



# Biology

Biology studies the origin, structure, development, reproduction, and evolution of life. Biological research holds the key to understanding many modern challenges, including bio-engineering breakthroughs, environmental concerns, ecological relationships, and medical issues. The need for dedicated, innovative, and socially responsible biologists has never been greater than it is today. Thus, at the core of Gonzaga University's Biology Department is the Jesuit mission to combine academic study with the pursuit of social justice and the development of the whole person.

## THE PROGRAM

The faculty members in the Biology Department are genuinely devoted to teaching, mentoring, and helping students fulfill their academic ambitions. The program provides a strong foundation of knowledge and hands-on research experience, while cultivating curiosity and critical thinking.

## DEGREES

The **Bachelor of Science (B.S.) in Biology** provides students with a broad education in biology, supported by a solid grounding in chemistry and physics. This degree is designed for students pursuing continued training in graduate programs in biological and biomedical sciences, medicine, and dentistry.

The **Bachelor of Arts (B.A.) in Biology** provides students with a thorough biology education, but with fewer chemistry and physics courses. It allows flexibility for students pursuing additional interests, such as teaching or a second major in another area of study.

## RESEARCH CONCENTRATION

The Research Concentration within the Biology major is designed for students who want to explore graduate level training in science. This concentration adds math courses, a significant research experience, participation in a seminar course and involvement in science outreach to the major requirements.

## CURRICULUM

The Biology Department curriculum emphasizes an integrative and evolutionary approach that exposes students to central ideas in the study of biology. All Biology majors take the same introductory courses that introduce foundational themes and concepts and then pursue their area of interest through elective courses. In general, our elective courses fall into the main categories of comparative physiology, genetics, cell and molecular biology, and ecology. Students are free to explore their interests in any or all of these areas.

## RESEARCH OPPORTUNITIES

Biology Department faculty involve students in their research projects because they are passionate about discovering new information and convinced that doing research is a great way for students to learn science. In recognition of their dedication to undergraduate research, the Biology Department and the Department of Chemistry and Biochemistry have been awarded two consecutive \$1.2 million grants by the **Howard Hughes Medical Institute** to support science education and research at Gonzaga. In 2008, the first of these four-year grants allowed Gonzaga to offer more research positions for undergraduates (both during the academic year and the summer), hire additional faculty, develop new courses, and expand our science education outreach program. The second grant, awarded in 2012, is focused on developing students as socially responsible leaders in science, research, and medicine by helping them develop a deep understanding of their discipline, extensive research experience, skills in communicating scientific ideas, and the ability to apply their scientific knowledge to societal challenges.

New initiatives include the implementation of the **Science Scholars Program** to promote greater diversity among science majors and a research-based lab experience for all students in our introductory biology class. Our intentional work with undergraduates in research has resulted in a strong overall research program. Gonzaga students present posters at regional and national scientific meetings and have co-authored papers in scientific journals with their faculty mentors.

Current research projects seek to answer such questions as:

- What affects the evolution of arboviruses like Zika?
- Can lady beetles be used in place of pesticides?
- What does calcium do in photosynthesis?
- What strategies can be used to disinfect catheter ports?
- How does an extra chromosome affect a cell?
- How do social woodpeckers choose mates?

- Can we use a naturally occurring fungus to fight cheatgrass invasions?
- How does heavy metal pollution affect animal behavior?
- Why are spider silk and other biomaterials so strong?
- How do salamanders communicate?
- What controls investment in reproduction over survival?
- How does environmental stress impact organisms and ecosystems?

For more detailed descriptions of faculty research, please see our Undergraduate Research website: [www.gonzaga.edu/science-research](http://www.gonzaga.edu/science-research).

## STUDY ABROAD

Often, Gonzaga Biology students combine research with travel, which allows students to learn about other cultures and ecological systems. Gonzaga is affiliated with the **School for Field Studies**, a consortium of colleges and universities that maintain science study abroad programs throughout the world. Through these programs, Gonzaga students gain “hands-on” experience in a variety of biological and ecological settings:

- Tropical Rainforest Studies (Australia)
- Sustainable Development Studies (Costa Rica)
- Biological Diversity (Ecuador, including Galápagos Islands)
- Wildlife Management Studies (Kenya)
- Tropical Island Biodiversity and Conservation Studies (Panama)
- Marine Resource Management Studies (Turks & Caicos)
- Chimfunshi Wildlife Reserve (Zambia)

Gonzaga also works closely with sponsored study abroad programs, such as the University of Glasgow in Scotland, where students can take biology courses that apply toward their major.

## SCIENCE OUTREACH

In addition to valuing research, the Department emphasizes the relationship between biological study and social justice. Gonzaga biology students participate in a variety of science outreach programs, including Science in Action! This popular science education outreach program sends teams of GU students to K-12 classrooms in Spokane to do inquiry-based science activities. Other students volunteer at local science education events or serve as lab mentors to high school students who have an interest in science.

