Department of Biology and Chemistry

Mission
The Department of Biology and Chemistry (http://www.apu.edu/clas/biochem) at Azusa Pacific University provides an environment in which undergraduate students can develop a Christian worldview and learn to integrate their faith into their lives as scientists. The department offers science courses that are consistent with the majors offered, that meet the goals of the General Education program (http://catalog.apu.edu/undergraduate/academic-programs/general-education-program), and that serve as support courses for students in other majors. The department also provides opportunities for students to prepare for graduate or professional studies and for success in their chosen careers.

Department Statement
The Department of Biology and Chemistry serves God through the integration of a Christian perspective into the disciplines of biology and chemistry, and the preparation of Christian men and women to serve in leadership or support roles in these sciences.

Program Learning Outcomes
Upon completion of a bachelor’s degree from the Department of Biology and Chemistry, graduates will be able to:

- PLO 1: Demonstrate a broad knowledge base in their chosen field.
- PLO 2: Effectively communicate scientific ideas and research orally.
- PLO 3: Effectively communicate scientific ideas and research in writing.
- PLO 4: Demonstrate proficiency in problem solving and applying the scientific method to scientific questions.
- PLO 5: Demonstrate laboratory skills and techniques.
- PLO 6: Demonstrate knowledge of relevant laboratory instrumentation.
- PLO 7: Express a Christian worldview that integrates faith with their vocation.

Department Overview
The Department of Biology and Chemistry offers a Bachelor of Arts in Allied Health (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/allied-health-major) and Bachelor of Science degrees in Allied Health (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/allied-health-major), Biology (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/biology-major), Chemistry (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/chemistry-major), and Biochemistry (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/biochemistry-major).

Requirements for Allied Health, Biochemistry, Biology, and Chemistry majors
While the Department of Biology and Chemistry does not cap enrollment in these majors, students are expected to demonstrate certain levels of achievement (detailed below) to enter and remain in these majors.

Entrance Requirements
Freshman and Transfer Applicants
To qualify for a major in allied health, biology, biochemistry, or chemistry, freshman and transfer applicants must submit documentation of the following (or their equivalents) and indicate their choice for one of those majors to the Office of Undergraduate Admissions (https://www.apu.edu/undergraduate-admissions) before the start of classes. After that date, the requirements in the Matriculated APU Students section (below) must be met.

- Math: Minimum 530 math SAT, 21 math ACT, 30 ALEKS, completion of MATH 95, or satisfaction of GE Quantitative Literacy criteria 1-8 (excluding AP Statistics)

Transfer applicants must complete MATH 110 (B- or higher) or equivalent prior to entrance in order to meet the prerequisites for CHEM 151. Otherwise, completion of major requirements may take longer than the desired number of semesters.
Matriculated APU Students
To qualify for a major in allied health, biology, biochemistry, or chemistry, matriculated APU students must submit evidence of all of the following:

- Math: Minimum 530 math SAT, 21 math ACT, 30 ALEKS, completion of MATH 95, or satisfaction of GE Quantitative Literacy criteria 1-8 (excluding AP Statistics)
- Completed prospective major advising in the Department of Biology and Chemistry

Milestone Completion
In order to progress through the allied health, biology, biochemistry, or chemistry major, two milestones need to be completed. Completion of Milestone 1 allows the student to become a candidate for lower-division courses, and completion of Milestone 2 enables the student to become a candidate for upper-division courses. These milestones are as follows:

Milestone 1
Allied Health/Biology: C- or higher in BIOL 151 (Prerequisites: B- in BIOL 101, or B in one year of high school biology along with completion or waiver of MATH 95 [for example, by a 45 ALEKS])
Biochemistry/Chemistry: C- or higher in CHEM 151 (Prerequisites: B- or higher in CHEM 101, or B or higher in one year of high school chemistry; and B- or higher in MATH 110 or equivalent)

All students who have not satisfied prerequisites to begin Milestone 1 courses should instead take the appropriate prerequisite courses. In some cases, such students may require more than eight semesters to complete the requirements for the major.

Milestone 2
Allied Health/Biology: C- or higher in BIOL 280 (Prerequisites: C- in BIOL 240 and CHEM 151)
Biochemistry: C- or higher in BIOL 280 (Prerequisites: C- in BIOL 240 and CHEM 151) and CHEM 252 (Prerequisite: C- in CHEM 251; Corequisite: CHEM 262)
Chemistry: C- or higher in CHEM 300 (Prerequisite: C- in CHEM 152)

Department Policies
The following are policies that apply to all students in courses offered by the department:

- A student must complete all prerequisites for a BIOC, BIOL, or CHEM course with a C- or better before taking the course (except as noted in the course description).
- Students with a total of three unsuccessful attempts (below C-) in any combination of BIOC, BIOL, and CHEM courses will be automatically dropped from subsequent enrollment in department courses.
- Any single BIOC, BIOL, or CHEM course may be taken only two times at APU.
- Students may not earn a chemistry minor if they are majoring in biochemistry, nor may they earn a biology minor if they are majoring in allied health or biochemistry.
- Students missing more than three labs in a course receive an automatic F in the course.
- Courses with labs in an online or correspondence format are not allowed to transfer as BIOC, BIOL, or CHEM courses.

