BIOL 0001 - GENERAL BIOLOGY

Catalog Description

Prerequisite: Completion of CHEM 1A, CHEM 3A/3B, or higher level chemistry course with grade of "C" or better; AND completion of intermediate algebra or higher with grade of "C" or better or appropriate placement; AND eligibility for ENGL 11
Advisory: Eligibility for ENGL 1A
Hours: 108 (54 lecture, 54 laboratory)
Description: Part of the BIOL 1/BIOL 140 and BIOL 1/BIOL 2/BIOL 3 course series for life science majors. Introduction to the principles of general biological concepts including the scientific method, biomolecules, cell structure and function with emphasis on cellular and molecular biology, genetics, and evolution. Lab focuses on key concepts of cell and molecular biology. Non-life science majors see BIOL 10 or BIOL 11. (C-ID BIOL 190) (CSU, UC)

Course Student Learning Outcomes

- CSLO #1: Perform and design investigations using appropriate methods, instruments, and techniques, including the main steps of scientific inquiry.
- CSLO #2: Explain the mechanisms of microevolution and describe the reproductive barriers that cause speciation.
- CSLO #3: Describe the structure and function of DNA and explain the various patterns of gene inheritance.
- CSLO #4: Describe the factors that regulate populations and impact biodiversity on earth.
- CSLO #5: Describe the major cellular processes, including gene expression, mitosis and meiosis, cellular respiration, fermentation and photosynthesis.

Effective Term

Fall 2024

Course Type

Credit - Degree-applicable

Contact Hours

108

Outside of Class Hours

108

Total Student Learning Hours

216

Course Objectives

Lecture Objectives:
Student will successfully:
1. Explain the main characteristics of life and the major areas of study in modern Biology;
2. Identify the main steps of scientific inquiry; correctly apply hypothetico-deductive reasoning and the principle of falsifiability to biological systems; explain the difference between a scientific hypothesis and a scientific theory;
3. List the major classes of organic molecules essential to living cells; describe the major biological functions of each group and their basic chemical structure; distinguish between a macromolecule and a polymer; reproduce the structural formulas of basic mono- and polysaccharides, triglycerides, polypeptides, and polynucleotides;
4. Identify the major structural components (organelles) of a living cell (eukaryotic and prokaryotic); compare and contrast the structure and function of a prokaryotic and a eukaryotic cell, as well as that of a typical animal and plant cell; formulate the Cell Theory;
5. Describe the main membrane processes in a living cell; evaluate the fluid-mosaic model of the plasma membrane; distinguish between passive and active transport; distinguish between simple diffusion and facilitated diffusion;
6. State the First and the Second Laws of Thermodynamics; apply the knowledge of these laws to the living systems; analyze the concept of entropy and free energy as they relate to the living systems; evaluate the role of ATP and enzymes in metabolic reactions;
7. Describe the structure of a typical photosynthetic cell and outline the main stages of photosynthesis; analyze oxidation-reduction reactions taking place in photosynthetic cells; describe the role of pigments in photosystems; evaluate the outcome of light reactions and Calvin cycle during C3 photosynthesis; outline the alternative mechanisms of carbon fixation (C4, CAM), and evaluate their adaptive significance;
8. Evaluate the role of photosynthesis and respiration in the cycling of chemicals and flow of energy in ecosystems; describe the main stages of respiration reactions in a living cell; summarize the reactions of glycolysis, transition step, and citric acid cycle; diagram the processes of electron transport and oxidative phosphorylation in a mitochondrion; compare and contrast electron movement in a chloroplast and a mitochondrion;
9. Describe lactic acid and alcohol fermentation reactions; evaluate the adaptive significance of different fermentation pathways;
10. Evaluate the importance of cell signaling in single-celled and multicellular organisms; describe the three stages of cell signaling; give examples of the typical receptors and messenger molecules involved in cell signal reception, transduction, and response;
11. Describe the stages of a typical cell cycle in a eukaryotic and prokaryotic cell; discuss the structure of a eukaryotic chromosome; describe the stages of mitosis;
12. Evaluate different life cycles in eukaryotes; assess the adaptive significance of sexual reproduction; describe main stages of oogenesis and spermatogenesis in animals; discuss the significance of genetic recombination during meiosis;
13. Outline the main principles of Mendelian genetics; analyze the concept of dominance as it relates to modern understanding of heredity; solve simple genetic problems using different approaches, such as Punnett square and probabilities; discuss exceptions to Mendelian rules (incomplete dominance, pleiotropy, co-dominance, multiple alleles, linkage, gene-gene interaction, phenotypic plasticity); evaluate patterns of inheritance of main human genetic disorders using pedigree analysis;
14. Analyze the chromosomal basis of inheritance; outline chromosomal mutations/abnormalities in humans and other animals; relate the concept of linked genes and genetic recombination to construction of chromosome maps;
15. Discuss events leading to discovery of three-dimensional structure of DNA; analyze the relationship between DNA structure and its function in a living cell; outline the main steps and the enzymes involved in DNA replication using prokaryotic model; discuss different types of RNA and their role in regulation of gene expression;

