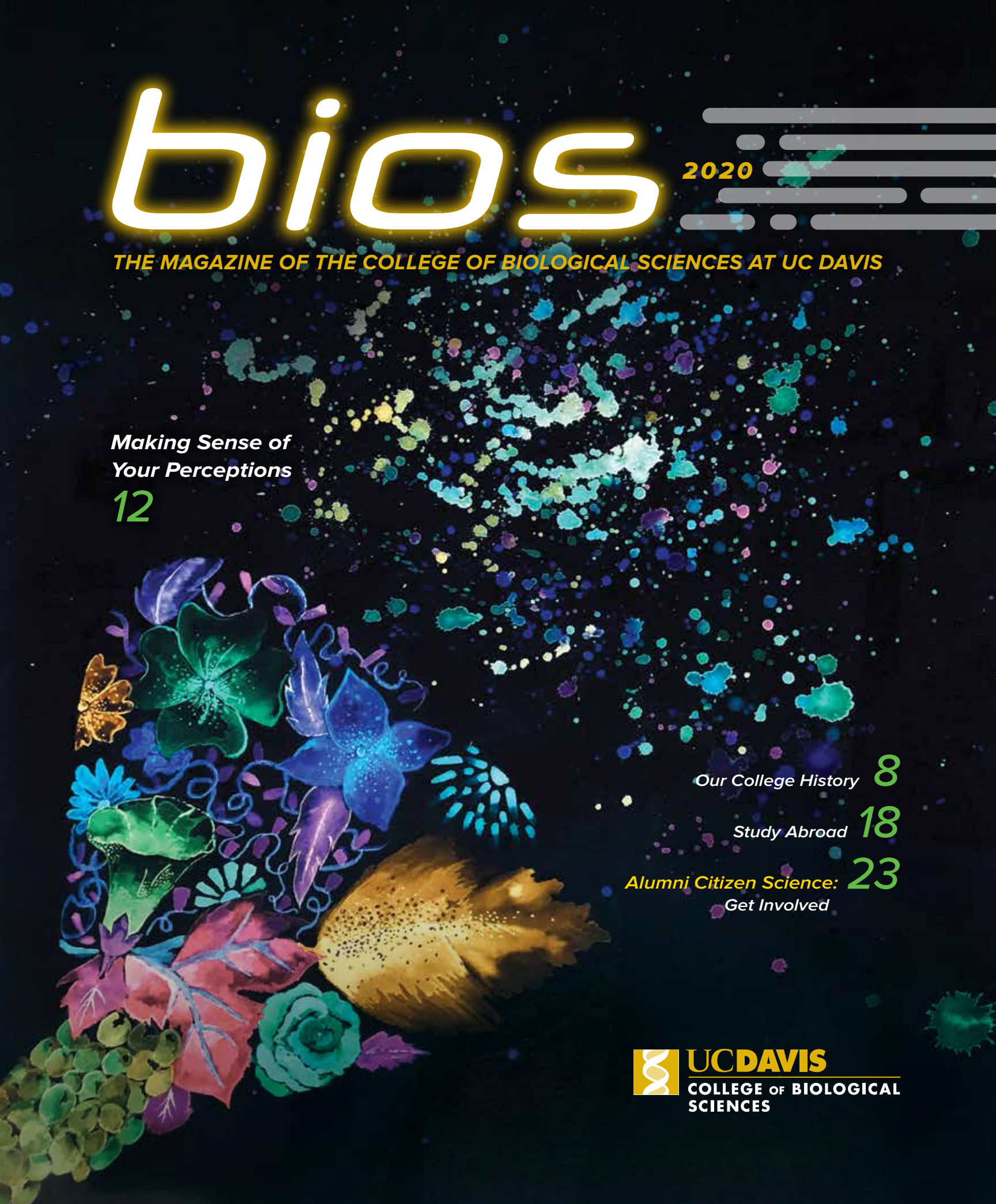
# bios 2020

THE MAGAZINE OF THE COLLEGE OF BIOLOGICAL SCIENCES AT UC DAVIS





UC DAVIS
COLLEGE OF BIOLOGICAL SCIENCES


DAVID SLIPHER / UC Davis

# ZEBRAFISH

## *A model organism*

**Graduate student Masuda Sharifi and Professor of Molecular and Cellular Biology Sean Burgess** use zebrafish to understand how errors in meiosis lead to birth defects and miscarriages. Researchers in the College of Biological Sciences also use zebrafish to study ovarian cancer and other reproductive diseases. The Zebrafish Facility houses more than 20,000 fish, the most numerous vertebrate for research in our college.

SCAN ME

*Dive in to the world of organisms our researchers study:*
*qr.biology.ucdavis.edu/Model*

# SALUTE TO SCIENCE

DAVID SLIPPER / UC Davis

## Our curiosity is our identity

This is a magazine about who we are as a college. From our outstanding students to our world-class faculty, our educational programs transform minds and our scientific discoveries transform lives.

But it's also a magazine about you and the myriad ways biology affects your daily life.

Biology is our passion, and we're here to share our exciting (and in our opinion, fun) research with you. Driven by curiosity, foundational science is the key to broader solutions and impacts for our society—many of which are just waiting to be discovered.

These effects will continue to grow and change through the technologies we gain in the 21st century, championed as "the century of biology."

Demonstrating the value of science in our lives has never been more essential. No matter your day job, you can be an advocate for science by sharing these stories and sparking discussions with the people who matter most to you.

We're proud to share these stories with you, and I hope they will in some way spark a dialogue about how biology affects you as an individual and as a member of your community. **Please join the conversation with us and tag @UCDavisBiology on social media.**

To the advocates for science, wherever you may be, we salute you.

Go Aggies,

Mark Winey, Ph.D.
Dean, College of Biological Sciences
and Distinguished Professor
of Molecular and Cellular Biology

*In these pages you'll find QR codes to scan with your phone for a deeper dive on our website. With videos and stories, it's a great place to see our world-class excellence in action—**and sign up for our monthly newsletter.***

## COLLEGE BY THE NUMBERS

**133** faculty members

**5,845+** undergraduates across 9 majors

**492+** graduate students in 8 graduate groups

**40,000+** alumni
*2018-2019 academic year*

**15** National Academy of Sciences members

**11** American Academy of Arts and Sciences members

**$124M** total funding
*2018-2019 academic year*

For Biological and Biomedical Sciences
**UC Davis is:**

**#1** in graduate degrees for Hispanics and Latinos

**#2** in undergraduate degrees for underrepresented minorities
*Diverse Issues in Higher Education, 2019*

SCAN ME

qr.biology.ucdavis.edu/Salute


SID GANESH / UC Davis

**On the cover:** An inversion treatment from *The Art of Harm Reduction*, a three-part watercolor series about substance use created by **neurobiology, physiology and behavior undergraduate Sid Ganesh.**

SCAN ME

*View Ganesh's works: qr.biology.ucdavis.edu/Harm*

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## FEATURES



## DEPARTMENTS

# ON THE RADAR

## Trending

**#opioidcrisis #addiction #opioidaddiction**

Opioid drugs and endorphins provide our brain cells with a "soothing light" that masks pain. Endorphins naturally turn this light on and then off; opioid drugs don't turn off the light. So our brain cells don "sunglasses" to dim the light, a metaphor **Jennifer Whistler, associate director of the Center for Neuroscience,** uses for tolerance and dependence. Whistler (pictured) takes cues from nature in her research and wants to design synthetic opioids that mimic endorphins. "Nature intended for it to be balanced and we've made it completely unbalanced," she says.

