

Course Title: Biology 1-2 (General, College Prep, Honors)

Grade Level: 9 – 10

Length of Course: 2 semesters

Prerequisites: Algebra 1-2 Completion or Concurrent, Teacher recommendation to the Honors Course

Credit: 5 units per semester

Course Description:

The Biology 1-2 course will cover all the biology/life sciences concepts outlined in the 2000 California State Standards, (cell biology, genetics, ecology, evolution and structure and function in living systems). Both conceptual and quantitative topics will be developed in more depth than at the college preparatory level. A college level text will be used and placement will be determined by an entrance assessment and faculty recommendation.

Goal Statements:

Students will:

- Achieve scientific literacy that is the ability to use, and understand, science in everyday life.
- Understand the major themes underlying science, such as energy, evolution, patterns of change, scale and structure, stability and systems and interactions.
- Understand that science has applications in technology and implications for society.
- Learn from their own experiences and interests, frequently using hands-on experiences that are integral to the instructional sequence.
- Learn the important ideas of science, which are then developed in depth, through inquiry and investigation.
- Experience both challenge and success through instructional strategies and materials that allow several levels and pathways of access.
- Learn that fundamental life processes of plants and animals depend on a variety of chemical reactions that are carried out in specialized areas of the organism's cells.
- Learn that mutation and sexual reproduction lead to genetic variation in a population.
- Learn that a multi-cellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization.
- Learn that genes, encoded in DNA, specify the sequence of amino acids in proteins characteristic of that organism.
- Learn that the genetic composition of cells can be altered by incorporation of exogenous DNA into the cells.
- Learn that stability in an ecosystem is a balance between competing effects.
- Learn that the frequency of an allele in a gene pool of a population depends on many factors, and may be stable or unstable over time.
- Learn that evolution is the result of genetic changes that occur in constantly changing environments.
- Learn that, as a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic), despite changes in the outside environment.
- Learn that organisms have a variety of mechanisms to combat disease.

Units of Study:

Molecules of Life

- Structures
- Bonding
- Acids and bases
- pH
- Macromolecules of carbohydrates, lipids, proteins, and nucleic acids
- Enzymes (Lab with catalase)

The Cell

- Differences between structure of prokaryotic and eukaryotic cells and viruses.
- Structure and function of organelles including cell membrane, rough and smooth endoplasmic reticulum, Golgi apparatus, cytoskeleton and cell wall.
- Movement of substances in and out of cells by passive and active transport.

Photosynthesis

- Light Capturing Reactions
- Electron Transport
- Calvin Cycle
- C4 and CAM (Labs looking at plant and animal cells, looking at cross sections of leaves, extracting pigments from leaves, volumeter to collect oxygen produced by plants exposed to different light intensities)

Cellular Respiration

- Glycolysis
- Fermentation
- Krebs Cycle
- Electron Transport Chain

Mitosis and Meiosis

- Chromosome Structure
- Cell Cycle
- Mitosis
- Meiosis

Protein Synthesis

- Structure of DNA and RNA (Build model of DNA)
- Replication of DNA (Use model to replicate DNA)
- Transcription of RNA (Use model to transcribe RNA)
- Translation of protein (Lab modeling protein synthesis)
- Genes are segments of DNA that code for a polypeptide or a protein.
- Mutations and the differences between somatic mutation and germ line mutations.

Fundamentals of Genetics

- Phenotypes of organisms based on genotype and if alleles are autosomal or X-linked, dominant, recessive, or incomplete dominance. Examples of each with human disorders.
- Probability based on monohybrid crosses and dihybrid crosses.
- Mendel's law of segregation and law of independent assortment (lab to build models of these laws).
- Diagram of pedigrees to show how traits are inherited.
- Specialization of cells in multi-cellular organisms is caused by differences in gene expression rather than differences in the genes themselves.
- Sex is determined by the inheritance of XX or XY sex chromosomes. The other 22 pairs of chromosomes are autosomes.

Genetic Engineering

- Techniques for recombinant DNA using restriction enzymes, bacteria, and viruses. (Activity using paper cut-out models to demonstrate technique.)
- DNA technology using restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation.

Ecology

- Biodiversity is the sum of the different kinds of organisms living in an area, the stability of the area and the resistance to change. (Fieldtrips, use of Internet, or guest speaker to discuss real research being conducted.)
- Analyze changes in an ecosystem due to predicted changes such as season, migrations, reproductive cycles as well as unpredicted changes such as fire or introduction of non-native species.
- Determine fluctuations in population sizes due to births, deaths, immigration, and emigration.
- Water, carbon, oxygen, and nitrogen cycles in the ecosystem.
- Producers and decomposers are vital for an ecosystem. (Set up an ecosystem to study the interactions of producers and decomposers.)
- Energy pyramids to show the loss of 90% of the energy at each level in the food web.

Evolution (Population Gene Pools)

- Natural selection acts on the phenotype rather than the genotype, therefore lethal genes may be maintained in a gene pool in heterozygous individuals.
- New mutations are constantly being accumulated in the gene pool.
- Variation in a species increases its chances of survival under changed environmental conditions.
- Hardy-Weinberg equilibrium asserts that the genetic structure of a non-evolving population remains constant over the generations. If mating in a large population occurs randomly without the influence of natural selection, the migration of genes from neighboring populations or the occurrence of mutations, the frequency of alleles and genotypes will remain constant over time. Conditions such as these are too restrictive and not likely to occur in nature.

- Use the Hardy-Weinberg equilibrium to solve for the predicted frequency of genotypes in nature.

Evolution (Change in Environments)

- Natural selection determines the differential survival of groups of organisms. (Activity with predator-prey relationships, demonstrate Peppered Moth example.)
- Genetic drift affects the diversity of a small population of a species. Examples are the bottleneck effect and the founder effect.
- Reproductive and geographic isolation affects speciation.
- Analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.