Additional Requirements for Allied Health, Biology, Biochemistry, and Chemistry Majors
All of the following requirements must be met to continue as an allied health, biology, biochemistry, or chemistry major. Failure to maintain these requirements will result in a student being dropped from the major. Reentry to the major is by petition only.

- A minimum cumulative GPA of 2.0 in all biology, chemistry, biochemistry, math, and physics courses required for the major must be maintained.
- A student must complete each BIOC, BIOL, or CHEM course with a C- or higher for the course to meet a degree requirement in the Department of Biology and Chemistry.
- Any single class within the major can be taken only two times at APU; students must change to a major outside the department after two unsuccessful (below C-) attempts in a single required course.
- Only two courses total within the major can be repeated; students must change to a major outside the department after unsuccessful (below C-) attempts in any three required courses.
- All majors are required to take BIOL 496 to meet their General Education Senior Seminar or Writing 3 requirement.
- While courses required of the major may be taken at other accredited institutions, subject to approval via a transfer inquiry form, lecture and laboratory components must be taken at the same institution in the same semester.
- It is strongly recommended that freshmen in all biology majors (including biochemistry) take General Chemistry I (CHEM 151) and General Biology I (BIOL 151) the first year, and that chemistry majors start with General Chemistry I (CHEM 151) and Calculus I (MATH 165) the first year. Should
math placement assessment require algebra of the student, then that course should be taken the first year and a five-year program may be indicated.

- BIOL 151 should be taken by allied health, biochemistry, and biology majors who receive AP biology credit, as many medical schools and graduate programs will not accept AP biology to meet requirements for admission.
- Students may take a maximum of 3 units total from the following courses for elective credit toward the B.S. in Allied Health or the B.S. in Biology:

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<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>BIOL 390</td>
<td>Pre-health Seminar</td>
<td>1</td>
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<td>BIOL 391</td>
<td>Medical Missions Practicum</td>
<td>1</td>
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<tr>
<td>BIOL 490</td>
<td>Biology Seminar</td>
<td>1</td>
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<td>BIOL 497</td>
<td>Readings</td>
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<td>BIOL 498</td>
<td>Directed Research</td>
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- The following courses may not be taken to meet upper-division elective requirements in any major in the department: BIOL 325, BIOL 330, BIOL 400, and BIOL 470.

**Dismissal Policy**

The department will audit student compliance with these policies each semester. Failure to maintain these requirements will result in the student being dropped from the major. Reentry to the major is by petition only.

**General Education Note**

Any health education requirement is waived for allied health, biochemistry, and biology majors.

**Science at the Secondary Level**

Students planning a career in teaching science at the secondary level should prepare for the CSET examination. Students should major in biology, chemistry, or physics to obtain subject-matter proficiency in one of these areas for the specialization test. In addition, to prepare for the breadth part of the test, students should take:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
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<tr>
<td>BIOL 151</td>
<td>General Biology I</td>
<td>4</td>
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<tr>
<td>BIOL 152</td>
<td>General Biology II</td>
<td>4</td>
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<tr>
<td>CHEM 151</td>
<td>General Chemistry I</td>
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<tr>
<td>CHEM 152</td>
<td>General Chemistry II</td>
<td>4</td>
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<tr>
<td>PHYC 130</td>
<td>Earth Science</td>
<td>4</td>
</tr>
<tr>
<td>PHYC 140</td>
<td>Introduction to Astronomy</td>
<td>4</td>
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<td>Select one of the following:</td>
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<td>8-10</td>
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<td>PHYC 151 &amp; PHYC 152</td>
<td>Physics for Life Sciences I and Physics for Life Sciences II</td>
<td></td>
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<tr>
<td>PHYC 161 &amp; PHYC 162</td>
<td>Physics for Science and Engineering I and Physics for Science and Engineering II</td>
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**Biology and Chemistry Fellowships**

Each year, the Department of Biology and Chemistry offers a limited number of fellowships to selected undergraduates to participate in the Student-to-Scholar (S2S) Program (http://www.apu.edu/clas/biochem/fellowships) involving laboratory research with a faculty-mentor.

