biology update

Winter 2017

CASE WESTERN RESERVE UNIVERSITY DEPARTMENT OF BIOLOGY

The Memoirs Program: PhD Students in Rwanda

By Katie Bingman

CWRU PhD student, Bonnie Baird, with University of Rwanda senior, Deo Dryumbagabe.

Since 2014, CWRU PhD students in biology, working out of the Cleveland Metroparks Zoo, have been partnering with undergraduate students at the University of Rwanda as mentors for their senior research projects. The Memoirs Program, which began in the early 2000's, is a conservation science capacity-building partnership between the Dian Fossey Gorilla Fund International (DFGFI), University of Rwanda, Rwanda Development Board, and more recently the Cleveland Metroparks Zoo. Participants include adjunct CWRU Biology Faculty Member Dr. Kristen Lukas and Ph.D. students Austin Leeds and Bonnie Baird.

The main goal of the program is to provide undergraduate biology students at the University of Rwanda the training they need to conduct and complete their projects. All projects support biodiversity conservation in Rwanda's National Parks. Nearly half of all projects are related directly to the conservation of Rwanda's critically endangered mountain gorillas and endangered golden monkeys.

Dr. Lukas and her PhD students have now travelled twice to Rwanda to help the undergraduates there with their research projects. The process starts with working on their proposal presentations, which they give to DFGFI staff, as well as staff from the Rwandan Development Board (Rwanda's National Parks Service) and other NGO's working with the gorillas. Dr. Lukas, Austin, and Bonnie follow that up with training on writing, designing data sheets, collecting data, and entering it, as well as some preliminary analysis.

Additionally, CWRU students offer training focused on soft skills, such as how to present and talk about science to different audiences, as well as how to write grants and network. The program evolves year to year, based on the needs of the students. Since its inception in 2003, more than 80% of Rwandan graduates have pursued careers or advanced degrees in conservation, science, or education.
The future of primate conservation depends on those living in primate range countries having the education, skills, and opportunities needed to implement or facilitate conservation measures. Asked to reflect on his time in the program, Austin Leeds said, "These are some of the most intelligent and motivated students I have ever worked with, and this program is all about giving them opportunities to reach their potential as future scientists and conservationists."

Source: Lukas, K., Tuyisingize, D., Ndagijimana, F., Vecellio, V., Eckardt, W., Leeds, A., Baird, B., & Stoinski, T. (2014). *The memoirs program: A partnership to build scientific capacity in Rwanda's future conservationists.* Poster presentation at the Cleveland Metroparks Zoo, Cleveland, OH.

INSIDE

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COLLEGE OF ARTS AND SCIENCES
CASE WESTERN RESERVE UNIVERSITY

How Do Flies Fly? Insights fro

By Jessica Fox

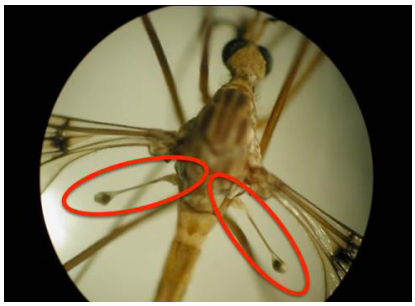
Humans and other animals need to process multiple kinds of information to move through the world. Although we are highly visual animals, we are still able to stand and walk if we're blindfolded, because we can tell which ways are "up" or "forward" using our vestibular system. The inner ear's vestibular system is an important sensory organ that helps humans and other vertebrates sense the position and direction of their head, and helps them to focus their eyes even when they are moving through space. When the inner ear is damaged or diseased, it can be debilitating, causing vertigo, nausea, and imbalance.

By studying flies...we will understand some of the princples that biologcal systems use for inegrating bodily senses with vision, increasing our understanding of brain function, providing ideas for cures for...nervous system disorders.

Insects are able to move around just as smoothly as vertebrates do, and they do this without the benefit of an inner ear. In fact, they move incredibly fast relative to their body size, and flying insects move in complex patterns in three dimensions. How do they do this without a vestibular system? One group of insects, the flies, has a unique solution: a pair of sensory organs called halteres. The halteres evolved from the hind wings of ancestral insects, and flies oscillate them up and down when they fly. The halteres do not generate any significant lift or aerodynamic force, but a set of sensory cells at their bases detects forces that bend the haltere as the fly's body rotates. These sensory cells send information to the fly's wing-steering machinery and to the muscles that control the position of its head. They do this very fast, about ten times faster than the fly's eyes can process visual information. Flies that are blinded will fly around until they crash into an obstacle, but flies without halteres don't get very far. They can take off, but quickly become unstable and crash to the ground.

