# BIO-1500: PRINCIPLES OF BIOLOGY I

## Cuyahoga Community College

### Viewing: BIO-1500 : Principles of Biology I

**Board of Trustees:**

December 2021

**Academic Term:**

Fall 2022

**Subject Code**

BIO - Biology

**Course Number:**

1500

**Title:**

Principles of Biology I

**Catalog Description:**

Designed for science majors. The molecular and cellular basis of life is explored through an introduction to cell biology, molecular biology, genetics, and evolution in both lecture and laboratory settings. Topics include scientific inquiry; chemical aspects of life; cell structure and function; energy and metabolism; cell division; molecular genetics; inheritance; population genetics; mechanisms of evolution; and evidence for evolution.

**Credit Hour(s):**

4

**Lecture Hour(s):**

3

**Lab Hour(s):**

3

**Other Hour(s):**

0

## Requisites

**Prerequisite and Corequisite**

ENG-0995 Applied College Literacies, or appropriate score on English Placement Test; and MATH-0955 Beginning Algebra or qualified math placement.

Note: ENG-0990 Language Fundamentals II taken prior to Fall 2021 will also meet prerequisite requirements.

## Outcomes

**Course Outcome(s):**

Process of Science: Apply the process of scientific inquiry to develop and explore questions about the natural world, and effectively communicate the findings.

**Essential Learning Outcome Mapping:**

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

**Objective(s):**

1. Distinguish among an observation, hypothesis, experiment, conclusion, and theory.
2. Use scientific methods of inquiry to gather data, write a hypothesis, design an experiment, draw a conclusion and document experimental results in written format.
3. Distinguish between observations and inferences.
4. Demonstrate that scientific evidence is reproducible, and distinguish between scientific and non-scientific methods of inquiry.
5. Demonstrate safe and proper use of lab equipment when observing specimens and performing experiments and procedures, and respond appropriately to instructor feedback as it is given.

6. Use lab equipment to collect and analyze data pertaining to metabolic processes in living organisms.
7. Use statistics and mathematical formulas when generating and analyzing data in labs.

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**Course Outcome(s):**

Chemical Aspects of Life: Relate the chemical properties of atoms, molecules, and bonds to biological processes.

**Objective(s):**

1. Distinguish among elements, atoms, and molecules.
2. Compare and contrast ionic, covalent, and hydrogen bonds.
3. Relate the properties of water to hydrogen bonding and how they are significant to life.
4. Describe the biological macromolecules important to life and their role in living organisms.
5. Explain the reactions involved in the synthesis and degradation of macromolecules.
6. Explain how the structure of a molecule determines its function.

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**Course Outcome(s):**

Cell: Illustrate how the components of cells contribute to cell signaling, transport, and metabolism.

**Objective(s):**

1. Compare and contrast prokaryotic and eukaryotic cells.
2. Describe the structures and functions of cellular organelles and other cellular structures.
3. Describe the parts of the endomembrane system and explain how they work together in the synthesis and distribution of macromolecules.
4. Explain the structure of the cell membrane and how it functions in cell transport, identity, and signaling.
5. Compare and contrast various types of passive, active, and bulk transport.
6. Explain the pathway from an extracellular chemical signal to an intracellular response.
7. Differentiate among the types of cell junctions and their roles in tissue formation and cell communication.

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**Course Outcome(s):**

Energy: Analyze the acquisition, transformation, utilization, and storage of energy in living things.

**Objective(s):**

1. Explain the laws of thermodynamics and how they relate to living systems.
2. Describe potential and kinetic energy, and recognize how one form of energy is converted to another.
3. Compare and contrast exergonic and endergonic reactions and describe how they relate to metabolism.
4. Explain the properties of enzymes and how the structure of an enzyme determines its function.
5. Describe how the structure of adenosine triphosphate (ATP) is linked to its role in energy storage and transfer.
6. Describe how a cell extracts energy from macromolecules in the presence or absence of oxygen.
7. Explain how photoautotrophs convert light energy into chemical energy through the process of photosynthesis.
8. Compare and contrast cellular respiration and photosynthesis.

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**Course Outcome(s):**

Continuity of Life: Illustrate how cell-cycle regulation controls cell division and development.

**Objective(s):**

1. Identify the stages in the sexual life cycle and explain the roles of mitosis and meiosis.
2. Describe the phases of the eukaryotic cell cycle and explain how it is regulated.
3. Compare and contrast mitosis and meiosis.
4. Explain how meiosis contributes to genetic diversity.
5. Describe the stages of early embryological development.

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**Course Outcome(s):**

Genetics: Relate the principles of molecular genetics and patterns of inheritance to genotype and phenotype.