16. State the "Central Dogma" of Molecular Biology; list stages of gene expression in a eukaryotic and a prokaryotic cell; evaluate the properties of genetic code; assess potential consequences of different types of point mutations on resulting proteins;
17. Analyze the logistic and ethical issues of modern recombinant DNA technology; describe the steps used in creating recombinant DNA with bacterial vectors; explain how techniques such as gel electrophoresis and PCR are used in biotechnology;
18. Discuss the history of evolutionary thought in 18th-20th centuries; compare and contrast contributions of James Hutton, Charles Lyell, J.-B. Lamarck, George Cuvier, Charles Darwin, Alfred Wallace, and others on the development of the theory of biological evolution; analyze main agents of microevolution (mutation, nonrandom mating, migration, genetic drift, selection); compare and contrast different forms of selection (natural selection, artificial selection, kin selection, group selection, sexual selection); outline main events in evolutionary history of Earth; explain how paleontology, comparative anatomy, and comparative biochemistry and DNA analysis provide evidence for biological evolution; apply Hardy-Weinberg theorem to estimate allele frequencies in a population;
19. Analyze the difference between traditional taxonomy and phylogeny; outline the main tools used in recreating phylogenetic trees; describe the main taxonomic categories used in modern systematics; describe and evaluate Miller's hypotheses of origin of life;
20. Outline the general scopes of study in modern ecology; describe current impact of human activities and population growth on natural ecosystems and the future of Earth; and
21. Communicate scientific information in an oral, written, or visual form; understand the relationship between the scientific process and the primary literature; learn to assess and distinguish among qualitative levels of scientific literature; learn to research a narrow topic of interest in the field of biology using both primary and secondary sources of information; learn to use CSE format for citations; and complete writing assignments involving the evaluation of scientific literature.

Laboratory Objectives

Student will successfully:
1. Use the main steps of scientific inquiry to design scientific experiments using living organisms or laboratory conditions that simulate biological systems;
2. Demonstrate the proper use of a compound light microscope; locate the optical and mechanical parts of the compound microscope and discuss the function of each part; calculate the total magnification and diameter of the field of view for all four objective lenses and use the information to estimate the size of an object;
3. List the major classes of organic molecules essential to living cells; describe the main functional groups of such molecules; distinguish between a macromolecule and a polymer; reproduce the structural formulas of basic mono- and polysaccharides, triglycerides, polypeptides, and polynucleotides; use chemistry models to build various functional groups and monomers;
4. Interpret the results of chemical tests for presence of polypeptides, lipids, sugars, and polysaccharides in unknown solutions;
5. Observe and identify the major structural components of living cells using a compound light microscope and laboratory models of cells. Compare and contrast the structures observed in bacteria cells, plant cells and animal cells using the compound light microscope and laboratory models of cells;
6. Determine the effect of tonicity on plant and animal cells; investigate the relationship between molecular size, molecular concentration, and distance on the rate of diffusion;
7. Evaluate the role of ATP and enzymes in metabolic reactions; experimentally assess various factors such as enzyme concentration, temperature and pH influencing progress of enzymatic reactions;
8. Describe the structure of a typical photosynthetic cell and outline the main stages of photosynthesis; measure the diffusion of pant pigments on chromatography paper; demonstrate how a spectrophotometer works; measure the effect of light and chloroplast function on the rate of photosynthesis and provide a graphical interpretation of the data;
9. Evaluate the role of photosynthesis and respiration in the cycling of chemicals and flow of energy in ecosystems; describe the main stages of respiration reactions in a living cell; investigate the effect of organism activity on rate of respiration;
10. Describe lactic acid and alcohol fermentation reactions; investigate factors influencing the rate of fermentation reactions;
11. Describe the stages of a typical cell cycle in a eukaryotic and prokaryotic cell; discuss the structure of a eukaryotic chromosome; identify the stages of mitosis in both plant cells and animal cells;
12. Describe main stages of oogenesis and spermatogenesis in animals; discuss the significance of genetic recombination during meiosis; observe microscope slides of ovaries and testes;
13. Solve simple genetic problems using different approaches, such as Punnett square and probabilities; evaluate patterns of inheritance of main human genetic disorders using pedigree analysis; collect and analyze genetics data, comparing observed to expected phenotypic ratios;
14. Outline the main steps and the enzymes involved in DNA replication using prokaryotic model;
15. State the "Central Dogma" of Molecular Biology; list stages of protein synthesis in a eukaryotic and a prokaryotic cell; use genetic code to "translate" a sample DNA sequence into a polypeptide sequence using puzzles or models;
16. Describe the steps used in creating recombinant DNA with bacterial vectors; explain how techniques such as gel electrophoresis and PCR are used in biotechnology; in a laboratory setting, isolate DNA from human tissue cells, apply PCR and gel electrophoresis techniques to assess the presence of specified non-coding genetic markers;
17. Analyze main agents of microevolution (mutation, nonrandom mating, migration, genetic drift, selection); outline main events in evolutionary history of Earth; explain how paleontology, comparative anatomy, and comparative biochemistry provide evidence for biological evolution; apply Hardy-Weinberg theorem to estimate allele frequencies in a population;
18. Choose and apply appropriate methods, instruments, and techniques in biological investigations; use metric system measurements in all laboratory exercises; apply simple statistical analyses (such as chi-square and t-test) when interpreting the results of a lab experiment; use scientific instruments (such as light compound microscope, spectrophotometer, micropipette), equipment and supplies safely and properly; contribute to team activities during lab exercises; and
19. Work in collaboration with other students to explain scientific information in oral, written, or visual form; present laboratory reports using scientific format; collect, record and report scientific information in an organized manner.