## OUTCOMES

The Biology Department faculty members are dedicated to excellence in teaching and mentoring students as they navigate the rigorous curriculum of the Biology degree. Consequently, Biology majors are well prepared for careers in research, teaching, medicine, and other biology-related fields. Some students decide to work for biotechnology companies after graduation, such as Jubilant HollisterStier Laboratories and ICOS Biopharmaceuticals. Others take jobs with government agencies, hospitals, or research university laboratories. Still others pursue careers that integrate a passion for biology with other interests, such as genetic counseling, science writing, forensics, law, and health care.

## GRADUATE STUDIES

Through their undergraduate research experience, a number of Gonzaga students discover how exciting and intellectually stimulating scientific research can be and decide to pursue graduate study for advanced degrees. Gonzaga graduates are currently working on Ph.D. degrees in neuroscience, infectious diseases, cell and molecular biology, ecology, molecular plant sciences, and others at research universities throughout the country, such as Yale University, Johns Hopkins University, Washington State University, and University of California, Berkeley.

## HEALTH SCIENCE CAREERS

Several members of the Biology Department serve on the **Committee for Health Science Careers**, an interdisciplinary group of faculty who advise Gonzaga students applying for professional schools in medicine, dentistry, and veterinary medicine. Before applying, students submit essays and practice interviewing before the Committee, who offer valuable feedback and advice. Many students are strong candidates for medical, dental, and veterinary schools, and each year a number of Gonzaga graduates are accepted. Gonzaga Biology alumni are currently at schools across the country, including the University of Washington, Washington State University, Mayo Medical School, Creighton University, Emory University, and others.



## GRANTS

**National Science Foundation.** Awarded to Joseph Haydock, Gonzaga University; Walter Koenig, Cornell University; Eric Walters, Old Dominion University. Collaborative Research: Evolution of Cooperative Behavior. 2015. Total Award Amount: \$645,186. Gonzaga Award: \$114,056.

**National Science Foundation.** Awarded to Brook Swanson, Gonzaga University; Laura Lavine, Washington State University. Collaborative Research: The Evolution of Extreme Trait Size. 2015. Award Amount: \$700,000. Gonzaga Award: \$142,110.

**Murdock Charitable Trust College Research Program for Natural Sciences.** Awarded to Carla Bonilla. Molecular Mechanisms of Bacterial Oxidative Stress Response in *Bacillus subtilis*. 2015. Award Amount: \$59,859.

**Murdock Charitable Trust Research Program for Natural Sciences.** Awarded to Elizabeth Addis. Urbanization of Yellow-Bellied Marmots (*Marmota flaviventris*). 2015. Award Amount: \$21,000.

**W.M. Keck Foundation.** Awarded to Jeff Watson and Carla Bonilla. Linked Experimental System. 2014. Award Amount: \$250,000.

**Great Basin Landscape Conservation Cooperative.** Awarded to Julie Beckstead, Gonzaga University; Susan Meyer, US Forest Service. Cheatgrass Stand Failure in the Great Basin: Fungal Pathogens, Carbon Dynamics, and Fungistasis. 2014. Award Amount: \$34,852

**Howard Hughes Medical Institute.** Awarded to Nancy Staub, Gonzaga University; Catherine Mader, Hope College; Luther Williams, Tuskegee University; Sandra White,

## THE PEOPLE

Gonzaga's Biology Department's core strength is its team of dedicated faculty. Faculty members serve as academic advisors and enjoy mentoring students both personally and professionally. Examples of recent accomplishments of Biology faculty, and our undergraduates, are listed in the next section.

## PUBLICATIONS

Staub, Nancy, Marianne Poxleitner, Amanda Braley, Helen Smith-Flores, CM Pribbenow, L Jaworski, D Lopatto and Kirk Anders. "Scaling Up: Adapting a Phage-Hunting Course to Increase Participation of First-Year Students in Research." *CBE Life Sci Educ.* 15, 1-11. (2016).

McGaugh, S.E., A.M Bronikowski, C.H. Kuo, D.M. Reding, E.A. Addis, L. Flagel, F.J. Janzen, T.S. Schwartz. "Rapid molecular evolution across amniotes of the IIS/TOR network (Insulin and Insulin-like Signaling/Target of Rapamycin)." *Proceedings of the National Academy of Sciences.* 112, 7055-7060. (2015).

Pope, WH, Bowman, CA, Russell, DA, Jacobs-Sera, D, Asai, DJ, Cresawn, SG, Jacobs Jr., WR, Hendrix, RW, Lawrence, JG, Hatfull, GM, Science Education Alliance Phage Hunters Advancing Genomics and Evolutionary Science. "Whole genome comparison of a large collection of mycobacteriophages reveals a continuum of phage genetic diversity." *eLIFE* 4:e06416. (2015). This article was co-authored by several Gonzaga faculty members and 130 undergraduates!

Telemeco, R.S., and E.A. Addis. "Temperature has species-specific effects on corticosterone in alligator lizards." *General and Comparative Endocrinology.* 206, 184-192. (2014).

Warner, D.A., E.A. Addis, W. Du, T. Wibbels, and F.J. Janzen. "Exogenous application of estradiol to eggs unexpectedly induces male development in two turtle species with temperature-dependent sex determination." *General and Comparative Endocrinology.* 206, 16-23. (2014).

