

grow

Wisconsin's Magazine for the Life Sciences SUMMER 2021

food systems • health • bioenergy • environment • climate • communities

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FUTURE
OF MEAT
SCIENCE

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The display garden at West  
Madison Agricultural Research  
Station in early August 2020.

PHOTO BY MICHAEL P. KING







# grow

Wisconsin's Magazine for the Life Sciences

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ON THE COVER: Meat plant operations manager Dillon Walker adjusts the doors to a carcass spray washer on the harvest floor at the Meat Science and Animal Biologics Discovery building. Read about the new facility on page 20.

PHOTO BY MICHAEL P. KING

Dean Kate VandenBosch

## Tech Transfer Then, Now, and Tomorrow



In 1925, biochemistry professor **Harry Steenbock** did something that, at the time, was considered highly unusual.

He had developed a process for using ultraviolet radiation to add vitamin D to milk and other foods to combat rickets. In that era, it was standard practice for university scientists to leave their inventions unprotected. But rather than follow convention, Steenbock used \$300 of his own money to file for a patent.

He didn't do this for personal gain. Instead, Steenbock rejected offers from industry to commercialize his invention and looked for a way to protect the discoveries made by himself and his UW colleagues. He wanted to ensure they were used for the public good and that the financial gains returned to the university. **Harry L. Russell**, dean of the College of Agriculture, and others at the university supported this idea and helped secure financial support from UW alumni.

Eventually, the UW Board of Regents approved the creation of the Wisconsin Alumni Research Foundation (WARF) to promote, encourage, and aid scientific investigation and research at UW. Since then, through patenting and licensing efforts, WARF has helped usher university innovations from campus laboratories to the marketplace, netting a substantial return in financial support for the institution. This includes \$3.4 billion in direct grants to UW and the Morgridge Institute for Research.

WARF was a transformative development for UW, and CALS was involved at the outset. Today, CALS is continuing this legacy of tech transfer. In fact, our faculty and alumni received two of four WARF Accelerator Microbiome Challenge Grants this year.

Greater understanding of microbiomes — communities of microorganisms found on humans and animals and in the environment — has the potential to transform health care.

The WARF grants are designed to help identify and support technologies that can advance this line of research. I'm proud to share that **Kerri Coon**, assistant professor of bacteriology, and **Vanessa Leone** BS'03, PhD'09, assistant professor of animal and dairy sciences, were both recipients in 2021.

Kerri has teamed up with **Lyric Bartholomay** PhD'04, a professor of pathobiological sciences in the UW School of Veterinary Medicine, to find ways to harness the power of the microbiome to control disease-transmitting mosquitoes. And Vanessa has joined three colleagues from the University of Chicago in looking for methods of

monitoring the gut microbiome as an indicator of fibrotic liver disease. I hope you're as excited as I am about following Kerri's and Vanessa's progress and seeing how their work benefits the citizens of Wisconsin and beyond.

On page 20 of this issue, in our feature about the new Meat Science and Animal Biologics Discovery building, you can learn more about Vanessa's work in other areas. This includes her exploration of components from the unutilized or undervalued portions of meat animals that can be used to improve human or animal health. Our meat science program has a strong record of turning these "biologics" discoveries into successful companies, and the article explains how our current generation of researchers is building on that tradition.

The concept of tech transfer at UW is nearly a century old, but it clearly remains on the cutting edge of academic science. It's one of the many ways we at CALS live the Wisconsin Idea, and we will pursue it with passion into the future.

"Tech transfer at UW is nearly a century old, but it clearly remains on the cutting edge of academic science."

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## The **TOP FIVE** Myths about Microwave Cooking

By Barbara Ingham

### **MYTH 1: Microwaves make food radioactive.**

**Fact:** Microwaves are a form of non-ionizing electromagnetic radiation used to detect speeding cars and to send telephone and television communications. But microwaves have relatively low energy and cannot make food radioactive. Consumers are most familiar with microwaves as a source of energy for heating food.

### **MYTH 2: Microwaves kill the bacteria in food.**

**Fact:** The heat that microwaves generate — not the microwaves themselves — kill bacteria found inside or on the surfaces of foods. Microwaves cook food by heating water molecules within the food. Put another way, microwaves cause water molecules to vibrate, and this vibration produces friction, which converts the water into steam, which, in turn, heats and cooks food.

### **MYTH 3: Microwaved food is less nutritious than food cooked in a conventional oven.**

**Fact:** When cooking in a microwave, the energy heats only the food, not the entire oven compartment. This rapid cooking may help microwaved food retain more vitamins and minerals than with other cooking methods. This is especially true when microwaving foods without added water.

### **MYTH 4: When food cooks unevenly in a microwave oven, it means the oven isn't working.**

**Fact:** Foods with irregular shapes or varying thickness can cook unevenly in a microwave oven, leaving cold spots. In addition to shape and thickness, packaging material affects heating. Glass, paper, ceramic, or plastic containers are used in microwave cooking because microwave energy passes through these materials, heating only the food. Packaging materials and containers only become hot when they absorb heat from food as it cooks.



### **MYTH 5: It's safe to microwave food until partially done.**

**Fact:** Sometimes microwaves are used to partially cook or thaw foods that are then finished on the grill or in the oven. But, to maximize safety, it's important to complete the cooking process right away. Avoid transferring partially cooked microwaved foods — especially meats — to the refrigerator to finish cooking later. Even more important, don't leave partially cooked foods on the counter for an extended period. The partial cooking process may warm food to the perfect growth temperature for bacteria. Be sure to always measure the temperature of foods with a thermometer to make sure they are fully cooked and safe to eat.

#### **Microwave Minutiae**

The USDA has established these safe cooking temperatures for foods cooked in a microwave oven, conventional oven, grill, or stovetop.

- Beef, pork, lamb, and veal steaks, chops, and roasts **145 °F**
- Fish **145 °F**
- Ground meats **160 °F**
- Poultry **165 °F**

The USDA also advises allowing microwaved food to stand for three minutes (to allow the cooking process to complete) before checking the internal temperature with a food thermometer.

Barbara Ingham is a professor in the Department of Food Science and a food safety specialist with the Division of Extension. Her expertise includes consumer perceptions of food safety and health as well as safe meat and food processing systems.

ILLUSTRATION BY ISTOCK.COM/ERZETIC



# Listen to the Forest — and Learn

With pandemic adaptations, Angela Waupochick has launched a bioacoustics study of black ash conservation in northern Wisconsin

In the forest, life is often heard before it's seen. Hikers and hunters are familiar with the creature chorus: cicada trills and tree frog chirps, wood thrush rhythms and whip-poor-will chants. This unique blend of animal noises is what scientists call the forest soundscape. And listening carefully to the soundscape is sometimes the best way to determine whether a forest is healthy.

Deep inside the forest-wetlands of northern Wisconsin, **Angela Waupochick** is listening.

A Ph.D. student in forest and wildlife ecology, Waupochick is among a growing number of scientists using a simple technique called bioacoustic monitoring to record forest soundscapes. The equipment they employ is relatively inexpensive and unobtrusive, but it can capture the sound signatures of all animals that are present — even the most elusive ones.

“Bioacoustic monitoring can show us even minute details about wildlife that might be harder to see, for example, nocturnal birds or bats, without having to disturb the animals,” says **Zuzana Burivalova**, an assistant professor in the Department of Forest and Wildlife Ecology and the Nelson Institute for Environmental Studies. She's also one of Waupochick's dissertation advisors.

With bioacoustic monitoring, researchers place small recorders in the forest. They then use computer software to parse out the captured sound signatures of different species. This information can reveal a lot about the biodiversity and overall health of the forest ecosystem. For instance, knowing which species are present — and at what times — can help land managers determine the most effective ways to protect their natural resources.

Waupochick is using bioacoustic monitoring in a forest-wetland research project in the Menominee and Stockbridge-Munsee Tribal Lands near Keshena, in northern Wisconsin. Her goal is to find the best conservation strategies for these black ash-dominated ecosystems because they are widespread in the area and a culturally significant tribal land resource.

“The Menominee word for wetland or swamp is *maskik* (pronounced ma-skeek), which is also our word for medicine,” explains **Ben Grignon**, a traditional arts teacher at the Menominee Indian High School and member of the Menominee Language and Culture Commission. “When we understand the Menominee worldview through our language, we



gain a deeper understanding and appreciation of our traditional ecological knowledge.”

Waupochick is concerned that, even though these areas are ecologically and culturally important, they are not a priority for management.

“The forested wetlands that have survived through [past] disregard for these systems will now be even more reduced by the emerald ash borer,” she says. “Since tribes have a significant amount of land holdings and forested wetlands, we need to acknowledge the importance of wetlands, and I am hoping, through this research, we are able to implement some degree of successful mitigation. Perhaps we can maintain some of the functionality for habitat, for the integrity of tribal forests. I am building my base to manage these systems in the long-term.”

By recording the forest soundscape, Waupochick is analyzing which species are present. She plans to combine this information with tree physiology data to evaluate existing management practices and provide conservation recommendations to address future disturbances. To complete this work, she has partnered with two indigenous communities in

Angela Waupochick's dissertation research project is being conducted in collaboration with scientists at the U.S. Forest Service Northern Research Station in Rhinelander, Wisconsin.



northeastern Wisconsin and researchers from the United States Forest Service.

At the start of 2020, Waupochick was planning to launch her first field season in late spring. Then came the global COVID-19 pandemic. Due to travel restrictions, the team of assistants she had assembled could no longer help her install and maintain her experiment.

“I had no choice but to recruit my 16-year-old son to help tackle the fieldwork,” Waupochick says.

Waupochick’s son, **Saswaen**, never planned to spend his summer plodding through wetlands with recorders, 12-volt batteries, solar panels, and tree sap flow meters strapped to his back. But mother and son made a wonderful team. Saswaen came to truly enjoy participating in the research, and he learned a lot.

“Mostly, I like being out in the woods,” he says, “I wouldn’t want to work at a restaurant or store now that I am being paid to be outside. Both of my parents work in forestry, so I knew they plan how the forest is cut, and they worry about plants that are not supposed to be here and insects that kill trees. Now I think I can identify all of the trees in the forest by

bark, not leaf, and know where to expect certain trees to be growing.”

Waupochick also recruited students in a trade class at the Menominee Indian High School to help build heat sensors for measuring characteristics of tree physiology. The sensors will detect sap flux density, which will help her understand the movement of water through the trees, a process known as transpiration. Then she’ll be able to compare relationships between a forest’s water budget and the presence of biodiversity at various sites that are exposed to different management techniques.

For example, Waupochick’s study aims to assess whether selective cutting — a management practice used to mitigate the devastation that would be caused by an emerald ash borer invasion — is the most effective way to protect forested wetlands. Waupochick’s study can also help determine whether changes in biodiversity are tied to alterations in the forest’s water budget that stem from climate change.

—KARIE CHERWIN

**A black ash stand, located on the Stockbridge-Munsee Reservation in Shawano County in June 2020. Angela Waupochick monitors the site as part of her bioacoustics study.**

PHOTO BY ANGELA WAUPOCHICK

**Waupochick stands near a solar panel, which powers the sap flow heat sensors she uses to monitor this forest-wetlands site in Shawano County.**

PHOTO BY ZUZANA BURIVALOVA



Lusayo Mwakatika

## Speaking Up for Farmers in Malawi



In addition to agriculture, public speaking and stand-up comedy are passions for Lusayo Mwakatika, a native of Malawi who graduated in May. Here he's pictured in a lounge area at Comedy on State in Madison, where he has performed during open mic nights.

PHOTO BY MICHAEL P. KING

**L**usayo Mwakatika BS'21 grew his first garden at the age of 14. He harvested his own vegetables, sold them to friends and neighbors, and used the earnings as his allowance. It was a living extension of the passion for agriculture he developed while growing up in Malawi, where farming is a pillar of culture.

In May, Mwakatika graduated from UW–Madison with a degree in agricultural business management and a certificate in entrepreneurship. Now his plan is to continue the work he started while on campus: renovating the agricultural sector in Malawi. That's the future Mwakatika sees for himself, but he also ushered his classmates into their own futures with the words he shared as student speaker at the spring commencement ceremony. And though he's moving on, he will leave a lasting imprint on campus through his achievements.

Mwakatika is the outgoing president of Project Malawi, a UW student club. The organization originally targeted medical infrastructure improvements in Malawi. But given that about 80% of Malawians engage in agriculture, he saw a better opportunity to help by shifting the group's focus toward modernizing farming in his home country.

In Malawi, young people traditionally inherit land, so they are expected to participate in agriculture. But many struggle to use their land effectively. For example, local farmers will grow the same

products that are imported from countries with more developed economies, so they're not able to sell their products in local markets. Gaps like these are what motivated Mwakatika.

"I think, mostly, I was almost angry, I would say, with the way opportunities were not being utilized in agriculture," he says.

Even with such zeal to guide him toward agriculture, majoring in the field was not always a foregone conclusion for Mwakatika. After high school, he took a gap year to prepare for college. During that time, he attended a presentation by **Hastings Nhlane**, the CEO of a farming-focused organization in Malawi called ACADES. Nhlane discussed the vital role of agriculture. What Mwakatika heard solidified his decision to make it his focus of study.

Mwakatika later stumbled on UW when he and his friend were searching for American universities with the prettiest campuses. The university sights captivated him. Eventually, he was offered scholarships at both UW and Michigan State University, but the strong international component in the agricultural programs at CALS drew him in.

It compelled Mwakatika, who had never left Malawi before, to fly more than 8,000 miles and 20-plus hours to Madison. In 2017, his first year, he joined the inaugural cohort of the King-Morgridge scholarship, which accepts six students each year — from African, Caribbean, and



**“Let’s go out there and open ourselves up to people, and be vulnerable . . . your problem might be the one that connects you to someone else.”**

Southeast Asian countries — who are passionate about giving back to their communities.