**Majors**

- Allied Health
  - Allied Health (B.A.) (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/allied-health-major)
  - Allied Health (B.S.) (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/allied-health-major/#bachelorofscienceinalliedhealth)
- Biochemistry (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/biochemistry-major)
• Biology (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/biology-major)
• Chemistry (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/chemistry-major)

Minors

• Biology (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/biology-minor)
• Chemistry (http://catalog.apu.edu/undergraduate/liberal-arts-sciences/biology-chemistry/chemistry-minor)

BIOC 360, Principles of Biochemistry, 4 Units
Lecture, 3 Hours; Lab, 4 Hours: Students gain a systematic and theoretical understanding of the biochemical activities of living cells, including an introduction to the structure, properties, and metabolism of proteins, carbohydrates, lipids, and nucleic acids. The course does not meet the requirements of the biochemistry major. Credit will not be given for both BIOC 360 and BIOC 380, nor for both BIOC 360 and BIOC 381.
Special Fee Applies
Prerequisite: CHEM 252 (C- or higher)

BIOC 380, Biochemistry I, 4 Units
Lecture, 3 hours; Lab, 4 hours: Students gain a systematic and theoretical study of the biochemical activities of living cells in this course. It is an introduction to the structure, properties, and metabolism of proteins, carbohydrates, lipids, and nucleic acids.
Special Fee Applies
Prerequisite: C- in CHEM 252

BIOC 381, Biochemistry II, 4 Units
Lecture, 3 hours; Lab, 4 hours: This course is a continuation of BIOC 380 Biochemistry I. Molecular lab techniques are emphasized.
Special Fee Applies
Prerequisite: C- in BIOC 380

BIOL 90, Laboratory Safety, 0 Units
This course provides an introduction to federal, state, and local regulations, material safety data suggestions, chemical hygiene plan, labels, equipment, spill response, and proper handling and disposal of chemicals as related to an academic laboratory.

BIOL 101, Fundamentals of Biology, 4 Units
Lecture, 3 hours; lab, 3 hours. This basic course covers the themes of cell biology, genetics, ecology, evolution, and human biology. It promotes an appreciation for the unification and interdependence of all life. Does not count toward biology major credit. Meets the General Education Requirement: Natural Science.
Special Fee Applies

BIOL 101H, Fundamentals of Biology - Honors, 4 Units
Lecture, 3 hours; Lab, 3 hours: This basic course covers the themes of cell biology, genetics, ecology, evolution, and human biology. It promotes an appreciation for the unification and interdependence of all life. This class must be taken concurrently with the corresponding lab. It is not applicable for biology majors. Meets the General Education Requirement: Natural Science.
Special Fee Applies
Prerequisite: To enroll in the course, must be a student admitted to the Honors Program and be considered a member in "active" status.

BIOL 109, Introduction to Biological Sciences, 3 Units
Designed for high school students participating in the APU/Azusa USD Summer GATE Program, this course provides an introduction and overview of biology concentrating on cell biology, genetics, kingdoms, and ecology. The emphasis is on basic science principles, their application to real-world situations, and developing the basic skills needed in college.
Prerequisite: High School biology course

BIOL 115, Anatomy and Physiology, 4 Units
Lecture, 3 hours; Lab, 3 hours: This is an introductory course in the principles of anatomy and physiology as they relate to the structure and function of the living human body. It is designed for physical education majors. Does not count toward biology major credit.
Special Fee Applies
Prerequisite: BIOL 101 or BIOL 151. (Nursing Majors: High School Biology and minimum SAT/ACT scores)

BIOL 151, General Biology I, 4 Units
Lecture, 3 hours; Lab, 4 hours; Discussion/Quiz, 1 hour: Principles of cell structure and function, genetics, development, reproduction, and animal systems biology are covered in this introductory course. There is a laboratory emphasis on the investigative approach and experimental techniques of biology. Meets the General Education Requirement: Natural Science.
Special Fee Applies
Prerequisite: B- in BIOL 101 or B in one year of high school biology along with completion or waiver of MATH 95 (for example by a 45 ALEKS)
BIOL 152, General Biology II, 4 Units
Lecture, 3 hours; Lab, 4 hours: This second-semester course deals with behavior, evolution, plant and animal diversity of life, plant biology, and introduction to ecology. There is a laboratory emphasis on plant and animal biology.
Special Fee Applies
Prerequisite: C- in BIOL 151

BIOL 220, General Microbiology, 4 Units
Lecture, 3 hours; Lab, 4 hours: This class is for students majoring in or planning to major in nursing. The focus is on fundamental microbiological principles and laboratory techniques with an emphasis on disease-causing microorganisms, new and old methods of disease treatment and prevention, and host immune responses.
Special Fee Applies
Prerequisite: C- in CHEM 112 or CHEM 123 and Department Consent

BIOL 230, Human Anatomy and Physiology I, 4 Units
This is the first semester of a two-semester course that examines the anatomy and physiology of the human body from an integrated perspective. Topics include basic biological and chemical concepts, tissue types, integumentary, musculoskeletal and nervous systems, and special senses. The laboratory component includes model-based anatomical studies and the examination of physiological processes via the scientific method.
Special Fee Applies
Prerequisite: Kinesiology students only

BIOL 231, Human Anatomy and Physiology II, 4 Units
This is a continuation of the Human Anatomy and Physiology I course. Topics include metabolism and the autonomic nervous, endocrine, cardiovascular, lymphatic, respiratory, urinary and reproductive systems. The laboratory component includes model-based anatomical studies and the examination of physiological processes via the scientific method. Meets the General Education Requirement: Natural Science.
Special Fee Applies
Prerequisite: C- or higher in BIOL 230. Kinesiology students only.

