

# grow

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agriculture • food • health • environment

Is it time to stop picking (on)

# CORN?



COLLEGE OF AGRICULTURAL & LIFE SCIENCES  
University of Wisconsin-Madison

MAPPING THE EDGE • GENETIC TESTS: A DOUBLED-EDGED HELIX • BADGERS IN BIOTECH



# On Henry Mall

News from around the college

## Badger at Heart

In many ways, UW–Madison’s new chancellor is coming home.

First, the name.

To her friends, colleagues, students and just about anyone else she meets, incoming UW–Madison Chancellor Carolyn A. Martin is simply Biddy, a nickname that traces from her earliest days, when her family called her the “biddy baby.”

But the colorful appellation is not the only thing Martin has carried from her youth. Growing up in a then-rural area outside Lynchburg, Va., where college often seemed a dream for someone else, Martin acquired a thirst for knowledge that led her to pursue a doctorate in German literature at UW–Madison in the early 1980s. Finding her calling in academia, she went on to Cornell University, where she rose through the ranks to become provost in 2000.

It was with considerable fondness that Martin accepted the chance to return to her academic roots. “It feels wonderful,” she said in an interview shortly before moving to Madison. “I loved it when I was there, and I’m really looking forward to returning.” (To read the full interview, go to [www.cals.wisc.edu/grow/](http://www.cals.wisc.edu/grow/).)

Martin’s new role may feel familiar for other reasons, as well. Like UW–Madison, Cornell is a land-grant institution renowned for its strength in agricultural and life sciences. As provost, Martin helped modernize the university’s land-grant mission by encouraging interdisciplinary research and fostering collaborations with government and industry to work on economic development issues. She also spearheaded Cornell’s recent campaign to guarantee financial aid to families earning less than \$75,000 a year, a program that aims to ensure students can graduate free from the burden of loan debt.

“Biddy has been an extremely successful provost at an outstanding, complex university much like ours,” says CALS Dean Molly Jahn, a former Cornell professor who came to know Martin when she was provost. “She has a real passion for our land-grant mission, and I think she will be an energetic and visionary leader.”

In UW–Madison’s broad array of biological

sciences, Martin says she sees a potent mix of talent ideally suited for taking on issues such as alternative energy and environmental protection.

“UW–Madison has an enormous advantage when it comes to addressing the types of problems that we will likely see in the next several decades,” she says, “and that’s because of the scope and the range of disciplines that are represented at a university of Wisconsin’s size and the quality of the faculty and students of a university of this stature.”

Martin says she will be “a champion and a cheerleader” for those efforts by creating an environment that encourages innovation and achievement. She says

the ingredients are in ample supply—talented faculty, enthusiastic students, and the spirit to work across boundaries and solve problems. “When all of those factors come together, and when the work of administrators can integrate those elements well,” she says, “it’s a wonderfully combustible mix.”

—MICHAEL PENN

JEFF MILLER/UW COMMUNICATIONS



Chancellor  
Biddy Martin

## Knock on Wood

Altered trees might overcome a major barrier to renewable fuels.

In the search for new renewable fuels, more than a few good ideas have gotten stuck on lignin. A tough, glue-like substance found in the walls of plant cells, lignin creates a sticky web that ensnares energy-rich sugars such as cellulose, making them harder to extract and convert into usable energy. If it weren't for lignin getting in the way, we might already be seeing ethanol from grasses and trees entering the market.

But CALS biochemist John Ralph PhD'82 may have found a way around the lignin problem: If we can't beat lignin, why not change it?

Ralph's lab team has figured out how to alter lignin so that it essentially unzips itself when exposed to mild chemicals, making more of a plant's sugars available for extraction. Plants and trees grown with this altered form of lignin might not require expensive chemical treatments before conversion into ethanol, which could eliminate one of the most cost-prohibitive steps in the production of cellulosic ethanol.

"We are trying to redesign an agricultural plant so that its lignin falls apart easier to make the production of ethanol much more efficient," says Ralph. "If we get this figured out, there is the potential for a huge reduction in the cost of ethanol."

Ralph's approach is so promising that it landed his scientific team at the center of a bidding war. A



Using a gene from kenaf plants grown in campus greenhouses, biochemistry professor John Ralph has engineered fast-growing trees that can be converted more easily into cellulosic ethanol.

native of New Zealand who has studied lignin since he was 18, Ralph spent the past 20 years working as a scientist with the U.S. Dairy Forage Research Center on UW-Madison's campus. When the U.S. Department of Energy announced a nearly half-billion dollar research effort to overcome the obstacles to cellulosic ethanol, he found his lignin expertise in serious demand. In the past year, he and his team received lucrative job offers from all three DOE-funded bioenergy research centers, including UW-Madison's Great Lakes Bioenergy Research Center.

"People with John's training, experience and creativity just do not exist in this country or elsewhere in the world," says Tim Donohue, director of the GLBRC. "It was critical to get John's research team plugged into the Wisconsin bioenergy effort."

While he opted to stay in Madison, Ralph's decision did put him on the move. He and his lab joined the biochemistry department so that he can now work full-time on unsticking the lignin problem. The group is already collaborating with a South Carolina biotechnology company called ArborGen to test its lab-altered lignin, with a goal of testing fast-growing poplar trees as a feedstock for the cellulosic ethanol industry.

—NICOLE MILLER MS'06

## Barn Raising

### DAIRY SCIENTISTS

aren't the only ones excited about CALS' new Integrated Dairy Facility, which opened this summer at the Arlington Agricultural Research Station. Apparently, so are the cows. Soon after the herd moved



into the 500-cow facility, modeled after the high-tech dairy centers now common in the industry, average milk yields jumped five pounds per day. Herd manager Mike Peters BS'95 says more milk is a sign that the cows are comfortable in the new barn, which offers much-improved climate control and bedding from Arlington's old facilities. And happy cows makes for happy researchers. "We want to get good research outcomes," says Peters. "You have to have comfortable cows to get good research outcomes."



# The Case for Queso

Research asks why U.S. cheeses don't cut it with Latino customers.

Everyone knows about Wisconsin cheese—but that doesn't mean that everyone likes it. For many Latino consumers, for instance, our cheese just doesn't cut it.

"It's not viewed as authentic," says Scott Rankin, an associate professor of food science. "When a (Latino) consumer sees a package of blended Colby, Jack and Cheddar labeled 'Mexican-style' cheese, it's almost insulting."

With the growth of the Latino population in the United States, Latin American-style cheeses have become one of the U.S. dairy industry's fastest-growing markets. Production of these cheeses jumped about 36 percent from 2003 to 2006, according to the National Agricultural Statistics Service. But Latino consumers are also "very attuned to a cheese's performance, such as melting qualities," says Rankin. "The shape, color and package all have to work."

For the past two years, Rankin has studied Latin American cheeses to learn why American-made ones don't measure up. With graduate student Luis Jimenez-Maroto and postdoctoral researcher Arnoldo Lopez-Hernandez, he has analyzed the chemical, microbiological and physical components of three popular types of cheese sold in Mexico, Central America and the Caribbean.

The team found that some American-made cheeses compare favorably to the taste of authentic Latin American cheeses, which have a simple flavor meant to complement other foods. But there were other differences between these cheeses that may factor as heavily as taste.

One of the biggest surprises was the importance of packaging and marketing. Cheeses from Mexico are usually round and prominently display the red, white and green colors of the Mexican flag on their labels. In Mexico, these cheeses are often sliced from larger blocks directly in the store. "The experience of buying cheese is important," says Rankin, noting that consumers typically have close relationships with merchants and show strong loyalty to local varieties.

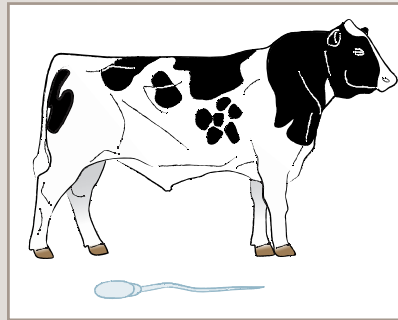
Partly because American-made cheeses don't offer the same experience, there's now a growing black market for authentic Latin American cheeses, which raises concerns about food safety. And that may be all the more reason for Wisconsin cheesemakers to take a closer look at the Latino market.

"There is no great technological hurdle to making this change," Rankin says. "The cultural change on the part of American producers is the hardest thing right now."

—THERESA LINS BS'92

# how to get a cow pregnant

**Milk and motherhood go hand-in-hand.** In order to produce milk, dairy cows have to give birth, which means they have to get pregnant every year. You might think that would be a simple birds-and-bees thing—put a cow and a bull in a paddock and give them some privacy. But in fact, it's one of the most sophisticated and difficult parts of modern herd management (and that's saying something).

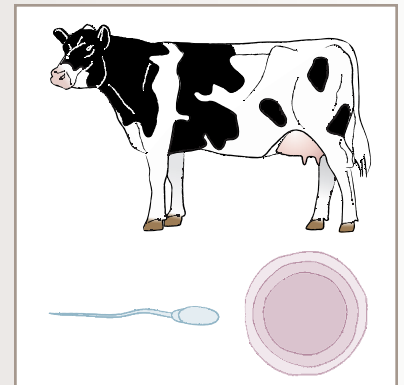


**Collect the semen.** In modern agriculture, bulls and cows rarely meet. Farmers order semen from genetics firms that "mate" top-quality bulls with artificial cows to collect semen.

**Freeze and ship.** The bull's semen is divided and packed

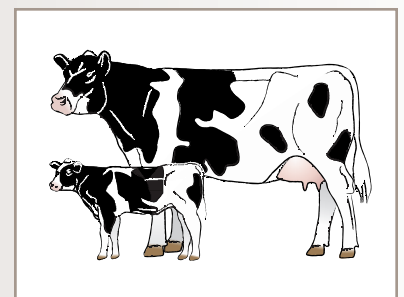
into plastic straws, each containing about 20 million sperm, along with nutrients and glycerol to help it survive freezing. Straws are shipped out to farms in liquid nitrogen.

**Timing is everything.** In the old days, farmers watched their cows closely for signs of estrus, indicating that she was ovulating and receptive to breeding. But because of their fast metabolism rates, today's high-producing dairy cows may be in estrus for as little as three hours. Many farms now use synchronization treatments, developed at UW-Madison, which cause cows to ovulate on schedule.



**The dirty part.** The actual insemination relies on some manual dexterity. After thawing semen in a warm water bath, a farmer (or a specialized technician) inserts a syringe-like inseminator through the cow's cervix and vagina to reach her uterus. At the same time, he or she inserts a gloved hand through the cow's rectum to manipulate the uterus through the rectal wall.

**Cross your fingers.** Old timers would be astounded by today's reproductive technology, but they'd also be amazed at the challenges. As milk production has increased, the fertility of dairy cows has decreased, dropping a few percentage points each year. The reasons aren't clear, but finding solutions is a central focus of modern reproductive physiologists.



ILLUSTRATIONS BY H. ADAM STEINBERG



## Crystal Clear

What to do with an unwanted mineral? Grow it.



BRYCE RICHTER / UW COMMUNICATIONS

**Chunks of crystallized struvite cling to the walls of a heat-exchange pipe at Madison's sewage treatment plant.**

Under a microscope, its crystals gleam like tiny gems. But when the phosphate mineral struvite starts clinging to the guts of a sewage treatment plant, it quickly loses its charm.

Fed by the copious phosphorus in wastewater, struvite crystals form by the billions, amassing in cement-like chunks that clog pipes and valves and block water flow. "It's (like) hardening of the arteries, that's for sure," laughs Steve Reusser, operations engineer for Madison's

sewage treatment plant, who routinely has to chip blocks of struvite out of pipes. "It's one (problem) that just won't go away. We keep juggling things, but we haven't come up with a great solution yet."

CALS soil scientist Phil Barak thinks he may now have one—and it's surprising for its counterintuitive logic: Why not grow the pesky mineral on purpose?

The point is to bring the natural crystal formation under control, Barak says. One of his graduate students, Merin Abraham, has done this by dosing a

sewage mix called acid digestate with limestone. The rise in pH causes the sewage to shed more than two-thirds of its phosphorus as crystals of struvite and brushite, a related mineral. Because those minerals are denser than water, they settle out of solution on their own, making them easy to remove before they congeal into hardened masses.

Limestone is cheaper than the iron salts that treatment plants now use to try to keep struvite at bay. And the new technology may have other benefits, such as reducing the amount of phosphorous in leftover bio-solids, which are often used as fertilizer. Reusser is working with the researchers to set up a pilot project at the Madison plant in the next year.

For Barak—who first encountered struvite 25 years ago, while a medic in the Israeli army—the project adds an unexpected chapter to his long fascination with the mineral. His first experience with it came while treating a tough sergeant who was reduced to tears by a bladder infection. When he examined the soldier's urine under a microscope, Barak saw a collection of razor-sharp struvite crystals, which had formed due to the infection.

Years later, Barak read about a method for crystallizing minerals on a slick of fatty acid molecules, which scientists had used to grow a rare mineral known as vaterite. He was curious if he could do the same with struvite, and he tucked the idea away as something to try one day.

It took a high-school student—Menachem Tabanpour—to jumpstart the project. Now a senior majoring in biology and French, Tabanpour landed in Barak's lab in the summer of 2004 as part of a NASA program for gifted high schoolers. Tabanpour handled Barak's pet struvite project with ease, but he didn't stop there. While waiting for experiments to finish, Tabanpour searched the literature and learned about the problems with struvite in sewage treatment plants. It was his suggestion that helped turn Barak's curiosity into a potentially cost-saving solution.

"I'm not so stodgy to have forgotten that you need to listen," says Barak. "The professor doesn't know everything out of the gate."

—MADELINE FISHER

## Organic Experience

Vance Smith inspects early-season kale in the F.H. King gardens.



**DON'T GO PICKING** the broad leaves of kale growing in neat rows near Picnic Point. Those vegetables—and all of the other produce on the 30,000-square-foot plot—are spoken for. They were sold last spring as part of UW-Madison's first community-supported agriculture farm, a small-scale experiment created by members of the UW's F.H. King Students for Sustainable Agriculture. Ten customers bought shares in exchange for weekly deliveries, which are made by students who devote an average of four hours a week working on the farm. "We're providing a service to students who want to become involved in farm marketing and farm management," says Vance Smith, a graduate student in the Nelson Institute for Environmental Studies who coordinates the effort. "(This is) a case study for students about how to run a CSA."

## doug weibel

## Magnetic Power

Lab steps in to aid in heparin scare.

When an unfolding health crisis nearly brought a Wisconsin drug manufacturer's work to a grinding halt earlier this year, only a few places in the country could offer the help the company needed to get going again. One of them happened to be on UW-Madison's campus.

Known as the National Magnetic Resonance Facility at Madison (NMRFAM), the research lab houses several large machines called NMR spectrometers, which can be used to study the structure of molecules in fine detail. Too big and expensive for most labs to own and operate, the machines are used by academic and industry scientists seeking to understand the molecules involved in human health and disease.