Research in my lab focuses on understanding how the halteres process information and how the fly uses this information to get around. This case of multi-sensory integration is much more convenient to study in flies than in humans, because flies have their "vestibular" system on the outside of their body, so it can be easily manipulated and stimulated in different ways. They also cannot move their eyes separately from their heads so we can determine the direction that they are looking simply by observing where their heads are facing.

In our lab, we use careful analysis of fly behavior in combination with neural recordings to determine how flies are using their halteres and integrating haltere information with vision. In our behavioral experiments, flies are glued to a small pin that holds them in place while they flap their wings, like a "treadmill" for observing flight. We can record how the flies are steering their wings and moving their heads using fast photodiodes and high-speed video cameras. While the flies are flying, we can show them different visual stimuli on an array of LEDs that are placed in front of them, essentially creating an IMAX experience for the fly. Using the measurements of the fly's wings, we can even determine how the fly is attempting to steer and use that information to let the fly control the visual stimulus with its wings, creating a virtual reality experience for the fly. After we measure the fly's responses to visual stimuli, we can alter, remove, or stimulate the halteres to determine how the fly integrates haltere information with visual motion.



A crane fly, with red ellipses drawn to indicate the halteres.

om the Fox Lab

From left: Shwetha Mureli, Research Technician, Jessica Fox , CWRU Assistant Professor, Alexandra Yarger , PhD student, Nick Kathman, Post Doc.

In a recent study, research technician Shwetha Mureli found that halteres are necessary for the fly to respond to a full-screen panoramic motion, but are not necessary for responses to small moving targets. Thus, the integration of haltere and visual information can change depending on the context in which the fly is behaving.

In addition to observing fly behavior, we also record the activity of neurons in the fly's brain and peripheral nervous system. This allows us to determine how the neurons respond to haltere and visual stimuli, and will provide clues about how the two streams of information interact to help the fly decide its course of action. Previous research had indicated that sensory information is sent directly from the halteres to the nerves that steer the wings and move the head. New data from our lab, in an experiment conducted by Dr. Nick Kathman, suggests that information from the halteres is also sent to the brain, where it could potentially be combined with visual, olfactory, or other information to help the fly decide where to go and how to get there.

Flies are some of the most successful animals on the planet, with 200,000 species found in all kinds of ecological niches all over the world. Do they all use their halteres in the same way, or have different flies adapted to use their halteres in different ways? In a recent study from our lab, two undergraduate students, Joshua Hall and Dan McLoughlin (both Biology majors from the class of 2015), spent a summer collecting flies from around the CWRU campus and filming their haltere movements in high speed as they walked and flew. They found that different flies move their halteres in different ways, and that these movements depended on the fly's place on the evolutionary tree: closely related flies moved their halteres in similar ways. They also found that some flies use their halteres to help them stabilize their bodies when walking up vertical walls. This is a newly discovered role for the halteres, which were previously thought to be used only during flight.

Our studies on halteres will help us answer questions about how the brain of a fly, with millions fewer neurons than the brain of a human, can process information rapidly and use it to control impressive behaviors. By studying flies, we will uncover principles of sensory integration that can be used to design bio-inspired sensors for man-made machines that can fly, walk, or climb walls. Furthermore, we will understand some of the principles that biological systems use for integrating bodily senses with vision, increasing our understanding of brain function and providing ideas for cures for vestibular and other nervous system disorders. In the tiny fly, we can find multitudes.

Undergraduate Feature
by Nathaniel Mullin

I joined Associate Professor Radhika Atit's lab as a sophomore, the semester I took the third introductory biology course taught by her. I had spent the previous three summers in a zebrafish lab in my hometown of Boston, and Dr. Atit's mention of fish as a model in our lecture piqued my attention and brought back good memories of my time working with these fish. Those summers had been some of the most interesting and enjoyable work I had done, and I knew I wanted to be involved in a lab at CWRU, though at that point I did not know where this path would lead. I approached Dr. Atit after class that day, and a few weeks later I had joined her lab.