General Education Information

- Approved College Associate Degree GE Applicability
  - AA/AS - Life Sciences
  - AS - Life Science Lab
- CSU GE Applicability (Recommended-requires CSU approval)
  - CSUGE - B2 Life Science
  - CSUGE - B3 Lab Activity
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)

- IGETC - 5B Biological Science
- IGETC - 5C Laboratory Science

Articulation Information

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Classroom Discussions
  - Example: Students are given a topic to research before coming to class (ex. the use of CRISPR to modify the DNA of various organisms). During class, the students discuss the information they found. Grade based on participation. Lecture objectives #17, 21; lab objectives #19.
- Essay Examinations
  - Example: Exam question: "Describe a specific example of microevolution, based on our classroom discussions of these examples. Include the type of organism (species), the mechanism of microevolution, and the biological changes that occurred." A grading rubric for the project is provided on the course website. Lecture objective #18; lab objective #17.
- Objective Examinations
  - Example: Exam question: Match each description to the correct stage of aerobic respiration. Answers can be used more than once or not at all. 1. ATP is made by oxidative phosphorylation. 2. Products include two molecules of carbon dioxide. 3. Glucose is oxidized to produce two molecules of pyruvate. 4. Acetyl coenzyme A is completely oxidized. Answers include A) glycolysis, B) pyruvate oxidation, C) citric acid cycle, D) electron transport chain and chemiosmosis. Lecture objective #8.
- Problem Solving Examinations
  - Example: Exam question: "Recall that eye color is a sex-linked (X-chromosome) condition in Drosophila. Red eyes are dominant to white eyes. Assume that a cross was performed between heterozygous females (carriers) and males with red eyes. A total of 619 offspring were produced. Calculate the chi square value for these data. Also determine if the observed data are significantly different from the expected data (a chi square table is provided). Show your work." A rubric is used to grade this question. Lecture objective #13; lab objective #13.
- Projects
  - Example: Students work in groups of 3-4 to design their own experiment to measure the effect of enzyme concentration or temperature or pH on the activity of a particular enzyme. The experiment must include the appropriate controls and test reagents. Students then perform the experiment they designed. Each student writes a laboratory report using the report template provided on the course website. A grading rubric for the project is provided on the course website. Lab objectives #4, 7, 18, 19.
- Reports
  - Example: Students work in groups of 3-4 to design their own experiment to measure the effect of enzyme concentration or temperature or pH on the activity of a particular enzyme. The experiment must include the appropriate controls and test reagents. Students then perform the experiment they designed. Each student writes a laboratory report using the report template provided on the course website. A grading rubric for the project is provided on the course website. Lab objectives #4, 7, 18, 19.
- Skill Demonstrations
  - Example: Students work in groups of 3-4 to design their own experiment to measure the effect of enzyme concentration or temperature or pH on the activity of a particular enzyme. The experiment must include the appropriate controls and test reagents. Students then perform the experiment they designed. Each student writes a laboratory report using the report template provided on the course website. A grading rubric for the project is provided on the course website. Lab objectives #4, 7, 18, 19.

