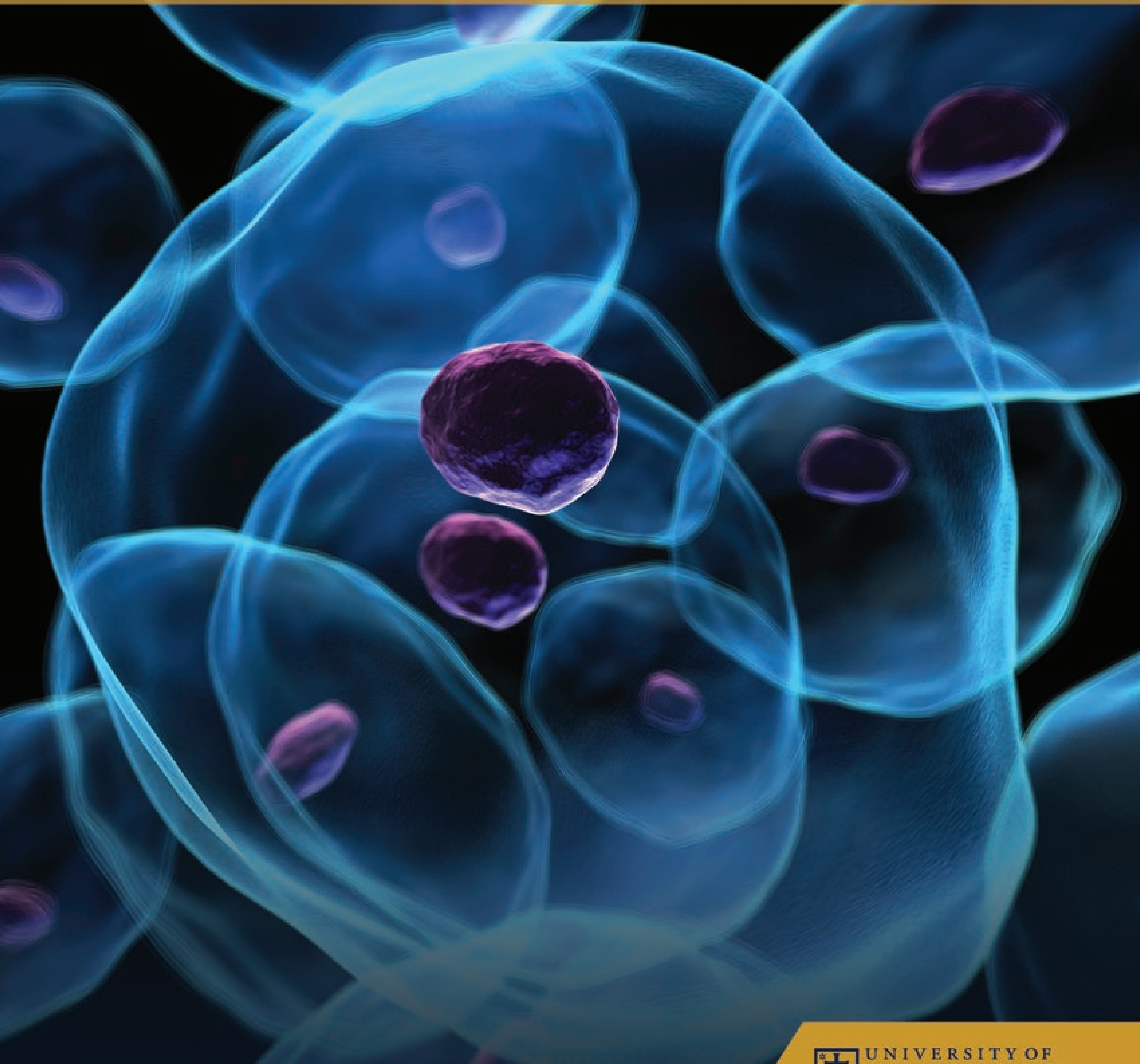
DEPARTMENT OF

BIOLOGICAL SCIENCES

2018-2019 ACADEMIC YEAR HIGHLIGHTS



ADVANCING HUMAN AND ENVIRONMENTAL HEALTH

UNIVERSITY OF NOTRE DAME
College of Science

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Design/layout by Matt Frazier

The Department of Biological Sciences at Notre Dame seeks to understand the fundamental mechanisms by which living systems operate, and employs a wide range of cutting edge and innovative experimental approaches and systems. The Department is highly interdisciplinary and well positioned to fulfill the promise of the new integrative approach to biology. Diverse disciplines and programs in the life sciences converge here to catalyze the development of new knowledge. Foundational research is at the center of our endeavors and fuels and inspires our teaching and training efforts.

Our overall mission is to conduct research at the forefront of 21st century integrative biology and to cultivate leaders who will make a difference to the future of human health and the environment. We continually strive for improvement through investments in our people; in growing and transforming our research enterprise; in enhancing our educational programs; in cultivating intramural and extramural partnerships; and in improving our operational efficiencies. We commit to ensuring diversity of all forms in the pursuit of excellence in learning and discovery.

DEPARTMENT LEADERSHIP

Crislyn D'Souza-Schorey
Pollard Professor and Department Chair

Nora Besansky
O'Hara Professor and Associate Department Chair

Elizabeth Archie
Associate Professor and Assistant Department Chair

Zach Schafer
Associate Professor and Assistant Department Chair

THE DEPARTMENT OF BIOLOGICAL SCIENCES WELCOMES JASON ROHR

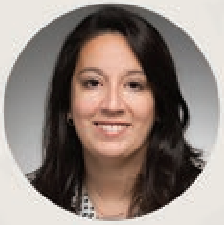
Jason Rohr joins the University of Notre Dame as the Ludmilla F., Stephen J., and Robert T. Galla College Professor of Biological Sciences. Jason comes to Notre Dame after serving as the professor and director of the Center for Infectious Disease Ecology Research and associate chair of the Department of Integrative Biology at the University of South Florida. Rohr's current and active research interest are numerous, and lie at the intersection of environmental science and infectious diseases.

One of his primary research areas is in schistosomiasis, a disease caused by infection caused by freshwater parasitic worms in certain tropical and subtropical countries, mostly in sub-Saharan Africa. The infectious worms are transmitted from snails in waterways that are common places for the retrieval of water for cooking and cleaning. Children ages 5-15 are most often affected, and while medications help to manage the disease, people often become re-infected when going back to the water.

Rohr's laboratory will include both indoor and outdoor areas to study schistosomiasis and other diseases. His outdoor laboratory, which will be located near the north end of campus, will contain 120, three-hundred gallon tanks that will be used to simulate freshwater environments. The tanks can be used to study shistosomiasis, as well as the effects pesticides and diseases have on amphibians, another key research area for Rohr.

Dr. Rohr earned a B.A. in Biology and in Environmental Studies at Binghamton University in 1996. He subsequently completed a Masters in Education in 1997 and his Ph.D. in Ecology in 2002 at Binghamton University. Following a postdoc at the University of Kentucky and Research Associate position at Penn State University, he was appointed as an Assistant Professor at the University of South Florida in 2007. Rohr progressed through the ranks at USF, becoming Full Professor in 2017. We welcome him to the department of biological sciences and as a member of the Notre Dame Environmental Change Initiative and the Eck Institute for Global Health.

