bears each year. But when they happen, they can be serious. In two separate incidents in 2007, Wisconsin deer hunters went to the hospital after startling bears.

All of this weighs on the minds of DNR wildlife managers, who are enlisted to help humans coexist with the state's wilder residents. To deal with those questions, the DNR is helping fund a research project led by Tim Van Deelen, a CALS assistant professor of





**Karl Malcolm and Dave MacFarland carry a black bear cub to be weighed after fitting it with a tracking collar. The researchers remove bears from their dens during winter hibernation, tranquilizing them before installing or retrieving collars. Typically, they receive help from the families of Wisconsin Bear Hunters Association members (facing page), who here keep cubs warm while researchers work on their mothers and siblings.**

forest and wildlife ecology who studies the population dynamics of large animals. Along with graduate students Karl Malcolm, Dave MacFarland and Lizzy Berkley, Van Deelen is out to understand not just where the wild things are in Wisconsin, but where they are going.

Keith Warnke BS'90, a DNR game specialist, ticks off questions he hopes the research will answer: "Are (bears) going to go specifically into the next

available patch of habitat, or do they just take up stakes, start walking and keep on going until they get to something good? Is there any way to predict which direction is going to be most suitable for the next dispersal wave of black bears?

"This is all useful, helpful kinds of management stuff that will enable us to prepare to be more proactive with bear range expanding into southern Wisconsin," he says.

**B**ack in the Cessna, Karl Malcolm nods at the landscape below—a tapestry of broad fields, dotted with woodlots, rural homes and hamlets and carved up by a labyrinth of roads. To the north, Interstate 94 carries a solid stream of traffic toward Eau Claire. "That bear has crossed this kind of landscape, crossed

that freeway a couple of times, crossed the Chippewa River," he marvels. "It has covered some pretty nasty territory. There are a lot of scattered woodlots, but that bear had to go through a lot of (land) that's not good bear habitat to reach them.

"I don't know how he crossed it," he adds, "but I will when I get his collar."

The bear Malcolm is following wears a \$2,500 collar, equipped with radio transmitters and a GPS recorder that logs the bear's exact position at least once every six hours. Last winter, Malcolm put collars on three male and seven female bears. (Only the males get GPS, since they wander more.) About every two weeks, he goes up on a DNR plane to check in on them, using radio signals to locate them. Once they den for the winter, he will track them down



## Bear-Friendly Wisconsin

Using remote sensing and census data, Dave MacFarland has used what he has learned about the places where bears are living now to predict where they are likely to be living in the future. The darker the area on the map, the more bear-friendly it is. The general conclusion: There's plenty of good habitat in western and southwestern Wisconsin for the state's burgeoning bear population.



and retrieve their collars, giving him a day-by-day, mile-by-mile account of how they navigated their surroundings.

Given Wisconsin's growing human population and its increasingly carved-up rural landscape, you might think bears wouldn't fare so well outside of the deep woods. But some changes in rural land use are making it easier for bears to expand their territory, Van Deelen explains. He says that a shifting of lands away from agricultural production has created habitat that's inviting not just to bears, but also deer, coyotes and other large mammals.

"A lot of farms that were active dairy farms 20 years ago are now hunting properties, or hobby farms, or part-time farms," he says. "So the fencerows get thicker, and the woodlots get bigger over time. The transition zone between what's clearly northern forest and what's clearly high-production agriculture is becoming more friendly from the bear's point of view."

In fact, a model developed by Dave MacFarland, another of Van Deelen's graduate students, shows there's plenty for bears to like about central and even southern Wisconsin. MacFarland spent the past two years creating a profile of bear-friendly habitat, based on the characteristics of lands where bears thrive now. His analysis shows that there are hundreds of square miles in Wisconsin that are currently bear-free, but may not be likely to stay that way (see map, above).

MacFarland's strategy involved some 2,000 pounds of bacon and 90,000 doses of the antibiotic tetracycline. With these, he made antibiotic-

laced baits, which volunteers from the Wisconsin Bear Hunters Association placed in every township in bear territory. During 2006, they monitored the baits, checking for claw marks on trees to confirm they had been taken by bears.

One goal of the project was to get a better handle on Wisconsin's existing bear population. DNR assessments are based on previous estimates and can grow inaccurate over time. MacFarland's study, the most comprehensive independent bear survey in the state, uses math to recalibrate the agency's model.

Researchers analyzed rib tissue from bears killed during the past two hunting seasons for traces of tetracycline to calculate how many bears in the harvest ate baits. Figuring that the ratio of bait-eat-

ing bears in the hunt should be the same as bait-eating bears in the total population, MacFarland then applied that ratio to the total number of baits taken to estimate the state's total population.

At the same time, MacFarland assembled information about the locations where baits were taken, including remote-sensing data on landscape features and census data on human habitation. He then developed a model to pinpoint similar landscapes in other areas of the state. Among the regions tabbed as potentially bear-friendly—but still relatively bear-free—are the hilly Driftless region of southwestern Wisconsin and the Baraboo Hills, both of which are well-traveled by humans.

MacFarland says the model can help identify trouble spots where bears might interfere with human activities. He plans to incorporate locations where bears have caused agricultural damage to help flag areas where such problems are likely to occur in the future.

"Twenty years ago there were no





# Forest Forensics

Lizzy Berkley goes biochemical to track what wild wolves are eating.

Watch out, *Canis lupus*, a.k.a., the wild grey wolf. Lizzy Berkley knows what you're eating. Sure, you may have licked the blood of your last prey from your paws, but there's a record of your deed that you can't hide.

For Berkley, a graduate student in forest and wildlife ecology, the proof is in the fat.

Typically, researchers have a difficult time telling exactly what wild animals eat. They can make guesses by picking through scat for bits of bone and fur or examining the stomach contents of dead animals. But even these methods still reveal only what an animal ate last night. What about last week? Or last month?



Graduate student Lizzy Berkley prepares samples of wolf fat tissue for testing in the lab.

Berkley and her advisor, forest and wildlife ecology assistant professor Tim Van Deelen, are experimenting with a new strategy, which traces telltale signs of an animal's diet in its fat cells.

