ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences and Business

COURSE: BIO 1003 Principles of Biology

Date: Spring 2023

Credit Hours: 4

Complete all that apply or mark "None" where appropriate:

Prerequisite(s): None

Enrollment by assessment or other measure? ☐ Yes ☒ No
If yes, please describe:

Corequisite(s): None

Pre- or Corequiste(s): None

Consent of Instructor: ☐ Yes ☒ No

Delivery Method:	☒ **Lecture**	**3 Contact Hours (1 contact = 1 credit hour)**
	☐ **Seminar**	**0 Contact Hours (1 contact = 1 credit hour)**
	☒ **Lab**	**3 Contact Hours (2-3 contact = 1 credit hour)**
	☐ **Clinical**	**0 Contact Hours (3 contact = 1 credit hour)**

Offered: ☒ **Fall** ☐ **Spring** ☐ **Summer**

CATALOG DESCRIPTION and IAI NUMBER (if applicable):
This course will present the unifying concepts of biology which form the foundation for the biological sciences. The topics will include an introduction to biochemistry, cellular structure, functions and processes of the cell, energetics of cellular respiration and photosynthesis, Mendelian and molecular genetics, and natural selection. **IAI Equivalent: BIO 910**

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:
The Science of Biology
a. Characteristics and examples of living things
b. Classification of organisms and binomial nomenclature
c. Darwin and evolution
d. Scientific method and experimental variables
Molecules of Cells
a. Elements of life, periodic table, atomic structure, chemical bonds
b. Acids and bases, pH scale, effect of pH on living organism (homeostasis)
Organic Molecules
a. Proteins, carbohydrates, lipids, and nucleic acids
i. Basic structure and building blocks
ii. Function
iii. Importance to living organism
Cell Structure and Function,
a. Cell theory, prokaryotes vs. eukaryotes
b. Bacterial cell structure and organelle identification and function
c. Animal cell structure and organelle identification and function
d. Plant cell structure and organelle identification and function
e. Actin filaments, microtubules, cilia, and flagella
Cell Membranes
a. Phospholipid bilayer
b. Membrane proteins
c. Diffusion and osmosis
d. Passive and active transport
Energy and Metabolism
a. Flow of energy through living systems
b. Exergonic and endergonic reactions, coupled reactions
c. ATP and ADP structure
d. Metabolic pathways; enzymes, pH, temperature
e. Oxidation/reduction reactions involving mitochondria and chloroplasts
Cellular Respiration
a. Connection to organic molecules, anabolism vs. catabolism
b. Cellular respiration phases including bacterial and eukaryote examples
c. Actual vs. theoretical yields
d. Anaerobic respiration
Photosynthesis
a. Reactions, light and Calvin cycle
b. Role of sunlight, chlorophyll and carbon dioxide
c. Comparison to cellular respiration
How cells divide
a. Binary fission
b. Cell cycle, Mitosis phases
c. Regulation of the cell cycle, cancer
Sexual Reproduction and Meiosis
a. Phases of Meiosis

b. Crossing over and Independent assortment
c. Importance of genetic variation through sexual reproduction

Mendelian Inheritance
a. Mendel's laws
b. Genotype vs. phenotype
c. Punnett squares for one trait cross, phenotypic and genotypic ratios
d. Multiple alleles, incomplete dominance, sex linked alleles, polygenic inheritance
e. Human examples of simple inheritance

Chromosomal Basis of Inheritance
a. X-linked disorders
b. Non-disjunction
c. Monosomy and trisomy, examples
d. Deletion, duplication, inversion, and translocation on chromosomes
e. Pedigrees

DNA
a. DNA structure, bases, replication
b. Scientists involved in DNA discovery
c. Telomeres

Gene Expression
a. Central dogma of molecular biology and exceptions
b. Transcription of DNA; location and mRNA
c. Translation of RNA; anti-codons, tRNA, ribosomes
d. Frameshift and point mutations

Control of Gene Expression, Biotechnology, Genomics
a. Control of gene expression
b. Genetic engineering, plant and animals examples
c. DNA sequencing and applications
d. Restriction enzymes, Polymerase Chain Reaction, CRISPR/Cas9

Genes within Populations
a. Allele frequencies
b. Five agents of evolutionary change; mutation, gene flow, genetic drift, non-random mating, selection
c. Natural selection
d. Fitness

Evolution
a. Darwin's Finches, Peppered Moths
b. Domestication of dogs (as an example of artificial selection)
c. Fossils, Anatomical evidence, convergent evolution

Origin of Species
a. Biological species concept
b. Natural selection and genetic drift at work in speciation
c. Speciation and geography

INSTRUCTIONAL METHODS:

Lecture
Discussion
Active learning activities
Laboratory
Case Studies

EVALUATION OF STUDENT ACHIEVEMENT:
Exams
Quizzes
Homework
Assignments
Laboratory exercises
Lab practicals

INSTRUCTIONAL MATERIALS:
Textbooks
Understanding Biology, Mason et al., McGraw Hill
Biology Laboratory Manual, Vodopich and Moore, McGraw Hill

Resources
Biology, Raven et al., McGraw Hill
Investigating Biology through Inquiry, Melville et al., Vernier

LEARNING OUTCOMES AND GOALS:
Institutional Learning Outcomes
☐ 1) Communication – to communicate effectively;
☒ 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;
☐ 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;
☐ 4) Responsibility – to recognize how personal choices affect self and society.

