



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. The first grant allowed us to significantly expand research opportunities and our science education outreach program. The second grant 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. 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 co-author papers in scientific journals with their faculty mentors.

The Biology Department's educational mission focuses on inclusive excellence and leadership; that is, we seek to provide a rigorous yet supportive environment in which all students can develop and hone their interests and skills. Students can do this by participating in research, as teaching assistants or peer mentors, or through involvement in our science outreach programs. We strive to attract, retain and promote the success of our students, including underrepresented minorities and first generation college students, and have developed specific programs to build community among our diverse learners, such as the Science Scholars program, Hughes After Dark mentoring program and Science In Action! outreach program.

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 strategies can be used to disinfect catheter ports?
- 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?
- How are the genes in viruses regulated?
- Why are spider silk and other biomaterials so strong?
- How do salamanders communicate?
- 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.

STUDY ABROAD

Often, Gonzaga Biology majors combine coursework or research with travel, which allows students to learn about other cultures and ecological systems while pursuing their educational goals. Gonzaga currently offers field biology programs in Ecuador and Zambia. Gonzaga is also 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. Sponsored programs in countries such as

Scotland also provide students who are interested in medicine and biotechnology with the opportunity to take some upper division elective courses that count toward their major requirements.

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

M.J. Murdock Charitable Trust Natural Sciences Grant. Betsy Bancroft. Interactions among native and invasive aquatic species under future climate scenarios: does the community context matter? 2017-2020. Award amount: \$79,388.

M.J. Murdock Charitable Trust Partners in Science Grant. Betsy Bancroft. Effects of climate change, invasive species, and nutrient input on aquatic community composition. 2017-2018. Award amount: \$15,000.

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.



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 research accomplishments are listed below.

PUBLICATIONS

*GU Biology faculty denoted in *italics*;
GU undergraduate co-authors in **bold**

Anders, K. R., **Murphy, A. M.**, Ettinger, W. F., Kempthorne, D., Kittridge, C., Kures, A., Lundgren, S., Masters, J., Noyes, R., Winters, C., Yazzolino, P., Ziebert, K., Haydock, J., Hayes, S., Garlena, RA, Russell, DA, Poxleitner, M. K., Ettinger, A-S. H. (2017). "Genome sequences of Cluster K mycobacteriophages DrHayes, Urkel, and SamuelLPlaqsom." Genome Announcements 5:e01388-16).

Andrade, C. C., Young, K. I., Johnson, W. L., Villa, M. E., Buraczyk, C. A., Messer, W. B. and Hanley, K. A. (2016). "Rise and fall of vector infectivity during sequential strain displacements by mosquito-borne Dengue virus." Journal of Evolutionary Biology 29:2205.

Bancroft, B. A., Lawler, J. J. and Schumaker, N. H. (2016). "Weighing the relative potential impacts of climate change and land-use change on an endangered bird." Ecology and Evolution 6:4468.

Beckstead, J., Meyer, S. E., **Ishizuka, T. S.**, **McEvoy, K. M.** and Coleman, C. E. (2016). "Lack of host specialization on winter annual grasses in the fungal seed bank pathogen *Pyrenophora semeniperda*." PLoS ONE 11:e0151058.

Mills, M. R., Nemri, R. S., Carlson, E. A., **Wilde, W.**, Gotoh, H., Lavine, L. C. and Swanson, B. O. (2016). "Functional mechanics of beetle mandibles: Honest signaling in a sexually selected system." J. of Exp. Zoology. Pt A, Ecological Genetics and Physiology 325:3.

Sever, D. M., **Pinsoneault, A. D.**, **Mackenzie, B. W.**, Siegel, D. S. and Staub, N. L. (2016). A Description of the Skin Glands and Cloacal Morphology of the Plethodontid Salamander *Karsenia koreana*. Copeia 104:816.

Barth, C. W., Meyer, S. E., Beckstead, J. and Allen, P. S. (2015). "Hydrothermal time models for conidial germination and mycelial growth of the seed pathogen *Pyrenophora semeniperda*." Fungal Biology 119:720.

Lefcort, H., Cleary, D. A., **Marble, A. M.**, **Phillips, M. V.**, **Stoddard, T. J.**, Tuthill, L. M. and Winslow, J. R. (2015). "Snails from heavy-metal polluted environments have reduced sensitivity to carbon dioxide-induced acidity." SpringerPlus 4:267

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

Meyer, S. E., Masi, M., Clement, S., **Davis, T. L.** and Beckstead, J. (2015). "Mycelial growth rate and toxin production in the seed pathogen *Pyrenophora semeniperda*: Resource trade-offs and temporally varying selection." Plant Pathology 64:1450.

Pope, W. H., Bowman, C. A., Russell, D. A., Jacobs-Sera, D., Asai, D. J., Cresawn, S. G., Jacobs Jr., W. R., Hendrix, R. W., Lawrence, J. G., Hatfull, G. M., **SEA-PHAGES**, PHIRE, and Mycobacterial Genetics Course. (2015). Whole genome comparison of a large collection of mycobacteriophages reveals a continuum of phage genetic diversity. eLIFE 4:e06416. (This article was co-authored by **130 Gonzaga students** and four Gonzaga faculty members.)

Hippe, S. R., Propper, C. R. and Staub, N. L. (2014). "The presence of sexually dimorphic submandibular glands in *Taricha granulosa*, the rough-skinned newt (Salamandridae)." Copeia 2014:38.

Moore, M. P., **Burt, C. R.**, **Whitney, T. D.**, **Hastings, S. A.** and Chang, G. C. (2012). Does social feeding improve larval survival of the two-spotted lady beetle, *Adalia bipunctata*? J. Insect Science 12:101.

Bonilla, C. Y. and Grossman, A. D. (2012). "The primosomal protein DnaD inhibits cooperative DNA binding by the replication initiator DnaA in *Bacillus subtilis*." Journal of Bacteriology 194:5110.

Koenig, W. D., Walters, E. L. and Haydock, J. (2011). "Variable helper effects, ecological conditions, and the evolution of cooperative breeding in the acorn woodpecker." American Naturalist 178:145.

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, 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.

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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