FACULTY PROMOTIONS



Anjuli Datta; *To Associate Teaching Professor*

Anjuli Datta earned her M.S. at the University of North Texas Health Science Center. She moved to Penn State University in 2009, joining the Instructional Faculty in the Department of Biochemistry and Molecular Biology. She moved to the University of Notre Dame in 2015, as Assistant Teaching Professor, and has taught Cell Biology and the Molecular Basis of Disease, and most recently, the new Biology II: Molecules to Ecosystems. Anjuli says, "It is a great honor to receive the promotion for my contributions to undergraduate education in the Department of Biological Sciences. Teaching has allowed me to share my passion for biology with the next generation of scientists and physicians. I continue to evolve as a teacher; exploring new ways to engage and prepare students for future careers".

Neil Lobo; *To Research Full Professor*

Neil Lobo earned his B.S. in 1994 at St. Joseph's Arts and Science College in Bangalore, India. Under the guidance of Dr. Malcom (Mac) Fraser, Neil received his Ph.D. from the University of Notre Dame in 2000, and remained here, progressing from post-doctoral fellow, to Research Assistant Professor in 2004, then Research Associate Professor in 2011. Lobo's research is focused mosquitos as vectors for diseases such as malaria, dengue, and Zika, developing new approaches to circumvent disease transmission through mosquito control. He is co-PI on one of the largest grants awarded to Notre Dame, and also receives funding through the Bill and Melinda Gates Foundation and the Deployed War Fighters Protection Program. Regarding his recent promotion, Neil states, "I feel privileged. I would like to thank the dean, our department chair, and my colleagues, for all the support I have received. I look forward to my continued learning and contributions to our department".

Adrian Rocha; *To Associate Professor with Tenure*

Adrian Rocha joined Notre Dame's Department of Biological Sciences as an Assistant Professor in 2012. Rocha's research has focused on the Arctic ecosystem and its adaption to climate change. Arctic ecosystems are particularly vulnerable to destabilization from global warming. Rocha studies the interactions among wildfire, soils and climate in the Arctic. Adrian's current work focuses on characterizing the effects of wildfire on climate forcing and vegetation recovery on the north slope of Alaska, an area of rapid environmental change. His research is supported by funding through the NSF and NASA. Adrian notes, "I'm honored to continue working for a world renowned research and teaching university with such rich history and values. Being awarded tenure has provided me with a renewed sense of excitement and urgency to bring the University of Notre Dame's research and teaching mission to fruition."

ASKING **BIG** QUESTIONS FROM MOLECULES TO ECOSYSTEMS

OUR NEW INTRODUCTORY BIOLOGY SEQUENCE

For many, the phrase "Introductory Course" conjures up the image of a large classroom, dominated by lectures and intensive exams. Notably however, introductory courses are critical for both providing a foundation for subsequent courses, and planting the initial seed of excitement for one's discipline. Introductory courses also link the educational past and future of students, and therefore, previous knowledge and experiences have to be considered while providing foundational content. But students may differ in both their knowledge and expectations for such courses. Add serving many hundreds of students each year, with a diversity of majors and career pathways, and you have the complex challenge of teaching Introductory Biology!

Three years ago, Biological Sciences faculty met to address this challenge by designing and implementing a new Introductory Biology course sequence. The overarching goal was to develop a set of courses that would incorporate innovative pedagogies and student-centered learning while actively engaging students in the discipline of biology.

Why was a new introductory biology course needed?

The impetus for initial discussions came at two levels. Nationally, there had been many calls for changes in the teaching of introductory biology at college and universities. This culminated with 'Vision and Change in Biology Education: A Call to Action' published by the American Association for the Advancement of Science in 2011. Vision and Change argued for a more process-driven approach to teaching biology, with less focus on rote memorization of facts and more emphasis on major concepts and competencies required for biological literacy. At the same time, faculty in Biological Sciences were discussing issues of student retention, engagement, and performance in introductory courses. With a charge from Crislyn D'Souza-Schorey, the department chair, a group of faculty began the design of an innovative introductory biology course that would meet the needs of students by harnessing the strengths of faculty.

What framework was established?

The team began with the goal of imagining the ideal first exposure to college biology. Faculty used *design thinking*, especially the "building-up" of ideas with few limits on discussion, and soliciting input from a broad representation of faculty. The team established "three pillars" or objectives of the introductory biology sequence:

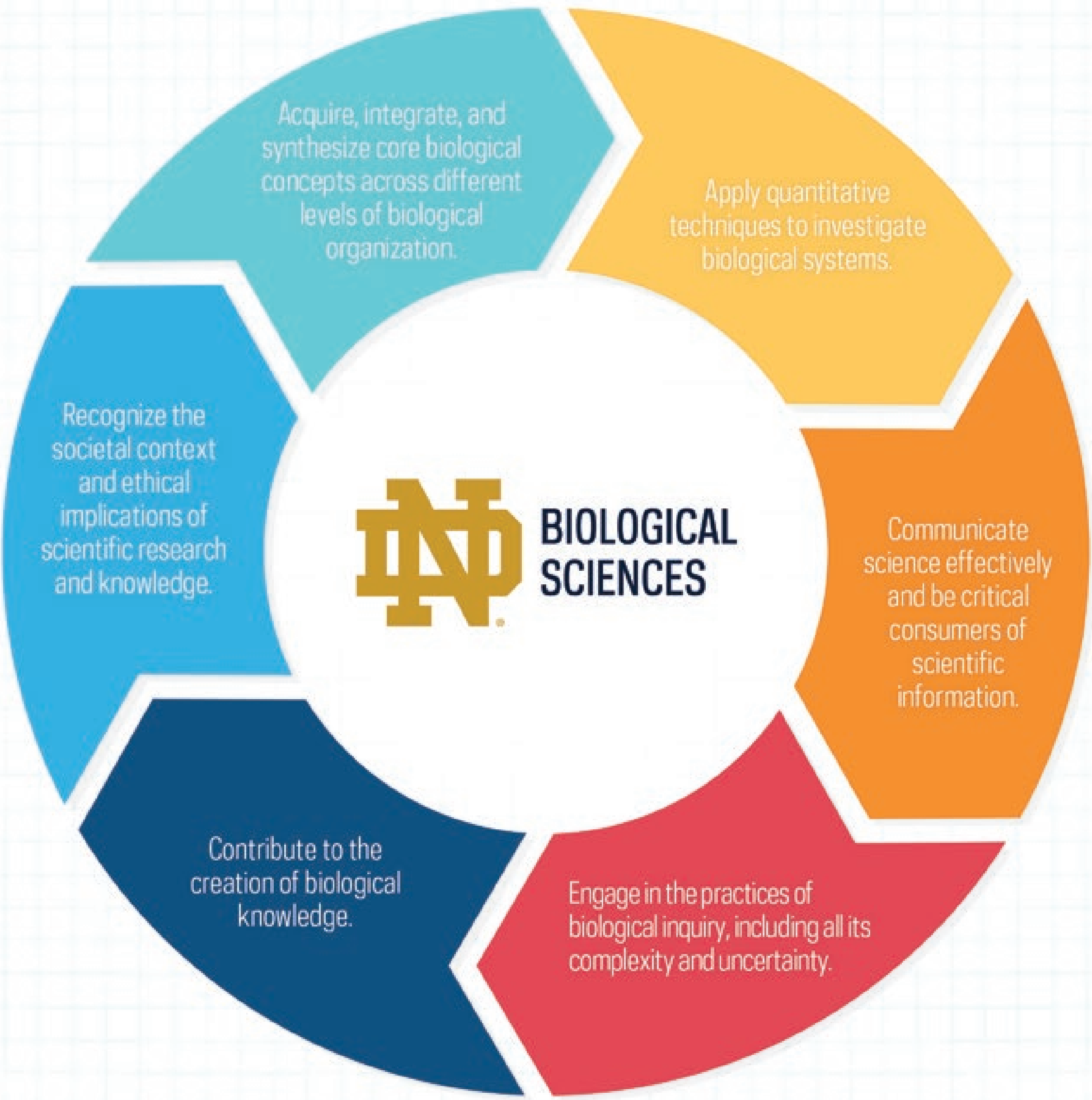
1. *To help students think like a biologist*
2. *To build a students foundational knowledge about biology*
3. *To develop enthusiasm in students for biology.*