**Essential Learning Outcome Mapping:**

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

**Objective(s):**

1. Describe the structure of DNA and the process of semiconservative replication.
2. Describe how genes are expressed through the transcription of DNA and translation of RNA into an amino acid sequence.
3. Explain how mutations affect genotype and phenotype.
4. Explain the effect of abnormal chromosome number on development and phenotype.
5. Identify patterns of inheritance determined by Mendelian and non-Mendelian genetics.
6. Use one or more examples from model organisms to test the predictions for monohybrid crosses, and apply the concept of inheritance patterns to the transmission and expression of genetic traits in organisms.
7. Calculate probabilities using Mendelian inheritance patterns.
8. Analyze the applications and limitations of important historical and modern innovations in molecular genetics that have enabled scientists to develop and implement tools to study and manipulate genetic material.
9. Explain examples of applications of biotechnology in the modern world, including those pertaining to agriculture and medicine.

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**Course Outcome(s):**

Evolution: Utilize evidence to support how populations change genetically over time through the process of evolution resulting in the unity and diversity of life.

**Essential Learning Outcome Mapping:**

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

**Objective(s):**

1. Explain the effect of a changing environment on the gene pool of a population.
2. Differentiate among the mechanisms by which populations change genetically over time.
3. Use evidence to support the scientific theory of evolution.
4. Explain how new species form.
5. Describe the natural mechanisms that keep species reproductively isolated.
6. Explain the theories of gradualism and punctuated equilibrium as they relate to the rate of evolution.
7. Apply specific equations to determine allele frequency changes over time in sample populations.

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**Methods of Evaluation:**

1. Quizzes
2. Exams
3. Laboratory practicals
4. Written reports
5. Research papers
6. Projects (individual or group)
7. Presentations (individual or group)
8. Article discussions/review/summaries
9. Discussion boards
10. Homework assignments
11. Case studies

**Course Content Outline:**

1. Concepts:
    a. Characteristics of life
    b. Cell theory
    c. Biological hierarchy
    d. Process of science, including observations and hypothesis testing
    e. Experimental design, including data, variables, and controls
    f. Scientific theory
    g. Inductive and deductive reasoning
    h. Primary and secondary sources
    i. Matter and elements

j. Atomic structure
k. Bonds, including covalent, ionic, and hydrogen
l. Chemistry and properties of water
m. pH, acids, bases, and buffers
n. Dehydration synthesis and hydrolysis
o. Biological macromolecules, including carbohydrates, lipids, proteins, and nucleic acids
p. Levels of protein structure
q. Prokaryotic and eukaryotic cell structure
r. Cell membranes and cell walls
s. Surface area to volume ratio
t. Evolution of endomembrane system and nucleus
u. Endosymbiotic theory of mitochondrion and chloroplast evolution
v. Cell transport, including active, passive, and bulk
w. Cell-cell interactions
x. Potential and kinetic energy
y. Laws of thermodynamics
z. Enzyme structure and function
aa. Oxidation-reduction reactions
bb. ATP as an energy carrier
cc. Metabolic pathways
dd. Feedback inhibition and activation
ee. Catabolism of carbohydrates, proteins, and fats
ff. Aerobic cellular respiration (glycolysis, pyruvate oxidation, Krebs cycle, electron transport, and chemiosmosis)
gg. Anaerobic cellular respiration
hh. Fermentation
ii. Photosynthesis, including $C_3$ (light dependent and independent reactions), $C_4$, and CAM pathways
jj. Cyclic and non-cyclic phosphorylation
kk. Photorespiration
ll. Types of cellular receptors
mm. Signal transduction pathway, including ligands, receptors, signal amplification, and response
nn. Prokaryotic cell division
oo. Eukaryotic cell cycle and mechanisms of control
pp. Mitosis
qq. Loss of cell cycle control and cancer
rr. Eukaryotic chromosomes, including chromatids and homologues
ss. Meiosis and crossing-over
tt. Gametogenesis in animals
uu. Embryological development in animals
vv. Independent assortment and segregation of chromosomes
ww. Nondisjunction of chromosomes
xx. Alleles
yy. Patterns of inheritance
zz. Phenotype versus genotype
aaa. Monohybrid and dihybrid crosses
bbb. Mutation
ccc. Double helix structure of DNA and complementary base pairing
ddd. Semiconservative replication of DNA
eee. Biotechnology
fff. Gene expression, including transcription and translation
ggg. Control of gene expression in prokaryotes and eukaryotes
hhh. The genetic code
iii. Theory of evolution
jjj. Agents of evolution, including natural selection, mutation, genetic drift, gene flow, and nonrandom mating
kkk. Population genetics
lll. Adaptations
mmm. Evidence for evolution