BIOL 240, Biology of Microorganisms, 4 Units
This course covers the fundamental principles and techniques of microbiology, with emphasis on the role of microorganisms in disease, immunity, and food production. Lecture, 3 hours; Lab, 4 hours.
Special Fee Applies
Prerequisite: C- in BIOL 151 and BIOL 152 or BIOL 250, as well as CHEM 151 (May be taken concurrently). Department consent required for all majors outside of the Department of Biology and Chemistry.

BIOL 250, Human Anatomy, 4 Units
This is an intensive course in human anatomy using the systemic approach. Lab exercises utilize human cadaver prosections. Lecture, 3 hours; discussion, 1 hour; lab, 4 hours.
Special Fee Applies
Prerequisite: B- in BIOL 101, or C- in BIOL 151, or preadmitted nursing status and a B in one year of high school biology.

BIOL 251, Human Physiology, 4 Units
Lecture, 3 hours; Lab, 4 hours: This course deals with how human organ systems function and maintain homeostasis. Laboratory exercises include biomedical instrumentation.
Special Fee Applies
Prerequisite: C- in BIOL 250; and C- in CHEM 101, CHEM 123, or CHEM 151 or B in one year of high school chemistry

BIOL 280, Cell Biology, 4 Units
Lecture, 3 hours; Lab, 4 hours; Discussion/Quiz, 1 hour: This course covers a theoretical approach to cellular and molecular biology, including ultra structure, cytology, metabolism, and molecular genetics. Laboratory emphasis is given to electron microscopy, centrifugation, and DNA and protein electrophoresis.
Special Fee Applies
Prerequisite: C- in BIOL 240 and CHEM 151

BIOL 300, Genetics, 4 Units
Lecture, 3 hours; Lab, 4 hours: Principles of heredity, including Mendelian, cytogenetics, population theory, human medical genetics and gene regulation, classical laboratory experimentation, and modern molecular biology techniques, are covered.
Special Fee Applies
Prerequisite: C- in BIOL 280
BIOL 320, Ecology, 4 Units
This course provides an understanding of the relationship of plants and animals to their environment, with particular consideration given to distribution, communities, and population analysis. Lecture, 3 hours; Lab, 4 hours. **Meets the General Education Requirement: Civic Knowledge and Engagement.**

Special Fee Applies

**Prerequisite:** C- in BIOL 152 and BIOL 280; Upper-division status.

BIOL 325, Humans and the Environment, 4 Units
Through lecture and lab experience students study the historical, biblical, and scientific aspects of the environment with particular emphasis on the impact of humans on God’s world. Students explore a variety of environmental aspects related to economics, global studies, and missiology in individual studies/papers. Does not count toward biology major credit. **Meets the General Education Requirement: Natural Science.**

BIOL 325H, Humans and the Environment - Honors, 4 Units
Through lecture and lab experience students study the historical, biblical, and scientific aspects of the environment with particular emphasis on the impact of humans on God’s world. Students explore a variety of environmental aspects related to economics, global studies, and missiology in individual studies/papers. Does not apply for biology major credit. **Meets the General Education Requirement: Natural Science.**

**Prerequisite:** To enroll in the course, must be a student admitted to the Honors Program and be considered a member in “active” status.

BIOL 326, Neurobiology, 4 Units
Lecture, 3 hours; Lab, 4 hours: Students undertake a detailed study of the structure and function of animal nervous systems. Special emphasis is given to the anatomy and neurophysiology of reflexes, motor pathways, senses, and neurological diagnosis. This course is designed for students oriented toward the health sciences.

Special Fee Applies

**Prerequisite:** C- in BIOL 280

BIOL 330, Gender Differences, 3 Units
Lecture/Discussion, 3 hours: This course examines in detail differences in gender. Realizing gender differences are related to one’s chronological age, these differences are studied from the biological, psychological, sociological, and theological perspectives and understood that each perspective influences the others. Does not count toward biology major credit.

BIOL 336, Vertebrate Biology, 4 Units
Lecture, 3 hours; Lab, 4 hours: This course provides a comprehensive survey of the natural history, anatomy, and systematics of vertebrate animals - fish, amphibians, reptiles, birds, and mammals. Laboratory will include training in dissection skills and experience with a human cadaver.

Special Fee Applies

**Prerequisite:** C- in BIOL 152

BIOL 340, Invertebrate Biology, 4 Units
Lecture, 3 hours; Lab, 4 hours: The classification, natural history, and functional morphology of invertebrate phyla are studied.