The three pillars provided the framework for more specific learning goals, such as being able to contribute to the creation of biological knowledge and applying quantitative techniques to the investigation of biological systems (Figure on next page).

INTRODUCTORY BIOLOGY

CONCEPTUAL FRAMEWORK

BUILD FOUNDATIONAL KNOWLEDGE | **THINK LIKE A BIOLOGIST** | **DEVELOP ENTHUSIASM FOR BIOLOGY**



Undergirding the broader framework was a commitment to *inclusive excellence* and development of *intellectual virtues*. Inclusive excellence recognizes that academic success depends, at least in part, on prior educational experiences, and that these experiences can differ dramatically among students in one classroom. Thus, inclusive classrooms and courses are thoughtfully designed so that all students can fulfill their potential. Intellectual virtues are thinking dispositions that enable the pursuit of truth, knowledge, and understanding, and establish essential traits for successful learning and research. This meant designing the new courses so that they promoted both understanding of biological concepts as well as thinking dispositions, such as curiosity and courage to generate and ask questions, along with the autonomy and open-mindedness when evaluating responses to those questions.

After several iterations and discussions with the faculty, the design group proposed a sequence of two lectures courses, *Biology I: Big Questions* and *Biology II: Molecules to Ecosystems*, and two laboratory courses, *Biological Investigations* and *Research Experience in Biology*. The structure and content of these courses would reflect not only the collective experience of faculty but also the best available research in science education.

So what is the new introductory biology sequence?

The sequence begins with Big Questions (BQ), a modular course designed to introduce t*imely, important, and engaging questions* that biologists grapple with in their research. The goal is to spark students' interest in the discipline, and to give them a chance to practice thinking like a professional biologist. Students selected two of eight modules offered by Biological Sciences faculty in their area of research expertise. With careful planning, all 532 students were able to participate in their top ranked module. Modules in Fall 2018 investigated questions in biology from the use of gene and stem cell therapy, to human evolution, and climate change (see table below). Although starting with asking big questions instead of traditional "content" may seem counterintuitive, this approach provides an intellectual scaffold onto which students can build knowledge and is consistent with the science of learning. Students need a mental framework in which to place new information; without a preexisting set of experiences that generate this framework, information retention is very low.

FACULTY	MODULE TITLE	RELEVANT LEVELS OF BIOLOGY
David Hyde	Blindness: Can We See Potential Gene and Stem Cell Therapies?	Molecules, cells, organisms, populations
Stuart Jones	Is Everything in Biology a Compromise?	Molecules, organisms, populations, ecosystems
David Medvigy	Hero or Villain: How Might Earth's Ecosystem Resolve the Climate Question?	Cells, organisms, ecosystems
Shaun Lee	Who's in Control? The Role of Microbiomes in Our World	Molecules, cells, organisms, populations
Jeanne Romero-Severson	What Powers Life on Earth?	Molecules, cells, organisms, populations, ecosystems
Jeff Schorey	Harnessing Our Immune System to Fight Disease: To Be or Not to Be!	Molecules, cells, organisms, populations
Mike Pfrender	Humans: How Did We Get Here, and Why Are We Like This?	Molecules, organisms, populations
Zach Schafer	Natural Selection: The Reason Why We Haven't Cured Cancer?	Molecules, cells, organisms, populations

Equipped with a set of tangible and cutting edge examples from biology, the second course in the sequence, Molecules to Ecosystems (M2E), addresses the details of how biology works, from the function of basic molecules to the dynamics of complex ecosystems. The course is structured into five units around the major themes in biology identified in Vision and Change, including the evolution of organisms, flow of biological information, relationships between structure and function, metabolism and the transformation of matter and energy, and homeostasis in biological systems. (See table: Molecules To Ecosystem Units). This approach allows students to acquire the foundational knowledge needed for future coursework along with developing the thinking dispositions of a biologist.

In the laboratory courses, students gain a practical experience of "doing biology". This begins with Biological Investigations, structured around four projects that introduce *critical techniques* and skills needed to undertake biological science. In the second semester, for Research Experience in Biology students choose a semester long research project which provides an opportunity to engage in active research at Notre Dame. Subjects include environmental change, vector biology, tuberculosis, and cancer biology. The laboratories provide a critical opportunity for students to apply the concepts and principles from the lecture courses, while experiencing the challenges and rewards of genuine research.

Throughout the course sequence there are four commonalities. First, the student to instructor ratio is kept relatively small with lecture section sizes of between 70-80 students to reduce the

MOLECULES TO ECOSYSTEMS UNITS

Evolution: Nothing in biology makes sense except in the light of evolution	All living organisms share a common ancestor. Species evolve over time, and new species can arise when allele frequencies change because of mutation, gene flow, genetic drift, and natural selection.
Information flow: Information received and understood	Organisms inherit genetic information that influences gene expression. Also, cells, organs and organisms all have mechanisms to sense and respond to changes in environmental conditions.
Structure-function: The right tool for the right job	Structures exist at all levels of biological organization, from molecules to ecosystems. The physical and chemical characteristics of a structure influence the interactions with other structures, and consequently function. Natural selection results in changes in structures that increase fitness within an evolutionary, developmental, and environmental context.
Metabolism: Energy flows and nutrients cycle	Energy and matter are neither created nor destroyed, but can be transformed. Energy captured by primary producers supports the maintenance, growth and reproduction of all organisms. Natural selection results in more efficient use of resources but with constraints.
Systems: Everything in moderation	Biological molecules, genes, cells, tissues, organs, individuals, and ecosystems all interact to form complex systems. Changes in one component of the system can affect many other components. Organisms integrate internal and external information, and through feedback control, respond to changes in the environment.