At UW, Mwakatika’s connection to ACADES continued. Through a partnership with Project Malawi, ACADES has been able to connect with UW expertise on a regular basis. The student organization is now working to get ACADES registered as a nonprofit in the U.S., with hopes to further expand its access to American resources.

“Lusayo’s been able to seek a lot of counsel from the university for ACADES, and he’s been a conduit of communication that really gets their foot in the door,” says Project Malawi’s past vice president, **Elise Reiche** BS’21, who graduated in May with a degree in life sciences communication and biology.

Most recently, the two organizations partnered to raise \$4,600 for a COVID-19 relief fund for rural farmers harmed by the pandemic. And they’ve started a new fundraiser called Malawi Market, where proceeds from the sales of Malawian art will help young people start their own agricultural enterprises in Malawi. Project Malawi has also engaged in fundraising partnerships with Malawi Children’s Village and Project Cure.

Mwakatika’s contributions to ACADES extend beyond resource sharing and fundraising: He has also founded an internship program for the organization. The program gives UW students the opportunity to travel to Malawi and explore their interests in agriculture and poverty relief. Interns also take on some of the workload for ACADES. With a staff of only about 10 serving more than 7,000 farmers, the support is more than welcome. The internship was virtual last year due to COVID-19, but it should resume in person as international travel restrictions are lifted.

“This internship is mainly focused on helping ACADES fill several gaps in the operations of the organization and providing different perspectives from the interns from UW,” Mwakatika says.

After graduation, Mwakatika plans on moving back to Malawi and working with ACADES.

His first goal is to make them more sustainable by developing a microfinance program. ACADES currently depends on donor loans, so they’re forced to turn away thousands of farmers due to lack of capital. Lusayo is assisting in creating a credit system, encouraging short term loans, and allowing farmers to open bank accounts directly with ACADES.

“We want it to run as an entity on its own,” Mwakatika says. “If someone else donates for an increase in funding, great; but at the same time, we want it to survive, even if the donor fund dries out.”

Lusayo Mwakatika’s commencement speech can be viewed at [wisc.edu/commencement](https://wisc.edu/commencement).



Given Mwakatika’s success in forming relationships, including with faculty and staff in CALS and across campus, the prospects for ACADES look bright. His skills in this regard may stem from his knack for public speaking. He competed nationally for Wisconsin Speech and Debate, and he has performed stand-up comedy at Comedy on State in Madison, at African Student Association events, and in San Francisco, Chicago, and New York. It might also come from his willingness to put himself out there, to ask for help and help others in turn — something he encourages his classmates to do.

“Let’s go out there and open ourselves up to people, and be vulnerable,” Mwakatika said in his commencement speech. “Because nobody has life figured out. And your problem might be the one that connects you to someone else.”

—KISA SOW

**Mwakatika delivers the student address at the spring commencement ceremony at Camp Randall on May 8, 2021.**

PHOTO BY BRYCE RICHTER

# Students Take on Dairy Dilemmas

Teams from three UW campuses developed innovative solutions to industry challenges for a Dairy Innovation Hub competition

Cold milk has long been offered alongside lunches and snacks in elementary schools, traditionally served in paper cartons. But those cartons require refrigeration, and they're far from beloved by students. This has prompted schools and the dairy industry to look for another option to encourage milk consumption.

Enter food science major **Caroline Lunning**. She partnered with three other students to develop an innovative design for a shelf-stable, quick-cool milk pouch. With support from an industry mentor, the team submitted its concept last fall to the UW Dairy Innovation Hub Student Challenge.

"It was really gratifying to have an opportunity to work with other students, outside of the curriculum, to apply what we're learning to something so important," says Lunning, a returning adult student who previously cooked in restaurants for 20 years.

For their efforts, the students received an enthusiastic thumbs-up from their mentor, **John Holevoet**, director of government affairs for the Wisconsin Dairy Business Association. "Fluid milk packaging really lags behind in the creativity department," he says. "It was really impressive to see a group of students come up with a cool new idea on how to do it."

Dairy is an important agricultural sector in

Wisconsin. It generates \$43.4 billion annually for the state's economy. But dairy is in the middle of a tough stretch, facing more than just packaging-related difficulties. Dairy farmers have endured low milk prices for several years. The industry has also been struggling with changing consumer preferences: Fluid milk consumption is down while demand for other dairy products, such as cheese, has increased.

All of these issues were recently outlined by the state's Dairy Task Force 2.0, which inspired CALS Associate Dean **Heidi Zoerb** to develop the student challenge. Her proposal was one of seven projects financed by the Hub last year, a state-funded, cooperative effort among three University of Wisconsin System campuses that works to support Wisconsin dairy research and development.

"We thought it was a great opportunity to leverage student creativity to address some of these issues," says Zoerb.

The Hub's student challenge benefited from the involvement of all three cooperating schools: UW–Madison, UW–Platteville, and UW–River Falls. With the help of industry mentors, students teamed up to propose innovative solutions in three focus areas identified by the task force: encouraging dairy

## EXPLORE ONLINE

View final presentations for the Dairy Innovation Hub Student Challenge at [go.wisc.edu/dih-student-projects](http://go.wisc.edu/dih-student-projects).

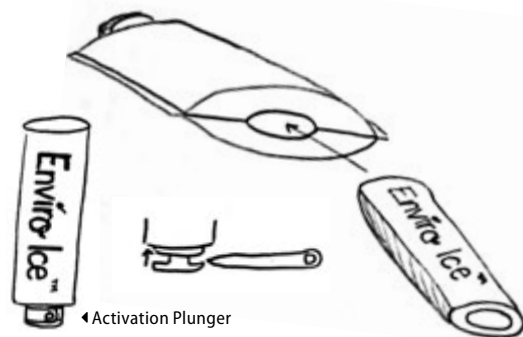
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A sketch of a shelf-stable, quick-cool milk pouch that a team of four students designed for the Dairy Innovation Hub Student Challenge.

ILLUSTRATION COURTESY OF CAROLINE LUNNING



consumption among Wisconsin students, enhancing the shelf life of dairy products, and utilizing new technologies to improve dairy farming. In creating and running the competition, Zoerb partnered with Hyper Innovation, a local agency that takes on complex problems in industry.

The COVID-19 pandemic put a wrench in the original plan to hold in-person meetings. Instead, the challenge was reformatted as an online program. Zoom calls replaced weekly meetings.

“One of the hidden benefits about having the whole thing online was that it was actually easier for all three campuses to participate on a much more level playing field because everyone was confined to virtual meetings,” says Zoerb. Instead of traveling to the UW–Madison campus, students could spend more time working on their projects.

**Ash Maheshwari**, a first-year MBA student at UW–Madison, teamed up with two undergraduates from UW–River Falls to work on two projects simultaneously. The trio developed a concept for a clip-on septum ring to monitor a calf’s temperature and respiratory patterns, and they created an online gaming concept to encourage dairy consumption.

For Maheshwari, participating in the competition was a great way to get involved with other parts of the UW community. “I was the sole MBA [student] in this challenge,” he says, “and I was eager to use what I had gained from my applied learnings on a real-world problem.”

The participants, which included undergraduate, master’s, and Ph.D. students, completed seven projects in total. They brought perspectives from multiple fields, such as agriculture, business, and food science.

Facilitating connections was one of the biggest successes of the student challenge. For **Varsha Swaminathan** MS’19, the partnerships she formed with her teammate, **Lauren Sipple** BS’17, and their industry mentor, **Adam Brock** of the Wisconsin Milk Marketing Board, were invaluable.

“[Adam’s] expertise in product development and his connections were a huge bonus,” says Swaminathan, who, along with Sipple, is a Ph.D. student in food science. “And Lauren was a very supportive, encouraging teammate. I believe that her constant support throughout the competition helped us win three prizes for our proposed solution.”

Their team proposed using bioactive molecules instead of chemical preservatives to increase the shelf life of yogurt. The duo won Best of Focus Area: Enhance the Shelf Life of Wisconsin Dairy Products, Best Execution Plan, and Most Sustainable. Judging took place in November 2020.

Zoerb was pleased to see students from three UW System campuses jump a multitude of hurdles to introduce their innovative ideas to the Wisconsin dairy industry.

“It was amazing,” she says, “how much these groups of students were able to get accomplished in eight weeks — virtually — during a semester where everything was really unpredictable.”

—JORI SKALITZKY BSx’22



PHOTO BY SEVIE KENYON

Since 1886, CALS has trained tens of thousands of agricultural professionals in the latest science-based management and production techniques through the Farm and Industry Short Course (FISC). To continue this legacy, CALS is looking to ensure that financial limitations won’t prevent the next generation of state residents from pursuing careers in agriculture.

Through a new financial assistance program called the Farm and Industry Short Course Tuition Promise, the university will guarantee that all FISC students from Wisconsin with a family income below \$60,000 — the median income in the state — will have their tuition funded by gifts and grants.

“In light of the recent financial hardships facing many of those in Wisconsin agriculture, we are pleased to make this commitment to training future generations of agricultural leaders,” says Dean **Kate VandenBosch**.

The tuition promise strengthens the college’s commitment to ensuring that a UW education is affordable. FISC has offered scholarships for decades — thanks to the success and generosity of program graduates — and it will continue to provide them for students who do not qualify for the FISC Tuition Promise.

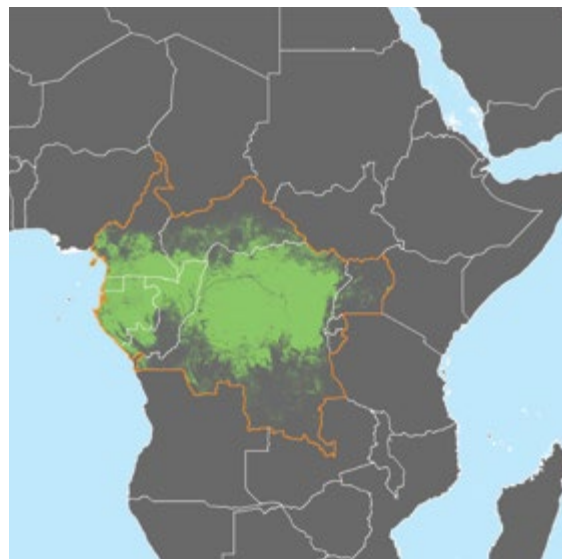
FISC is the primary farmer-training program offered by CALS. Participants take courses on campus between fall harvest and spring planting. The curriculum covers crops, dairy, meat animals, agricultural engineering, farm business planning, agribusiness, human relations, and communications. Coursework involves lectures, hands-on labs, and tours.

## THE TROPICS

## A View from Space Can Save the Trees

Research into the ability of satellite alert subscriptions to help reduce deforestation covered 22 tropical countries (outlined in orange) across South America, Africa, and Asia. Forest cover in 2010 is indicated in green.

IMAGES COURTESY OF FANNY MOFFETTE



For government agencies and conservation groups, protecting forests can be a tall order. Their resources often don't allow them to cover the sheer amount of acreage they need to monitor, and there are a lot of places to conceal damaging and illegal activity.

But it's hard to hide destructive practices from eyes in space.

That's the idea behind GLAD, the Global Land Analysis and Discovery system. Launched in 2016, GLAD uses satellite-acquired data to provide frequent, high-resolution alerts when it detects a drop in forest cover. Governments and others interested in halting deforestation can subscribe to the alerts on the free and interactive interface called Global Forest Watch and then intervene to limit forest loss. And it seems to be working, at least in one part of the world.

According to research led by **Fanny Moffette**, a postdoctoral researcher in the Department of Agricultural and Applied Economics and the Nelson Institute for Environmental Studies, deforestation dropped by 18% in two years in African countries where organizations subscribed to receive forest cover warnings from GLAD. And the carbon emissions avoided by reducing deforestation were worth between \$149 million and \$696 million, based on the ability of lower emissions to reduce the detrimental economic consequences of climate change.

The researchers — including Moffette's collaborators **Jennifer Alix-Garcia** at Oregon State University, **Katherine Shea** at the World Resources

Institute, and **Amy Pickens** at the University of Maryland — studied deforestation in 22 tropical countries across South America, Africa, and Asia from 2011 to 2018. They set out to understand whether these kinds of automated alerts could achieve their goal of reducing forest loss, which has global climate implications. Land-use changes such as deforestation account for 6–17% of global carbon emissions. And avoiding deforestation is several times more effective at reducing carbon emissions than regrowing forests.

“The first question was to look at whether there was any impact from having access to this free alert system,” Moffette says. “Then we were looking at the effect of users subscribing to this data to receive alerts for a specific area.”

Simply being covered by GLAD did not help a country combat deforestation. Only those African countries in which organizations had actually subscribed to receive alerts saw a decrease in deforestation. Intuitively, this finding makes sense, says Moffette. Having access to information is good. But what you need to change the course of deforestation are people committed to using that information and acting.

However, deforestation did not decrease in South American or Asian countries, even where organizations subscribed to receive warnings. There



The study was led by **Fanny Moffette**, a postdoctoral researcher in agricultural and applied economics and environmental studies.

Findings from this study were published in January in the journal *Nature Climate Change*.





are multiple potential causes for this continental discrepancy.

“We think that we see an effect mainly in Africa due to two main reasons,” Moffette says. “One is because GLAD added more to efforts in Africa than on other continents, in the sense that there was already some evidence of people using monitoring systems in countries like Indonesia and Peru. And Colombia and Venezuela, which are a large part of our sample, had significant political unrest during this period.”

The GLAD program is still young, and as more governments and organizations sign on to receive warnings and decide how to intervene at sites of deforestation, the system’s influence may grow.

