

BIOLOGICAL SCIENCES

<https://www.pacific.edu/liberalarts/academics/departments-and-programs/biological-sciences>

Phone: (209) 946-2181

Location: Biology Building, South Campus

Tara Thiemann, Co-Chair

Douglas Weiser, Co-Chair and Director of Graduate Studies

Degrees Offered

Bachelor of Arts

Bachelor of Science

Master of Science

Majors Offered

Biological Sciences (BA, BS, MS)

Biological Sciences with Departmental Honors (BS)

Biological Sciences for Teaching Credential Candidates (BS)

Minors Offered

Biological Sciences

Preparation for Careers in Biology

The Biology programs are designed to equip students for their desired career paths. The Bachelor of Arts degree offers students the opportunity to blend their study of Biology with additional studies in other sciences such as Chemistry or Geosciences. The Bachelor of Science degree for Teaching Credential Candidates prepares students seeking a science education career in grades K-12 or in adult school. The Bachelor of Science and the Bachelor of Science with Honors degrees offer students the highest level of Biology preparation.

In each program, students select the Biology electives that interest them most and prepare them for their future careers in health care (e.g., dentistry, medicine, pharmacy, nursing and physical therapy), research (e.g., biotechnology, microbiology, and vector biology), wildlife biology (e.g., ecology, biodiversity and conservation) or higher academics (earning a Master's or Doctorate degree to teach at the community college or university level). Along each path, students are exposed to the major areas of the biological sciences so they can discover and develop the subject areas that stir their passion as they prepare for post-baccalaureate study or employment.

Preparation for admission to the undergraduate program should include high school work in algebra, geometry, trigonometry, biology, chemistry, and physics.

Experiential Learning Opportunities

Many students participate in undergraduate research (BIOL 197). Over a period of one or more semesters, these students interact closely with faculty on research projects and get hands-on experience with modern research techniques.

Graduate Program

Master of Science in Biological Sciences

For a graduate degree in the Department of Biological Sciences, the candidate may take a broadly based program in biology or may specialize in areas such as molecular and cellular biology, physiology or ecology.

Candidates for the master of science degree in biological sciences must hold a bachelor's degree that includes the equivalent of the baccalaureate program in biology at University of the Pacific. Candidates holding the bachelor's degree with a major in fields other than biology may be accepted provided deficiencies in biology are made up.

Information Literacy

Demonstrate mastery of general content knowledge from several sub-disciplines, including evolution, ecology, genetics, and molecular biology. (Information Literacy)

Describe science as a way of knowing, including the role of the scientific method and hypothesis-driven research and discovery in the development of scientific knowledge. (Information Literacy)

Critical Thinking & Quantitative Reasoning

Critically evaluate new knowledge, information, and claims in the discipline. (Critical Thinking, Quantitative Reasoning)

Demonstrate laboratory skills and integrate knowledge and skills to formulate relevant questions and design appropriate experiments to advance knowledge in the disciplines. (Critical Thinking, Quantitative Reasoning)

Integrate knowledge of the discipline with broader knowledge gained through a liberal arts education to analyze the potential societal implications of new knowledge in the discipline. (Critical Thinking, Quantitative Reasoning)

Oral & Written Communication

Demonstrate oral and written communication skills necessary for entry into the profession or further study. (Written Communication, Oral Communication)

Collaboration & Teamwork

Demonstrate collaboration and intercultural skills necessary to work effectively in the profession or succeed in further study. (Written Communication, Oral Communication) (Note: Collaboration & Teamwork are not Univ Core Competencies)

- Bachelor of Arts Major in Biological Sciences (p. 1)
- Bachelor of Science Major in Biological Sciences (p. 2)
- Bachelor of Science Major in Biological Sciences with Departmental Honors (p. 3)
- Bachelor of Science Major in Biological Sciences for Teaching Credential Candidates (p. 4)

Bachelor of Arts Major in Biological Sciences

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 2.0 in order to earn the Bachelor of Arts degree with a major in biological sciences.

I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

Note: 1) CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

Note: 1) No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

Note: 1) Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

Note: 1) Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

II. College of the Pacific BA Requirement

Students must take one year of college instruction or equivalent training in a language other than English.

Note: 1) Transfer students with sophomore standing are exempt from this requirement.

III. Breadth Requirement

Students must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.)

IV. Major Requirements

Students must complete a minimum 66 units that include:

BIOL 051	Principles of Biology	5
BIOL 061	Principles of Biology	5
BIOL 101	Genetics	5
BIOL 175	Ecology	5
CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5

Biology Electives 16-20

Select 4 additional BIOL course above BIOL 061, excluding BIOL 089, BIOL 093, BIOL 191. At least 2 courses must include a laboratory component.*

Math Elective 3-4

Select one of the following:

MATH 033	Elements of Calculus
MATH 037	Introduction to Statistics and Probability
MATH 041	Pre-calculus
MATH 045	Introduction to Finite Mathematics and Calculus
MATH 051	Calculus I
MATH 053	Calculus II

Physics Electives

Select one 1st semester Physics course from the following: 5

PHYS 023	General Physics I
PHYS 053	Principles of Physics I

Select one 2nd semester Physics course from the following: 5

PHYS 025	General Physics II
PHYS 055	Principles of Physics II

Additional Science Electives

Select 2 additional courses in Biological Sciences, Chemistry, or Geosciences** 7-8

Total Hours 66-72

* 1) After completing 4 or more units of BIOL 197, 4 of those units can be counted as one Biology elective.

