DEPARTMENT OF BIOLOGY
INDIANA UNIVERSITY
College of Arts and Sciences
Bloomington

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Who's in the photo on page 1? Clockwise from left: Ramya Natarajan (research associate, Fuqua lab), Bala Venkatakrishnan (postdoc, Zlotnick lab), Maureen Onyeziri (grad student, Fuqua lab), Kate Hummels (grad student, Kearns lab), Kayla Miller (grad student, Newton lab), Courtney Ellison (grad student, Brun lab), Montana Howell (Courtney's partner, supporter of biology), Alex Canzoneri (undergrad, Kearns lab), Aisha Burton (grad student, Kearns lab), and Melissa Lamanna (grad student, Winkler lab) at the March for Science in Indianapolis on April 22, 2017.

Keep in touch

We'd like to hear from you! Email bionews@indiana.edu to share your recent accomplishments to be added to the "class notes" section in our fall issue of *BioNews*.

Visit https://biology.indiana.edu/news-events/newsletters to read past issues of IU Biology news.

Contact information changed?

Notify Kathy Wyss at biodevst@indiana.edu or 812-855-6195.

Update your record with the IU Alumni Association at https://myiu.org/my-profile/alumni-directory.

Sandra Sanchez | IU Biology

Sandra Sanchez | IU Biology

March for Science
Indianapolis, April 22, 2017

Top: Postdocs Amelia Randich (Brun lab) and Breah LaSarre (McKinlay lab)
Bottom: Grad student Ali McCully (McKinlay lab), postdoc Felix Dempwolff (Kearns lab), and grad student Britta Rued (Winkler lab)

Yves Brun | IU Biology

Young scientist at march.

INDIANA UNIVERSITY College of Arts + Sciences

BioNews

Keeping you updated on what's happening in the **Department of Biology**

Spring 2017

Courtesy photo (Who's in the photo? See page 8.)

Contents

Editor's note

The process of science

Some will argue that the scientific method has come increasingly under attack. Means to sustain and support the integrity of the process have mobilized. In April, throngs of people worldwide marching for science demonstrated support en masse for the process of science.

Yves Brun is collecting instances of scientific research that at first seemed useless but eventually had tremendous impact on society. This quest stems from his commitment to the scientific process. His collection of anecdotes will drive home the fact that it is impossible to cherry-pick which proposals will bring the biggest rewards to society. Read Brun's article, "Why we marched for science" on page 2.

On page 3, Armin Moczek tells why he does outreach to introduce the scientific method. According to Moczek, instilling a love for science one student, classroom, teacher, grade level, school, and district at a time is a perfectly fine way to start. Local educator Kirstin Milks provides tips on how to get started (page 6).

Also realizing the influence of outreach, recent graduate Mandy Gibson discusses on page 7 her hands-on Red Queen game that requires students to collaborate to generate data and test predictions of the Red Queen hypothesis. For designing the game, Gibson won the 2016 Thomas Henry Huxley Award. She was able to publish the game open-access because of funding she received from IU Biology's Ruesink Outstanding Associate Instructor Teaching Award.

And, quite busy in their specific pursuits of the scientific process, we introduce to you our newest faculty members on pages 4 and 5.

Terri Greene, *BioNews* editor

BioNews is published by the IU Department of Biology—with support from the IU College of Arts and Sciences—for alumni and friends to encourage their interest in and support for Indiana University, the College of Arts and Sciences, and our department.

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Why we marched for science

by Yves Brun

On April 22, 2017, half a million scientists and friends of science participated in the March for Science in more than 200 U.S. towns and cities together with hundreds of thousands more around the world. We marched because, even though most people agree that science saves lives, makes our world better, and creates jobs, there is an increasing and alarming trend to discredit scientific consensus and to restrict research to politically acceptable topics. Participation in the march was in no small part driven by a recent White House budget proposal to significantly reduce government-funded research. Funds would instead be focused "in the highest priority research and training activities." But, the history of science and innovation tells us instead that we cannot predict what research has the best chance of yielding the strongest benefits for humanity. An example from Indiana University's illustrious history of research in microbiology makes this clear.

Courtesy photo

Brun (left) and Thom Kaufman, Distinguished Professor of Biology, at the March for Science on April 22. Many more from the department joined them at the march in Indianapolis while others made the journey to participate in Washington, D.C.