Developed by a team at the University of Maryland, which includes Pickens, GLAD made several improvements over its predecessors. It has very high spatial resolution, roughly 900 square meters, which is orders of magnitude more precise than older tools. And it can provide alerts up to every eight days if the skies are cloud-free when satellites reimage a section of Earth. Users can define custom areas to monitor. They then receive weekly emails, available in six languages, that contain geographic coordinates of the alerts within the monitored areas.

Going forward, the team is looking to evaluate the effect of the monitoring platform’s new features, such as data that can inform forest restoration, while supporting efforts of organizations that try to intervene to halt deforestation.

“Now that we know subscribers of alerts can have an effect on deforestation, there’s potential ways in which our work can improve the training they receive and support their efforts,” Moffette says.

—ERIC HAMILTON

## Awards and Honors

### A FLURRY OF FIRSTS

Alumni and faculty are treading new ground in the land of awards and recognition. Professor of agronomy **Natalia de Leon** MS’00, PhD’02 has received the inaugural Leadership Award from the Maize Genetics Cooperation. In the Department of Forest and Wildlife Ecology, professor **Anna Pidgeon** PhD’00 recently became the first woman to be named the Beers-Bascom Professor in Conservation. And in the realm of biochemistry, professor **Michael M. Cox** and former postdoctoral researcher **Squire Booker** have joined the first class of fellows at the American Society for Biochemistry and Molecular Biology.

### WOMEN OF DISTINCTION

Congratulations to horticulture research associate **Elina Adhikari** for receiving the 2021 Jeanie Borlaug Laube Women in Triticum Award, and to **Monica White**, associate professor in the Department of Community and Environmental Sociology, for being named a 2020–21 recipient of the Outstanding Women of Color Award at UW.



## Number Crunching

Around 25,000 species of insects live in Wisconsin. And we know summer has arrived because we can hear their buzzing in the background. But have you ever wondered how these noisy little creatures make it through the winter? According to **P.J. Liesch** MS’10, director of the UW Insect Diagnostic Lab and extension entomologist, many of the six-legged species found in our state are native to the area, so they have adapted to the cold over time. For some, their blood contains natural antifreeze compounds. Others simply overwinter in sheltered locations — down in the leaf litter under the snow, for example — where they’re well protected, even from the harsh conditions of the polar vortex.

PHOTO ILLUSTRATION BY JANELLE JORDAN NAAB. IMAGE BY ISTOCK.COM/ERIKKARITS

# The Tree of Life Is Rooted in Math

Claudia Solís-Lemus reveals a clearer picture of the evolutionary interconnectedness of organisms by modeling data, both big and small

Interview by **Caroline Schneider MS'11**

**C**laudia Solís-Lemus has always loved numbers. Throughout her schooling in Mexico City, she found mathematics classes to be the easiest and most interesting — perhaps because the logic from which math is derived naturally made sense to her. She's also a puzzle enthusiast, and math exercises felt like opportunities to solve them.

Now an assistant professor with the Department of Plant Pathology and the Wisconsin Institute for Discovery, Solís-Lemus is a statistician embedded in a life sciences department. She solves puzzles for biologists; in turn, biologists inspire the statistical tools she builds. She is pursuing two main lines of work.

First, in the field of evolutionary biology, she aims to understand how we determine which organisms are more closely related to others and how we can better estimate networks of life, which can have practical applications in the life sciences. These phylogenetic networks are like standard evolutionary trees that link species to one another and to common ancestors, but hers become more complicated because they account for gene flow or hybridization between species.

Second, Solís-Lemus studies microbiomes; specifically, how microbial communities help or harm plants through interactions with pathogens and impact on growth and yield. By using mathematical modeling, she can study more variables at one time to determine how different species of microbes may be interacting with a number of characteristics in a field, such as fertilizer use or drainage. By connecting these elements, she creates a tool that will allow growers to input variables related to microbial abundance and environmental conditions and come away with a network that will tell them how connected those components are and, ultimately, how to manage their plants.

## WHAT IS IT LIKE BEING A STATISTICIAN IN A PLANT PATHOLOGY DEPARTMENT?

I have worked on applications related to biology ever since my Ph.D. program, where I focused on developing methods for evolutionary biology. Being in a biological department is mutually beneficial, I think. I get to collaborate with really smart people who have many biological questions they want to explore, and they collect a lot of data. I bring my expertise as a data scientist to help them analyze their data, and it ultimately inspires the statistical tools that I develop. I think it's a really nice symbiosis.

## WHAT IS BIG DATA, AND HOW DO THE TOOLS YOU'VE DEVELOPED ADDRESS BIG DATA?

We're collecting massive amounts of data, and it's important to be able to handle that data. In biology, because the cost of genetic sequencing is dropping, for example, people are sequencing more whole genomes for different species. The standard method for reconstructing phylogenetic networks could only handle 10 species at the most. We simplified the process so that we were approximating the answer instead of trying to find the exact network. We proved that this was accurate enough. But it was much more scalable and much, much faster.

Now we are able to handle 25 or 50 species with our current tools. Even with just 52 species, you have more possible phylogenetic trees than there are atoms in the universe. But biologists would love to have networks for hundreds or thousands of taxa [i.e., groups of organisms], so we're still investigating ways to approach that.

There is a balance with big data. You either go the exact route, but then it is not scalable, or we come up with ways to approximate the answer that you lose a little bit of accuracy. So, there is this trade-off of accuracy and scalability.

## WHY IS IT IMPORTANT TO ALSO THINK ABOUT SMALLER DATA SETS?

Everybody talks about big data. But there's also the problem on the other end. For certain machine learning methods, you need a lot of data for them to work. But some of my collaborators do not have that many replicates [repeats of an experiment] because they're doing the experiments in their lab. We don't necessarily always have gigantic data sets, and so we still want to be able to draw conclusions from smaller data sets. We want to have methods for both.

## IN WHAT WAYS ARE YOU SEEING THE TOOLS YOU DEVELOP BEING USED?

Recently, people have been using a lot of phylogenetic techniques to track and understand the evolution of the coronavirus. That's one area where people are using the tools that I'm creating. This has been a learning opportunity. Many of our methods are not primarily for viral evolution. They are meant for eukaryotes, plants, or animals. Viruses have completely different ways of evolving, so some of our methods are not suitable to explain their evolution. That's why I think it's important that we continue developing phylogenetic networks.

For the microbiome work, if you're a farmer, you want to protect crops from pathogens, right? The standard way is to use chemicals — fungicides, for example. But pathogens





evolve and become resistant. Some of the work that we're doing is trying to not rely on chemicals but on the microbiomes — the plant microbiome, the soil microbiome. We're asking what is it about the microbial communities that makes some plants stronger than others.

### WHEN MAKING PHYLOGENETIC NETWORKS, WHY IS THE MICROBIOME MORE DIFFICULT TO STUDY THAN SPECIFIC SPECIES?

When we're reconstructing the tree of, say, fish, you grab one fish and sequence it. You know that this sample is coming from this fish. But when you're studying the microbiome, you cannot just grab one microbe. You get a sample of the whole soil, and then you sequence everything in there. You don't know which microbe the sequences are coming from. You have a collection of genomes. That means that we first need to use statistics to cluster these pieces of genetic information. Then, after we cluster them, we can identify what is specific to a given microbe. But it's an extra step that we need to do with microbiome studies.

### WHAT ARE YOUR FAVORITE PARTS OF YOUR WORK?

I really enjoy the process of writing scientific papers, and I also like programming. Learning to program is learning to communicate with the computer, and once you've learned one language, it is easy to translate to other languages. I think that knowing how to program opens doors, regardless of your field. Right now, in my lab, we are producing many different programs that are meant to allow biologists to analyze their data.


But there's another aspect that I really enjoy, and that's mentoring students. I'm just starting to have students in my lab, and mentoring is something you have to learn. Just getting a Ph.D. doesn't make you a good mentor. So I've had to learn a lot about how to mentor students and best support people from many different backgrounds. That's something I really like about my job.

### WHAT DO YOU ENJOY MOST ABOUT BEING AT CALS AND UW-MADISON?

I was born and raised in Mexico City. So when I first came here, I was not sure if I would like living in a smaller city. But I really loved it. I felt so instantly welcome here at the university and the city in general. And that was so valuable to me. The people are so smart, and they do such great research, and they're so nice and friendly. Plus, I like to be outdoors. I like to run or bike, and it's a great city for that. In the summer, I like to go to Devil's Lake State Park and swim. That's my happy place.

PHOTO BY MICHAEL P. KING; EQUATIONS COURTESY OF CLAUDIA SOLÍS-LEMUS

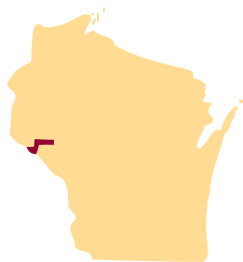




# A WISCONSIN IDEA WIN-WIN

Through the UniverCity Year program, CALS works with local communities to address troublesome issues while pursuing valuable teaching and research opportunities

BY DENNIS CHAPTMAN



A road undulates through Wisconsin's Pepin County, where CALS students and researchers lent their expertise to water quality efforts as part of UW's UniverCity Year program.

PHOTO BY TIM MATTIMORE

**A**t a sweeping bend of the Mississippi River, where the waterway widens and flows through shimmering Lake Pepin, tourists come to snarf slabs of homemade pie, stroll through artisan shops, and enjoy water sports.

This is northwest Wisconsin's Pepin County, whose zigzag boundaries enclose 249 square miles, making it the state's smallest county by land area. Home to only 7,265 people, it's also one of the smallest by population. But every year, Pepin County draws gobs of tourists with its remarkable views of valleys and bluffs and the sweet, crusty allure served up at the renowned Stockholm Pie and General Store. Downriver, in the village of Pepin, fans of literature make pilgrimages to the birthplace of Laura Ingalls Wilder, whose *Little House on the Prairie* and other children's books have entertained generations.

From Devil's Corner to Durand, Porcupine to Stockholm, Pepin County is one of Wisconsin's jewels, picturesque and charming. But no community is perfect. Underlying all those beguiling snippets of rural Dairyland life are perplexing problems and concerns.

Similar issues exist all around the state, but they aren't going unnoticed or unaddressed. A

UW-Madison program called the UniverCity Year is partnering with communities across Wisconsin to find solutions to knotty problems and bolster the quality of life for the state's citizens. And students, faculty, and staff from CALS are helping to tackle those challenges by bringing research to bear on Main Street issues — in Pepin County and beyond.

"We make the Wisconsin Idea very practical and tangible," says **Gavin Luter**, managing director for the UniverCity Year program. "We get people from the university working hand in hand with people at the local level to build their capacity to do good self-governance."

**UNIVERCITY YEAR WAS DEVELOPED BY** the UniverCity Alliance, a collection of faculty and staff members from across campus who share a common interest in local governments. The first project launched in 2016 in the city of Monona, near Madison. Since then, communities across the state have benefited from the three-year-long partnership. Using university expertise, they have tackled challenges as wide-ranging as economic development, senior housing, prisoner reentry into society, child-care, and toxic blue-green algae buildup in lakes.



Each spring, the program accepts applications for projects from localities. The communities are asked to commit \$20,000 to \$30,000 to each thematic area — such as housing or sustainability — that they would like to have addressed.

The first year is devoted to understanding the scope of the projects and matching them with appropriate faculty and students. The work, with set deliverables, is completed in the second year, and in the third year, participants target ways to put the results into action.

“We are embedded in local governments, helping them solve challenges where they don’t have expertise on their own — and even if they do, they don’t have the bandwidth to handle everything,” Luter adds.

UniverCity Year also frees faculty from the sometimes-difficult chore of finding partners for meaningful class projects. And it provides institutional structure for those projects.

In Pepin County, 186 students, faculty, and staff from six UW schools and colleges participated in 25 projects. From tourism marketing to educational analysis to stormwater mitigation and wastewater treatment, classes and faculty researched problems and helped point the way to solutions.

“We’ve given design recommendations to the village of Stockholm to prevent flooding in their small downtown, and the village of Pepin got a walking tour app that was created by our computer science students,” Luter says. “They got a lot of tangible things that they can point to and say, ‘UW helped us do that.’”

**ONE OF THE MAIN FOCUS AREAS** for UniverCity Year’s Pepin County project was groundwater quality, specifically nitrate contamination. That’s where CALS students and researchers shared their expertise.

Water quality is a sensitive issue in the county. Nitrates arise from various sources, including farm fields — where nitrate-rich fertilizers and manure are spread — and aging septic systems. The Wisconsin Department of Natural Resources in 2019 reported that 20% of tested private wells in the county exceeded the hazardous limit on nitrate content.

**Bret Shaw**, associate professor of life sciences communication and environmental communication specialist for the UW–Madison Division of Extension, and graduate student **Theresa Vander Woude** conducted a survey of Pepin County farmers. They used the responses to develop a framework for communications strategies to promote agricultural best practices and conservation methods that could help ease the problem. The survey examined whom farmers trust for information on groundwater

quality issues, what best practices they were likely to use to minimize nitrates, and the obstacles to adopting nutrient management techniques.

The results will inform how local land managers can best communicate the problem to farmers. “We looked at what practices farmers have done and what they are willing to do. That has implications for planning and reaching out to people,” says Shaw, an expert in social marketing.

For example, the survey shows that farmers like to get information about groundwater quality issues from (in preferential order) crop advisors and agronomists, county land and conservation experts, U.S. Department of Agriculture officials, UW–Madison Division of Extension officials, and other farmers in Pepin County. They place less confidence in seed and fertilizer dealers, consumers, and trade publications. Elected officials ranked last on the list.

The survey also addressed nutrient management techniques and gauged which ones farmers are most likely to adopt to manage nitrate use. Results showed that farmers are more likely to plant cover crops and utilize split (i.e., smaller but more frequent) applications of fertilizers. They are less likely to use compost or remove fields from production.

