BIOL 1A: PRINCIPLES OF CELL BIOLOGY

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2025
Units:	6
Hours:	4 lecture, 6 laboratory per week (120 total per quarter)
Prerequisite:	CHEM 1A.
Advisory:	Students taking the biology majors' sequence (BIOL 1A, 1B, 1C) 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:

1. Identify and apply the steps of the scientific method to study a question.
2. Relate the themes of biology to the specific topics of cell and molecular biology.
3. Discuss the role and importance of water and carbon to life.
4. Describe the structures and functions of biological macromolecules.
5. Compare and contrast eukaryotic and prokaryotic cell structure.
6. Explain the relationship of structure and function, with respect to macromolecules, membranes, organelles, and cells.
7. Explain the importance of ATP to the cell and describe the methods available in nature to produce it.
8. Compare and contrast chemiosmosis in respiration and photosynthesis.
9. Describe mechanisms of cell communication.
10. Identify the phases of mitosis.
11. Compare and contrast mitosis and meiosis.
12. Explain cell cycle regulation and relate it to cancer.
13. Discuss the importance of genetics and inheritance, from both historical and current perspectives.
14. Solve simple genetic problems.
15. Describe DNA replication, transcription, and translation in prokaryotes and eukaryotes.
16. Discuss the types and importance of mutations.
17. Compare and contrast the organization and control of prokaryotic and eukaryotic genomes.
18. Use and describe instrumentation and techniques commonly found in a cell and molecular biology laboratory.
19. Analyze experimental data and draw appropriate conclusions.
20. Design an experiment to study an original question and explain experimental techniques and results both orally and in writing.
21. Describe some of the contributions made by eminent scientists, including women and minorities, to the fields of molecular and cell biology.
22. Explore and discuss scientific issues related to the topics in cell and molecular biology, especially those impacting diversity, equity, inclusion, and social justice.

Course Content

1. The scientific method
    a. Making observations
    b. Asking questions
    c. Forming hypotheses
    d. Testing hypotheses
    e. Experimental conditions
        i. Independent variable
        ii. Dependent variable
        iii. Controls
        iv. Repeatability
    f. Collecting and analyzing results
        i. Methods of data display
    g. Drawing conclusions
    h. Scientific literature
        i. Original research
        ii. Peer-review
        iii. Authorship
2. Themes of biology
    a. Characteristics of life
    b. Hierarchical organization of life
        i. The Cell Theory
    c. Emergent properties
    d. Correlation of structure and function
    e. Unity vs. diversity of life
    f. Evolution
    g. Taxonomy and binomial nomenclature
        i. Issues with controversial scientific names
    h. The nature and limits of science
3. Water and carbon
    a. Water
        i. Hydrogen bonding of water
        ii. Properties of water

1. Cohesion and surface tension
2. Temperature buffer
3. Solvent

iii. Role of water in chemical reactions
iv. Role of water in membrane structure

b. Carbon
i. Structure of carbon atom
ii. Diversity of organic molecules
iii. Functional groups

4. Biological macromolecules
a. Monomers and polymers
b. Carbohydrate structure and function
i. Monosaccharides
ii. Oligosaccharides
iii. Polysaccharides
c. Lipid structure and function
i. Unsaturated vs. saturated fatty acids
ii. Simple lipids
iii. Complex lipids
d. Protein structure and function
i. Amino acids
ii. Levels of protein folding
iii. Denaturation/altered protein structure (prions, abnormal hemoglobin)
e. Nucleic acid structure and function
i. Nucleotides
ii. RNA
iii. DNA

5. Cell structure
a. Plasma membrane
i. Fluid mosaic model of membrane structure
ii. Structure and function of transmembrane proteins
iii. Transport
1. Passive - simple diffusion, facilitated diffusion, osmosis
2. Active - active transport, cotransport
3. Endocytosis - phagocytosis, pinocytosis, receptor-mediated endocytosis
4. Exocytosis

b. Prokaryotic cells
i. Extracellular structures
1. Flagella, pili, capsule, cell wall
ii. Intracellular structures
1. Nucleoid, plasmids, ribosomes

c. Eukaryotic cells
i. Nucleus
1. Chromatin
2. Nucleoli
ii. Endomembrane system
1. Smooth, rough endoplasmic reticulum
2. Golgi apparatus
3. Vesicles, vacuoles
4. Lysosomes
iii. Mitochondria and chloroplasts
1. Endosymbiosis
iv. Ribosomes
v. Cytoskeleton
1. Flagella, cilia
vi. Centrosome/centrioles
vii. Cell wall
viii. Intercellular junctions

6. Bioenergetics
a. Metabolism
i. Enzymes
ii. ATP and its role in cellular work
iii. Metabolic pathways
iv. Regulation
v. Autotrophic vs. heterotrophic growth
vi. Chemotrophic vs. phototrophic growth
b. Respiration
i. Mitochondrion structure
ii. Glycolysis
iii. Krebs cycle
iv. Electron transport
v. Chemiosmosis and oxidative phosphorylation
c. Fermentation
i. Glycolysis
ii. Pyruvate reduction
d. Photosynthesis
i. Chloroplast structure
ii. Nature of light and its interaction with pigments
iii. Light-dependent reactions
1. Photosystems
2. Cyclic and noncylic electron flow
3. Chemiosmosis and photophosphorylation
iv. Carbon-fixing reactions
1. Calvin-Benson cycle
v. Photorespiration
1. C4 and CAM plants
2. The role of science in feeding a warming and growing planet
3. Metabolic diversity in prokaryotes

