Life Sciences Concentration

OVERVIEW

The Life Sciences (LS) concentration will feature an interdisciplinary curriculum that provides a solid foundation in the sciences with courses that embody the latest discoveries in biology and chemistry and a pedagogy that challenges students to apply what they have learned to realistic scenarios. Within the Life Sciences concentration, students will practice science through authentic research experiences that train students in experimental design, data collection and analysis, and presentation of experimental results.

To fulfill the LS concentration requirements, students will take two foundational courses that are prerequisites for most upper level LS courses: Foundations of Chemistry (CHEM 150) and Integrated Biology and Chemistry (IBC 200). These two courses can either fulfill the physical science and biological science general education requirements, or they may count as LS concentration courses; they cannot be double-counted.

Students concentrating in Life Sciences will also be required to take at least one Project-Based Laboratory (PBL) course and a minimum of two additional 300 or 400-level concentration courses. LS students will also complete a capstone project with a scientific focus. Students are able to fulfill their concentration requirements in either a focused or broad fashion from course offerings within the fields of biology and chemistry, or through courses from other concentrations that are cross-listed with Life Sciences.

When Life Sciences students graduate, they should be able to

1. Demonstrate technical laboratory skills through the generation of novel data in the context of authentic course- based research
2. Demonstrate problem-solving and experimental design skills
3. Acquire and synthesize scientific knowledge
4. Communicate science effectively

One goal of the Life Sciences Concentration is to prepare students for post-graduate study in medical and affiliated health fields (dental, veterinary, physical therapy, physician's assistant, nursing, pharmacy, etc) or graduate study toward a doctoral degree in the sciences. In addition, students should be well-prepared to directly enter the workforce after graduation in biotechnology, basic or medical research, or pharmaceutical careers as laboratory technicians. Students will also be able to use their scientific training in diverse careers, such as those related to policy, communication, law, forensics, education, and food science.

Some LS courses have redundant and overlapping content with some Science and Mathematics general education courses. Therefore, enrollment in certain LS courses will prevent co- or later enrollment in some general education Science and Mathematics courses. Please check course catalog descriptions carefully.

Topics (290), Advanced Topics (390, 490), Special Study (298, 398, 498), and Independent Study (299, 399, 499) courses may be offered as needed at 1-4 units.

Life Sciences Concentration Classes

BIO 205: Biostatistics

This course is an introduction to statistics, a field which involves the collection, organization, analysis, interpretation, and presentation of continuous or categorical data. This course is designed for students in the Life Sciences concentration and students interested in medical careers who are not in Life Sciences. This course will focus specifically on biological and chemical examples and datasets.

Units: 3
Prerequisites:

IBC 200

BIO 301: Genetics

This course will take an in-depth analysis of prokaryotic and eukaryotic genetics at the level of molecular, cellular, organismal, and population genetics. Data analysis will rely on a quantitative approach. An integrated laboratory project will utilize basic genetic techniques.

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

BIO 302: Genomics and Bioinformatics

Bioinformatics is the use of computer databases and algorithms to analyze biological data. This course will apply bioinformatics to the field of genomics: the study of the protein, mRNA, and DNA sequences that comprise an organism's genome. Topics will include sequence databases, pairwise and multiple sequence alignments, genome browsers, genome assembly and annotation, molecular evolution, phylogenetic analysis, and population genetics. The computer-based laboratory component will provide students with training in several command-line and web-based bioinformatics tools.

Units: 3
Prerequisites:
Instructor consent.

BIO 303: Human Physiology

This course will explore the fascinating workings of the human body in both form and function. We will take a tour of the major organ systems and learn about how they work together to maintain homeostasis. This tour will include the respiratory system, circulatory system, digestive system, including energy and metabolism, immune system, urinary system, reproductive system, and finally, how these systems communicate with one another via the endocrine system and nervous system. This course will use a combination of lectures, class discussions, and group activities that involve case studies, physiology experiments, and dissections. This course will be useful for those who are planning on pursuing a career in the health sciences.

Prevents co- or later enrollment in BIO 120.

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

BIO 304: Evolutionary Biology

Theodosius Dobzhansky famously said, "Nothing in biology makes sense except in the light of evolution." Evolution is genetic change over time, and as genes change, so does the organism. This course will explore microevolution, which is evolution at the population level, and macroevolution, which is evolution at the species level and higher. An example microevolutionary question is: Why does a male peacock have such a large tail when it makes him more vulnerable to predation? An example macroevolutionary question is: Why do some modern humans have gene variants that originated in Neanderthals?

Units: 3

Prerequisites:
Instructor consent.

BIO 305: Cell Biology

This course will enable students to describe cellular contents in terms of membranes, organelles, and intracellular trafficking; recognize amino acids, their modifications, and the implications on protein structure and function; describe cellular biochemistry including basic enzyme kinetics, glycolysis, TCA cycle, oxidative phosphorylation, photosynthesis, fermentation, and alternative pathways; manipulate signaling pathways from extracellular or intracellular stimuli to generate a cellular response; describe how cells divide and die, specifically in terms of protein regulation of these pathways; and apply all these normal cellular processes to neurobiology and its pathology. A laboratory component will practice basic tissue culture techniques by imaging cellular proteins under different signaling conditions.

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

BIO 306: Zoology

Prevents co- or later enrollment in BIO 135.