anonymity of larger class sizes while facilitating active learning. Second, course content goes beyond textbook coverage. Instead of following a predictable sequence of textbook chapters, students are invited into the world of biology by exploring relevant questions, debates, and primary literature. Furthermore, the information is contextualized; in BQ, by the research of faculty and in M2E, by Vision and Change concepts. Third, significant thought and effort are devoted to the design of assignments and assessments used in courses. For example, in BQ a variety of novel assignments, such as the production of a Public Service Announcement video, are used to generate student interest; in M2E, a diversity of assessments reflected inclusive excellence and reduced the impact of high-stakes testing. Fourth, the courses provided a wealth of online and in-person resources to help students to succeed regardless of their prior knowledge, experiences, and capabilities. This included integration of graduate and undergraduate teaching assistants in both lecture and laboratory courses, providing an essential intellectual bridge between students and instructors.

What were student and faculty experiences?

From a faculty perspective, the new courses required a significant amount of resources and effort. This came as no surprise as new and innovative courses are never undertaken lightly, especially those that require the coordination of 20 faculty involved in lecture and laboratory courses. However, the consensus from instructors was that the effort and resources were worth the investment from several perspectives. Students were engaged in course content and this was then reflected in the day-to-day attendance in lecture, retention in the course and the major, and student performance in assignments and assessments. Moreover, student comments suggest that while improvements could be made, the student experience of introductory biology has been transformed by the new courses.

What are the next steps?

Most immediately, a formal assessment of course content and outcomes by the Institute for Educational Initiatives is underway and will be completed by August 2019. Faculty have also reflected upon course structure and content, and how that translated into student experience, and will use those reflections, to modify courses for the upcoming academic year. For example, M2E is considering better alignment of exam content with learning objectives while BQ is considering how assessment of individual assignments contributes to the overall grade. One important longer term goal is to share the results of these endeavors regionally and nationally. Presentations and manuscripts are being considered for national conferences and education journals. Everyone involved in the development and implementation recognizes that, as with any new course, repeated implementation and evaluation will help address any remaining issues. Nonetheless, tremendous progress has been made in offering a suite of innovative introductory biology courses.

Conclusion

Our development of a new introductory biology sequence has been successful in addressing the initial charge. We have met the initial goals of developing and implementing innovative introductory courses. There is recognizable need to build on this initial success and sustain the course into the future. With continued support from the department, college, and university, instructors are optimistic about the future of the new Introductory Biology sequence, and its potential promise for both students and faculty.

Compiled by Dominic Chaloner, Stuart Jones, Shaun Lee, Kristin Lewis, and Michelle Whaley

FIGHTING FOR GLOBAL HEALTH

NOTRE DAME RECEIVES ITS SINGLE LARGEST RESEARCH AWARD

The University of Notre Dame will lead a five-year program to determine the efficacy of a spatial repellent product in preventing mosquito-borne diseases such as malaria, dengue and Chikungunya. Unitaid will fund the $33.7 million effort. It is the largest research grant awarded to a single proposal in Notre Dame's history.

John Grieco, research associate professor in the Department of Biological Sciences and associate director of the Eck Institute for Global Health is the principal investigator on the project. Grieco, a former Notre Dame undergraduate and biology major, was first introduced to Vector Biology as an undergraduate researcher in the laboratory of late George B Craig Jr. He returned to the University and Biological Sciences in 2014.

"The Biology Department at the University of Notre Dame has a long history of being a leader in the field of Vector Biology" Grieco says. It is on this foundation and due to the transformative work by the faculty in this department that UNITAID has had the confidence to fund this program. We are now entrusted with a unique opportunity to advance a tool to stop some of the world's deadliest diseases."

Grieco and his team —Nicole Achee, Alex Perkins, Sean Moore, Neil Lobo, all from Biological Sciences, along with Notre Dame researchers Fang Liu and Jarek Nabrzyski — will be responsible for coordination and implementation of all aspects of the study.

Unitaid is an international organization that invests in new ways to prevent, diagnose and treat HIV/AIDS, hepatitis C, tuberculosis and malaria more quickly, more affordably and more effectively. It accelerates access to innovation so that critical health products can reach the people who most need them. Unitaid's work facilitates large-scale introduction of health products through funding by the Global Fund, the United States President's Emergency Plan for AIDS Relief (PEPFAR) and by governments.

The program will include two clinical trials, one in Kenya and one in Sri Lanka, as well as studies among displaced populations in Mali and in refugee settings in Uganda. The goal of the program will be to further generate evidence to support a recommendation to the World Health Organization (WHO) of spatial repellent use for public health purposes and to inform the optimal delivery and implementation of use within humanitarian response situations.

> **"The global burden of vector-borne diseases such as malaria and dengue can overwhelm health systems," Grieco says. "Current interventions such as insecticidal nets and indoor and outdoor spraying of chemicals have helped to reduce transmissions in some cases, but not in all. We need new products to support ongoing mosquito control efforts with our ultimate goal being elimination of these diseases."**

The World Malaria Report, an annual report published by WHO, estimated 219 million new cases of malaria and 435,000 deaths in 2017, and it estimates dengue to affect more than 3.97 billion people across 128 countries. Although gains have been made in reducing these mosquito-borne diseases, international governmental and nongovernmental agencies are continually challenged by these illnesses due to limitations in both technical support and mosquito control options. In addition, political and/or environmental crises can result in refugee situations — including displaced families living in temporary shelters, where current mosquito vector control tools are not practical. New public health tools under development, such as spatial repellent products, can play a life-saving role.

Adapted from the original press release by Jessica Seif at www.nd.edu

Spatial repellents release volatile chemicals into the air to inhibit certain insect behaviors such as feeding and encourage movement away from a treated space. Grieco and his team will evaluate the efficacy and cost-effectiveness of scalable spatial repellents in reducing and protecting against new infections of malaria and dengue in order to provide key decision makers with data to inform public health strategies in endemic countries.

The team will work, with industry partner SC Johnson to develop the novel spatial repellent delivery method, advance the insect-borne disease research and test the product in multiple endemic areas around the world, as well as with a number of consortium members, including the Kenya Medical Research Institute, the U.S. Centers for Disease Control and Prevention, Catholic Relief Services, the National Dengue Control Unit in Sri Lanka and the Johns Hopkins Center for Communication Programs. Notre Dame will also partner with FHI 360, a clinical research organization, which will assure the quality and integrity of data collected.

Many faculty lead in their disciplines through scholarship. Here is a sampling of faculty accomplishments and honors in the past academic year.

Gary Belovsky, Professor and Gillen Director of UNDERC, and colleagues at University of Notre Dame and the Utah Division of Wildlife Resources (UDWR), completed a study spanning over 20 years to evaluate and improve management of the Great Salt Lake. Their findings were published in ***Ecological Applications***, (March 2019).