nnn. Speciation
ooo. Punctuated equilibrium and gradualism

2. Skills
   a. Demonstrate proper lab safety procedures.
   b. Write a hypothesis.
   c. Design and perform an experiment to analyze questions about the natural world.
   d. Document experimental results in a written format.
   e. Critically evaluate the source of information.
   f. Distinguish between primary and secondary resources.
   g. Gather, organize, and analyze data using computer graphing programs.
   h. Measure mass, volume, and length using the metric system.
   i. Measure liquids utilizing standard pipettes and micropipettes.
   j. Calculate simple statistics, including mean, standard deviation, and percent error.
   k. Utilize the compound microscope and dissecting microscope.
   l. Prepare wet mount slides, utilizing stains when appropriate.
   m. Differentiate between types of prokaryotic and eukaryotic cells using a microscope.
   n. Measure absorbance and percent transmittance using a spectrophotometer.
   o. Create a standard curve to determine the concentration of an unknown.
   p. Identify stages of mitosis in animal and plant cells under the microscope.
   q. Differentiate between sister chromatids and homologous chromosomes.
   r. Identify early stages of development in animal embryos.
   s. Construct a Punnett square to predict genotypic and phenotypic probabilities of offspring.
   t. Identify patterns of inheritance using a pedigree.
   u. Solve Mendelian genetics problems.
   v. Interpret a karyotype to determine gender and chromosomal abnormalities.
   w. Transcribe a DNA sequence and translate an RNA sequence.
   x. Perform gel electrophoresis and interpret the results.
   y. Interpret a DNA fingerprint.
   z. Calculate frequencies of alleles and genotypes using the Hardy-Weinberg equation.

3. Issues
   a. Relationship between structure and function
   b. The nature of science
   c. Biodiversity
   d. Evolution as a scientific theory
   e. Continuity of life
   f. Cells as the basic unit of life
   g. Homeostasis
   h. Populations change over time
   i. The species concept
   j. Flow of energy through living systems
   k. The unity and diversity of life due to evolution
   l. Universal nature of the genetic code

## Resources

Dolphin, W., Vleck, D., Colbert, J.T., and Westgate, L.M. *Biological Investigations; Form, Function, Diversity, & Process*. 12th ed. New York: McGraw-Hill, 2019.

Raven, P.H., Johnson, G.B., Mason, K.A., Losos, J.B., and Duncan, T. *Biology*. 12th ed. New York: McGraw-Hill, 2020.

Vodopich, D.S. and Moore, R. *Biology Laboratory Manual*. 12th ed. New York: McGraw-Hill, 2019.

Lewis, R. *Human Genetics*. 12th ed. New York: McGraw-Hill, 2017.

Brooker, R.J., Widmaier, E.P., Graham, L.E., and Stiling, P.D. *Biology*. 5th ed. New York: McGraw-Hill, 2019.

Lodish, H., Berk, A., Kaiser, C.A., and Krieger, M. *Molecular Cell Biology.* 8th ed. New York: W.H. Freeman, 2016.

Gould, S.J. *The Structure of Evolutionary Theory.* 1st ed. Belknap Press of Harvard University Press, 2002.

Dawkins, R. *The Selfish Gene.* 3rd ed. Oxford University Press, 2006.

Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V., and Reece, J.B. *Campbell: Biology in Focus*. 3rd ed. New York: Pearson, 2019.

Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V., and Reece, J.B. *Campbell Biology.* 11th ed. New York: Pearson, 2017.

Jenkins, C., Freer, M., Koch, J., Lehnert, M., Vaidya, E., Kowalczyk, T. (2019) *Principles of Biology I: BIO 1500 Lab Manual*, Minneapolis: Blue Door LLC.

**Resources Other**

1. The Biology Project http://www.biology.arizona.edu/
2. Virtual Cell Animation Collection http://vcell.ndsu.edu/animations/
3. Learn Genetics http://learn.genetics.utah.edu/
4. Howard Hughes Medical Institute Biointeractive http://www.hhmi.org/biointeractive/
5. PBS Evolution http://www.pbs.org/wgbh/evolution/
6. Understanding Evolution http://evolution.berkeley.edu/
7. Darwin – American Museum of Natural History http://www.amnh.org/exhibitions/darwin/?src=h_h
8. McGraw-Hill Virtual Laboratory http://www.mhhe.com/biosci/genbio/virtual_labs/
9. Virtual Labs Media Library http://virtuallabs.stanford.edu/
10. NSF National Center for Case Study Teaching in Science http://sciencecases.lib.buffalo.edu/cs/
11. Encyclopedia of Life http://eol.org (http://eol.org/)
12. NOVA http://www.pbs.org/wgbh/nova/

## Instructional Services

**OAN Number:**

Ohio Transfer 36 TMNS and Transfer Assurance Guide OSC003 and OSC024 (1 of 2 courses, both must be taken)

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