

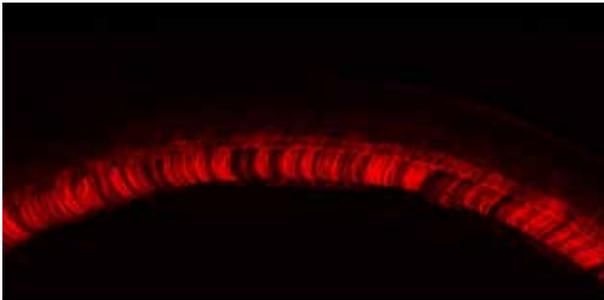
## Professors receive over \$5 million in awards; patent

### ***GDCB professors receive \$2.9m NIH award to develop advanced gene editing method***

Department of Genetics, Development and Cell Biology Professors **Jeff Essner**, **Maura McGrail**, and **Drena Dobbs** are collaborating with two Mayo Clinic professors in a \$2,979,645 project funded by the National Institutes for Health. They will create new and precise gene editing techniques for zebrafish to identify genes that promote human health.

Mayo Clinic Assistant Professor Karl Clark and Professor Stephen Ekker from Mayo's Department of Biochemistry and Molecular Biology are collaborating with the GDCB professors.

Essner and his colleagues will create revertible alleles to test genes for their ability to alleviate disease states and enhance the efficiency of using homology-directed repair of double-strand DNA breaks to create targeted mutations.



*This image demonstrates the gene-editing technology. It depicts floating head knock-in allele showing expression of the red fluorescent protein in the notochord of the zebrafish embryo.*

### ***Wurtele receives over \$2m NSF award to leverage "orphan" genes in crop plants***

Department of Genetics, Development and Cell Biology Professor **Eve Wurtele** recently received a \$2.175 million award from the National Science Foundation titled "Orphan genes: An untapped genetic reservoir of novel traits driving evolutionary adaptation and crop improvement."



*Eve Wurtele*

The goal of the award is to develop computational software that facilitates a predictive understanding of the function of orphan genes, to harness these resources for improving crops. A focus will be maize, in the context of the evolution of grasses and the adaptation and selection that has occurred as the result of human intervention for improved agronomic traits.

The information will be disseminated to researchers via community crop databases and to the public by creation of new digital games.

### ***Professor receives patent, submits another***

GDCB Professor **Eve Wurtele** received U.S. Patent No. 9,157,091 and submitted another U.S. Patent application.

Her intellectual property is related to improving genetic elements and increasing plant stress resistance in important agricultural crops. Her patent is a method to increase the amount of protein content in a plant, including the agronomic species maize, soybean and rice, by expressing the Qua-Quine Starch (QQS) orphan gene.

## AAAS honors two GDCB faculty: Gu, Howell

The American Association for the Advancement of Science (AAAS) recognized two Department of Genetics, Development and Cell Biology professors in November 2016. **Xun Gu** and **Stephen Howell** were among six Iowa State University researchers recognized by AAAS for their contributions to statistics, plant biology, bioinformatics, crop improvement, astrophysics and plant pathology.



*Xun Gu*



*Stephen Howell*

The researchers are among this year's class of 391 new AAAS fellows, the association announced. The recognition is bestowed on association members by their peers and recognizes scientifically or socially distinguished work to advance science or its applications.

### ***Xun Gu***

Gu's current research is to integrate genome big data, high throughput computing and principles of genome evolution into a unified framework. That may have broad applications in various biological fields, including plant and animal domestication, evolutionary medicine and certain cancer mutations.

### ***Stephen Howell***

Howell is the Charles F. Curtis Distinguished Professor in Agriculture and Life Sciences. His lab is studying the effect of climate change on plants. In particular, his lab is studying how plants respond to and tolerate adverse environmental conditions.

The new AAAS fellows were announced in the Nov. 25 issue of the journal *Science* and were honored on Feb. 18 at the AAAS meeting in Boston. AAAS members can be nominated for the honor by the steering groups of the association's 24 sections, by any three fellows or by the association's chief executive officer.

## **Chang receives Women of Innovation award, scholarship**

**Jennifer Chang**, an Iowa State University bioinformatics and computational biology (BCB) program Ph.D. candidate, received the Collegian Innovation and Leadership award and a \$2,500 scholarship at the Ninth Annual Des Moines Area Community College Iowa Women of Innovation Awards ceremony on Nov. 10 at the Community Choice Credit Union Convention Center.

The Iowa Women of Innovation Awards recognizes and celebrates women in business, government or academia who are leaders in the fields of science, technology, engineering and math (STEM). The event is a Technology Association of Iowa program.