Every animal species has a unique mix of fatty acids. When one animal eats another, some fatty acids from the prey are deposited largely intact into the fat tissue of the predator, creating a signature that can be identified through lab analysis. Since fat accumulates over time, researchers can learn about what an animal has eaten for the past six months by studying a sample of its fat.

Guided by Van Deelen, Berkley is using the model to assess the diet of wild wolves in the upper Midwest. The goal is to determine how much wolf diets vary according to the prey available: Do they eat mostly what's around and plentiful, or do they prefer a particular species if they can find it? Answers to these questions might help wildlife managers protect livestock or fragile populations of elk or moose.

Berkley's model actually begins with dogs. To create a baseline for how prey species' fatty acids show up in wolf tissue, she prepared hundreds of what she calls "fatsicles"—Dixie cups full of frozen moose, beaver, deer and cow fat—and fed them to a group of Inuit sled dogs, closely related to wolves. She then took tissue samples from the dogs and analyzed them using a gas chromatograph, an instrument that separates organic material into component compounds.

Next, she'll compare those profiles to fat samples collected from wild wolves trapped throughout the Midwest. Since she knows what the dogs ate, she hopes that similar fat signatures will create a record of what the wolves have been feasting on, as well. It's kind of like *CSI: Up North*, except smellier.

bears in the central forest. Now there's a strong, healthy population in the central forest, and we're getting bears moving to the west," MacFarland says. "That's what we want to focus on: When can we expect populations of bears in Iowa County? Or should we?"

Even as MacFarland tests his model, Wisconsin bears seem to be confirming its validity. "We have bears pushing into Vernon County and Richland County, (and) a bear reported denning in Iowa County," he points out.

Ultimately, MacFarland's maps and Malcolm's collars will provide wildlife managers with information about how a population of occasionally pesky animals is making its way across Wisconsin and into places where interactions with humans are inevitable.

But how many bears end up living in those places will not be up to the bears, points out the DNR's Keith Warnke.

"It's going to be determined by people," he says. "Bears are dispersing into unoccupied but very suitable range. That's where we need to work. We need to proactively think about how many bears are going to be tolerated there and about educating people about what it means to be living with bears."

To Mike Gappa BS'70, a retired DNR wildlife biologist who now works with the Wisconsin Bear Hunters Association, it sounds a lot like the way things were in central Wisconsin a couple of decades ago, when wildlife managers felt sure no bears would take up residence south of Highway 64.

"The feeling back then was the animal will not exist in the central forest because people won't tolerate the animal," he recalls. "I always felt that the animal could exist here, and it pretty much depended on people's attitudes. Bears are telling us by their presence that they can live with us. The question is, can we live with them?" ■



# SCIENCE *through a blind eye*

*Tim Cordes can't see the proteins he studies.  
But as a scientist, he's proven he has  
extraordinary vision.*

With the friendly help  
of guide dog Vance, Tim  
Cordes has navigated  
UW-Madison's labs and  
labyrinths with aplomb.

*By Michael Penn*



**A** single piano key sounds into the darkened lab, mostly empty on this late autumn evening. Tim Cordes adjusts the volume on his laptop computer and types a short command. Another note, softer and higher.

"That's a carbon atom," he says. "A little bit away from us."

A few more keystrokes, and a different tone sounds, this time an organ, high and strong. "Oxygen," he notes. "You can tell it's higher in the structure from the pitch."

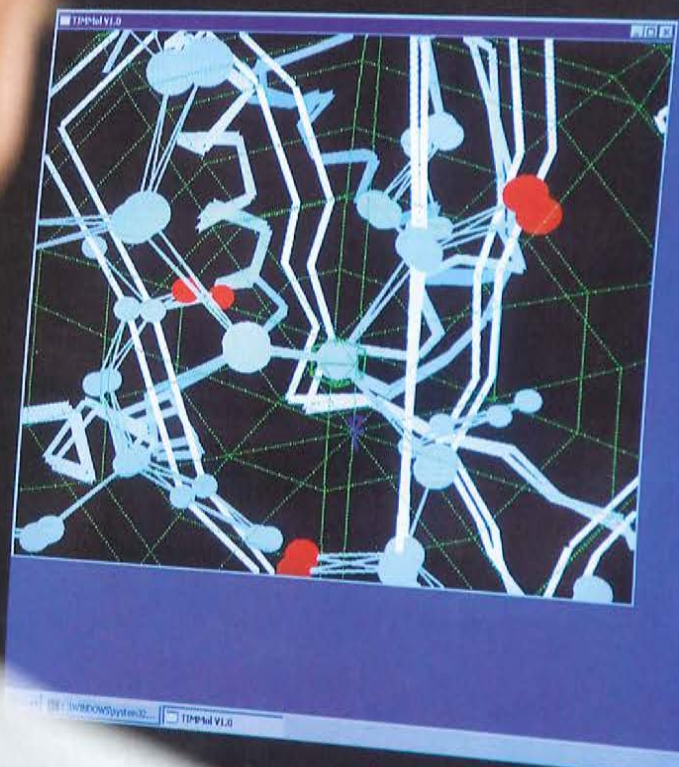
With each click, Cordes is burrowing deeper inside the molecular structure of a protein, one of the hundreds of thousands of proteins that carry out the work of living cells. Like snowflakes, no two of these remarkable molecules are quite alike. They're formed by unique combinations of 20 different amino acids, which fold up on top of each other like a wad of tangled spaghetti, and it's these distinctive shapes that interest researchers such as Cordes.

A 31-year-old medical resident, who last fall completed a Ph.D. in biomolecular chemistry to go along with an M.D. he earned in 2004, he has been studying proteins for eight years, probing their atomic makeup for information that might help researchers design new drugs or combat genetic diseases. Any one of the thousands of atoms inside that tight bundle might be a clue about how the protein works—or, in the case of proteins that cause infections and diseases, how to stop them from working.