In the 1960s, IU Professor Thomas Brock became interested in the distribution of photosynthetic microorganisms along the thermal gradients created by the outflow channels of hot springs. In 1966, he obtained an ~$88,000 grant from the National Science Foundation for a project titled, "Biochemical Ecology of Yellowstone Hot Springs." It's fair to say that few people would pick this research as high priority for funding if likelihood of benefitting society was a criterion. As Brock conducted his studies, he became curious about the bacteria living in the hot springs. Around 1968, his undergraduate student, Hudson Freeze [BA '68], isolated a bacterial species, which they named *Thermus aquaticus*, from the hot springs and began to study the basis for its ability to survive at high temperature. Freeze found that the bacterium's enzymes were extremely resistant to high temperatures, even to boiling.

Jeremy Bauer-Wolf | Inside Higher Ed

Olivia Ballew, Annie MacKenzie, Ali Ordway, Tiffany Musser, and Associate Professor of Biology Soni Lacefield (from left to right) drove 11 hours to march for science in Washington, D.C. Ordway's sign carries a Neil deGrasse Tyson quote: "The good thing about science is that it's true whether or not you believe in it." Ballew, MacKenzie (both in Lacefield's lab), and Ordway (in Professor of Biology Justin Kumar's lab) are PhD candidates in our Genome, Cell, and Developmental Biology Program. Musser is a research associate in Lacefield's lab.

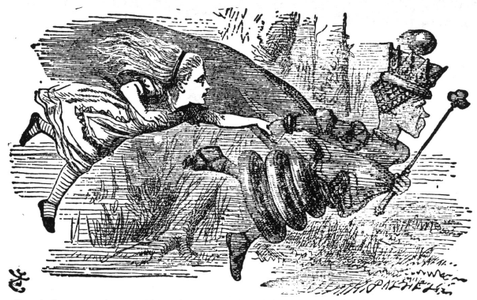
Fast forward 20 years: *Thermus aquaticus* would become the source of the temperature-resistant enzyme Taq polymerase, a key component for the polymerase chain reaction (PCR), used to amplify very small quantities of DNA. PCR rapidly became one of the most important tools of biomedical research and revolutionized the biotechnology industry. Disease diagnostic methods, the ability to rapidly identify bacterial contaminants in food sources, and forensic tests are only a few of the myriad applications of PCR.

How to bring evolution into the classroom

by Amanda Gibson

Students learn science best by doing. That's what the data say—students perform better in science courses when professors replace lecture with more active forms of learning, like discussion, group work, and case studies. Active learning techniques can even reduce the achievement gap between students from disadvantaged vs. nondisadvantaged backgrounds (as shown by former IU postdoc David Haak and colleagues, *Science* 2011).

As an evolutionary biologist, I want to know: how can students engage directly with evolutionary concepts in the classroom? Teaching evolution is notoriously challenging. There are of course the pervasive misconceptions and controversy surrounding evolution. On top of that, its temporal nature means students don't typically get to "see" the evolutionary process unfolding. Yet evolution is the most fundamental of the biological sciences—a failure in the evolution classroom reverberates throughout the rest of a student's biology training.



Red Queen hypothesis, a major idea in evolutionary biology, took its name from the Red Queen character in Lewis Carroll's *Through the Looking Glass* who said, "It takes all the running you can do, to keep in the same place." Likewise, organisms must continually evolve to combat their natural enemies. Illustration by Sir John Tenniel, *Through the Looking Glass*

Games offer one solution to this challenge. Like computer simulations, students can use games to rapidly play out evolutionary scenarios. Playing cards are particularly useful: they're cheap, and their familiarity automatically eases students into the exercise. IU Professor Curt Lively, former IU postdoc Devin Drown, and I developed the Red Queen game to teach host-parasite coevolution using playing cards. In our game, students collaborate to generate data and test predictions of the Red Queen hypothesis, a core hypothesis in evolutionary biology. It proposes that host-parasite coevolution maintains genetic variation in populations. Students play against one another as host and parasite, and the card suits function as different genotypes. The students record their own success or failure to generate data on changes in host and parasite genotype frequencies through time. They personally experience rapid oscillations in genotype frequencies, with rare genotypes increasing and common ones declining. Genetic variation is clearly maintained, supporting the Red Queen's prediction. Another advantage of playing cards is their flexibility: we encourage students to modify the rules of the game, or even build a new game, to test other evolutionary hypotheses. The game has spread since we first played it in IU's Honors Evolution course: students in high schools and colleges across the country, even in England, have chased the Red Queen. Learn more about the game at https://evolution-outreach.springeropen.com/articles/10.1186/s12052-015-0039-2.

