Biology

Students must pass the High School Assessment in Biology to earn a high school diploma in Maryland. The HCPSS curriculum in Biology is aligned to the Maryland State Curriculum in Biology.

Special Note for the 2014-15 School Year: In 2013, the Maryland State Board of Education adopted the *Next Generation Science Standards* (NGSS) that set forth a vision for science education where the Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs) of science, and Crosscutting Concepts (CCCs) of science are blended seamlessly into a three dimensional learning environment for all students. The transition to NGSS across Maryland and in HCPSS will be deliberate, and full implementation of NGSS in Maryland is planned for the 2017-18 school year. The shifts required in NGSS implementation are great, and revision of curriculum requires careful consideration of these changes as well as time to develop, pilot, and implement. During this transitional period, resources in support of NGSS are being developed and posted for teachers' use within Alfresco. Additionally, beginning in 2014-15, select schools will pilot project based learning experiences developed by HCPSS curriculum writers. All students in HCPSS high school science courses regardless of the whether the student attends a school that is an early implementer of NGSS or not, will have exposure to the skills and processes and the content included in the Essential Curriculum documents. The order in which students encounter these concepts, however, may differ slightly among schools due to this transition.

EL indicates a goal that supports the Maryland Environmental Literacy Standards.

G/T Differentiation
Conceptually challenging, in-depth, distinctive, and complex learning experiences should be the hallmark of the G/T Biology Course. Students are expected to engage in longer-term investigations where they research complex topics or issues that lead them to create new knowledge or to design original solutions much like professionals within the discipline. Teachers are expected to use a wide array of instructional strategies that encourage creative problem solving appropriate for highly able/high achieving students.

UNIT I: Chemistry of Life

Associated Disciplinary Core Ideas (DCIs) from NGSS include:
LS1: From Molecules to Organisms: Structures and Processes
LS1.A—Structure and Function
LS1.C—Organization for Matter and Energy Flow in Organization

Essential Question:
How do organisms live and grow?

Goal 1. The student will demonstrate the ability to describe the unique characteristics of chemical compounds and macromolecules utilized by living systems.

Objectives - The student will be able to: ***EL***

a. Describe the properties of water (polarity, density, solvent properties, and inorganic molecule) that make it a good medium for biochemical reactions and cellular environments.
b. Describe and contrast the characteristics of organic compounds.
c. Compare the four classes of macromolecules (i.e., carbohydrates, lipids, proteins, and nucleic acids) in terms of structure and function.
d. Describe the general role of macromolecules, vitamins (i.e., C- wound healing, K- blood clotting, and D- bone growth), and minerals in the maintenance of good health and nutrition in living systems (including humans).

Goal 2. The student will demonstrate the ability to discuss the structure and function of enzymes.

Objectives - The student will be able to:

a. Diagram and explain theories of enzyme action.
b. Investigate factors (i.e., temperature, pH, enzyme/substrate concentration) that affect the activity of enzymes.
c. Predict a possible effect of a malfunctioning enzyme on an organism (e.g., phenylketonuria and Tay-Sachs).
d. Discuss the supportive role of vitamins and minerals in enzymatic reactions.

UNIT II: Cells and Homeostasis

Associated Disciplinary Core Ideas (DCIs) from NGSS include:
LS1: From Molecules to Organisms: Structures and Processes
LS1.A—Structure and Function
LS1.B—Growth and Development of Organisms
LS1.C—Organization for Matter and Energy Flow in Organization
LS1.D—Information Processing

Essential Question:
How do organisms live and grow?

Goal 1. The student will demonstrate the ability to discuss cell structure and function in unicellular and multicellular organisms.

Objectives - The student will be able to:

a. Compare prokaryotic and eukaryotic cells.
b. Describe the structure and function of cellular organelles (including the cell membrane, cell wall, chloroplasts, mitochondria, nucleus, and ribosomes).
c. Explain the mechanisms of movement (cellular- flagellate, ciliate, amoeboid; interaction between skeletal, and muscular systems).
d. Discuss the role of the cell membrane in controlling what enters and leaves cells (by the processes of diffusion, osmosis, passive transport, active transport, endocytosis, and exocytosis).
e. Describe the effect of temperature change on rates of diffusion and osmosis.

f. Illustrate the statement "The cell is the unit of structure and function in living organisms."
g. Review and discuss the basic structure and function of human body systems (cardiovascular, endocrine, respiratory, skeletal, integumentary, muscular, nervous, digestive, and excretory systems).

Goal 2. The student will demonstrate the ability to describe how communication and regulation are accomplished within multicellular organisms.

Objectives - The student will be able to:

a. Relate the concept of cellular specialization to multicellular organisms.
b. Explain how communication by nerve cells occurs in multicellular animals (i.e., neurons, nerve impulses, and nervous system).
c. Explain how chemical regulation occurs in multicellular plants and animals (e.g., how hormones function, endocrine system).