“A lot of strategic communication is knowing your audience,” says Vander Woude, a master’s student in the Department of Life Sciences Communication and the Nelson Institute for Environmental Studies. “There are some good opportunities for thinking about how to best communicate about removing underperforming parts of a field from production or incorporating more manure composting, which are less widely used methods.”

When farmers were asked about their satisfaction with financial incentives and with technical support for nitrate-reducing practices, about 25% answered

#### EXPLORE ONLINE

Learn more about CALS contributions to the UniverCity Year projects over the last five years at [go.wisc.edu/grow-university](https://go.wisc.edu/grow-university).

A large part of Pepin County borders the Mississippi River, seen here from Maiden Rock Bluff State Natural Area. The natural beauty of the area attracts numerous tourists.

PHOTO BY AARON CARLSON,  
CC BY-SA 2.0





Two researchers participating in the UniverCity Year program surveyed Pepin County farmers about their sources for water quality information and their nutrient management techniques, and the responses helped them develop strategies that land managers can use to better communicate with farmers about problems and solutions.

PHOTO BY TIM MATTIMORE

“don’t know” for the former, and about 20% gave the same answer for the latter. Most responded positively or neutrally. However, there were more negative responses on financial incentives than on technical support — an example of how different people have different motivators. Knowing those motivators makes it easier to tailor effective communication plans, Shaw and Vander Woude say.

Vander Woude found that the UniverCity Year project broadened her experience in an area outside of south-central Wisconsin and opened doors to real-world research applications.

“I don’t know that I would have been engaged in a project like this otherwise — connected to the northwest part of the state, directly talking with land conservation professionals, and interviewing farmers,” she says. “It connected us to a community that really did want to work with researchers.”

Shaw says the Pepin County survey — the results of which were presented virtually at the Wisconsin Land and Water Conservation’s annual conference in March — shows promise as a template.

“I hope we’re creating a model that other counties and other regions of the state could tweak, refine, and scale up,” Shaw says. “Every part of the state is a little bit different, but the questions we’re asking are probably universal across the state, even if the results wouldn’t be.”

**Chase Cummings** worked closely with the UniverCity Year groundwater projects as Pepin County’s conservationist before moving to the same post in Dunn County last January. He says Shaw’s and Vander Woude’s findings are important in

understanding how to engage landowners and affect change.

“We’ve had anecdotal conversations, but you’re never quite sure how honest people are,” Cummings says. “The project really helped get at what are the true feelings in the farming community and how that affects their decision-making. How do we help build capacity for them to understand and for us to understand what the challenges are — and how do we overcome them?”

**FOR ANOTHER UNIVERCITY YEAR PROJECT**, soil science professors **Nick Balster** and **Stephen Ventura** engaged students in their Soil Science 499/ Environmental Studies 600 course to examine other aspects of groundwater quality in Pepin County. The semester-long capstone course is designed to provide students from three majors (environmental sciences, soil science, and environmental studies) with a real-world challenge that involves interactions with actual clients.

“Through facilitated consultations with the client, the students define their final product, and we put them in the driver’s seat of figuring out how they’re going to accomplish the goal,” Balster says.

A steady rise in nitrate contamination rates in private wells across the county spurred the class to create susceptibility maps that identified areas in Pepin County with a high likelihood of water contamination. As one of their deliverables, they developed a handout to help residents assess the quality of their drinking water and how to take action.

“Our goals were helping students understand



things like project management, interpersonal dynamics, and personal communications skills,” says Ventura, an emeritus professor of soil science and environmental studies.

Balster, who also studies teaching and learning in environmental science, says the class began with an overview of groundwater issues and nitrate contamination in wells. Then they transitioned to a more hands-on approach and project development.

Students interacted with county personnel and other officials in Pepin County to gauge the extent of the problem and gain their perspectives — and get a sense of what a real-world client would expect as a deliverable. They also learned how to take on project design, deal with deadlines, perform skills assessments of classmates, and manage subgroups to tackle various aspects of the project in a timely manner.

“They coalesced around an informational pamphlet that could be put into county offices, handed out to homeowners and others to explain the issue succinctly and summarize its environmental importance,” Balster says.

The project, which was completed prior to the COVID-19 pandemic, also encountered some bumps along the way, Balster notes. “[The students] got way ahead of their timeline and made arrangements to stop at a few farms for interviews without checking in with our county contacts to get it all okayed in advance,” he says.

Cummings says that because the subject is so sensitive and residents can be defensive about the issue, students pulled back on those plans. Both he and Balster note, however, that even that experience provided a valuable object lesson in how to work with clients.

And, Luter adds, “Even though a project may not go perfectly, it still ends up being beneficial for everyone involved because they’ve given time and dedicated mental resources to sit down and think through an issue. People have told us that’s been really invaluable.”

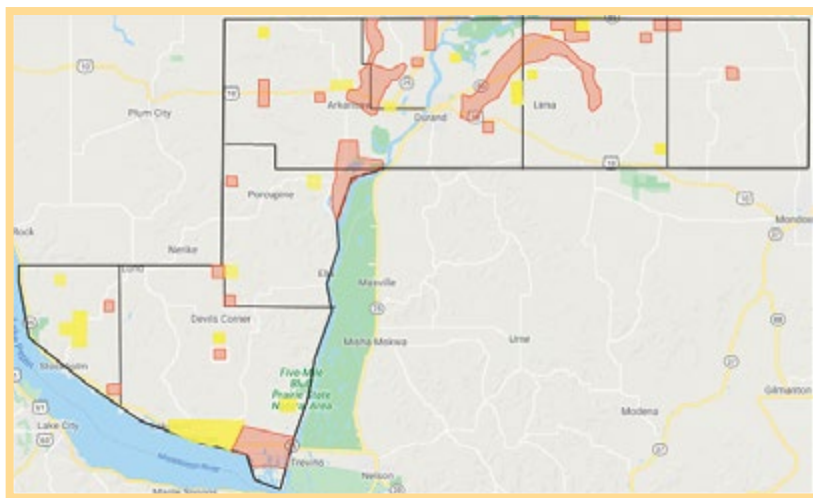
The pamphlet the students ultimately produced summarized the problem and implications, as well as prevention strategies and resources, in seven pages. Along with the pamphlet, they produced a 25-page research paper that included five maps that conveyed the susceptibility of nitrate contamination based on drainage, infiltration, and leaching for soils.

Ventura led graduate students in his technology-oriented Environmental Monitoring Seminar in another Pepin County-based project. Since private waste disposal systems, fertilizer, and animal wastes can all contribute to groundwater nitrate contamination, students were challenged to provide relevant information without exacerbating conflict between

farmers and other rural residents — in other words, to display well water quality without pointing fingers.

The project aimed to educate the public on the importance of water quality while preserving the privacy of residents and encouraging them to work collaboratively. Students analyzed 15 to 20 years of well water sampling data to come up with their maps.

“The maps didn’t point fingers directly at individual wellheads or sample points,” Ventura says. “It provided a more generalized view of areas in the county where there were high levels. It did so in a time series that allowed them to develop an animation that showed changing patterns over time.”



**LATER THIS YEAR, UNIVERCITY YEAR** will partner with Marathon County, Racine County, the village of Waunakee, and Milwaukee to tackle community-based challenges. Marathon County administrator **Lance Leonhard** is enthusiastic about the collaboration.

“In an environment with constantly tightening budgets, local governments are always looking for partnerships to help us develop strategies to accomplish our goals,” says Leonhard. “We are excited to be part of the UniverCity program because it’s an opportunity for us to address needs across a wide range of subject areas.”

Cummings says UniverCity Year produced practical results for Pepin County and for the faculty and students that lent their expertise to solving community-based problems.

“There aren’t a lot of opportunities to connect with the university in such a broad fashion,” Cummings says. “It’s also a unique chance to check off things you might have had on to-do lists for long-term planning. But it wasn’t all about us. It was about the students, too. It was a mutual education experience. It worked for everybody.”

A version of this map was included in a pamphlet that students created to educate the public on the importance of water quality. It shows areas with the highest level of projected risk for nitrate contaminants in private well water in Pepin County.

IMAGE CREATED IN ARCMAP

UniverCity Year is made possible by financial support from American Family Insurance, the Evjue Foundation, UW–Madison’s Baldwin Wisconsin Idea Endowment, COWS, the Nelson Institute for Environmental Studies, and UW alumni John Holton and Patrick Thiele.



THE FUTURE HOLDS

# No Limits

FOR **MEAT SCIENCE** AT **CALS**

With a new state-of-the-art facility,  
the Meat Science and Animal Biologics  
Discovery program looks to fulfill its  
untapped potential and more

STORY BY  
Nicole Miller  
MS'06

PHOTOS BY  
Michael P. King, Bryce  
Richter + Jeff Miller

**MS**  
**ABD**







[Left] The atrium of the Meat Science and Animal Biologics Discovery (MSABD) building, viewed from the second floor.

PHOTO BY MICHAEL P. KING

Students participate in an Animal Sciences 305 anatomy lab course, taught by Jim Claus, where they identify various muscles in a pig.

PHOTO BY BRYCE RICHTER



**Jordan Nehls BS'17** cooks up a lot of hamburgers and chicken breasts — but it's not the sort of fare she can serve to her family and friends.

Before the meat goes in the oven, Nehls, a master's student in animal sciences, inoculates each raw patty or breast with eight different strains of *Salmonella*. Next, she runs them through an impingement oven, an industrial appliance that meat processors use to prepare precooked frozen items, such as chicken nuggets and wings and hamburger patties.

“Your product goes through the impingement oven on a conveyor belt, and, as it goes along, there are jets that [blast] very hot air from above and below the product,” explains Nehls. “That decreases your cooking time significantly and adds desirable quality attributes, such as color, texture, and taste.”

When her samples come out the other side, Nehls breaks up each item in a sterile sample bag containing buffer solution. Later, she counts how many pathogens survived the journey. Her work is part of an ongoing research effort, launched when Wisconsin meat processing companies reached out to

UW–Madison in 2017 to help develop and assess impingement oven updates needed to meet new food safety guidelines from the U.S. Department of Agriculture.

This isn't the kind of work you can do in an ordinary laboratory space. It calls for commercial meat processing equipment and microbiology laboratory capabilities that can handle human foodborne pathogens.

Fortunately for Nehls, that isn't a problem. She does her work in the Biosafety Level 2 (BSL-2) microbiology facility inside the new Meat Science and Animal Biologics Discovery building on the UW–Madison campus. The building, which opened in summer 2020, is the new home of the Meat Science and Animal Biologics Discovery (MSABD) program, a group of 10 faculty and staff in the Department of Animal and Dairy Sciences devoted to research, teaching,



The kitchen in the MSABD building's BSL-2 microbiology facility.

PHOTO BY MICHAEL P. KING





[Left] The Meat Science and Muscle Biology Lab, utilized 1931–2020.

The front entrance to the Meat Science and Animal Biologics Discovery building in summer 2020.

PHOTOS BY MICHAEL P. KING

and outreach related to meat science and safety and beyond.

The BSL-2 facility — just one of several major technological advancements in the new MSABD building — is like a magical wonderland for meat-focused food safety researchers. Its design and equipment mimic what’s found in government-inspected industry facilities; but instead, it’s a federally designated space where researchers can work with moderate-risk microbes, making it the place in the building to study “anything that can make somebody sick,” explains facility manager **Cindy Austin**. Austin worked as a meat microbiologist at Oscar Mayer for 16 years, so she’s well aware of how special it is to have a space of this kind.

“When I was at Oscar Mayer, if I had said I wanted to inoculate a product with *Salmonella* and then cook it and try to kill it, they would have looked at me like I was crazy, because you can’t do that in a commercial meat facility,” says Austin. “But here, in the BSL-2, I can do that. It’s a very specialized facility where we can do projects to help the industry that they can’t actually do in their own facilities.”

In addition to the BSL-2 facility,

the building boasts a USDA-inspected meat and poultry processing facility with sophisticated animal handling, harvesting, and processing capabilities. Together, these two installations form the core of the MSABD’s research, teaching, and outreach efforts. The USDA-inspected plant hosts all of the non-pathogen work, including a wide array of academic and industry-sponsored research, short courses for industry professionals, hands-on sessions for UW laboratory courses, and hands-on training for student employees. The building also has state-of-the-art classrooms, conference rooms, laboratory space, and offices, plus a retail store — Bucky’s Varsity Meats (see sidebar, “Bucky’s Varsity Meats Educates and Delights”).

For MSABD program director and professor **Steve Ricke** PhD’89, it’s hard to overstate the extent of the facility upgrade and how much it will help bolster the program’s overall efforts. This includes building cross-campus collaborations and partnerships with industry.

“I think the capabilities are just mind-blowing,” he says. “Probably the bigger challenge is just figuring out how to expand our programs to fit some of

these capabilities. But I don’t think limitations are going to come into our conversations very much as we talk to industry. From a facility standpoint, there are no limits.”

In concert with major commitments to infrastructure, the program has made major investments in people over the past couple of years, including strategic hires for new positions. Today, six of 10 program personnel are new faces, including Ricke.

During this time of change, the program is also embracing a new focus area. In addition to its historical strengths of meat science and food safety, the program is expanding to include animal biologics — the search for value-added compounds and components from animal byproducts. It all adds up to an exciting time for the program, an era of renewal and growth.

“We’re beginning a new chapter,” Ricke says. “We can do anything from very basic research all the way to immediate application-type research. All of those capabilities are here, and the people are in place to pull it off. I think the sky’s the limit.”



The MSABD building under construction on June 5, 2018.

PHOTO BY JEFF MILLER

## SLOW-COOKED TO PERFECTION

To those involved in making it happen, the MSABD building was a long time coming — and much needed. The program's previous home, known as the Meat Science and Muscle Biology Laboratory (MBL), was built in 1931, with additions completed in 1959 and 1971. The MBL became old and cramped, and it hampered the program's potential in research, teaching, and outreach.