**#maternalimmunology #maternalhealth**

To explore the origins of autism and schizophrenia, **Kimberley McAllister, director of the Center for Neuroscience,** looks to the developing brain. Previous research has revealed an association between viral infection during pregnancy and an increased likelihood of the child developing these disorders. "By measuring traits from the female even before they get pregnant, we can predict which ones will go on to have susceptible or resilient pregnancies," says McAllister. "Now, we're doing a full behavioral analysis on these offspring from susceptible and resilient pregnancies so that we can start to see how one risk factor can lead to different psychiatric disorders in offspring."

DAVID SLIPHER / UC Davis

**#aquaculture #oceanacidification #climatechange**

The future of sustainable food from the sea depends on new advances in aquaculture. UC Davis researchers are riding this culinary wave and **partnering with local businesses, including Hog Island Oyster Co., to develop eco-conscious practices.** "There's a revolution in the aquaculture industry that focuses on the impacts of climate change on the future sustainability of coastal ecosystems, from the genomes of oysters and other shellfish and how they'll respond to ocean warming and acidification to how we can use seagrass restoration in tandem with growing shellfish to enhance the resilience of coastal environments," **says Richard Grosberg, director of the Coastal and Marine Sciences Institute.**

# BIG QUESTIONS: What You Should Know Before Getting Personal with Genomics

A baby is anonymously left on the doorstep of a fire department. His genetic data could point to the parents who left him. A political candidate is pressured to take a genetic profile test to prove his identity to his constituents. An apartment leasing office requires an elderly woman be screened for Alzheimer's disease to show she'll be a safe tenant.

As DNA profiling reshapes our society, how will we decide how and when this genetic information is appropriate to use? For **Professor of Evolution and Ecology Graham Coop**, it's something we can't wait to address.

"We need to start having a set of public conversations about all of the different areas of genetic profiles in our lives," says Coop, "because the applications of these methods are going to evolve very quickly."

DNA profiles also invite many personal questions and, according to Coop, the most significant results may give cause for you to reexamine who you are and how you define yourself as an individual and part of a group.

**Here are some tips when considering a DNA profile:**

- **Talk to your family first**—this may help plan for any potential surprises
- **Keep an open mind**—your results may not be conclusive or may change in time as databases grow
- **Manage your expectations**—the results might not be what you expect, but that doesn't have to change your identity or story

SCAN ME

*Coop goes in depth on what to expect from your DNA profile:* **gr.biology.ucdavis.edu/DNAtest**



# EXERCISE & YOUR BODY: FIVE THINGS YOU DIDN'T KNOW

## 1 Endurance is about evolution

Long before refrigerators, humans depended on hunting. Scientists theorize this led to physiological changes improving human endurance. The result: we could chase animals over vast distances, a practice called persistence hunting.

"We evolved over hundreds of thousands of years to be highly active with relatively low amounts of food," **says Professor of Molecular Exercise and Physiology Keith Baar.** "In the last 200 years, our activity level has gone down about four- to six-fold and our caloric intake has gone up because it's easier to get food."

The lack of endurance activity affects every tissue in your body. In fact, research suggests inactivity causes 18% of deaths each year in the U.S.

## 2 Stretching doesn't prevent injury

According to Baar, being overly flexible creates laxity in joints, requiring you to use more muscle energy to stabilize them. Hyperflexibility increases the likelihood of injury as much as inflexibility.

"There's a really nice meta-analysis of lots and lots of different studies, and their conclusion was that stretching had no effect on musculoskeletal injury rate," says Baar. "The better way to maintain flexibility is to do strength training."

## 3 For strength training, reps trump sets

A single set of 10 to 12 reps on each exercise is all you need to complete a strength training program in 12 to 15 minutes, Baar says.

"The research here is really clear—one set of an exercise is as good as three sets or five sets of an exercise," he says, noting you want to lift with a safe load through the full range of motion until you can't lift anymore. "You just want to do movements that use lots of different muscles and go until you can't possibly lift the weight again."

Muscular failure is the only time we use every muscle fiber, which leads to better strength training results. Baar employed this technique while working as a strength coach for the Division I University of Michigan football team.

"The guys would lift weights twice a week for about 15 minutes, and they were some of the strongest football players in the NCAA," he says. "They also had a very low rate of musculoskeletal injuries."

GREG WAITR / UC Davis

*From genes to the gym, Keith Baar studies exercise.*

## 4 Spark up a runner's high

Our bodies evolved neurobiological systems that reward physical activity. Research shows the sensation described as "runner's high" can be attributed to the body's production of endocannabinoids, which deliver a chemical experience similar to cannabis. This signaling has various effects on the human body, from mitigating pain to inciting appetite.

"You're stimulating the endocannabinoid effect," says Baar. "It's the same thing as somebody who's going to smoke some marijuana. They're going to go out and get the munchies."

"The animals that have the most stimulation of endocannabinoids are the ones that exercise the most out of enjoyment," adds Baar.

## 5 Science supports the mind-body connection

Exercise isn't just a medicine for the body. It's medicine for the mind, promoting biochemical processes integral to mental health.

Our bodies use and recycle amino acids from food but not all byproducts of this process are safe. Take the metabolite kynurenine. Its presence in the brain is associated with depression, Alzheimer's disease and Parkinson's disease. Exercised muscles are better at preventing kynurenine buildup in the brain by converting it to kynurenic acid, which can't cross the blood-brain barrier.

"If you exercise, you make more of the enzyme that converts kynurenine to kynurenic acid," says Baar. "Therefore, exercising decreases kynurenine, getting rid of this potential toxin that's associated with depression, Alzheimer's and Parkinson's."

SCAN ME

*Explore the undergraduate research experience in Baar's lab:* **gr.biology.ucdavis.edu/Injury**

## COLLEGE HISTORY:

# A Home for Biology

*by Greg Watry*


Botany Lab (undated)

In 1924, UC Davis established the Department of Botany, now Plant Biology. It was one of the seeds that would one day grow to become the College of Biological Sciences.

*In the early 20th century,* when the University of California, Davis, was still known as the University Farm, the seeds that would germinate to become the College of Biological Sciences were already sowed. They were planted in the fertile soil of the Central Valley, the heart of U.S. agriculture, in 1905, when the California State Legislature approved the establishment of the Davisville campus under the auspices of UC Berkeley. Much has changed since the days when enrollment numbered less than 100.

Today, the College of Biological Sciences is home to more than 6,000 students, 130 faculty members, 400 staff members and an alumni base of more than 40,000. As one of the nation's top colleges dedicated exclusively to life sciences, its departments span the breadth of biology: Evolution and Ecology; Microbiology and Molecular Genetics; Molecular and Cellular Biology; Neurobiology, Physiology and Behavior; and Plant Biology.

