

BIOL 1A: PRINCIPLES OF CELL BIOLOGY

Foothill College Course Outline of Record

Heading	Value
Units:	6
Hours:	4 lecture, 6 laboratory per week (120 total per quarter)
Prerequisite:	CHEM 1A or 1AH.
Advisory:	Students taking the biology majors' sequence (BIOL 1A, 1B, 1C, 1D) are strongly advised to take the sequence in its entirety.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Students can describe life at the cellular level.
- Students can compare and contrast prokaryotic and eukaryotic life.
- Students can pose questions, state hypotheses, and identify variables from any given experiment.
- Students can graph experimental results.
- Students can analyze experimental results to draw a conclusion.

Description

An introduction to biological molecules, cellular structure and function, bioenergetics, the genetics of both prokaryotic and eukaryotic organisms, cell communication and signaling, the cell cycle, and elements of molecular biology. Intended for biology majors.

Course Objectives

The student will be able to:

- identify and apply the steps of the scientific method to study a question.
- relate the themes of biology to the specific topics of cell and molecular biology.
- discuss the role and importance of water and carbon to life.
- describe the structures and functions of biological macromolecules.
- compare and contrast eukaryotic and prokaryotic cell structure.
- explain the relationship of structure and function, with respect to macromolecules, membranes, organelles, and cells.
- explain the importance of ATP to the cell and describe the methods available in nature to produce it.
- compare and contrast chemiosmosis in respiration and photosynthesis.
- describe mechanisms of cell communication.
- identify the phases of mitosis.
- compare and contrast mitosis and meiosis.
- explain cell cycle regulation and relate it to cancer.
- solve simple genetic problems.

N. describe DNA replication, transcription, and translation in prokaryotes and eukaryotes.

O. discuss the types and importance of mutations.

P. compare and contrast the organization and control of prokaryotic and eukaryotic genomes.

Q. use and describe instrumentation and techniques commonly found in a cell and molecular biology laboratory.

R. analyze experimental data and draw appropriate conclusions.

S. design an experiment to study an original question and explain experimental techniques and results both orally and in writing.

T. describe some of the contributions made by eminent scientists, including women and minorities, to the fields of molecular and cell biology.

U. explore and discuss scientific issues related to the topics in cell and molecular biology.

Course Content

A. The Scientific Method

- making observations
- asking questions
- forming hypotheses
- testing hypotheses
- experimental conditions
 - independent variable
 - dependent variable
 - controls
 - repeatability
- collecting and analyzing results
 - methods of data display
- drawing conclusions
- scientific literature
 - original research
 - peer-review
 - authorship
- Themes of Biology
 - characteristics of life
 - hierarchical organization of life
 - The Cell Theory
 - emergent properties
 - correlation of structure and function
 - unity vs. diversity of life
 - evolution
 - taxonomy and binomial nomenclature
 - the nature and limits of science

C. Water and Carbon

- water
 - hydrogen bonding of water
 - properties of water
 - cohesion and surface tension
 - temperature buffer
 - solvent
 - role of water in chemical reactions
 - role of water in membrane structure
- carbon
 - structure of carbon atom
 - diversity of organic molecules
 - functional groups
- Biological Macromolecules
 - monomers and polymers
 - carbohydrate structure and function
 - monosaccharides