** 2) These electives may include a lab. Biology electives above BIOL 061, excluding BIOL 089, BIOL 093 and BIOL 191. Chemistry electives above CHEM 121, excluding CHEM 191 and CHEM 197. GESC electives above GESC 020, excluding GESC 191 and GESC 197.

Bachelor of Science Major in Biological Sciences

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 2.0 in order to earn the Bachelor of Science degree with a major in biological sciences.

I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

Note: 1) CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry

Note: 1) No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

Note: 1) Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

D. Fundamental Skills

Students must demonstrate competence in:

Writing

Quantitative Analysis (Math)

Note: 1) Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

II. Breadth Requirement

Students must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.)

Note: 1) DS 101, DS 106, and DS 212 can be counted toward the breadth requirement for all students in the Pre-dental major.

III. Major Requirements

Students must complete a minimum of 77 units that include:

BIOL 051	Principles of Biology	5
BIOL 061	Principles of Biology	5
BIOL 101	Genetics	5
BIOL 175	Ecology	5
CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5

Biology Electives **24-30**

Select 6 additional BIOL courses above BIOL 061, excluding BIOL 089 and BIOL 093. At least 2 courses must include a laboratory component. *

Math Elective **3-4**

Select one of the following:

MATH 033	Elements of Calculus
MATH 037	Introduction to Statistics and Probability
MATH 041	Pre-calculus
MATH 045	Introduction to Finite Mathematics and Calculus
MATH 051	Calculus I
MATH 053	Calculus II

Physics Electives

Select one 1st semester Physics course from the following: 5

PHYS 023	General Physics I
PHYS 053	Principles of Physics I

Select one 2nd semester Physics course from the following: 5

PHYS 025	General Physics II
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- * 1. After completing 4 or more units of BIOL 191, 4 of those units can be counted as a Biology elective.
- 2. After completing 4 or more units of BIOL 197, 4 of those units can be counted as one Biology elective.
- 3. Students in the 2+3 Pre-dental major satisfy the Biology Elective requirement with BIOL 128, BIOL 170, BMS 124, BMS 130, BMS 133, BMS 220, BMS 232, BMS 233, OS 230, OS 231 and one Biology elective above BIOL 122 excluding BIOL 130, BIOL 134, BIOL 145, BIOL 162, BIOL 169, BIOL 171, BIOL 176, BIOL 180, and BIOL 185.

Bachelor of Science Major in Biological Sciences with Departmental Honors

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 3.7 in order to earn the Bachelor of Science degree with a major in biological sciences with departmental honors.

I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

Note: 1) CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

Note: 1) No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

Note: 1) Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

Note: 1) Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

elective above BIOL 122 excluding BIOL 130, BIOL 134, BIOL 145, BIOL 162, BIOL 169, BIOL 171, BIOL 176, BIOL 180, and BIOL 185.

II. Breadth Requirement

Students must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.)

Note: 1) DS 101, DS 106, and DS 212 can be counted toward the breadth requirement for all students in the Pre-dental major.

III. Major Requirements

Students must complete a minimum of 77 units that include:

BIOL 051	Principles of Biology	5
BIOL 061	Principles of Biology	5
BIOL 101	Genetics	5
BIOL 175	Ecology	5
BIOL 197	Undergraduate Research	1-4
CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5
Biology Electives		20-25

Select 5 additional courses above BIOL 061, excluding BIOL 089, BIOL 093 and BIOL 197. At least 2 courses must include a laboratory component.**

Math Elective

Select one of the following groups: 3-4

MATH 033	Elements of Calculus	
MATH 037	Introduction to Statistics and Probability	
MATH 041	Pre-calculus	
MATH 045	Introduction to Finite Mathematics and Calculus	
MATH 051	Calculus I	
MATH 053	Calculus II	

Physics Electives

Select one 1st semester Physics course from the following: 5

PHYS 023	General Physics I	
PHYS 053	Principles of Physics I	

Select one 2nd semester Physics course from the following: 5

PHYS 025	General Physics II	
PHYS 055	Principles of Physics II	

Total Hours 77-83

- * Students must complete a minimum of two semesters and at least 4 units of BIOL 197 prior to graduation and communicate their research results in a meeting poster, oral presentation or peer-reviewed publication.
- ** After completing 4 or more units of BIOL 191, 4 of those units can be counted as a Biology elective.
- Students in the 2+3 Pre-dental major satisfy the Biology Electives requirement with BIOL 128, BIOL 170, BMS 124, BMS 130, BMS 133, BMS 220, BMS 232, BMS 233, OS 230, OS 231 and one Biology

Bachelor of Science Major in Biological Sciences for Teaching Credential Candidates

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 2.0 in order to earn the Bachelor of Science degree with a major biological sciences for Teaching Credential Candidates.

I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

Note: 1) CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

Note: 1) No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

Note: 1) Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

Note: 1) Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

II. Breadth Requirement

Students must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.)