**Prerequisite:** C- in BIOL 152

BIOL 342, Medical Microbiology, 3 Units
This lecture course emphasizes the importance of microbiology to medicine and applied areas of science. The spectrum of infectious agents, host response, current diagnostic methodologies, and recent advances/problems in diagnosis and treatment are covered.

**Prerequisite:** C- in BIOL 240 and BIOL 280

BIOL 346, Regional Human Anatomy, 4 Units
Lecture, 3 hours; Discussion, 1 hour; Lab, 4 hours: This is a dissection-based course in human anatomy, utilizing cadavers and a regional approach to study the human body. Upon completion, students will be able to identify major skeletal, muscular, nervous, and vascular structures, organs, and the relationships of these structures to each other in each body area. They will learn the flow of blood from the heart through vascular structures to organs and limbs, understand the structure and significance of the cervical, brachial, and lumbosacral plexuses, and be able to explain the actions of muscles based on origin and insertions. Students will gain skills in dissection and in collaboration with colleagues to dissect and present findings to the class. Finally, students will gain an appreciation of the intricacy and detail of the human body, the importance of precision and accuracy in experimental work, and the value of collaborative learning.

Special Fee Applies

**Prerequisite:** C- in BIOL 151 and BIOL 280

BIOL 350, Mammalian Physiology, 4 Units
Lecture, 3 hours; Discussion, 1 hour; Lab, 3 hours: This course offers an analysis of physiological mechanisms in animals with emphasis on the function at the organ systems level. This course is appropriate for those preparing for medical school and related graduate study. Introductory experiences applying physiological principles to clinical medicine are covered.

Special Fee Applies

**Prerequisite:** C- in BIOL 280
**BIOL 365, Plant Biology, 4 Units**  
Lecture, 3 hours; Lab, 4 hours: This course introduces botanical research topics, including plant classification, genetics, structure and function, growth and development, and evolution and ecology. It integrates themes and processes of the California State Science framework.  
**Prerequisite:** C- in BIOL 280

**BIOL 370, Prosection, 1 Unit**  
Students are introduced to the human body through gross dissection and demonstration of selected portions of a human cadaver. This course requires 30 hours of laboratory.

**BIOL 390, Pre-health Seminar, 1 Unit**  
This course provides a background to the Biblical, historical and philosophical aspects of healthcare as well as an understanding of the reasons to pursue a career in the field. The course also covers the key principles required for success in applying for and matriculation into graduate programs in healthcare fields such as writing effective personal statements and interviewing well.  
**Prerequisite:** Junior standing

**BIOL 391, Medical Missions Practicum, 1 Unit**  
Lecture/Discussion, 1 hour: This course offers a practicum experience for students preparing for a career in the medical/health-related sciences. Didactic medical-clinical instruction in first aid, assessment, and medical history is emphasized. Students gain practical field experience as Team Luke members with Mexico Outreach.  
**Prerequisite:** BIOL 101, BIOL 151, or BIOL 250

**BIOL 395, Science Internship, 1-3 Units**  
This course gives students an opportunity to apply knowledge gained in the academic setting to the real world by allowing them to establish either paid or volunteer science-related internships with local business, organizations, etc. Students gain a realistic view of their career goals, explore possible career choices, and gain valuable experience under the guidance of their job supervisor and academic supervisor.  
**Prerequisite:** C- or higher in BIOL 280 and CHEM 240 or CHEM 251; Junior standing and instructor consent

**BIOL 396, Topics in Biology and Christian Thought, 1 Unit**  
This course covers the basic ideas behind the Creation/evolution and Creation care discussions. Students are exposed to, and are asked to critically evaluate the scientific, philosophical, and theological foundations of these two debates.  
**Prerequisite:** BIOL 151, CHEM 152, UBBL 100 or UBBL 230, Junior Level Standing

**BIOL 400, Science and Children, 4 Units**  
Lecture, 3 hours; Lab, 3 hours: This course is designed for liberal studies majors interested in obtaining a Multiple-Subject Teaching Credential. It assists the student in developing knowledge and skills in science content for teaching science concepts and processes emphasized in the California State Science Framework, K-6. Does not count toward biology major credit.  
**Special Fee Applies**

**BIOL 410, Molecular Biology, 4 Units**  
Lecture, 3 hours; Lab, 4 hours: This course covers the traditional molecular biology curriculum which includes transcription, translation, and gene expression in both prokaryotes and eukaryotes. Lecture includes theory on key molecular techniques. Laboratory exercises emphasize current techniques in molecular biology such as molecular cloning, blotting, PCR, and assays of gene expression.  
**Prerequisite:** C- in BIOL 280

**BIOL 435, Stewardship Ecology, 3 Units**  
The history of humankind's view of nature and the resulting treatment of nature that arise from such views are examined. The biblical approach known as stewardship ecology is developed and supported as a foundation for the student's approach to this field.  
**Prerequisite:** C- in BIOL 320