"When I came to UW–Madison in 2007, I had all kinds of ideas banked in my mind, plans for what I wanted to do for building a nationally recognized and prolific Meat Science Extension program," says **Jeff Sindelar**, professor and extension meat specialist in the Department of Animal and Dairy Sciences. "I had to learn my limitations due to the building's constraints. We didn't have enough space, and I had to learn to adapt, to figure out other ways I could be impactful."

The path to the new building started in June 2009, when MSABD and CALS leaders established a Meat Science Advisory Board of program alumni and industry leaders to help develop a vision for the project. Program alumnus **Steve Van Lannen** BS'91, president and COO of American Foods Group, has been one of the steadfast members of the board.

"We have a great history here, but the prior facility was so old and so decrepit that it made it difficult to attract young faculty," says Van Lannen. "So it was really pivotal to be able to get this new facility to attract the faculty that we need to reestablish the meat science program."

Wisconsin's meat industry is recognized for its strength and innovation, with a track record for developing new products and embracing best practices.



## ONLINE EXTRA BUCKY'S 'MEATY' HISTORY

Wisconsin has a Grade A past when it comes to the meat industry. Learn how UW's meat-related research, instruction, and outreach programs have changed throughout history at [go.wisc.edu/meaty-history](http://go.wisc.edu/meaty-history).

PHOTO COURTESY OF UNIVERSITY OF WISCONSIN—MADISON ARCHIVES

The state is home to more than 500 meat and poultry processors in 58 counties. They employ more than 105,000 workers, directly and indirectly, and make a \$44.3 billion impact each year. Industry members have long turned to UW–Madison for training and research partnerships.

"We have all of these wonderful state-inspected plants all around Wisconsin," says Van Lannen. "You go in every small town, and they have craftspeople producing unique meat items. And they really rely on Extension folks. Having a facility where Extension staff can train them, through offerings like the Master Meat Crafter Program, is really important."

A big role of the Meat Science Advisory Board was to advocate and help raise funds for the project. And they did that in spades. A total of 270 donors — both companies and individuals, primarily from the state's meat industry — contributed more than \$20 million to help support the \$57.1 million building project.

The project was approved by the UW Board of Regents in August 2012, design was completed in June 2016, and construction launched later that fall. Move-in started in summer 2020.

Sindelar, who served as the program and department representative throughout the process, is excited to finally be able to expand his Extension programming, including the Master Meat Crafter Program, so they can achieve the original goals he envisioned.

"Now we can do anything, and I can take the Extension programs that I developed — which, before, could only be proofs of concepts — and fully develop them while also creating new ones," says Sindelar. "I can finally expand all of my previously limited programming and be much more prolific."

## WASTE PRODUCT TO MEDICAL WINDFALL

It is indeed a new chapter for the MSABD program, as Steve Ricke says, and it introduces a number of new characters. Ricke is one of them. He joined the program as MSABD director in October 2020.



A leader in the field of microbial food safety in poultry, he is well-known for his research exploring how illness-causing *Salmonella* and *Campylobacter* survive in food animals on the farm and during processing as well as interventions to mitigate the risk these pathogens pose to consumers. Before coming to CALS, Ricke was a faculty member at the University of Arkansas, where he was the director of the university's Center for Food Safety.

Ricke's MSABD role is a homecoming of sorts. He received his Ph.D. in bacteriology and meat and animal science from CALS. As a graduate student, he trained under professor emeritus **Dan Schaefer** BS'73, MS'75, who served as MSABD's first director until his retirement in late 2019. For Ricke, one of the exciting things about being back at CALS is overseeing the program's launch into a new research focus area — animal biologics.

"We've always been well-positioned to do what I call traditional meat science — meat quality, food safety, those sorts of things," says Ricke. "One of the [new] priorities for the building, for the program, is right in the title: biologics."

The idea for this new focus arose early in the planning process, according to Van Lannen.

"In working with the college and the advisory committee, we said, 'How do we make this not just like every other meat science building around the country,'" he says. "We decided that this focus could help add value for producers and help make it a unique facility."

Biologics, briefly, are components or compounds from the unutilized or undervalued portions of meat animals

that can be used to improve human or animal health. A good example is heparin, a blood-thinner medicine derived from porcine intestinal tissue.

This isn't a new thing, actually. The meat processing industry has been saving certain components for medical uses for many years. There are glands and tissues that go toward pharmaceutical drug manufacturing; heart sacks and heart valves for human transplants; veins and cartilage for certain vitamin supplements or biomedical manufacturing.

The aim for MSABD, notes Ricke, is to take it to the next level.

"Our goal should be to have a purpose for every part of that animal. Every bit of it — gut contents, gut tissue, hooves, tails, the whole nine yards — so none of it ends up in a generic waste rendering stream," says Ricke. "We're going to promote that mentality because we believe it is an important aspect of the future of meat processing."

CALS already has a track record in this area thanks to the work of **Mark Cook** and the research teams he led over the course of many years.

Cook, a professor of animal sciences who passed away in 2017, propelled the animal biologics component of the MSABD program. In addition to his poultry nutrition research, he explored a number of biologics, including proteins from chicken eggs to help boost meat animal growth and oil from the

chicken preen gland to reduce stress in aquaculture-grown fish. Cook was a prolific entrepreneur with more than 40 patents and three start-up companies. The MSABD building's main atrium area is named in his honor.

"I think Mark would very much personify what our biologics focus represents," says Ricke. "This field helps with increasing sustainability, decreasing waste streams, and creating markets for producers of food animals and meat processors. As a land-grant university, that's a wonderful thing for us to be doing."

Two MSABD faculty members were hired in 2020 specifically to help launch the program's efforts in this area.

## PRIME FACULTY

**Wei Guo** and **Vanessa Leone** BS'03, PhD'09 are eager to pursue the hunt for biologics, and they're gearing up to expand their research programs to do so.

"Wei and I already have pretty well-established research tracks that we're on," explains Leone. "I think as we pick up more pilot projects with biologics, and they start to gain traction, we'll be able to shift our efforts to be more biologics-focused. We have the skill sets to do that, and now we're in the program and the building to do it."

Leone did her Ph.D. training in Mark Cook's lab, where she studied poultry nutrition with a focus on the biologics molecule conjugated linoleic

Steve Van Lannen, COO of the American Foods Group in Green Bay, Wis., and a CALS alumnus, hosts a live webcast virtual celebration of the opening of the MSABD building on Friday, Nov. 6, 2020. Participating in the program are MSABD program personnel, including director Steve Ricke, assistant professor Wei Guo, professor emeritus Dan Schaefer, researcher Cindy Austin, assistant professor Vanessa Leone, professor Jim Claus, and professor Mark Richards.

PHOTO BY MICHAEL P. KING



acid — a fatty acid from meat and dairy products shown to help reduce cancer, heart disease, and body fat. She then went to the University of Chicago's Department of Medicine, where she learned about the microbiome and how to study it.

Now, back at UW, Leone is eager to merge her animal sciences and microbiome training. Her focus is on understanding how the gut microbial community promotes wellness and also contributes to disease — in people and animals. She looks at the host-microbiome interaction and how it is affected by diet, particularly in the context of circadian rhythms.

"Rhythms are important — feeding rhythms, sleeping rhythms — and they're definitely a part of wellness," says Leone. "How microbes contribute to those factors is really a key feature in understanding basic physiology."

Stresses to this system, caused by changes in diet, for instance, can contribute to metabolic diseases, such as obesity and diabetes, and can degrade immune function. Now, in one of

her projects, Leone is exploring the role played by antimicrobial peptides produced in the gut of the host. Peptides are made of short chains of amino acids (longer chains are called proteins), and they are known to carry out important functions in the body.

"We think that antimicrobial peptides are really important for resetting the local intestinal clock, which helps all of our tissues in our body to stay aligned from a metabolic perspective," says Leone. "We think that is important to prevent the development of metabolic diseases like obesity and diabetes."

Collaborations seem to come naturally to Leone. She's developing projects with multiple partners, on and off campus. With MSABD faculty member **Mark Richards**, Leone will be exploring the impact of oxidized lipids on a host's microbial community and disease development, and with associate professor of bacteriology **Federico Rey**, she plans to dissect the effects of a fast-food diet using germ-free mice. She's also developing some research ideas with **Jordan Sand** PhD'10, chief technology

officer at Ab E Discovery, the bio-functional feed technology company he cofounded with Mark Cook. And she's just excited to work with poultry again. She can also envision collaborations with Ricke.

"With Steve and myself back on campus, we're excited to reestablish those partnerships between the state's poultry industry and UW-Madison," she says.

While Guo's research looks quite different from Leone's, he's also in a good position to identify new biologics. Guo investigates the fundamental mechanisms of muscle growth, development, and function, particularly looking at skeletal muscle and heart muscle. As a postdoctoral researcher in the lab of **Marion Greaser**, now a professor emeritus of animal sciences, Guo developed expertise in muscle biology and RNA metabolism as he helped identify and characterize a new gene — known as RNA-binding protein 20, or RBM20 — and he's been studying it ever since.

RBM20 helps modify the mRNA of an important muscle gene, called



The American Foods Group Harvest Floor in the MSABD building.

PHOTO BY MICHAEL P. KING



titin, which produces the largest natural protein known to science. The modification performed by RBM20 determines the size of individual titin proteins, which can range from around 27,000 to 33,000 amino acids in length.

"Titin protein is like a rubber band," Guo says. "Its long form produces lower passive tension while its short form generates higher passive tension. It's why our muscle is more flexible, like elastic, allowing our muscles to stretch."

Different muscle tissues need different balances of short and long titin proteins. If the balance is off, that can lead to tissues that are too slack or too stiff, which can cause problems. For instance, in the heart.

People with a certain mutation in their RBM20 gene end up with more of the longer form of titin in their heart muscle, causing the muscle to be relatively slack. This causes a condition, known as dilated cardiomyopathy, where patients have enlarged hearts that don't pump blood very well. With support from a National Institutes of Health grant, Guo is taking a deeper look at what happens in this situation and is attempting to develop a bioactive compound to treat this condition.

Guo notes that RBM20 is also an important factor for skeletal muscle development and growth. "Once we have an in-depth understanding of titin RNA metabolism through RBM20 regulation, I believe we can also improve muscle growth and production efficiency in food animals and thus increase animal producer profitability by targeting RBM20," he says.

A newer focus of Guo's program is exploring an RNA-based approach to delivering growth-promoting bioactive peptides to animals. The approach involves injecting animals with mRNA molecules that code for a desired peptide, such as a growth factor or a hormone. Once inside the body, the mRNA is then transcribed into peptides that help boost muscle growth.

"The mRNA-based COVID vaccines inspired me to go in this direction," he says.

A third major project for Guo is



PHOTOS BY MICHAEL P. KING

## BUCKY'S VARSITY MEATS EDUCATES AND DELIGHTS

An important public-facing part of the MSABD program now has pride of place. The storefront for the campus meat shop — recently renamed Bucky's Varsity Meats (formerly Bucky's Butchery) — lights up the MSABD building's main lobby, enticing passersby with a wide variety of meats produced in the facility as well as other made-in-Wisconsin foods and beverages.

"At the old store, there were always customers that had trouble finding it because you had to wind around these hallways," says store employee **Taylor Gracyalny**, a senior double-majoring in life sciences communication and dairy science. "Now we have a whole designated space right in the front of the building — and it looks so good."

Gracyalny, who was hired during her sophomore year, started out working in the old retail store. "I really enjoyed that because it allowed me to do customer service and talk to people about where their food comes from," she says. "Plus, other student workers showed me the processing side, like cutting and packaging. I really enjoyed seeing the whole process."

Bucky's Varsity Meats has a loyal base of customers who rave about the products and like that the operation is largely run by UW–Madison undergraduate students, overseen by a staff manager. Due to the coronavirus pandemic, the store has been offering curbside pickup (only) and operating with limited staff. When it's fully up and running, the shop will employ up to 10 part-time students who will have opportunities to gain experience in animal harvest, meat processing, food safety procedures, product display, marketing, and customer service.

"The students we employ are all very talented and very diverse in their interests," says **Mitch Monson**, the store's retail operations manager. "I encourage them to learn different roles and take the opportunity to try new things if they want to explore and grow."