III. Major Requirements

Students must complete a minimum 82 units that include:

BIOL 051	Principles of Biology	5
BIOL 061	Principles of Biology	5
BIOL 101	Genetics	5
BIOL 153	Cell Biology	4
BIOL 175	Ecology	5
BIOL 179	Evolution	4
CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5
GESC 051	Dynamic Planet	4
GESC 053	Earth and Life Through Time	4
PHYS 041	Astronomy	4

Biology Electives

Select one Anatomy course from the following: 4-5

BIOL 162	Comparative Vertebrate Anatomy
BIOL 165	Embryology and Development
BIOL 170	Human Anatomy

Select one Physiology course from the following: 4-5

BIOL 134	Comparative Physiology
BIOL 180	Human Physiology
PHYS 023	General Physics I

Select one Botany course from the following: 4

BIOL 079	California Flora
BIOL 130	Plant Kingdom

Select one Zoology course from the following: 4

BIOL 072	Vertebrate Biology
BIOL 074	Biology of Insects
BIOL 077	Marine Birds and Mammals
BIOL 185	Comparative Animal Behavior

Math Electives

Select 2 MATH electives, from MATH 033 or above. * 7-8

Physics Electives

Select one 1st semester Physics course from the following: 5

PHYS 023	General Physics I
PHYS 053	Principles of Physics I

Select one 2nd semester Physics course from the following: 5

PHYS 025	General Physics II
PHYS 055	Principles of Physics II

Total Hours 93-96

* One course in statistics is recommended. Credit is not given for both MATH 033 and MATH 051.

Master of Science in Biological Sciences

Students must complete a minimum of 32 units with a Pacific cumulative grade point average of 3.0 in order to earn the master of science degree in biological sciences.

I. Required Graduate Courses

Select one of the following Techniques/Methods Course: 4

BIOL 259	Molecular Biological Techniques	
BIOL 271	Methods in Field Biology	
BIOL 295	Graduate Seminar	4

Note: 1) Students who have received credit for BIOL 159 or BIOL 171 with a grade of B or better prior to entering the graduate program cannot take BIOL 259 or BIOL 271, respectively. With program director consent, these students must take either the alternative Techniques/Methods class (i.e., students with credit for BIOL 159 can take BIOL 271, and vice versa), or an additional 4 unit BIOL elective numbered 200 or above (see "Electives" below). **2)** All biology graduate students must take two semesters of BIOL 295.

II. Thesis/Research

Minimum of 8 units

BIOL 297	Graduate Research	4-6
BIOL 299	Thesis	2
		or
		4

III. Electives

BIOL Electives (3 courses numbered 200 or above excluding BIOL 291, BIOL 295, BIOL 297, and BIOL 299) 12

Note: 1) With program director permission, students may substitute BIOL 291 for one BIOL elective. **2)** With program director permission, students may substitute one 100-level BIOL course (excluding BIOL 191 and BIOL 197) for one graduate-level BIOL elective. **3)** Students may count a maximum of six (6) units of BIOL 297 toward their degree. **4)** Students are encouraged, where appropriate, to select courses offered by other departments or units of the University, such as Chemistry or the Thomas J. Long School of Pharmacy and Health Sciences.

Biological Sciences Courses

BIOL 011. Human Anatomy and Physiology. 4 Units.

A lecture and laboratory introduction to the structure and function of the various systems of the human body is the focus. This class is intended primarily for non-science majors; not open to biology majors. (GE3A, GESI)

BIOL 035. Environment: Concepts and Issues. 4 Units.

Principles of ecology as they bear on world environmental problems are introduced with an emphasis on biological aspects of world problems and on the interrelationships between culture and environment. Global dimension of population, resources, food, energy and environmental impact are considered. Course does not count toward a biology major. (GEGR)

BIOL 041. Introduction to Biology. 4 Units.

A lecture and laboratory introduce the concepts of biology. Physical structure, physiology, nutrition, reproduction, growth and behavior are examined from the perspective of adaptation and interaction with the environment. Human, animal and plant systems are covered. Recommended for non-majors. Course does not count toward a biology major. (GE3A, GESI)

BIOL 051. Principles of Biology. 5 Units.

A lecture and laboratory introduction to evolutionary biology and ecology. Preparation for continued studies in biological science.

BIOL 061. Principles of Biology. 5 Units.

This course is a lecture and laboratory introduction to cellular and molecular biology, cellular energetics, biochemistry, genetics and evolution. Preparation for continued studies in biological science.

BIOL 072. Vertebrate Biology. 4 Units.

Taxonomy, life history, ecology and evolutionary history of vertebrates are emphasized. Prerequisites: BIOL 051 and BIOL 061.

BIOL 074. Biology of Insects. 4 Units.

A lecture and laboratory introduce a broad study of the structure and function of insects, the most diverse terrestrial organisms with over 1 million described species. The course includes a study of their anatomy, physiology, ecology, evolution, reproduction, behavior and relation to humans. The laboratory work includes field trips in addition to the preparation of 50 classified insects. No prerequisites. Successful completion of this course will satisfy the GE Scientific Inquiry category. (GE3A, GESI)

BIOL 076. Marine Biology. 4 Units.

General concepts of community ecology, taxonomy and phylogeny, anatomical and physiological adaptations of marine organisms, and their interaction with the physical environment are the main focus. The class emphasizes natural history and identification of marine organisms of the Central California intertidal and sub-tidal environment. Prerequisites: BIOL 051 and BIOL 061. (GE3A, GESI)

BIOL 077. Marine Birds and Mammals. 4 Units.

Ecology, behavior, economic importance and conservation of cetaceans, pinnipeds, otters, sirenians, seabirds and shorebirds are introduced. Physical and biological oceanography are considered as they relate to distribution and abundance of marine birds and mammals. This course is open to non-majors as well as majors. Junior standing.

BIOL 079. California Flora. 4 Units.