Like evolution, the college's identity is constantly changing, adapting to new challenges and technologies, and innovating for the future. Our faculty, staff and students are collaborating to solve the world's greatest challenges, from developing climate-resistant crops to growing miniature organs to better understand and fight cancer.

> ***"While our college may be young, its roots run deep. The tradition of foundational life sciences research has a storied past at UC Davis."***
>
> — Mark Winey,
> *Dean of the College of Biological Sciences*


Bacteriology Lab Course (circa 1923)

Our students and faculty have conducted research at the cutting edge of science for more than a century.

"Curiosity is a driver of innovation and our researchers are curious about life," **says Mark Winey, dean of the College of Biological Sciences and distinguished professor of molecular and cellular biology.** "We're actively working to solve the pressing problems of the 21st century. While our college may be young, its roots run deep. The tradition of foundational life sciences research has a storied past at UC Davis."

The Division of Biological Sciences was established in 1970, 11 years after the formal founding of UC Davis. Home to zoology, botany, bacteriology, genetics, biochemistry, biophysics and animal physiology, its charge was to "coordinate undergraduate biology majors in the College of Letters and Sciences and the College of Agricultural and Environmental Sciences."

In 1993, the division reorganized into five sections, which included Evolution and Ecology; Microbiology; Molecular and Cellular Biology; Neurobiology, Physiology and Behavior; and Plant Biology. The division also united interdisciplinary units including the Center for Neuroscience, the Center for Population Biology and later the Genome Center and the Coastal and Marine Sciences Institute.

But a division isn't the same as a college. To meet the needs of the growing number of biology students on campus, the Division of Biological Sciences leadership and faculty united for a new vision that would allow the proposed college to grant its own degrees and have its own faculty governance. In July 2005, the University of California Regents approved the decision to change the Division of Biological Sciences to the College of Biological Sciences, making UC Davis one of a handful of universities in the nation with a college devoted exclusively to biology teaching and research.

This "century of biology" brings focus and urgency to our educational and research missions as we enter a brave new world. As bioinformatics, computer modeling and mathematics become more important to research, the college's curriculum is evolving to give the next generation of biologists the skills they need for success.

"We're already on the cutting edge of technology and research, but what's beyond the blade?" asks Winey. "Through innovative initiatives and programs, we are equipping our students with the tools they need to positively change the world."

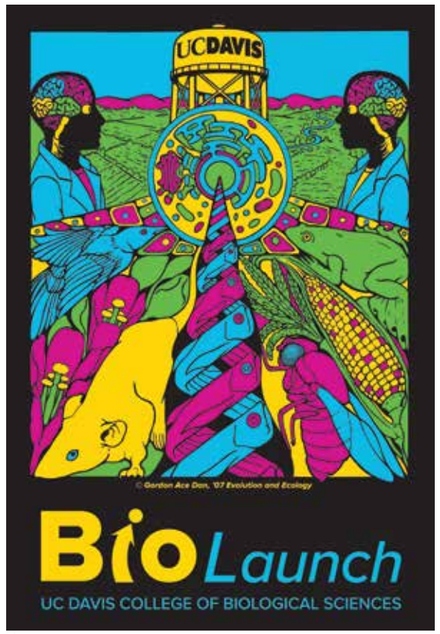
### A COLLEGE OF BIOLOGICAL SCIENCES Timeline

| | |
|---|---|
| **1922** | Department of Zoology established ***now Evolution and Ecology*** |
| **1924** | Department of Botany established ***now Plant Biology*** |
| **1946** | Department of Bacteriology established ***now Microbiology and Molecular Genetics*** |
| **1950** | Department of Genetics established ***now Molecular and Cellular Biology*** |
| **1958** | Department of Biochemistry and Biophysics established ***now Molecular and Cellular Biology*** |
| **1964** | Department of Animal Physiology established ***now Neurobiology, Physiology and Behavior*** |
| **1970** | The Division of Biological Sciences forms between the College of Agricultural and Environmental Sciences and the College of Letters and Science |
| **2005** | The University of California Regents ***establish the College of Biological Sciences*** |

# ART ALIVE

*Exploring the Creative Side of life sciences*


***Tomato Frog***
Digitally illustrated, this artwork by **evolution, ecology and biodiversity student Megan Ma** will be printed in the new BIS 2C Lab Manual.




***BioLaunch 2019 T-Shirt Design***
In homage to M.C. Escher's animal pattern lithographs, **artist Gordan Ace Dan, '07 evolution and ecology,** digitally created this artwork for a limited edition shirt for our 2019 freshmen and transfer students.
*Learn more about the BioLaunch program on page 20.*

***Severed Strands***
Inspired by a lecture from Professor Sean Burgess, biochemistry and molecular biology student Natascha Varona created these whimsical DNA dragons. Painted in ink and gold leaf, they represent the *CRISPR-Cas9* gene-editing process.

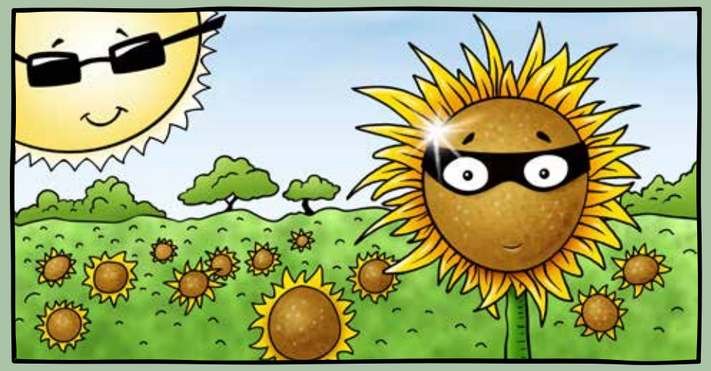
***Death Valley***
Painted by **Alex Kozik, a bioinformatics specialist with the UC Davis Genome Center,** this is a psychedelic splash of watercolors that plays with perception.

**Get your biology-related art featured in our college lobby**

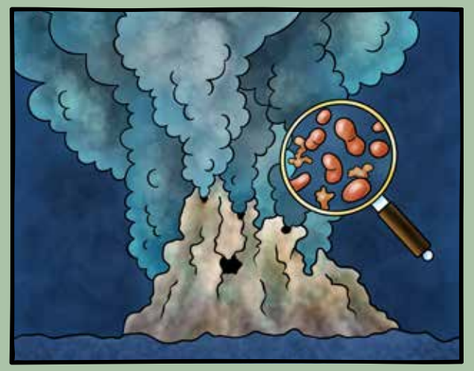
*Email us at* **biology@ucdavis.edu**



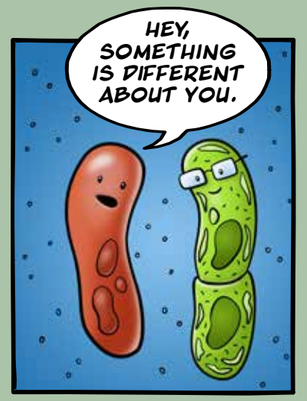
# THE ANCIENT ORIGIN OF PHOTOSYNTHESIS



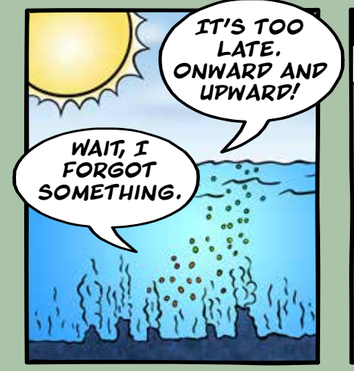
THE ORIGIN OF PHOTOSYNTHESIS IS A TALE OF BIOLOGICAL THIEVERY THAT STARTED BILLIONS OF YEARS AGO.