Chang was recognized in her field for her academic achievement, inventiveness, creativity and extracurricular activities. She is a co-founder, software developer and chief financial officer at Complex Computation, LLC. She is also a research assistant at Iowa State helping to update the open source software called Lucy2 for analyzing raw DNA sequence data. In addition, she serves as a teaching assistant for upper-level undergraduate courses in genetics and bioinformatics.

Dr. Hui-Hsien Chou is Chang's adviser and co-founder, chief technology officer, Complex Computation, LLC. Chou is an ISU Department of Genetics, Development and Cell Biology associate professor in computational biology and bioinformatics.



Jennifer Chang (right), an Iowa State University bioinformatics and computational biology Ph.D. candidate, won a Collegian Innovation and Leadership Award and scholarship at the Iowa Women of Innovation Awards ceremony. Chang's adviser is Dr. Hui-Hsien Chou (left).

## **3 GDCB grad students present research at symposium**

Three Department of Genetics, Development and Cell Biology graduate students' abstracts were selected from those submitted to present research at the eighth annual Neuroscience Research Day, which was held at Iowa State University on Sept. 17, 2016. GDCB students presenting were **Lauren Laboissonniere**, **Sweta Roy-Carson** and **Rebecca Chowdhury**.

The first place award for outstanding student speaker went to Laboissonniere from the Trimarchi Lab, while Roy-Carson from the Kuhlman Lab was presented with second place in the same category.

This year's meeting welcomed over 100 registrants from a number of Midwest universities and colleges, including Iowa State University, Minnesota State University-Mankato, University of Northern Iowa, University of Iowa, Simpson College, Grinnell College, Wartburg College, Drake University, Des Moines University, University of La Crosse-Wisconsin and Northwestern University.

This year's event featured two keynote speakers: Knut Stieger, DVM Ph.D., from the Department of Ophthalmology, Faculty of Medicine at Justus-Liebig-University Giessen, Germany,



GDCB graduate student Lauren Laboissonniere (right) receives the First Place student speaker award at the Neuroscience Research Day.

and Tiffany Schmidt, Ph.D., from the Department of Neurobiology at Northwestern University.

Stieger spoke about "In vivo genome editing to treat retinal dystrophies - how close are we to success?" Dr. Schmidt presented her research on "Genetic mapping of visual circuits."

Additional faculty speakers included Dr. Gil Ben-Shlomo (ISU-CVM) and Dr. Wendy White (ISU).

In addition to Laboissonniere, Roy-Carson and Chowdhury, other graduate student speakers who presented their research were Patricia Izbicki (Stegemoller Lab, ISU-College of Human Sciences), Chu-Ling Yen (Shields Lab, University of Iowa) and Hilary Hu (Jeffery Lab, ISU-College of Veterinary Medicine).

Student poster awards at the event went to: first place: Alyson Williamson and Hayley LeBlanc (Craigie Wrenn's Lab, Drake University), and second place, Edmund Norris (Coates Lab, ISU-Department of Entomology).

Participants enjoyed a social reception at the close of the day's activities at Alluvial Brewing Company.

# Roy-Carson takes 1st in ISU Grad College 3MT event

**Sweta Roy-Carson** won the Iowa State University Graduate College 3-Minute Thesis (3MT) contest, which was held in the fall.

Roy-Carson is a bioinformatics and computational biology (BCB) Ph.D. student working under the supervision of her Department of Genetics, Development and Cell Biology major professor **Julie Kuhlman** and her co-major professor **Drena Dobbs**.

Roy-Carson's work focuses on delineating genetic factors involved in the development of the enteric nervous system using zebrafish as a model organism.

"I study the 'little brain' or the nervous system that controls our digestive system," Roy-Carson explained. "Not much is known on what genes are specifically involved and that poses a hurdle in discovering treatments for digestive disorders such as Hirschsprung's disease."

When asked about the long-term vision for her research, Roy-Carson said, "The knowledge obtained from my research will

help us learn more about the molecular and genetic components in the enteric nervous system, and thus facilitate the discovery of treatments and potential cures for chronic diseases of the digestive system."

Having won the competition at ISU, Roy-Carson will now represent the university at the regional competition in Indianapolis on April 7.



Sweta Roy-Carson and her glow-in-the-dark zebrafish she uses to solve the molecular mysteries of digestive disorders.

## Faculty, students participate in Freshman Research Initiative

GDCB faculty and students, including Dr. **Elizabeth Sandquist** and Professors **Jeff Essner, Karin Dorman** and **Don Sakaguchi**, are participants in a pioneering initiative to facilitate introducing undergraduate freshmen to scientific research.



Professor Karin Dorman discusses the nuances of bioinformatics research with students.

The Freshman Research Initiative (FRI) at Iowa State University introduces freshman undergraduates to authentic research in the fields of astronomy, electrical and computer engineering, geology, molecular biology, genetics and physics. Streams of 15 to 20 students in introductory classes are co-opted into the research programs of faculty members where students design their own experiments for course credit. These course-based research projects have the potential to reach more students than traditional one-on-one mentoring. Faculty in different courses are exploring a variety of ways to provide research opportunities in their classes.