That's exactly what Scientific Protein Laboratories, of Waunakee, Wis., needed to do earlier this year. The company produces the active ingredient in heparin, a widely used drug that thins blood. After contaminated heparin from another source caused more than 80 deaths earlier this year, the U.S. Food and Drug Administration ordered rigorous testing of all heparin supplies to ensure their purity.

SPL placed an urgent call to the NMR lab, which scrambled to accommodate the request. The staff made several recommendations that helped the company save time and money, says SPL president David Strunce.

"The FDA was pushing for information immediately and your facility was the only one that could help us," Strunce wrote in a letter to Milo Westler, NMRFAM's director. "Without this accommodation, we would have been unable to meet the FDA deadlines."

—NICOLE MILLER MS'06

Number  
Crunching

18

**DIFFERENT KINDS OF CHEESE** are produced by the Babcock Hall Dairy. All told, the plant produces nearly 60,000 pounds of cheese in a

year, from garden-variety Cheddars and Swiss to specialty types like Monterey Jack with chives and pesto-infused Havarti. The breadth of cheeses is unusual for a campus dairy, says plant manager Bill Klein. And customers seem impressed: One of the most popular cheeses at Babcock's Dairy Store is Juustoleipa, a Finnish style of cheese that connoisseurs love for its browned, crusty surface.

- **job** Assistant

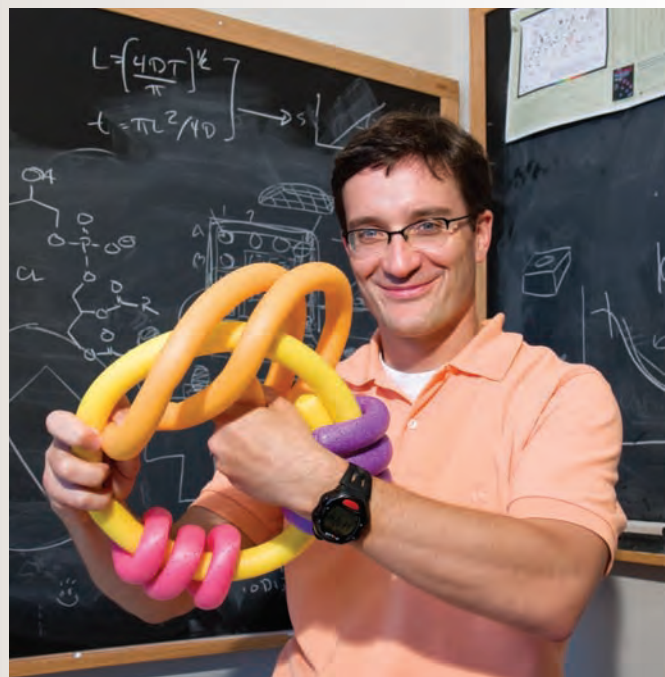
Professor of  
Biochemistry

- **lab** Fourth

floor, Biochem-  
istry Building  
Addition

- **current  
research**

The biochemistry  
of microbes



**What's the research question on your mind right now?** How do bacterial cells make the switch from individual behavior to collective, multicellular behavior?

**Who works in your lab?** One post-doctoral fellow, four graduate students, five undergraduate students, one incoming undergraduate student and a high school student. This summer we also had a first grade teacher working in the lab and 10 undergrads working on the International Genetically Engineered Machine competition. It's a busy place right now.

**Describe a typical day in the lab.** Actually, I haven't done an experiment in months, so I can't say with 100 percent certainty. But everyone is working on a different project, so there are very few activities that are routine, with the exception of growing bacteria and washing glassware.

**What's the view from the window?** My office faces the 1956 wing of Biochemistry. The lab has a terrific view of Elmer, the old elm tree.

**What's playing on the radio?** Right now, "Rainbows," by Radiohead. In the lab, the preference seems to be

to work without music. I respect that decision—it promotes interaction and conversation.

**What's the most unique feature of your lab or office?** I had blackboards installed in my office. Several of my colleagues think this represents unusual behavior.

**If you had to evacuate, what would you grab first?** Well, if my kids were in the office, which they often are on Saturdays, I would grab them first.

**Clean desk or messy desk?** A clean desk. I can't work efficiently in a messy environment.

**Any personal items in the lab?** Nail polish. It comes in very handy for all sorts of things (microscopy, annealing, gluing, etc.).

**Where do you get your best work done?** In my office very early in the morning.

**Why did you go into research as a career?** Because science is a blast.

**What's the coolest thing you've learned by doing research?** That I can get paid for doing this job. It still amazes me...



## CHINA



## Wisconsin Goes for the Gold—in Dairy

Hundreds of miles from the glitzy fanfare of the Beijing Olympics, a different kind of international competition is playing out against the backdrop of a modernizing China. And this one has nothing to do with shot puts or synchronized swimming.

most recently in Harbin, at the heart of Chinese dairy country. On one level, the events are intended to impart the latest research findings on issues such as genetics, milk quality and farm management. But Nielsen also hopes the increased presence of U.S. and Wisconsin dairy experts will open doors for state businesses looking to establish contacts in China.

So far, that seems to be happening. Companies such as CRI, a Shawano-based genetics firm, have taken advantage of Babcock events to meet potential clients and foster new business. Bob Stratton, associate vice president of international marketing for CRI, says the company's sales in China for the first six months of 2008 exceeded all of last year, and he's optimistic about future growth.

Although equipping Chinese dairies might seem like aiding the competition, Nielsen says the growth in China's dairy market leaves plenty of room for all comers. China's consumption of dairy products—recently as low as one fifth the world average—is rising fast, thanks in part to a government program promoting milk in schools. Although the government and international companies have invested heavily to meet new demands, many Chinese dairies struggle with low milk quality, inefficient technologies and poor animal maintenance and breeding. Chinese dairy cattle currently produce less than half

as much milk as American cows.

"I think the United States and Wisconsin are in a unique position to be able to offer expertise to China right now," says Stratton. "We have the kind of dairy industry that China wants to build. We can offer what they are looking for."

—MICHAEL PENN



KAREN NIELSEN

Dairy products line the shelves of a grocery store in China, where demand for milk and cheese is fueling rapid growth in the dairy industry.

In Heilongjiang and other provinces along China's northern border, the battle is over feed mixers and bull semen—and more generally, about which nation's experts are best equipped to usher China's dairy industry along the path of scientific advancement. Governments and businesses from Europe, Canada and Australia have been angling for a piece of the burgeoning industry, which has doubled in size since 2000. And until recently, the United States had barely showed up for the match.

"The Chinese dairy industry is rapidly expanding, and the U.S. is very late getting into the picture," says Karen Nielsen, associate director of CALS' Babcock Institute for International Dairy Research and Development. "Most of the machinery and products you see being used on the farms in China are from other places in the world."

For the past several years, Nielsen and other Wisconsin officials have worked to change that picture. In 2005, UW-Madison forged a partnership with China Agricultural University and began organizing annual dairy seminars throughout the country,

## PERU



## A Game Effort to Combat Poverty

For the small-scale cotton farmers who work the fertile valleys surrounding Pisco, Peru, there is usually little time for games. Cotton is a labor- and cost-intensive crop, and despite their best efforts, they often suffer significant losses due to the elements and agricultural pests.

# A Failure to Communicate

Professor **Dietram Scheufele** says scientists often aren't connecting with the public about the value of their work. And that's not good news.

## FEW SCIENTISTS

have the public pulse under closer watch than Dietram Scheufele. A professor of life sciences communication, Scheufele uses public opinion surveys and statistical modeling to explore people's attitudes toward controversial scientific issues such as stem cell research, nanotechnology and genetic engineering. He leads the Wisconsin research program for the Center for Nanotechnology and Society, funded by the National Science Foundation to probe the social issues that often swirl around emerging technologies. A native of Germany, Scheufele earned his master's and doctoral degrees from UW-Madison's School of Journalism and Mass Communication.

**G While most people in CALS study science, you look at how science is communicated and perceived by the public. Why is it important to study this issue?**

It's probably more important now than it's ever been. Issues like nanotechnology and stem cell research raise questions about what it means to be human, what kind of applications we want in the market and how quickly.

The tricky part is that, while scientists generally realize how important it is to connect with the public, many people have taken the approach that it will be enough if we just put sound science out there. But unfortunately that's not really supported by the research. Most recent studies, including some of our own, show clearly that information is only part of the equation. For one thing, if it doesn't reach certain parts of the audience, we obviously have a problem. But even if we reach everyone, there are still different publics who all use information differently.

**G Are scientists putting too much faith in information?**

Not necessarily. Information is still at the core of the message. But scientists may be too optimistic about the power of information alone, rather than also paying attention to how that information needs to be presented—especially to audiences who traditionally don't pay that much attention to science. We often think that museums, science sections of newspapers and traditional outreach are enough to inform the public. And they do a great job. But simply putting scientific information out there through traditional channels may in fact favor people who already know more or are more interested in science. In other words, we may end up unintentionally widening knowledge gaps.

**G Is (Google CEO) Larry Page right in saying that science has a marketing problem?**

Well, in some ways, that was an unfortunate statement, because it reinforces a concern that many scientists have, which is that science is somehow going to engage in spin. On the other hand, he's absolutely right. There are similarities between commercial marketing and how we communicate science. We're dealing with a public that is not overly informed or interested in science, and in order to connect with

these reluctant audiences, we need systematic research and strategic communication. It's all about understanding different audiences and developing targeted messages based on careful public opinion research.

**G If you look at embryonic stem cell research as an example, even after 10 years of debate there still isn't a public consensus about this field. What has influenced attitudes on this issue?**

Stem cell research is a great example, because it's an issue that has been heavily influenced by strategic campaigns on both sides. Interest groups have spent a lot of money researching what kinds of messages make people more or less likely to support certain aspects of stem cell research, and they've put considerable effort into framing the issue to their advantage. Religious groups, for example, have been very effective at framing stem cells as a moral issue, rather than a medical one.

One thing that is frustrating in these public debates is that science is often virtually absent. We have religious groups, we have Michael J. Fox, but we really have very little discussion about the scientific merits of stem cell research.

**G Why do you think scientists have been reluctant to be more visible on issues like these?**

We've actually done some research on this with the Center for Nanotechnology and Society. When we asked scientists about media coverage of science, about two-thirds said they thought media coverage was usually inaccurate, and almost half of them said that coverage was hostile to science. So while they think communication can make a difference, they're really reluctant to go through mass media.

**G Can they afford not to?**

I don't think they can. First, we've seen from issues like stem cell research and nanotechnology that federal funding guidelines and regulations are directly linked to the public debates surrounding these issues. And second, if scientists don't communicate effectively, we'll continue to have public discourse where interest groups frame the issue very successfully and early on, and science ends up playing a secondary role.

The long-term consequence is that once certain metaphors and frames are established in the public's





**“The difficult part is not to talk about science to a PBS audience. It’s making PBS content accessible to an MTV audience.”**

mind, those images are quite difficult to counter. If you think about a label like Frankenfood, for example, it’s a very intuitive tool for information processing. People can relate to it and immediately understand its message. Once a frame like that is established in people’s minds, it’s going to be hard to turn the conversation back to science.

The result is that, for fields like nanotechnology, we’re seeing policy debates about regulating certain applications long before we have actually produced the science that would make these applications possible. This is very different in terms of scope and timing from what we saw for nuclear energy or even genetically modified organisms.

**Q But isn’t nanotechnology fairly well accepted by most people?**

Lots of people don’t realize that there are 600 nano products that are already on the market, but they’re still overall positive about the technology itself. Our research has shown that this is mostly a function of positive framing in the media early on in the issue cycle. The early coverage has been dominated by talk about the potential of a \$1.3 trillion worldwide industry by 2015 and the idea of new scientific frontiers.

**Q So in that case, people are seeing the potential benefits of the science.**

Yes, economic ones, at least.

**Q But we often don’t know the benefits of emerging science at the outset. Where’s the line between projecting the potential and engaging in hype?**

Scientists always struggle with that. They’ve been trained to be very balanced in presenting their findings and all the caveats that go along with them. That’s an inherent contradiction with how journalists work. They want punch lines that will help them tell stories in ways that make sense to a reader who in most cases

has little or no science training. But I don’t think this requires a major shift for scientists. It’s just a matter of telling people why they’re excited about the work they’re doing. What do they hope to achieve?

**Q Do they have to “dumb down” the science?**

Absolutely not. It’s just the opposite. If scientists don’t know how to communicate well, their message gets dumbed down for them by other people, who will try to simplify or sensationalize the issue in order to fit their particular purposes.

Good communication is about deciding what you want to say, and then developing and applying the tools to get the message across. It’s about keeping others from politicizing science by making sure that we’re reaching all audiences with scientific information. The difficult part is not to talk about science to a PBS audience—they’re already doing that. It’s making PBS content accessible to an MTV audience.

**Q Most scientists I know would cringe at the idea of talking science on MTV.**

Well, it has to be done—not on MTV, necessarily, but in ways that reach audiences who traditionally care little about science. And I think it can be done. If we take an interdisciplinary approach, we can find ways to connect with audiences without compromising the message.

And the fact is that we do this already in the classroom every day. The approach we take in a graduate seminar is very different from what we do in a large, undergraduate class. Am I conveying to them different types of content? Not at all—I’m telling them the same thing, but those audiences have different levels of experience and different goals, and I need to use a different set of tools to engage them. It’s exactly the same thing for public communication. It’s about finding the channel that best allows you to reach your audience and tailoring your message to their needs. **Q**

But small groups of these farmers have made time recently to play a game of chance. No ordinary pastime, this game was designed by a team of CALS agricultural economists to teach the value of crop insurance—an entirely unfamiliar concept in places such as rural Peru. And it may just be one step toward breaking the cycle of poverty that often rules subsistence crop farmers around the world.

The game simulates farming cotton, with each round representing a growing season. Before each round, farmers decide whether or not to borrow money from a bank and pay for crop insurance. A poker chip and a ping-pong ball are then drawn to represent weather and crop health. As they play, farmers learn how economic decisions can lead to debt or help them survive a succession of bad seasons.

“It takes farmers about 10 to 15 years in the game to become self-aware of their decision-making patterns,” says Michael Carter, a professor of agricultural and applied economics who is spearheading the project, part of a federal program to understand and alleviate rural poverty in developing nations. “After they get the idea of it, about 70 percent choose to buy insurance each year.”

But Carter’s project has also turned the game into reality. The professor has worked with banks and insurance companies to establish a micro-insurance program, which has begun offering real-life policies to farmers in the region. If those policies result in higher incomes for farmers, Carter aims to bring the entire program—game and all—to other struggling economies around the world.

—NICOLE MILLER MS’06



**Peruvian cotton farmers play a Monopoly-like game designed by CALS researchers to teach the value of crop insurance.**

studied mountain pine beetles for 30 years, says the insects use a kind of jujitsu, harnessing a tree’s natural chemical defenses to send out a welcoming beacon to other beetles. If enough respond, they can overcome their host’s resistance, turning it instead into a nursery for their eggs. As they bore deep inside, the beetles leave a trail of microorganisms that cut off the tree’s nutrient supply, choking it to death.

