

# BIOLOGY – M.S., PH.D.

The Biology Program leading to the Master of Science and Doctor of Philosophy degrees is offered by the Department of Earth and Biological Sciences. M.S. and Ph.D. curricula provide a broad and unified approach to the life sciences, as well as specialization—as evidenced by the conduct of significant, original research; and in the selection of courses related to the area of research interest. Study in various areas, from molecular biology to natural history, is available to the student seeking preparation for teaching or for research in modern biology. Some areas of specialization are animal behavior, animal physiology, molecular systematics, ecological physiology, behavioral ecology, conservation biology, marine biology, and paleontology.

## Objectives

The Biology Program strives to:

- Instill in students the values of honesty, scientific integrity, careful research, and critical independent thinking.
- Provide the tools and intellectual environment that will facilitate the biologist's attainment of the highest potential in scholarship, research, teaching, and interdisciplinary service learning.
- Challenge graduate students to consider the relationships among science, faith, and societal responsibility.

## Rosario Beach summer courses

In cooperation with the Walla Walla University Marine Station at Anacortes, Washington, facilities are available for marine courses and research for students of this program, in consultation with their advisors.

## Programs

- Biology – M.S. (<http://llucatalog.llu.edu/medicine/biology/ms/>), Ph.D. (<http://llucatalog.llu.edu/medicine/biology/phd/>)

## Courses

### BIOL 116. Introduction to Human Biology. 3 Units.

Introductory course in human biology. Explores basic principles of human anatomy and physiology and their relationships to social functioning. Fulfills the human biology prerequisite for the master's degree Social Work Program.

### BIOL 205. Biostatistics. 4 Units.

Introductory statistics course that provides background and experience in biology and ecology data analysis. Topics include interpretation of data, appropriate use of tables and figures, study design, hypothesis testing, confidence intervals, the normal curve, probability, discrete and continuous data including ANOVA, correlation, and regression. Biological and ecological examples are used throughout the course.

### BIOL 305. Statistics Using the R Software Package. 1 Unit.

Provides an overview of the R statistical package for performing statistical tests. Equips students with a basic working knowledge of this software for a variety of statistical procedures.

### BIOL 406. Marine Biology. 4 Units.

Surveys marine species of the world and the oceanographic processes and ecological interactions that affect them. Emphasizes tropical and coral ecosystems. Includes an independent project. Four class hours per week, plus all-day field trips (usually on Sunday).

### BIOL 407. Herpetology. 3 Units.

Covers a broad range of topics in herpetology, including systematics, diversity, morphology, physiology, behavior, ecology, conservation, and research methodology. Focuses field experience on Southern California herpetology. Two hours lecture, three-hour laboratory each week.

### BIOL 409. Mammalogy. 4 Units.

Studies the mammals of the world, with emphasis on North America. Includes classroom and field study of systematics, distribution, behavior, and ecology. Per week: class three hours, one three-hour laboratory.

### BIOL 414. Biology of Marine Invertebrates. 4 Units.

Behavior, physiology, ecology, morphology, and systematics of marine invertebrates, with emphasis on morphology and systematics. Three class hours per week, one-day field trip alternate weeks, or the equivalent.

### BIOL 415. Ecology. 3 Units.

Covers the interaction between living organisms and their environment, animal and plant diversity, and the biotic and abiotic factors that contribute to organisms interacting with their environment. Encompasses the ecologies of terrestrial, freshwater, and marine environments. Also covers population ecology, including population dynamics, population growth, and population genetics, and the interaction of organisms at the individual, community, and ecosystem levels.

### BIOL 426. Invertebrate Paleontology. 4 Units.

Structure, classification, ecology, and distribution of selected fossil invertebrate groups. Considers principles and methods involved in the study and analysis of invertebrate fossils. Per week: class three hours, plus one three-hour laboratory.

### BIOL 427. Vertebrate Paleontology. 4 Units.

Fossil vertebrates, with emphasis on the origins of major groups. Systematics, biology, and biogeography of ancient vertebrates. Per week: class three hours, plus one three-hour laboratory.

### BIOL 428. Genetics and Speciation. 4 Units.

Introduces genetic mechanisms of biological change. Processes of inheritance through time evaluated in their ecological context.