**BIOL 440, Developmental Biology, 3 Units**  
Lecture/Lab/Discussion, 3 hours: This is a study of the origin, morphology, and chemical control of developing germ layers, tissues, and systems of the body.  
**Prerequisite:** BIOL 280 (C- or higher)

**BIOL 450, Histology, 4 Units**  
Lecture, 3 hours; Lab, 4 hours: This course teaches the structure and function of animal tissues. Emphasis is on preparation and recognition techniques of cell and tissue structure.  
**Prerequisite:** C- in BIOL 280

**BIOL 454, Electron Microscopy for Biological Sciences, 2 Units**  
This lecture course deals with theory and principles of various microscopy methods, with emphasis given to electron optics, specimen preparation, and operation of transmission and scanning electron microscopes and ultrastructure analysis.  
**Prerequisite:** PHYC 151, PHYC 152 or instructor consent
BIOL 455, Laboratory in Electron Microscopy, 2 Units
This companion course to BIOL 454 covers biological and medical specimen preparation techniques and basic photographic protocol. Current laboratory instrumentation, dealing with both scanning and transmission electron microscopy, is emphasized.
Prerequisite: BIOL 280 or BIOL 454 (may be taken concurrently)

BIOL 465, Practicum and Topics in Allied Health, 4 Units
Lecture/discussion, 3 hours; lab, 4 hours. This course deals with diagnosis strategies, prevention, and rehabilitation programs integral to the field of allied health. An emphasis on research literature facilitates the student's development of knowledge, aptitudes, and skills within the allied health field. The clinical laboratory component emphasizes current instrumentation and practice. Special Fees Applies. Meets the General Education Requirement: Integrative and Applied Learning.
Prerequisite: C- in BIOL 280 or KIN 490; C- in BIOL 250, BIOL 336, or BIOL 230; BIOL 251, BIOL 350, or BIOL 231 (may be taken concurrently)

BIOL 470, Science for the MCAT, 1 Unit
This course builds on lower-division courses in general and organic chemistry, biology, and physics to prepare students for the basic science content contained in the Medical College Admission Test (MCAT). Additional topics in genetics, biochemistry, physiology, and physics are presented and integrated with practical mathematical skills in an interactive problem-solving setting. The course is intended for students with upper-division standing and acceptance to a premedical program. This course may be repeated for 2 units of credit.

BIOL 490, Biology Seminar, 1 Unit
This course consists of review and discussion of current periodical literature. Written and verbal presentations are required.
Prerequisite: Junior or Senior Standing

BIOL 494, Advanced Topics in Biology, 4 Units
This course presents advanced coverage of topics in physiology or other biological sciences. The course may be repeated for credit when different topics are offered. Lecture plus laboratory.
Prerequisite: C- or higher in BIOL 280; Jr or Sr Standing

BIOL 495, Advanced Topics in Biology, 3 Units
This course presents advanced coverage of topics in physiology or other biological sciences. The course may be repeated for credit when different topics are offered. Lecture only.
Prerequisite: C- or higher in BIOL 280; Jr or Sr Standing

BIOL 496, Writing 3: Ethics and the Sciences, 3 Units
This course covers the basics of worldviews, science, and ethics, while delving deeper into the details of various ethical perspectives and their implications for science. Specific areas of science are explored from a Christian ethics viewpoint through lectures, writing instruction, a thesis, and oral presentations. Meets the General Education Requirement: Writing 3: Writing in the Disciplines.
Prerequisite: Writing 2 and a C- or higher in one of the following: BIOL 280, CHEM 252, or CHEM 240

BIOL 497, Readings, 1-3 Units
This is a program of study concentrating on assigned readings, discussions, and writing arranged between and designed by, a university student of upper-division standing and a full-time professor. An independent study fee is assessed for each enrollment in this class. May be repeated subject to department policies.

BIOL 498, Directed Research, 1-3 Units
This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log writing, and seminar presentation within the department or in a university research symposium. No more than one unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment. May be repeated subject to department policies.
Prerequisite: Junior or Senior Standing

BIOL 498H, Directed Research- Honors, 1-3 Units
This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log writing, and seminar presentation within the department or in a university research symposium. No more than one unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment. May be repeated subject to department policies.
Prerequisite: Honors College, Junior or Senior standing

CHEM 90, Laboratory Safety, 0 Units
Students are introduced to federal, state, and local regulations, material safety data suggestions, chemical hygiene plans, labels, equipment, spill response, proper handling, and disposal of chemicals as related to an academic laboratory.
CHEM 101, Introduction to Chemistry, 4 Units
Lecture, 3 hours; Lab, 3 hours: This elementary course is designed for the student with no previous high school or college chemistry. Prepares the student for CHEM 123 or CHEM 151. Meets the General Education Requirement: Natural Science.
Special Fee Applies

CHEM 105, Citizen Chemistry, 4 Units
Lecture, 3 hours; Lab, 3 hours: This course is designed for nonscience majors and presents chemistry in its broad cultural, social, and economic context. The lectures and laboratories cover experiences that are of concern to students' everyday lives.