Students can also experience evolution in action using organisms that breed quickly. When Levi Morran [BS in Biology '04] moved from his postdoc at IU to a professor position at Emory University, he collaborated with lecturer Megan Cole to do experimental evolution with students in Emory's Intro Bio labs. The students can do this because Dr. Morran's organism of choice, the nematode *Caenorhabditis elegans*, has a generation time of 3 to 4 days. Students select for disease resistance by feeding nematodes the pathogenic bacteria, *Serratia marcescens*, over multiple generations. Only the resistant nematodes contribute offspring to the next generation. Does this experience, of seeing evolution happen over the course of the semester, improve student learning of evolutionary concepts? We're currently working with Dr. Cole to figure this out.

With inquiry-based classroom activities like these, we may be able to enrich students' understanding of evolution. In doing so, we can promote scientific literacy and improve biology training as a whole.

IU Biology alum Amanda "Mandy" Gibson graduated in July 2016 with her PhD in Evolution, Ecology, and Behavior. She is now a postdoc in Levi Morran's lab at Emory University and has accepted an assistant professorship in the Department of Biology at the University of Virginia, starting in January 2019.

Her IU mentor, Distinguished Professor of Biology Curt Lively, was pleased to announce earlier this year that Gibson had received the John Maynard Smith Prize from the European Society of Evolutionary Biology, a major award for recent PhDs in evolutionary biology. Her prize will be celebrated at the upcoming ESEB congress in The Netherlands, where Gibson will present the 2017 John Maynard Smith Prize Lecture.

Photo: Gibson presented the Red Queen game to the National Association of Biology Teachers in November 2016 in Denver. | Courtesy photo

Science outreach continued from page 3

so the members of my lab now routinely contribute. This increases the range and diversity of outreach efforts we can contribute, while at the same time providing training in the do's and don'ts of developing lasting outreach initiatives. In addition, after leaving my lab,

Moczek in classroom | Courtesy photo

former contributors have designed their own outreach initiatives at their respective new home institutions at least in part after their experiences in my group, further extending the reach of our initial efforts. At the same time, many of the modules and resources we developed turned out to be useful in a wide range of settings outside traditional classrooms. We now take them to libraries, the daisy scouts, or retirement centers. They also get used in special education classes, allowing me to work with learning disabled or autistic students or students with multiple cognitive and physical disabilities—demographics that often fall through the cracks. And other teachers, without any of our doing, have picked up on our materials and incorporated them into language-arts projects, some of which we proudly exhibit in their school and at WonderLab.

Science outreach has emerged as a gift that keeps on giving. Working with teachers, schools, and WonderLab has multiplied our efforts in ways I did not expect, as has been helping train the next generation of scientists in becoming more effective ambassadors for science. And, it has made me a more effective communicator of the existential value scientific literacy holds in our daily lives.

How researchers can help teachers

by Kirstin Milks

Now, more than ever, we need a supportive and scientifically literate populace. If you're looking for ways to help, look no further than your local school! Working with science teachers to reach the youngest of our society might not change budget allocations this year, but it will, slowly but surely, change the public's perception of science and scientists.

Here are three tips for getting started:

- First and foremost, **get the students to do the thinking**. This comes in many forms—whether having students engage in a game or simulation like Mandy Gibson's (see page 7) or looking at carefully structured sample data and drawing conclusions as Armin Moczek has students do in his modules (page 3).

Storytelling is a very powerful mode of communication, and you might be tempted to put together a magnificent lecture about a compelling subject. But students, particularly adolescents, are being told things all the time—by their parents, their teachers, their religious leaders, their friends, their social media feeds—and many of these stories are directly conflicting.

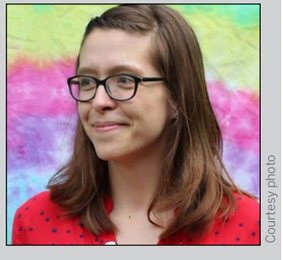
If you can shift sensemaking to students, though, you accomplish a few important goals. First, you show that science is a process—that it's not about belief or identity. You also give a taste of the power of sensemaking at a time when students are looking for places in their lives to feel powerful.

It can be as easy as simplifying a key figure or getting students to move strips of a story around until the order is correct. But, to know what will work best . . .