Identification and classification of flowering plants, gymnosperms, ferns and fern allies as represented in Northern Calif. are studied. (GE3A, GESI)

BIOL 087. Internship. 1-4 Units.**BIOL 087A. Internship. 1-4 Units.****BIOL 089. Lab Assistant in Biology. 1-4 Units.**

Students attend organizational meetings during which laboratory material is discussed and then students assist in the laboratory answering student questions, doing dissections, etc. Attendance at class lectures is recommended and students are expected to take lecture and laboratory examinations. Usually one laboratory meeting per week will earn two units credit; two laboratory meetings per week will earn four units credit. Grading is Pass/no credit only.

BIOL 093. Special Topics. 1-4 Units.**BIOL 101. Genetics. 5 Units.**

Emphasis of study is heritable variations and their relation to structure, behavior and function of genetic material. This basic course is for students concentrating on biological sciences, medical sciences and liberal arts. In addition to lecture, one-three hour laboratory per week is required. Prerequisites: BIOL 051 and BIOL 061. Recommended: Sophomore standing.

BIOL 112. Human Anatomy & Physiology I. 5 Units.

This lecture and lab course is the first in a 2-semester sequence of Human Anatomy and Physiology for students in the Dental Hygiene Program. This course reviews basic chemistry, molecular movement, biological macromolecules, cells, and tissues. The integumentary, skeletal, muscular, nervous and sensory systems and the heart are covered in detail. Labs utilize microscopes, models, dissections, and physiological experiments to cover the skin, the skeleton, major skeletal muscles, joints, the heart, the nervous system, the eye and ear. Credit will not be given for this course if a student has already received credit for BIOL 170 Human Anatomy or BIOL 180 Human Physiology. Enrollment limited to undergraduates in the Dental Hygiene Program. Prerequisites: BIOL 061 and CHEM 025.

BIOL 113. Human Anatomy & Physiology II. 5 Units.

This lecture and lab course is the continuation of a 2-semester sequence of Human Anatomy and Physiology for students in the Dental Hygiene Program. This course reviews homeostasis and the interactions between the nervous system, sensory systems, the musculoskeletal systems and the heart before covering the structures and functions of the remaining organ systems of the body: Endocrine, circulatory, lymphatic, immune, respiratory, digestive (with treatment of energy metabolism and intermediary metabolism), urinary, and reproductive systems. Labs utilize microscopes, models, dissections, and physiological experiments to cover the endocrine, lymphatic/immune, respiratory, digestive, urinary, and reproductive systems. Credit will not be given for this course if a student has already received credit for BIOL 170 Human Anatomy or 180 Human Physiology. Enrollment limited to undergraduates in the Dental Hygiene Program. Prerequisites: BIOL 061 and CHEM 025.

BIOL 116. Applied Microbiology. 4 Units.

An introduction to medically relevant bacteria, plus fungi, viruses, parasites and biting arthropods. In addition to basic topics that include basic cell structure and function, biochemistry, and metabolic diversity, students acquire knowledge and practical understanding of antimicrobial treatment and immunology. An organ systems approach to learning about pathogens allows students to practice problem-solving skills in treating human infections. Case studies from the CDC reinforce problem-solving skills and provide students with a comprehensive, practical and holistic approach to learning microbiology. Credit will not be given for this course if a student has already received credit for BIOL 147 Medical Microbiology. Prerequisites: Enrollment limited to undergraduates in the Pre-Pharmacy Advantage program who have received C or better grades in BIOL 061 and CHEM 025 or CHEM 026.

BIOL 117. Applied Physiology. 4 Units.

A lecture and practicum course reviewing the functions of all major organ systems of the human body. Lectures use a systems-level approach with physiological performance explained in the context of anatomical structures. Practicum exercises include case studies analyzing how pharmaceutical drugs work and the biological effects & side-effects of pharmaceutical drugs in both normal and pathological states. Credit will not be given for this course if a student has already received credit for BIOL 180. Prerequisites: Enrollment limited to undergraduates in the Pre-Pharmacy Advantage program who have received C or better grades in BIOL 061, BIOL 116, and CHEM 025 or CHEM 026.

BIOL 118. Applied Biochemistry and Molecular Biology. 4 Units.

A broad overview of the fields of Biochemistry and Molecular Biology, with a particular emphasis on health-related topics for students preparing for Pharmacy School. Topics include rates of reactions, pH and protein-ligand binding, protein folding and structure, enzyme catalysis, cell signaling, genome mutation and gene regulation. Credit will not be given for this course if a student has already received credit for BIOL 169 Biochemistry. Prerequisites: Enrollment limited to undergraduates in the Pre-Pharmacy Advantage program who have received C or better grades in BIOL 061, BIOL 116, BIOL 117, two semesters of general chemistry and one semester of Organic Chemistry.

BIOL 122. Principles of Immunology. 4 Units.

The fundamental properties of antigens and antibodies are covered with an emphasis on the theories of antibody production, tolerance, transplantation immunity, autoimmunity and tumor immunology. Prerequisites: BIOL 101 and CHEM 121.

BIOL 124. Cancer Biology. 4 Units.

The course examines the morphological and molecular events that accompany the changes of a normal mammalian cell into a cancer cell, with an emphasis on the major pathways that affect cell growth and division, cell communication, cell death and metastasis. Prerequisite: BIOL 101.

BIOL 126. Neurobiology. 4 Units.

This course focuses on the molecular and cell biology of neuronal function and development, and how neurons work together to retrieve and process information and respond accordingly, with thorough discussions of sensory and motor systems and a brief review of more complex brain functions, such as emotions, speech and language, and memory. Prerequisites: BIOL 051 and BIOL 061.

BIOL 128. Histology. 4 Units.