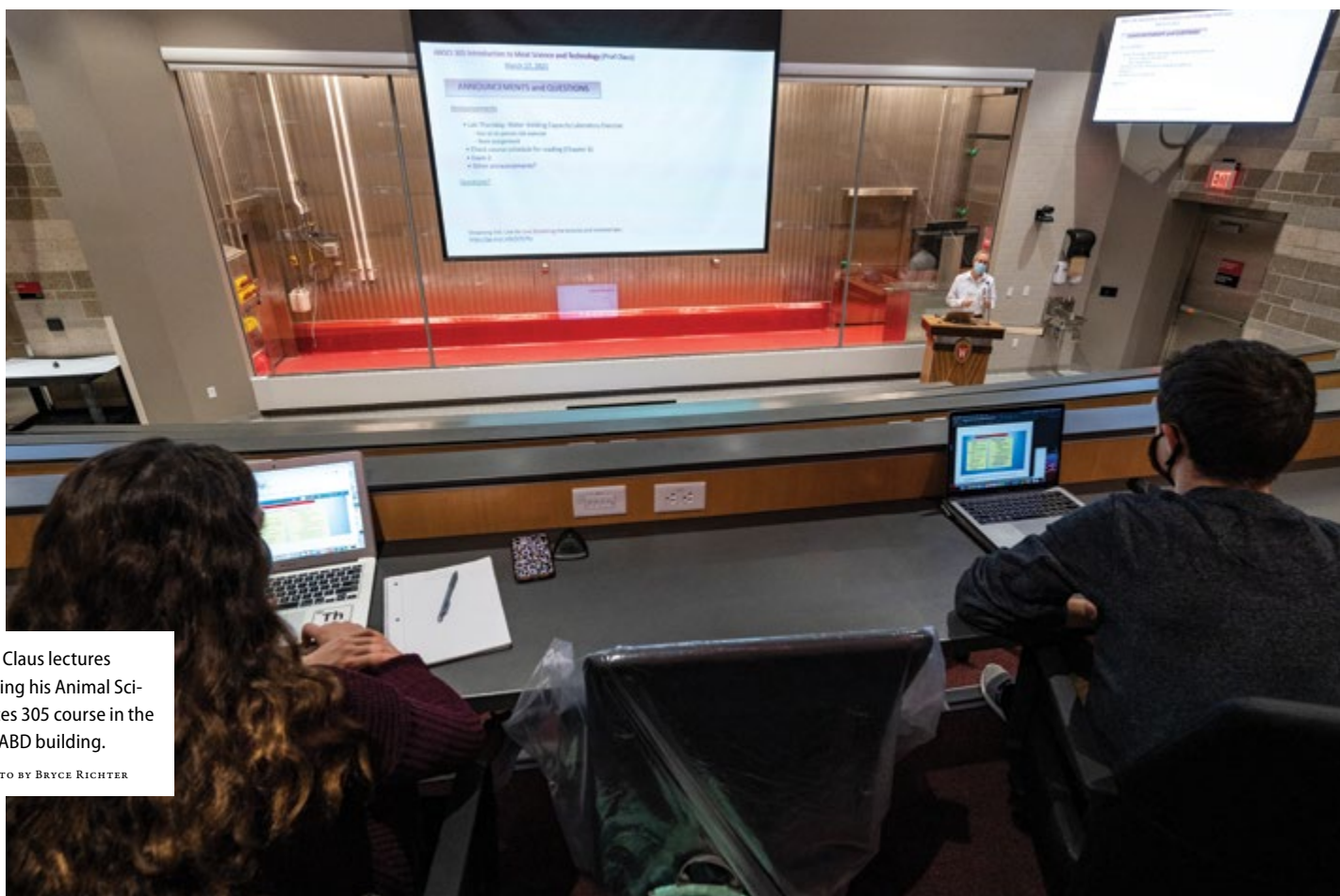
With the retail space closed to customers, Gracyalny proposed a new role for herself, one designed to further prepare for her future career in marketing communications. With Monson's blessing, she took over the store's existing social media accounts and launched an Instagram account.

"For a lot of bigger companies, like food companies, it's important to know how customers perceive packaging," Gracyalny says. "They want to know where their food comes from. They want to know how it's made. And I think I gained really valuable experience from interacting with customers in the store. Likewise, by doing the social media marketing, I was able to see what's getting the most engagement and how best to reach our customers."

—NICOLE MILLER MS'06

### FOLLOW BUCKY'S VARSITY MEATS

Facebook: @VarsityMeats  
Instagram: @varsitymeats



Jim Claus lectures during his Animal Sciences 305 course in the MSABD building.

PHOTO BY BRYCE RICHTER

looking at the impact of RNA binding proteins on fetal programming to determine how these proteins affect short-term and long-term development. This work could one day help prevent metabolic and other diseases caused by in utero exposure to damaging environmental factors.

Guo's work has attracted the attention of a handful of faculty across campus, including several in the UW–Madison School of Medicine and Public Health. He is in the process of developing multiple research collaborations.

### A JOINT VENTURE

A lot of action in the MSABD building — including harvesting animals and collecting samples for Guo's and Leone's research — takes place in the USDA-inspected processing plant. It has the capabilities to handle, harvest, and process all major meat and poultry species, including beef, pork, lamb, chickens, turkeys, and ducks. It contains upward of 50 pieces of meat processing equipment, many of them brand new and all

of them laced with technology.

"A lot of them are quite complex and require the company that donated it to come in and train us," says **Dillon Walker**, who is in charge of the plant's operations. "Everything that we have been trained on, we are using and operating."

Walker runs things with the help of around 10 undergraduate part-time employees, a few limited-term staff, and occasional help from graduate students and faculty. Together, they tackle a wide variety of work. They make the meat products that are sold at Bucky's Varsity Meats, the MSABD program's retail component. They help set up for laboratory sessions, such as the muscle anatomy lab for the undergraduate course called Introduction to Meat Science and Technology, which is led by animal and dairy sciences professor **Jim Claus**. And they do what's needed to support researchers from the department and across campus.

A significant and expanding portion of their work involves interfacing with

and supporting companies that have fee-for-service projects they want conducted in the space.

"It's exciting when we're helping out different companies with their projects," says Walker. "Those have been ramping up. It has been really fun just connecting with people in the meat industry and learning about their companies and what their research groups are pursuing as far as meat science goes."

Companies approach Walker to partner on all kinds of projects. They want to utilize the building's state-of-the-art pilot plant, as well as program and campus expertise, to test pieces of equipment they own, try out MSABD equipment that they don't (yet) own, assess new or altered product formulas, test the shelf life of their products, and more.

"We plan to pursue problem-solving research, and I think that's the backbone of any kind of research question being asked," says Ricke. "Because of the diverse nature of our faculty, staff, and students, we can work on a wide range of [projects]. That makes me confident



that we're going to be valuable partners for industry."

Each industry project also presents an opportunity for Walker's student trainees to learn about meat companies and interact with their research and development people.

"[The students] also get exposed to the companies that come in," says Walker, "For instance, a student that was with me [during a company visit] had some positive interactions with this company, and they asked for his contact info so they could reach out to him about his interest in a job."

As Walker's student employees gain experience, and as he develops the necessary systems, he envisions having between 30 and 40 undergraduates helping part-time in the USDA-inspected plant down the line. And there's sure to be a need for these well-trained students when they graduate. Like the dairy industry, the state's meat industry is anticipating a wave of retirements in the coming decade or so.

"A big benefit of the facility is the human capital," says Van Lannen. "We're always looking for strong individuals who are trained well in meat science or food safety."

“

**WE'RE ALWAYS  
LOOKING FOR  
INDIVIDUALS  
WHO ARE  
TRAINED WELL  
IN MEAT SCIENCE  
OR FOOD SAFETY.”**

— Steve Van Lannen, COO, American Foods Group

#### ROOM TO GROW — AND THINK BIG


Opening a building during a global pandemic presents challenges. For the MSABD building, it slowed a lot of things down: moving in, gearing up research projects, offering in-person classes, hiring student employees, connecting with industry partners.

The grand opening, which took place in fall 2020, was a virtual-only event, and, so far, only small groups have been able to go through and use the building. The program staff looks

forward to hosting tours, classes, and outreach programs for larger groups down the line. They are eager for people to see the inside of the building — and to get a sense for what's possible there.

"When I give tours of the USDA plant, there's two types of reactions," Sindelar says. "One group, the people who have been in meat plants before, are like, 'Wow, this place is awesome. You guys did an amazing job.' The other group gets this overpowering effect. For them, it's like going to New York City for the first time in your life. You're just so overwhelmed, all the senses — the sights, the smells, the sounds. It's just a lot to process."

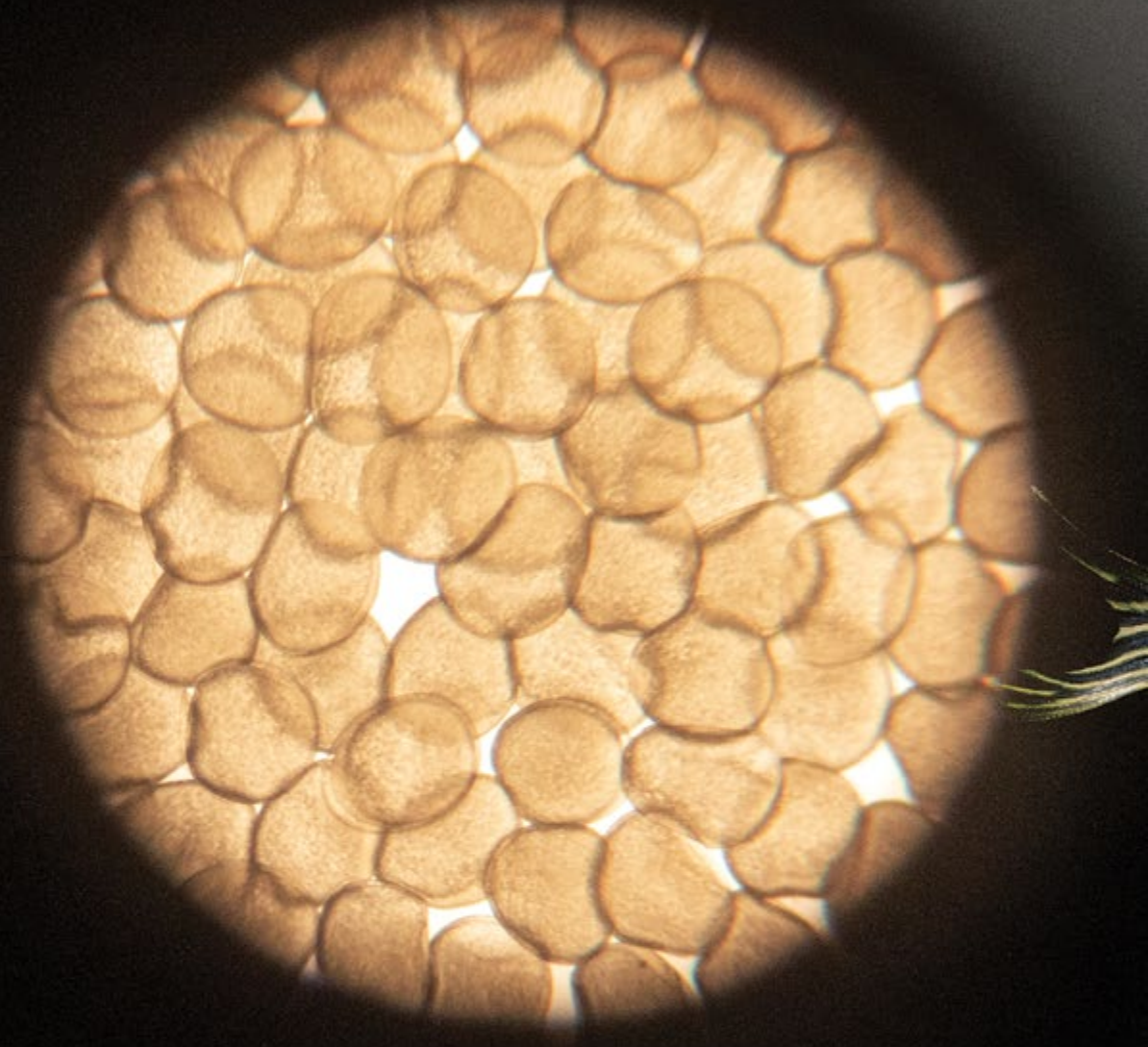
While activity has ramped up, some things aren't yet moving at full steam. It's also worth noting that the building is going to feel big — and a little empty — for a long time. It was built that way — with the future in mind, with the capacity to accommodate decades and decades of growth.

"I'm looking forward to tomorrow more than today for lots of reasons," says Sindelar, "to really start bringing people into the building and seeing the original vision being carried out — and in ways we haven't even envisioned yet." 



This digitally rendered composite panorama shows the atrium of the MSABD building, viewed from the second floor. The mezzanine level is at the bottom of the frame; Observatory Drive can be seen through the windows.

PHOTO BY MICHAEL P. KING



Zebrafish eggs are seen through a microscope after being treated with a chemical and UV light to break down their nuclei in Francisco Pelegrí's lab at the UW Genetics-Biotechnology Center.

PHOTO BY MICHAEL P. KING



Swimming zebrafish (*Danio rerio*).

PHOTO BY ISTOCKPHOTO.COM/DAN OLSEN





# *THE RACE TO THE* **ANIMAL VAULT**

As fauna fade from existence across the globe, CALS researchers look for ways to store tens of thousands of genetic samples and use cloning to preserve and revitalize endangered — and possibly extinct — species

***BY CASSANDRA WILLYARD***

**T**he last known Pyrenean ibex, a wild goat named Celia, died more than two decades ago, the victim of a falling branch. But before she died, scientists managed to biopsy her skin and stash the sample in a freezer. They were already envisioning a future in which cloning might enable geneticists to bring species back to life.

In 2003, they thawed those cells and made a first attempt to clone Celia. Since they didn't have any living Pyrenean ibex, they had to get creative. They removed genetic material from goat eggs and replaced it with DNA from Celia's skin cells. After a mild electric shock, the eggs began to divide. The scientists then implanted these embryos into surrogate moms — goats or goat hybrids. This process — known as interspecies cloning — is tricky. One kid made it to term, but he died a few minutes after he was born.

**Francisco Pelegrí** first learned about the ibex cloning effort when one of his students brought a news article describing the feat to class. Pelegrí, a geneticist, was stunned. "From a technical perspective, it didn't make sense," he says. "By the time you only have 100 individuals, you're pretty close to extinction." The researchers had cells from a single animal, and they were trying to bring an entire species back. "It struck me that we really are not prepared for this at all," Pelegrí says.

The Earth is in the midst of a sixth mass extinction event, and most scientists point to human activity as the primary cause. Each day, the planet loses an average of five to 30 species. While efforts are under way to preserve their habitat, these efforts may not be enough to save them. Extinct species, by definition, no longer exist. But their genetic material can live on in biobanks, offering the possibility of resurrection. Think of it as an extinction loophole.

Pelegrí thinks this loophole will become an increasingly crucial part of conservation. But to successfully leverage it, scientists need a smarter way to proactively biobank samples — not just one or two, but hundreds, from each species. They also need to understand the rules that govern interspecies cloning. For example, how close do two species need to be on the tree of life for cloning to succeed? With a grant from UW2020, a campus-based initiative that rewards high-risk, high-impact research, Pelegrí and his collaborators aim to find out.