### BIOL 437. Animal Behavior. 4 Units.

Behavioral mechanisms of animals and their role in survival. Lectures and projects.

### BIOL 439. Behavioral Ecology. 4 Units.

Examines in depth how behavior contributes to the survival of animals, with emphasis on behavioral strategies that reflect adaptation to the animal's environment.

### BIOL 444. Paleobotany. 4 Units.

Fossil plants; their morphology, paleoecology, taphonomy, classification, and stratigraphic distribution. Analyzes floral trends in the fossil record. Per week: class three hours, plus one three-hour laboratory or field trip.

### BIOL 449. Biodiversity and Conservation. 3 Units.

Examines contemporary issues related to diminishing biodiversity on regional and global scales, and the need to conserve both biodiversity and the critical habitats that support threatened flora and fauna.

### BIOL 456. Techniques in Vertebrate Ecology. 3 Units.

Theory and practice of vertebrate ecology research, including marking methods, population estimation, home range and habitat analysis, and radiotelemetry. Software used extensively for analysis of data, some of which will be collected during field trips.

### BIOL 465. Introduction to GIS for the Natural Sciences. 2 Units.

Principles and practice of GIS data acquisition, data editing, map making, and geodatabase management. Recommended for students beginning a research project.

**BIOL 466. Multivariate Statistics. 3 Units.**

Practical, software-based application of multivariate statistics to complex data sets, including both null hypothesis testing and practical significance. Builds on the foundation of an introductory statistics course.

**BIOL 475. Philosophy of Science and Origins. 4 Units.**

Concepts in the history and philosophy of science, and the application of these principles in analyzing current scientific trends.

**BIOL 479. Readings in Biology. 1-4 Units.**

Studies, analyzes, and discusses current and classic papers.

**BIOL 488. Current Topics in Biology. 1-4 Units.**

Reviews cutting-edge literature in the biological sciences. Different sections may be repeated for additional credit.

**BIOL 495. Undergraduate Research. 1-4 Units.**

Student pursues original investigation and/or literature study under the direction of a faculty member. May be repeated for additional credit.

**BIOL 497. Special Projects in Biology. 1-4 Units.**

Student responsible for a special research project in the field, laboratory, museum, or library. May be repeated for additional credit.

**BIOL 502. Orientation to Graduate Biology. 1 Unit.**

Introduces students to skills and strategies for successfully navigating through EBS as graduate biology students. Provides opportunities for discussion, activities related to topic areas, discovery, group exchange, instruction, and critical evaluation and decision making regarding ethical practices in research.

**BIOL 504. Biology of Marine Invertebrates. 4 Units.**

Behavior, physiology, ecology, morphology, and systematics of marine invertebrates, with emphasis on morphology and systematics. Per week: class three hours; one-day field trip alternate weeks, or the equivalent.

**BIOL 505. Marine Biology. 4 Units.**

Surveys marine species of the world, and the oceanographic processes and ecological interactions that affect them. Emphasizes tropical and coral ecosystems. Includes an independent project. Per week: class four hours, plus all-day field trips (usually on Sundays).

**BIOL 507. Herpetology. 3 Units.**

Covers a broad range of topics in herpetology, including systematics, diversity, morphology, physiology, behavior, ecology, conservation, and research methodology. Field experience focuses on southern California herpetology. Per week: Two hours lecture and a three-hour laboratory.

**BIOL 515. Biogeography. 3 Units.**

Present and past distribution and migrations of the natural populations of organisms.

**BIOL 517. Ecological Physiology. 4 Units.**

Studies the interface between the individual and the environment, with emphasis on unusual environments, in order to explore the limits of physiological systems. Per week: class four hours. Offered alternate years.

**BIOL 518. Readings in Ecology. 2 Units.**

Studies, analyzes, and discusses current and classic papers.

**BIOL 529. Mammalogy. 4 Units.**

Studies the mammals of the world, with emphasis on North America. Includes classroom and field study of systematics, distribution, behavior, and ecology. Per week: class three hours, one three-hour laboratory. Additional work required beyond BIOL 409.

**BIOL 539. Behavioral Ecology. 4 Units.**

Examines in depth how behavior contributes to the survival of animals, with an emphasis on behavioral strategies that reflect adaptation to the animal's environment.