Now, nearly two and a half years later, my perspective on research has changed, but my love of the work and belief in its importance have only grown stronger. During my time in the Atit Lab, I have primarily worked to characterize the genes and proteins that contribute to fibrosis of the skin. I have experienced the aggravation of experiments not working for months on end, but have also enjoyed the interspersed moments of pure joy when all goes as planned. On my personal project, I have spent time designing experiments and interpreting results, realizing that the essence of scientific research is much more intellectual than it is physical.

Most importantly, I have had the chance to see research implemented to help real patients. During a summer in the lab of our collaborator studying the fibrotic element of scleroderma, I gained access to data from patients. Firsthand, I saw the same genes I had been sifting through for a year, now overexpressed in the skin of real people. This experience gave me personal validation of both the power and clinical usefulness of our system, and has propelled me to work even more vigorously in describing these fibrotic mechanisms.

My time in the Atit Lab has solidified my passion for scientific research, but has also steered me towards the work that is most clinically translatable and relevant. After graduation in May, I will begin work as a Research Assistant in the Stem Cell Program at Boston Children's Hospital. My eventual goal is to continue this translational work as a physician-scientist.

Instructors and Lecturers

Dianne Kube

Dianne earned her PhD from The University of North Dakota School of Medicine in Biochemistry/Molecular Biology. She came to CWRU as a post-doc in the Center for Cystic Fibrosis and worked on a variety of projects as the co-director of the CF Imaging Core Facility. Dianne teaches several courses, including Microbiology and laboratory and a SAGES Departmental Seminar.

Sue Burden-Gulley

Sue received her BS in Biology at Ohio Northern University and earned her PhD in Neuroscience at CWRU, exploring the role of cell adhesion molecules in axonal pathfinding during nervous system development. She then went on to a post-doc position at CWRU as well. Sue teaches Cell Biology and Developmental Biology courses and directs the Development and Physiology lab course.

Leena Chakravarty

Leena received her MS and PhD degree from Ohio State University After a post-doc at the University of Illinois at Chicago, she worked at a biopharmaceutical company for several years. As an instructor at CWRU she is currently teaching several courses and laboratories, both at the undergraduate and graduate level.

New Research Faculty

Sarah Diamond
Assistant Professor

Assistant Professor Sarah Diamond joined the department in January 2014. She is an evolutionary ecologist with specific interests in biological responses to climate and land-use change, and she dissects the mechanisms underlying these patterns using manipulative field and laboratory experiments. Diamond's lab group has forged collaborations with the University Farm, The Cleveland Botanical Garden, and the Cleveland Museum of Natural History. The work in Diamond's lab is more question-forward than system-specific, though her team does typically focus on terrestrial arthropods. She has co-authored over thirty peer-reviewed publications, and serves on the editorial boards of Ecography and Functional Ecology. At CWRU she serves on the Department of Biology Awards Committee, helping to recognize the contributions of our excellent undergraduates, graduate students, and faculty.

Jessica Fox
Assistant Professor

Assistant Professor Jessica Fox is originally from upstate New York and majored in entomology at Cornell University. From there, she went to the University of Washington to earn a PhD in Neurobiology and Behavior, and then to UCLA for postdoctoral research in integrative biology and physiology. She's been interested in insect behavior her entire career, and her research focuses on how insect sensory systems process information for insect behavior. Fox studies both vision and mechanosensation, and she's particularly interested in how the two systems interact to guide fly flight. Her lab uses a combination of quantitative behavioral analysis, electrophysiology and computational modeling to understand how sensory systems function and how insects use them when flying at high speeds. Scientists at all levels are currently working in her lab.

Karen Abbott
Associate Professor

Associate Professor Karen Abbott is a theoretical ecologist, meaning that she thinks about ecological questions through the lens of mathematics. She received her PhD in Ecology & Evolution from the University of Chicago in 2006, and joined the CWRU Department of Biology after spending three years as a postdoc at the University of Wisconsin and four years on the faculty at Iowa State University. Her lab studies ecological population dynamics in many different contexts, using mathematical models. Current projects consider plant-insect interactions, multi-host disease dynamics, mutualisms, spatial synchrony, and spatial pattern. Within many of these topics, there is a special emphasis on the complex and fascinating role that random environmental disturbances can have on ecological systems. Abbott is drawn toward questions that can't be answered directly through feasible experiments, because that is where she believes theory can be the most useful.