But proteins are tiny and complex, too intricate to study with microscopes, and so science has had to invent tools to analyze them. Most protein researchers rely on computer graphics programs, which take data on the positions of thousands of individual atoms inside a protein and create a brightly colored, three-dimensional ball that scientists can rotate and probe for interesting features. These programs typically give scientists the power to see the invisible, seeking out places where drugs might bind or proteins might interact.

But the models don't do much good for Tim Cordes, for whom all of life is invisible. That's because he is blind.

Unable to see the intricate contours of protein molecules, Cordes wrote a program to translate their structures (shown on screen) into sound.





*“Every visualization of a protein  
is just a mental abstraction anyway,  
so I figured, why not use sound?”*

Early on in his research, Cordes tried using the graphics packages, attempting to memorize coordinates and get a picture of certain regions of a protein in his head. Two years ago, he had a better idea. A dabbling musician who's recently been teaching himself accordion, he began experimenting with turning structure into sound, using audio tones to represent the physical arrangement of atoms along a protein's backbone.

Now, like a biochemical Bach, he conducts a symphony in which proteins play their shapes to him, an alternative world where oxygen sounds like an organ and carbon plays the piano.

“It's pretty intuitive,” he says, demonstrating the software. “Every visualization of a protein is just a mental abstraction anyway, so I figured, why not use sound?”

*I*t seems likely that Tim Cordes would have stood out at UW-Madison if he had 20/20 vision. Even among graduate students, no collection of also-rans, his résumé was uncommonly stoked with accomplishments. As an undergraduate at the University of Notre Dame, he logged two years at a lab bench studying antibiotics and ticked off a 3.99 grade point average while majoring in biochemistry. (His only blemish: an A-minus in Spanish.) He wrote computer programs, won awards as a wrestler and even earned a black belt in jujitsu.

That he did it all blind sometimes struck people as the least interesting of his qualities.

“If I had to describe Tim, the fact that he's blind would probably be about the 10th or 12th thing I would list,” says Adam Hofer, who assisted Cordes with his laboratory research while earning his degree in microbiology. “He has so many other distinguishing characteristics and achievements.”

In a world that often treats people

with disabilities as heroes or victims, Cordes has spent much of his life trying to avoid being either. Diagnosed with Leber's disease, a rare degenerative condition of the retina, when he was just five months old, he gradually lost his sight as a boy. By 16, his world was darkness. Yet he embraced his passions with little regard for the presumed boundaries of ability. Although he could not drive, he read *Road & Track* in Braille and learned the mechanics of combustion engines. He water-skied and went hiking in the wilderness. As a teenager, when he was asked on a survey to evaluate the effect of blindness on his life, he answered “minor inconvenience.”

“I just tried to do the things that I wanted to do,” he says. “Everybody has circumstances in their lives, and I think you just go forward and deal with what you're dealt.”

In graduate school, however, Cordes sought out a path where blindness seemed anything but a minor inconvenience. He applied to the UW School of Medicine and Public Health's medical scientist training program, a brutally demanding odyssey that involves completing both medical school and Ph.D.-level academic research at the same time. As a medical student, Cordes faced anatomy labs that required him to identify internal organs and blood vessels—he did it by feel—and patient consultations on everything from heart murmurs to skin rashes. He found a specialty in psychiatry and is now a resident in the psychiatric unit of the William S. Middleton Memorial Veterans Hospital in Madison.

For his Ph.D. research, Cordes

wound up doing something no less visual in nature: creating and analyzing molecular models of proteins. Inspired by his experience studying antibiotics at Notre Dame, he wanted to explore the biology of disease-causing microbes, which he thought might connect well with his clinical training and open the door to a career in medical research. That led him to Katrina Forest, a CALS professor of bacteriology who studies pathogenic bacteria by isolating the proteins they use to interact with host cells. Using a technique known as X-ray crystallography, Forest's graduate students grow large crystals of proteins and then bombard them with X-rays to figure out their molecular structure, a first step in designing new antibiotics or devising strategies for treating infectious diseases.

When Forest met Cordes in 1998, she was new to the faculty and had hardly worked with graduate students, much less a blind one. But she saw no reason Cordes could not contribute to her team. For one thing, he was a computer whiz who had written code since he was 10. Forest initially figured he would dive into the mountain of data created by crystallography trials and help resolve the structures of the bacterial proteins her lab was studying. But when that task was completed, “Tim's project evolved in a different way,” says Forest. “He ended up doing a lot of lab work, which I wouldn't have expected to be right up his alley.”

Mostly, it was. Cordes put Braille labels on bottles of reagents and installed voice software on lab equipment, allowing him to grow and purify proteins and test their functions. For



*“Science is perceived as a visual discipline in many ways, but the **data that underpin it all** aren’t necessarily visual.”*

times when seeing was absolutely necessary—if needed to see whether protein crystals were forming correctly, for example—the lab employed an undergraduate assistant to act as his eyes. Adam Hofer did that job for a semester, making precision measurements and occasionally describing how a reaction was progressing. But Hofer says he was the one who benefited most.

“I learned a ton by working with Tim,” Hofer says. “Sometimes I felt like he was giving me responsibilities just so I had something to do. He could pour volume, and he knew where all the reagents were. Honestly, if you walked into the lab and didn’t see Vance (his guide dog) sitting under his desk, you’d have no idea he was blind.”

**B**ut Cordes’ blindness is impossible to ignore because that fact alone makes him extraordinary in the sphere of laboratory science. In the United States, only 139 blind or visually impaired people earned doctorates in science and engineering fields from 2001 to 2005—around one-tenth of 1 percent of the total number of doctorates in those fields, according to data from the National Science Foundation. At UW-Madison, Cordes became the first blind student to earn a medical degree, and one of only two blind or visually impaired students to receive a doctorate of any kind since 2001.

This bucks a more-promising trend in access to higher education generally. The percentage of students with disabilities enrolled in U.S. universities has more than tripled in the past 30 years,

from less than 3 percent in 1978 to more than 11 percent in 2004. While spurred by federal legislation requiring that disabled students’ needs be accommodated, the rise is also closely connected to a boom in technology, which is making it far easier to open doors for students with sensory or physical disabilities.