Nora Besanksy, O'Hara Professor and Associate Chair, and co-authors at Notre Dame and Indiana University, explored chromosomal inversions - a crucial way Anopheles mosquitoes are adapting as vectors for malaria transmission - in a study published in the ***Proceedings of the National Academy of Sciences*** (July 2018).

Crislyn D'Souza-Schorey, Morris Pollard Professor and Department Chair, and colleagues, in a study published in ***Nature Cell Biology*** (June 2019), outlined the delivery mechanism tumor cells use to move nucleic acids into small sacs shed from their surfaces—information that is eventually shared with other cells within the tumor microenvironment—causing the cancer to spread.

John Greico, Research Associate Professor, will lead a five-year program to determine the efficacy of a spatial repellent product in preventing mosquito-borne diseases such as malaria, dengue and Chikungunya. Unitaid will fund the 33.7 million-dollar effort, which is the single largest research award at Notre Dame. See page 8.

Kasturi Haldar, the Rev. Julius Nieuwland, C.S.C. Professor and Parsons-Quinn Director of the Boler-Parseghian Center for Rare and Neglected Diseases, was the recipient of the 2019 College Research Award. Haldar is an internationally recognized scientist who has made ground-breaking discoveries to advance the understanding of malaria pathogenesis and to develop novel therapies in both infectious and genetic diseases.

Gary Lamberti, Professor, was elected fellow of the Society for Freshwater Science. The distinction recognizes sustained excellence in contributions to freshwater science, research, policy, or management. Lamberti also was honored with the 2019 Faculty award at Notre Dame. The Faculty Award singles out that faculty member who, in the opinion of his or her colleagues, has contributed outstanding service to the University, such as through leadership activities, mentoring of peers, or exemplary dedication to students.

In a study in the ***Proceedings of the National Academy of Sciences*** (September 2018), **Xin Lu**, the John M. and Mary Jo Boler Assistant Professor, and colleagues found that nitration of an amino acid can inhibit T-cell activation, thwarting the T-cell's ability to kill cancer cells in prostate tumors. Xin Lu also was awarded grants from the Elsa U Pardee and the Mary K. Foundation to further these studies. Finally, he was the recipient of a 2018 Susan G. Komen career catalyst award to identify potential new therapies for treating metastatic breast cancer.

Nancy Michael, Assistant Teaching Professor and Director of Undergraduate Studies for the Neuroscience and Behavior Major, earned the 2018 Frank O'Malley Undergraduate Teaching Award, an annual prize that honors any faculty member who displays outstanding service to the students of the Notre Dame community.

In a study published in ***Nature Communications*** (March 2019), **Alex Perkins**, Eck Family Assistant Professor, and colleagues in China and Europe published a study utilizing computer models to evaluate key conditions that led to the 2014 outbreak of dengue fever in southern China.

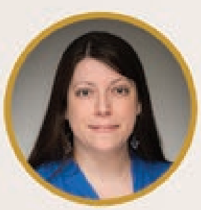
Matthew Ravosa, Professor, was awarded the Rev. Edmund P. Joyce, C.S.C., Award for Excellence in Undergraduate Teaching. The award annually honors up to 20 faculty members who have had a profound influence on the undergraduate learning experience, elevated students' intellectual engagement, and fostered students' ability to express themselves effectively within a disciplinary context.

Jason Rohr, Galla Professor, and colleagues in a review article published in ***Nature Sustainability*** (June 2019), describe how the increase in population and the need to feed everyone will give rise to human infectious disease, a situation the authors of the paper consider 'two of the most formidable ecological and public health challenges of the 21st century.'

In a study published in the ***Journal of Experimental Medicine*** (October 2018), **Jeffrey Schorey**, the George B. Craig Jr. Professor, and Yong Cheng, Research Assistant Professor, discovered that the pathogen Mycobacterium tuberculosis (MTB) releases RNA into infected cells to support the growth of the pathogen. In a second paper, published in ***EMBO Reports*** (March 2019), the Schorey laboratory described how structures, called extracellular vesicles (EVs), contain Mycobacterium tuberculosis components and transfer them to other cells. This starts a built-in weapon system against the disease in the form of an immune response.

In a paper in published in ***Nature Communications*** (February 2019), **Cody Smith**, Elizabeth and Michael Gallagher Assistant Professor, and colleagues determined that a widely dismissed hypothesis developed in the early 20th century is actually correct, and serves as the first step in a two-pronged approach by which the fibers, called axons, enter the spinal cord. In a second study published February 2019 by in the ***Public Library of Science Journal, PLoS Biology***, the Smith group described how microglia invade through the spinal boundary, crossing into the peripheral nervous system in response to injury.

Jennifer Tank, Galla Professor and Director of the Environmental Change Initiative, was one of 10 individuals named a 2019 Hoosier Resilience Hero by the Indiana University Environmental Resilience Institute. Tank was recognized for her research that sits at the intersection of freshwater systems and agriculture in the Midwest. Tank was also honored with the 2019 Ruth Patrick Award from the Association for the Sciences of Limnology and Oceanography (ASLO).



Rebecca Wingert, Elizabeth and Michael Gallagher Associate Professor, and colleagues published a study on kidney cell development and ciliopathies--diseases of the cilium in which cilia do not function correctly, in ***Proceedings of the National Academy of Sciences of the United States of America (PNAS)***, May 2019. The Wingert laboratory also published findings in ***E-Life*** that revealed new insights into the genetic pathways that control kidney cell development.

Siyuan Zhang, the Dee Associate Professor, landed a nearly 1.1 million-dollar Breast Cancer Research Program Breakthrough Award through the Department of Defense in August 2018 to study the mechanisms of targeting triple-negative breast cancer genomic vulnerability. In a study published in ***Nature Communications*** (June 2019), the Zhang laboratory provided rationale for how certain proteins induce vulnerability to cell cycle inhibition in triple-negative breast cancer.

Jenna Davidson, advised by Neil Lobo, Research Professor, received an American Fellowship from the American Association of University Women (AAUW), a group aiming to empower women and girls through research, scholarship, and community projects. The award supported the final year of her research program in vector epidemiology, working to reduce mosquito-borne disease transmission by marshaling bionomics to inform intervention strategies. Davison successfully defended her research in March.

Elsa Barron, a rising junior who is double majoring in biology and peace studies, spent last summer conducting research in Bangalore, India as Notre Dame's first undergraduate Bose Scholar. The Bose Scholarship program is a partnership between the WINStep Forward and the Indian government via the Indo-U.S. Science and Technology Forum, and facilitates exchange programs between premier educational institutions in the U.S. and India.

Guido Camargo España, postdoctoral research associate in the laboratory of Alex Perkins, Eck Family Assistant Professor, has received a Postdoctoral Training Award in Translational Research from the Indiana Clinical and Translational Sciences Institute (CTSI). The fellowship provides support for Camargo Espana's work conducting simulation modeling to estimate dengue vaccine profiles from trial results, in conjunction with Dr. Perkins and Timothy Endy, professor at State University of New York.