Beckstead, Julie, Susan Meyer, Kurt Reinhart, Kellene Bergen, Sandra Holden, and Heather Boekweg. "Factors affecting host range in a generalist seed pathogen of semi-arid shrublands." *Plant Ecology,* 215:427-440. (2014).

Hippe, Scott R., Catherine R. Propper, and Nancy L. Staub, "The presence of sexually dimorphic submandibular glands in *Taricha granulosa*, the Rough-Skinned Newt (Salamandridae)." *Copeia* (1); 38-43. (2014).

Lefcort, Hugh, Elizabeth A. Wehner, Paul L. Cocco. "Pre-exposure to heavy metal pollution and the odor of predation reduce the ability of snails to avoid stressors." *Archives of Environmental Contamination and Toxicology,* 64:273-280. (2013).

Addis, Elizabeth A., A.D. Clark, R.A. Vasquez, and J.C. Wingfield. "Seasonal modulation of testosterone during breeding of the Rufous-collared sparrow (*Zonotrichia capensis australis*) in southern Patagonia." *Physiological and Biochemical Zoology,* 86:782-790. (2013).

Swanson, Brook, Matthew George, Stuart Anderson, and John Christy (collaborator from the Smithsonian). "Evolutionary variation in the mechanics of fiddler crab claws." *BMC Evolutionary Biology,* 13:137. (2013).

Weaver, James C., Garrett W. Milliron, Ali Miserez, Kenneth Evans-Lutterrodt, Steven Herrera, Isaias Gallana, William J. Mershon, Brook Swanson, Pablo Zavattieri, Lefcort, H., J. Vancura, and E. Lider. "75 years after mining ends, stream insect diversity is still affected by heavy metals." *Ecotoxicology,* 19:1416-1425. (2010).

Swanson, B.O., S. Anderson, C. DiGiovine, R. Ross, and J. Dorsey. "Evolution of complex biomaterial performance: the case of spider silk." *Integrative and Comparative Biology,* 49:21-31. (2009).

Kleiber, D., C. Stern, J. Haydock, J. Dickinson, M. Stanback, V. Schmidt, E. Eisenberg, and C. Stolzenberg. "Characterization of polymorphic microsatellite loci in the western bluebird *Sialia mexicana* and eastern bluebird *Sialia sialis*." *Molecular Ecology Resources,* 8:1348-1350. (2008).

Lefcort, H., Z. Freedman, S. House, and M. Pendleton. "Hormetic effects of heavy metals in aquatic snails: Is a little bit of pollution good?" *EcoHealth,* 5:10-17. (2008).

Elaine DiMasi, and David Kisailus. "The Stomatopod Dactyl Club: A Formidable Damage-Tolerant Biological Hammer." *Science,* 336:1275-1280. (2012).

North Carolina Central University; Véronique Delesalle, Gettysburg College; Bettye Sue Hennington, Tougaloo College; Robert Merritt, Smith College. *The Phage Model Goes Viral: Developing Other Models for Course-based Research Experiences (CREs).* 2013. Award Amount: \$50,000.

**National Science Foundation-TUES Grant.** Awarded to Kirk Anders, Nancy Staub and Marianne Poxleitner. *Phage Discovery Goes Viral: Engaging All Biology Students in Research.* 2013-2015. Award Amount: \$129,675.

**Howard Hughes Medical Institute.** Awarded to Gonzaga University Biology and Chemistry & Biochemistry Departments. Grant to develop students as socially responsible leaders in science, research, and medicine and provide course-based undergraduate research experiences. 2012. Award Amount: \$1,200,000.

**National Science Foundation Research Opportunity Award.** Awarded to Nancy Staub and L.D. Houck, OSU (Collaborative Research). Grant to study interaction effects in a pheromone signaling system. 2009. Award Amount: \$15,740.

**Howard Hughes Medical Institute.** Awarded to Gonzaga University Biology and Chemistry & Biochemistry Departments. Grant to strengthen undergraduate research, mentoring, and computational skills in the biomedical sciences. 2008. Award Amount: \$1,200,000.

**Joint Fire Science Program (USDI and USDA).** Awarded to Julie Beckstead (with collaborators, Dr. Meyer and Dr. Allen). *Enhancing the Effectiveness of Annual Grass Weed Biocontrol with the Black Fingers of Death Pathogen (*Pyrenophora semeniperda*).* 2012. Total Award Amount: \$424,018; Gonzaga Award: \$160,000.

**Murdock Charitable Trust College Research Program for Life Sciences.** Awarded to Gary Chang. Study of the population ecology of a weevil. 2012. Award Amount: \$37,650.

**Murdock Partners in Science.** Awarded to Nancy Staub and Kari Sikel (Colton, OR). Variation in pheromones in plethodontid salamanders. 2011. Award Amount: \$15,000.

**U.S. Air Force Office of Scientific Research Young Investigators Program Award.** Awarded to Brook Swanson. Grant awarded for discovery of high-performance biomaterials for defense applications. 2010. Award Amount: \$345,000.

## FACULTY CONTACT & SPECIALTIES

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