CHEM 123, General, Organic, and Biological Chemistry for the Health Sciences, 4 Units
This course covers an overview of general, organic, and biological chemistry topics with a particular emphasis on health science applications. Topics include radioactivity, intermolecular forces, solution behavior, acids and bases, nomenclature, physical characteristics of organic compounds, and selected reactions with focus on the simple organic functional groups and carbonyl chemistry. The biochemistry topics cover chemical reactions and physiological significance of cellular macromolecules including proteins, enzymes, nucleic acids, and metabolism. Meets the General Education Requirement: Natural Science.
Prerequisite: C- in CHEM 101 or Pre-admitted Nursing status and B in one year of high school chemistry

CHEM 151, General Chemistry I, 4 Units
Lecture, 3 hours; Lab, 4 hours. This is a foundational course for science majors and the first of a two-semester sequence covering the basic laws and concepts of modern chemistry. Topics include atomic structure, chemical bonding, thermochemistry, stoichiometry, chemical reactions, solution chemistry, nuclear chemistry, and the behavior of gases. Meets the General Education Requirement: Natural Science.
Special Fee Applies
Prerequisite: B- or higher in CHEM 101 or B or higher in one year of high school chemistry. B- or higher in MATH 110 or equivalent.

CHEM 151H, General Chemistry I - Honors, 4 Units
Lecture, 3 hours; Lab, 4 hours. This is a foundational course for science majors and the first of a two-semester sequence covering the basic laws and concepts of modern chemistry. Topics include atomic structure, chemical bonding, thermochemistry, stoichiometry, chemical reactions, solution chemistry, nuclear chemistry, and the behavior of gases. Meets the General Education Requirement: Natural Science.
Special Fee Applies
Prerequisite: C- in MATH 110, and C- in CHEM 101 or B in one year of high school chemistry. Must also be a student admitted to the Honors College and be considered a member in "active" status.

CHEM 152, General Chemistry II, 4 Units
Lecture, 3 hours; Lab, 4 hours. This is a foundational course for science majors and the first of a two-semester sequence covering the basic laws and concepts of modern chemistry. Topics covered include solution chemistry, chemical kinetics, equilibrium, acid-base theory, thermodynamics, and electrochemistry.
Special Fee Applies
Prerequisite: C- in CHEM 151

CHEM 152H, General Chemistry II - Honors, 4 Units
Lecture, 3 hours; Lab, 3 hours; Discussion, 2 hours: This is a continuation of CHEM 151 General Chemistry begun in the fall. Topics covered include solution chemistry, chemical kinetics, equilibrium, acid-base theory, thermodynamics, and electrochemistry. This class must be taken concurrently with the corresponding lab.
Special Fee Applies
Prerequisite: CHEM 151. Must also be a student admitted to the Honors College and be considered a member in "active" status.

CHEM 240, Introduction to Organic and Biochemistry, 4 Units
Lecture, 3 hours; Lab, 3 hours: Students are introduced to the names, properties, and reactions of organic functional groups with applications to biochemical monomers and macromolecules.
Special Fee Applies
Prerequisite: C- in CHEM 152

CHEM 251, Organic Chemistry - Theory I, 4 Units
This is a general course in bonding theory, structure analysis, isomers, nomenclature, physical properties, functional groups, fundamental reaction mechanisms, stereochemistry, spectroscopy, and synthesis of hydrocarbons. The laboratory course CHEM 261 must be taken concurrently with CHEM 251.
Prerequisite: C or better in CHEM 152; must be taken concurrently with CHEM 261

CHEM 252, Organic Chemistry - Theory II, 4 Units
This is a general course in the spectroscopy, physical properties, reaction mechanisms, thermodynamics, kinetics, aromaticity, and fundamental reaction mechanisms of hydrocarbons, carbonyl compounds, and biological macromolecules. The laboratory course CHEM 262 must be taken concurrently with CHEM 252.
Prerequisite: C- in CHEM 251, CHEM 262 (may be taken concurrently)
CHEM 261, Organic Chemistry - Lab, 1 Unit
Techniques of determining chemical and physical properties and synthesis of organic compounds are the focus of laboratory study. Must be taken concurrently with CHEM 251.
Special Fee Applies
Corequisite: CHEM 251

CHEM 262, Organic Chemistry - Lab, 1 Unit
Techniques of determining chemical and physical properties and synthesis of organic compounds are the focus of laboratory study.
Special Fee Applies
Corequisite: CHEM 252

CHEM 300, Quantitative Chemical Analysis - Theory, 2 Units
The theoretical basis of gravimetric and volumetric analyses are covered in this course. Topics include multiequilibria, acid-base equilibria, and redox reactions as applied to quantitative analysis.
Prerequisite: C- in CHEM 152

CHEM 310, Quantitative Chemical Analysis - Laboratory, 2 Units
This is a laboratory course in the analysis of materials by the methods studied in CHEM 300.
Corequisite: CHEM 300