- Start by contacting a school or teacher directly and **plan your visit with a classroom teacher**. Teachers have information you deeply need to make your efforts go the farthest. Teachers like me know state and national science standards for our classroom, what our students studied last year, and what they'll study next year. We know which literacy and numeracy skills are easy for our students and which ones are challenging. We know what kinds of supports will work for the whole group and how to modify your plans to make sure you reach all learners. Co-planning your lesson will ensure that you won't put effort and time into materials that won't be used.

- Finally, teachers need you to **be a warm body in the classroom**. To solve science's image problem, kids of all ages need engaged and interested scientists who bring them fun things to do. Making a great lesson and emailing it along isn't enough. Friendly, smiling, and encouraging questions can be a huge boost to students' motivation and engagement—as well as their perception of science.

If possible, put together a multi-age team. When IU Associate Professor of Biology Laura Hurley brings her animal behavior students to visit, my students talk for days afterwards about how cool it is. A large part of that is because they get to see themselves reflected in these young adults. But, the most important thing is to find little places throughout the lesson to share your thinking, your journey, and how much fun it can be to do the critical work that you do!



Courtesy photo

Kirstin Milks (on Twitter @DrMilks) trained to be a science teacher after getting a PhD in biochemistry from Stanford University. She now teaches AP Biology and Earth/Space Science at Bloomington (IN) High School South. Milks is a National Board Certified Teacher and a Senior Fellow of the Knowles Science Teaching Foundation, where she serves as co-editor-in-chief of *Kaleidoscope: Educator Voices and Perspectives*.

In 2013 Brock and Freeze received the Golden Goose Award. The award highlights odd, seemingly useless research that eventually had a high societal impact. Indeed, in addition to helping save countless lives, PCR's market value this year is evaluated at $8 billion. Not bad for an initial $88,000 taxpayer investment!

If you are interested in promotion of the scientific enterprise, follow the **Concerned Scientists @ IU** group. The group is dedicated to strengthening the essential role of science and evidence-based decision making at all levels: individual actions and community-based efforts, state and federal government, and international organizations.

Visit the website at https://csiub.org, follow on Facebook and Twitter @CSIUB, or sign up for the email distribution list by emailing csiu-l@list.indiana.edu.

The history of innovation abounds with many such examples, summarized by Eric Lander, Co-Chair of President Obama's Council of Advisors on Science and Technology, in a recent compelling presentation (https://vimeo.com/133400574). As Lander indicates, ". . . transformative ideas and discoveries often come out of left field . . . . You cannot predict where they come from." This is why it is important to invest in basic, curiosity-driven scientific research and to invest in a broad portfolio of the best quality research, without trying to guess which research is most likely to yield practical dividends.

Yves Brun is a faculty member in the Microbiology Program within the IU Department of Biology. He has earned the titles of Distinguished Professor of Biology and Clyde Culbertson Professor of Biology. Brun's research lab focuses on mechanism, regulation, and evolution of bacterial shape, differentiation, and biofilm formation.

Why I engage in science outreach

by Armin Moczek

You protect what you love,
you love what you know,
you know what you are taught. *(African proverb)*

Why I engage in science outreach: Science empowers us to make sense of the physical world around us. I engage in science outreach because, first and foremost, I want to contribute to teaching future generations the methods of science, so that students at all ages and abilities have a chance to appreciate the explanatory power and problem-solving value of science, learn to employ scientific thinking themselves, and defend science when it comes under attack.

What I do: I moved to Bloomington in 2004. About a year later I began to partner with Karen Jepson-Innes at WonderLab [local, award-winning science museum that provides opportunities to experience the wonder and excitement of science] to develop teaching modules that support Indiana Science Teaching Standards, to disseminate these modules through teacher training workshops, and to help teachers implement these modules through classroom visits. So far I have developed ten such modules, taught 18 workshops to over 350 teachers, and spent between 30-50 hours per year in local classrooms assisting teachers and their students. These efforts, while sometimes exhausting, have been immensely gratifying, both because they yielded some of the results I had hoped they would, but also because they gave rise to other positive developments I could not have foreseen.