Goal 3. The student will demonstrate the ability to apply the concept of homeostasis to understanding how living systems respond to a wide range of environmental conditions. *EL*

Objectives - The student will be able to:

a. Use system analysis (inputs, outputs, feedback, equilibrium) to explain homeostatic mechanisms in unicellular and multicellular organisms (Include nervous, endocrine, and osmotic examples).
b. Explain how the pH scale is used (relative values for acids and bases) and the effect of substances with varying pH in living systems.
c. Apply the principles of homeostasis to unicellular and multicellular organisms as those principles relate to water and pH balances, temperature control, and enzyme regulation.
d. Conclude that cells exist within a narrow range of environmental conditions, and changes to that environment (e.g., boiling or freezing, radiation, and toxins) may cause the death of the cell or organism.

UNIT III: Energy Transfer and Use

Associated Disciplinary Core Ideas (DCIs) from NGSS include:
LS1: From Molecules to Organisms: Structures and Processes
LS1.A—Structure and Function
LS1.B—Growth and Development of Organisms
LS1.C—Organization for Matter and Energy Flow in Organization
LS1.D—Information Processing

Essential Question

How do organisms live and grow?

Goal 1. The student will demonstrate the ability to discuss the transfer and use of matter and energy in photosynthesis and chemosynthesis. *EL*

Objectives - The student will be able to:

a. Describe the basic molecules involved in photosynthesis.
b. Explain how cell organelles are involved in photosynthesis.
c. Trace the flow of energy from sunlight to the energy stored in high-energy chemical compounds.
d. Summarize how chemosynthesis differs from photosynthesis.
e. Explain how environmental factors affect the rate of photosynthesis.
f. Explain how the processes of photosynthesis and respiration are interdependent.

Goal 2. The student will demonstrate the ability to discuss the transfer and use of matter and energy in cellular respiration.

Objectives - The student will be able to:

a. Describe the basic molecules involved in cellular respiration.
b. Explain how cell organelles are involved in cellular respiration.
c. Trace the flow of energy in cellular respiration.
d. Compare aerobic and anaerobic respiration.
e. Explain how environmental factors affect the rate of cellular respiration.
f. Identify ATP as an energy carrier molecule.

Goal 3. The student will demonstrate the ability to describe the role of organ systems in the transfer and use of matter and energy by multicellular organisms.

Objectives - The student will be able to:

a. Describe the structure and function of vascular tissue in multicellular plants.
b. Explain how the circulatory, respiratory, and excretory systems are involved in energy transfer and use in multicellular animals.
c. Apply the principles of homeostasis to multicellular organisms as they relate to oxygen and carbon dioxide balance.
d. Use the principles of system analysis (inputs, outputs, feedback, and equilibrium) to explain the control of the circulatory, respiratory, and excretory systems in multicellular animals.

UNIT IV: Nucleic Acids and Protein Synthesis

Associated Disciplinary Core Ideas (DCIs) from NGSS include:
LS3: Heredity, Inheritance, and Variation of Traits
LS3.A—Inheritance of Traits
LS3.B—Variation of Traits

Essential Question:
How are characteristics of one generation passed to the next?
How can individuals of the same species and even siblings have different characteristics?

Goal 1. The student will demonstrate the ability to explain the connections among genes, chromosomes, and DNA.

Objectives - The student will be able to:

a. Describe the structure and function of the DNA molecule.
b. Discuss how the genetic code is contained in the structure of DNA and how the structure of DNA makes replication possible.
c. Describe the structure and function of a chromosome.
d. Analyze the relationship between DNA, genes, and chromosomes.

Goal 2. The student will demonstrate the ability to explain cell cycles.

Objectives - The student will be able to:

a. Describe and illustrate asexual reproduction (binary fission, budding, and vegetative reproduction (propagation)).
b. Describe and illustrate each phase of the eukaryotic cell cycle.
c. Summarize and compare the phases of mitosis in plant and animal cells.

Goal 3. **The student will demonstrate the ability to explain how a genetic trait is determined by the code in a DNA molecule.**

Objectives - The student will be able to:

a. Describe the genetic code.
b. Distinguish between the structure, function, and location of mRNA, tRNA, and rRNA.
c. Describe what happens in both transcription and translation, including the importance of triplets, codons, anticodons, and amino acids.
d. Explain that inherited characteristics can be observed at a variety of levels, from the molecular level to the level of the whole organism.

UNIT V: Genetics

Associated Disciplinary Core Ideas (DCIs) from NGSS include:
LS3: Heredity: Inheritance and Variation of Traits
LS3.A—Inheritance of Traits
LS3.B—Variation of Traits

Essential Questions:

How are characteristics of one generation passed to the next?
How can individuals of the same species and even siblings have different characteristics?

Goal 1. **The student will demonstrate the ability to illustrate that the sorting and recombination of genes during sexual reproduction has an effect on variation in offspring.**

Objectives - The student will be able to:

a. Explain the results of meiosis.
b. Demonstrate how new gene combinations can result when sex cells unite during fertilization (combination of gametes to form a zygote).
c. State that plants and animals are capable of sexual reproduction.