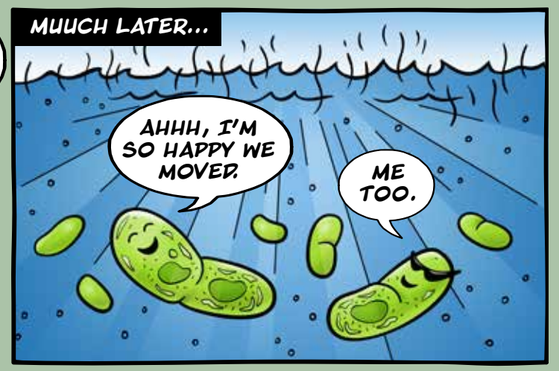
Back then, sulfur-dependent organisms lived on the ocean floor, gleaning energy from hydrothermal vents.



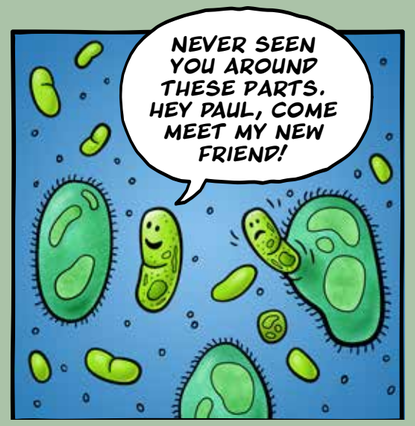

Some bacteria developed "oxygen-evolving complexes" and "chlorophyll reaction centers," allowing them to extract electrons from water using light from the sun.



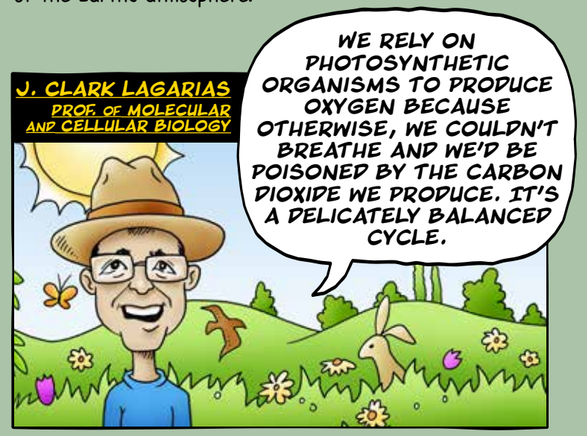

The evolutionary innovations led to an exodus, and the first photosynthetic pioneers left for more well-lit pastures.




In a Goldilocks Zone near the surface, cyanobacteria soaked up sunlight and produced oxygen, changing the makeup of the Earth's atmosphere.




Complexity became the name of the evolutionary game and soon single-celled eukaryotes arrived on the scene. A hungry eukaryote eventually gobbled up cyanobacteria and through a process called endosymbiosis integrated the bacteria's light-feeding properties into its own biology.




Life continued to diversify, leading to today's plants and a constantly evolving system in which no part is greater than the whole.

# MAKING SENSE OF YOUR PERCEPTIONS

*by David Slipher*

**WHEN YOU STEP INTO WILSAAN JOINER'S LAB,** the foosball table in the corner might seem a bit out of place. But for Joiner's research on perception and eye movement, playing a simple game can tell you a lot about how your visual system works.

Your eyes are amazing sensors. Visual information sweeps across the retinas so fast that what you perceive should be a blur. However, your visual system smooths the action like an image stabilization tool for shaky camera shots. Your brain constantly applies corrections, providing a seamless picture of your world.

In the brains of people who have schizophrenia, bipolar disorder and other mental illnesses, these unconscious functions are in disarray, blurring the lines between internal and external sensations.

"Your central nervous system is making constant predictions about your body all the time," says Joiner, an assistant professor of neurobiology, physiology and behavior. "It's always going on in the background and you're not typically aware of it. But when you can't do it, it has pronounced consequences that are fairly devastating. You can't make sense of many of the common things we experience in the world."

**UC Davis College of Biological Sciences neuroscientists like Joiner and his colleague Jochen Ditterich** are exploring new ways to understand how our brains make sense of our perceptions, in hopes to help diagnose and fight these debilitating conditions.

> *"Your central nervous system is making constant predictions about your body all the time. It's always going on in the background and you're not typically aware of it."*
>
> – Wilsaan Joiner

## To fool the eye—or brain?

A key to understanding our visual processes is the concept of "corollary discharge," a term that describes the brain's capability to anticipate a change in sensory information due to self-movement. This guidance system allows you to distinguish the source of changes that occur in our environment and likely contributes to performing rapid activities, like hitting a baseball.

**Neuroscientists Jochen Ditterich and Wilsaan Joiner** are dedicated to understanding how our brains and eyes integrate complex perceptions into seamless experiences. Their research could help diagnose and fight debilitating conditions including schizophrenia and bipolar disorder.

DAVID SLIPHER / UC Davis

Another way to think about this internal, unconscious signal is to consider how it's impossible to tickle yourself. Somehow, your brain recognizes your self-initiated movement and betrays the physical stimulation you're trying to induce.

In healthy brains, the thalamus likely conveys this information with great fidelity. But schizophrenic patients have perceptual difficulty with tasks that rely on corollary discharge, including identification of visual changes in the environment.

It's unclear whether this difficulty is related to the transmission or actual utilization of the signal. Without it, test subjects will make a perceptual decision solely based on visual information rather than some combination of internal knowledge of our movements and the experienced visual information.

With a simple visual test, Joiner can evaluate corollary discharge in both non-human primates and humans with schizophrenia. In the experiments, which involve eye movements and perceptual decisions, Joiner found subjects relying solely on visual information consistently make the wrong choices.

"It's only when you have this kind of deficit that you have more pronounced perceptual symptoms," says Joiner. "So what this is showing is a somewhat simple visual perception task that correlates very well to the extent that you have delusions and hallucinations."

While the absence of these internal signal cues reveals a larger void in our understanding of the origins of psychosis, it provides clues about how individuals with mental illness perceive themselves and the origins of their thoughts and ideas.

> *"It's only when you have this kind of deficit that you have more pronounced perceptual symptoms."*

DAVID SLIPHER / UC Davis

– Wilsaan Joiner

Joiner's research suggests that deficits in corollary discharge may be an accurate and objective tool for diagnosing mental health conditions with psychotic symptoms.

Joiner discovered that as an individual's deficit in corollary discharge increases, their sense of agency (e.g., ownership over thoughts or actions) decreases. This behavior can lead to trouble recognizing self-caused vs. externally caused sensations, which may lead to confusion, hearing voices and other psychoses.