Does it make a difference? YES! On a personal level I learned a lot about the realities and challenges teachers face in the classroom and the incredible diversity of demands that are placed upon them. This has made me a better teacher myself, and I earned friends in the process. At the same time I managed to contribute to the teaching environment of regional teachers and their students: about half of the modules I developed are now routinely used in schools across MCCSC [local district] and neighboring districts, and every year nearly a hundred classes use at least one such module. This is what I had hoped for! But, unplanned consequences also emerged: demand for these modules exceeded what I alone could provide,

continued on page 6

Indiana University

Armin Moczek is Professor of Biology in our Evolution, Ecology, and Behavior Program. His lab researches evolution and development, insect genomics, behavioral ecology and sexual selection, insect endocrinology, invasive species and post-invasion evolution, and natural history on *Onthophagus* beetles. Moczek teaches a popular, not-your-standard undergraduate entomology course. He was awarded the Guggenheim Fellowship for 2017. Fellowship recipients are selected on the basis of prior achievement and exceptional promise in their respective fields.

IU Biology welcomes new faculty members

"We have been fortunate to hire a cohort of accomplished and promising biologists over the past few years. Many use and develop cutting-edge approaches such as next generation DNA sequencing applications, metabolomics, optogenetics, and high resolution microscopy—taking advantage of IU's excellent research facilities. Their contributions to the department are already significant, and their potential for the future is boundless. We are delighted that these talented individuals have joined the IU Biology faculty." *Clay Fuqua, Professor and Chair*

C. Sue Carter

Executive Director, Kinsey Institute
Rudy Professor of Biology
Evolution, Ecology, and Behavior

Education
PhD in Zoology, University of Arkansas, Fayetteville
NIH Postdoctoral Trainee, Biology, Michigan State University, East Lansing

Joined IU Biology faculty
November 2014

Research expertise
Hormonal basis of behavior: Biological basis of monogamy and love; oxytocin, vasopressin and social behavior; developmental effects of oxytocin and birth interventions

Previous position
Professor, University of North Carolina, Chapel Hill

Recent accomplishment
Distinguished Alumni Award, Life-Time Achievement, Drury College, 2016

Roots
Born in San Francisco, CA, but grew up in Missouri Ozarks

What you might not know about her
Of all the positions she's held, Dr. Carter finds her current position as Director of the Kinsey Institute by far the most interesting.

Carter

Dalia

Ankur Dalia

Assistant Professor of Biology
Microbiology

Education
PhD in Cell and Molecular Biology, University of Pennsylvania

Joined IU Biology faculty
August 2015

Research expertise
Dissecting the regulation and mechanism of natural transformation and exploiting this process to develop novel genetic tools

Previous position
Postdoc, Andrew Camilli Lab, Tufts University of Medicine

Recent accomplishment
K22 transition award from NIH (NIAID)

Roots
New Jersey

What you might not know about him
Dr. Dalia likes to climb (mostly bouldering and plastic indoors). He enjoys relaxing with his furry feline kids Sancho, Chewie, and Taco.

Erik Ragsdale

Assistant Professor of Biology
Evolution, Ecology, and Behavior

Education
PhD in Entomology, University of California, Riverside

Joined IU Biology faculty
August 2014

Research expertise
Genetic regulation and evolution of developmental plasticity, biodiversity and the evolution of novelty, nematode systematics

Previous position
Postdoctoral Fellow, Max Planck Institute for Developmental Biology

Recent accomplishment
Publication: Ragsdale, E. J. and Ivers, N. A. (2016). Specialization of a polyphenism switch gene following serial duplications in *Pristionchus* nematodes. *Evolution* 70: 2155–2166.

Roots
California

What you might not know about him
Dr. Ragsdale plays the bagpipes.

Ragsdale

Rosvall

Kimberly Rosvall

Assistant Professor of Biology
Evolution, Ecology, and Behavior

Education
PhD in Biology, Duke University

Joined IU Biology faculty
August 2014

Research expertise
Identifying genomic and physiological bases of behavioral adaptation and plasticity and how these mechanisms change over evolutionary time by using conceptual and analytical tools from animal behavior, neuroendocrinology, evolutionary ecology, physiology, and genomics—almost entirely by studying free-living birds

Previous position
Research Scientist, Indiana University

Recent accomplishment
Approximately half-million-dollar National Science Foundation grant to understand behavioral and physiological effects of social competition on female birds at local field sites where the lab monitors tree swallows breeding in nest boxes.

Roots
Southern California. Dr. Rosvall notes that her secret goal to study/work at historically important NCAA basketball powerhouses (UCLA, Duke, and IU) severely tests her alliances in spring.