But the beetles’ trickery alone doesn’t explain why they are fast spreading across Canada, Raffa says. “We’ve always had outbreaks of mountain pine beetles in the western forests,” he says, but the effects of those sporadic breakouts are usually fleeting and localized. “What’s different now is that we’re seeing them expand to areas where they haven’t been before.”

Raffa is working with the Canadian Forest Service and researchers at several U.S. and Canadian universities to understand why. The researchers attribute at least some of the population boom on global warming: Average winter temperatures in Canada have risen by 4 degrees in the past 30 years, and recent winters have simply not been cold enough to kill off the beetles in large numbers.

But Raffa is also interested in the effect of forest management practices, such as decisions to thin forests or suppress wildfires. Working with three UW-Madison colleagues—forest ecologist Phil Townsend, zoologist Monica Turner and microbiologist Cameron Currie—Raffa’s lab team has begun studying the problem from several angles, including how fire affects beetle populations and the role of bacteria in helping beetles invade new habitats.

“We want to understand how all of these factors intersect, from the biological scale to the landscape scale,” says Raffa.

—MICHAEL PENN

## CANADA



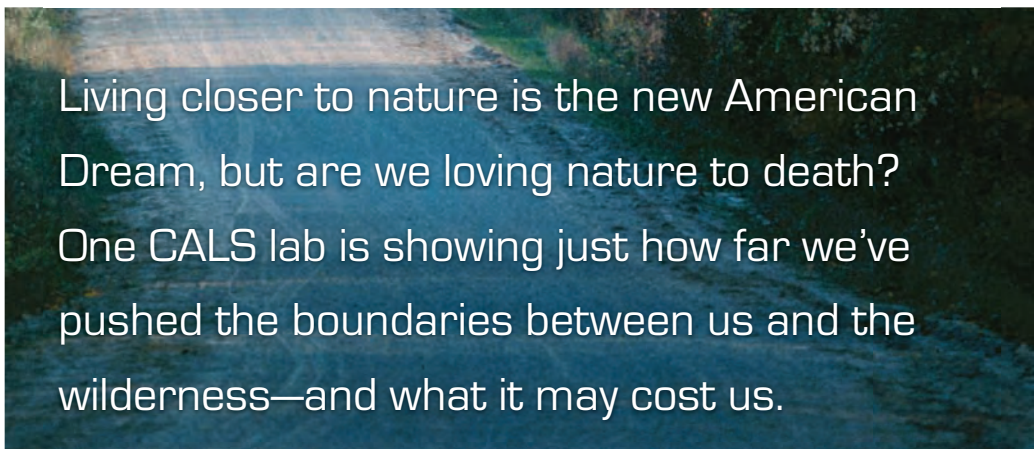
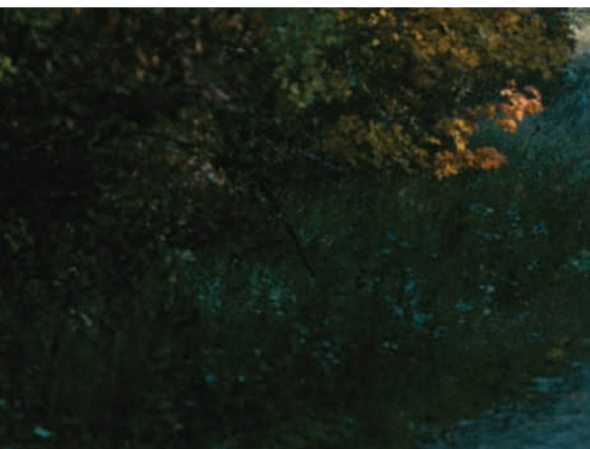
## Beetle’s Taste for Bark is Taking a Bite

On its own, the mountain pine beetle hardly seems a menace. No larger than a grain of rice, it is often the victim when it tries to burrow into a towering pine, killed by the tree’s natural defenses.

But let that beetle call over some friends, and watch out. Acres of trees can fall in their wake. In British Columbia, where pine beetle populations are exploding, the insects have already killed nearly half of lodgepole pine trees in the province’s central forest, and they’re claiming new territory each year. Authorities now say the beetle outranks wildfire or logging as the greatest threat to the Canadian forest.

What accounts for such deadly teamwork? Kenneth Raffa, an entomology professor who has





Living closer to nature is the new American Dream, but are we loving nature to death? One CALS lab is showing just how far we've pushed the boundaries between us and the wilderness—and what it may cost us.






# Into the Wild

By Adam Hinterthuer

Just off of a winding, narrow road in Wisconsin's Baraboo Range, a gravel driveway cuts into the forested margins of Devil's Lake State Park and leads to a new log cabin sitting in a small clearing. If you closed your eyes and imagined the perfect house in the woods, it might look like this. The sun-speckled roof, half shaded by a rustling green canopy. Bird feeders swaying from tree branches that nearly brush the front porch. Flower beds cradling clumps of color, resplendent against the brown leaf litter of the forest floor. Thoreau would've happily stretched out his legs here, not far from where an inspired Leopold took up his pen. It seems an ideal human complement to untrammelled nature—a soft, blurred line between domesticity and wilderness. Yet to the trained eye, all is not well in this Eden. Which is why Gregorio Gavier Pizarro is tromping into the nearby woods where there are no trails.



**ABOVE:** A road cuts into the forest in Wisconsin's Baraboo Range, where nature and civilization meet in sometimes inharmonious ways.



Sweat drips from Pizarro's nose and onto the screen of a handheld GPS device as he winds his way through the forest with a familiarity bred from repeated visits over the last two years. Waving away the persistent swarms of mosquitoes, he pauses every few yards to point at a plant and call out its name. They sound pleasant enough—Japanese barberry, honeysuckle, European buckthorn, *Rosa multiflora*. But these plants don't belong here. They just act like they do, proliferating across the forest understory, shoving native plants aside and changing the dynamics of entire ecosystems. They hint at a harder edge to the bucolic boundaries of house and wood.

drive cutting into the woods brings human influence with it.

Pizarro's work is just one chapter of a story playing out on the fringe of civilization, a shifting boundary that ecologists refer to as the wildland-urban interface. At this edge, some of the most pressing conflicts between humans and nature occur, from the property damage caused by raging wildfires to the eroding habitat for forest-dwelling species to run-ins with predatory animals. And to see what is truly going on with the wildland-urban interface—to really separate the forest from the trees—you can't just focus on a single house in the woods. You need to plot out that edge at its

graphical sketches for information-laden pixels. The SILVIS lab amasses mountains of information—from small-scale field studies like Pizarro's to census reports on the spread of houses and the growth of towns—and feeds them into a mammoth database that carves the entire country into pieces as small as 30 square meters. The end result is a geographic information system, or GIS—a map that reveals startling detail about every last parcel of American soil, from how many houses sit on it, to what plants grow there, to what percentage of its area is covered by woods or crops or development.

"Even 10 years ago it was simply not

## The spread of invasive plants hints at a harder edge to the bucolic boundaries of house and wood. And in the Baraboo Range, they're everywhere.

And they're everywhere. Pizarro, a graduate student in forest and wildlife ecology, began his research with a hypothesis that invasive species were linked to human land use and housing development. But when he started sampling random plots around Devil's Lake, he found so many invaders that he thought he would never make sense of his data. "Everything was just totally invaded," he says.

Eventually, he found a pattern in his maps. A ring of invasive plants forms around houses in the Baraboo Range as the species establish themselves on the fringe between yard and forest. Then they emanate outward, pushing deeper into the woods. The invasion slows as you look further into the woods—the largest intact swath of upland forest in southern Wisconsin. In places such as Baxter's Hollow, 5,000 acres of woodland protected from development by the Nature Conservancy, native plants and animals still hold dominion. But in most of the Baraboo Range, each new gravel

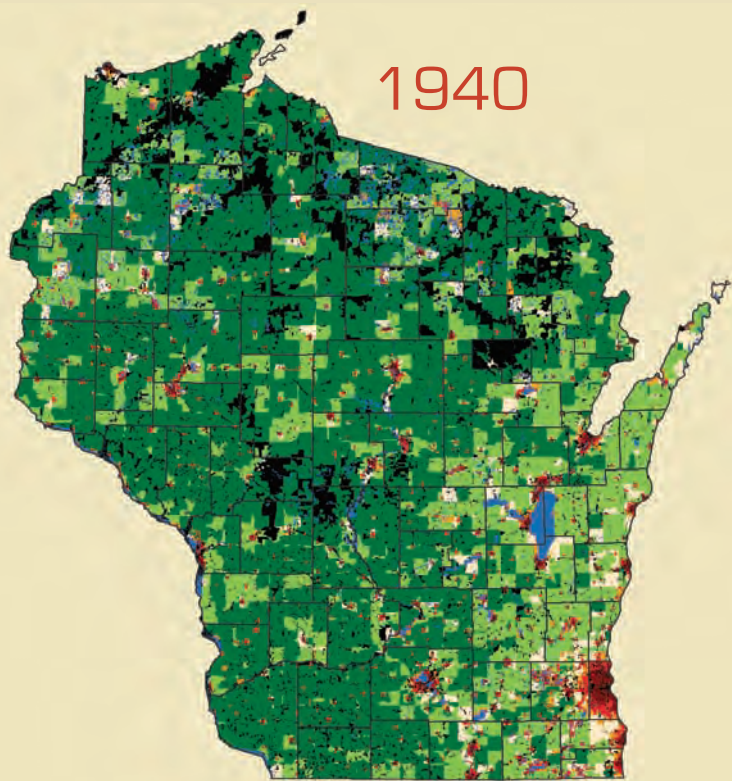
widest scale, finding where it lies, what moves it forward and what stands in its path. And that is where Pizarro's advisor, Volker Radeloff PhD'98, enters the picture. He has his eye on the Baraboo Range—and a thousand other places like it—to tell the story of what's happening to the edge of the wilderness, where people and nature meet in often inharmonious ways.

Radeloff, an associate professor of forest and wildlife ecology, runs a UW-Madison lab called SILVIS, which roughly derives its name from its mission to provide "spatial analysis for conservation and sustainability." With his wife, associate scientist Anna Pidgeon PhD'00, and a team of staff, graduate students and postdocs, Radeloff examines pastoral settings like the Baraboo Range in excruciating detail and then stitches them together into a larger picture of what's happening on the nation's landscape. It's a modern kind of mapmaking, which dispenses drafting tables for powerful computers and topo-

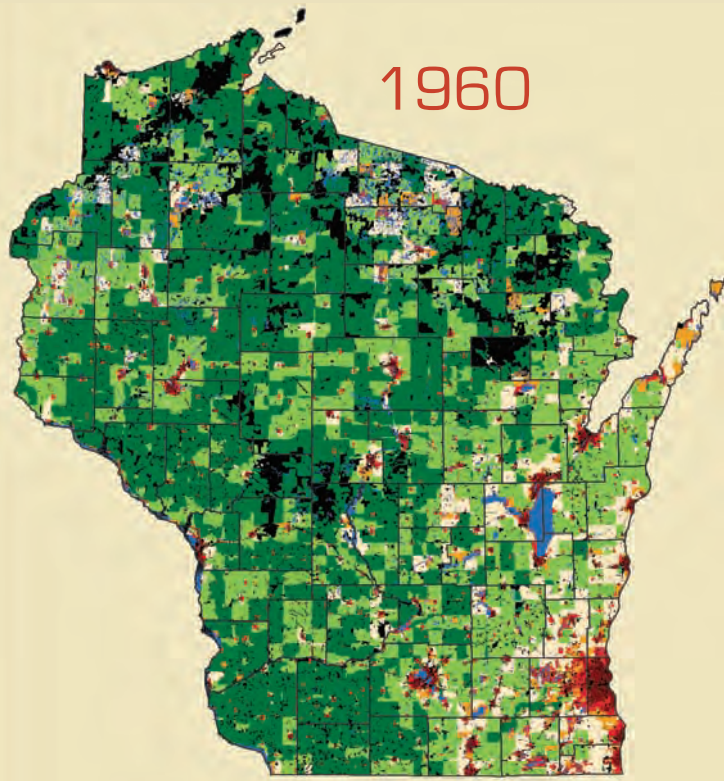
possible to analyze such a large data set," Radeloff says, sitting at his desk in a first-floor office of the Russell Labs building. He turns to one of the two wide-screen monitors that dominate his desktop and pulls up a series of maps of the United States, all alight in various pixels of reds, yellows and greens. "The computers (that) process this," he says, patting his desktop machine, "well, this wouldn't do it. We have servers down in the basement where the processing happens." In fact, in terms of memory and speed, the computers that generate the SILVIS maps rival those used to run complex experiments for the UW's physics department.

Why so much power? Consider the census data alone. Every decade, the U.S. Census Bureau compiles surveys on each household in the country. In 2000, there were 105.5 million of them. In the 1990s, those millions of paper documents were transferred into digital files, awaiting a computer with the power to crunch the data. Now, with today's

1940



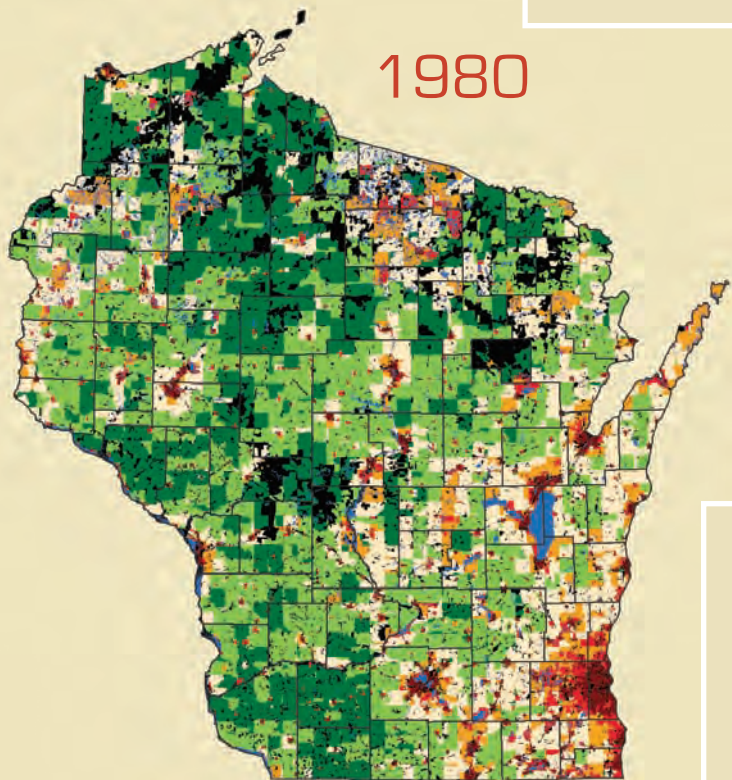
1960



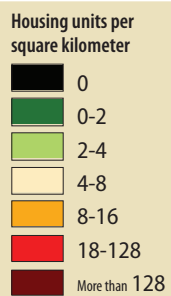
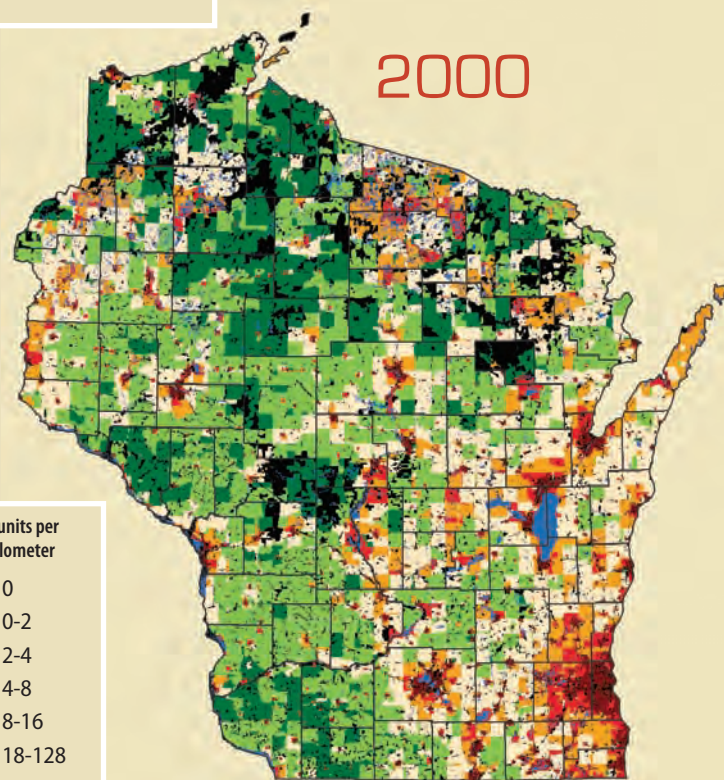
## A State on the Edge

Housing-density maps created by the SILVIS lab detail the progression of housing across Wisconsin, which is pushing the edge of wilderness further toward the outermost fringes of the state.

