spring 2005

BIO

COLLEGE OF BIOLOGICAL SCIENCES

UNIVERSITY OF MINNESOTA

BUILDING

Minnesota's Bioscience Economy

The College of Biological Sciences is creating an "ecosystem" to grow new bioscience companies. But, does Minnesota have what it takes to make the industry thrive? See story on page 9.

SOUPED-UP SOYBEANS • RESEARCH AT CEDAR CREEK • MICROBES AND ELECTRICITY

Robert Elde, Dean

FROM THE DEAN

The UEL incubator—like Earl Bakken's garage 50 years later

In the early 1950s, Earl Bakken, a recent University of Minnesota engineering graduate, launched Medtronic and the medical device industry when he created the first pacemaker in his garage.

Today, that industry is looking to biology for the next generation of heart healing therapies. But it will take more than spare parts, pliers, and a garage to produce them. Biology has become an engineering discipline, but the spare parts are molecules, the tools are enzymes, and garages just don't make good labs. I like to think of the new business incubator, University Enterprise Laboratories (UEL), as a biotech garage.

The idea for UEL began to "incubate" five years ago when faculty member Perry Hackett told me he was planning to leave for a California university where he would have the opportunity to develop his own biotech inventions. We found a lab to serve as incubator space for him and he stayed. But, I realized that many states and universities were providing similar opportunities for faculty—Minnesota was falling behind.

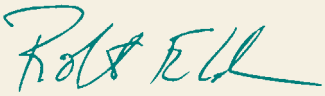
I was particularly concerned about what this meant for our students. They were at risk of losing some of their best teachers. And, without the same opportunities for research and internships as students in other states, they would be unable to compete for good jobs.

Fortunately, I found partners who shared my concerns: Mayor Randy Kelly, Kent Larson of Xcel Energy, and Jerry Fischer of the University of Minnesota Foundation. Some of Minnesota's most respected companies soon joined us: 3M, Allina, Medtronic, Boston Scientific, Guidant, Dorsey & Whitney, Surmodics, and Ecolab. I am grateful to them for their vision and support.

I hope that UEL is the start of a strong and enduring relationship between the University, industry, and government to promote the growth of Minnesota's biotechnology industry. By continuing to work together, we can accomplish even more. Our priority should be to create a joint plan for where we want to be in five years. We could take a cue from Iowa, which commissioned Battelle Institute to conduct an assessment of its strengths and weaknesses and to make recommendations. As a result, they have a very clear idea of their next steps.

Key to this planning is to recognize the growing number of ways that biotechnology—which is essentially engineering at the molecular level—can be applied in industry and agriculture, and in creating renewable energy. It's not just about medicine anymore.

Minnesota is in a very strong position to capitalize on the transition from biomedical to biological engineering because of our strengths in medicine and technology, and because of the entrepreneurial spirit in the Twin Cities. I look forward to seeing how this will unfold.



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BIO

SPRING 2005 ▮ Vol. 4 No. 1

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On the Cover (left to right) Saint Paul mayor Randy Kelly, CBS dean Bob Elde, and Xcel Energy's state vice president for Minnesota, North Dakota, and South Dakota Kent Larson toured the new University Enterprise Laboratories. The facility will be a key component for generating new bioscience businesses in Minnesota. *Photo by Jonathan Chapman*

BIO is published two times a year by the University of Minnesota College of Biological Sciences for alumni, faculty, staff, and friends of the College. It is available in alternative formats upon request; please call 612-624-0774 or fax 612-624-2785.

Wind turbine launches Morris center for renewable energy

A wind turbine that will meet half of the electricity needs for the University's Morris campus will be commissioned at an Earth Day celebration on April 22, culminating a week of events to promote renewable energy.

The first large-scale wind research instrument at a public university in the Midwest, the turbine is part of a larger demonstration project at the University's Renewable Energy Research and Demonstration Center at Morris. The center was funded by the Initiative for Renewable Energy and the Environment.

A community-scale, research and demonstration initiative, the center will focus on wind, biomass, biofuels, anaerobic digestion, and renewable hydrogen. Its purpose is to integrate renewable energy into Minnesota's rural economy and develop Minnesota's research and education strengths in this area. Greg Cuomo is director.

Other projects being developed at the Morris outreach center include:

- Wind-to-hydrogen demonstration;
- A biomass district heating and cooling system;
- A hybrid wind and biodiesel energy system;
- An energy "smart" solar building addition; and
- A community anaerobic digester and methane pipeline system.

Hendrickson lab gets $2.8 million from the NIH for genetics research projects

Eric Hendrickson (Biochemistry, Molecular Biology, and Biophysics) and colleagues in his laboratory have been awarded grants of $2.8 million from the National Institutes of Health for research on a common genetic mechanism that underlies a rare disease and for a project on a gene involved in repairing damaged DNA.

The researchers will receive $1.8 million over five years for "A human somatic cell model for Dyskeratosis congenita." The study focuses on KARP-1, a gene believed to cause Dyskeratosis congenita (DC), a rare inherited disorder that affects continuously renewed tissues such as the skin, mucous, and bone marrow. DC, which causes death from bone marrow failure or cancer, appears to be related to dysfunction of telomeres—repetitive sequences of noncoding DNA that cap chromosomes. The goal of Hendrickson's research is to use human cells with altered expression of KARP-1 to understand the molecular mechanisms of telomere dysfunction in human patients. By studying the abnormal processing of telomeres in individuals with this disease, his team also hopes to characterize the mechanism of telomere maintenance in normal human beings.

Eric Hendrickson (top, second from left) and members of his lab: Goutam Ghosh, Der-I Kao, Farjana Fattah, Matthew Thorseth, Junghun Kweon, Brian Ruis, Kat Larson, Yongbao Wang, and Riaz Fattah.

For the second study, Hendrickson and colleagues will receive $1 million over four years to study a gene that regulates telomere length and genomic stability and is involved in repairing damaged DNA. The gene is also believed to play a role in several forms of cancer. ■

CBS researcher is co-investigator of $6.6 million corn genomics grant

Nathan Springer (Plant Biology) is a co-principal investigator on a $6.6 million, four-year award from the National Science Foundation Plant Genome Project for a research effort entitled "Functional genomics of corn [maize] chromatin." Corn production in the U.S. is double that of any other grain, and it is used for materials and fuel as well as food. Understanding corn genomics provides insights for making corn more productive and nutritious while decreasing the need for chemical fertilizers and pesticides. The project involves collaborators at the University of Missouri, University of Arizona, Washington University, University of Wisconsin, and University of Georgia. ■

Tropical food web study shows caterpillars are picky eaters

Findings could help biologists identify species at risk of extinction

Despite a smorgasboard of dining choices, 90 percent of caterpillars in the tropical rain forests of Papua, New Guinea, eat only one kind of plant, according to a study co-authored by George Weiblen, assistant professor of plant biology at the College of Biological Sciences. The study was published in the November/December, 2004, issue of *Ecology Letters*.