One example of the research carried out by participants is the "Stem Cells for Neuroregeneration" research stream led by Sandquist in Sakaguchi's lab. Sakaguchi was the 2015 McNair Program Faculty Mentor of the Year. He has mentored 144 undergraduate research trainees in his lab.

Students participating in this opportunity perform neuroscience research, studying the plasticity of

stem cells using zebrafish as a model system. The differentiation potential of adult stem cells is evaluated by injecting cells into embryonic zebrafish, when a variety of developmental factors are present. Students will characterize the phenotype of transplanted and host cells employing molecular biology techniques. Freshmen will gain knowledge about cell biology, neuroscience and development and will acquire science competencies, including quantitative reasoning, the interdisciplinary nature of science, and the ability to communicate scientific findings to a variety of audiences. Bhavika Patel, a second-year neuroscience graduate student, is the teaching assistant in the course.

Professor Dorman is spearheading another exciting research endeavor within the Initiative. Dorman has established the first [bioinformatics-centered Freshman Research Initiative stream](#), which is being offered in spring 2017 semester. This program offers opportunities for students in biology, genetics, bioinformatics, statistics, mathematics, and computer science for a truly interdisciplinary group research/learning experience. [Learn more...](#)

### GDCB appreciates your support

In this era of restricted research budgets, GDCB strives to obtain private, institutional and federal funding to maintain its many vigorous and cutting edge research programs.

The Iowa State University Foundation manages all donations. If you would like to make a direct donation to the department, [click here](#). This link directs your donation specifically to GDCB.

Your support is greatly appreciated!

# Kraft, Yandeau-Nelson receive Miller Faculty Fellowship

A recent award will fund innovations in the Principles of Genetics laboratory course. The GDCB Genetics 313L teaching team of Dr. **Jelena Kraft**, teaching lab coordinator, and Professor **Marna Yandeau-Nelson** were one of five proposals awarded a Miller Faculty Fellowship for the 2016-17 academic year. Their proposal titled “Genetics laboratory: Integrating training in molecular techniques and bioinformatics tools to promote deeper understanding of core biology concepts,” was awarded \$8,700 of the total \$51,000 awarded. The Center for Excellence in Learning and Teaching (CELT), which administers the program for Iowa State University’s President’s Office, will supplement the Miller funds with nearly \$8,000. Matching funds — which aren’t required — total nearly \$36,000.

A Miller Faculty Fellow must propose innovative approaches to advance undergraduate teaching. The faculty team of Kraft and Yandeau-Nelson will seek to integrate a series of bioinformatics exercises using the molecular biology software, SnapGene, to integrate within the Genetics 313L lecture with hands-on bioinformatic exercises that conceptually describe lab

experiments and core genetic processes that will enable students to achieve a level of mastery over these essential professional skills. Three assessments are planned to evaluate the effectiveness of these exercises.



Professor Marna Yandeau-Nelson (left) and Dr. Jelena Kraft (right) received a Miller Faculty Fellowship for the 2016-17 academic year.

## Henderson, Mathur develop a ‘DNA Nanobot’ for diagnostics, therapeutics and biophysical measurements

Imagine you want to build an intricate work of architectural wonder like the Sydney Opera House, but all you had to do was mix all the pieces together and it would build itself! Now imagine this being done a size so small, it was invisible to your eyes.

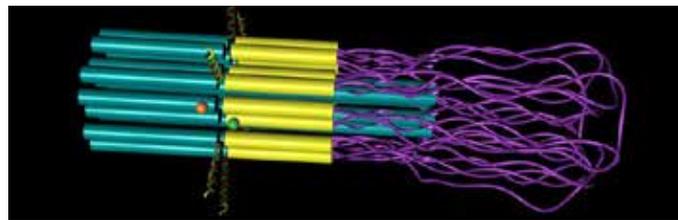


Illustration of the OPTIMuS self-assembling DNA nanosensor developed by Dr. Divita Mathur and Professor Eric Henderson placed over an atomic force micrograph of the actual device.

You’ve just entered the nanoscale world of the “Nanosquad,” the researchers in the laboratory of Professor **Eric Henderson**. If this sounds like magic to you, it’s the same magic that nature has been using for billions of years to build the code of life out of DNA.

“It’s the magic of how DNA works,” said Henderson, a GDCB professor. Henderson, and his former graduate student Dr. **Divita Mathur** (now at the Naval Research Laboratory in Washington, D.C.), build self-assembling nanomachines that may have real-world medical applications someday soon. Henderson and Mathur recently published an article in the peer-reviewed Scientific Reports describing his laboratory’s successful effort to design a nanomachine, named OPTIMuS, capable of detecting genetic sequence for Ebola and many other pathogens.