What you might not know about her
Dr. Rosvall loves to spend her free time with her family building forts, exploring the outdoors, or making pancakes with her husband and daughter.

W. Dan Tracey

Linda and Jack Gill Chair
Associate Professor of Biology
Genome, Cell, and Developmental Biology

Education
PhD in Genetics, SUNY Stony Brook
Postdoctoral Fellow, California Institute of Technology

Joined IU Biology faculty
January 2015

Research expertise
Molecular and cellular mechanisms of nociception (pain) and of touch sensation; development of neuroscience research tools; high throughput methods for behavioral analysis; molecular genetics

Previous position
Associate Professor, Departments of Anesthesiology, Neurobiology and Cell Biology, Duke University

Recent accomplishment
Publication: Nociception. Tracey WD Jr. *Curr Biol*. 2017 Feb 20;27(4):R129-R133.

Roots
Williamsville, NY (a suburb of Buffalo)

What you might not know about him
Dr. Tracey likes to ride bicycles and cook and is fond of craft beers; he fits in well in Bloomington! He's also a sailor—on his one-person Laser here and with his dad on a 34-foot sailboat in Florida.

Tracey

van Kessel

Julia C. van Kessel

Assistant Professor of Biology
Microbiology

Education
PhD in Molecular Biology, University of Pittsburgh
Postdoctoral Fellowship, Molecular Genetics and Microbiology, Princeton University

Joined IU Biology faculty
August 2016

Research expertise
Quorum sensing (bacterial cell-cell communication) in pathogenic *Vibrio* species to understand how bacteria coordinate group behaviors, including biofilm formation, virulence factor secretion, and bioluminescence

Previous position
Assistant Research Scientist, Molecular and Cellular Biochemistry Department, Indiana University

Recent accomplishment
Publication: Chaparian RC, Olney SG, Hustmyer CM, Rowe-Magnus DA, and van Kessel JC. Integration Host Factor and LuxR synergistically bind DNA to co-activate quorum-sensing genes in *Vibrio harveyi*. (2016) *Molecular Microbiology*.

Roots
Born in Danbury, CT, and grew up in Millbrook, NY

What you might not know about her
Dr. van Kessel enjoys camping in the Adirondacks, tasting microbrewed beer, gardening, and baking sweet treats for her family. She plays piano, flute, and piccolo, and she loves musicals.

Xindan Wang

Assistant Professor of Biology
Microbiology

Education
DPhil in Biochemistry, University of Oxford
Postdoctoral Fellow, University of Oxford

Joined IU Biology faculty
January 2017

Research expertise
Combination of classic and modern molecular, genetic, and imaging approaches to study contribution of a set of highly conserved factors in bacterial chromosome biology in order to uncover general principles of chromosome organization and segregation in all domains of life

Previous position
Postdoctoral Fellow, Harvard Medical School

Recent accomplishment
Publication: Wang, X., Brandão H.B., Le, T.B., Laub, M.T., Rudner, D.Z. (2017) *Bacillus subtilis* SMC complexes juxtapose chromosome arms as they travel from origin to terminus. *Science*. 03 Feb 2017: Vol. 355, Issue 6324, pp. 524-527.

Roots
Northeast China

What you might not know about her
Dr. Wang makes a lot of dumplings. She notes that her friends love them (they say).

Wang

Zentner

Gabriel Zentner

Assistant Professor of Biology
Genome, Cell, and Developmental Biology

Education
PhD in Genetics, Case Western Reserve University

Joined IU Biology faculty
August 2015

Research expertise
Regulation of transcription and chromatin. Specifically, the regulation of transcriptional initiation by general transcription factors and the Mediator complex using genetic and genomic methods in budding yeast and the role of CTCF and its paralogous protein BORIS in the regulation of chromatin structure in human cells.

Previous position
Postdoc, Steve Henikoff Lab, Fred Hutchinson Cancer Research Center

Recent accomplishments
The lab's first paper on CTCF and BORIS, a genome-wide study of their binding in mouse germ cells, in *Scientific Reports*. Publications in the works include a video methods article on our ChEC-seq technology and a theoretical population genetic study of CRISPR/Cas9-based gene drives in beetles in collaboration with IU Biology colleague Mike Wade.

Roots
Indianapolis, IN

What you might not know about him
Dr. Zentner has been playing guitar since he was 13. His favorite music to play—believe it or not—is metal.

Learn more about our faculty at https://biology.indiana.edu/about/faculty.