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

BIO 307: Microbiology

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

BIO 309: Ecology

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

BIO 310: Fundamentals of Molecular Structural Biology

Have you ever wondered how scientists determine the three-dimensional structure of nucleic acids and proteins? Or what can be gleaned about the function of a macromolecule from its structure? Focusing on nucleic acids and proteins, this course includes an introduction to structural bioinformatics, methods of macromolecular structure determination by diffraction and spectroscopic techniques, and the visualization and representation of biomolecules. Representative biomolecules provide the framework for the discussion of such concepts as motifs, domains, folds, conformation, molecular assembly, dynamics and recognition, as well as for addressing how specific biological questions are answered at the atomic level.

Units: 3
Prerequisites:
CHEM 150
IBC 200

BIO 350: Project-Based Lab I

Using techniques relevant to ecology and evolutionary biology, this laboratory-intensive course will focus on primary literature research, experimental design, data collection and analysis, and science communication.

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

BIO 351: Project-Based Lab III

Using techniques relevant to cell and molecular biology, this laboratory-intensive course will focus on primary literature research, experimental design, data collection and analysis, and science communication.

Units: 3
Prerequisites:
CHEM 150 and IBC 200.

CHEM 301: Organic Chemistry I

This course provides a fundamental overview of organic chemistry to students interested in pursuing careers in the sciences, engineering, or medical fields. We will explore the relationship between the structure and function of molecules, the major classes of organic compounds, and their reactions and reaction mechanisms. Students will learn how to determine molecular structure via spectroscopic techniques. In the laboratory, students will be introduced to some techniques and procedures for the isolation, purification, and characterization of organic compounds and to some of the reactions used in the organic chemistry laboratory such as the Grignard, elimination, and substitution reactions.

Units: 4
Prerequisites:
CHEM 150

CHEM 302: Organic Chemistry II

This course is continuation of CHEM 301 that provides a deeper overview of organic chemistry to students interested in pursuing careers in the sciences, engineering, or medical fields. We will specifically explore the synthesis and reaction mechanisms of aromatic compounds and organic molecules with carbonyl and carboxylic acid functional groups. Students will learn how to plan for multi-step synthetic pathways to form a given organic molecule and the reaction mechanisms involved. A complementary laboratory will reinforce content.

Units: 3
Prerequisites:
CHEM 150
CHEM 301

CHEM 303: Advanced Chemistry

Units: 4
Prerequisites:
CHEM 150 and IBC 200 or instructor consent.

CHEM 304: Nanochemistry in Medicine

Units: 4
Prerequisites:
CHEM 150 and IBC 200.

CHEM 340: Biochemistry

We will learn, in detail, how the cell uses just a few types of raw materials to construct complex structures. Some have evolved to catalyze chemical reactions with a high degree of selectivity and specificity; we will uncover their enzymatic strategies. Living things harvest energy from their environment to fuel metabolic processes, reproduce, and grow; we will keep account of these transactions and consider the exquisite control that permits a cell to be responsive and adapt its responses to inputs from the environment. Key topics: protein structure and function, thermodynamics, enzyme mechanisms, transport, signaling, intermediary metabolism, and regulation. (Recommended prerequisite for medical school admissions.)

Units: 3
Prerequisites:
CHEM 150, IBC200, and CHEM301.

CHEM 350: Project-Based Lab II

Using techniques relevant to biochemistry, this laboratory-intensive course will focus on primary literature research, experimental design, data collection and analysis, and science communication.
Units: 3
Prerequisites:
CHEM 150 and IBC 200.

CHEM 351: Project-Based Lab IV

Using techniques relevant to chemistry, this laboratory-intensive course will focus on primary literature research, experimental design, data collection and analysis, and science communication.
Units: 3
Prerequisites:
CHEM 150 and IBC 200.

IBC 200: Integrated Biology and Chemistry with Lab

This interdisciplinary course will focus on the molecular biology of cancer and the underlying chemistry of cell biology. Students will learn how proteins are encoded and the impact of genomic instability on protein structure and function; alterations of normal metabolism in cancer cells; and basic pathways of cell division and death. Complementary chemistry topics include chemical structure and bonding, biological polymerization, thermodynamics, enzyme kinetics, and redox reactions. Laboratory research will use model systems to understand cancer biology. *Intended for Life Sciences concentrators and those planning to pursue post-graduate science or health programs.*

Units: 4
Prerequisites:
CHEM 150 or instructor consent.
Program: ChemistryBiologyPhysical Science

PHYS 180: Physics for Life Sciences I

Units: 3

PHYS 181: Physics for Life Sciences II

Units: 3

CAPSTONE 390

This is a 1 unit P/NP course where students will select and work with a faculty mentor to complete a proposal for the capstone research project.

Units: 1

CAPSTONE 400: Capstone I

All SUA students participate in a capstone research project over the last block and semester of their senior year. This research project is intended to be a culminating experience, drawing upon the skills and expertise that they have developed during their career at SUA. Each student works with a faculty mentor to propose, develop, and carry out a research project. Students meet regularly with their capstone mentor for support and feedback.

Units: 4
Prerequisites:
Senior standing. CAPSTONE 390. Instructor Consent Required. This course cannot be taken on a P/NP basis.

CAPSTONE 450: Capstone II

Continues Capstone I. All SUA students will participate in a capstone research project over the last block and semester of their senior year. This research project will be a culminating experience, drawing upon the skills and

expertise that they have developed during their career at SUA. Each student will work with a faculty mentor to propose, develop and carry out a research project. Students will meet regularly with their capstone mentor for support and feedback.

Units: 4
Prerequisites:
Senior Standing or CAPSTONE 390. Instructor consent required. This course cannot be taken on a P/NP basis.