A study of the tissues which comprise the organs of the human body. Thin sections of organs are examined, and their structures related to function. Emphasis is placed on learning how cells and tissues which have been treated with different colored stains appear under light microscopy, interpreting how those stains reflect the chemical makeup of the cells, and recognizing when preparative artifacts distort the appearance of the normal tissue. Credit will not be given if a student has taken BIOL 129. Prerequisites: BIOL 051 and BIOL 061.

BIOL 130. Plant Kingdom. 4 Units.

Through lectures, laboratories and field trips, students are introduced to the morphology, reproduction biology and environmental requirements of all major groups of plants. Included are material bearing on the evolutionary relationships within and between each major group. Individual projects are required. Prerequisites: BIOL 051 and BIOL 061.

BIOL 134. Comparative Physiology. 4 Units.

This course is a detailed review of organ function in diverse groups of organisms. Emphasis is on physiological adaptation to the environment. Prerequisites: BIOL 051 and BIOL 061.

BIOL 145. Microbiology. 5 Units.

The biology of microorganisms is studied with emphasis on viruses, bacteria, fungi and protozoa. In addition to lecture, one three-hour laboratory per week is required. Prerequisites: BIOL 051, BIOL 061; CHEM 025, CHEM 027.

BIOL 146. Industrial Microbiology. 4 Units.

An in-depth knowledge of the industrial applications of microorganisms. The course uses an understanding of microbial physiology and genetics to illustrate how these organisms are utilized to create commercial products ranging from medicines to food products. Prerequisite: BIOL 145.

BIOL 147. Medical Microbiology. 4 Units.

Medical microbiology covers a survey of microorganisms implicated in human disease; emphasis on characteristics and properties of microorganisms, chiefly bacteria and fungi which are responsible for pathogenesis. Laboratory includes methods of isolation, characterization, and identification of bacteria and fungi responsible for human disease. Credit will not be given for students who have passed BIOL 116. Prerequisites: BIOL 145 and CHEM 121 with a C- or higher or permission of instructor.

BIOL 148. Emerging Infectious Diseases. 4 Units.

This class focuses on the evolutionary and ecological principles driving new infectious diseases of humans, wildlife, and domesticated animals. Through the exploration and application of real cases worldwide, students will have an understanding of how diseases emergence and present threats to global health. Research projects, writing assignments, case studies, and other activities will help students to synthesize a stronger appreciation for this aspect of health. Prerequisites: BIOL 051 and BIOL 061.

BIOL 151. Parasitology. 4 Units.

Principles of parasitism as well as biology of animal parasites with special emphasis on the protozoa, platyhelminths, nematodes, acanthocephala and arthropods are studied. Techniques of recovery of parasites from various vertebrate hosts are introduced including staining, mounting and identification. Prerequisites: BIOL 051, BIOL 061, BIOL 101.

BIOL 152. Human Parasitic Diseases. 4 Units.

This class focuses on parasitic diseases of humans, wildlife, and domesticated animals. Through the exploration and application of real cases worldwide, students will have an understanding of how parasitic diseases emergence and present threats to global health. Midterm exams which focus on research projects and writing will help students to synthesize a stronger appreciation for these kinds of infectious diseases. Students will also engage in many discussions online as a method of improving their analytical and critical thinking, argumentative writing, and collaborative skills. Prerequisites: BIOL 051 and BIOL 061.

BIOL 153. Cell Biology. 4 Units.

Cell Biology studies cell structure and function with emphasis on the dynamic nature of the cellular environment and the methodologies of cell biology. The experimental basis of our present understanding of the cell is also stressed. Prerequisites: BIOL 051, BIOL 061, BIOL 101, CHEM 025 and CHEM 027. Recommended: Organic chemistry.

BIOL 155. Biological Electron Microscopy. 4 Units.

The process and techniques involved in examining biological specimens with the transmission electron microscope will be covered in detail. When competence in specimen processing is achieved, each student performs an original experiment as a term project. Prerequisites: BIOL 051, BIOL 061, CHEM 025, CHEM 027. Recommended: BIOL 101.

BIOL 157. Topics in Biomedical Research. 4 Units.

Basic research in the areas of cell biology, biochemistry, molecular biology and physiology are examined in their applications to current problems in medicine. Topics covered include genetic engineering, gene therapy, transplants and cloning. Prerequisites: BIOL 051, BIOL 061, BIOL 101; CHEM 121.

BIOL 159. Molecular Biological Techniques. 4 Units.

This advanced laboratory course in the methods of molecular biology, has an emphasis on modern techniques and their application in the laboratory. Topics covered include gene cloning, protein expression systems, nucleic acid isolation and purification, and basic methods of bioinformatics. Prerequisites: BIOL 101 and CHEM 121 with a "C-" or higher.

BIOL 160. Proteomics. 4 Units.

This course introduces students to the fundamental principles of mass spectrometry and its applications to investigate macromolecules, with an emphasis on proteins. The use of mass spectrometry, specifically in the area of proteomics, is an emerging, powerful technology that is rapidly becoming an essential tool for scientists to study biological systems and the function of proteins. Prerequisites: Grade of C or better in BIOL 061.

BIOL 162. Comparative Vertebrate Anatomy. 5 Units.

The evolution of vertebrate organ systems as revealed by comparative morphology are emphasized. Prerequisites: BIOL 051 and BIOL 061. Recommended: BIOL 101.

BIOL 165. Embryology and Development. 4 Units.