Weiblen says that's probably because the two co-evolved, with the caterpillar evolving ways to overcome defenses that plants evolved to avoid becoming dinner.

The findings could mean that rain forest creatures have a tough time adapting when their favorite food is eliminated by deforestation. About two percent of remaining rain forests are lost to deforestation each year, Weiblen says. Understanding tropical food webs could help biologists identify which species are at risk of extinction.

Tropical food webs are challenging study subjects because of their complexity. Weiblen overcame that by using native parataxonomists—members of local tribes—to gather, identify, and record data. With a little training, they can actually do a better job than scientists, Weiblen says, because they so are attuned to rain forest life. ■

IN PRINT

Professor Craig Packer and graduate students **Anna Mosser** and **Bernard Kissui** (Ecology, Evolution, and Behavior) are co-authors of a paper published in the January 21 issue of *Science* on "Large-scale ecological change, group territoriality, and non-linear population dynamics in Serengeti lions." Their study showed sudden shifts to new equilibria of lion populations as a response to gradual changes in prey availability and the lions' grouping behavior.

Anthony Dean (Biotechnology Institute and Ecology, Evolution, and Behavior) and **G. Zhu** (Biotechnology Institute) published an article titled "The Selective Cause of an Ancient Adaptation" in the February 25 issue of *Science*. By genetically engineering an ancestral version of an enzyme and using subsequent selection experiments to show how the enzyme changed, their research revealed the selective basis of an adaptive event that occurred billions of years ago

David Redish (Neuroscience) has developed a computational model of addiction that can be used to make predictions about human and animal behavior. The model was reported in the December 10, 2004 issue of *Science*. Redish says that bringing addiction theory into a computational realm helps researchers address questions that will lead to a better understanding of addictive behavior. The model was developed based on two hypotheses: that the normal brain uses the neurochemical dopamine to reward learning, and that cocaine produces an increase in dopamine.

David Stephens (Ecology, Evolution, and Behavior) has discovered what may be the evolutionary basis for impulsive behavior. Through experiments involving blue jays, he and colleagues observed that this behavior evolved because, in nature, short-term small rewards (small morsels of food) actually provide more long-term benefits than waiting for bigger rewards. The work may help explain why many humans today find it hard to turn down an immediate reward —for example, food, money, sex, or euphoria—to wait for something better. The work was published in the December 7 issue of the *Proceedings of the Royal Society* (London).

Larry Wackett (Biochemistry, Molecular Biology, and Biophysics) co-authored a study published November 5, 2004, in *Science* titled "Accumulation of Mn(II) in *Deinococcus radiodurans* Facilitates Gamma-radiation Resistance." The article attributes this bacterium's ability to withstand high levels of radiation to its accumulation of manganese. *Deinococcus radiodurans* could be used to clean up sites contaminated by radiation.

Dean Elde speaks to legislative committees about U bioscience

Dean Bob Elde, left, addresses a legislative committee.

Bob Elde, CBS dean, spoke to the House Higher Education Finance Committee on Wednesday, March 2, to promote President Bruininks's bioscience initiatives as part of St. Paul Day at the Capitol.

Elde described how much progress the University has made in biological sciences thanks to legislative support for the Molecular and Cellular Biology Initiative, which has resulted in 41 new faculty and two new research buildings. He added that with their continued support, the University could make even more gains in this rapidly developing field over the next few years.

Students are at the heart of this effort, he emphasized. "We provide students with transformative education and research experiences. And they transform the quality of life in Minnesota by using biology to improve human health, agriculture and nutrition, the environment, and the economy.

Elde also testified before several other legislative committees about bioscience and biotechnology during the session. ■

CBS recruits new associate dean for research from the NIH

Huber Warner, a National Institutes of Health (NIH) research director, is the new associate dean for research at the College of Biological Sciences. In his new role, he will lead research initiatives and graduate programs and help implement CBS's strategic plan. Warner, formerly a CBS biochemistry professor, left the University to join the NIH where he has held several executive positions for the National Institute of Aging. For the past five years he has been associate director for the Institute's Biology of Aging Program where he developed new research programs and managed $150 million annually in grants and research contracts. Warner arrives on June 1. ■

TIM RUMMELHOFF

Move over Texas—Minnesota aims to lead biofuel production

The North Star state hopes to give the Lone Star state a run for its money, at least when it comes to energy. Dean Bob Elde and Richard Hemmingsen, director of the Initiative for Renewable Energy and the Environment are working to secure $30 million in federal funds to build a national center for biofuels research.

The Minnesota lab, potentially located adjacent to the Cargill Building on the St. Paul campus, would be modeled after the National Renewable Energy Laboratory in Golden, Colorado. It would develop and commercialize technologies that use the state's agricultural and forest products to produce biofuels and bioproducts.

"Minnesota has the natural, academic, and business resources to become the Texas of the biofuel industry," Elde says. Minnesota already leads the nation in production of ethanol.

Governor Tim Pawlenty endorsed the plan last fall at a press conference where he announced his own plans to develop renewable resources to reduce Minnesota's dependence on imported oil, strengthen the state's economy, and protect the environment. ■

Funds sought to restore two Itasca cabins

CBS has launched a fund-raising campaign to rebuild two cabins at Lake Itasca Biological Station and Laboratories.

Cabin 4, a three-bedroom structure built in 1911 from Tamarack logs on a stone foundation, has been one of the most popular cabins among faculty and visiting scientists. But it cannot be salvaged because of structural issues. The plan is to dismantle it and use the logs to construct a winter-proof replica on the same site. The budget for this project is $150,000. Retired professor John Tester, who worked at Itasca for more than 40 years, is leading the fund-raising effort.

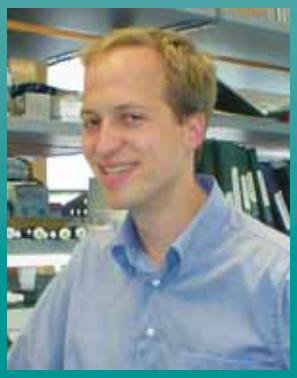
The second project is a new cabin for women students to replace Cabin 30, which was condemned and demolished in fall 2004. The budget for this effort is $50,000. CBS plans to enlist the help of alumni, faculty, staff, and students as volunteers to assist with construction. Itasca Director David Biesboer, professor of plant biology, and Associate Director Jon Ross, adjunct professor of ecology, evolution, and behavior, will lead volunteer construction crews over two weekends in September.