Joiner's long-term hope is that the absence of corollary discharge may help provide a simple, but objective litmus test that clinicians can use to accurately identify and develop treatments for these neurological diseases.

"If you have deficits in transmitting or utilizing corollary discharge signals, it speaks to higher mental disorders that are very pronounced, but we don't quite understand," says Joiner.

> ***"As engineers, we know a lot about how machines process information. You can use all the mathematics and the engineering tools behind that to analyze what's going on biologically, to reverse-engineer the brain."***

DAVID SLIPER / UC Davis

– Jochen Ditterich

## The power of decision-making

If you hear an unfamiliar sound in the woods, your survival could depend on making a rapid decision with very limited information.

**Ditterich, an associate professor of neurobiology, physiology and behavior,** wants to better understand how our brains make such quick decisions. He evaluates this process through a "decisional threshold," which describes the amount of information you want to collect before you commit to a particular choice. For any scenario, the goal is to find a tradeoff between maximizing the accuracy of the decision and minimizing the time it takes to do so.

With the clear and precise diction of his German accent, combined with a system engineer's analytical perspective, Ditterich methodically outlines his plan to transform the way we treat neurological and psychiatric diseases that involve cognitive deficits.

"Implanting a technical device called a deep brain stimulator (DBS), has become a viable treatment option for patients with motor disorders, like Parkinson's, that do not respond well to drug therapy," says Ditterich. "Using a more intelligent version of stimulation, we might at some point be able to treat cognitive deficits resulting from neurological or mental disorders that are also difficult to treat with medications."

His approach is ambitious, but if successful, it could one day improve cognitive functioning related to decision-making, attention, memory and more. The basic idea is to design an intelligent, implantable device that directly communicates with the brain and steers it in an attempt to restore healthy neural signaling. In concept, such an advanced device would monitor and decode a patient's neural activity and dynamically stimulate the brain to achieve a desired state. But first, Ditterich needs to understand precisely how cognitive functions are implemented within a healthy brain.

While this scenario may sound like science fiction, implants are already being used on a regular basis to treat patients with Parkinson's. They are also being tested to treat conditions like depression and obsessive-compulsive disorder. But these devices aren't particularly intelligent. Instead of responding to dynamic brain states, the current generation of stimulators provides only constant and steady stimulation.

Parkinson's is generally thought of as a motor disorder, but it turns out patients experience cognitive deficits as well, including decision-making deficits, which are not typically addressed through current treatment options.

Ditterich's research suggests that these patients experience problems using previous knowledge when making decisions. It's not a learning problem but an implementation problem, and the patients' decision thresholds cannot adjust appropriately.

## Lifting the neural veil

By compiling neural activity from healthy brains during different decision-making situations, Ditterich can use machine learning to plot an optimal decision path for any scenario. It's like coming up with enough evidence for a choice before the exact moment of committing to it. And amazingly, the data shows that in healthy brains the decision process is an approximation of a statistically optimal algorithm.

Your healthy brain operates across a vast distributed network involving the frontal cortex, parietal cortex, basal ganglia and other subcortical areas that collectively compute different outcomes simultaneously. You can take pride that the final results of your "organic computing" are on par with even the most advanced supercomputers.

This staggering concept is what first drew Ditterich to neuroscience. An electrical engineer by training, he began investigating how the eye recalibrates during movement, similar to Joiner's research on visual perception.

For Ditterich, who sees the central nervous system as the ultimate information processor, "there are some things that are just very, very hard to do with machines that the brain can accomplish with ease. We have to figure out how, " he says.

"As engineers, we know a lot about how machines process information. You can use all the mathematics and the engineering tools behind that to analyze what's going on biologically, to reverse-engineer the brain," he adds.

While such advanced implantable devices are still a ways off, Ditterich is already in talks with control engineers at UC Davis to explore machine guidance. "They know very well how to steer airplanes and navigate other complex technical systems," says Ditterich. "Could we use this understanding to steer the brain into a particular desired state?"

Now Ditterich is collaborating with UC Davis Health clinicians to monitor brain activity in patients receiving a DBS implant. He conducts research performing the same perceptual decision tests in both humans and rhesus monkeys.

"We use identical tasks to understand how cognitive functions work in humans and can be validated in non-human primates," Ditterich says. "Behaviorally, in visual decision-making tasks, we find very, very similar results."

## Reframing your world

Your eye movement and decision-making processes are things you probably take for granted. Your identity is intimately connected to your ability and independence to make decisions.

But imagine if you couldn't answer, "Who's in control?" How would this impact your routine decisions, like "What will I eat for lunch? What do I do next in my day?" These are the very real challenges that people with cognitive deficits face every day.

Fortunately, building the foundations to diagnose and treat these conditions is a driving force for Joiner and Ditterich and many other faculty and student researchers at UC Davis.

They're pushing the boundaries of knowledge to make sense of our world, and to help us make sense of our place in it.

Jochen Ditterich envisions a future in which an intelligent, implantable device can monitor and respond to changes in brain activity. This device would communicate with the brain using electrical impulses to steer and restore healthy neural signaling.

The distinctive teal-colored growth chambers of the Controlled Environmental Facility give researchers precise control over temperature, humidity and lighting conditions.

# Gee Whiz!

For 25 years, the Controlled Environmental Facility has been a proving ground for pushing the limits of extreme plant environments

DAVID SLIPHER / UC Davis

## Around the world in a box

From the cold, dark, Alaskan winters to the seething furnace of Chile's Atacama Desert, the CEF's 186 growth chambers re-create climates from across the globe, right here in Davis

## Controlling climate change

Understanding plant adaptations in extreme environments is a key step to designing the climate-resistant food crops of our future—with less water, fertilizer and time

## Silencing the "plant noise"

To "hear" the delicate and complex signals plants transmit across their vascular systems loud and clear, scientists need precision growth conditions—the kind of control you can't get in a greenhouse or outdoors

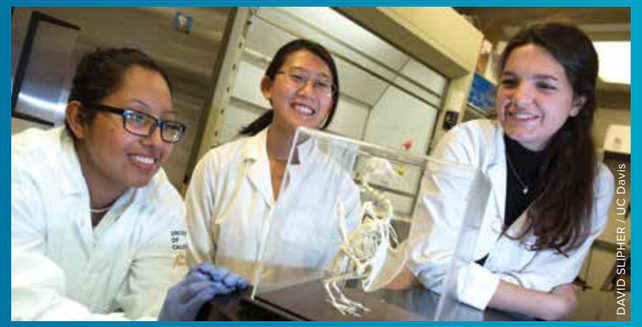
*The original control panel from 1994, still in use on a few growth chambers.*






# SPEAK UP!

## Putting Women Scientists **FIRST**



DAVID SLIPHER / UC Davis

*Undergraduates Denis Sanpedro and Tiffany Chen, and Ph.D. student Victoria Farrar are members of the Calisi Rodríguez Lab.*

*"I didn't really understand how unjust the academic system was for career advancement until I had children. Despite a mountain of research findings emphasizing the importance of supporting the physical and mental health of both mother/caregiver and child, the lack of support we still experience is appalling, and a major cause of inequality in STEM. With help from UC Davis, I am determined to help close the gender gap and make things better for parents who science."*

**– Rebecca Calisi Rodríguez**

**Associate Professor Rebecca Calisi Rodríguez, Department of Neurobiology, Physiology and Behavior**, is an advocate for changing academic culture for the better. Recently, she organized a diverse group of 45 Mothers-In-Science to develop extensive recommendations for creating supportive environments for breastfeeding parents at scientific conferences. Their publication in the *Proceedings of the National Academy of Sciences* has been downloaded over 95,000 times. She's also the creator and host for the upcoming National Geographic-funded digital series, "I CAN SCIENCE," which promotes women in STEM from underrepresented backgrounds.