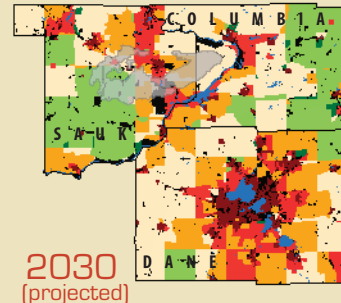
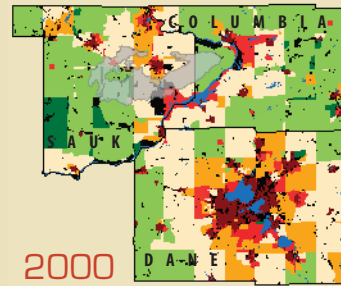
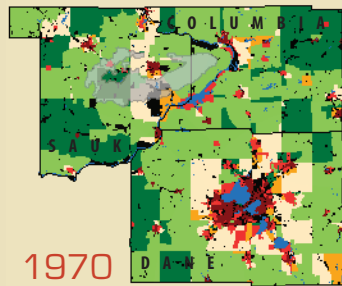
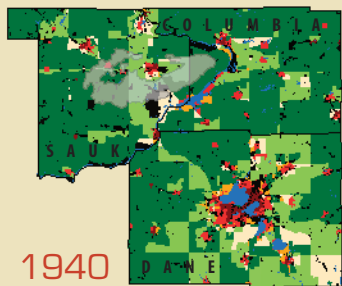
1980



2000







processing power, scientists and policy-makers can analyze demographic patterns on a national scale.

And when they started looking at these data, researchers saw something interesting. Until the 1970s, population growth in metropolitan areas far exceeded that of rural areas. But then, the trend reversed. The outskirts became the choice destination. Americans moved out.

It's impossible to pinpoint what, exactly, led to this "back-to-the-land" movement, but it's clear several forces were at work. For one, the expanding interstate highway system let both

"People want to be closer to nature, which is a good thing," Radeloff says of our spread to the exurbs. "It shows where their heart is. But by building houses there, they are destroying the very thing that they sought out in the first place."

Radeloff began seeing the effects of this movement in the late 1990s, when much like Pizarro, he was a CALS Ph.D. student canvassing the woods. He was interested in how human suppression of wildfire in northwest Wisconsin's pine barrens was affecting wildlife, and it soon dawned on him that while he knew tons about the local flora and fauna, he

civic planners and academic researchers. They provide a century's worth of information, showing changing national conditions and predicting trends through the year 2030. Through the clever combination of data and visual display, they identify literal hot spots—the places most vulnerable to damage from wildfires, where extra precautions are most advised.

But risks from wildfire aren't the only thing Radeloff's maps can tell us. There is another, perhaps more troubling trend visible when you map the wildland-urban interface: Green is disappearing.

"People want to be closer to nature, which is a good thing. But by building houses there, they are denying the very thing they sought out in the first place."

people and workplaces move away from cities. But another powerful draw was our notion of cities. Urban areas have long suffered an image problem in the country's environmental literature, which has often blamed them for their fabricated landscapes and detachment from nature. In his 1932 book *The Vanishing City*, Frank Lloyd Wright called urban areas a threat to our very future, "like some tumor grown malignant." Wright's own flight from the Chicago suburbs to the Wisconsin hills followed a long line of philosophers—from Thoreau to Emerson to Muir to Leopold—who sought the perfect balm of nature as a place where a man could live a proper, wholesome life. Their sentiments fueled a growing environmental movement, punctuated by Gaylord Nelson's first Earth Day on April 22, 1970, which primed a nation to search for undeveloped plots of land to call their own.

knew far less about the human half of the equation. "I just got more and more curious about who was living there," he says. "What was the population trend? What's the area going to look like in 20 or 30 years?"

He enlisted Roger Hammer, then a UW professor of rural sociology, to help him answer these questions. They set out to map northern Wisconsin with a view toward wildfire, plotting where houses stood closest to forests, what access roads could aid fire trucks, how much rain fell and even what species of trees surrounded homesteads. Officials with the U.S. Forest Service, coming off a particularly bad year of wildfires in 2000, took note. Under pressure to develop a national wildfire plan, they asked Hammer and Radeloff for help.

"With a gulp," Radeloff remembers, "we said, 'We can do that.'"

Today, their maps have been downloaded by thousands of federal agents,

Beginning with the earliest data from 1940, Radeloff's decade-by-decade maps of the United States reveal a remarkable shift in color. Red blobs, indicating urban areas like Chicago and the Twin Cities, expand as they move through the decades. But these consolidated areas are outpaced by a faint yellow pall spreading across the land. This is the color of low-density housing. A rural exurb. A cabin in the woods. Each new yellow pixel means another small chunk of green—the uninhabited wild land of our country—is being zoned and developed right out of existence. All because so many Americans want to live near the green.

This is a conundrum that Michael Slavney knows all too well. Slavney is a principal planner for Vandewalle & Associates, a Madison-based consultant group that helps officials with regional planning and economic development. He often uses GIS maps to show civic



A satellite photo reveals the spidery network of roads reaching into the Baraboo Range, which has become increasingly pressured by the growth of nearby Madison and its suburbs (see maps, facing page).

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planners how their farmed and forested land has been shaped over the decades. While the vast majority of those towns initially welcomed development, he says most eventually put the brakes on growth in order to preserve their “rural character.”

“What everybody thinks of is the first house in the subdivision or that first little isolated lot,” Slavney says. “And what you need to think about is, what will be the character when the last one goes in?”

There are profound economic and environmental tolls of decentralized development, he says. A typical town may average around five dwellings per acre, but out beyond the suburbs, at the fringe of natural lands, it’s not uncommon for a homeowner to live on five or more acres. That’s 25 times more land supporting a single household. “When I hear the term urban sprawl,” Slavney says, “to me, it’s an oxymoron. The sprawl that we really get is exurban.”


But while such developments raise questions about resources and energy use, there’s another reason to worry about houses pushing out on the fringes of wildlands. It turns out that nature loves the fringe, as well. Anna Pidgeon, who studies the effect of development on ecosystems, worries that we are

“perforating forest(s) with holes for houses.” And where the sun can shine unhindered by a forest canopy, a riot of growth occurs. Birds settle into these over-producing habitats because they provide bugs and berries for food and cover for nests. But the birds bring in seeds of invasive plants and, as those plants grow and flower, they help move them deeper into the forest. A bird feeder hung in an open lawn can also be a magnet for aggressive species such as house finches and cowbirds, which swoop in and force native birds out. This avian population explosion is soon tempered by predators such as raccoons, skunks, and domestic cats and dogs that roam these man-made avenues, sampling the bounty of the edge.

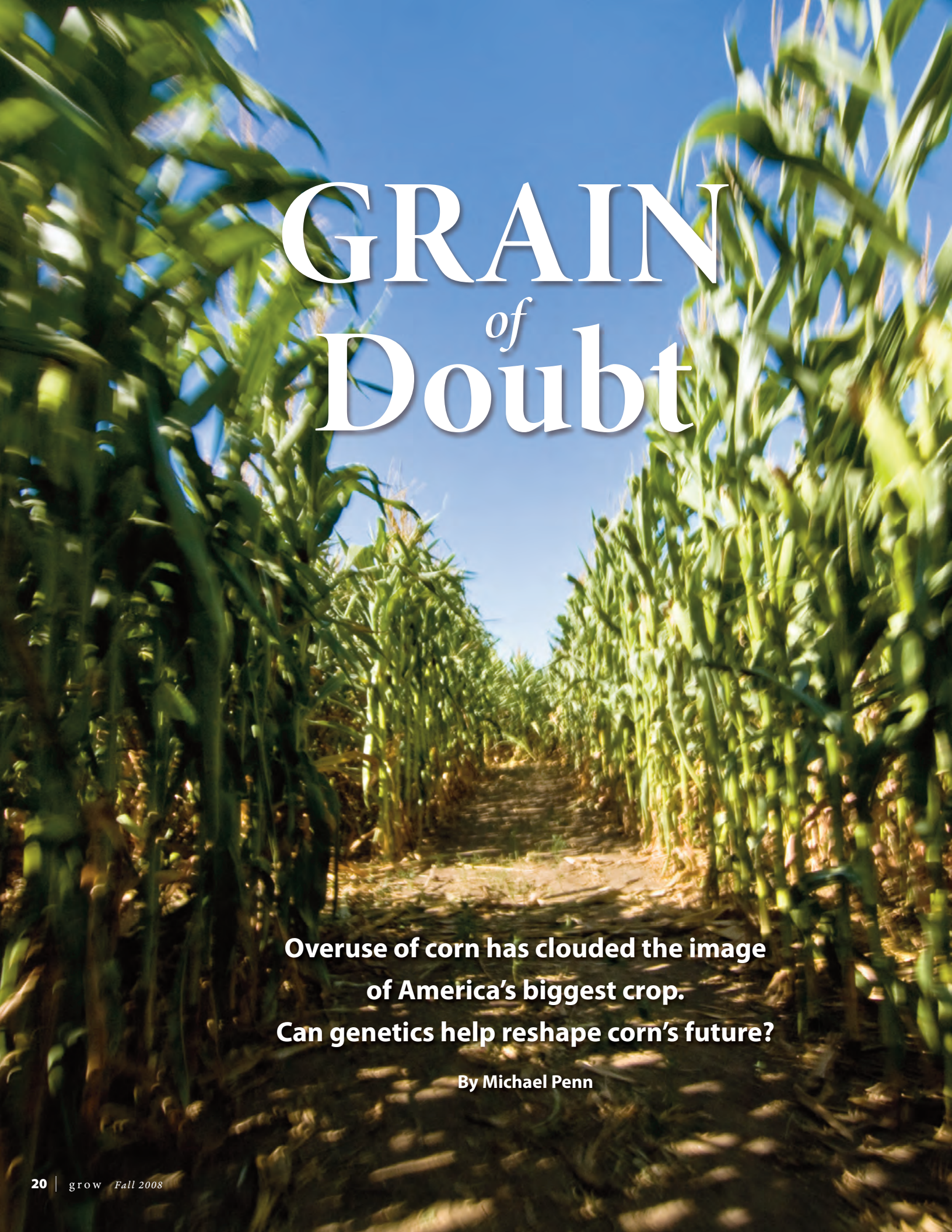
Pidgeon says she’s not advocating that people stop moving. Her hope is that people will realize it’s a question of scale. “The old hunting cabin probably didn’t have too much of an effect,” she says, “but McMansions with big lawns and forest all around them, that’s something else.”

This is the kind of development visible all over the town of Middleton, just west of Madison. Two-lane rural routes are growing to four-lane arteries, from which a sprawling network of subdivisions sprout like weeds. On each sit

three-story houses, ringed by acres of lush grass and exotic flowering trees. It is here that Wright’s remarks about cancer seem most apt. While a city may indeed sit like a giant tumor on a landscape, belching greenhouse gases and paving over green space, it is at least operable. Contained. The truly dangerous cancers, oncologists will tell you, are the ones that spread throughout the body. Now, three decades after the American Dream adopted the American ideology of wide-open spaces, the yellowing dots on Volker Radeloff’s maps seem like blips on an MRI readout. They are diagnostic tools, and they’re signaling big problems.

Back in the boundaries on Devil’s Lake State Park, Pizarro stops at a thick cluster of garlic mustard, another invasive plant flooding into Wisconsin. Most people strolling through these woods might not even notice the weeds, entranced instead by the whispering leaves overhead. But Pizarro frowns at the ground. Already this crop has gone to seed, spreading future invaders deeper into the forest. “We call this the loneliness of the ecologist,” he says. Other people enjoy their walks in the woods, envisioning a pristine habitat. But ecologists see the reality—the closer we move towards our cherished wildlands, the further we push them away. 






# GRAIN *of* Doubt

**Overuse of corn has clouded the image  
of America's biggest crop.  
Can genetics help reshape corn's future?**

**By Michael Penn**





**L**ike a swarm of fireflies, a group of teenagers creates a chaotic dance of flashlight beams as they scatter down a path leading into Don Schuster's corn. Within moments, they are gone, swallowed by the deepening blackness of the tall corn and the encroaching fall evening. Only their voices drift back to us, standing on the periphery of the nine-acre field. Others, too—the excited peal of children and young couples who have come to wander the serpentine paths Schuster has carved into his corn. Their laughter floats above us like the whispers of ghosts, happily lost in this maze of maize.

Strange phenomena, corn mazes. Schuster BS'86 MS'94 has been creating them for nine years on his farm near Deerfield, Wis., and he's still uneasy about tearing up good corn to make a human-sized rat race. "It goes against everything I was brought up to think about a cornfield," he says. But as a part-time economist with CALS' Center for Integrated Agricultural Systems, he also understands the bottom line. In a good year, 11,000 people will pay two to six dollars each to get lost in his family's field, enough to make whatever money he gets from the corn itself incidental.

This would have seemed a bizarre reality to Schuster's ancestors, who farmed corn for four generations before him. But if those men could walk through Don Schuster's field today, they would be lost for a different reason. The plants that towered around them would look alien, hardly resembling any cornfield they would have known.