"Everybody agrees we need seed banks for plants, but when we talk about seed banks for animals, people start to think it's crazy," Pelegrí says. But to him, it seems like an obvious and necessary

solution to curb the catastrophic loss of biodiversity. "Everything revolves around climate change and population control. We're doing our best to provide all the tools that we're going to have at our disposal to help with the problem."

## ANIMAL LOVER

Pelegrí has always had a passion for nature. As a child growing up in Venezuela, he watched nature shows hosted by the Spanish naturalist **Félix Rodríguez de la Fuente** and developed a deep love of animals. He memorized their scientific names and collected trading cards with their pictures.

When Pelegrí bought a small farm near Madison in 2006, he began thinking about what kind of animal he should raise to support conservation. He landed on a breed of endangered ponies. "They're essentially the only derivatives we have of the European wild horses, which became extinct," he says.

At the time, conservation was a hobby. In the lab, Pelegrí focused on developmental genetics, trying to work out how an egg becomes an embryo. "My passion for nature has always been there, but it was not a part of my profession," he says.

After Pelegrí read the story about the ibex, however, he started learning more about the role of genetics in conservation. But, as he read more about the field, he grew increasingly bewildered. Scientists seemed to be jamming genetic material from one animal into another willy-nilly — whale into pig egg or panda into rabbit egg. These mash-ups — called cybrids — didn't have a chance at succeeding. "The organisms were so far apart," he says.

Pelegrí realized he could use his two decades of expertise in developmental genetics and his own zebrafish lab to work out which pairings could be successful and which could not. "I can literally apply what I've learned in all these decades to something that I've always cared about," he says.

## FISH FAMILY

In the basement of the UW Biotechnology Center, Pelegrí pushes open a gray steel door to reveal row after row of shelves stacked with glass and plastic tanks. Each tank houses dozens of zebrafish — *Danio rerio*. The main room and a smaller back room currently hold some 50,000 fish. Pelegrí, in bright green Crocs and a navy "Badger State" hoodie, points out some that glow pink and babies no bigger than the tip of a pencil.

Zebrafish aren't endangered, of course. They're

Francisco Pelegrí, at his home near Brooklyn, Wis., with two of his Dartmoor ponies, the only remaining derivative species of now-extinct wild European horses. Pelegrí breeds them to contribute to conservation efforts.

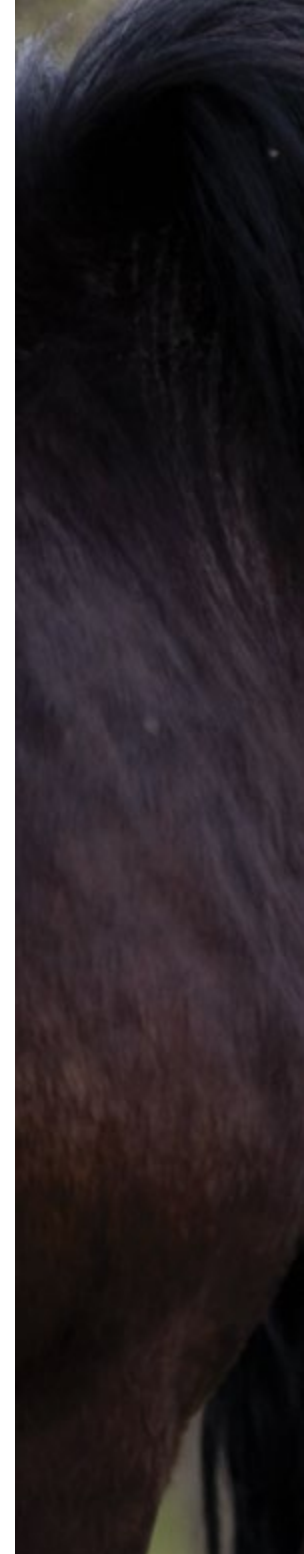






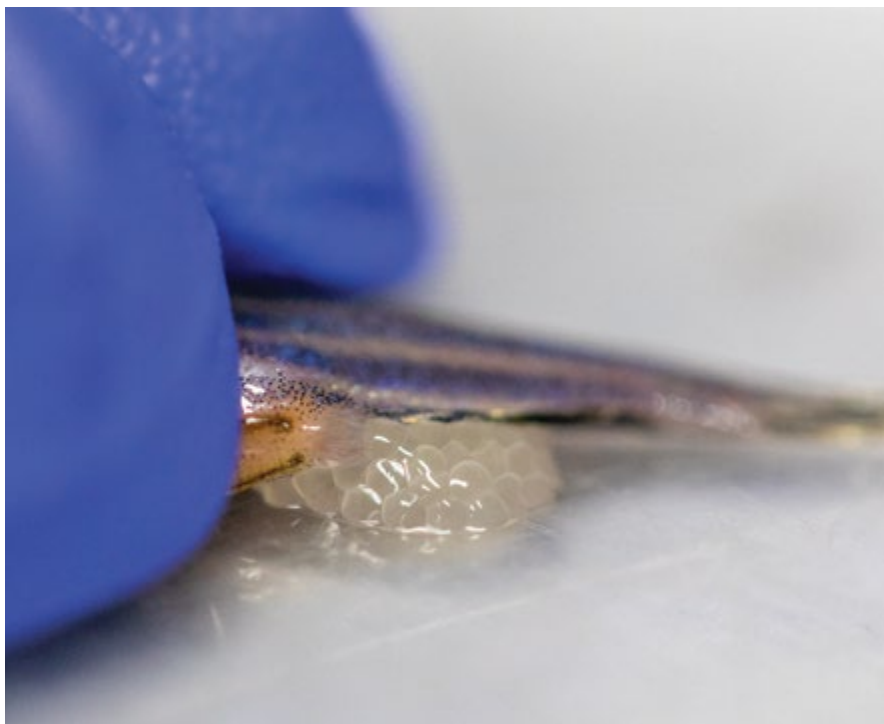
PHOTO BY MICHAEL P. KING

readily available in pet stores and labs all around the globe. But some of their distant cousins are under threat. Pelegrí believes that he and his colleagues can use this family of fish to work out the limits of interspecies cloning.

At the front of the fish room, **Ryan Trevena**, a graduate student in Pelegrí's lab, is busy matchmaking, pairing males and females and placing them in small tanks. The females' bellies are swollen with eggs. As soon as one of these fish begins to lay, Trevena scoops her out and places her in a beaker of anesthetic to knock her out. He carefully dries her with a paper towel and then gently presses on her belly with a gloved finger until a drop of milky liquid appears on her abdomen. This single

***"I can literally apply what I've learned in all these decades to something that I've always cared about."***

— FRANCISCO PELEGRÍ



PHOTOS BY MICHAEL P. KING

Research assistant Ryan Trevena treats zebrafish eggs with a chemical before exposing them to UV light to break down their nuclei in Francisco Pelegrí's lab at the Genetics-Biotechnology Center.

[Right] Trevena expresses eggs from a zebrafish.

droplet carries dozens of microscopic eggs. He treats the eggs with a chemical that, with help from a UV light, breaks down their nuclei.

Upstairs, in a much smaller room, dozens of tanks hold other members of the Danionin family. Some have Dalmatian-like spots. Others are almost translucent. Trevena mixes the zebrafish eggs he just collected with sperm from *Danio albolineatus*, the pearl danio. Over the next several hours, the eggs will start dividing. Three days later, they will hatch.

These fish won't survive — they have only half the genetic material of a normal fish and typically die in the first few hours after birth. But it's enough time for Pelegrí and his colleagues to examine whether cloning the pearl danio using a zebrafish egg might work. Performing nuclear

transplants is finicky work that takes time, “and the success rate is fairly low,” says genetics Ph.D. student **Trevor Chamberlain** MS'19, who is working on the project with Pelegrí and Trevena. In vitro fertilization — the process they're using — is a quick and easy way to screen for combinations that might work. “We're doing it for the throughput,” Chamberlain says.

For cloning to work, a transplanted nucleus must communicate with the rest of the egg cell. If the nucleus and egg are from two different species — especially distantly related ones — that communication can break down. For example, “the mitochondria only code for a small handful of genes, but they're core genes,” Chamberlain says. They are key to respiration. If the mitochondrial DNA and the nuclear DNA aren't compatible, the

Interspecies cloning can be achieved through a process called somatic cell nuclear transfer. In simple terms, the nucleus of a somatic (body) cell of one species and the nucleus of the egg cell of a closely related species are both removed. The somatic cell nucleus is then placed in the egg cell to create a cloned embryo, which begins dividing before, if needed, it is placed in a surrogate mother for further development.

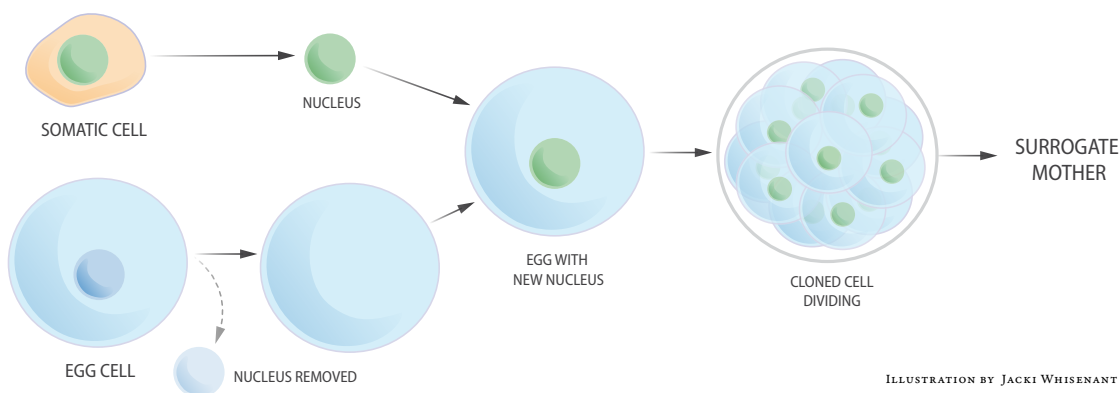


ILLUSTRATION BY JACKI WHISENANT



embryo may never develop correctly. In primates, humans can mix with chimpanzees, Pelegrí says. “But when you get as far as orangutans, then it breaks down.”

Knowing these limits will be essential if biologists want to boost endangered populations or revive extinct animals through cloning. Using eggs from the animal’s closest living relative might produce the best success, but it won’t always be feasible.

One model system, of course, won’t be enough. The limits that exist in the Danionin lineage may not apply to other families. “We need to look at other lineages precisely for that reason,” Pelegrí says. That’s why he has recruited collaborators working with other model organisms: frogs and bees.

Brilliantly colored mantella frogs, from Madagascar, are tiny and poisonous. Eleven species are either at risk, endangered, or vulnerable. The golden mantella, which now exists only in one small patch of forest, is critically endangered. And many other amphibians are under threat too from a fungal outbreak that has decimated populations around the globe. According to a 2019 study, fungi contributed to the decline of some 500 species between 1965 and 2015. Of those, 90 are presumed extinct.

Pollinator populations have also been on the decline. “These insects are critically important, so their declines are pretty troubling,” says **Sean Schoville**, a molecular ecologist, associate professor of entomology, and Pelegrí’s collaborator. “We are focusing on bees — mostly bumblebees — as a good model because they’re declining across the world, but especially in the United States,” he says. “There are more direct measures of conservation that are still possible with insects. But we might find ourselves needing these kinds of techniques because we haven’t actually found the cause of the decline.”

The factors that create a mismatch between nucleus and egg won’t be the same for every family. The boundaries might be different for bees than they are for fish or frogs. But by studying all three groups, Pelegrí says, the team might be able to “get a ballpark idea of what those parameters might be.”

Cloning is one way to revive endangered populations or re-create extinct ones, but there are other

## RESEARCH CREATES TEACHING OPPORTUNITIES

In 2015, genetics professor **Francisco Pelegrí** launched a course called Developmental Genetics for Conservation and Regeneration that ties directly to his ongoing research program. The aim is to have students think about how they could use molecular genetics to preserve biodiversity. Students learn about topics from cellular reprogramming to synthetic biology.

“Pretty much everything I’ve learned about biobanking, I’ve learned by teaching this class,” he says.

And it’s growing in popularity. In the first year of the course, Pelegrí had four students; last year he had 60.

Pelegrí also leads an optional study abroad trip to Costa Rica each spring. “The study abroad is essentially an extension of the in-house course,” he says.

In Costa Rica, he and his students are studying the feasibility of using mosquitoes for sample collection. In 2019, the group attempted to test some mosquito collection methods, but they had little success. “It rained on us the whole time we were there, and there weren’t a lot of mosquitoes,” says graduate student **Trevor Chamberlain** MS’19, who went

on the trip because he won a coin toss with fellow student **Ryan Trevena**. Though the team was drenched at the time, prior to their arrival, an extended period of drought in the sampling area — a rainforest, no less — had caused a decline in the mosquito population, highlighting one way that climate change can complicate research.

The COVID-19 pandemic also complicated matters. It forced Pelegrí to cancel the 2020 and 2021 trips, but he has high hopes for their prospects in 2022. “Costa Rica is notorious for not letting people take samples out of Costa Rica,” he says. “But nobody cares about mosquitoes. They basically said, ‘you can take your mosquitoes with you.’”

Pelegrí has even started talking with his students about the possibility of engineering mosquitoes to go and gather blood samples. “Mosquitoes may not work at all, but we are trying to be innovative,” he says. “The important thing is to get the process going with the latest technologies.”

Pelegrí’s enthusiasm is obvious to everyone around him. “He is one of the most passionate people I’ve met,” Chamberlain says. And he wants his students to share that enthusiasm. For the past six years, Pelegrí has been collecting photos of all of them. He hopes to eventually have enough to create a photo mosaic. A viewer could step back from the collage and watch the small photos merge into a larger picture.