“Technology is changing everything,” says Cathy Trueba, director of UW-Madison’s McBurney Disability Resource Center, which works with faculty to accommodate students with disabilities in classes. She cites advances such as e-mail, voice-recognition software and automated document readers, all of which have made it far simpler for professors to provide learning materials in accessible formats. UW-Madison also now owns a rapid prototyping printer, a device that builds three-dimensional models of objects such as atoms, proteins or even bones, which can help visually impaired students learn spatial relationships in a more meaningful way. UW’s Nanoscale Science and Engineering Center recently used the printer to make models of nano-sized objects to interest blind students in the field.

But in scientific fields, especially, technology advances run up against long-held misconceptions about what disabled students can and can’t do—and how that may affect their careers as scientists. “I think there’s a presumption that science is not easily adaptable (to students with disabilities), but really, in most cases, it’s very adaptable,” says Andrew Hasley, a first-year student in the CALS genetics program who is legally blind. “And even when it isn’t ...

a blind person might not be able to see through a microscope, but he is probably smart enough to tell someone else what to look for.”

Jo Handelsman, chair of the bacteriology department, says changing these beliefs is part of the greater process of science recognizing the value of diversity. “We still have a somewhat rigid view of what a scientific community looks like and how it functions,” she says. “We need to get to the point where accommodation is not a favor, but something we do from entirely selfish perspectives, because science will be richer and more dynamic by bringing in people with different ideas.”

To Handelsman, that’s what makes Cordes’ work so striking. “There’s something about the intrinsic inconsistency of it,” she says. “It’s not like he did theoretical physics. He did visualization of structure. It’s such an aggressive challenge to the assumptions about who can do what in science.”

But Cordes isn’t so sure. Asked about the visual nature of his science, he considers the question for a moment, and then replies: “It is, and it isn’t. When you compare it to something like microscopy, where it’s all images, crystallography is far less dependent on sight. It’s essentially coordinates of numbers, and you can access those numbers by different means.

“That’s true for a lot of science,” he adds. “It’s perceived as a visual discipline in many ways, with graphs and figures and protein structures. But the data that underpin it all aren’t necessarily visual.”

**T**herein lies the genius of Cordes’ protein visualization software, which he calls TimMol. (The abbreviation stands for Tonal Interface to MacroMolecules, which he says only coincidentally spells its author’s name.) Since no one can see proteins anyway, why should a blind student be at a disadvantage studying



them? At the protein level, we're all blind.

Cordes' invention, like so many, was birthed from necessity. The standard programs for studying protein structures "are sort of like playing video games," says Katrina Forest. "You get this graphical model on the screen that you can spin around, and that helps you see it in three dimensions." But to make any sense of the interface, Cordes had to copy data into a separate file and then try to extrapolate how atoms related to each other in his head. "I couldn't do a whole protein," he says, "but maybe I could think about one active site."

TimMol's alternative concept is quite simple. It replaces the three spatial dimensions with three different kinds of audio cues, so that atoms inside a protein become like speakers in a surround-sound system. From a given point inside a protein, a user can hear what other atoms are nearby, placing them by the pitch and orientation of the sounds they make. A higher or lower pitch indicates that the atom is above or below the user's position. Louder means closer, while softer means farther away. Atoms to the left play in the left ear of the user's headphones, and those to the right play in the right. To help distinguish different kinds

of atoms, Cordes assigned each a musical instrument—piano for carbon, organ for oxygen. "I picked kind of a cool, jazzy vibraphone for nitrogen," he says, "because nitrogen is usually shown in blue in models."

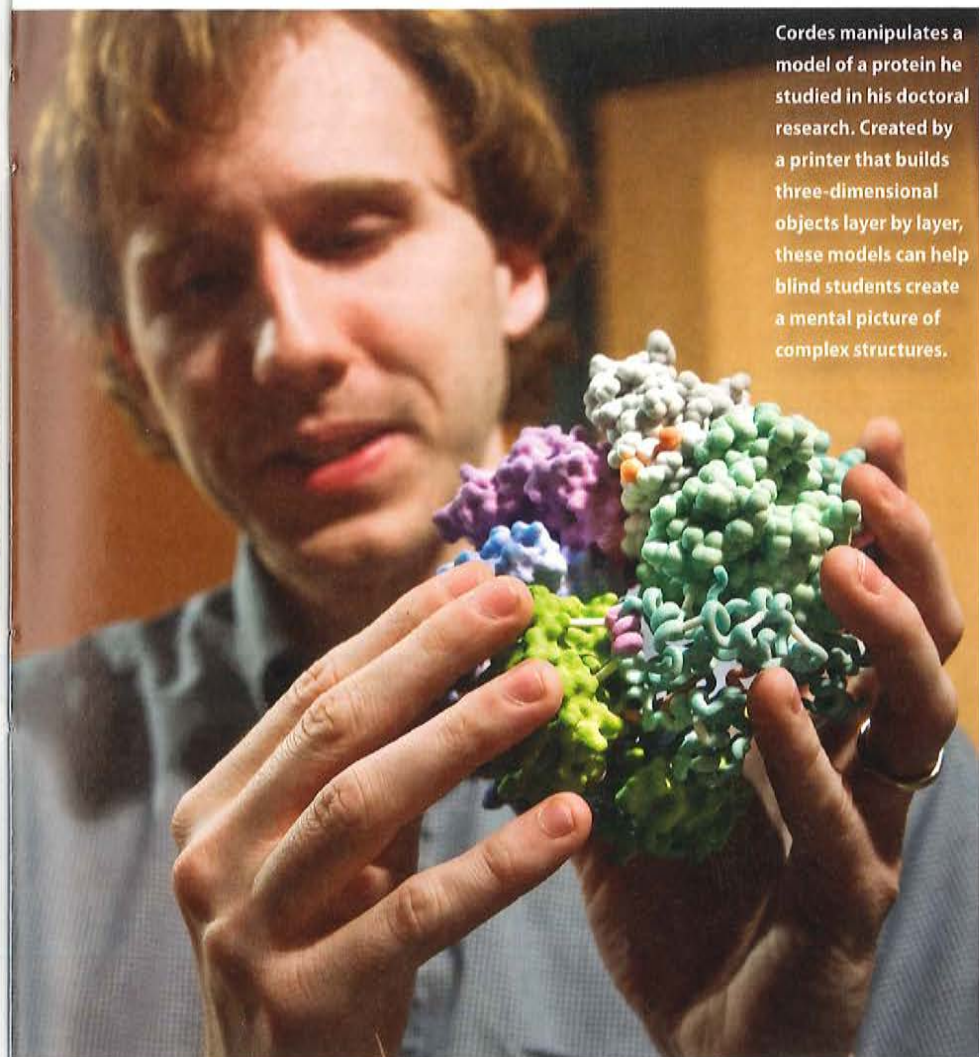
Partly for amusement, Cordes included a function that plays an entire protein by tracing its backbone of amino acids, creating a meandering trail of rising and falling notes. It sounds like some kind of minimalist sonata, but the tune is deep with significance. "Usually, when I come to a new protein, one of the first things I do is to play it atom by atom," Cordes says. "It helps you get an overall sense of what you're looking at, and you can get a feel for its shape and structure."