# MENTAL HEALTH

## Changing the Culture for Ph.D. Students

**Imposter syndrome, research pressure and financial insecurity are among** the stressors faced by graduate students. According to a pilot survey by **Plant Biology Ph.D. student Leonardo Jo**, roughly 35% of the UC Davis graduate students sampled show signs of moderate to severe anxiety and/or depression.

**Professor of Psychiatry and Behavioral Sciences Carolyn Dewa** says graduate students struggling with mental health often don't seek help because either they don't recognize a need for help or they don't know how to seek help. Dewa and **Associate Professor of Plant Sciences Georgia Drakakaki** are making sure life sciences graduate students don't fall through the cracks.

Through "Gatekeeper Training" workshops, faculty are learning how to identify signs that a student is struggling with mental health, so they can help them stay on track for success. Now, Dewa and Drakakaki are offering a graduate-level course that'll give students tools for their mental health utility belts.

"The course focuses on evidence-based methods, coping mechanisms and ways to enhance your environment," says Drakakaki. The goal is to implement changes that will ripple through academia.

"When our graduate students leave, they're going to have that knowledge for the labs they build," says Dewa.

"We're changing culture."

SCAN ME

*Learn how we're shifting the culture around mental health:* ***qr.biology.ucdavis.edu/PhDHealth***

# SPARK THE TRAVEL BUG

by Greg Watry

**Nearly 200 years ago, a one-kilometer wall was** constructed on the northeast side of Ireland's Dublin Port. Sand accumulated over the wall, creating a 15- square-kilometer spit known as Bull Island Today, it's a national nature reserve home to plants, mammals, birds and sea life. Inland from the shore, Bull Island changes. Small sand dunes dappled with tufts of grass grow in size as flora and fauna shift.

For **UC Davis College of Biological Sciences student Kiana Nava,** Bull Island exemplifies principles of ecology and evolution she learned as part of the "Bio Sci 2B in Dublin" study abroad program. Ask Nava, and she'll say the experience revealed to her the causal nature of biology.

"One thing leads to the next, leads to the next, leads to the next, and I think that's really beautiful in the sense that everything has a purpose and has significance," says Nava, a sophomore majoring in neurobiology, physiology and behavior. "That's what intrigues me the most about biology."

Nava's trip to Ireland was made possible thanks to the Dean's Circle Study Abroad Scholarship. During her voyage, Nava attended classes at the University College Dublin, made new friends and traveled to Ireland's many ecological and cultural landmarks, including Bull Island and the Cliffs of Moher.

"This has been a great experience and I've been very thankful for the opportunity," says Nava, who noted the scholarship eliminated financial pressures. "Even though I was studying, I was still able to have really no worries and I was really able to soak up everything that this country has to offer."

Courtesy photo

Kiana Nava (at far left) and the other study abroad students visited Ireland's famous landmarks, including the Cliffs of Moher.

## An eye on biology

Raised in El Centro, California, Nava eyed medicine as a potential career early. Her positive experiences while visiting the optometrist influenced her decision to explore the ophthalmology field.

During high school, she interned in a lab at the Shiley Eye Institute at UC San Diego, investigating the molecular mechanisms of age-related eye diseases, including glaucoma. Though guided by mentors, Nava learned the importance of self-reliance. After all, acclimating to a new lab requires adaptation and fast learning skills. It was the perfect primer for college.

At UC Davis, Nava decided to major in neurobiology, physiology and behavior, inspired by her interest in the optic nerve. When she heard about the Dean's Circle Study Abroad Scholarship, she applied.

"I wasn't going to be able to afford it otherwise," says Nava. "I knew that if I was going to go and travel that I should at least try to take the opportunity that the school is offering."

Fortunately, Nava received the scholarship. In June 2019, she boarded a plane for the Emerald Isle. It marked her first time traveling outside of the United States of America.

## Establishing a lifelong curiosity

Nava embraced her new surroundings. She explored Dublin, marveling at cathedrals and museums, tasting the local cuisine and imbibing at the Guinness Storehouse. In addition to Bull Island, she visited the Cliffs of Moher, where the choppy Atlantic blue meets steep cliffs capped with vibrant green grass.

On the academic side, Nava learned evolution and ecology principles from faculty at the University College Dublin.

"We actually had six or seven different professors and they were selected based on their specializations in ecology and evolution," says Nava. "It was very personal because we were in such a small class."

The passion exhibited by her professors was inspiring. It made Nava realize that science is a lifelong curiosity.

Now in her sophomore year, Nava reflects fondly on her summer experience. More than anything, the trip furthered her self-confidence.

"It's kind of daunting to travel alone," says Nava. "But when you're alone, it's really the one place where you're able to think and appreciate everything that's around you and when you're really able to learn by observation."

"You're also learning about life," she adds.

Courtesy photo

Nava spent the summer touring Ireland and taking classes at the University College Dublin.

Courtesy photo

Nava was able to participate in the "Bio Sci 2B in Dublin" study abroad program thanks to the Dean's Circle Study Abroad Scholarship.

> ***"Even though I was studying, I was still able to have really no worries and I was really able to soak up everything that this country has to offer."***
>
> — Kiana Nava

# **NEW STUDENTS** Countdown to BioLaunch


DAVID SLIPHER / UC Davis

*Lauren Watson and Jannerfer An became fast friends thanks to the BioLaunch Mentor Collective peer-to-peer program.*

> ***"Becoming a mentor is really, really great for demonstrating your leadership."***
>
> – Lauren Watson

**Put yourself in the shoes of a new UC Davis student. It's your first day; you've just arrived** on campus, excited and eager to start your Aggie experience. But where do you even begin? How do you find your place among nearly 6,000 other College of Biological Sciences undergraduates?

The BioLaunch Mentor Collective helps make the transition to the UC Davis campus easier for freshmen and transfer students. New students are paired with a returning UC Davis student, who can offer them advice and support across many areas of campus life.

"Since I transferred from a small community college, I was worried about the size of the campus and Davis, and I didn't know where my classes were or where I would go for resources, and the whole size was very daunting," **says biological sciences student Jannerfer An,** who joined BioLaunch as a mentee.

An was paired with **evolution, ecology and biodiversity student Lauren Watson.** The two exchanged messages online, Watson answering any questions An asked about UC Davis. Eventually, the two met and a friendship formed. Not only did Watson answer questions from An, but An answered questions from Watson.