CHEM 320, Instrumental Analysis - Theory, 3 Units
The theory and operation of modern analytical equipment are covered in this course, including electrochemical methods; UV-visible, infrared, and flame emission spectrophotometry; chromatographic methods; and others. Meets the General Education Requirement: Writing 3 if taken with CHEM 330.
Prerequisite: C- in CHEM 152

CHEM 330, Instrumental Analysis - Lab, 1 Unit
In this laboratory course, students analyze materials by the methods studied in CHEM 320. Meets the General Education Requirement: Writing 3: Writing in the Disciplines.
Prerequisite: CHEM 320

CHEM 390, Physical Biochemistry, 3 Units
The physical and chemical theories of thermodynamics, equilibria, kinetics, and spectroscopy are examined in the context of the chemical and physical properties of a living cell.
Prerequisite: C- in BIOC 360 or BIOC 380

CHEM 395, Chemical Science Internship, 1-3 Units
This course gives students an opportunity to apply knowledge gained in the academic setting to the real world by allowing them to establish either paid or volunteer science-related internships with local businesses and organizations. Under the joint direction of the instructor and an on-site supervisor, students gain hands-on experience as well as realistic views of potential career fields in chemical sciences.
Prerequisite: CHEM 251, CHEM 252, CHEM 261, CHEM 262, CHEM 300, CHEM 310; GPA 3.0 or higher; Instructor consent.

CHEM 401, Physical Chemistry I, 3 Units
An advanced course covering the theoretical basis of thermodynamics, including the laws of thermodynamics and their applications. Topics include energy, enthalpy, entropy, gas laws, kinetic model of gases, phases, chemical potential, and the kinetics of chemical reactions.
Prerequisite: C in CHEM 152 and C- in MATH 161

CHEM 402, Physical Chemistry II, 3 Units
An advanced course covering the Schrodinger equation and its applications to the particle in a box, the rigid rotor, and the harmonic oscillator. Once a firm foundation has been established in the underlying theories of quantum mechanics, they are applied to atomic and molecular structure, vibrational and electronic spectroscopy, and computational chemistry.
Prerequisite: C- in CHEM 401 and C- in MATH 162; Recommended: PHYC 152 or PHYC 162

CHEM 411, Physical Chemistry I Lab, 1 Unit
This is an upper-level laboratory over one semester on thermodynamics and kinetics and their applications. Laboratories include experiments, theoretical calculations, and mathematical methods recitations on the topics of partial molar volume, calorimetry, phase diagrams, electrochemistry, kinetics, colligative properties, molecular dynamics, and partial derivatives.
Special Fee Applies
Corequisite: CHEM 401
CHEM 412, Physical Chemistry II Lab, 1 Unit
This is an upper-level laboratory over one semester on quantum mechanics and its applications. Laboratories include experiments, theoretical calculations, and mathematical methods recitations on the topics of linear algebra, multivariable calculus, symmetry, probability, Planck temperature distribution, photoelectric effect, quantum dots, spectroscopy, particle in a box, and molecular orbitals.
Special Fee Applies
Corequisite: CHEM 402

CHEM 451, Advanced Organic Chemistry, 4 Units
This course covers advanced physical organic chemistry, modern organic synthesis strategies, reaction mechanisms, and bonding theories.
Prerequisite: CHEM 252

CHEM 461, Inorganic Chemistry, 3 Units
This course lays a foundation in the subjects of atomic structure, bonding theory, symmetry theory, and acid-base chemistry, which is then used to explore advanced topics involving crystalline compounds, coordination compounds, and organometallic compounds. Topics include bonding, spectroscopy, and kinetics.
Prerequisite: C- in CHEM 252

CHEM 490, Chemistry Seminar, 1 Unit
The seminar consists of reviews, reports, and discussions on current scientific literature.
Prerequisite: Senior Standing

CHEM 495, Advanced Topics in Chemistry, 3-4 Units
This course presents advance coverage of topics in chemistry. Course credit is 4 units when a laboratory component is included. The course may be repeated for credit when different topics are offered.
Prerequisite: Junior Standing

CHEM 497, Readings, 1-4 Units
This is a program of study concentrating on assigned readings, discussions, and writing arranged between and designed by a university student of upper-division standing and a full-time professor. An independent study fee is assessed for each enrollment in this class. May be repeated subject to department policies.

CHEM 498, Directed Research, 1-4 Units
This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log writing, and seminar presentation within the department or in a university research symposium. No more than one unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class. May be repeated subject to department policies listed above.
Prerequisite: Junior or Senior Standing

CHEM 498H, Directed Research- Honors, 1-4 Units
This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log writing, and seminar presentation within the department or in a university research symposium. No more than one unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class. May be repeated subject to department policies.
Prerequisite: To enroll in the course, must be a student admitted to the Honors Program and be considered a member in "active" status.

Faculty
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