Although he began building the model primarily to help him complete his doctoral thesis—its invention is the topic of one chapter—Cordes is enthusiastic about making it publicly available. A beta version is already on the web, and he is waiting to hear from a top educational journal about publishing his work.

"I think this can help shift that balance in science, where everything is so visually loaded, so that more people who are not visually inclined can get access to this kind of information," he says.

But if he wanted an example of how visually loaded science can be, he need only consider his own thesis experience. Late last year, when he went before his committee to defend his work and polish off his doctorate, the committee had a few final requests. One struck him as profoundly ironic. While the reviewers widely praised Cordes' scholarship and methodology, they said his presentation needed brushing up. The group suggested more graphics.

"That didn't surprise me," says Cordes. "It doesn't help me any, making these representations. But at the same time, it is the language of science right now, and I have to speak that language, too." In the end, it was only a minor inconvenience. ■



Cordes manipulates a model of a protein he studied in his doctoral research. Created by a printer that builds three-dimensional objects layer by layer, these models can help blind students create a mental picture of complex structures.



## WISCONSIN

## Playing Matchmaker for a Threatened Chicken



In terms of entertaining courtship rituals, few animals can hold a candle to *Tympanus cupido pinnatus*—the drummer of love, commonly known as the greater prairie chicken. Mating males put on a captivating display, inflating their vibrant orange throat sacs, drumming their feet and strutting about with pinnae standing up like feathery ears as they compete for the attention of hens.

Each spring, birdwatchers flock to the “booming grounds” where these birds drum, sing and fight for the chance to breed. Farmers are catching on, too: Some sell admission to spectators, who hide behind plywood blinds for hours watching the spectacular display.

But this show could have a limited run, says CALS wildlife ecologist David Drake, because the prairie chickens are in serious trouble. Once prevalent in every Wisconsin county, the quirky grassland bird has been on the state’s threatened species list since 1979. Due to fragmentation and degradation of its native habitat, its population has dwindled to an estimated 1,200 birds statewide. Now, many of those chickens live in four geographically separate state wildlife areas, preventing intermixing of populations and threatening genetic diversity.

To combat this looming genetic bottleneck, Drake, an assistant professor of forest and wildlife ecology, is working with researchers from UW-Milwaukee, UW-Stevens Point, and Wisconsin’s and Minnesota’s state natural resources divisions in an attempt to broaden the chickens’ gene pool. As part of a five-year project, the team is moving birds from Minnesota, where they are plentiful, to the Buena Vista Grasslands in Portage County, where

With their colorful mating rituals, prairie chickens have earned legions of fans, who flock to the birds’ “booming grounds” to watch them drum up some affection.



the birds are collared and tracked using radio telemetry, allowing the researchers to monitor their breeding and nesting behaviors.

Two years into the project, 64 Minnesota hens have made Wisconsin home, and so far, Drake says the birds are adapting just fine. But he cautions that new blood alone won’t be enough to save these charismatic birds. To reverse their slide, the chickens ultimately need more habitat to establish new populations and intermingle with other birds, Drake says.

To that end, Drake and graduate student Ashley Steinke are launching a survey of farmers and private land owners to explore their willingness to convert parts of their lands to grassland. Drake says farmers can not only help create more habitat for the birds, but also can realize a new economic opportunity by cashing in on their popularity.

“They are one of the most charismatic birds you’ll ever see,” says Drake. “It doesn’t get much better than that.”

## MEXICO



## Sustainable Farming Key to Dairy’s Growth

In Jalisco, where central Mexico’s dairy industry is booming, Michel Wattiaux sees an opportunity to get it right the first time.

“Why repeat the mistakes that everyone else around the world has made?” asks Wattiaux, a professor of dairy science. “We are hoping to find a way to make it more sustainable.”

Throughout the region, subsistence dairy, beef and poultry farms are giving way to larger, more-industrialized operations. Capacity is expanding quickly, and increased production is the main priority. Unfortunately, Wattiaux says, few farmers have the time or training to be concerned about reducing the impact of their operations on the environment.

But as the industry develops, Wattiaux believes it can incorporate more sustainable practices from the ground up. He is currently leading a project to encourage farmers to integrate decisions about feed and fertilizer, which he says can boost farm profitability while preventing environmental problems caused by runoff.

“There are some basic questions that need to be answered,” he says, “like, how do the farmers handle the manure? Do they handle it like something rich that’s highly valued, or do they ignore it?”

Wattiaux notes, for example, that some of Jalisco’s dairy farmers, such as those with no cultivated cropland, have more manure than they can handle, while others don’t have enough. Establishing a manure



market could redistribute nutrients and reduce the need for commercial fertilizers, he says. To help increase awareness of such win-win propositions, Wattiaux is teaming with Jesus Olmos PhD'04, a dairy science lecturer and researcher at the University of Guadalajara-Los Altos who works with the region's farmers to promote sustainable practices.