Seventy years ago, Schuster's grandfather might have planted 8,000 corn seeds per acre, leaving plenty of room for the stalks to spread out. Today, most farmers put in 30,000. Schuster goes beyond that: To enhance the closed-in feel of his maze, he plants rows in both directions, packing 44,000 stalks into each acre. By August, his corn forms an eight-foot-tall wall with a canopy so thick that sunlight hardly reaches the ground.

"That's a lot of what makes people enjoy the maze," says Schuster. "You get in there and you can't see over the corn. It's like a big tunnel." But it's an effect created not by light or darkness or by Schuster's zero-turn-radius mower. It owes its magic to the plant itself, and the human conquest of it. We have made corn a jungle.



## The real trouble with corn may not be what it does wrong,

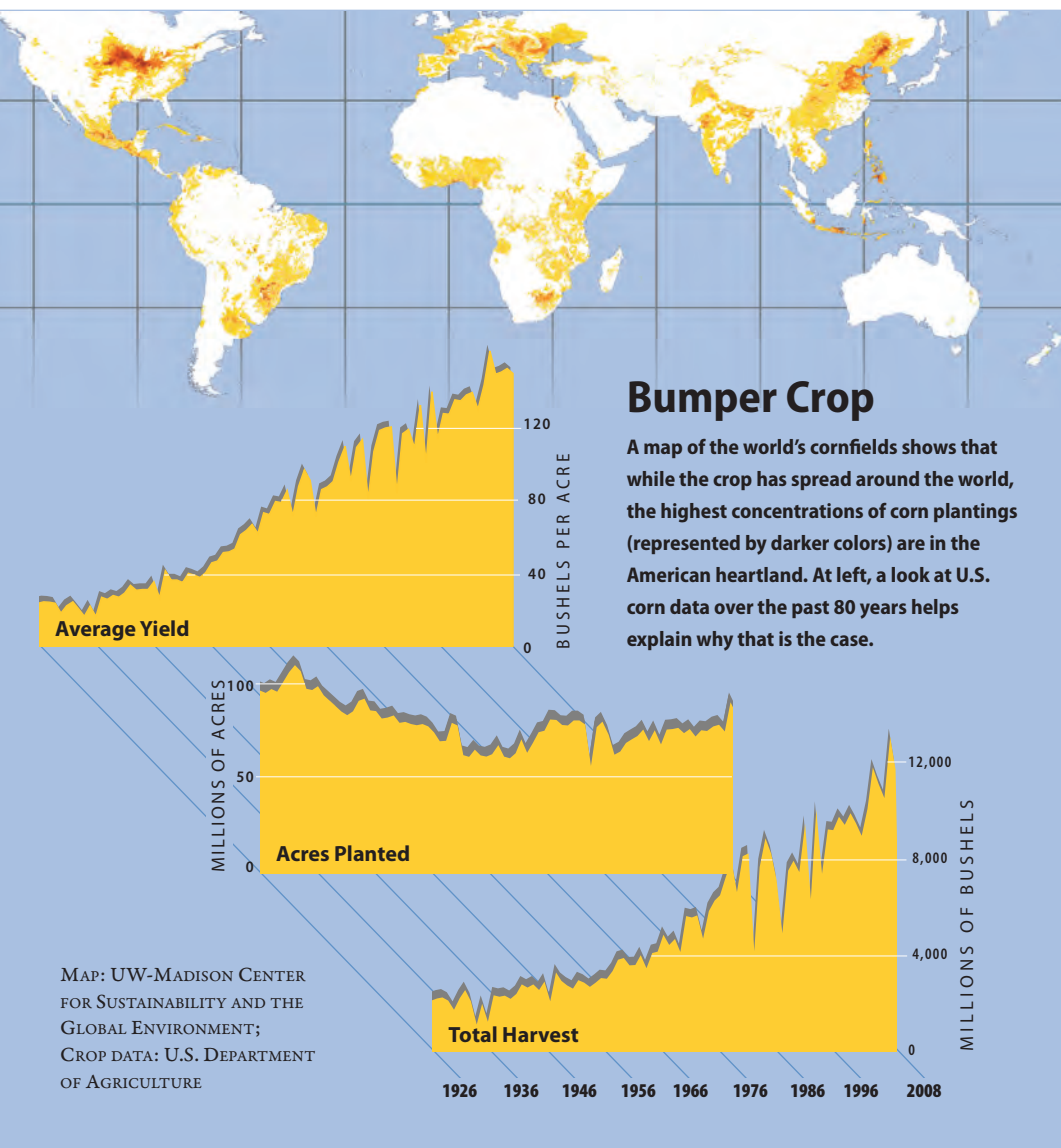
Through 7,000 years of farming, humans have turned a wild grass that grew in the valleys of Central America into *Zea mays*, one of the most bountiful food crops in existence. Today, corn grows on every continent except Antarctica, from the American heartland to the northern plains of China to the Andes mountains. Worldwide, farmers harvest some 700 million metric tons of its kernels each year, making it the second-largest food crop on the planet, behind sugarcane.

Ample credit for that dominance goes to the generations of farmers and breeders who have tailored the genetic superiority of the corn plant. Like a thoroughbred race horse, modern corn is a rare beast, designed to perform. It has been honed to grow taller and healthier and live closer to its neighbors, traits that have driven per-acre corn yields to historic levels. While 80 years ago American farmers yielded about 26 bushels of corn from one acre, now they often haul in more than 200. Although

corn occupies about 20 percent less land now than it did before World War II, our nation's annual corn harvest has more than quintupled. Last year, farmers harvested a record-busting 13.1 billion bushels of corn—enough to supply every man, woman and child in the country with a six-and-a-half pound box of kernels every day for an entire year.

Of course we don't eat all of that corn, at least not as kernels. Only about 12 percent of the U.S. corn crop goes directly into food production; the rest is fed to animals, turned into products such as ethanol or exported. But corn finds its way back to us in many ways—as sweeteners like high fructose corn syrup and dextrose, as starches in baked goods and confectionaries, as cooking oils and margarine, and as proteins and enzymes added to hundreds of foods. More than one quarter of the items on supermarket shelves now contain some form of corn, from Twinkies to fruit juice, from waffles to salad dressing, from soup to nut bread. Order a typical fast-food meal and you're eating corn in every bite: Corn feeds the cattle that make the beef; corn enriches the bread in the bun; corn sweetens the soda and bathes the French fries to golden perfection. It's even in the ketchup.

And therein lies the problem. As much as we have ruled corn, corn now rules us. It's in our T-shirts and boxer shorts and our children's disposable diapers. It's in our vitamins and our prescription drugs. It's in lipstick. It's in soap. Corn starch is in the finish applied to these magazine pages, the cardboard boxes they were shipped in and the gasoline tanks of the vans that delivered them. Our daily lives have come to rely so heavily on corn that 13.1 billion bushels of it seems hardly enough. Increased demand for corn, especially from foreign markets and the ethanol industry, has pushed corn prices to historic highs, more than tripling in the



but what it does right.



Corn plants dance in the wind as a summer storm rips across a field in southern Wisconsin.

past two years. After summer floods in Iowa and Wisconsin raised fears of a poor harvest, corn spiked to near \$8 a bushel, a level never before seen.

With corn now blanketing a swath of U.S. soil that could cover half of Texas, planting more hardly seems appealing. Nitrogen and phosphorus runoff from cornfields in the Mississippi River basin is contributing to a growing dead zone in the Gulf of Mexico, where excess nutrients cause oxygen levels to drop and make water uninhabitable for fish. Growing more corn would exacerbate those problems, especially since most of the lands best suited for corn are already planted with it. If farmers choose to till highly erodable grasslands for corn, soil erosion and runoff problems are bound to get worse.

But the real trouble with corn may not be what it does wrong, but what it does right. Corn is among an elite collection of plants, including sugarcane and switchgrass, that has evolved a super-efficient way of capturing sunlight

and carbon dioxide from the air, known to botanists as C-4 metabolism. C-4 plants soak up these energy sources without wasting water, which allows them to store more energy and tolerate heat and drought better than others. Plant one seed of corn and you'll get 400 seeds in return. Do the same with wheat or soybeans and you'll get little more than 100.

This advantage made corn desirable to the early farmers who first domesticated it—and to virtually every western civilization since. When Native Americans introduced European settlers to the crop, the newcomers quickly abandoned the wheat they'd carried across the Atlantic and embraced corn as the foundation of their survival. Two hundred years later, as corn seeds found their way across the globe, British scientist William Cobbett would write that the plant "was the greatest blessing God ever gave to man."

But corn's eager submission to humans' will may also explain why its

great success now borders on excess. "Farmers want to grow corn because it's very good at what it does," says Bill Tracy, who leads CALS' sweet-corn breeding program. "The issue is that because it's so good at what it does, we have 80 million acres of it."

Is this the fate of corn, to be so loved it's hated?

Statues of Mayan corn gods stand atop the bookshelves in Bill Tracy's office, keeping watch over the accumulated treasures of a life spent pursuing corn. Tracy's desire to breed the perfect kernel has taken him throughout the western hemisphere, from the black soils of Wisconsin to the remote wilds of Chile and Argentina. The last time he wasn't growing corn somewhere in the world, Jimmy Carter was president.

It's hard to say which Tracy enjoys more, growing corn or eating it. Occasionally, those activities intersect: In the fall, after he and his staff harvest corn



from the program's 20-acre research plot at the West Madison Agricultural Research Station, he walks along each row, sampling ears. Most years he'll taste 500 different varieties of sweet corn, noting subtle differences in each.

But Tracy also knows the plant he admires is troubled. "Corn is a technology," he says, "and technologies can be misused. As much as I love it, I do worry that we're leaning too heavily on corn."

The advantage of Tracy's job is that he can do something about it. Breeders in positions like his have played no small role in the modern evolution of corn. It was the work of academics George Shull and Edward East, who a century ago

began mating inbred lines of corn to test the powers of genetics, that revealed the promise of hybrid corn varieties. Another professor, a man named R.A. Brink, who had studied with Shull and East, brought hybrids to Wisconsin when he was hired by the College of Agriculture in 1923. The college's first hybrid line was released in 1933, and within eight years, 90 percent of Wisconsin's cornfields were growing hybrids. By 1958, average yields had doubled, and the state's overall production had more than tripled. Former CALS Dean Glenn Pound PhD<sup>43</sup> would later say that the college's hybrids boosted the value of the state's corn crop by \$20 million a year between 1950 and 1970.

University breeding programs have since faded into the background of a picture dominated by the giants of the for-profit seed industry. Two companies—Monsanto and Pioneer Hi-Bred—now control more than 60 percent of the corn seed market. Certainly, the landscape changed with the emergence of genetically modified seeds, which were introduced by Monsanto in the 1980s and now comprise more than two-thirds of the corn planted in the United States. But an erosion of funding for crop research has helped

diminish the role of public breeding programs. Of the dozens of university plant breeding programs that were birthed by the hybrid revolution, only a handful remain. Those survivors often struggle for grants and graduate students, who are often lured by higher-paying jobs in industry. In a world of genetic engineering, plant sex just isn't as sexy. But life on the periphery has its benefits, and one of the biggest is that Tracy doesn't have to worry much about the demands of the market. While his program does release the occasional sweet-corn hybrid, his primary mission is to experiment with the genetic limits of the plant. "Commercial breeders are driven by their business not to stray too far from what's working," he says. "As a university breeder, I can go to material that is maybe too wild or too exotic for somebody who is trying to turn out a new hybrid."

And few plants offer so much room to experiment as corn. Although you might not suspect it from looking at the orderly symmetry of a Wisconsin cornfield, corn is extraordinarily diverse. Its stalks can tower 15 feet in the air or barely break knee level. Its kernels turn out a rainbow of colors—yellow, orange, white, red, blue—and can be either grain or vegetable. But the real asset is corn's unique structure, with its male flowers high up in the air and ears down at waist level. The separation of the sex organs makes it trivially easy to prevent corn's natural, open pollination and instead play matchmaker. This, essentially, is what programs such as Tracy's do, year in and year out. Using hundreds of varieties gathered from around the world, breeders cross particular plants with an eye toward enhancing desired genetic traits, or tamping down undesirable ones.

Combine handling ease with genetic diversity, and you understand why Tracy's job is so much fun. "It's hard not



**In a CALS research field, Natalia de Leon shows off a bushy type of corn plant that produces more leaves and ears than standard field corn (above). The goal is to "start thinking about corn in different ways," she says. "Maybe we need to make the plants look different and do different things."**



because really, it's like corn wants to be bred."

to anthropomorphize it, because really, it's like corn wants to be bred," he says. "We can just about pick what we want the plants to do and direct them there." To illustrate the point, he pulls over a wooden tray stacked with dried ears from a breeding experiment. Picking a few at random, he turns the ears over in his hand and points out various kernels, some smooth and glassy, others wrinkled and opaque. "All of this variation we got by selecting for two genes," he says. "Corn has between 25,000 and 50,000 genes, so we're talking about an amazing amount of diversity."

And more arises every day. When breeders select for certain traits, they create novel genetic combinations that can expose previously unseen abilities. One of Tracy's pet projects, for example, has been to essentially reverse the evolution of sweet corn, which descended as a mutant form of dent corn, the type most commonly used to make flour and livestock feed. In a kernel of dent, the sun's energy is converted into starch, but sweet corn carries a gene that interferes with that conversion, filling its kernels instead with the sugars that give it a sweet taste. In the late 1980s, guided by little more than curiosity, Tracy began plucking off the starchiest-looking kernels he could find in his sweet corn populations and planting those. After seven generations, he had all starch and no sugar. With advances in molecular biology, his lab has now identified at least three genes altered by the experiment, potentially unearthing an entirely new genetic pathway for the production of starch in corn.

To fellow agronomy professor Natalia de Leon MS'00 PhD'02, Tracy's experiment shows that agriculture hasn't yet reached the summit of what it can ask corn plants to do. "It's just an amazing species. If you do selection appropri-

ately, there are very few things that you cannot change in a corn plant," she says.

But de Leon has her own poster children for corn's genetic flexibility, an odd collection of plants that grows in a small square on her research fields. Fat with leaves and branches, they look more like bushes than corn stalks. But then you see the ears—in some cases, as many as 20 per stalk.

Known as Golden Glow, the plants are the offspring of an experiment begun in 1971 by CALS agronomist John Lonnquist, who wanted to convince farmers that corn plants with many small ears could yield as much grain as the ones we're used to seeing, which have one or two large ears dangling from a central

**At his West Madison research fields, two of agronomy professor Bill Tracy's chief interests intersect: eating corn and breeding it.**

stalk. Beginning with a plot of ordinary field corn, Lonnquist picked plants with the most ears and crossbred those generation after generation. Lonnquist handed the project to Jim Coors, another agronomy professor, who assigned maintenance of the crop to de Leon when she was a graduate student. In 2006, de Leon returned to CALS to take over her mentor's breeding program—the only public program in the nation that focuses on silage—and she re-inherited the Golden Glow project. Now in their 33rd generation, the plants





## Corn has lost much of its oil and protein. The old flavors “just aren’t

are showing a prolificacy that few people believed corn possessed. But many farmers remain skeptical, says de Leon. “To them, it doesn’t look like corn is supposed to look. It’s just not right.”