Funds from the estate of Thomas Morley (a professor of plant biology who died in 2002) are being used as challenge grants. For information about either project, or to make a contribution, contact development director, Ames Sheldon, at 612-624-9460 or sheld057@umn.edu ■

PEOPLE

Mervyn de Souza (M.S. microbial engineering,1997, and Ph.D. microbial biochemistry, 1998) has received the Alumni Service Award from the Board of Regents. He was recognized for his contributions as president of the Biological Sciences Alumni Society. De Souza, whose graduate adviser was Larry Wackett, professor and head of microbial biochemistry, is a principal scientist in Cargill's Biotechnology Development Center. He uses microbial biotechnology to develop new and improved processes for food and bio-based materials.

Mervyn de Souza

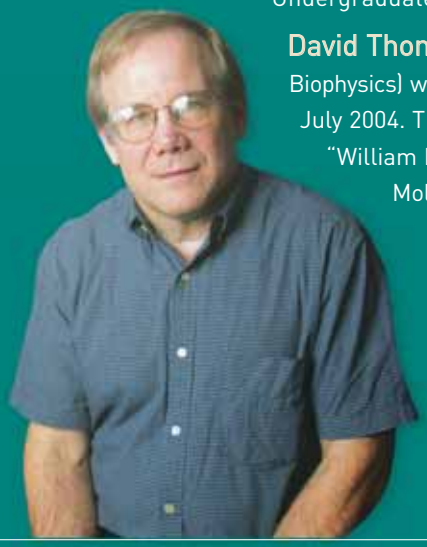


Reuben Harris

Reuben Harris (Biochemistry, Molecular Biology, and Biophysics) and **George Weiblen** (Plant Biology) have been selected as McKnight Land Grant Professors for 2005–07. The two-year awards recognize the University's most promising junior faculty. Harris studies the role of mutations in human cancers and the use of mutations to destroy pathogens. Weiblen, who joined the plant biology faculty in 2001, is also curator of flowering plants at the Bell Museum. His research concerns biodiversity in tropical rain forests, with an emphasis on the evolution of plant and insect interactions. Weiblen and Harris are among 11 recipients University-wide.

George Weiblen

Robin Wright, associate dean for faculty and academic affairs, spoke about undergraduate biology curriculum at a November meeting of the National Academy of Sciences Board on Science Education. The title of her talk was "Scholarship of Teaching and Learning in Undergraduate Biology."



David Thomas

David Thomas (Biochemistry, Molecular Biology, and Biophysics) was named William F. Dietrich Professor in July 2004. The full name of this endowed chair is the "William F. Dietrich Land Grant Chair in Fundamental Molecular and Cell Biology in the Basic Sciences." Dietrich, who died in 1990, was president and CEO of the Green Giant Company. The first holder of the Dietrich chair was Leonard Banaszak, who carried the title from May 1989 until July 2004, when he began a phased retirement.

PLANT BIOLOGY

Souped-Up Soybeans

Researcher applies genomics to create better biofuels

TIM RUMMELHOFF

Plant biologist Sue Gibson is studying ways to make soybeans produce more oil.

Those who hope to decrease America's dependence on foreign oil look increasingly to one of Minnesota's signature crops—soybeans—to do the job. Oil derived from soybean seeds may serve as a replacement for petroleum-based diesel fuel. Biodiesel, as it's often called, has many things going for it: It's renewable, it can be used in existing engines, and it produces less pollution than conventional diesel fuel. There's only one problem: At current prices, it may cost more to make than it's worth.

Sue Gibson thinks she can do something about that. An associate professor in the Department of Plant Biology, Gibson explores how sugars guide plants as they distribute the energy and carbon they gather from sun and air throughout the plant, a process called partitioning. As a practical application of her research, she's currently figuring out ways to coax soybeans to make more oil for biodiesel.

"We've been working for years on trying to understand how plants make those types of decisions," Gibson says. "I started thinking about how to apply what we're learning. The work that we do is really pretty basic, but we always recognized that if you understood it, then you could potentially manipulate it in ways that would be economically useful."

At current prices, biodiesel may cost more to make than it's worth.

Gibson's actual subject of study is not the soybean but *Arabidopsis thaliana,* a small flowering plant of the mustard family that is widely used as a model organism in plant biology—it's the botanical equivalent of the white rat. Because its genome has been sequenced and many mutants are available, *Arabidopsis* provides a rich resource for exploring the function of various plants. Last year Gibson and David Somers, professor of agronomy and plant genetics, were awarded a seed grant from the University's Initiative for Renewable Energy and the Environment (IREE) to learn more about partitioning as a first step toward improving biodiesel production. Using DNA chip technology, the two identified some 200 genes that appear to play a role in transforming signals sent by sugars into decisions about what carbon goes where.

Next, with additional support from IREE and the Georgia-based Consortium for Plant Biotechnology Research, Gibson hopes to narrow the field even more by studying partitioning in *Arabidopsis* strains with mutations in the genes they identified in the pilot project.

"Based on that, we'll pick out a handful of genes that look promising and test those in soybeans," Gibson says. Once she has a clearer understanding of the genetic control of partitioning, Gibson says, the next step will be to manipulate it to enhance the soybean's production of oil—and of protein, because the seeds have value as animal feed after the oil is extracted. The ultimate goal is a more economically sound alternative to conventional diesel fuel.

—Mary K. Hoff

Current Events

Daniel Bond gets a charge out of microbes

If you looked at the jars and bottles of murky, green and brown-tinted water and sediment in Daniel Bond's laboratory refrigerator, you'd never guess the magic that may come from their contents. In fact, you might tell Bond, an assistant professor in the Department of Microbiology and the Biotechnology Institute, that it's time to clean out the refrigerator.

> "It's like alchemy... Imagine making electricity from mud."
>
> *—Daniel Bond*

Yet, these bottles contain the miraculous microbe *Geobacter sulfurreducens,* a microorganism widely found in the sediment beneath bodies of water, at the bottom of a pond or the ocean, for example. *Geobacter* offers tremendous potential for two things: the creation of electrical current and bioremediation of polluted environments. That's because it possesses an extraordinary ability to transport electrons and reduce metal ions in a chemical process through which it adds electrons to the ions. The flow of electrons from the bacterium to a metal, or to an electrode, is the same as when electrons flow from one pole to the other in a battery, thus creating an electrical current. In the process, the organism breaks down organic molecules in the sediment, including many that are introduced by accident (e.g., fuel spills). Some metals, such as uranium, become less soluble when reduced by *Geobacter* and precipitate into solids, which are easier to remove from the site.

Bond arrived at the University of Minnesota in July from the University of Massachusetts-Amherst where, as a post-doc, he was part of the groundbreaking discovery of how *Geobacter* produces electricity. Now, in CBS's Gortner laboratories, he is ramping up his new lab to study how to more efficiently harness these organisms to create electricity. "So far we can do tricks, like make a light bulb burn or run a toy robot," he says, "but we can't put it to larger use. We need a way to get more power." Many of the answers to the problem lie in the fields of engineering, bio-sensing, and bio-catalysis rather than in microbiology. That's why he's delighted to be involved with the Biotechnology Institute where he can easily tap the resources and expertise of those disciplines. He's also searching for other organisms that, like *Geobacter*, serve as tiny electrical generators.