Joseph Chambers has been awarded a fellowship from Advanced Diagnostics and Therapeutics for his research on the genetics of polycystic kidney disease. Chambers is a graduate student in the lab of Rebecca Wingert, Elizabeth and Michael Gallagher Associate Professor of Biological Sciences.

Daniel Erickson was awarded a 2018 fellowship through the Advanced Diagnostics & Therapeutics (AD&T) Berry Family Foundation Graduate Fellowships for his research developing transgenic silkworms which produce silk that could become a low-cost source of cancer therapies. Erikson works in the laboratory of Malcolm J. Fraser Jr., Rev. Julius A. Nieuwland, C.S.C. Professor of Biological Sciences.

The Graduate School launched a new experiential training program, Leaders Advancing Socially Engaged Research, or LASER, designed to infuse leadership skills and social responsibility through a practicum experience. Third and fourth year doctoral students devise ways in which their research passions can improve conditions in their communities. Biological Sciences students **Hannah Corman**, **Mauna Dasari**, and **Casey Stefanski** were among the inaugural year LASER participants.

Six University of Notre Dame graduate students in biological sciences received fellowships from the Eck Institute for Global Health (EIGH): **Katelyn Carothers** advised by Shaun Lee, Associate Professor; **Rose Donohue** advised by Edwin Michael, Professor; **Catherine Flanley** advised by Mary Ann McDowell, Associate Professor; **Rachel Oidtman** advised by Alex Perkins, Eck Family Assistant Professor; **Kevin Sanchez** advised by Patricia Champion, Associate Professor; and **Morgan Smith**, also advised by Edwin Michael.

UP CLOSE WITH DEPARTMENT CHAIR, CRISLYN D'SOUZA-SCHOREY

BY MATT FRAZIER

Crislyn D'Souza-Schorey is Professor and Chair of the Department of Biological Sciences. She is the first woman to serve in the role. In addition to oversight of a department of over 80 faculty and one of the largest undergraduate majors and graduate programs on campus, she also runs her cancer research laboratory. She is married to Jeffrey Schorey, Professor of Biological Sciences; they have a son, who will be a freshman in high school in the fall.

What have you found appealing in your role as chair?

The department is the core of the life sciences at Notre Dame. We have a terrific faculty, many with extraordinary accomplishments. They brainstormed to strategically plan the growth and expansion of the department. And it's been opportune time to implement innovations in teaching. Our collective **strategic goals** have allowed us to further excellence in our laboratories, promote creative expression in our classrooms and make a difference in the community. It's fulfilling to chart a path that seems to impact many.

What makes being a biologist at Notre Dame special?

The size and breadth of our programs allow not just disciplinary efforts but also cross-disciplinary interactions. We are positioned to be more than the sum of our individual parts. That's exciting. Our efforts lend seamlessly toward societal good and are in keeping with the mission of the University. We also have a superb student body. At every commencement, I find myself in awe of, and energized by, the vast and varied accomplishments of our seniors.

You've been on the faculty for a while. Do you feel any differently as the department chair?

I have a lot more responsibility as chair. And with it comes increased accountability. Purpose matters. It's humbling. But I've also got great teams, both faculty and staff, to assist me. In this role, success is linked to and determined by those you serve and work with.

What is your teaching philosophy from undergraduates to postdoctoral researchers?

Learning is a life long process. The classroom should encourage creative thinking, inclusivity and be a safe place to learn. Years after a student graduates, he or she may not remember the specifics, but if they can think through a problem—the why and the how—then as science professors, we've done our job. As for my graduate students and postdocs, I encourage them to ask exciting questions that challenge them. It takes a high level of discipline to keep one's self on task. My role is to guide the process and ensure that they reach their full potential of experimental creativity and rigor.

Is there a department project you are particularly excited about?

Introductory Biology. We have revamped our introductory biology classes, and we've done so largely because of the changing science education landscape. The major focus of the biological sciences —understanding life—remains unchanged, but breakthrough discoveries of the 20th century have changed the nature of the questions asked, while new technologies are changing the ways key questions are addressed. As a result, what we should teach, and how, has evolved and this forms the basis of Vision and Change in Biology Education, spearheaded by the AAAS. It emphasizes the importance of scientific competencies, and also, inclusive excellence in the classroom, i.e. reaching all students—with diverse backgrounds, skills and preparedness. Since students learn science best by doing science, our remodeled introductory teaching labs allow every undergraduate student an original research experience. I am proud of, and grateful to, the faculty who were responsible for enabling the revamping of these courses, which required thoughtful deliberation and execution. My colleagues have described this undertaking as transformative to our curriculum and department. I concur.

I am also enthusiastic about more recent ongoing efforts to further the global profile and engagement of our graduate program. I see it as crucial to advancing our mission of excellence in discovery and learning in the present day.

What is your approach to growing the research enterprise?

Our approach has been to build strategically and programmatically around particular thematic areas—areas of strength, or areas that are trending in the life sciences that we'd like to develop. We are excited to invest in those unique individuals who bridge traditional disciplinary strengths and have made some terrific hires in this regard. But as with any bridge, if the pillars aren't strong, it can fall apart. Balance is important. It paves the way for strategic and strong partnerships, both internal and external.

Can you tell us about your own research and what aspects of it you are excited about?

My research program places at the intersection of two tremendously exciting areas of biomedical research--Cell Biology and Molecular Oncology. I am a cell biologist keenly interested in understanding the mechanisms that underlie tumor progression. We focus on deciphering how tumor cells acquire the invasive phenotype—i.e. the ability to break away from its primary site and infiltrate the surroundings. Non-cancerous cells are not nearly as mobile. We dissect these processes in molecular detail. Some of our work has considerable translational potential. For example, we study extracellular vesicles, which are small sacs shed by tumor cells into body fluids. We were one of the first labs to describe a subset of these sacs that may in fact serve as reporters of the state of the tumor. This could form the basis of a rather innovative diagnostic platform.

What one adjective would you use to describe your department?

Collaborative. Our faculty have research interests that span the breadth of the life sciences, across foci as varied as global health, cancer, organ regeneration, climate change and biodiversity. We have interdisciplinary collaborations within our department, across campus, and with universities worldwide, through life science-related investigation and problem solving. Several faculty lead or are involved in large program type endeavors. They get that they are part of something larger. An example is the recent grant from UNITAID to eradicate vector-borne disease, the core of which involves 5 of our faculty but with strategic partners across campus and other organizations across the globe. Embarking on such projects requires a collaborative spirit.

What if you had another adjective?

Dedicated. We have had our share of let downs and disappointment and experienced loss in more ways than one. Yet in the past year we have surpassed our best record yet of research funding alongside a very strong showing of research productivity, and further, we launched one of the most transformative changes to our curriculum. I think it's because for the most part we have a resilient and dedicated faculty who focus on the mission at hand and less on differences or challenges. And when you do that, there is no challenge too great.

What is your philosophy on faculty hiring and promotion?