"I've actually learned a lot from my mentee," says Watson. "She's taken some courses that I haven't taken yet and I've taken courses that she hasn't taken yet, so there's like a great reciprocity between the two of us."

An had such a great experience with the program that she's returning as a mentor this year.

"I decided to become a mentor because I received so much help from Lauren that I just want to pass it on," she says.

SCAN ME

*Watch a video to learn more about Lauren and Jannerfer's experiences in the BioLaunch Mentor Collective:*
*gr.biology.ucdavis.edu/**BioLaunch***





# A CURE for the Research Itch

Life sciences research is intensive. For new UC Davis students, the prospect of joining a lab can be intimidating. So how can undergrads familiarize themselves with the rigors of research while acclimating to a new environment?

Course-based undergraduate research experiences, or CUREs, provide an answer. Offered to students during the fall, winter and spring quarters, CUREs are open to any freshman or transfer student curious about research at UC Davis. Want to know why plants are nature's master chemists? Or why scientists study animal calls to learn about their evolution and behavior? We've got CUREs for that and more.

DAVID SLIPHER / UC Davis

*Hands-on learning is a hallmark of our student experience.*

CUREs equip new undergraduates with research skills, connect them to UC Davis faculty and link course material to the real world, ensuring a well-rounded educational experience fit for the 21st century of biology.

# Take a Walk on the WILD Side

You don't have to leave UC Davis to be wild. **Assistant Professor of Teaching Laci Gerhart-Barley, Department of Evolution and Ecology,** knows this well. Her class, EVE 016 Wild Davis, a California Naturalist certification course, aims to familiarize non-biology undergraduates with the natural history and urban ecology around them.

"What sorts of interactions are these animals having in an urban setting on campus compared to rural settings?" asks Gerhart-Barley. "If you pay attention out on the Quad, the squirrels openly beg people for food, like puppies. So there's questions. Are they intentionally hanging out there? Are they concentrated where people are? Or do you see a lot of them foraging on their own?"

LACEY GERHART_BARLEY / UC Davis

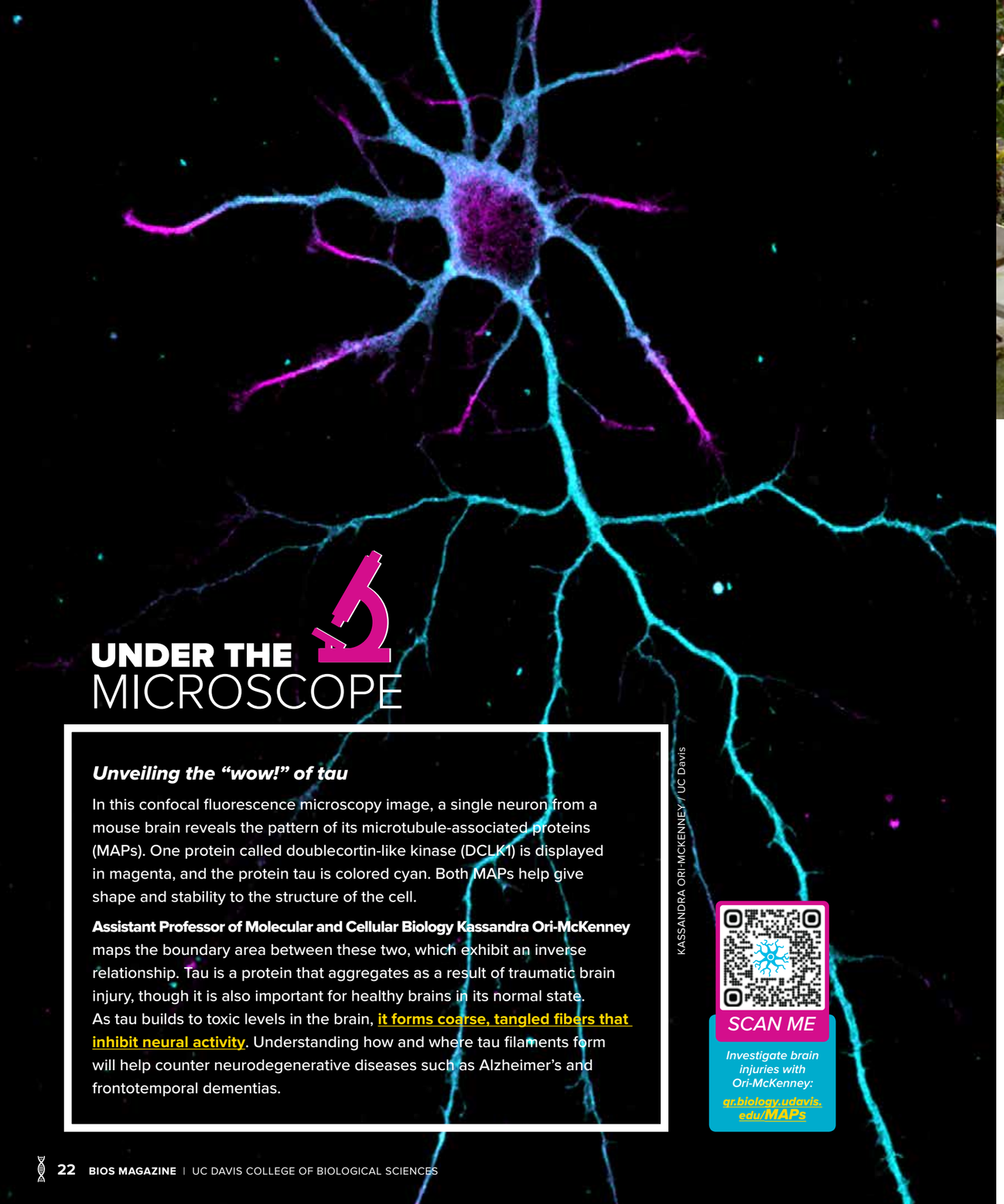
*Students conduct a turtle survey along the Arboretum.*

From tailing turtles in Putah Creek to tallying parasitic growths on trees in the UC Davis Arboretum, students contribute data to citizen science projects by observing and logging ecological interactions.

"As our populations are becoming more urban, people are becoming less attuned to nature," **says Professor of Evolution and Ecology Sharon Strauss,** who helped design the course. "But nature is really everywhere."

Students who take the Wild Davis course know that feeling.

DAVID SLIPHER / UC Davis



KASSANDRA ORI-MCKENNEY / UC Davis

## UNDER THE MICROSCOPE

### *Unveiling the "wow!" of tau*

In this confocal fluorescence microscopy image, a single neuron from a mouse brain reveals the pattern of its microtubule-associated proteins (MAPs). One protein called doublecortin-like kinase (DCLK1) is displayed in magenta, and the protein tau is colored cyan. Both MAPs help give shape and stability to the structure of the cell.

**Assistant Professor of Molecular and Cellular Biology Kassandra Ori-McKenney** maps the boundary area between these two, which exhibit an inverse relationship. Tau is a protein that aggregates as a result of traumatic brain injury, though it is also important for healthy brains in its normal state. As tau builds to toxic levels in the brain, **it forms coarse, tangled fibers that inhibit neural activity**. Understanding how and where tau filaments form will help counter neurodegenerative diseases such as Alzheimer's and frontotemporal dementias.