Wattiaux has spent years helping Wisconsin farmers curtail ammonia emissions and nitrogen runoff by managing the amount of nutrients in animal feed. But in Mexico, the geography and climate make transferring strategies difficult. Around Guadalajara, farmers battle heavy rains in the summer, making the application of manure to pasture surfaces nearly impossible. Jalisco's dairy industry, ranging from subsistence-level systems to technologically advanced operations, is also more diverse than Wisconsin's.

But some lessons of integrated management are universal, Wattiaux says. "Whether we talk of subsistence farmers in Mexico or industrialized producers on either side of the border, often times, what is good for the producer's wallet is also good for the environment," he says. "We, the scientists, extension agents and producers, cannot overlook those opportunities anymore."

## ANTARCTICA

### Treading Lightly on Earth's Last Frontier



Polar soil scientist Jim Bockheim has spent more than three decades trekking to the ends of the earth to study how soils form in extreme climates. But these days, the ends of the earth are becoming more crowded.

In 2006, nearly 30,000 travelers journeyed to Antarctica to see penguins, whales and the South Pole. These excursions, which range from \$4,000 to \$30,000, offer eco-tourists a chance to visit one of the world's last great frontiers, communing with seals and climbing unnamed mountains.

But Bockheim—who himself has a mountain in Antarctica named for him—worries about the impact of this activity on a fragile ecosystem. Antarc-

tica's perpetually frozen soils have been likened to soils on Mars because they contain almost no moisture and are easily eroded. Thus, he says, they are highly vulnerable to human activities.

To Bockheim, those soils are like an archive of the planet's glacial cycles, which he can read to assess what happened to bring on previous glaciations and make predictions about future climate changes. He is now collaborating with colleagues from New Zealand and several international organizations to develop comprehensive maps of Antarctica's permafrost and soils, with the goal of creating a trail system for visitors. "If tourism becomes more extensive," he says, the maps can show "where the best place would be to lay these trails out with minimum impact."

But tourists aren't alone in beating a path toward Antarctica. McMurdo Station, Antarctica's largest settlement, now hosts at least 1,000 scientists and support staff year-round. Bockheim says there's growing awareness among scientists, as well, that care is needed to preserve the continent's resources.

"Every time I dig a soil pit, I'm conducting some kind of disturbance," he says. "So now, we dig the soil layers very carefully and put them on a tarp." After collecting samples and data, his team gently replaces all the soil and stones. They even pack out their own human waste.

Although it takes days for Bockheim to reach his research location in Antarctica's Dry Valley, the trip is always worth it, he says.

"It's spectacular," he says. "I'm interested in life at the extremes."

—KATE TILLERY-DANZER



When collecting soil samples in Antarctica, Jim Bockheim says he rarely hears a sound from the desolate landscape. But he hopes the results of his work speak volumes about the need to preserve the spectacular continent.



## Climbing to the Top

Forestry grad **Joe House** goes out on a limb to promote tree safety.

If you had been there in August, crouched on the soggy Warner Park grass, squinting into the leafy canopy, you would have seen Joe House BS'95 moving purposefully among the branches like an arboreal Spiderman, ducking obstacles, ringing bells, hitting targets and rescuing an injured dummy.

If you had been there in July, at the Olympics of tree climbing, watching competitors from 13 coun-

tries scrambling through branches on the University of Hawaii-Manoa campus, you would have seen House toss a lead-filled pouch to hit targets 40 and 60 feet above him.

If you could see Joe House climb, you would know this man is born to be in the trees. The way he grasps a climbing rope between his fingers and launches himself upward, scaling 50 feet in just 16 seconds—it is an art form. And few in the world do it better. A Wisconsin native who studied forestry at CALS, House has twice won the Wisconsin Arborists Association's tree climbing competition, and last year he placed sixth overall at the international competition in Hawaii.

But House's art is also a science. And his sport is also his job. Four days a week, he works for Madison's Stephenson Tree Care, which employs six arborists to prune, remove and care for urban trees. "I'm a surgeon, I remove limbs," he says with a laugh.

Surgery is an apt metaphor, because arboriculture demands both physical and mental strength, combining biology with on-the-fly knowledge of physics and mathematics. Not long ago, House and his tree-care team spent two and a half days removing a 100-foot-tall tree that had fallen on the roof of a client's house. Each cut piece, wrapped in ropes and hauled by pulleys, weighed close to 1,000 pounds. Arborists must constantly make quick mental calculations about how to support and move such heavy loads. Errors can be catastrophic.

"You really have to understand what you are doing when you're taking a huge tree down," says owner John Stephenson. "If things go bad in a hurry, you can be injured or killed. That's the reality of this industry."

To be prepared, Stephenson's employees perform regular drills and simulate aerial rescues at least twice a year. But safety hasn't always been the bottom line in arboriculture, he says.

"There was this association, years ago with tree companies being ... we call them ruthless, toothless, dirty tree trimmers," says Stephenson. "There are plenty of those types of companies still out there, but they're going away."

One reason they are is the rise of climbing competitions. While they inject an element of fun and rivalry—and maybe a chance to show off—the competitions also offer a venue for sharing and learning good practices. And that is helping change the culture of the industry. In the old days, says House, "you

Joe House goes vertical during the Wisconsin Arborists Association's state tree climbing championships, where House is a two-time champion.





**“You drove past that work site, and you gave them the eyeball . . . Now, with the competitions, it’s such a community of sharing.”**

never talked to anybody. You drove past that work site, and you gave them the eyeball, and you know ... you didn’t like them. And now, with the competitions, it’s such a community of sharing.”

That suits House just fine. “Like this year at inter-nationals, I picked up probably four revolutionary things that I’m more than happy to share with the guys in Wisconsin,” he says.