This laboratory course focuses on the events that occur as a single-celled embryo develops into an adult organism. Developmental processes are studied at the descriptive and mechanistic levels, leading to an understanding of how and why complex structures are produced. Major emphases is placed on animal embryology (both vertebrate and invertebrate) leading to the production to tissues, organs and organ systems. Later developmental processes also are studied, as well as sex determination. Additional topics include cancer and evolution as seen in the context of development. Prerequisites: BIOL 051, BIOL 061, BIOL 101.

BIOL 167. Evolution and Developmental Biology. 4 Units.

How do butterfly wings get their spots and stripes? Why do dolphins and humans have the same bones in their limbs? How did Darwin's finches quickly evolve so many different beak shapes? These are all questions that require an understanding of Evolutionary Developmental Biology (EvoDevo) to answer. EvoDevo explores the intersection of Evolution, Developmental Biology, and Genetics. This course covers introductory topics in those three fields, theoretical underpinnings of EvoDevo, as well as case studies. This course uses phylogenetic and developmental genetics frameworks to examine topics that include body-plans and patterning, genetic and morphological complexity, and novel features. Prerequisites: BIOL 051 and BIOL 061 or permission of instructor.

BIOL 168. Pharmacology. 4 Units.

Pharmacology is a complex field focusing on the mechanism of action of drugs. This course provides background information on the basic mechanisms of drug absorption, distribution and interaction with targets. In addition, this course covers how drugs are discovered and regulated. Finally, a selected set of drug families focusing on the nervous system and anti-cancer treatments are examined. This course is intended as a primer for later study of pharmacology covering many more drug families. Other courses such as Organic Chemistry, Physiology and Genetics are helpful but are not required. Prerequisites: BIOL 051, BIOL 061, CHEM 025, CHEM 027.

BIOL 169. Elements of Biochemistry. 4 Units.

The field of biochemistry is the focus in this non-lab course that is designed as a preparation for students preparing for Dental, Medical or Pharmacy School. Topics include nucleic acid and protein structure and synthesis, intermediary metabolism, enzyme action, and synthesis and degradation of important biological molecules. The relationship of biochemistry, nutrition, and human disease is discussed. This course does not count for the Biochemistry major. Credit will not be given for this course if a student has already received credit for BIOL 118 Applied Biochemistry and Molecular Biology. BIOL 051, BIOL 061, BIOL 101, CHEM 025, CHEM 027 and CHEM 123, all with a grade of "C-" or higher.

BIOL 170. Human Anatomy. 5 Units.

This lecture/lab course is a study of the structure of the organ systems of humans. The course emphasizes macroscopic anatomy and adds details of cellular and molecular structure. Some aspects of evolutionary history and clinical application are also discussed. Weekly lab activities include examination of microscope slides, anatomical models and dissections. Credit will not be given for this course if a student has already received credit for either BIOL 112 Human Anatomy & Physiology I or BIOL 113 Human Anatomy & Physiology II. Prerequisites: BIOL 051 and BIOL 061.

BIOL 171. Methods in Field Biology. 4 Units.

A course focused on methods of biological investigation with emphasis on modern field sampling techniques and instrumentation. Students are trained in experimental design and quantitative data analysis used to address a range of biological questions. Prerequisites: BIOL 051 and BIOL 061 with a "D" or better.

BIOL 175. Ecology. 5 Units.

The structure and dynamics of populations, biotic communities and ecosystems, is emphasized with particular focus upon relationships of organisms to their environments. Prerequisites: BIOL 051 and BIOL 061.

BIOL 176. Ecology and Conservation Biology. 4 Units.

The principles of ecology are introduced with attention to consider threats and disruptions to ecological systems from the level of local populations through ecosystems, landscapes, and global processes. Ecological principles are used to help understand these systems, to make predictions for the future or for other systems, and to evaluate possible solutions. The class considers the importance of economic and demographic forces in causing conservation problems and in shaping conservation strategies, and students practice planning conservation areas. Prerequisite: BIOL 051.

BIOL 177. Natural Medicines. 4 Units.

A lab course that surveys drugs found in nature, in particular their history, uses, and mode of action, and is designed as a preparation for students who will attend a Pharmacy or Dental School. Topics include history of medicine, survey of natural compounds relevant to pharmacology, and survey of naturally-derived drugs used to treat cancer, heart disease, and neurological disorders. Prerequisites: BIOL 051, BIOL 061, BIOL 101, CHEM 123 with a "C-" or higher.

BIOL 179. Evolution. 4 Units.

Lectures and readings on the mechanisms of evolutionary change in organisms are the focus. Prerequisites: BIOL 051 and BIOL 061. Recommended: BIOL 101.

BIOL 180. Human Physiology. 5 Units.

This course is a lecture- and laboratory-based review of the functions of the major organ systems of vertebrates with emphasis on the human body. Lab exercises demonstrate basic physiological processes in the human body and emphasize techniques of data acquisition and presentation. Credit will not be given for this course if a student has already received credit for either BIOL 112 Human Anatomy & Physiology I, BIOL 113 Human Anatomy & Physiology II, or BIOL 117 Applied Physiology. Prerequisites: BIOL 061 and one semester of Introductory Chemistry (CHEM 023, CHEM 024, CHEM 025, CHEM 026 or CHEM 027).

BIOL 181. Integrative Metabolism. 4 Units.