Nanoengineers Professor Eric Henderson (left) and Dr. Divita Mathur (right).

Mathur and Henderson envision the use of such technology in the developing world where access to diagnostic medical equipment can be rare. The technology is extraordinarily inexpensive and robust. It may be used in conjunction with a smartphone app so it

is accessible to virtually anyone, and the test results are globally available instantly.

Henderson said, “If we can pull DNA out of dinosaur bones that are thousands of years old, why not use this tough biological material to build rationally designed and useful nanodevices.”

The trick lies in understanding the rules that govern how DNA works. The iconic DNA double helix is formed by the binding of one DNA sequence to a perfect partner in the other strand. The rules of partnership are simple, but rich with design and nanoengineering opportunity. Using the right design, researchers can create complex nanodevices that build themselves. Based on the pioneering work of other groups worldwide, Mathur and Henderson harnessed these rules of self-assembly to create OPTIMuS. The recipe could not be simpler: add salt water, heat, cool, and use.

Just how “nano” is a nanomachine? Henderson said about 40 billion individual machines fit in a single drop of water. Since the nanobots are too small to visualize directly, Henderson and Mathur employed an embedded photonic system that reports the presence of the target molecules by a change in color and intensity of the drop containing the 40 billion nanobots. Henderson said this type of readout is compatible with existing consumer devices like cell phones and tablets.

# Trimarchi receives award for outstanding mentoring

GDCB Professor **Jeffrey Trimarchi** received a 2016 University Honors Committee Award for Excellence in Honors Teaching and Mentoring. Trimarchi was nominated by students in the ISU Honors program.

Two awards are given annually to recognize Iowa State University faculty and staff who support Honors at ISU through general excellence in teaching of Honors courses, seminars or other courses taught for Honors credit; or in the mentoring of Honors students through academic advising, advising of Honors projects, and mentoring of students in the First-Year Honors/Mentor Research Program.



Professor Jeff Trimarchi was honored by the University Honors Program for outstanding mentoring. Two students he has mentored are Madelyn Mullally and Caitlin Albrecht.

## Undergrads: Research hones critical thinking skills and enlightens scientific curiosity

It is not unusual for Trimarchi's research group to include more than 10 undergraduate researchers at one time. Some are performing research on understanding the genetic basis of retinal development and some are doing work on the degeneration of motor neurons using three different model organisms: mouse, chick and zebrafish.

Trimarchi has mentored many undergraduate students in his lab at ISU, including **Madelyn Mullally, Caitlin Albrecht, Mary Horton, Alicia Manning, Annie Wester** and **Quinton Bose**. These students recently co-authored a research paper titled "Expression Profiling of Developing Zebrafish Retinal Cells" in the journal *Zebrafish* (2016 Mar 16). The paper details their research on the examination of gene expression in developing retinal neurons using zebrafish that express green fluorescent protein in the eye.

Each undergraduate student was responsible for determining the expression of different genes and performed all the experiments from experimental design through expression analysis. Through the series of in situ hybridizations, designed and performed by the undergraduate students, they were able to identify genes marking different developing retinal neurons. Future experiments will now use genome-editing techniques to assess the function of these genes.

The authors of this paper believe research played an integral role in their education as both students of science and future clinical professionals. It taught them practical laboratory skills, while enabling them to experience the scientific method firsthand. In addition, they were able to take the knowledge learned in the classroom and apply it directly to experimental research performed in the lab. More importantly, they believe participation in undergraduate research honed their critical thinking skills and

enlightened their scientific curiosity in a manner that has transcended the classroom. Conducting the research as a team with other undergrads strengthened their collaborative skills.

Mullally, a biology major, and Albrecht, a nutritional science major, are both graduating seniors. Albrecht will attend the University of Minnesota College of Pharmacy to pursue her Doctor of Pharmacy degree, while Mullally will attend the Southern College of Optometry in Memphis to earn her Doctor of Optometry degree. Wester and Bose, both biology majors, are also seniors. Wester will also attend Southern College of Optometry in Memphis to earn her Doctor of Optometry degree, while Bose will continue at ISU for an additional semester. He plans to attend medical

school in the future. Manning is currently working at Pioneer and is planning to enroll in Des Moines University in the fall. Horton is currently in a Master of Public Health program at Columbia University. Manning and Horton earned their Bachelor of Science degrees in biology from ISU.



## Comments, feedback welcome

GDCB enjoys hearing from its former students and other interested parties.

Please send your comments and requests for additional information by emailing [gdcbnews@iastate.edu](mailto:gdcbnews@iastate.edu). In addition, let GDCB and your fellow alumni know about your career moves. Send all notes to [gdcbnews@iastate.edu](mailto:gdcbnews@iastate.edu).

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