Course Outcomes and Competencies
1. Explain the nature and methods of biological science.
   1.a Describe the characteristics that all living organisms share.
   1.b Explain the hierarchy of biological classification.
   1.c Use the binomial nomenclature system properly.
   1.d Apply the methods of science to questions in biology.
2. Explain basic properties of atoms and molecules in particular carbon and water.
   2.a Describe the structure of an atom and how they form bonds.
   2.b Describe the characteristics of water as it relates to living organisms.
   2.c Describe the pH scale and buffers.
3. Describe the chemical building blocks of life.
   3.a Describe structure and function of the four organic molecules in living organisms: carbohydrates, proteins, nucleic acids, and lipids.
   3.b Compare and contrast dehydration synthesis and hydrolysis.
   3.c Distinguish between monosaccharides, disaccharides, and polysaccharides (including starch, glycogen, cellulose, and chitin).
   3.d Describe the essential functions of proteins in living organisms.
   3.e Explain the four levels of protein structure.
   3.f Compare and contrast DNA, RNA, ATP, and NAD.
   3.g Distinguish between saturated, unsaturated, and polyunsaturated and trans fats.

4. Explain the importance of the cell to living organisms.
   4.a State cell theory and describe differences between bacterial, archaeal, and eukaryotic cells.
   4.b Identify bacterial cell structures and explain their functions.
   4.c Identify animal cell structures and explain their functions.
   4.d Identify plant cell structures and explain their functions.
   4.d Describe extracellular structures.
5. Explain cell membrane interactions.
   5.a Describe the components of cell membranes: phospholipid bilayer, transmembrane proteins, interior protein network, and cell surface markers.
   5.b Describe the structure phospholipid bilayers.
   5.c Describe the functional classes of membrane proteins.
   5.d Compare and contrast diffusion and osmosis.
   5.e Explain how organisms maintain osmotic balance.
   5.f Describe the sodium-potassium pump.
   5.g Compare and contrast active and passive transport.
6. Explain how energy flows through living systems.
   6.a Define endergonic, exergonic, and redox reactions.
   6.b Define the First and Second Laws of Thermodynamics.
   6.c Describe the structure of ATP and the ATP cycle.
   6.d Explain how catalysts affect chemical reactions.
   6.e Describe how enzymes bind to substrates.
   6.f Explain pH and temperature effects on enzyme-catalyzed reactions.
   6.g Describe biochemical pathway and feedback inhibition.
7. Explain cell respiration.
   7.a Explain how the reactions in cell respiration are redox reactions.
   7.b Describe the function NAD and ATP in cell respiration.
   7.c Describe the steps of cell respiration: glycolysis, transition reaction, citric acid cycle, and the electron transport chain.
   7.d Explain how anaerobic and aerobic respiration differ.
   7.e Describe ethanol and lactic acid fermentation.
8. Explain photosynthesis.
   8.a Describe the steps in photosynthesis: light reaction and Calvin cycle.
   8.b Describe the structure of chlorophyll and explain its absorption of light.
   8.c Describe accessory pigments.
   8.d Compare and contrast cell respiration and photosynthesis.
9. Explain how cells divide.
   9.a Describe binary fission.
   9.b Describe the eukaryotic cell cycle.
   9.c Explain the stages of mitosis and describe important structures.
   9.d Compare and contrast plant and animal mitosis.
   9.e Distinguish between oncogenes and tumor suppressor genes.
   9.f Describe the cell-proliferation-signaling pathway.
   9.g Explain the stages of meiosis.
   9.h Compare and contrast mitosis and meiosis.
10. Explain the principles of inheritance.
   10.a Describe Mendel’s work.
   10.b Describe the Principles of Segregation and Independent Assortment.

10.c Illustrate monohybrid and dihybrid crosses.
10.d Define continuous variation, pleiotropy, incomplete dominance, codominance and environmental effects.
10.e Explain dosage compensation in sex chromosomes.
10.f Define polymorphisms.
10.g Explain non-disjunction.
10.h Properly interpret pedigrees.

11. Explain the structure and function of genetic material.
    11.a Describe the works of Griffith, Avery, Hershey and Chase, Chargaff, Franklin and Watson and Crick as it pertains to the discovery of DNA as the genetic material.
    11.b Explain how Meselson and Stahl proved that DNA replication is semi-conservative.
    11.c Explain the steps of DNA replication and the machinery need for the process.
    11.d Describe the action of telomerase.
12. Explain gene expression
    12.a Explain the central dogma of molecular biology and how reverse transcriptase violates it.
    12.b Describe the genetic code.
    12.c Explain the processes of transcription and translation.
    12.d Describe RNA molecules and polymerases involved in gene expression.
    12.e Describe posttranscriptional modifications to mRNA.
    12.f Compare and contrast different kinds of point mutation and chromosomal mutations.
    12.g Explain how alternative splicing can produce multiple proteins form one gene.
13. Describe advances in Biotechnology.
    13.a Explain how restriction enzymes are used to make recombinant DNA
    13.b Explain the polymerase chain reaction.
    13.c Describe CRISPR/Cas9 gene editing.
    13.d Explain methods for creating transgenic plants.
14. Explain biological evolution.
    14.a Explain the assumptions of Hardy-Weinberg equilibrium.
    14.b Use the Hardy-Weinberg equation to predict allele frequencies.
    14.c Describe the five agents for evolutionary change: mutation, gene flow, nonrandom mating, genetic drift, and natural selection.
    14.d Explain the differences between directional, stabilizing, and disruptive selection.
    14.e Define evolutionary fitness.
15. Explain the evidence for evolution.
    15.a Describe how the Galapagos finches demonstrate natural selection.
    15.b Explain how peppered moth population changes were affected by environmental changes.
    15.c Describe artificial selection of various organisms.
    15.d Explain the importance of the fossil record.
    15.e Describe anatomical evidence for evolution.
    15.f Explain convergent evolution.
16. Explain the origin of species.
    16.a Describe the biological species concept and reproductive isolation.
    16.b Explain the effect of geography on speciation.
    16.c Describe adaptive radiation.