Bond's "current pursuits" belie his earlier academic interest: He began his education with a musical bent, attending high school at the prestigious Interlochen Arts Academy in Traverse City, Michigan, where he studied piano. Still, the scientific mindset is a family affair. He grew up in Midland, Michigan, where his parents worked in the chemistry and computer fields for Dow Chemical and Dow Corning. He's passing

TIM RUMMELHOFF

Daniel Bond studies the electricity-producing microbe *Geobacter* which is found beneath bodies of water.

that tradition of scientific thinking on to his three-year-old daughter, Lola, and admits he tries to describe for her what's going on in the compost pile.

"I chose microbiology because it has all of biology in a one-micron package. It's like alchemy. Bacteria are where the magic is.

"Imagine making electricity from mud," he says. "There's always something even more fantastic on the horizon."

—Terri Peterson Smith

Saint Paul mayor Randy Kelly, Xcel Energy vice president Kent Larson, and Dean Bob Elde tour the UEL construction site.

JONATHON CHAPMAN

BUILDING

Minnesota's Bioscience Economy

The College of Biological Sciences is upping the ante in the high-stakes race to build a new industry.

Construction workers are hammering in the last nails to complete the new bioscience business incubator, University Enterprise Laboratories (UEL). When UEL's doors open officially this summer, the College of Biological Sciences (CBS)— along with University, corporate, and government partners— will have put in place another piece of the structure that will help the biosciences flourish in Minnesota.

The building, located midway between the University's two Twin Cities campuses, is the latest in the college's many efforts to serve as a catalyst in turning bioscience ideas into reality, moving them from the laboratory into the world of business. By building an infrastructure of facilities, scientific expertise, and a rich source of potentially patentable technology, CBS is helping to create the perfect environment for new companies to take root. That could position Minnesota as a player in the new bioscience industry and in a technology boom that will make the information technology boom pale in comparison.

At the heart of this effort: University of Minnesota students. "If we put the needs of students first, everything else falls into place," says Dean Bob Elde who is chairman of the UEL board of directors. He says students need to be in close proximity to members of the bioscience industry in order to explore careers in bioscience and biotechnology and to participate in real-world research.

"They need the inspiration that comes from interaction with people in the bioscience industry, and UEL will provide that," says Elde. "There are science and technology companies crowded around the periphery of most university campuses," he says, citing Palo Alto and Boston. "That proximity provides opportunities and inspiration that our students haven't had because companies like 3M and Cargill are miles away. "What is there to inspire you here? Grain elevators?"

Like 22 Garages

Business lore abounds with new inventions that were born somewhere between the family car and garden implements. Stanford students Bill Hewlett and Dave Packard designed the audio oscillator that became the foundation of their electronics empire in a garage. Ditto for Earl Bakken, founder of Medtronic. UEL founders have created an environment that offers the high-tech equivalent of those early garages. They intend to spark the creativity there that will have similarly spectacular commercial success. "With 22 wet labs built into the center of the building, this is like having 22 garages," says UEL CEO Pete Bianco.

Formerly the headquarters of Target Direct, the 125,000-square-foot facility will house a mix of early- and mid-stage companies along with service providers, such as patent attorneys and bookkeepers. Some of UEL's earliest tenants include Gel-Del, which uses purified proteins to produce materials that can be molded or shaped into almost any form and engineered to

JONATHON CHAPMAN

UEL's CEO Pete Bianco predicts that new companies will "graduate" from UEL in three to five years.

> "There's an organic element to building this industry. You have to create the 'ecosystem' where people interact and collaborate."
>
> *—Pete Bianco*

mimic the body's own tissue. Stent Tech develops biocompatible stents, the tiny tubes that prop open blocked arteries. ANDX uses genomic information to develop diagnostic tests for the pet and agricultural animal sectors. Another company, Prism Research, specializes in Phases I and II clinical trials for new pharmaceutical products and medical devices. St. Paul mayor Randy Kelly hopes that UEL will eventually serve as the starting point for an entire technology park in the area.

Yet, Bianco emphasizes that UEL is about more than just a collection of offices and wet labs—it's a way to create a network. "There's an organic element to building this industry," he says. "You have to create the 'ecosystem' where people interact and collaborate. You can't force it. The power of collaboration is huge. It exponentially leverages the ability of a company to succeed. There's a cultural and social aspect to this that people don't understand."

Building Bonds

Relationship-building is a fundamental aspect of another CBS endeavor, the Biotechnology Institute (BTI), which was launched in 1983 with $300,000 annual funding from the legislature. It was among the first wave of university-based biotechnology centers. BTI's members include faculty from CBS, the Institute of Technology, Medical School, and College of Agricultural, Food and Environmental Sciences. The institute's cross-disciplinary, intercollegiate structure makes it a convenient entry point to use the University's biotechnology expertise and equipment. "The Biotechnology Institute is really one of the strongest outreach efforts to the biotech community," says BTI director Ken Valentas.

Doug Cameron, director of biotechnology, Cargill

While Hewlett and Packard could launch their electronics ideas from a garage, with bioscience it's not so easy. Inventors need complex and costly equipment and facilities—clusters of computers, for example, or equipment for large-scale protein expression or fermentation—things not commonly found at the local hardware store. BTI is the place where researchers can go for technical help in ramping up their ideas before they're ready for a facility like UEL. In fact, the institute operated incubator laboratory space in Snyder Hall and Gortner Laboratories from which some of UEL's first tenants "graduated."

BTI works in several specific ways. It led to Biodale, which operates in Snyder Hall and Gortner Lab and bills itself as "Minnesota's shopping mall for biotechnology and life sciences research support services." You won't find Starbucks or Gap at this mall. It caters to customers in both the business and the University community, offering space and state-of-the-art equipment that many companies could not afford to purchase. Perhaps most important, Biodale "shoppers" find problem-solving expertise. There are six different shops, each staffed by specialized scientists and technicians.

The "anchor tenant" of Biodale is the Biotechnology Resource Center (BRC), according to its director, Marc von Keitz. BRC is a pilot-scale facility, staffed with a team of highly trained scientists, which provides services in molecular biology, protein expression and purification, and fermentation process development and scale-up. BRC offers advice on refining experiments, or its staff will fully execute a project.

Doug Cameron, director of biotechnology in Cargill's Biotech Development Center, says that his group makes significant use of Biodale, and their experience shows the

strong University-industry relationship that results. "We see the U as the 'go to' university for day-to-day activities. The U of M is in our backyard. We know the people, and we have the best success at recruiting new employees there."

The groundwork first laid with BTI led to Biodale, and the makeshift bioscience business incubator in Snyder Hall evolved into UEL. But new efforts continue. Valentas says that BTI will continue to be strong in research on biocatalysis and biodegradation. BTI has also submitted a proposal to the NIH for a $9 million grant to create a chemical biology screening center.