Ryan Martin
Assistant Professor

Assistant Professor Ryan Martin received his B.S. from the University of California at Santa Cruz and his PhD from the University of North Carolina at Chapel Hill. He joined the department in January 2014 from the National Institute for Mathematical and Biological Synthesis, where he was a postdoctoral fellow. Martin is an evolutionary ecologist interested in understanding the links between ecological variation and evolutionary change. His lab uses several complementary approaches to understand these links: observational studies in the field; manipulative experiments; and meta-analyses to evaluate the generality and predictability of empirical results. The research in Ryan's lab is firmly question based, and spans many biological systems, including carnivorous tadpoles, Arabian gazelles, fishes on Caribbean Islands, dragonflies at the University Farm, and the microbial communities living in animals. Martin serves on the Committee for Graduate Affairs in the department and teaches two courses.

Department of Biology Alumnus Now Working at CWRU Medical Center

By Katie Bingman

Michael W. Konstan, MD - Vice Dean for Translational Research, CWRU School of Medicine and Vice Chair for Clinical Research, Department of Pediatrics, Rainbow Babies and Children's Hospitals and CWRU SOM.

When Michael Konstan was a freshman pre-dental student at CWRU, he volunteered to help care for the young patients on the cystic fibrosis unit at Rainbow Babies and Children's Hospital across the street from the Department of Biology. The experience of caring for young children with a terminal illness drove him to shift his focus from working on the hospital unit to becoming an undergraduate researcher in a cystic fibrosis research laboratory at CWRU. He could now contribute directly to finding a cure by studying the basic biology underlying the disease. His time as an undergraduate researcher led to a medical degree from CWRU School of Medicine and resulted in a career-long commitment to research focused on understanding the natural history of and developing new therapies for cystic fibrosis, while maintaining a clinical practice treating patients with this disease. During the period of his involvement from the mid-1970s to today, his research has contributed to tripling the life expectancy of a person with cystic fibrosis from the early teens to nearly 40.

We asked Dr. Konstan to answer a few questions about his experiences in the Department of Biology.

1) What did you learn as a Biology major that helped you in your career?

I really liked the opportunity that I had as a Biology major to seek out research experiences with just about anyone on campus. The breadth of what I was exposed to in my classes introduced me to interesting and engaging fields that I might not have otherwise learned about. I clearly identified with the Department of Biology more than any other on campus.

2) Was there a particular faculty or staff member in the biology department who inspired or influenced you and your development?

Dr. James Zull stands out in my mind. He took the time to sit down with me and discuss and advise me on my career decisions. He was a great classroom teacher and he gave me great advice.

3) What kind of advice would you give to our pre-med or pre-health care undergraduates?

First and foremost, keep an open mind. It is a mistake to be headstrong and assume that you know what profession you want to be in and ignore the opportunities and experiences that come your way. The experiences you have during your undergraduate years and beyond may take you down paths that you have not imagined. You will find what is right for you. You will have a long career and it will be best to spend it doing something that is both rewarding and enjoyable.

CWRU Leads Effort to Replace Prostheses with Engineered Cartilage

Case Western Reserve University will open a new center designed to develop evaluation technology and set standards for testing and improving engineered cartilage that could one day replace a variety of prosthetic devices.

Biology Professor Arnold Caplan and colleagues have received a 5-year, $6.7 million grant from the National Institute of Biomedical Imaging and Bioengineering to open and direct the Center for Multimodal Evaluation of Engineered Cartilage.

"The grant supports a research center developing state-of-the-art technology to be used by experimentalists from all over the world," Caplan said.

Letter from the Chair

Hello everyone,

This may be the first newsletter you have received, or maybe the first in quite some time. Whichever it is, welcome back to the Department of Biology.

I am in my first year as chair of the department. Dr. Chris Cullis stepped down from the chair's position and back into his research lab after guiding the department through a six-year period of rapid change and growth. There is no question that our department is a better and more exciting place to work, in all ways, than it was when he took up the chair position in 2010. It is my goal to help our faculty and students continue this upward trajectory by building on our excellent reputation and enhancing our impact nationally, internationally, and in the local Cleveland area.