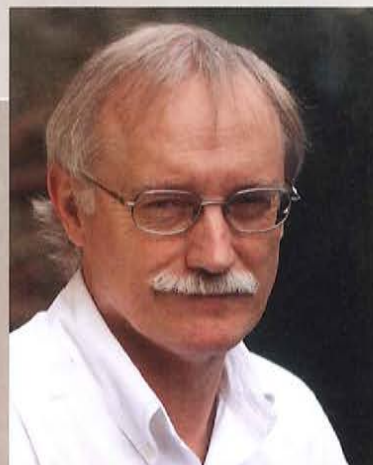
Climbing events have grown significantly over the years, both in popularity and sophistication. “When the Wisconsin competitions started in the mid-1990s, it was just a bunch of climbers trying to see how fast they could go, with skimpy leather saddles and hemp ropes,” says Mike Wendt of the Wisconsin Arborists Association. Now they’ve evolved to high-tech, standardized championships, which typically involve a full day of events that test speed, agility and accuracy.

Like any athlete, House trains rigorously for the competitions. In addition to on-the-job practice, he climbs at his home on Madison’s west side, which he and his wife Lori bought partly for its climbing opportunities. Towering white and red pines dot the yard, and a wide stone chimney offers plenty of handholds for rock climbing. The couple even spent a recent Fourth of July nested 40 feet up in a white pines to watch fireworks, carrying a baby monitor to keep tabs on their sleeping daughter.

Although he is equally adept as a rock climber, House loves climbing trees because—well, he loves trees. He loves moving through the wide open branches of red and white oaks and reading each tree’s story from the things he finds. He especially loves hanging in the canopy during fall bird migrations when cedar waxwings flutter around his ropes.

At the same time, House wants nothing more than to preserve those experiences for future generations. He is not likely to set any tree-climbing height records, for example, because he doesn’t think scaling redwoods is responsible. Even walking around these ancient trees compacts soils and threatens roots, he says, adding, “I’m worried that our need to get close to these trees is killing them.” And in that case, the best way to save them is to keep his feet on the ground.

—KATE TILLERY-DANZER



**MS’74** Agricultural Journalism  
**home** Arlington, Virginia  
**occupation** Executive Editor, National Geographic Magazine  
**what I’m doing when I’m not working** Being a dad to our daughters, Claudia and Sofia, and a husband to my wife, Kim. I also run, walk and cook barbecue chicken weekly, using special secret marinades.

**best thing I learned at CALS** Radio—I had never done radio before I met Larry Meiller, and now I love it. Larry was a wonderful mentor and guide.

**How did you come to work for National Geographic?**

I spent a lot of years working for daily newspapers as a photographer, writer and editor. Someone noticed my work, and I got a phone call.

**What’s your role now?**

I think up ideas for stories, do original research to flesh out ideas, write outlines of potential visual situations that would animate and illustrate ideas, manage projects, work with writers and text editors to be sure words and pictures for stories are on same track, edit film, and work with photographers and layout editors to select and sequence pictures that will appear in a story. Meetings. Lots of meetings.

**National Geographic is famous for its photography. What makes for a winning image?**

Two things basically determine whether a picture succeeds. Is it relevant? Does it have emotional appeal? It must have both. One without the other fails.

The pictures must be on point and speak to why we are doing a story. They also must connect with us in ways that cause our intuitive nature to respond. Hearts and minds, pictures must appeal to both.

**How much ends up on the cutting room floor?**

Depends. Some stories may have 20,000 pictures taken. But it’s not the number of pictures that matters, really. What matters are the situations chosen to photograph, the when and how and where of the photography, and whether pictures are being taken at a time when emotional intensity is being revealed, the points of inflection. Decisive moments, if you will.

**What’s it take to be a good editor?**

My work is much akin to that of a documentary film producer. I’m responsible for originating, orchestrating and implementing a film in still images that tells a story.

This requires great and ongoing awareness and understanding of what goes on in the world, and why. Lots of diplomatic skills are needed in working with and inspiring a whole team of creative collaborators. My education only really began the day I walked out of UW-Madison. I need to learn new things every day to survive.

**Have you had any scrapes in the field working for the magazine?**

I don’t work in the field, so mostly, my scrapes are riding the subway to work. It stinks, but it beats driving.



**Five things** everyone should know about . . .

## GIS Maps

By Stephen Ventura

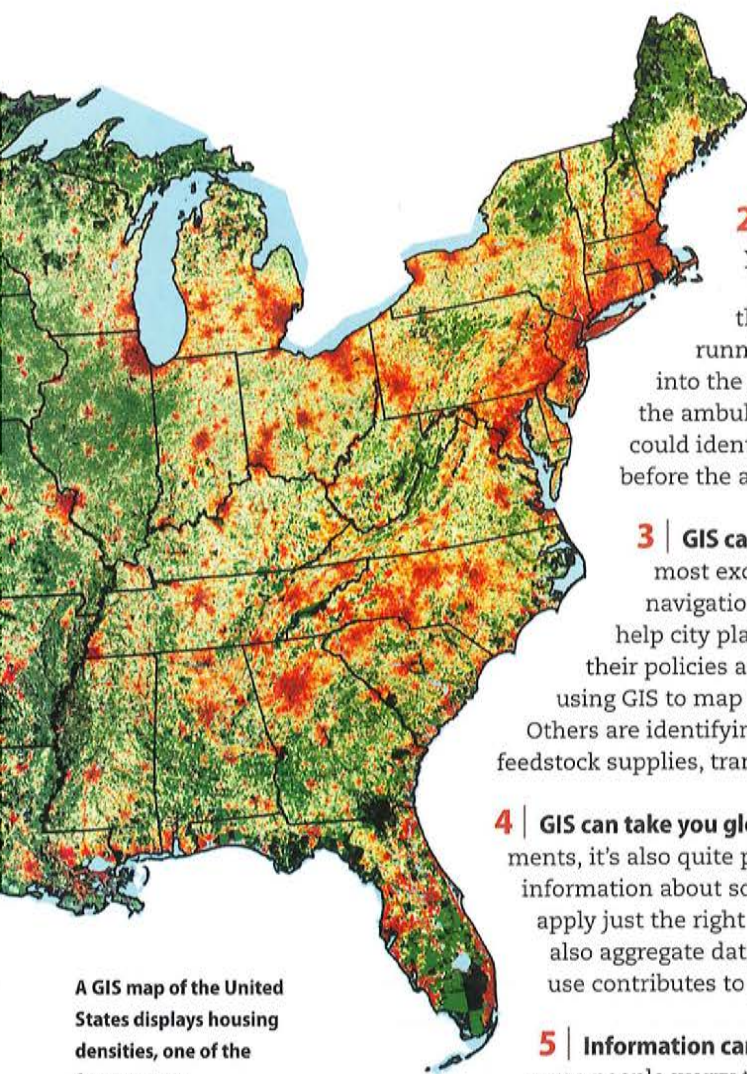
**1 | GIS is about more than maps—it's about the meaning behind the maps.** Geographic information systems, known collectively as GIS, are probably best known because of online mapping sites such as Google Earth and MapQuest, but they also are essential analytic tools for scientists, public agencies and businesses. These data systems integrate maps with other information, such as traffic patterns, census data or land features, allowing a user to get a picture of how given data relate to location. You might use GIS to find a route to the nearest post office or see where the fish are biting; scientists use it to explore and model patterns in everything from land use to animal migration.