This course provides a survey of topics related to metabolism, including metabolic pathways, endocrine and neural regulation and integration of metabolism, specialized metabolic adaptations in animals, metabolic disease, and the intersection of metabolism and society, among others. We will read, analyze, and discuss scientific articles throughout this course to familiarize you with the scientific process, current research in the field of metabolism, and to examine how scientific findings are disseminated and used to inform health-related policy. Students will complete a capstone research project addressing metabolic health, media, and society. The goal of this course is to prepare you for more advanced graduate and professional work by developing critical thinking, experimental analysis, and scientific communication skills and the ability to critically evaluate scientific literature. Prerequisite: BIOL 061.

BIOL 182. Medical Endocrinology. 4 Units.

This lecture/lab course presents the fundamentals and current topics in human endocrinology from a medical and clinical perspective. Lectures cover normal endocrine physiology, endocrine diseases, diagnostic rubrics for patient assessment/disease evaluation, and current treatment recommendations. Lab is divided into two units: (1) Histology of healthy endocrine glands and histopathology of diseased endocrine glands; and (2) Developing patient assessment/diagnosis skills using computer "virtual patients." Prerequisites: BIOL 051, BIOL 061, CHEM 025 and CHEM 027. Recommended: BIOL 71 or 81 or BIOL 128.

BIOL 183. Comparative Oral+ENT Biology. 4 Units.

This course is a hands-on introduction to the mouth, ears, nose and throat of vertebrates. It provides a comparative view of the evolution, design and function of the mouth and associated cavities. Mastication, swallowing, speech and hearing are examined from various perspectives. Common clinical issues in humans, as well as species with extreme performances are also discussed. Labs include practical training in technical sculpture, casting, dissection, drilling, adhesives, wire work, anesthesia, and experiments on speech and hearing. The target audience is students interested in dentistry, otorhinolaryngology, audiology, speech pathology or organismal biology. Prerequisites: BIOL 051 and BIOL 061.

BIOL 185. Comparative Animal Behavior. 4 Units.

The ecology and evolution of animal behavior are examined from both proximate and ultimate perspectives. Genetic, hormonal, neural and environmental influences on the development and expression of behavior are discussed, as well as how behaviors are shaped and constrained by ecology and evolutionary history. Through laboratory and field activities, students practice observational and quantitative methods to record and analyze a variety of animal behaviors.

BIOL 186. Hormones and Behavior. 4 Units.

An on-line reading/discussion/writing course focusing on the bidirectional interactions between an animal's behaviors and its endocrine system. Topics include: overview of the vertebrate endocrine system, biological sex and gender issues, courtship and sex behaviors, parenting behavior, pheromonal communication, aggression and other social behaviors, learning and memory, hunger, stress, and biological rhythms. Discussions also analyze current research publications, research methodologies, and results. Students practice scientific writing and prepare a 10-12 page research paper. This course counts as an upper division elective in the Biology major and as an elective in the Gender Studies degree. Prerequisites: BIOL 051 and BIOL 061. (GEND)

BIOL 191. Independent Study. 2-4 Units.**BIOL 194. Science Communication. 4 Units.**

This course provides students the opportunity to improve their skills at assessment of primary scientific literature, oral presentation of scientific research, and scientific writing. Students critically analyze a series of journal articles related to their own research, perform several writing exercises, orally present preliminary results of their research or research prospectus, write a research proposal, and evaluate peers' oral and written communication efforts. Additionally, students attend and participate in departmental seminar presentations given by researchers from Pacific and other universities. Prerequisites: Instructor permission.

BIOL 197. Undergraduate Research. 1-4 Units.**BIOL 222. Immunology. 4 Units.**

Students study immunoglobulin structure, function, and expression in animals. Molecular and cellular mechanisms of humoral immune response, cell-mediated immunity, complement system, autoimmune diseases, tolerance induction, transplantations, cancer immunity, vaccines, and cytokine actions are also emphasized. Graduate standing.

BIOL 224. Cancer Biology. 4 Units.

The course examines the morphological and molecular events that accompany the change of a normal mammalian cell into a cancer cell, with an emphasis on the major pathways that affect cell growth and division, cell communication, cell death and metastasis.

BIOL 226. Neurobiology. 4 Units.

The course focuses on the molecular and cell biology of neuronal function and development, and how neurons work together to retrieve and process information and respond accordingly. It involves thorough discussions of sensory and motor systems and a brief review of more complex brain functions, such as emotions, speech and language, and memory.

BIOL 234. Comparative Physiology. 4 Units.

This course offers a detailed review of organ function in diverse groups of organisms. Emphasis is on physiological adaptation to the environment. Graduate standing.

BIOL 244. Developmental Biology. 4 Units.

Students examine the genetic control of development and the physiological mechanisms involved in fertilization and differentiation. Graduate standing.

BIOL 246. Industrial Microbiology. 4 Units.

An in-depth knowledge of the industrial applications of microorganisms. The course uses an understanding of microbial physiology and genetics to illustrate how these organisms are utilized to create commercial products ranging from medicines to food products. Prerequisite: BIOL 145.

BIOL 247. Medical Microbiology. 4 Units.

This course content is the same as BIOL 147 with three additional hours per week of seminar and/or special project. Graduate standing.

BIOL 251. Parasitology. 4 Units.

This course content is the same as BIOL 151. Principles of parasitism, biology of animal parasites with special emphasis on the protozoa, nematodes, helminths, acanthocephala, and arthropods are covered with three additional hours per week of seminar and/or special project. Graduate standing.

BIOL 253. Cell Biology. 4 Units.

This course content is the same as BIOL 153. Students take an in-depth look at the structure and function of a cell with an emphasis on the methodologies of Cell Biology. Research-based current understanding of the topics is stressed and a special project is required. Graduate standing.

BIOL 255. Biological Electron Microscopy. 4 Units.