**BIOL 545. Genetics and Speciation. 4 Units.**

Comparative analysis of species concepts, mechanisms of speciation, and analysis of micro- and macroevolution. Prerequisite: A course in genetics and philosophy of science.

**BIOL 546. Techniques in Vertebrate Ecology. 3 Units.**

Theory and practice of vertebrate ecology research, including marking methods, population estimation, home range and habitat analysis, and radiotelemetry. Software used extensively for analysis of data, some of which will be collected during field trips.

**BIOL 549. Biodiversity and Conservation. 3 Units.**

Examines contemporary issues related to diminishing biodiversity on regional and global scales and the need to conserve both biodiversity and the critical habitats that support threatened flora and fauna.

**BIOL 555. Molecular Genetics. 3 Units.**

An overview of the molecular basis of life, with emphasis on DNA as an information storage medium. The systems of information retrieval found in prokaryotes and eukaryotes.

**BIOL 558. Philosophy of Science. 4 Units.**

Studies selected topics in the history and philosophy of science, and applies these principles in analyzing contemporary scientific trends.

**BIOL 559. Philosophy of Science and Origins. 1 Unit.**

Studies selected topics in the history and philosophy of science, and applies these principles in analyzing current scientific trends. Provides an advanced update in the topic for students who have had a similar course at the undergraduate level.

**BIOL 565. Introduction to GIS for the Natural Sciences. 2 Units.**

Principles and practice of GIS data acquisition, data editing, map making, and geodatabase management. Recommended for students who are beginning a research project.

**BIOL 566. Multivariate Statistics. 3 Units.**

Practical, software-based application of multivariate statistics to complex data sets, including both null hypotheses testing and practical significance. Builds on the foundation of an introductory statistics course.

**BIOL 588. Current Topics in Biology. 1-5 Units.**

Reviews cutting-edge literature in the biological sciences. Different sections may be repeated for additional credit.

**BIOL 589. Readings in Biology. 1-4 Units.**

Studies, analyzes, and discusses current and classic papers on an individual basis with advisor.

**BIOL 607. Seminar in Biology. 0.5 Units.**

Seminar presentations by guest scientists on recent research and developments in biological science. No student presentation required.

**BIOL 616. Research and Experimental Design. 2 Units.**

Concepts, methods, and tools of research, including experimental design and data analysis. Cross-listing: GEOL 616.

**BIOL 617. Proposal Writing and Grantsmanship. 2 Units.**

Develops skills in writing proposals and acquiring funding for research. Increases understanding of the culture of research. Reviews the infrastructure of science funding and identifies individualized sources of potential funding. Presents successful proposal-writing strategies for both governmental and nongovernmental sources of funding. Emphasizes development of effective writing skills during preparation of the student's thesis or dissertation proposal.

**BIOL 618. Writing for Publication. 1 Unit.**

Explores the mechanics and processes of preparing, submitting, revising, and resubmitting a manuscript for publication in a peer-reviewed journal. Designed for students who are well along in the process of writing their first manuscript for publication. Prepares students to handle the manuscript revision process when the manuscript is returned from reviewers, as well as the final stage of resubmission to the journal.

**BIOL 658. Advanced Philosophy of Science readings. 2 Units.**

Reading and discussion of selected references in the philosophy of science, and the application of these concepts in the practice of scientific research and interpretation, including their influence on scientific study of origins. Best taken near the end of a student's graduate program. Two-hour class session per week.

**BIOL 664. Science Communication Outreach. 1 Unit.**

Guided immersion into science communication outreach. Principles of communication outreach and small group work presented. Student teams devise project that engages a specific, identified community. Small teams collaboratively interact with community to address a need, present findings, evaluate impact, and reflect on experience. Cross-listing: GEOL 664.

**BIOL 695. Special Projects in Biology. 1-4 Units.**

Student responsible for a special research project in the field, laboratory, museum, or library. May be repeated for additional credit.

**BIOL 697. Research. 1-8 Units.**

See department checklist for recommended number of units.

**BIOL 698. Thesis Research. 1-8 Units.**

Credit for research and for writing the master's thesis. Grade received does not indicate whether thesis is completed and approved.

**BIOL 699. Dissertation Research. 1-8 Units.**

Credit for research and for writing the doctoral dissertation. Grade received does not indicate whether dissertation is completed and approved.