Hire the best. Retain the best. With faculty recruiting we have to ensure that we have applicant pools and short lists that are diverse. We have generated a set of recommended practices for faculty searches that fosters inclusive excellence and raises awareness about implicit bias. The inclusion of the full tenured faculty in our tenure promotions process has provided transparency and accountability in our evaluations at the department level. I'm also pleased that the faculty voted unanimously to change the department's tenure clock, a move that was supported by the University's administration. With the roughly 30 promotion and reappointment cases I've overseen as chair, I've appreciated even more the unique ways each and every junior colleague contributes to the fabric of our department.

Can you sum up the state of the department in a sentence?

Our research and academic foundations are strong, we've launched transformative teaching initiatives, and our interdisciplinary culture creates opportunities for faculty and students to make a difference and change the world.

Academia is still male-dominated. How do you handle it?

At many points in my career, I've been given opportunities. Some of my most impactful mentors, those who have made a difference, have been male. I will add that there are strong women role models in academia too. I admire and have learned from them even from afar. All of these experiences guide my approach to research, teaching and administration. If I have encountered situations that I consider inappropriate, I first question if my own perception is accurate, and if so, I do not hesitate to address the situation. Usually institutions have portals to address true breaches.

What advice do you have for young women faculty?

Don't make assumptions, do your homework. Stay task-focused, follow through, try and find common ground whenever possible. Make time for your family and personal life.

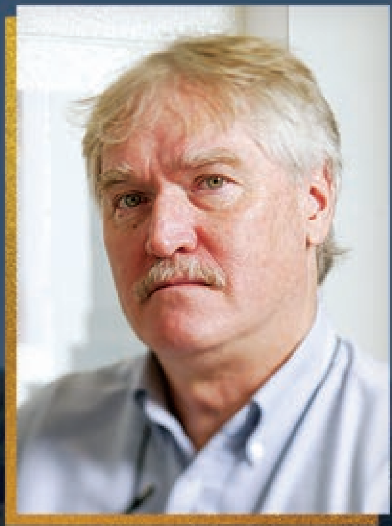
How do you balance your professional and personal life?

My personal responsibilities and obligations as scientist and administrator are all essential elements of my current roles. Each day I prioritize and make choices about what is most important at any given time. My family has always been supportive and keeps me centered.

D'Souza-Schorey enjoyed a vacation with her husband, Jeff Schorey (far left) and son, Jason, in South Africa, this summer.

WHAT WOULD YOU FIGHT FOR?

COUNQUERING THE MALARIA CHALLENGE IN AFRICA



HONORING FRANK COLLINS

The WHO African Region carries a disproportionately high share of the global malaria burden. The mosquito *Anopheles gambiae* is the most important component of the African malaria vectorial system, a system more powerful than any other available to human malaria parasites. Despite that recognition, few in the relatively small community of vector biologists focused their research on this species until the 1980s, when Frank Collins made a groundbreaking discovery in *An. gambiae* that captured international attention. As described below, this discovery positioned him to lead the development of genetic resources for An. gambiae that were entirely lacking at that time, and in leading those development efforts, he brought research on this species to the forefront where it belongs if the goal of malaria eradication is to be realized. It is not an exaggeration to say that the tools, resources and insights emerging from his scientific leadership democratized and empowered vector biology as a whole.

Attaining the PhD in Entomology in 1981 from the University of California, Davis, Dr. Collins became a Staff Fellow at the National Institutes of Health, where he launched a line of investigation whose dramatic and influential results were ultimately published in a 1986 Science paper, his 6th-most highly cited (422 times). In this research, he reports the selection of a line of *An. gambiae* mosquitoes fully or mostly refractory to numerous species of malaria parasites, including non-human primate and human malaria species, after only a short series of breeding steps. This study, coinciding with the rise of *Drosophila* molecular genetics and recombinant DNA technology, stimulated intense interest in vector immunity (and more broadly, insect immunity), which was a virtual black box at the time. However, a major roadblock had to be eliminated before the mosquito immune system could be characterized. His paper concluded, "Attempts to define the precise genetic basis for refractoriness have been complicated by a lack of genetic markers…".

By 1983, Collins had moved to the Centers for Disease Control as a Research Entomologist, eventually rising to the level of Deputy Chief of the Entomology Branch, Division of Parasitic Diseases. There, he pioneered an approach to species identification in the *An. gambiae* complex that has since been applied to virtually every other anopheline species complex. The approach was based on ribosomal DNA (rDNA), genes that are tandemly repeated hundreds of times in anopheline genomes, rendering them easy targets. It exploited two traits characteristic of rDNA: (i) highly evolutionarily variable noncoding regions that differ even between closely related species, and (ii) low intraspecific differences due to a homogenizing process known as 'concerted evolution'. By the time that Collins was developing his rDNA approach, the prevailing gold standard, applied since its discovery in the 1960's, was cytotaxonomy. Cytotaxonomy was highly effective and proved a major improvement over crossing experiments, but required a high degree of training and skill that drastically limited its application. Collins' rDNA approach, published initially in 1987 (cited 413 times), and then developed in 1993 into a simple, rapid PCR-based assay (cited 907 times), met a crucial need and democratized the process, which was now accessible to virtually any laboratory, including field-based malaria surveillance and control units across Africa.

It works robustly on dried specimens and even partially degraded DNA, and is applicable irrespective of mosquito gender or developmental stage. This approach has since been extended to many other anopheline cryptic species complexes with equal success. Cytotaxonomy of Anopheles is now a dying art.

Frank Collins was recognized during a home football game by Provost Tom Burish.

In 1997, Collins joined the University of Notre Dame as the George and Winifred Clark Chair in the Department of Biological Sciences. That summer, discussions between Collins and Fotis Kafatos (then Director, European Molecular Biology Laboratory) led to plans for fully sequencing the genome of *An. gambiae*.

As Principal Investigator of an NIH Cooperative Agreement Proposal ("The *Anopheles gambiae* genome project"), Collins guided and directed this international effort, which was completed in 2002 and published in Science (cited 1,414 times) not long after the draft human genome in 2001.

The major roadblock to characterizing the *An. gambiae* immune system (and all other aspects of its fundamental biology) was finally and emphatically eliminated.

After 2002, when the giddy excitement of the *An. gambiae* genome sequence settled, and as other vector genomes were planned, initiated and completed, there was a clear need for a central web-based repository serving the scientific community, staffed by experts who could provide first-pass annotation or re-annotation and resources for browsing and data mining.

Collins became the founding Director of this resource in 2004, guiding it through three successive 5-year funding cycles as Principal Investigator (NIH/NIAID contract, VectorBase: A Bioinformatics Resource Center for Arthropod Vectors of Human Pathogens).

As of 2019, VectorBase houses 62 arthropod genomes and associated data sets, not only mosquitoes [*Anopheles* (25), *Aedes* (2), and *Culex*], but also *Cimex*, *Glossina* (6), *Ixodes* (2), *Lutzomyia*, *Pediculus*, *Phlebotomus*, *Rhodnius*, *Simulium* (10), *Triatoma* (3), and others.