Since our last newsletter, the Department of Biology has made rapid progress. Both students and faculty have been recognized for their important contributions in research and teaching. This is reflected by this longer than usual newsletter. We have also added a new feature section highlighting the career accomplishments of biology alumni who are more senior and those who have graduated more recently. We will use this feature to illustrate the amazing breadth of possibilities and heights of success open to you with a degree in Biology from CWRU. Although there are many accomplishments discussed in these pages, first and foremost are those of the exciting new young faculty who have joined our department since our last newsletter.

Our faculty is strong across our three focal areas, and from the most senior to the most junior. In these pages we highlight their successes, although there are many more we simply didn't have room for. Our faculty have been extremely productive, both in securing grants from prestigious foundations and in publishing dozens of articles. We have nearly 350 undergraduate students pursuing Biology degrees with future aspirations of medical school, research, PhD programs and more. I look forward to leading this group of motivated and impressive faculty, staff, and students through my tenure as department chair.

We would love to hear news from our alumni! Please feel free to contact the Department of Biology with your professional and personal achievements so we can potentially highlight you in our next newsletter! I look forward to hearing from you and hope you follow us on our website to learn the most recent news from the department.

Sincerely,

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Biology Alumnus Develops Drone for Cleveland Metroparks

By: Katie Bingman

Dakota Benjamin with a drone at Cleveland Metroparks

Dakota Benjamin, a 2015 CWRU graduate with a BA in Biology, is working as a geospatial developer at the Cleveland Metroparks. He supports both the natural resources and planning departments' mapping needs with applications, web services, and quantitative analyses. He also works with the new drone program to plan flights, capture aerial photography, and create and analyze the products of those flights. Dakota first began working with the Metroparks as a freshman student liaison with the GLISTEN program. After his stint with the program was finished, he was asked to stay on with the Metroparks as a seasonal intern for each of the following summers. We asked Dakota a few questions about how his experience as a Biology major helped prepare him for his career.

1. What did you learn as a Biology major that helped you in your career?
Besides the basis of knowledge of biology, I learned the importance of doing through research before diving into a project. It doesn't matter if the project is technical or biology-related, the more information I have going in, the better prepared I am to handle the challenges that inevitably arise.

2. Was there a particular faculty or staff member who inspired or influenced your development?
Ronald Oldfield helped me tremendously during my last two years as my Ichthyology professor and capstone advisor. His work ethic and passion for his [research] encouraged me to work harder in my studies. Even though his expertise is different from my own interests, he helped me realize how much I enjoyed geography and its applications to biology.

3. What kind of advice would you give students interested in a career like yours?
A technical background can open up many doors. My favorite biology courses were Quantitative Biology and Maximum Likelihood Methods. They both had heavy programming components, but they are also the most relevant to my work today. Someone told me that potential employers and grad schools look kindly on someone who not only has a great understanding of biology, but also has strong technical skills to back that up.

Graduate Student National Fellowship

This spring, Abe Perez, a second-year PhD student in the lab of Dr. Sarah Diamond, was awarded a National Science Foundation Graduate Research Fellowship to fund his research on linking insect community responses to urbanization with morphology and physiology. The Graduate Research Fellowship provides three years of financial support within a five-year fellowship period ($34,000 annual stipend and $12,000 cost-of-education allowance to the graduate institution) for graduate study that leads to a research-based master's or doctoral degree in science or engineering.

The project Abe proposed for the NSF fellowship is to study insect community composition and its morphological and physiological variation across multiple urban-rural gradients in Ohio. Cities are often warmer than the surrounding rural areas, a phenomenon known as the Urban Heat Island effect. Abe hypothesized that insect community composition and species morphological and physiological traits will vary across these gradients in response to the warmer temperatures.

As part of his first year of the fellowship, Abe has established field sites throughout Ohio, collected data and actively mentored Case undergrads. Abe is one of three Case Western Reserve University students to receive the highly competitive award, and the only student from the College of Arts & Sciences; at the national level, the success rate was 12%, or 2000 funded proposals out of 16,500 total.

Faculty Highlights

Roy Ritzmann has been published in Current Biology.
Martin, J.P., P. Guo, L. Mu, C.M. Harley, and R.E. Ritzmann (2015) Central-complex control of movement in the freely walking cockroach. Curr. Biol. 25:1-9. http://dx.doi.org/10.1016/j.cub.2015.09.044

Hillel Chiel has been published in Current Biology.
Cullins, M.J., Gill, J.P., McManus, J.M., Lu, H., Shaw, K.M., Chiel, H. J. (2015) Sensory feedback reduces individuality by increasing variability within subjects. Curr. Biol. 25: 1-5. http://dx.doi/org/10.1016/j.cub.2015.08.044

Jessica Fox was awarded a Young Investigator grant from the Air Force Office of Scientific Research. The project title was: "Mechanosensory And Visual Integration For Fly Takeoff And Flight." http://www.wpafb.af.mil/news/story.asp?id=123466938.