7. Cell communication
a. Stages of cell signaling
i. Signal reception
ii. Signal transduction
iii. Cellular responses
1. Cytoplasmic responses
2. Nuclear responses
b. Role in cancer

8. Cell cycle and cell division
a. Cell cycle
i. G_0
ii. Interphase (G_1, S, G_2)
iii. Mitosis (phases)
iv. Cytokinesis (plant vs. animal)
b. Control of the cell cycle
i. Internal regulatory mechanisms
ii. External regulatory mechanisms
c. Cancer

i. Cellular characteristics
ii. Oncogenes
iii. Tumor suppressor genes
iv. Mutagens and carcinogens
v. Disproportionate impacts of cancer

d. Sexual vs. asexual reproduction
i. Mieosis (phases)
ii. Sources of genetic variation
iii. Methods of sex determination (sex vs. gender in biology)

e. Stem cells

9. Transmission genetics (inheritance)
a. Mendelian genetics
i. Mendel's experimental methods
1. Monohybrid crosses
2. Dihybrid crosses

ii. Mendel's laws
1. Misuse of the term law
2. Principle of segregation
3. Principle of independent assortment

b. Solving inheritance problems
i. Genotype vs. phenotype
ii. Dominant vs. recessive
iii. Autosomal vs. sex-linked

c. Non-Mendelian patterns of inheritance
i. Incomplete dominance
ii. Codominance
iii. Linkage
iv. Pleiotropy
v. Epistasis
vi. Polygenic inheritance
vii. Multifactorial inheritance

d. Epigenetics
i. Impact of trauma and inheritance

10. Molecular genetics/biology
a. Historical perspective
i. Griffith experiment
ii. Hershey-Chase experiment
iii. Watson-Crick-Franklin-Wilkins
iv. Meselson-Stahl experiment

b. DNA replication
i. Process
ii. Leading vs. lagging strand synthesis
iii. Telomeres

c. Gene expression/transcription
i. Central dogma
ii. Process
1. RNA processing
2. Alternative splicing vs. gene rearrangements

d. Gene expression/translation
i. Process
ii. Ribosome structure
iii. tRNA structure
iv. The genetic code

e. Prokaryotic vs. eukaryotic events in replication, transcription, translation

11. Mutations
a. Chromosomal number
b. Chromosomal structure
c. Point mutations

12. Regulation of gene expression
a. Constitutive genes
b. Prokaryotic mechanisms
i. Operon structure and function
ii. Negative vs. positive control

c. Eukaryotic mechanisms
i. Organization of the eukaryotic genome
ii. Chromatin structure modifications
iii. Transcription and post-transcriptional control

13. Applications of molecular biology
a. Laboratory techniques: PCR, restriction digest, gel electrophoresis
b. Human Genome Project and bioinformatics
c. Genetic engineering, recombinant DNA, cloning
d. CRISPR
e. Ethical considerations

Lab Content

1. Skills
a. Apply the scientific method
b. Design an experiment to test an original hypothesis
c. Calculations, including dilutions
d. Graphical display of data
e. Use of standard curves
f. Drawing appropriate conclusions from experimental results

2. Techniques and instrumentation
a. Measuring devices, including micropipettors
b. Microscopes
c. Spectrophotometer
d. PCR/thermal cycler
e. Restriction digest
f. Gel electrophoresis

3. Topics
a. Enzymology
b. Microscopic examination of cells
c. Respiration, fermentation, photosynthesis
d. Genetics
e. Molecular biology

Special Facilities and/or Equipment

1. Multimedia lecture room and fully equipped cell and molecular biology laboratory.
2. Student and instructional computers with internet access.

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

One or more lecture midterm exam(s), which will include objective and subjective questions, assessing critical thinking and application of knowledge, and may include short answer/essay, diagramming, calculations. Exams have individual and collaborative portions
Comprehensive lecture final exam
One or more lab midterm exam(s) or frequent lab quizzes, which may include references to publications, lab skills, calculations, graphing
Comprehensive laboratory final exam, which may include practical-style (hands-on) activities
Formative written lecture assignments requiring application of lecture content, given throughout the lecture session, allowing students to practice and explore ideas prior to assessment
Mastering Biology computerized homework questions, requiring student-purchased access from publisher
Lab report homework, including, but not limited to, pre-labs, graphs, and analysis of laboratory results with written conclusions
One oral laboratory presentation of original experimental design and results
One written laboratory analysis of original experimental design and results
Participation in laboratory group project
Participation in discussions and group activities during lecture and lab to apply content to real-world scenarios, allowing students to select topics relevant to their lives

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lecture presentations with individual and/or small group lecture activities

Laboratory experiments using the techniques and methodologies of cell and molecular biology
Small group discussions on specific topics in cell and molecular biology
Collaborative testing components, resubmissions, and formative assessments with feedback for assignments in both lecture and lab

Representative Text(s) and Other Materials

Urry, Cain, Wasserman, Minorsky, and Reece. Campbell Biology with Mastering, 12th ed.. 2021.

This textbook is updated with each new edition, approximately every 3 years.

Instructor-generated laboratory content (protocols) provided to students at no cost

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

1. Reading assignments:
    a. College-level, lower division, biology majors text readings: approximately 40 pages weekly
    b. Primary and secondary scientific literature selected by instructor as appropriate
2. Writing assignments:
    a. Quiz and exam short answer/essay preparation questions requiring synthesis and application of course content
    b. Laboratory pre-lab preparation homework (calculations, hypothesis/prediction statements, identification of experimental variables/controls)
    c. Laboratory experimental results interpretation (data display, graphing, calculations) and analysis (including appropriate conclusion statements)

Discipline(s)

Biological Sciences