- b. oligosaccharides
- c. polysaccharides
- 3. lipid structure and function
 - a. unsaturated vs. saturated fatty acids
 - b. simple lipids
 - c. complex lipids
- 4. protein structure and function
 - a. amino acids
 - b. levels of protein folding
 - c. denaturation/loss of protein structure prions
- 5. nucleic acid structure and function
 - a. nucleotides
 - b. RNA
 - c. DNA
- E. Cell Structure
 - 1. plasma membrane
 - a. fluid mosaic model of membrane structure
 - b. structure and function of transmembrane proteins
 - c. transport
 - 1) passive - simple diffusion, facilitated diffusion, osmosis
 - 2) active - active transport, cotransport
 - 3) endocytosis - phagocytosis, pinocytosis, receptor-
 - 4) mediated endocytosis
 - 5) exocytosis
 - 2. prokaryotic cells
 - a. extracellular structures
 - 1) flagella, pili, capsule, cell wall
 - b. intracellular structures
 - 1) nucleoid, plasmids, ribosomes
 - 2. eukaryotic cells
 - a. nucleus
 - 1) chromatin
 - 2) nucleoli
 - b. endomembrane system
 - 1) endoplasmic reticulum
 - 2) Golgi
 - 3) vesicles
 - 4) lysosomes
 - 5) vacuoles
 - c. mitochondria and chloroplasts
 - 1) endosymbiosis
 - d. peroxisomes
 - e. ribosomes
 - f. cytoskeleton
 - 1) flagella, cilia
 - g. centrosome/centrioles
 - h. cell wall
 - i. intercellular junctions
- F. Bioenergetics
 - 1. metabolism
 - a. enzymes
 - b. ATP and its role in cellular work
 - c. metabolic pathways
 - d. regulation
 - e. autotrophic vs. heterotrophic growth
 - f. chemotrophic vs. phototrophic growth
 - 2. respiration
 - a. mitochondria structure
 - b. glycolysis
 - c. Krebs cycle
 - d. electron transport
 - e. chemiosmosis and oxidative phosphorylation
 - 3. fermentation
 - a. glycolysis
 - b. pyruvate reduction
 - 4. photosynthesis
 - a. chloroplast structure
 - b. nature of light and its interaction with pigments
 - c. light-dependent reactions
 - 1) photosystems
 - 2) cyclic and noncyclic electron flow
 - 3) chemiosmosis and photophosphorylation
 - d. carbon-fixing reactions
 - 1) Calvin-Benson cycle
 - e. photorespiration
 - 1) C4 and CAM plants
 - 2) metabolic diversity in prokaryotes
- G. Cell Communication
 - 1. stages of cell signaling
 - a. signal reception
 - b. signal transduction
 - 1) phosphorylation/dephosphorylation
 - a) kinases
 - b) phosphatases
 - 2. second messengers
 - a. cyclic AMP
 - b. calcium ion
 - c. inositol triphosphate
 - c. cellular responses
 - 1) cytoplasmic responses
 - 2) nuclear responses
- H. Cell Cycle and Cell Division
 - 1. cell cycle
 - a. G0
 - b. interphase
 - 1) G1
 - 2) S
 - 3) G2
 - c. mitosis
 - 1) phases
 - d. cytokinesis
 - 2. control of the cell cycle
 - a. internal regulatory mechanisms
 - 1) molecular check points
 - 2) cyclins
 - 3) cyclin dependent kinases
 - b. external regulatory mechanisms
 - 1) growth factors
 - 2) density dependent inhibition
 - 3) anchorage dependence
 - c. cancer
 - 1) oncogenes
 - 2) tumor suppressor genes
 - 3) oncoviruses and carcinogens
 - 3. sexual vs. asexual reproduction
 - a. phases of meiosis
 - b. sources of genetic variation
 - c. methods of sex determination
 - 4. stem cells
 - I. Genetics
 - 1. Mendelian genetics
 - a. Mendel's experimental method
 - 1) monohybrid crosses
 - 2) dihybrid crosses