Physiology (Various organ systems work together to maintain homeostasis within the body despite a changing environment outside.)

- Digestive system
- Circulatory system
- Pulmonary system
- Excretory system
- Nervous system
- Endocrine system
- Muscular system

Immune System

- Skin as a physical barrier
- Antibodies
- Vaccinations and how they work
- Differences between bacteria and viruses
- Compromised immune system

Student Outcomes for all Unit of Instruction:

As a basis for understanding these concepts, students will display an understanding:

Molecules of Life

- Cells are enclosed within semi-permeable membranes that regulate their interaction with their surroundings.

The Cell

- Enzymes are proteins and catalyze biochemical reactions without altering the reaction equilibrium. The activity of enzymes depends on the temperature, ionic conditions and pH of the surroundings.
- That prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.
- That the Central Dogma of molecular biology outlines the flow of information from transcription of RNA in the nucleus to translation of proteins on ribosomes in the cytoplasm.

- About the role of the endoplasmic reticulum and Golgi apparatus in secretion of proteins.

As a basis for understanding these concepts, students will display an understanding:

Photosynthesis

- That usable energy is captured from sunlight by chloroplasts, and stored via the synthesis of sugar from carbon dioxide.
- About the role of the mitochondria in making stored chemical bond energy available to cells by completing the breakdown of glucose to carbon dioxide.
- That most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.
- How chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.

Fundamentals of Genetics

- How eukaryotic cells are given shape and internal organization by a cytoskeleton and/or cell wall.
- That the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.
- How to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.
- How mutations in the DNA sequence of a gene may or may not affect the expression of the gene, or the sequence of amino acids in an encoded protein.
- That specialization of cells in multi-cellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.
- Proteins can differ from one another in the number and sequence of amino acids.
- Why proteins having different amino acid sequences typically have different shapes and chemical properties.

Protein Synthesis

- About the general structures and functions of DNA, RNA and protein.
- How to apply base-pairing rules to explain precise copying of DNA during semi-conservative replication, and transcription of information from DNA into mRNA.
- How genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.
- How basic DNA technology (restriction digestion by endo-nucleases, gel electrophoresis, ligation, and transformation).
- Is used to construct recombinant DNA molecules.

As a basis for understanding these concepts, students will display an understanding:

- How exogenous DNA can be inserted into bacterial cells in order to alter their genetic makeup and support expression of new protein products.

Mitosis and Meiosis

- That meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.
- Only certain cells in a multi-cellular organism undergo meiosis.
- How random chromosome segregation explains the probability that a particular allele will be in a gamete.
- That new combinations of alleles may be generated in a zygote through fusion of male and female gametes (fertilization).
- Why approximately half of an individual's DNA sequence comes from each parent.
- About the role of chromosomes in determining an individual's sex.

Genetic Engineering

- How to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.

Evolution (Population Gene Pools)

- How to predict the probable outcomes of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).
- About the genetic basis for Mendel's laws of segregation and independent assortment.
- How to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.
- How to use data on frequency of recombination at meiosis to estimate genetic distances between loci, and to interpret genetic maps of chromosomes.
- Why natural selection acts on the phenotype rather than the genotype of an organism.
- Why alleles that are lethal in a homozygous individual may be carried in a heterozygote, and thus maintained in the gene pool.
- That new mutations are constantly being generated in a gene pool.

As a basis for understanding these concepts, students will display an understanding:

Evolution (Change in Environments)

- Be aware of the theory of natural selection and how it leads to evolution.
- Comprehend the evidence for evolution and appreciate that the great diversity of animals that we have today is due to 3.5 billion years of evolution.
- Understand the classification system used by biologists today.

Ecology

- Describe how atoms, molecules, and energy flow through ecosystems.
- Understand the interactions between organisms and with their environment in an ecosystem.

- Describe the dynamics of populations and how they are affected by their environment and limited resources.
- Describe the effect humans have on their environment.

Physiology

Identify and describe the parts of the various systems of the human body.
Explain the physiology of immune systems and how vaccinations work.

Assessment Strategies:

All assessment strategies will measure expected course outcomes:

- Demonstration
- Open ended or structured laboratory investigation.
- Analysis or guided discussion of the phenomena under investigation.
- The use of design and construction assignments to stimulate individual student problem solving and project management.
- Inquiry based discussion and lab investigation.
- Cooperative learning.
- Research projects, essay or computer/multimedia presentation to class, with questions/assessment for class.
- Print/radio advertising design.
- Laboratory simulations where real experiment would be hazardous.
- Computer assisted or generated simulation exercises.

Skills to be Mastered:

Students will:

- Practice using safe laboratory procedures and become skilled in the use of laboratory equipment.
- Develop an understanding of the structure and function of the cell and the chemical reactions and processes that take place within the cell.
- Understand that genetic information is stored in the DNA which also directs the synthesis of protein.
- Conceptualize the processes of photosynthesis and cellular respiration and how they are interrelated and dependent on each other.
- Describe how cells are specialized in multi-cellular organisms.
- Describe the structure and function of DNA and how genetic information is passed on from parent to offspring.
- Describe chromosomes and how sex is determined in humans.
- Understand inheritance patterns in humans and how genes are expressed and repressed.
- Understand what mutations are, how they occur, how they can affect an organism, and how they can be passed on to offspring.
- Give examples of modern DNA technologies.

Instructional Strategies:

- Lecture
- Lab
- Models
- Simulations
- Demonstrations
- Poster projects
- Research paper
- Presentations using PowerPoint
- Formal lab reports
- Videos
- Overheads
- CD-Roms
- Reading material
- Comprehension questions
- Analogies
- Brainstorming
- Cooperative learning