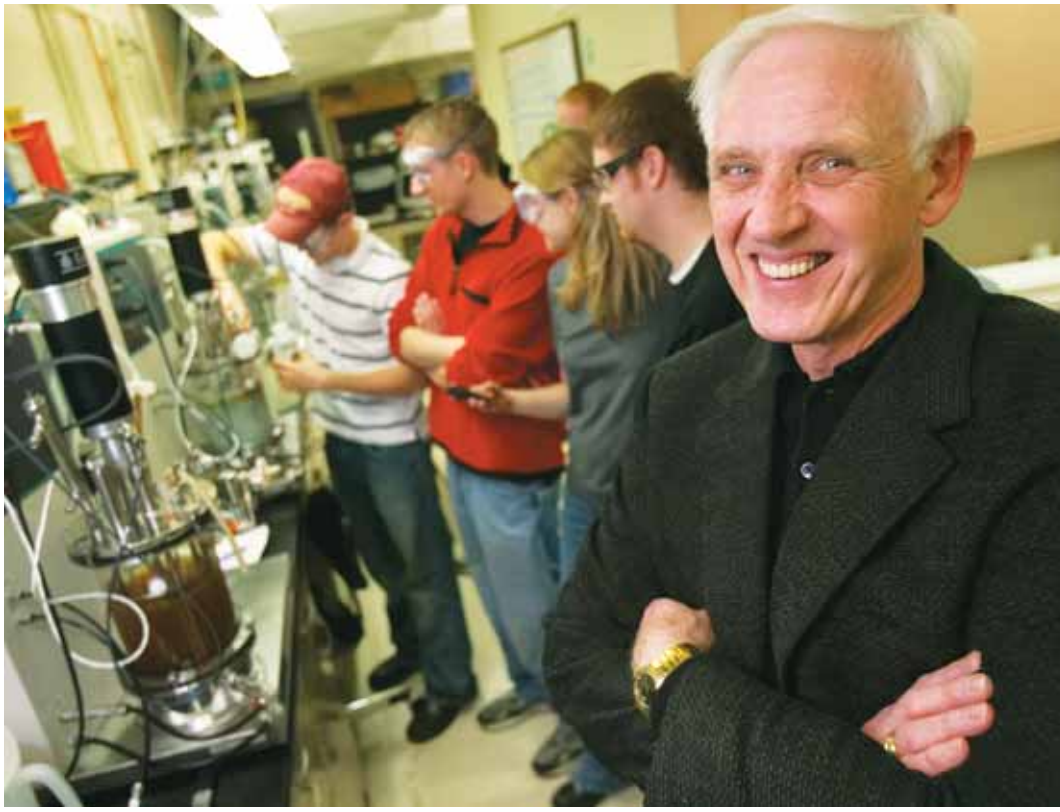
Redefining "Biotech"

Look carefully at UEL, BTI, and their business partners. You'll see that convergence is the hallmark of the work going on there—biology with engineering, agriculture and biochemistry, high-speed computing and genomics, medical devices with pharmaceuticals—all combining to create a new definition of biotech. Most people have a notion of biotechnology, perhaps vaguely related to genetic engineering. But that limited concept of biotechnology is as out of date as a transistor radio.

Now, biotechnology is "applied biology," the application of biological knowledge and techniques to develop products. It uses living organisms to make products or run processes. By this definition, the classic techniques used for plant and animal breeding, fermentation, and enzyme purification would be considered biotechnology. Biotech isn't one technology, Elde summarizes. It's a platform technology for many different activities.

Cargill provides a good example. Cameron says, "We're involved in animal biotechnology, using animals' genetic information to determine how to best feed them or for selective breeding. We use it in diagnostics, for tracking animal diseases, such as mad cow or avian flu, and for tracking traits in plants. But it's not limited to food production. Cargill applies biotechnology to the manufacture of materials. "We use enzymes and microorganisms for processing and making ingredients such as plastics, and we apply fermentation technology to produce products used in industrial markets," says Cameron. "We're headed toward a sustainable chemical industry that will replace the petrochemical industry."

Medtronic provides another local example.



JONATHON CHAPMAN

BTI director Ken Valentas, with students from the Institute of Technology who are learning about biocatalysis.

The company is moving beyond its long-standing heart pacemaker business, using its medical device expertise to deliver biologically based pharmaceuticals. "The main reason I came to Minnesota was to catalyze the convergence of medical devices and 'biologicals'," says Stephen Oesterle, Medtronic's senior vice president for medicine and technology, who arrived here from Harvard Medical School. "This will be the decade characterized by protein, cell, gene, and RNA therapies. These biologicals can't be ingested or they will be digested, so they have to be delivered by implantable devices." He cites the examples of Medtronic's implantable insulin pump and vascular stents coated with drugs or proteins to treat vascular disease. "Bioscience is integral to the efforts of this industry."

Farm Team or Big League?

Governor Tim Pawlenty is looking at the bioscience boom and likes what he sees. He says, "It's the next wave of innovation, not just in health

> "Bob Elde and the College of Biological Sciences have done a tremendous job and have been consistent drivers of this. The University is a powerful part of the process, but we have to support it. The University can't do it alone."
>
> *—Doug Astry*

Stephen Oesterle, senior vice president, Medtronic

care, but agriculture, pharmaceuticals, and much more. The bioscience industry will have a tremendous impact and be a large part of the overall growth of our economy, both domestically and globally. It's especially significant for Minnesota," he says.

But are we in time to be a real player or is Minnesota destined to be a mere farm team for the coasts where the real bioscience action is? "Minnesota has a decent start," says Pawlenty. "We're not as well-positioned as we should be, but to say that we've missed the boat is ridiculous. I'm excited and optimistic about this sector, but we can't lead in every sub-category. We have to focus on areas of historical advantage and exploit them." Based on Minnesota's traditional industrial strengths, industry observers see the best chance for Minnesota in three main bioscience areas—medical devices, food, and industrial biotechnology. Says Cameron, "Minnesota can be a leader in convergence of related technologies and leapfrog over the competition."

Yet, before the state can make the leap, it needs a stronger blend of community leadership, capital, and bioscience management skills. Walt Plosilla, vice president of technology partnership at the Battelle Institute, a global science and technology enterprise that develops and commercializes technology, says, "The marketplace drives development, but you must bring the community together to create a vision. There must be a stronger effort than serendipity alone. The private sector, funding sources, academia, and government must work together to move in a straight line."

Doug Astry, general manager of diagnostics and drug discovery at Surmodics in Eden Prairie and president of the bioscience trade organization, MNBIO, says, "Different organizations have tried to provide leadership. Bob Elde and the College of Biological Sciences have done a tremendous job and have been consistent drivers of this. The University is a powerful part of the process, but we have to support it. The University can't do it alone. You need community and government leadership. So far, it's been inconsistent at best." He adds, "There's a role for government in this area, at both a national and state level."