- b. Mendel's laws
 - 1) misuse of the term law
 - 2) principle of segregation
 - 3) principle of independent assortment
 - 4) solving inheritance problems
 - a) genotype vs. phenotype
 - b) dominant vs. recessive
 - c) autosomal vs. sex-linked
- 2. Non-Mendelian patterns of inheritance
 - a. incomplete dominance
 - b. codominance
 - c. linkage
 - d. pleiotropy
 - e. epistasis
 - f. polygenic inheritance
 - g. multifactorial inheritance
- J. Molecular Biology
 - 1. historical perspective
 - a. Griffith experiment
 - b. Hershey-Chase experiment
 - c. Watson-Crick-Franklin-Wilkins
 - d. Meselson-Stahl experiment
 - 2. DNA replication
 - a. mechanism
 - b. leading vs. lagging strand synthesis
 - c. telomeres
 - 1) aging
 - 2) cancer
 - d. prokaryotic vs. eukaryotic
 - 3. gene expression
 - a. central dogma
 - 1) retroviruses
 - b. transcription
 - 1) mechanism
 - 2) RNA processing
 - 3) alternative splicing vs. gene rearrangements
 - 4) prokaryotic vs. eukaryotic
 - c. translation
 - 1) mechanism
 - 2) ribosome structure
 - 3) tRNA structure
 - 4) the genetic code
 - 5) prokaryotic vs. eukaryotic
 - d. mutations
 - 1) chromosomal number
 - 2) chromosomal structure
 - 3) point mutations
 - 4) mutagens and mutagenesis
 - 4. control of gene expression
 - a. constitutive genes
 - b. prokaryotic mechanisms
 - 1) operon structure and function
 - 2) negative vs. positive control
 - c. eukaryotic mechanisms
 - 1) organization of the eukaryotic genome
 - 2) chromatin structure modifications
 - 3) transcription and post-transcriptional control
 - d. applications of molecular biology
 - 1) laboratory techniques: PCR, restriction digest, gel electrophoresis
 - 2) Human Genome Project and bioinformatics

- 3) ethical considerations: genetic engineering, recombinant DNA, cloning, CRISPR

Lab Content

- A. Skills
 - 1. apply the scientific method
 - 2. design an experiment to test an original hypothesis
 - 3. calculations, including dilutions
 - 4. graphical display of data
 - 5. use of standard curves
 - 6. drawing appropriate conclusions from experimental results
- B. Techniques and Instrumentation
 - 1. measuring devices, including micropipettors
 - 2. microscopes
 - 3. spectrophotometer
 - a. O.D. vs. %T
 - 4. PCR/thermal cycler
 - 5. restriction digest
 - 6. gel electrophoresis
- C. Topics
 - 1. enzymology
 - 2. microscopic examination of cells
 - 3. respiration, fermentation, photosynthesis
 - 4. genetics
 - 5. molecular biology

Special Facilities and/or Equipment

- A. Multimedia lecture room and fully equipped biology laboratory.
- B. Student and instructional computers with internet access.

Method(s) of Evaluation

- A. One or more lecture midterm exam(s), which will include summative and formative questions.
- B. Comprehensive lecture final exam.
- C. One or more lab midterm exam(s) or frequent lab quizzes, which will include calculations.
- D. Comprehensive laboratory practical final exam.
- E. Written lecture assignments requiring application of lecture content.
- F. Mastering Biology computerized homework questions, summative and formative.
- G. Lab homework, including, but not limited to, graphs and analysis of laboratory results with written conclusions.
- H. One oral laboratory presentation of original experimental design and results.
- I. One written laboratory analysis of original experimental design and results.
- J. Participation in laboratory group project.
- K. Participation in discussions.

Method(s) of Instruction

- A. Lecture presentations with individual and/or small group lecture activities
- B. Laboratory experiments using the techniques and methodologies of cell and molecular biology
- C. Small group discussions on specific topics in cell and molecular biology

Representative Text(s) and Other Materials

Urry, Cain, Wasserman, Minorsky, and Reece. Campbell Biology. 11th ed. with MasteringBiology. San Francisco: Pearson/Benjamin Cummings, 2017. ISBN: 9780134082318

Erickson, Karen. Laboratory Exercises for Biology 1A. Foothill College, 2019.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

A. Reading Assignments:

1. College-level, lower division, biology majors text readings: approximately 40 pages weekly.
2. Primary and secondary scientific literature.

B. Writing Assignments:

1. Lecture essay questions requiring synthesis and application of lecture content.
2. Laboratory experimental results interpretation and analysis.

Discipline(s)

Biological Sciences