Repeatable

No

Methods of Instruction

- Laboratory
- Lecture/Discussion
- Distance Learning

Lab:

1. Instructor demonstrates how to use micropipettes and how to perform gel electrophoresis. Students first practice using the micropipettes and then load the DNA from various sources of a simulated crime scene (DNA from crime scene, victim, 2 suspects) into the gel. Students analyze the results of the gel electrophoresis to determine which suspect left his/her DNA at the crime scene.

Lecture:

1. Instructor introduces concept mapping using a specific example (e.g. cells and cell functions). Assignment instructions and grading rubric are distributed to students. Students then work in small groups (2-4 students/group) to construct their own concept map integrating the relationships between cell parts and cell functions. Maps are created using large pieces of poster paper with colored pens/pencils and presented for class discussion. Online, the students turn in electronic versions using the discussion board.

Distance Learning

1. Instructor presents a lecture via the course website explaining structure and characteristics of the major classes of organic molecules essential to living cells. The lecture format includes transcript or closed captions, audio, and video information. Students complete an electronic version of a concept map or a summary table showing the following: Main concept: Biological Macromolecules Categories of Macromolecules (Carbohydrates, Lipids, Proteins, Nucleic Acids) Information about each category: main functions, general chemical structure; monomer names and examples; polymer names and examples.

Typical Out of Class Assignments

Reading Assignments

1. Read the chapters on Molecular Genetics in the textbook and answer specific questions at each level of Bloom's taxonomy (understand, apply, analyze, evaluate). 2. Read a research paper (review article) on genome editing using CRISPR-Cas9 and answer specific questions about what CRISPR-Cas 9 is and how it can be used to create genetically modified organisms. Use the Internet or library databases to search for a scientific/scholarly article about an application or product using genome editing with CRISPR-Cas9. Explain the application or product and how it

is being used by scientists or the general public. Cite the article in Council of Science Editors (CSE) format.

Writing, Problem Solving or Performance

1. Genetics problems (10 problems). Example problem: One gene for coat color in cats is sex-linked (X chromosome). The dominant allele produces a yellow coat color, the recessive allele produces a black coat color and the heterozygous condition produces tortoise shell color. Give the sex and coat colors for all possible offspring from the mating of a black male with a tortoise shell female. Show your work. 2. Transcription and translation exercises and problems (5 problems). Example problems: a. Using a given sequence of amino acids in a polypeptide, write the possible sequences of nucleotides in the gene (DNA) for that polypeptide. b. Using a given sequence of nucleotides in DNA, determine the consequences of a specified mutation in terms of transcription and translation of the gene. Also explain how the final polypeptide might be affected.

Other (Term projects, research papers, portfolios, etc.)

Complete several 1-2 page writing assignments such as the evaluation of content in primary scientific literature, a comparison of information available from the primary and secondary literature, or the preparation of an annotated bibliography (in CSE format) for a particular topic; or research and write a 5-7 page review paper (in CSE format) on a biological topic; or research and prepare a poster on a biological topic, including references in CSE format. Sample assignments: Topic: Scientific Method and Scientific Process Read material on specific websites provided by the instructor (ex. UC Berkeley website called “Understanding Science, how science really works” and perform the following objectives: compare and contrast the steps of the scientific method described in lecture or the textbook to the scientific process practiced by most scientists; describe the peer evaluation process for publishing a scientific article in a peer-reviewed journal; explain how scientists study physical phenomena thar are beyond human senses or time frame (ex. phenomena that cannot be seen directly or occurred before humans evolved on earth). Student responses for these objectives are submitted online. Topic: Ecology or another topic covered in lecture Analyze a scientific article on this topic provided by the instructor and perform the following objectives: identify the major sections of the scientific article and describe the type of information found within each section; compare and contrast the writing style of the scientific article and a magazine article written for general public; identify the citation format used in the scientific article; answer instructor’s questions about the authors’ overall goals, experiments, and findings. Student responses for these objectives are submitted online. Topic: Enzymes (function and regulation) Collaborate with 2-3 other students in the lab group to write a laboratory report in scientific format summarizing the amylase experiment performed during the Enzyme Lab. Template for the report is provided online and the report is submitted as a group online.

Required Materials

- Raven Biology
  - Author: Raven et al.
  - Publisher: McGraw-Hill
  - Publication Date: 2020
  - Text Edition: 12th
  - Classic Textbook?:
  - OER Link:
  - OER:
- General Biology Laboratory Manual
  - Author: Laura Brahce
  - Publisher: Sierra College
  - Publication Date: 2019
  - Text Edition: 2019
  - Classic Textbook?:
  - OER Link:
  - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.