The booming biofuels business might change their minds. Golden Glow’s ample branches create more space for leaves and tillers, which may eventually supplant kernels as the prime feedstock for ethanol. One of de Leon’s graduate students, Candy Hansey, is searching for the genes that control tiller growth in hopes of stimulating corn plants to produce more green matter without affecting their grain yield. “If we can increase the number of leaves and the width of the leaves, we can have more area for the sun to hit and bring more energy in,” says Hansey. “Energy in means energy out for biofuels.” Other breeders are beginning to experiment with corn that grows no ears at all, the theory being that corn’s leaves might be valuable enough to grow on their own as an energy crop, regardless of grain.

“The overall idea,” says de Leon, “is that maybe we have to start thinking about corn in different ways, not just the typical single stalk, annual system that we know. Maybe we can make the plants look different and do different things.”

**I**t’s striking to note that Golden Glow’s strongest resemblance is not to corn, but to teosinte, the wild grass from which corn evolved some 7,000 years ago. Like Golden Glow, teosinte plants have several tall branches that hold small pods of kernels. The similarities are so apparent that when de Leon showed pictures of Golden Glow at a recent meeting of corn geneticists, a few scientists in the audience suggested that her plants must somehow have been pollinated by corn’s ancient ancestor.

Genetics professor John Doebley, who has studied the evolution of

teosinte to corn, says there’s good reason for the likeness. “In a sense, what (de Leon’s team) is doing is undomesticating corn,” he says. In less than a human lifetime, they’ve successfully undone a shape and stature farmers have refined over several millennia.

It’s not hard to understand why farmers wanted corn to look the way it does. In the days before mechanical harvesting, who would have wanted to pluck 50 ears from every plant? Teosinte had other problems, too. Although its seeds were nourishing, they were encased in hard shells, which had to be cracked open to get to the edible parts. And they tended to fall all over the place, meaning someone had to go pick them up off the ground to get dinner. Whenever a more appealing mutant appeared—the odd kernel that developed a softer shell, or perhaps a plant that grew larger ears—its seeds were saved and replanted. And so the human conquest of corn began.

By favoring certain seeds, early farmers carved out a subset of genes that fit their needs. But needs change. We no longer harvest by hand, and so breeding for large, easy-to-grab ears may not be as important any more. (In fact, it may be disadvantageous to the plant’s health by concentrating disease and pest risk into a small number of ears.) But the intriguing possibility is that we can go backward, using ancient gene reserves to restore traits that may have been bred out of corn through past selections. “There’s no reason to believe that those ancient people got all the good stuff out of teosinte,” says Doebley. “There is likely still some good stuff in there that modern breeders may be able to identify and transfer into the corn plant.”

One example that has caught the attention of the sustainable-agriculture community is perennial corn. Domesticated corn requires annual replanting, which can be an expensive proposition if

you’re fueling a diesel tractor to plant a few hundred acres each spring. The alluring possibility of self-regenerating corn dawned in 1978, when a Mexican botany student named Rafael Guzmán stumbled across a field of perennial teosinte, which was believed to be extinct. He sent a few seeds to UW-Madison botanist Hugh Iltis, who with Doebley, then his graduate student, confirmed Guzmán’s find—and realized something better still. The wild plant had the same number of chromosomes as *Zea mays*, which meant it could be mated with modern corn.

So far, the discovery has created more flash than fire. Although breeders have successfully bred perennialism into corn, the resulting hybrids inherit teosinte’s love of tropical climates, making them impractical for the harsh winters of the Corn Belt. Because perennial plants siphon off some of their energy building root structures to survive winter, perennial corn is also not likely to approach the yield of annual varieties. Yet the idea remains compelling. If it did emerge as a viable option, perennial corn might save hundreds of millions of dollars in fuel costs and eliminate the need for soil-eroding tillage.

But branches and roots weren’t the only losses from corn’s domestication. A more recent victim is corn’s nutritional portfolio. While its kernels have always been rich in starches and sugars, older varieties boasted a richer mix of oils and proteins than is typical today. If you doubt this, try biting into a fresh ear of field corn. What you’ll taste is the chalky sensation of near-pure starch, which makes up three quarters of the weight of a standard modern corn kernel.

You’re also tasting the dominant role of yield in modern corn farming. From a corn plant’s view, it’s more efficient to turn sunlight into starch than it is to make oils or protein, which require more energy to produce. So if you’re

there anymore.”



**Hugo Gonzales Dupuy and Laura Smith plant rows of corn in an experimental plot at the Michael Fields Agricultural Institute in East Troy, Wis., where researchers have been working to enhance the protein content of organic corn. The effort has yielded kernels so rich in carotenoids that they have the orange color of candy corn (above).**

looking to stockpile as much energy as possible in the form of digestible food, starchy corn is the way to go. This pursuit of the highest yield has turned corn into “more of a pure carbohydrate-producer now,” says Walter Goldstein, who researches corn at the Michael Fields Agricultural Institute in East Troy, Wis. “It’s lost a lot of its protein and oil content and a lot of its flavors. If you taste some of the old varieties, they have rich perfumey tastes and deep flavors. Those just aren’t there anymore.”

For most of the past two decades, Goldstein has been working to restore those lost qualities. On a patchwork of research plots down a country road from the institute’s offices, he grows corn that differs from industrial varieties in several ways. For one thing, he eschews chemical herbicides and pesticides, fitting with the institute’s mission to promote organic agriculture. But Goldstein’s corn is also far richer in protein, in some cases nearly double the amount in standard corn. By going back to older varieties that contain a key gene for protein synthesis, Goldstein has bred strains of corn that have significantly elevated levels of lysine and other essential amino acids. Some of the seeds are so choked with carotenoids, the orange pigments that protect eyesight and boost immune function, that they look like candy corn.

One can argue that humans have a wealth of options for eating protein, especially if they live in developed countries where meat is plentiful. But pro-

tein-rich corn may have other uses. Organic poultry producers, for example, are clamoring for a natural source of methionine, a protein that promotes egg development in chickens. Most farmers now add synthetic methionine to their chickens’ corn feed, but the National Organic Standards Board has ordered an end to that practice by 2010. Goldstein is leading a group of nearly a dozen researchers scrambling to perfect methionine-rich corn as an alternative.

On one level, results have been encouraging. In just three generations, the researchers have boosted corn’s methionine content by 75 percent, plenty sufficient to meet farmers’ needs. The problem is yield. As often happens when breeders ramp up a particular genetic trait, the plant’s energy needs change and overall production suffers. At this point, Goldstein estimates that his best high-methionine hybrids yield about 80 to 90 percent of normal organic corn.


Goldstein is confident that cross-breeding his plants with higher-yielding varieties will narrow the gap. If he can, he estimates the immediate demand from poultry producers alone would call for 5 to 8 million bushels of high-methionine corn, requiring as many as 60,000 acres to grow.

True, 60,000 acres—a little larger than the city of Madison—won’t put a dent in the dominance of dent corn. But it could add something not much seen in the U.S. corn industry: alternatives.


With a few exceptions—sweet corn being the most obvious—the market regards corn as corn. Unlike apples or potatoes, where honey crisps and russets occupy their own niches, corn is generally aggregated into a few large heaps, whether it’s headed for a gas tank or a tortilla chip.

That fact has always surprised Joe Lauer, an agronomy professor and CALS’ chief extension specialist on corn. “There’s always been talk of identity-preserved marketing channels, but it has never happened,” he says. And when the market won’t pay for higher quality corn, he says farmers really only have one choice: Grow as much of it as humanly possible.

“Yield is how farmers get their raises,” Lauer says. “You can grow high-protein corn, but the market has to be willing to pay a premium for that corn. Otherwise farmers aren’t going to accept those lower yields.”

That may sound like pessimism, but it’s the hard reality that underlies the hopeful science of plant breeding. The truth is that scientists can’t change corn, at least not for long. Only society can. The genetics of corn allows us to take the plant in myriad new directions, but like the blind alleys of Don Schuster’s maze, many of them may lead nowhere. And it’s tempting, when we stumble into one of those dead ends, to blame the maze and say it’s the corn’s fault for hemming us in. But really, we know it’s the path we chose. 





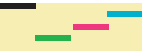
**FIFTY-FIFTY.** Susannah Gilbert was well aware of her odds, but in the cramped counseling room at UW-Madison's Paul Carbone Comprehensive Cancer Center, she heard her genetic counselor go over them once more. It was a flip of a coin, a 50 percent chance that she had inherited her mother's Lynch Syndrome, the genetic disorder that had caused her repeated battles with cancer. Although she was only 16 years old—active, healthy and hardly of the age to worry about cancer—Susannah knew that her own DNA was keeping a secret from her. And she was ready to know the answer.

With her parents by her side around the Formica-topped table, Susannah nodded in quiet understanding. The Gilberts had been through this before. A few months earlier, Susannah's older sister, Emily, had been tested for the disorder, and the whole family rejoiced when they discovered she didn't have it. But privately, Susannah worried. "It felt like one of us should end up with it," she confessed later. "I felt like I had a higher chance of having it somehow because she didn't." Now, it was her turn to learn the truth—information that would set her down one of two paths. Down one lay rigorous annual cancer screenings and the likelihood of surgeries, radiation and chemotherapy. The other path held the deceptively simple promise of a normal life.

For nearly two hours, Amy Stettner, who counsels patients through genetic testing for the UW-Madison-affiliated Waisman Center, walked Susannah through the steps that she would take to find out which path her life might follow. First, Susannah would provide a sample of her blood, which would be packed in a small tube and shipped to a lab in Salt Lake City, Utah. There, lab technicians would perform PCR amplification on the sample to hone in on a key part of her DNA. They would look for the presence of a small error in her genetic code in a process akin to checking to see if a book has a particular typo on a particular page. Once their testing was done, they would check one of two boxes on a form, either "No Mutation Detected" or "Positive for Deleterious Mutation."

Then, two weeks later, Susannah would return to the small counseling room to learn the results. Either way, the test would reveal a deeply intimate piece of information about her, a glimpse into the very makeup of her being. On that day, she would discover information

that, once known, could never be unknown. For better or worse, she would learn what her body might have in store for her future.



### Sarah Gilbert

was 31 years old when she got her first cancer diagnosis. She had been sick for more than a year, and she was shocked to learn she had been suffering from colon cancer. But then, after surgery to remove the tumor, it was gone. Three years later, Sarah was given a clean bill of health. She and husband Peter, who had just finished a master's degree in library science at UW-Madison, decided to celebrate by having a second child. "Susannah was sort of our victory baby," says Sarah.

A few years later, Sarah started having unusual menstrual periods. By then, the family was living in Appleton, Wis., where Peter had taken a job in Lawrence University's library system. Thinking she was experiencing early menopause, Sarah tried alternative medicine. But doctors discovered something else: her

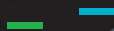
second and possibly third cancers. "They couldn't exactly tell from the pathology whether I had stage three uterine cancer that had spread to my ovary, or stage two uterine cancer and stage one ovarian cancer cropping up at the same time," says Sarah. To be safe, Sarah was treated for both. She had a complete hysterectomy, followed by radiation therapy for her uterine cancer and chemotherapy for her ovarian cancer.

By this point, Sarah and her family were convinced that this was more than a string of bad luck. Sarah's sister, a doctor living in Indianapolis, had recently read about Lynch Syndrome, which seemed to explain Sarah's litany of cancers. Caused by a mutation in a gene that helps ensure DNA gets coded correctly when cells grow and divide, Lynch Syndrome carries a significantly elevated risk of developing tumors, especially in the colon (*see box, page 32*). While most people have a 2 percent chance of developing colorectal cancer during their lifetime, for instance, people with Lynch Syndrome face an 80 percent likelihood. Their odds of a second colorectal cancer

# DOUBLE-EDGED HELIX

When 16-year old Susannah Gilbert got the chance to read her DNA, it changed nothing about her life. And everything.

BY NICOLE MILLER MS'06







Susannah Gilbert with  
her mother, Sarah.

within 15 years are 50-50.


But before Sarah had a chance to be tested for Lynch Syndrome, she was again diagnosed with cancer. This time, surgeons removed most of her colon, followed by three months of chemotherapy that were made tortuous by blood clots and infections. All this before she turned 44.

It came as little surprise, then, that her DNA tested positive for Lynch Syndrome. "I was actually happy to find out something so concrete, and that it wasn't my lifestyle, it wasn't my fault somehow," says Sarah. "I mean, this was just somehow in the cards I was dealt, so it was okay."

Although Sarah's parents and siblings were also tested for the defective gene, none proved to have the mutation. "Part of me wanted to have the Lynch Syndrome gene just to support her," says Sarah's brother Michael Holt, an emergency room physician at St. Mary's Hospital in Madison. Holt had planned to have T-shirts made to show off the family's faulty genetic code. Instead, Sarah discovered that she was the originator of a spontaneous mutation—a freak occurrence that took place inside one of the early embryonic cells that gave rise to her being.

Sarah's daughters, however, faced a different situation. They knew they stood a 50 percent chance of inheriting the faulty gene from their mother, a gene that would trump the effects of the working gene they received from their father. They also had an option their

mother never did: They could be tested for the mutation before any appearance of symptoms. They could get an early warning.

 **The ability**  
to test one's genes—practically unheard of even 20 years ago—has grown out of the dramatic advances in genetics research. Scientists, including many working in CALS and UW-Madison's other life-sciences colleges, have made breakthrough discoveries that have opened up huge portions of the human genetic code to inspection. By identifying and sequencing the genes underlying a host of genetic conditions, this science is revolutionizing medicine. Already, genetic tests exist for some 900 disorders, including cystic fibrosis, Duchenne muscular dystrophy and Lou Gehrig's disease, and many more are developed each year.

With such tests, doctors are gaining the ability to identify genetic conditions years before they ever make themselves apparent and treat patients according to their unique genetic makeup. But genetic testing has also created an entirely new kind of question, a personal, emotional dilemma that Emily and Susannah Gilbert have faced head-on: If you had a genetic disease that might not emerge for years, if ever, would you want to know?

On one level, the answer seems easy. With the completion of the human genome project, which sequenced the


sum total of human DNA, genetics researchers have created a mountain of data about the genes that define nearly every facet of our being—not only whether we're blue-eyed or brown, or will lose our hair as we age, but also whether we are predisposed to diseases like breast cancer or

hemochromatosis, an iron storage disorder. Knowing our genetic vulnerabilities can undoubtedly improve—or even save—our lives. "We are all genetically flawed in some way, and knowing what those problems are really gives you a tremendous advantage, in terms of having personalized healthcare," says Amy Stettner, the Gilberts' genetic counselor. She cites an example of a 30-year-old woman who has a mutation making her more likely to develop breast cancer. "I think every doctor taking care of you needs to know that, including the radiologist that reads your mammogram. If it's not clearly evident that you are a carrier, they are not going to look at your mammogram the same way."