**2 | It's not the same as GPS.** Global positioning systems tell you where you are; GIS captures and stores information about the places around you. Here's a tragic example of why this difference matters: A few years ago, during a brutally hot running of the Chicago marathon, a suburban ambulance came into the city and picked up a victim of heat exhaustion. Although the ambulance had on-board GPS, it did not have a GIS database that could identify the location of the closest hospitals, and the patient died before the ambulance could reach a hospital.

**3 | GIS can do more than get you from point A to point B.** Some of the most exciting applications of GIS data don't have anything to do with navigation. Looking at patterns of land use on a map, for example, can help city planners assess the environmental and economic effects of their policies and make better decisions. At CALS, some researchers are using GIS to map urban and wooded areas to characterize wildfire risks. Others are identifying optimal locations for biofuel plants, based on regional feedstock supplies, transportation infrastructure and other factors.

**4 | GIS can take you global—or local.** While GIS is useful for big-picture assessments, it's also quite practical for refining small-scale decisions. A GIS can store information about soil conditions across a farmer's fields, allowing him or her to apply just the right amount of fertilizer in each place. At the same time, GIS can also aggregate data across broad areas to help us understand where fertilizer use contributes to problems such as the "dead zone" in the Gulf of Mexico.

**5 | Information can be a double-edged sword.** As GIS applications emerge, some people worry that easy access to data about their property might threaten their privacy or security. It's important to remember that most GIS applications use publicly available data and adhere to strict privacy guidelines. But as with any new information technology, these questions are important to discuss. The more the public participates in the use of GIS applications, the better we can balance information access with protection of privacy and the better we can ensure that GIS is a democratizing influence on public decision-making.



A GIS map of the United States displays housing densities, one of the factors CALS researchers are using to assess wildfire risks.

Stephen Ventura is a professor of soil science and director of UW-Madison's Land Information and Computer Graphics Facility, which conducts GIS-aided research and helps local governments develop GIS applications to aid land use planning.



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## Agronomy:

Do seed companies prefer to sell hybrids or pure lines? Why?

- Pure lines, because it's easier to produce seed.
- Hybrids, because they are more uniform than pure lines.
- Hybrids, because growers cannot save seed and replant the next season.
- Hybrids, because everyone enjoys detasseling.
- Pure lines, because they are more resistant to insects and diseases.

From Agronomy 100: Principles and Practices of Crop Production, taught by Bill Tracy

## Entomology:

A unique aspect of the life cycle of the human bot fly is:

- The female lays her eggs on blood-feeding insects.
- The female often lays her eggs on dirty diapers.
- The female lays her eggs on meat, which is then ingested by humans.
- The female flicks live larvae at the nose of the host.
- Human bot flies can do all of the above.

From Entomology 201: Insects and Human Culture, taught by Susan Paskewitz

## Genetics:

The yellow body gene (y) of *Drosophila* is X-linked with yellow body (y-) being recessive to black body (y+). What are the expected progeny when a black-bodied male is mated with a heterozygous female?

- 100% black for both sexes
- 100% yellow for both sexes
- all black males; 50% black/50% yellow females
- all black females; 50% black/50% yellow males
- 50% black/50% yellow for both sexes
- all yellow males; all black females
- all yellow females; all black males
- all tan females; 50% black/50% yellow males
- all tan females; all yellow males
- all tan females; all black males

From Genetics 466: General Genetics, taught by John Doebley

## Engineering:

Latitude and longitude data were collected in the field using a GPS unit. After projecting these points onto a map, what system would be used to describe the position of these points?

- Triangulation
- Grid coordinates
- Differential correction
- The data are no longer accurate.

From Biological Systems Engineering 201: Surveying Fundamentals, taught by John Panuska

## Economics:

From mid-1960s to 1980, the ratio of college-educated workers to non-college-educated workers in the U.S. economy rose from about one-third (1:3) to two-thirds. Over that same time frame, the "skill premium" for college-educated workers—the amount by which college-educated workers pay exceeded that of non-college-educated workers—fell from 50% to 40%. By the year 2000, there were slightly more college-educated than non-college-educated workers in the U.S. labor force. What happened to the skill premium for college-educated workers between 1980 and 2000?

- It had fallen further, to about 15%.
- It stayed at about 40%.
- It had increased to about 65%.

From Agricultural and Applied Economics 374: Growth and Development of Nations in the Global Economy, taught by Brad Barham and Michael Carter

LAST ISSUE: Answers were 1: a, 2 humus, 3: d, 4: e, 5: (in order) b, a, e, c, d. Congratulations to Sandra Laurent-Michel BS'01, of Longmont, Colo., who was among 17 people to answer all questions correctly and was drawn as winner of a box of Babcock Hall cheese.





## THE **BEET** GOES ON

**VIBRANT RED DYE** from crushed beets collects in beakers in a CALS horticulture lab, one of the world's only labs studying the under-appreciated, but versatile vegetable. ■ WANT TO SEE OTHER COOL STUFF GOING ON AT CALS? ■ VISIT: [www.cals.wisc.edu/grow/](http://www.cals.wisc.edu/grow/)

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