Pawlenty agrees. "The government has an important role in creating the infrastructure and the environment where innovation occurs. There must be leadership from government, as well as business and academia, so that we're all singing the chorus of the importance of this industry to the future of Minnesota."

For bioscience to thrive, says Plosilla, "you need a continuum of capital. It's not just venture capital. You need equity capital at all stages." Twenty-five states including North and South Carolina, Texas, and Wisconsin, invest a percentage of their state pension funds to foster the biosciences industry. They invest that money in venture capital funds to minimize the risk, an idea that Pawlenty advocated when he was a legislator.

> **"The bioscience industry will have a tremendous impact and be a large part of the overall growth of our economy, both domestically and globally. It's especially significant for Minnesota."**
>
> ***—Governor Tim Pawlenty***

Oesterle and Bianco add that the need for management expertise in this new industry goes hand-in-hand with such investment. Says Bianco, "For people on the coasts, creating new companies has become part of their DNA. Here, we have the infrastructure and expertise for medical devices, but none for biotechnology."

Those who look to the University for the new ideas, the research and development support that BTI provides, and places like UEL to grow them, hope that the missing pieces will fall into place or the state risks losing out. "In five years, all of the big companies will have significant investments in biotechnology—through joint ventures, collaborations, and technology licensing," says Oesterle. "The game is set. It doesn't have to be played here, but it would be easier."

Bianco says cheerleading for the development of new biosciences companies isn't enough. "The rah-rah is great, but back it up," he says. "In three to five years we will deliver on the promise to deliver healthy biotech companies from this building. The next step is where do they go?

"We're executing now," he says. "Will the rest of the community deliver?"

—Terri Peterson Smith

The Next Big Thing

The field of proteomics makes genomics look easy

A decade ago, biology was abuzz about genomics, the study of the structure and function of genes. Today the word to watch is *proteomics*—the field that focuses on proteins and how they alter, and are altered by, other cellular components. Scientists have begun to amass knowledge of the *proteome*, which is all of the proteins produced by a given species, just as the genome is the totality of the genetic information possessed by that species.

Proteins are the major workhorse factors in cells," says David Bernlohr, professor and head of the Department of Biochemistry, Molecular Biology, and Biophysics (BMBB). "They form many of the structures involved in cellular integrity, they catalyze the reactions necessary for cellular function, and they facilitate the transmission of genetic materials. Many diseases are really problems with protein function. As a consequence, we're trying to understand the complexity of the proteins in a cell."

Tim Griffin, assistant professor of BMBB, is one of the University's leaders in proteomics. Five years ago, he, like many other biochemists, focused his attention on genes. "That was fun and exciting, but then I moved on," he says. "Proteins present an even more complicated challenge.... The whole proteomics field is one that's just ripe with questions."

And it's hefty, too. A human cell has some 30,000 to 35,000 genes—and perhaps ten times that many different proteins. "And those proteins are associated with other proteins," Bernlohr says. "It makes plain old genes seem pretty simple."

> "The whole proteomics field is one that's just ripe with questions."

Griffin is currently working to develop new techniques for applying mass spectrometry—a technology that measures the mass-to-charge ratio of a molecule—to analyzing proteins. When information about the mass and charge of a protein is combined with information about an organism's genome, researchers can answer a variety of questions.

"The proteome is extremely complicated, with many levels of information," Griffin says. "What we do is develop the tools that will allow us to answer questions about what proteins do." He's currently working with Bernlohr to look at how obesity alters proteins within a cell. He's also collaborating with School of Dentistry professor Nelson Rhodus to study how saliva-borne proteins differ between healthy people and those with oral cancer.

To make the most of opportunities in this emerging field, BMBB last July instituted the Mass Spectrometry and Proteomics Initiative with $2 million in support from the Academic Health Center and the Graduate School.

"The idea is to stimulate research in proteomics and to allow investigators to develop new grants and new initiatives in protein technologies in both agriculture and health sciences," Bernlohr says. The funds are being used to acquire new technology and support staff, and to provide seed grants that allow investigators to gather preliminary data needed to win major federal grants.

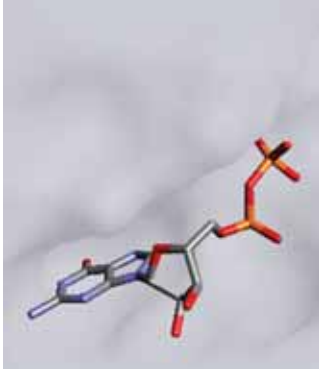
TIM RUMMELHOFF

Tim Griffin is one of the University's leaders in proteomics, the study of the structure and function of proteins.

According to Bernhohr, every institution is investing mightily in the study of proteomics.

"Minnesota has really first-rate facilities, and the availability of computational power through the Supercomputing Institute has allowed us to be a leader in this field."

—Mary K. Hoff



FIELD NOTES

Ecological Time Machine

The results of long-term research at Cedar Creek make Dave Tilman an advocate for the environment

TIM RUMMELHOFF

David Tilman, Regents Professor of Ecology, uses biodiversity research to see the future of Earth's ecosystems.

If David Tilman were a prairie plant, he might be *Andropogon gerardi,* the native prairie grass known as Big Bluestem.

Like Big Bluestem, Tilman uses resources with exquisite efficiency, says Clarence Lehman, associate director of Cedar Creek Natural History Area, where Tilman conducts research that has made him one of the world's foremost ecologists. But while Big Bluestem dines on nitrogen, Tilman thrives on time.

"Dave is one of the most focused people I know," Lehman says. "If he finds he has three minutes to spare before a seminar begins, he'll pop back into his office to write another sentence for the paper he's working on. That's one reason he gets so much done." And Tilman, who has one foot in research and one in environmental advocacy these days, has a lot to do.

Resource competition has been a key theme of Tilman's research since he published a doctoral study on the subject in *Science* in 1976. Since then, his use of mathematical models to better understand ecosystem dynamics has helped shape the field of ecology, making it a much more quantitative and predictive science, according to an article published in *Proceedings of the National Academy of Sciences* in 2004 to recognize Tilman's membership in that august body. So it's not surprising that he keeps an eye on the clock and puts his own resources to good use.

Hidden Treasure

Big Bluestem is one of hundreds of plant species in Tilman's biodiversity research plots at Cedar Creek. By varying combinations of species and nutrients in each of the plots, Tilman explores the role of biodiversity in ecosystems. The 20-year-old project is funded by the National Science Foundation as part of a national network of Long-Term Ecology Research projects. And it has elevated Tilman and Cedar Creek to international prominence. Although Cedar Creek is a hidden treasure within Minnesota, its name and Tilman's research are well known by ecologists around the world.