But as science sheds light on wider sections of our genetic code, the data we can amass about ourselves is piling up. Biotechnology companies are springing up to sell the ability to read your own DNA. In one case, customers simply mail a saliva sample to a laboratory and get online access to swaths of their genetic code, where they can surf for telltale signs of various genetic disorders.

"Not very far from now—two years, three years, five years—it'll be economically feasible to take a small amount of blood and analyze your whole genome," predicts Norman Fost, director of UW-Madison's bioethics program. "And what that means, for one, is that patients will be just flooded with information, just complete sensory overload."

The larger question is whether this information glut will ultimately benefit



If you had a genetic disease that might not emerge for years, if ever, would you want to know?

patients. Fost points out that the ability to test always runs ahead of the ability to treat. While medical therapies exist for genetic disorders such as PKU and cystic fibrosis, he says genetic testing will identify “more and more disorders for which there are no effective treatments.”

One such example is Huntington’s disease, the degenerative brain disease that killed singer Woody Guthrie. In such cases, “it’s not clear whether the benefit of prior knowledge outweighs the burden for many patients,” Fost says.

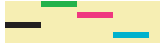
Fost worries, too, about tests that show modest predispositions to diseases. What should a man do if he finds out his risk of developing diabetes is 30 percent higher than average? Does he give up sugar? Start taking medication? And if so, at what age?

“A genetic test is good when the test is linked to something that’s useful for the patient,” says Fost. “Knowledge by itself is not good. Knowledge is good only if it leads to something else that makes your life better.”

In the case of Lynch Syndrome, early identification does have some clear benefits. Although there is no cure or treatment, a positive test can allow doctors to more aggressively monitor patients for signs of early cancer. Lynch Syndrome patients generally start undergoing annual colonoscopies at age 20, for instance, and women have more-extensive gynecological exams to monitor their uteruses and ovaries. Most are advised to have preventive hysterectomies in their late 30s.

But even life-saving knowledge can have fallout. The revelation of a severe genetic disorder can affect how people feel about themselves and their families, potentially altering dreams of pursuing certain careers or raising children. Many patients also worry about discrimination: Will identification of a genetic disorder affect their ability to work in certain fields or obtain health insurance?

Despite the significant progress made in 2008 toward an anti-genetic discrimination bill, such worries seem valid. As Fost points out, genetic labels are “very sticky, particularly if they get in your medical record.”



**T**hese issues troubled Peter and Sarah Gilbert as their girls grew up. What if Emily and Susannah had Lynch Syndrome? Testing them at a young age might benefit their health, but what about their psyches? And what if they didn’t have it? Finding that out could relieve them of the stress of not knowing and save them the hassle of rigorous medical examinations. Ultimately, they decided it was up to the girls. When they were old enough, they could choose.

Both Emily and Susannah had been home-schooled, and purely by virtue of being at home day in and day out, they had come to understand what living with Lynch Syndrome would mean. Even though their mother had been cancer-free for seven years, they had watched her suffer through bouts of painful digestive blockage and dehydration due to her scar-tissue-riddled colon. Her surgeries had created a situation where, as Sarah jokes, “food doesn’t like to go through me.” Periodically, she requires additional surgery to clear her intestinal tract.

Initially, Emily Gilbert thought she didn’t want to know if this is what her future held. When she turned 21, she changed her mind and took the test. “After a while, I decided it would be better if I did because I tend to worry about things,” says Emily, who works part-time at Heritage Hill State Historical Park, a living-history museum located in Green Bay. “I realized I’d fret over (not knowing) a lot more than knowing for sure one way or the other.”

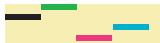
When Emily’s test results arrived in

the spring of 2007, Stettner had to deliver the news over the phone. Sarah was in the hospital that day with digestion problems.

Susannah admits she felt ambivalent about her sister’s test result. “I felt like I should be really happy for her, but it was hard because that is when I said, ‘Okay, I definitely think I have it now,’” she says. She asked to be tested shortly thereafter, but both Sarah and Stettner agreed that it would be best for the sake of sibling harmony if Susannah waited a bit longer. “We both thought, ‘Let’s let Emily enjoy this for a little while,’” says Stettner. “If Susannah tests positive, all of the sudden all of the attention will be focused on Susannah, and the happiness from Emily’s result will be overshadowed.”

Six months later, Susannah again said she was ready. There was some hesitation about her age: Generally, minors aren’t given genetic tests out of concern that they don’t have the emotional maturity to cope with the results. But Stettner had worked with the Gilberts long enough to know that Susannah was special. She was a thoughtful young woman who explored her ideas through writing and photography. She understood the disease. She understood the odds. And most of all, she wasn’t fazed by what the test might mean.

“To a lot of kids my age, cancer is this big scary thing. (To them,) people get cancer and die,” Susannah says. “To me, it’s part of my life. It’s part of how I grew up. I just want to know so I can process (it), make plans and get on with my life.”



**T**wo weeks passed, and Susannah returned to the counseling room in the cancer center. Stettner sat down at the table and exchanged brief pleasantries with Susannah and her parents. But this time, there



## Letter Imperfect

A single letter in Sarah Gilbert's DNA is responsible for her battles with cancer. The difference affects a gene known as MSH2, which helps protect the integrity of the genetic code inside our cells by proofreading newly made DNA before cells divide in two. In Sarah's case, a mutation known as Q601X—referring to the spot in her MSH2 gene where a chemical unit of DNA represented by the letter C is changed to the chemical unit known as T—renders the gene defective, causing it to form proteins that are too small to do their full share of work. As a result, genetic errors go undetected and accumulate in new cells, which can lead to the formation of tumors.



was no long discussion about statistics. Stettner turned immediately to her results.

Susannah was positive.

Susannah's face reddened, and water welled in her eyes. She stared at the table, afraid to look at her parents and lose what composure she was managing to hold on to. Stettner waited, letting the emotion roll over her. Susannah exhaled deeply, then looked up, ready to listen again.

There was more talk about Lynch Syndrome and how good it was to know early. Then the Gilberts drove home. In the car, Susannah slept, while Sarah stared ahead in silent reflection, moving through waves of successive emotion. She felt sadness and guilt, but also hope that Susannah's cancers would be caught much sooner than her own had. And she realized that she was no longer alone.

Possessing a genetic mutation can be a lonely burden, especially for a rare condition like Lynch Syndrome, which affects only a fraction of 1 percent of the U.S. population. When Sarah had been diagnosed, she had set out to contact others with the disease, hoping to form a support group in her area. She soon realized that there weren't any others to be found. She once wrote a poem expressing her envy of breast cancer survivors, with their immense support network and pink ribbons. There were no ribbons for Lynch Syndrome.

But Sarah has found comfort in her family, who have accepted her struggles with light-hearted grace. They helped Sarah find the humor in her condition, joking that she should have a zipper installed on her abdomen to give doctors easy access. Now she could provide that support for her daughter.

"It would be a happier thing if I was an island. But, on the other hand, what a bonding," says Sarah. "And maybe I can help Susi just by being a survivor and being there for her—a little camaraderie."


As they neared Appleton, Sarah called Emily, who had stayed home to cook one of Susannah's favorite dinners, lasagna. Emily had been on tenterhooks all afternoon, and the news was deflating. "I felt sort of guilty that she had it, and I didn't," says Emily. That night, the family watched a movie. Nobody talked about the test. Two months later, the sisters still hadn't talked about it directly.

Talking about it, in fact, turns out to be the worst part, Susannah says. At least for now. "One of the hardest things has been telling my friends, because teenagers don't do this sort of thing well. They either blow it off or start looking at you like you're terminally ill," says Susannah. Adults aren't much better. Susannah doesn't like hearing about her "strength." Nor does she like saccharine assurances about the phenomenal leaps and bounds medicine will make in

upcoming years.

For now, Susannah's day-to-day life is very much the same. During the day, she studies under the guidance of her mom. She babysits the neighbor kids for extra cash and spends it hanging out with friends. She is learning how to drive. The banality of it all "kind of bugs me in some ways," she says. "There's nothing I can do right now. I just know."

But there are other signs that the tiny mistake in Susannah's DNA has begun to creep into her consciousness, defining more than just her biological function. "I think it's going to be one of those things that's always just at the back of my mind whenever I'm making decisions," she says. "The doctors have said that if I want to have kids, I need to have them young, like before I'm 30 preferably, because that's when mom got her first cancer. It's kind of weird to have to think about that now, and to (know that) if I want to get married I need to find somebody who I know can handle going through this with me. In some ways, I'm thinking farther ahead than I should have to."

This fall, Susannah starts her junior year in high school. Although she's determined to take life as it comes, she knows bigger challenges are ahead. Right now, she's thinking about college. "The other day," she says, "I said to myself, 'I should find one near a nice hospital.'" 

### Coming Off the Bench

Career paths in the biotech industry are expanding beyond science.

**A**fter graduating with a bachelor's degree in genetics, Heather Gerard BS'00 took a good position in a campus lab. Yet she couldn't help worrying about her future.

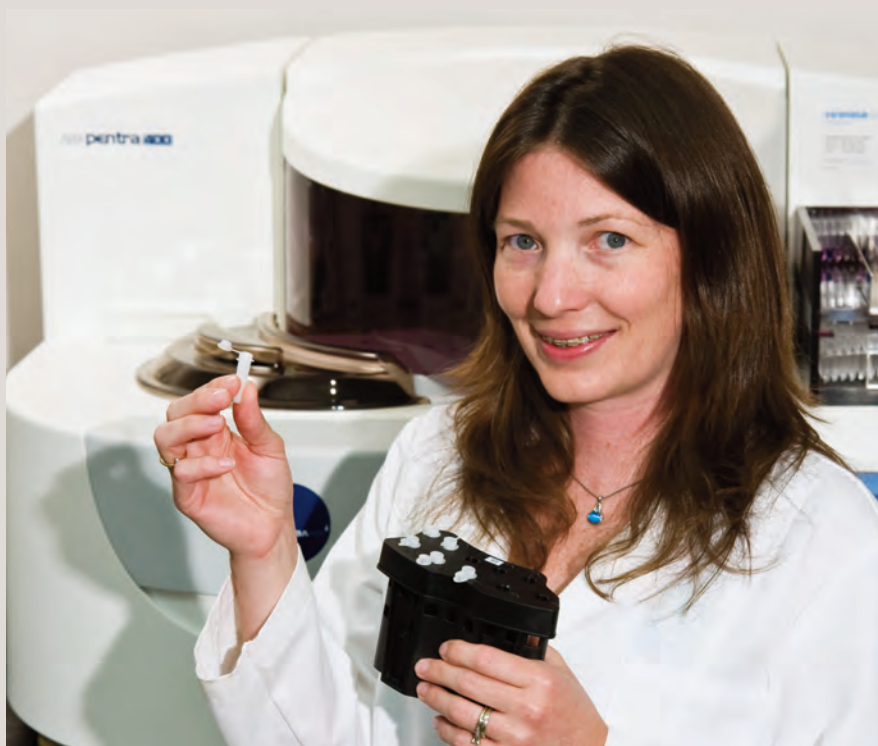
"I didn't want to be a bench scientist my whole life," says Gerard, who now works as a patent liaison at the Madison-based biotech firm Promega. "But I was totally oblivious to what else was out there."

To find out, she joined UW-Madison's Master's of Science in Biotechnology program, which aims to help young professionals navigate the complex world of biotechnology. Begun in 2004, the two-year program doesn't teach science as much as it does business acumen—one of the clear signs that biotechnology is establishing itself as more than just a scientific toolkit, but as an industry where science and technology meet medical needs, market forces, government oversight and ethics.

In addition to scientists, the program attracts lawyers, business professionals and an assortment of others who want to be a part of the growing biotech industry, which generated nearly \$60 billion in 2006. Consistently, demand for graduates far outstrips supply.

"No matter where you are in the biotech pipeline, understanding the big picture translates into efficiency, into (consumers getting) faster access to new technology," says Kurt Zimmerman, director of the biotech master's program. "Our goal is to help populate all the points along this pipeline with people who have this broad understanding, so that at some point it will become an unobstructed path."

Along the way, students quickly learn that the biotech industry has a culture and ethic all its own. Things change quickly, and companies face a near-constant onslaught of difficult decisions about which early-stage products to develop and how to fund them. Not surprisingly, the industry tends to attract



people who are both pragmatic and idealistic—those willing to acknowledge that companies need to earn profits as they speed potentially life-saving therapies to consumers.

"The thing that really keeps me going is the idea that this work might help people someday," says Jamie Nehring, a scientist who works in the lab of biochemistry professor Hector DeLuca MS'53 PhD'55, where she is working on an analog of vitamin D that has shown promise as a therapy to prevent diabetes. Although she works in an academic setting, Nehring also sought out the rounded education of the master's program, which she says has prepared her to follow her project through toward clinical trials and commercialization.

"Now if I do go to a smaller-sized biotech company, I'll be able to provide input in a variety of areas, not just the science side of things," she says.

—NICOLE MILLER MS'06

**Jamie Nehring earned a master's degree in biotechnology to augment her bench skills with a broader perspective on the industry.**



## The Grow Dozen

12

Alumni who are making a difference in biotechnology

## About the Dozen

These 12 alumni represent the stunning depth and breadth of CALS graduates' accomplishments. Selections for the list are made by the Grow staff and are intended to reflect a sample of alumni stories. It is not a ranking nor a comprehensive list. To read more about CALS alumni, go to [www.cals.wisc.edu/alumni/](http://www.cals.wisc.edu/alumni/)

Next issue: Dairy

Know someone who should be in the Grow Dozen? Email us at: [grow@cals.wisc.edu](mailto:grow@cals.wisc.edu)

## Jeff Browning

PhD'76, Biochemistry

As senior director of immunobiology research at Boston-based Biogen Idec, Browning has presided over the development of several new pharmaceutical drugs. One success story gives him particular satisfaction. Earlier in his career, Browning co-discovered the surface form of lymphotoxin, an important signaling chemical in the human body. The discovery led to the development of Baminercept, an early-stage drug designed to treat rheumatoid arthritis. Biogen is currently ushering this drug through human clinical trials, and scientists there are optimistic it will work to treat other autoimmune diseases as well.

interact, searching for genes that can help doctors fine-tune drug dosages given to patients. Right now, for instance, he's studying what genes affect the activity of Warfarin, a widely used, but tricky, blood-thinning drug. This emerging field, known as personalized medicine, offers the promise of medical therapies tailored to each patient's unique genetic profile.



Michel Chartrain

## Michel Chartrain

PhD'86, Bacteriology

Bread, cheese and wine are all products of fermentation, but so are many of our medications. This is Chartrain's bailiwick—coaxing bacteria to mass-produce the proteins and molecules that go into our drugs. As a distinguished senior investigator in the bioprocess research and development unit at Merck, he and his team tend to enormous vats of microbial life, adjusting conditions to create the optimal environment for fermentation. With this technology, he recently devised a novel method for generating plasmids for DNA vaccines, a critical step in the creation of effective pharmaceuticals.