This course content is the same as BIOL 155. The processes and techniques involved in examining biological specimens with the transmission electron microscope are covered in detail. When competence in specimen processing is achieved, each student performs an original experiment as a term project. Graduate standing.

BIOL 259. Molecular Biological Techniques. 4 Units.

This is an advanced laboratory course in the methods of molecular biology, with emphasis on modern techniques and their application in the laboratory. Topics covered include gene cloning, protein expression systems, nucleic acid isolation and purification, and basic methods of bioinformatics. Graduate standing.

BIOL 260. Proteomics. 4 Units.

This course introduces students to the fundamental principles of mass spectrometry and its applications to investigate macromolecules, with an emphasis on proteins. The use of mass spectrometry, specifically in the area of proteomics, is an emerging, powerful technology that is rapidly becoming an essential tool for scientists to study biological systems and the function of proteins. Prerequisites: Graduate standing.

BIOL 267. Evolution and Developmental Biology. 4 Units.

How do butterfly wings get their spots and stripes? Why do dolphins and humans have the same bones in their limbs? How did Darwin's finches quickly evolve so many different beak shapes? These are all questions that require an understanding of Evolutionary Developmental Biology (EvoDevo) to answer. EvoDevo explores the intersection of Evolution, Developmental Biology, and Genetics. This course covers introductory topics in those three fields, theoretical underpinnings of EvoDevo, as well as case studies. This course uses phylogenetic and developmental genetics frameworks to examine topics that include body-plans and patterning, genetic and morphological complexity, and novel features. Prerequisites: Graduate standing.

BIOL 268. Pharmacology. 4 Units.

Pharmacology is a complex field focusing on the mechanism of action of drugs. This course provides background information on the basic mechanisms of drug absorption, distribution and interaction with targets. In addition, this course covers how drugs are discovered and regulated. Finally, a selected set of drug families focusing on the nervous system and anti-cancer treatments are examined. This course is intended as a primer for later study of pharmacology covering many more drug families. Prerequisites: Graduate standing.

BIOL 271. Methods in Field Biology. 4 Units.

This is a course focused on methods of biological investigation with emphasis on modern field sampling techniques and instrumentation. Students are trained in experimental design and quantitative data analysis used to address a range of biological questions. Graduate standing.

BIOL 274. Biology of Insects. 4 Units.

A lecture and laboratory introduce a broad study of the structure and function of insects, the most diverse terrestrial organisms with over 1 million described species. The course includes a study of their anatomy, physiology, ecology, evolution, reproduction, behavior, and relation to humans. The laboratory work includes field trips in addition to the preparation of 50 classified insects. Project assignments include but are not limited to identification of taxa of interest, and analysis of insect data related to student interests.

BIOL 279. Evolution. 4 Units.

This course content is the same as BIOL 179 and a special project is required. Graduate standing.

BIOL 281. Integrative Metabolism. 4 Units.

This course provides a survey of topics related to metabolism, including metabolic pathways, endocrine and neural regulation and integration of metabolism, specialized metabolic adaptations in animals, metabolic disease, and the intersection of metabolism and society, among others. We will read, analyze, and discuss scientific articles throughout this course to familiarize you with the scientific process, current research in the field of metabolism, and to examine how scientific findings are disseminated and used to inform health-related policy. Students will complete a capstone research project addressing metabolic health, media, and society. The goal of this course is to prepare you for more advanced graduate and professional work by developing critical thinking, experimental analysis, and scientific communication skills and the ability to critically evaluate scientific literature. Prerequisite: Graduate Standing.

BIOL 282. Medical Endocrinology. 4 Units.

This lecture/lab course presents the fundamentals and current topics in human endocrinology from a medical and clinical perspective. Lectures cover normal endocrine physiology, endocrine diseases, diagnostic rubrics for patient assessment/disease evaluation, and current treatment recommendations. Lab is divided into two units: (1) histology of healthy endocrine glands and histopathology of diseased endocrine glands; and (2) developing patient assessment/diagnosis skills using computer "virtual patients." Prerequisites: Graduate Standing.

BIOL 283. Comparative Oral+ENT Biology. 4 Units.

This course is a hands-on introduction to the mouth, ears, nose and throat of vertebrates. It provides a comparative view of the evolution, design and function of the mouth and associated cavities. Mastication, swallowing, speech and hearing are examined from various perspectives. Common clinical issues in humans, as well as species with extreme performances are also discussed. Labs include practical training in technical sculpture, casting, dissection, drilling, adhesives, wire work, anesthesia, and experiments on speech and hearing. The target audience is students interested in dentistry, otorhinolaryngology, audiology, speech pathology or organismal biology. Prerequisites: Graduate standing.

BIOL 291. Independent Study. 2 or 4 Units.**BIOL 294. Science Communication. 4 Units.**

This course provides students the opportunity to improve their skills at assessment of primary scientific literature, oral presentation of scientific research, and scientific writing. Students critically analyze a series of journal articles related to their own thesis research, perform several writing exercises, orally present preliminary results of their thesis research or thesis prospectus, write a thesis research proposal, and evaluate peers' oral and written communication efforts. Students also form and meet with their graduate thesis committee to discuss thesis research. Additionally, students attend and participate in departmental seminar presentations given by researchers from Pacific and other universities. Prerequisites: Open to first-year graduate students.

BIOL 295. Graduate Seminar. 4 Units.**BIOL 297. Graduate Research. 1-6 Units.****BIOL 299. Thesis. 2 or 4 Units.**