“I’m trying to teach them that we’re all part of the process,” he says. “There are seven billion people on the planet, so there are seven billion problems. But there are also seven billion solutions.”



/// A group of students participating in a 2019 spring break study abroad trip to Costa Rica are pictured here in La Selva Research Station.

PHOTO BY TREVOR CHAMBERLAIN

*“We don’t have to wait until the species become extinct to do anything. In fact, we shouldn’t.”*

— FRANCISCO PELEGRÍ

ways that might work better. One method being considered for mammals relies on the plasticity of the mammalian embryo. In the earliest stages, scientists can fuse cells from an endangered species onto the embryo. That organism then becomes a chimera — part engendered, part not. And some of its germ cells might be wholly composed of endangered species DNA.

“You could get sperm that is pure sperm from an endangered species or pure eggs from endangered species,” Pelegrí says. Those cells could then be mixed to create an embryo that is wholly the endangered species.

Research intern  
Gabby Voit works with  
zebrafish in the lab of  
Francisco Pelegrí at  
the Genetics-Biotechnology Center.

### TAKE IT TO THE BANK

The success of cloning as a conservation strategy depends, in large part, on having well-stocked, long-lasting biobanks. Pelegrí envisions a network of biobanks that would house samples from thousands — or even tens of thousands — of species. To maintain genetic diversity, they would store samples from 500 individuals for each one. The first conundrum is how to obtain samples from species that are already under threat. “You cannot go somewhere and be invasive and affect the species you want to save,” Pelegrí says.

One idea is to outsource the collection to mosquitoes. Their guts hold blood from a wide variety of species, “a possum or a tiger or whatever,” Pelegrí says. If researchers can catch the insects and identify which cells belong to which animal, this method could be an easy, noninvasive way to get cells from species whose populations are already dwindling.

A second hurdle is the biobanking itself. Existing animal biobanks store cells in massive



PHOTO BY MICHAEL P. KING





These zebrafish embryos were generated using eggs with nuclei that were inactivated by high-energy X-rays and then fertilized with intact sperm. This is a simple method researchers use to replace an egg nucleus with a nucleus from another organism and test models to improve nuclear transfer.


subzero freezers, “which, just from an energy standpoint, is pretty costly,” says **Caroline Barry** BS’16, a graduate student who is working with Pelegrí. It also makes them vulnerable to power outages or political whims. So the team is working to develop less energy-intensive ways to preserve samples. The goal is to make the animal cells more like plant seeds.

Barry hopes to do that by taking some lessons from the adorable and nearly indestructible tardigrade (also known as the water bear or moss piglet). These animals can survive for years, or even decades, without water. They can withstand blasts of UV radiation, extreme temperatures, and the vacuum of space.

Barry is currently trying to grow tardigrades in the lab, and then she’ll begin working to imbue fish eggs with some of the tardigrade’s toughness by bathing them in tardigrade messenger RNA. That might allow for eggs to be stored at higher temperatures. And if the tardigrade doesn’t work, there are plenty of other bio-inspired options to explore. Keratin — a protein found in hair, nails, feathers, and horns — might provide good protection from bacteria and help keep DNA stable. Or the team might be able to use cells called osteoblasts, which play a crucial role in bone formation, to encase the samples in a tough mineral shell. They are using new mRNA delivery methods, which allow them to test these different options efficiently.

Barry is also investigating methods for giving individual samples unique barcodes so that entire populations can be stored in a single vial. Vertebrates alone account for 66,000 species. So combining individuals would save much-needed space.

Conservation biologists tend to view cloning and other genetic manipulations as a last-ditch effort to save species. But Pelegrí says it’s crucial to be proactive rather than reactive. Samples need to be collected and banked before populations begin to crash. “We don’t have to wait until the species become extinct to do anything,” he says. “In fact, we shouldn’t.” As a population shrinks, so does its genetic diversity. Cloning could be used to reinject diversity, essentially boosting a struggling species.

“These technologies are coming,” Pelegrí says. In 50 years, they might be commonplace. “What we need to do now is prepare for that future.” 

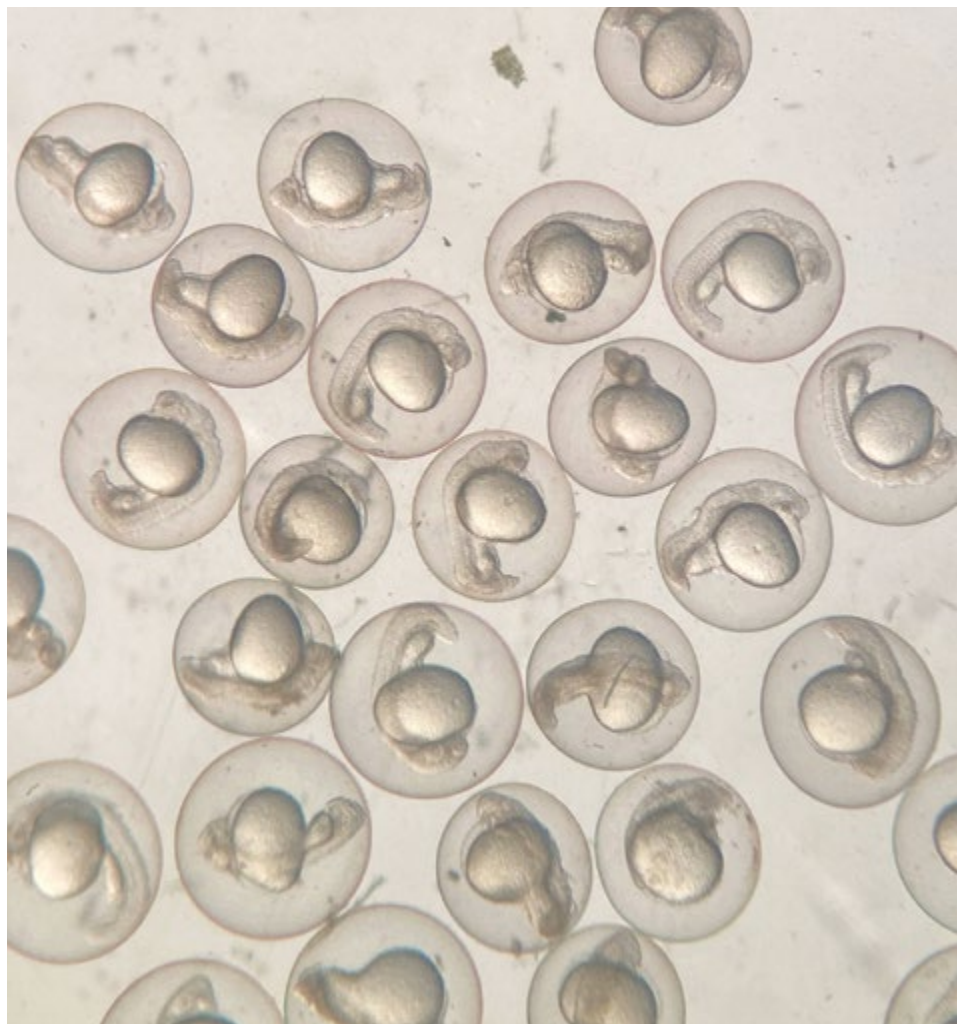


PHOTO BY RYAN TREVENA

## A CROSS-CAMPUS COLLABORATION

The animal biodiversity biobanking project involves faculty, staff, and students from the College of Agricultural and Life Sciences, the College of Engineering, the College of Letters and Science, the Morgridge Institute for Research, the Nelson Institute for Environmental Studies, and the School of Medicine and Public Health. Here are some of the key collaborators.

### Principal Investigator

**Francisco Pelegrí**, professor of genetics

### Co-Principal Investigators

**Elizabeth Hennessy**, assistant professor of history

**William Murphy**, associate professor of biomedical engineering

**Paul Robbins**, director, Nelson Institute for Environmental Studies

### Co-Investigators

**Wesley Culbertson**, assistant professor of medical physics

**Claudio Gratton**, professor of entomology

**Susan Paskewitz**, professor and chair of entomology

**Sean Schoville**, assistant professor of entomology

**James Thomson**, director of regenerative biology, Morgridge Institute for Research



Food Research Institute scientist Hiroshi “Sugi” Sugiyama at work in the lab. Sugiyama, who made significant contributions to the study of botulism and as a food science instructor, has, along with his family, bestowed CALS with a gift that will provide long-lasting support for graduate students.

PHOTO COURTESY OF THE FOOD RESEARCH INSTITUTE

## Estate Gift Offers Boon for Graduate Students

**A** former Food Research Institute (FRI) scientist and his family have bestowed CALS with a gift that will offer long-lasting support for graduate students as they work toward new discoveries.

**Hiroshi Sugiyama**, better known as “Sugi” to many, came to UW–Madison in 1961, following FRI as it moved from the University of Chicago. In addition to his work as a principal investigator at FRI, Sugi taught food science classes. He remained at UW–Madison until his retirement.

Sugi’s first passion was research. He made his main contributions in the area of botulism (a form of poisoning from *Clostridium botulinum* and similar bacteria that can thrive in canned foods), which he studied for the entirety of his career. His devotion to increasing our understanding of food-related problems — and our capacity for solving them — inspired Sugi and his wife, **Yuri**, to create an estate gift for CALS.

The Sugiyama gift became available as a fund to support CALS after Yuri died in 2019. Sugi preceded her in 2006. Though they’ve passed away, they are remembered fondly by their daughters, **Gayle** and **Linda Sugiyama**, who have honored their father’s legacy with gifts of their own to the fund.

Called the Hiroshi and Yuri Sugiyama Fund for Graduate Studies, it is dedicated to supporting CALS graduate students.

“I think that my father’s experiences during the period before World War II are among the reasons he so strongly supported graduate education,” Linda says.

After graduating from the University of California, Berkeley, Sugi aimed to become a doctor of medicine. But no medical schools in California would admit a Japanese-American at the time. He was drafted into the U.S. Army in 1942; shortly after, his mother and younger siblings were sent to internment camps. After the war, Sugi was able to attend graduate school at the University of Chicago on the GI Bill, and this propelled him into a career in public health and, eventually, brought him to UW.

The Sugiyama fund has arrived at a crucial time. In the wake of the COVID-19 pandemic — and the disruptions it created for research — many graduate students are in need of financial support as they work to get their studies back on track.

At the beginning of the pandemic, CALS faculty, staff, and students transitioned to a remote working environment. During that time, **Bill Barker**, associate dean for research and graduate programs, had to work with researchers to quickly find a way to continue caring for the research organisms and animals. After this, only certain research projects deemed essential resumed, and they were limited by social distancing and other protective measures. The scenario was unprecedented.

“I can’t think of anything even remotely like this ever happening,” Barker says.

It has been well over a year since the pandemic brought everything to a standstill, but Barker and others have been hard at work getting everyone safely back in the lab. The Sugiyama gift, in addition to other ongoing efforts to support CALS grad students, should be able to provide some welcome relief in the near future. Although the logistics of the fund are still in the works, it is hoped that the money will become available to students for the 2021–22 school year.

“You have to be brave,” Barker says. “And I think our grad students have been super brave.”

—JORI SKALITZKY BSx’22

**TO MAKE A GIFT** in support of graduate students, contact **Henry Lagrimini** at [henry.lagrimini@supportuw.org](mailto:henry.lagrimini@supportuw.org) or 608-308-5375.





## WE ARE SO PROUD...

... to call you our alumni. Last year, we saw firsthand how you take on a challenge. You face it head-on. You adapt. You persevere. We thank you, CALS 2020 winter grads, for your flexibility, your fortitude, and your grace under pressure. **Nothing can stop you now.**



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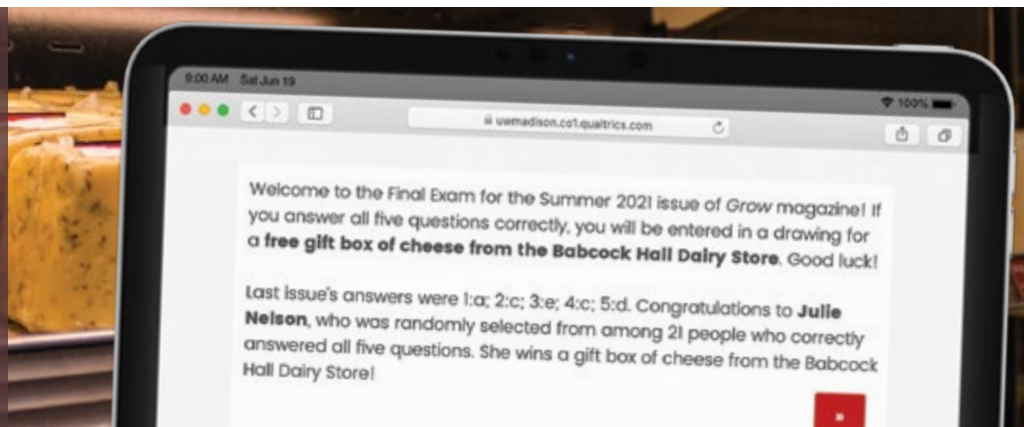
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PHOTO BY JEFF MILLER | LIST OF WINTER 2020 BACHELOR'S, MASTER'S, AND DOCTORAL GRADUATES AS OF DEC. 4, 2020

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BACKGROUND PHOTO BY BEN VINCENT





Genetics professor Francisco Pelegrí at his home with Polo, a Samoyed dog. Samoyeds are one of the few remaining “natural” breeds, meaning they are among the closest, genetically, to their wolf precursors. Pelegrí incorporates Polo into his genetics course to teach about phylogeny (evolutionary development), domestication, captive breeding, and reintroduction to the wild. [Read more on page 30.](#)

PHOTO BY MICHAEL P. KING