Located just 30 miles north of the Twin Cities, Cedar Creek makes an ideal living laboratory for ecology research because of its biodiversity. Most of North America's primary ecosystems—western prairies, northern coniferous forests, and eastern deciduous forests—are represented within its 5,400 acres. The Minnesota Academy of Science acquired Cedar Creek and transferred ownership to the University in the early 1940s. Shortly afterward, graduate student Raymond Lindeman, who is credited with coining the term "ecosystem," established the modern theory of ecosystem ecology based on his research at Cedar Creek.

Blast from the past: This outdated lab is used as an office.

Tilman arrived on the scene and created his biodiversity plots,

which resemble a patchwork quilt of prairie plants, in the early 1980s. The long-term nature of the research is what makes it valuable, he says. "Cedar Creek is a time machine that shows what could happen in 50 or 75 years if we remain on the same course and continue increasing the amount of nitrogen and carbon dioxide in the environment."

Strength in Biodiversity

Tilman stunned the international ecology community during the mid-1990s with a series of groundbreaking articles, published in *Science* and *Nature*, showing that biodiversity strengthens ecosystems and species, and that nitrogen fertilizers decrease biodiversity and ecosystem function. His most well-known article, published in 1994 in *Nature*, rejected a long-held belief that diversity destabilizes individual species and thus, presumably, entire ecosystems. The discoveries made him the most cited ecologist for more than a decade and led to a Pew Fellowship, a MacArthur Award, and membership in the National Academy of Sciences, among other honors.

His discoveries also compelled Tilman to share his news and concerns with a broader audience. A few years ago, he started *Issues in Ecology,* a publication for educators and policymakers. Each edition takes on a major issue related to human impact on the environment. Other efforts range from public lectures to Congressional testimony to international conference presentations.

About a year ago, Tilman began working with Stephen Polasky, professor of applied economics and ecology, to calculate the full costs of energy and agricultural practices and to place an economic value on the services that ecosystems provide. Polasky focuses on economic strategies to encourage people to preserve the environment.

"The economics of nature and the economics of society are amazingly similar," Tilman says. The economic analogy is important, he believes, because consumers make economic choices that often harm the environment without realizing the long-term costs. And ecosystems provide a valuable service to consumers by filtering at least some pollutants out of the air and water.

"By placing a monetary value on nature's services, we can determine if environmental policies will cost us money or save money," he says. "Then we can make decisions that have the best long-term benefits for society."

Research at Cedar Creek Natural History Area has long outgrown this modest facility, which was constructed in the 1950s. David Tilman is raising $4 million for renovation and expansion.

One of his primary concerns is the impact of agriculture on the environment. "People don't realize that agriculture takes an even greater toll on the environment than energy," he says, citing the double impact of eliminating ecosystems to plant crops and then using nitrogen fertilizers, which leach into water supplies and reduce biodiversity elsewhere. With the global population projected to increase from six billion to nine billion over the next 50 years, the problem could get much worse, he says.

Public Education

While Tilman is committed to advocacy, he is concerned about the amount of time it keeps him away from his research at Cedar Creek. So he has a plan to bring public education to him. It's part of a larger effort to expand Cedar Creek's very modest research and education facilities to accommodate the growing number of students and faculty who study and work there, and the growing importance of the work. The new center will include an auditorium and meeting rooms to hold educational programs for teachers, legislators, journalists, park naturalists, and others who can help get his message out to the public. He and others at Cedar Creek have raised more than $1 million of the $4 million needed and hope to break ground within the next year.

Perhaps this will give him a little more quality time with Big Bluestem and friends at Cedar Creek.

"There's a lot more to learn about biodiversity," he says. "Why are there so many species? And how do they co-exist? These are questions that have intrigued biologists since Darwin. Without knowing the answers, we can't really understand how ecosystems are affected when species are lost, and how humans will ultimately be affected by diminished ecosystems."

—Peggy Rinard

Life in the Lab

Genetics research gives sophomore Joe Foley's career an early boost

TIM RUMMELHOFF

CBS sophomore Joe Foley scored 1600 on his SAT exam.

Joe Foley has a history of getting a head start. While the CBS sophomore was still in high school, he decided to try his hand at research to see if lab work might be in his future. So while spending the summer in St. Louis, he served as a volunteer technician in a research lab at the Washington University School of Medicine, studying the genetics of the alga *Chlamydomonas reinhardtii.*

Then, as a freshman at the University of Minnesota, Foley asked a professor if he knew of anyone doing genetic research who might need an assistant. As fate would have it, he learned that plant biology professor Carolyn Silflow was working on *Chlamydomonas reinhardtii,* the same organism he had studied in St. Louis, and he was able to start volunteering in her lab in his first year.

In Silflow's lab, he is working on the positional mapping of the APM1 gene. Finding the position of the gene directly on the genome is the first step of a much larger effort that he says "would characterize the gene and what else it does, and ultimately help figure out exactly what makes the gene resistant to herbicides." Even though *C. reinhardtii* is algae, he notes, it serves as an excellent model for plant study.

"I've just been amazed by how easy it's been to get into the scientific community here..."

In 2004, Foley received a Summer Undergraduate Research Fellowship from the American Society of Plant Biologists, which funds part of his work. "It's kind of a coup, I guess," Foley says. "Dr. Silflow heard about it and thought that I didn't have anything to lose if I applied." He has received a number of other scholarships, partly because he achieved a score of 1600 on his SAT exam while at Mounds View High School.

While he obviously appreciates his time in the lab, Foley enjoys other pursuits as well. He is currently a violinist in the U's Campus Orchestra for nonmajors, and he recently enrolled in his violin teacher's new music ensemble, which will afford him the chance to perform with professional musicians.

Foley was elected co-chair of the University's Campus Atheists and Secular Humanists club this year and, although he doesn't have much time for it, he enjoys "reading for pleasure." He says, "I would call it that. Other people aren't so sure because it's almost all science books. It keeps me busy, but it's a lot of fun, too."

Down the road, after graduate school, Foley envisions a career in research, perhaps in human genetics. He's pleased at the head start that CBS has provided. "I've had access to the labs of two of the biggest people in the country [Silflow and plant biology professor Paul Lefebvre] in *C. reinhardtii* research," Foley says. "I've just been amazed by how easy it's been to get into the scientific community here...and that's something I couldn't have done at other universities that don't have the same focus on research. So, it says more about the University than about me."

—Rick Moore

Development priorities: scholarships, fellowships, and facilities improvements

I'd like to introduce myself to you, the people who care about the College of Biological Sciences, because I hope to have contact with as many of you as possible in the coming months and years. I began my job as director of development at CBS last July, and while I have worked in development for 24 years (starting at the Sierra Club in San Francisco), I am new to the University of Minnesota and to raising funds for the biological disciplines. Therefore, I have spent my first months here learning about the college and its history.

As a newcomer to CBS, I'm struck by the convergence of talent in our faculty and students, the visionary leadership, and the quality of the experience that our students find here. I'm also impressed by the breadth of research conducted here and the extent to which this knowledge will make a real difference to improving the health of both people and the environment. This is a very exciting place to be.