Sarah Diamond has been published in Science Advances.
Diamond, S.E. et al. (October, 2016). Climatic warming destabilizes forest and communities. Science Advances. Vol 2. no. 10 http://advances.sciencemag.org/content/2/10/e1600842.full.pdf+html

Karen Abbott, was named an Early Career Fellow by the Ecological Society of America. Additionally Abbott, along with Co-PI Peter Thomas, were selected for funding for an NSF grant entitled "Stochastic shielding in ecological networks."

Rebecca Benard won the CWRU Wittke Award for excellence in undergraduate teaching.

Chris Cullis signed on as the Co-Editor-in-Chief of the journal: Research and Reports in Biology

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Graduate/Undergraduate Student highlights

Iiulien Gherghel and Michael Moore of Ryan Martin's lab published a paper. Gherghel I., Sotek, A., Papeş M., Strugariu A., Fusu L. (2016): Ecology and biogeography of the endemic scorpion species Euscorpius carpathicus (Scorpiones: Euscorpiidae): a multiscale analysis. Journal of Arachnology.

Moore MP, Landberg T, and Whiteman HH. 2015. Maternal investment mediates offspring life history variation with context-dependent fitness consequences. Ecology 96(9): 2499-2509. http://dx.doi.org/10.1890/14-1602.1

Biology PhD candidate Sydney Brannoch and her research advisor, Dr. Gavin Svenson of the Cleveland Museum of Natural History, have been featured across several news outlets for the paper that Brannoch recently published in which she identifies a new species of praying mantis: Ilomantis ginsburgae. The new praying mantis honors Ruth Bader Ginsburg, equality and frilly neckwear. https://www.sciencedaily.com/releases/2016/06/160601110730.htm

Undergraduate student Yunsoo Kim published along with his PI, Chris Cullis, in the Journal of Experimental Botany. Yunsoo Kim and Christopher Cullis. (2016) A novel inversion in the chloroplast genome of marama (Tylosema esculentum). Journal of Experimental Botany in press.

Three undergraduates working under the mentorship of Biology Department faculty won awards at the Fall 2016 CWRU-wide undergraduate research forum, Intersections. Mahima Devarajan in Dr. Radhika Atit's lab and Alexandra Faidiga, in Dr. Jean Burns' lab, tied for first place in the Natural Sciences Poster Competition. Erin Conway in Dr. Mike Benard's lab tied for second place, also in the Natural Sciences Poster Competition.

Biology is Awarded the GAANN

By Mike Benard

Our graduate students fill an important role in the research and educational efforts of the Department of Biology. As graduate students conduct their research, they advance our knowledge of biology. Undergraduate students conducting research alongside graduate students and faculty learn how the scientific process works. Department of Biology faculty and staff are continually seeking opportunities to strengthen our graduate program. A recent successful effort was an $855,000 Graduate Assistance in Areas of National Need (GAANN) grant awarded to the Department of Biology by the U.S. Department of Education in September, 2015. The goal of the GAANN program is to provide fellowships to support outstanding graduate students who demonstrate financial need. Over three years, the GAANN will provide support for approximately 12 PhD students in the Department of Biology. Students selected as GAANN Fellows will take graduate classes, conduct research, receive training as educators, and participate in peer mentoring. GAANN Fellows will also be provided with opportunities to explore career paths both inside and outside of academia. Graduate students supported on the GAANN will be drawn from across the diverse fields of biology, including molecular and cellular biology, neurobiology and behavior, and ecology and evolutionary biology. The GAANN proposal was prepared by Biology faculty Karen Abbott, Mike Benard, Hillel Chiel, Emmitt Jolly, and Claudia Mizutani, and Graduate Program Coordinator Julia Brown.

Support the Department of Biology

You can contribute to our on-going success by making a gift to the department. Your gift will allow us to continue to offer opportunities for our students to excel academically and to conduct cutting-edge research. Please return your gift in the enclosed envelope or give online at giving.cwru.edu/casgiving

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