Professor Collins retired in July 2019. Over his career, Collins published more than 230 papers (H-index 62) and served the vector biology in ways too numerous to name, notably sitting on the NIH/NIAID Board of Scientific Counselors, the American Society of Tropical Medicine and Hygiene Policy and Advocacy Leadership Group, External Scientific Advisory Groups for the Innovative Vector Control Consortium, the Strategic Advisory Committee of the Institute of Molecular Biology and Biotechnology (Crete), the Tropical Disease Research, World Health Organization Scientific Working Group on Insect Disease Vectors and Human Health, the International *Anopheles* Genome Consortium and on multiple panels and expert groups advising the Bill & Melinda Gates Foundation including the Malaria Forum and the Malaria Elimination Research Agenda consultations. Frank Collins was elected Fellow of the American Society for the Advancement of Science in 1998.

Collins took special pride in training the next generation of vector scientists, supervising 15 post-graduate students and mentoring 30 post-doctoral scientists during his distinguished career. He has had an exceptionally influential scholarly career and at Notre Dame we will always be grateful for his stellar contributions to the Department, the Eck Institute of Global Health, the College and University. Most important, his contributions had their basis in his extensive field work in Africa (The Gambia, Zimbabwe, Kenya), and grew out of an entomologist's appreciation both for the role of vectors in malaria epidemiology, and for the role of vector control in malaria elimination, a vision that guides us today.

IN MEMORIUM

Professor Robert (Bob) A. Schulz

Robert (Bob) A. Schulz, Notre Dame Professor of Biological Sciences at the University of Notre Dame, died on July 6, 2019. He was 64.

Schulz received his undergraduate degree in Chemistry from the University of North Carolina and his doctorate in Biochemistry from Georgetown University. He worked as a Postdoctoral Fellow at Harvard University.

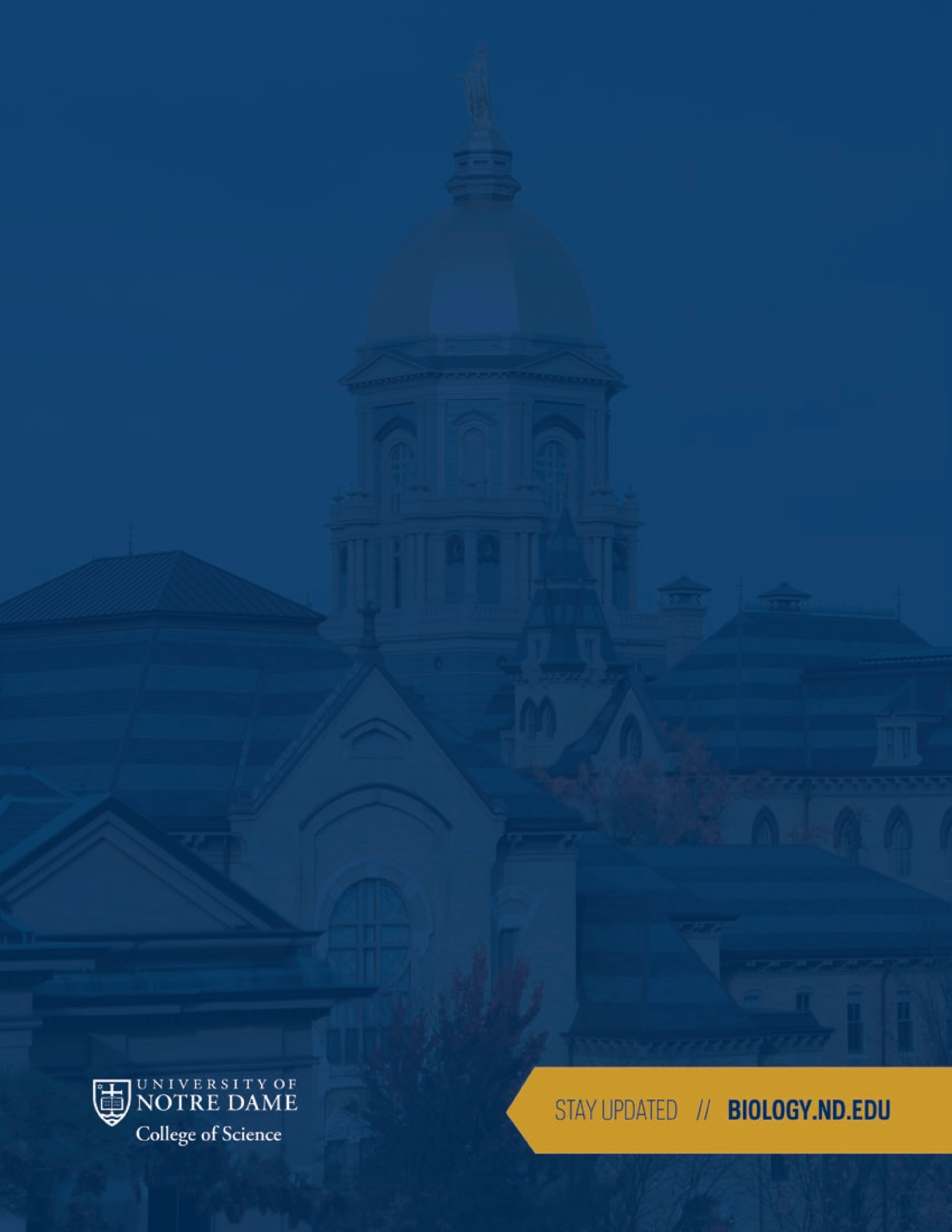
Schulz joined the Notre Dame faculty in 2007, and before that rose through academic ranks at the University of Texas MD Anderson Cancer Center from 1985 to 2007.

His research focused on blood formation and immunity in the fruit fly, *Drosophila melanogaster*. Because fruit flies and humans share 60 percent of their genes, Schulz's work provided a better understanding of how the processes of blood formation and immunity occur in people. His work led to advancements in the understanding of congenital heart defects, leukemias and cancer stem cells. He was affiliated with the Center for Stem Cells and Regenerative Medicine and the Harper Cancer Research Institute.

Schulz taught Developmental Biology and General Biology for undergraduates at Notre Dame. He also ran a seminar course for graduate students and served as advisor to the Biology Graduate Student Organization for several years.

Schulz enjoyed traveling, especially to Rome, with his wife, Cathy, attending sporting events and spending time with family. Bob will be remembered for his love of family and friends and his unique sense of humor.

He is survived by his wife, Cathy; two daughters, Erica (Allen) Swackhamer of San Antonio, Texas and Lisa (Ian) Schmit of Cedarburg, Wisconsin; one son, Michael Schulz of Columbus, Ohio; two grandsons, Liam and Oliver Schmit; three sisters, Carol Karalewich of Shrewsbury, New Jersey, Terri (T.R.) Fraley of East Brunswick, New Jersey and Lisa (Mark) Garboski of Newton, Pennsylvania; and by many loving in-laws, nieces and nephews. He was preceded in death by his parents and his brother, James Schulz. Memorial contributions may be directed to St. Jude Children's Research Hospital.



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