The University has made investments to strengthen programs in the biological sciences. These investments are beginning to pay off, but we need to go farther by raising private funds to continue CBS's outstanding work. The College's priorities for fund-raising are for scholarships and fellowships as well as improvements in the facilities at the Cedar Creek Natural History Area and at the Itasca Biological Station and Laboratories. We will also seek funds to endow a chair in bioremediation and biocatalysis, one in quantitative analysis of ecosystems, and another in zoonotic diseases. These chairs will enable us to attract and retain faculty at the forefront of these fields. We will soon ask you to consider supporting priorities that matter most to you.

I look forward to meeting you. In the meantime, please feel free to contact me at sheld057@umn.edu or 612-624-9460 with any questions or ideas.

Thank you for your support.

Ames Sheldon

Class Notes

Arne Skytt Andersen (M.S. in Botany, 1959) is an active retiree after working for more than 40 years at the Royal Veterinary and Agricultural University in Copenhagen, Denmark. Formally a professor of floriculture and physiology, Andersen is an author of articles and books on that subject. He visits Minnesota on a regular basis with his wife, Lorna, a St. Paul native.

Jan Marie Lundgren (B.S. in Biology, 1974) is working for the University's School of Nursing as administrator for both the Center for Gerontological Nursing and the Center for Child and Family Health Promotion Research. Previously, she worked in research grants implementation for the University's Health Computer Sciences for 11 years. Recently accepted to graduate school, Lundgren is pursuing a master of liberal studies degree, focusing on connections between healthy aging, dance-movement, and spirituality.

Mazen I. Abbas (B.S. in Genetics, Cell Biology, and Development, 1996) finished a doctor of osteopathic medicine degree in 2003 from Ohio University, completed an internship at DeWitt Army Community Hospital, and started a pediatric residency at Tripler Army Medical Center in Honolulu, Hawaii, in 2004. He also has an M.P.H. from Emory University and served as a fellow at the Centers for Disease Control. Abbas is a captain in the U.S. Army, stationed in Mililani, Hawaii, with his wife, Corrie, and their two children.

Marianne Trcka Scherzer (B.S. in Ecology, Evolution, and Behavior, 1996) is co-owner, with her husband, of a landscaping business near Bagley, Minnesota.

Paul D. Rooprai (B.S. in Genetics, Cell Biology, and Development, 1997) is a business development consultant at the University of Louisville. Over the past four years, he has also been developing curriculum and lecturing to students at both the University of Louisville's School of Medicine and Bellarmine University's graduate nursing program on topics related to the business of medicine in the U.S. His lectures are designed to help nursing and medical students and residents prepare their business minds for the practice of medicine.

Nick Bhagroo (B.S. in Ecology, Evolution and Behavior and Genetics, Cell Biology, and Development, 1998) is working in Robert Sorenson's lab in Genetics, Cell Biology, and Development. Nick and his wife, Gwen, enjoy spending time with their four children.

Stephen Lines (B.S. in Biochemistry, 1998) is a program manager at AstraZeneca, L.P. He specializes in new product development and post-marketing activities. Prior to joining AstraZeneca, Stephen was director of finance for a consulting subsidiary of First Hospital Corporation, a firm specializing in broadband consulting in the pharmaceutical, biotechnology, and device industries, and he held positions at Monsanto and Abbott Laboratories. Stephen also holds an M.B.A. from the Keller School of Management in Chicago and is currently enrolled in the executive education program at Wharton School of Business.

Max McLaughlin (B.S. in Microbiology, 1998) is production manager for Wisconsin BioProducts, a contract fermentation company in Milwaukee, Wisconsin. WBP produces animal feed additives, food flavorings, and a variety of cosmetic additives.

Jim Wilkinson (Ph.D. in Biochemistry, Molecular Biology, and Biophysics, 1999) is in his third year with Amgen Inc. and is currently a manager in the medical affairs department. After postdoctoral work at the University of Minnesota Cancer Center, he has thoroughly enjoyed his switch to the business side of the biotech industry.

Brian Kaneshiro (B.S. in Biology, 2001) is in his third year as a middle school science teacher in Honolulu, Hawaii. He attended a national convention for middle school faculty and administrators last fall in Minneapolis.

Send your news to Emily Johnston, ejohnsto@cbs.umn.edu.

—Emily Johnston

CBS Calendar

CBS All-College Picnic

Friday, May 6, noon to 2 p.m. on the lawn in front of Snyder Hall.
Celebrate the last day of classes with a free lunch, music, door prizes, and gifts for graduating seniors.

UMAA Annual Celebration: U's Night with Aaron Brown

Tuesday, May 10—5:30 p.m. social hour and dinner, McNamara Alumni Center; 8:00 p.m. program, Northrop Memorial Auditorium.
Anchor of CNN's "News Night with Aaron Brown" will be keynote speaker.

CBS Commencement

Saturday, May 14, 7:30 p.m. in Northrop Memorial Auditorium.

BTI 20th Anniversary Symposium and Celebration

Friday, June 10—Saturday, June 11, Cargill Building.
Alumni, students, and members of biotechnology industry are invited.
See the BTI Web site: www.bti.umn.edu/index.html, for details.

St. Paul Saints Game

Friday, June 24, 7 p.m., Midway Stadium.
BBQ and baseball—the Saints vs. the Winnipeg Goldeyes.

Homecoming

Saturday, September 24, the Metrodome.
Breakfast, parade, and game—the Gophers vs. Purdue.

For more information about any of the above events, contact Emily Johnston at 612-624-4770 or alumni@cbs.umn.edu

Biotechnology Institute celebrates 20th anniversary

TIM RUMMELHOFF

Pictured are the deans and directors who have guided the Biotechnology Institute since its inception. From left to right are Michael Flickinger, the first BTI director; Dean Bob Elde; Ken Valentas, current BTI director; former CBS dean Pete Magee (front center); founding dean Richard Caldecott; and Victor Bloomfield, dean of the Graduate School and former head of the biochemistry department. Caldecott and Bloomfield proposed the concept for BTI to the legislature and were awarded $300,000 for the first year. MNBIO was created through BTI in 1991.

The Biotechnology Institute was created in the mid 1980s with funding from the Minnesota Legislature to support the growth of Minnesota's biotechnology industry. The institute launched a year-long celebration of its 20th anniversary at the annual Fall BTI Dinner, which was held in the Cargill Building for Microbial and Plant Genomics on the St. Paul campus. The BTI dinners, held twice yearly, provide opportunities for people from biotech companies and the University to meet and discuss topics of mutual interest. BTI is planning a two-day anniversary celebration on June 10 and 11, featuring a symposium and other activities. The event is open to alumni, students, and industry members. Check the BTI Web site, www.bti.umn.edu/index.html, for details.

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