SCAN ME

*Investigate brain injuries with Ori-McKenney:*

*qr.biology.udavis.edu/MAPs*






DAVID SUPHER / UC Davis

# All in for Citizen Science

*Jonathan Eisen and undergraduate Ivy Yuson inspect tomato seeds at the Science Lab Building.*

## THE "GERM"-INATION ALUMNI SCIENCE PROJECT

**Unless you've been hiding under a** very clean rock, you've probably heard of microbiomes. Right now, millions of individual life forms are crawling all over you. Based on cellular counts alone, the microbes have you matched 1 to 1.

The dazzling complexity of these microscopic ecosystems captures our imaginations and conjures countless questions. Take for example a seed. Where does its microbiome originate? How much comes from its parents? How much from the soil? How does its microbial community change as it germinates, grows and reproduces?

These questions wriggle in the mind of **Jonathan Eisen, professor of evolution and ecology.** But as an advocate for community science engagement, he has larger questions like, how do you bring microbe-oriented science to the people? How do you tap the growing citizen science fervor seen in other areas like bird watching and galaxy classification and apply it to the unseen world of microbes?

**This is where you come in. We need your help designing and collecting the results of an experiment on seeds.**

You'll help us accumulate a tapestry of knowledge to better understand seed microbiomes. Together, we'll move beyond crowdsourcing to true, distributed community science. **You've just been recruited.**

With this project, Eisen puts the full scientific process in the hands of UC Davis alumni and their families and friends.

"Most people already think like a scientist some of the time," says Eisen. "That's why this is so exciting; we're getting people to think more about the importance of microbes and their help is extremely useful for driving science research."

Eisen is no stranger to crowdsourced microbiology projects. He's involved broad communities in studying the microbiomes of kitties, seagrass, humans, sporting arenas and even the International Space Station. But in these projects, the communities were mainly involved in collecting samples, not in designing experiments and analyzing data.

The data generated through GASP could even be used to craft course-based undergraduate research experiences (CUREs).

*(Get hands-on with CUREs on page 21)*

**START SOME SCIENCE:** Sign up to join the GASP "extended lab" and get your seeds in the mail!

SCAN ME

*qr.biology.ucdavis.edu/GASP*

### Here's how you can help:

1. We send you tomato seeds
2. You select among variables for your experiment
3. You germinate the seeds, take observations and collect samples
4. You send some samples back to us and we analyze them
5. We merge and share our data with the community's data, so all participants can analyze the results
6. Meanwhile, you grow the plants to maturity and enjoy delicious tomatoes
7. Optional: You collect the seeds of the next generation for a heritability test

# Strengthening the Science Muscles:

## BUSP Creates Opportunities to Pay It Forward

**Biological sciences senior Diana Quintero likes to use** the gym as an analogy for the Biology Undergraduate Scholars Program (BUSP). Initially, new fitness enthusiasts might feel like they don't measure up to their peers. But with training and persistence, they can acclimate to the rigors of hard work.

"I feel like that's what BUSP was for me," says Quintero.

For 30 years, BUSP has helped underrepresented, disabled, and economically and socially disadvantaged students find their academic footing at UC Davis. During their first two years of undergrad, BUSP students participate in an academic program that culminates with a biology research laboratory experience during their sophomore year.

BUSP is about more than acclimation. It's about fostering lifelong connections that extend beyond the UC Davis campus. For Quintero, this network—spearheaded by **BUSP Director Connie Champagne**—helped her land a summer internship at Baylor College of Medicine in Houston, Texas, with **UC Davis alumnus and fellow BUSPer Rodney Samaco,** who majored in genetics as an undergraduate.

Now an assistant professor of molecular and human genetics, Samaco works in the behavioral neuroscience arena, studying how molecular dysfunction leads to disorders of the brain. "BUSP was instrumental in getting me where I am today," says Samaco.

By the time she arrived in Houston, Quintero already had research experience. At UC Davis, she worked in the **lab of Assistant Professor Alex Nord, Department of Neurobiology, Physiology and Behavior**, where she studied how non-coding regions of the genome affect the development of schizophrenia. She had basic laboratory skills down but didn't have any experience with animal models.


*Aggies Diana Quintero and Rodney Samaco reconnected to celebrate 30 years of BUSP.*

"I'd never been to a mouse husbandry area with racks of mice," says Quintero. "It was like a library but for mice."

In Samaco's lab, Quintero used mouse models to study how Parkinson's disease affects social behavior. The research required her to learn the ABCs of brain dissection and the nuances and "art" of conducting rigorous and ethical rodent behavioral studies.

The experience proved to Quintero she had the grit for animal research. The support she received from Samaco and his team bolstered her confidence as a scientist.

"I'm just grateful that he took me in and I felt very comfortable," she says.

Quintero now works with the Nord Neurogenomics Lab at UC Davis, but she caught up with Samaco at the BUSP 30th anniversary celebration last April.

"After that reunion, we were walking around campus together talking and he was just giving me advice," says Quintero. "When I have a lab, I want to be like him."

SCAN ME

*Relive the reunion and 30 years of BUSP:*

*qr.biology.ucdavis.edu/BUSP*


*Former "BUSPers" returned to campus from near and far for the 30th anniversary celebration.*


DAVID SLIPHER / UC Davis

# LEAN IN

## Benchside at Bodega Marine Laboratory

For more than 50 years, the Bodega Marine Laboratory has been at the forefront of ocean and coastal sciences. The land and waters surrounding the facility are a world-class research site. First protected in 1965, they became the Bodega Marine Reserve in 1970.

Here, along the coast of the Pacific Ocean, UC Davis researchers find solutions to the challenges that threaten the health of marine ecosystems. Research expertise in ecology, oceanography, ocean health and habitat and species restoration informs public policy and sustainable business practices both at home in California as well as on the national and global stages.

This spirited history, culture and character make the Bodega Marine Laboratory an unforgettable and immersive place to see marine science in action.

### Can you spot(?):

1. The mesmerizing research subjects of Cadet Hand, professor of zoology and founding director of BML
2. A larval robot used to study the behavior of zooplankton at different ocean depths
3. The album that helped prevent the proposed development of a nuclear power plant at Bodega Head
4. The iconic headgear of choice at BML, styled loosely on the look made popular by oceanographer Jacques Cousteau
5. A microscope light owned by BML co-founder Ralph Smith, professor of zoology
6. The famous Hitchcock flick, filmed on location in Bodega Bay and based on actual events of bizarre avian behavior
7. Student theses spanning decades of research, which are proudly displayed in the library
8. Something you can count on for accurate quantity measurements in the lab
9. A focal species for biodiversity, coastal restoration and carbon sequestration research

*Special thanks to Kitty Brown, Molly Engelbrecht, Jacqueline Sones and Eric Sanford for their generous assistance and support on this project*

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Thanks to the Dean's Mentorship Award, **Matt Whalon, '16 Ecology Ph.D.,** was able to hire **marine and coastal science undergrad Madison Snider** as a lab technician to assist with eelgrass research.

At UC Davis, collaboration is the name of the game and it gives our students opportunities to expand their technical and team skills while working on meaningful and inspiring research.