## Krishna Ella

PhD'93, Plant Pathology

Not everyone manages to realize his grandest dream, but Ella is well on his way. After studying and working in the United States, Ella returned to his native India vowing to fight the spread of infectious diseases in developing countries. In 1996, he and his wife, Suchitra, founded Bharat Biotech with the goal of producing vaccines for diseases such as hepatitis and typhoid for pennies on the dollar. Bharat has supplied more than 1 billion vaccine doses to Asia, Africa and Latin America, and the company has two grants from the Bill and Melinda Gates Foundation to develop affordable vaccines for malaria and rotavirus. Meanwhile, Ella has emerged as one of his country's strongest advocates for research and development. He says his dream is to connect UW-Madison with India to act as a catalyst for its agricultural economy. One way he's working toward that goal is by paving a route for Indian science students to study at the UW through the new Khorana Scholars exchange program.



James Burmester

MARSHFIELD CLINIC

## James Burmester

BS'83 PhD'89, Biochemistry

Burmester's work at the Marshfield Clinic Research Foundation in Marshfield, Wis., shows the intriguing ways biotechnology is intersecting with medical care. As a senior research scientist at Marshfield's Center for Human Genetics, Burmester studies how genes and drugs



Krishna Ella



Brendlyn Faison

### Brendlyn Faison

PhD'85, Bacteriology

Since the beginning of her career, Faison has used the tools of biotechnology to protect the environment—although in many different ways. At consumer giant Procter & Gamble, she assessed the biodegradability of diaper materials and helped develop environmentally compatible fabric softeners. At the U.S. Department of Energy's Oak Ridge National Laboratory, she worked on bioprocesses for converting coal to liquid fuels and removing radioactive materials from wastewater. And now, as a microbiologist for the U.S. Environmental Protection Agency, she reviews new public health-related research while monitoring the emergence of new soil- and waterborne pathogens.

### George Golumbeski

PhD'85, Genetics

Earlier this year, Golumbeski left his job at pharmaceutical giant Novartis, where he had been vice president of business development, to take the reins of the Austrian biotech company Nabrivia Therapeutics. As chief executive officer, he oversees a 55-person team working on the next generation of antibiotics—including three developmental products

designed to fight methicillin-resistant *Staphylococcus aureus*, a frightening bacterial infection that doesn't respond to common antibiotics. Golumbeski enjoys tackling the scientific, organizational and fiscal issues in bringing new drugs to patients. "After nearly 20 years," he says, "my work remains fresh, complex and very challenging."

### Michelle Higgin

PhD'04, Biochemistry



Michelle Higgin

Higgin's diverse skills are helping her become a young leader within the biotech industry. After completing a postdoctoral position at the National Institute of Environmental Health Sciences, she joined PharmaDirections, a North Carolina-based company that provides scientific

and strategic oversight to biotech and pharmaceutical start-ups. As the company's biologics development manager, she wears many hats, serving as a scientific advisor to some clients and a business-development representative to others. She's overseen clinical trials, managed drug formulation projects and completed key experiments. That broad perspective aids in her role on the national committee for the Biotechnology Industry Organization, one of the industry's biggest professional associations.

### Robert Morrow

PhD'87, Horticulture

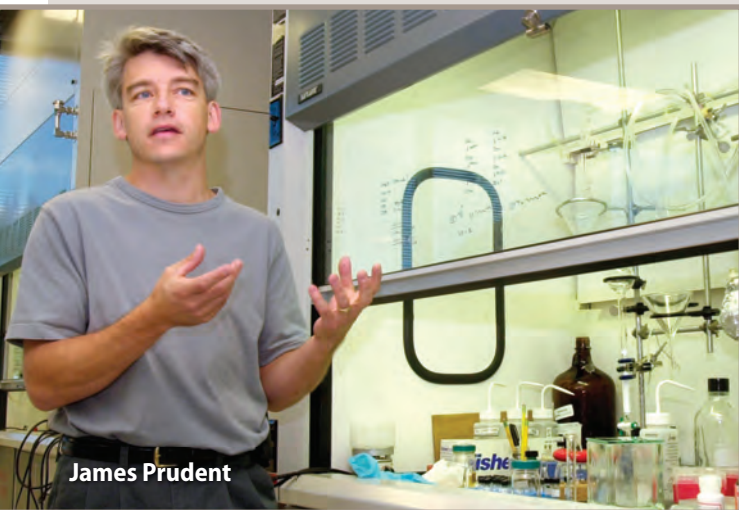
Morrow's technology attacks one of the major drawbacks of being an astronaut: the food. As a senior scientist at Orbital Technologies, Morrow is working on better ways to grow plants in space so that one day, astronauts can trade in their processed, vacuum-packed meals for fresh greens. In 2002, a compact plant-growth system he helped develop was tested aboard the International Space Station, and other models have been taken on space shuttle flights. Larger models of such systems might not just enable longer space missions, Morrow says—they could help people grow food while living on the moon or Mars.



Robert Morrow



# The Grow Dozen



THE CAPITAL TIMES VIA WWW.MERLIN-NET.COM

## James Prudent

BS'85, Bacteriology

Madison biotech startup Centrose is based on a sweet idea. Co-founded by Prudent in 2007, the company creates novel drugs by adding sugar molecules to currently marketed pharmaceuticals in ways that enhance their original properties. It's just the latest in a string of intriguing ideas from Prudent, a veteran of the Madison biotech scene. A former chief scientific officer at EraGen Biosciences, Prudent made a name for himself at Third Wave Technologies, where he invented a sensitive DNA and RNA detection technology and then helped turn it into a multimillion dollar product line. And don't expect Prudent to stop tinkering. "The obsession of using billions of years of evolution to create better ways of living just has not gone away," he says.

## Richard Scheller

BS'74, Biochemistry

As executive vice president of research and chief scientific officer at Genentech, Scheller

oversees strategy for the company's research and drug discovery activities. This is no small task. Genentech, which is headquartered in California's Silicon Valley, is considered one of the founders of the biotech industry and is now a world leader in the production of cancer medicines. It has an impressive number of drugs on the market, and one of the most robust product pipelines in the industry.

## Terry Sivesind

BS'75,

Agricultural Economics

While he's not a bench scientist, Sivesind may have more to do with the growth of Madison's biotech community than anyone. As a founder of Wisconsin Investment Partners, an angel investors network designed to seed local biotech start-ups, he's helped raise and distribute more than \$5 million to jumpstart fledgling companies. And he's an industry insider in another way. Since getting in on the ground floor at Promega, one of Madison's best-established biotech firms, he has been a founder or senior executive at several firms, including PanVera, Mirus, Takara Bio USA, Metabologics, Renovar, Poseidon Probes and Collectar. He also runs the Silver Lining Foundation, a private family foundation that focuses on helping Wisconsin's disadvantaged youth and families.



WISCONSIN STATE JOURNAL VIA WWW.MERLIN-NET.COM

## Willem "Pim" Stemmer

PhD'86, Plant Pathology

Stemmer is an engineer, albeit not your typical kind. He's what you might call a bio-therapeutics engineer, using the human body's own molecular building blocks to create new and better pharmaceuticals. To this end, he invented a technology known as DNA shuffling, where related genes from various species are combined in new ways to create novel genes and thus novel proteins. Stemmer co-founded Maxygen Incorporated in 1997 to commercialize this technology, and he oversaw the successful development of a dengue fever vaccine, as well as an immune system enhancer. Another of his engineered molecules led to the founding of the Avidia Research Institute, which developed a novel treatment for Crohn's disease while Stemmer was with the firm. He's now CEO of Amunix, which he co-founded in 2005.



Pim Stemmer

### Bryan Renk BS'82 MS'85, Animal Sciences

Three years ago, Bryan Renk was director of licensing at the Wisconsin Alumni Research Foundation when an intriguing new technology hit his desk. Developed in the lab of animal sciences professor Mark Cook, the process derived a powder from eggs that boosted the nutrition of animal feeds. Renk liked the idea so much that he joined the company. He's now chief executive officer of aOva Technologies, which is selling its feed additive to chicken, hog and fish producers across the country.

● **You spent a long time working with WARF. How did technology transfer lead to a job transfer?**

Well, for me, the first transition was moving from my family's seed business, which has a long history in Wisconsin and a long history working with the university. So when I went to WARF, I was initially focused on helping WARF work with ag biotech and biotech companies. But later on, as my career there developed, I got to see all these start-ups happening. We were putting the deals together and doing the paperwork, and we could watch the whole evolution. After a while, you start thinking, can I do that? Would it be fun, and would the challenge be there?

● **I'm sure you saw a lot of different promising technologies. What made aOva the right one for you?**

One thing was the professor (co-founder Mark Cook). He had a great track record of commercializing technology, and we thought this had a good chance of success. And it was in agriculture, so my background was a good fit.

● **Do you think coming from an agricultural background helped prepare you for the uncertainty of running a business?**

I think the answer has to be yes. The risk in agriculture is huge. You have to deal with Mother Nature, and you have to come up with solutions in a lot of different situations where there really isn't an existing answer. Most of the people I've known in agriculture are great problem solvers, and they're solving problems in so many different specialties. You get to cross over a lot, and that's great training.

● **Tell me about the name aOva.**

Well, the company used to be called Ovatech, but there was some confusion with other existing technologies. So when I came on board, we changed it to aOva Technologies. The small "a" denotes "antibody," and "Ova" means "egg"—and that's basically what we do.

● **You make antibodies in eggs?**

Yes. We produce a vaccine that causes hens to produce a particular antibody in their eggs, and then we turn those eggs into a powder that can be used as an ingredient in livestock feed. The antibody works on an enzyme in the immune cascade, which prevents the animal's immune system from going into overdrive. Basically, we think that animals and humans are overbuilt in terms of their immune response—when it kicks in, it takes away energy from the body and the animal is less efficient in its ability to grow. But this disrupts that function so that the animal can still fight off stresses without using so much energy.

● **And I imagine that's appealing to producers.**

It is. With feed prices increasing, they're concerned about feed efficiency, and we think we can help them use less feed to get growth. We also think it can add some health benefits, like helping use minerals better in their diets and reducing phosphorus in excretions.

● **So you really are a growth business.**

We hope so. So far the trend is positive.





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

# Emerald Ash Borer

By Chris Williamson

**1 | It's here!** Native to Asia, the emerald ash borer—a small, green beetle that bores its way underneath the bark of ash trees—was first discovered in the United States in 2002, near Detroit. Since that time, the invasive pest has spread to 10 states, killing some 25 million ash trees throughout the upper Midwest. The first positive identification of emerald ash borer in Wisconsin came this summer, when the insects were found in ash trees in Ozaukee and Washington counties, just northwest of Milwaukee.



JAMES E. APPLEBY/ UNIVERSITY OF ILLINOIS

**2 | EAB has likely been here for a while.** While this summer's finding generated a lot of media attention, the number of beetles found strongly suggests that they didn't just show up in Wisconsin. Trees can be infested for two or three years before they show any outward signs of stress, which means the beetle has probably gone undetected in Wisconsin for at least a couple of years. That's not all bad news—it shows that the insect is fairly slow in establishing itself and spreading to nearby trees.

**3 | Wisconsin has more than 765 million ash trees.** And that number means we should take emerald ash borer seriously. Because this beetle is not native to Wisconsin, our trees have no known natural defense to ward off the beetles' attacks. If emerald ash borer showed up in Madison, where almost 30 percent of the terrace trees are ash, the results could be devastating.

**4 | We can fight EAB—but there are no silver bullets.** Research shows that several types of pesticides—including both over-the-counter and professionally applied insecticide treatments—can be effective in controlling emerald ash borer. The best results come from pesticides that contain the compounds imidacloprid or emamectin benzoate, two neurotoxins that have been shown to kill emerald ash borer. But remember that we have only known about this bug since 2002, and we don't yet have comprehensive data on any treatment. Nothing has been proven to work all the time, and there's no evidence that higher-cost, more invasive techniques are any more effective than do-it-yourself ones.

**5 | We humans are likely the biggest reason for the spread of EAB.** On its own, an emerald ash borer typically flies less than one-half mile per year. It spreads far faster by getting a ride in infested firewood or other ash products. That means the best strategy for controlling the insects' spread is what Wisconsin has already done—establish a quarantine zone around known infestations and block shipment of any wood from those areas. The highest area of risk lies within 10 to 12 miles of an EAB infestation. Outside of this area, I don't think there is much reason for landowners to worry, at least for now. However, if it brings you peace of mind, you can certainly treat your high-value or specimen ash trees with insecticide.

*Chris Williamson is an associate professor of entomology and an insect-control specialist for UW-Extension. He is researching the effectiveness of several insecticides and application technologies in preventing the spread of emerald ash borer, and he also maintains a web site on the beetles at [www.entomology.wisc.edu/emeraldashborer/](http://www.entomology.wisc.edu/emeraldashborer/).*



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## Nutritional Sciences:

Where is the greatest volume of water in the human body found?

- a. Extracellular fluid
- b. Intracellular fluid
- c. Blood

From Nutritional Sciences 132: Nutrition Today, taught by Peter Anderson

## Horticulture:

Inbreeding in a population causes which of the following?

- a. Changes in gene frequency
- b. An increase in the genetic variance among families
- c. An increase in the genetic variance within families
- d. Enhanced expression of heterosis

From Horticulture 501: Principles of Plant Breeding, taught by Jim Nienhuis and Irwin Goldman

## Entomology:

The Louisiana purchase was affected by:

- a. Dengue
- b. Lymphatic filariasis
- c. Plague
- d. Kala azar
- e. All of the above
- f. None of the above

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

## Rural Sociology:

Which type of rural area experienced the highest population growth rates during the 1990s?

- a. Mining-dependent areas
- b. Recreational/retirement areas
- c. Commuting areas
- d. Farming-dependent areas

From Rural Sociology 140: Introduction to Rural Sociology and Development, taught by Gary Green

## Biochemistry:

Which of the following is true regarding the presence of uncoupling proteins (UCPs) in the mitochondria of hibernating bears?

- a. UCPs prevent the production of ATP while hibernating to ensure that the bear remains asleep.
- b. UCPs permit the bear to conserve fat reserves throughout the winter.
- c. UCPs permit more fat to be oxidized than is required to meet ATP needs to provide extra heat and water.
- d. All of the above

From Biochemistry 501: Introduction to Biochemistry, taught by Richard Amasino

LAST ISSUE: Answers were 1: b; 2: d; 3: b; 4: c; 5: d. Congratulations to Adam Hofer BS'06, of Minneapolis, who was randomly selected from the 14 people who aced our Final Exam and wins a free box of Babcock cheese.





## SIMPLE COMPLEXITY

Biochemistry graduate student Jenna Eun used a light microscope to capture this image of hydrogels spontaneously forming a pattern as they absorbed water. Eun says the picture, which won second place in the National Science Foundation's Science and Engineering Visualization Challenge, represents what she loves about science—its capacity for surprising beauty.

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