Goal 2. **The student will demonstrate the ability to analyze selected patterns of inheritance.**

Objectives - The student will be able to:

a. Explain the concept of dominant and recessive gene traits.
b. Distinguish between genotypes and phenotypes.
c. Use a Punnett square to predict the possible genotypes and phenotypes that can result from a monohybrid cross.
d. Explain the role of the X- and Y-chromosomes in sex determination in humans.
e. Illustrate, explain, and give examples of sex-linked inheritance.
f. Explain other patterns of inheritance (i.e., codominance, incomplete dominance, polygenic inheritance, and multiple alleles).
g. Interpret a pedigree and suggest a pattern of inheritance that is consistent with the data shown in a given pedigree.
h. Discuss how environmental factors can influence genetic expressions.

Goal 3. **The student will demonstrate the ability to describe the effect of gene alteration on an organism.**

Objectives - The student will be able to:

a. Cite examples of agents that can cause genetic mutations.
b. Explain the circumstances that lead to individuals passing mutations on to their offspring.
c. Discuss the effect of an alteration in the number of chromosomes and give examples of human conditions associated with this problem.
d. Differentiate between a carrier of an inherited condition and an individual who actually has the condition.

Goal 4. **The student will demonstrate the ability to describe the role of genetic counseling and biotechnology in society.**

Objectives - The student will be able to:

a. Analyze and explain selected human genetic situations (e.g., genetic risks).
b. Explain common uses of biotechnology (e.g., cloning, gene splicing, recombinant DNA, DNA fingerprinting; genetic counseling).
c. Identify issues (e.g., privacy and ethical issues) that result from advances in biotechnology.

UNIT VI: Evolution, Diversity, and Classification

Associated Disciplinary Core Ideas (DCIs) from NGSS include:
LS4: Biological Evolution: Unity and Diversity
LS4.A—Evidence of Common Ancestry and Diversity
LS4.B—Natural Selection
LS4.C—Adaptation
LS4.D—Biodiversity and Humans

Essential Question:

How and why do organisms interact with their environment, and what are the effects of these interactions?
What evidence shows that different species are related?

Goal 1. **The student will demonstrate the ability to explain evidence that illustrates that living things have changed over time.**

Objectives - The student will be able to:

a. Analyze fossil evidence and provide possible explanations for the changes that occurred in given organisms over time, including the mass extinction of some species.
b. Conclude that geology, biochemistry, embryology, and comparative anatomy provide evidence that living things have evolved.

Goal 2. **The student will demonstrate the ability to analyze and explain the mechanisms of evolutionary changes (i.e., genetic variation, environmental changes, and natural selection).**

Objectives - The student will be able to:

a. Discuss how new traits may result from new combinations of existing genes or from mutation of genes in reproductive cells within a population.
b. Give examples of how genes code for characteristics that can be observed at varying levels within an organism.
c. Analyze the impact of environmental change on the selective advantage and disadvantage of given characteristics.
d. Describe the effect of gene alteration on a population.
e. Discuss the components of the theory of natural selection, including:
    - overproduction
    - inheritance of variation
    - selective advantage in competition for survival and reproduction
    - adaptation leads to speciation
    - conditions in nature control evolution.

Goal 3. **The student will demonstrate the ability to explain the relationship between biodiversity and evolution.**

Objectives - The student will be able to:

a. Cite examples of organisms that survive and thrive in extreme environments.
b. Justify the importance of biodiversity.

Goal 4. **The student will demonstrate the ability to estimate degrees of kinship among organisms or species.**

Objectives - The student will be able to:

a. Use Linnaeus' classification system to classify and name organisms.
b. Draw conclusions about organisms given information about how they are classified.
c. Draw conclusions about organisms given information about the anatomy and biochemistry of the organisms.

UNIT VII: Ecology

Associated Disciplinary Core Ideas (DCIs) from NGSS include:
LS2: Ecosystems: Interactions Energy, and Dynamics
LS2.A—Interdependent Relationships in Ecosystems
LS2.B—Cycles of Matter and Energy Transfer in Ecosystems
LS2.C—Ecosystem Dynamics, Functioning, and Resilience
LS2.D—Social Interactions and Group Behavior

Essential Question:
How and why do organisms interact with their environment, and what are the effects of those interactions?

Where practicable, teachers are encouraged to engage students using the Issues Investigation or MELP Frameworks for student-driven inquiry on environmental issues.

Goal 1. The student will demonstrate the ability to analyze the relationships among organisms and between organisms and abiotic factors (ecosystem; biomes; abiotic/biotic factors: space, soil, water, air, temperature, food, light, organisms; relationships: predator-prey, parasite-host, mutualism, commensalism, saprophytism). *EL*

Objectives - The student will be able to:

a. Determine the relationship among given organisms.
b. Give examples of abiotic and biotic factors and how they may impact an ecosystem.
c. Define the major roles of organisms in an ecosystem:
   - Producer, consumer (primary and secondary), decomposer
   - Omnivore, herbivore, carnivore.
   - Characterize several biomes by comparing abiotic and biotic factors (deciduous forest, desert, grassland, savanna, taiga, tropical rainforest, and tundra).

Goal 2. The student will demonstrate the ability to describe the flow of matter and energy between living systems and the physical environment. *EL*

Objectives - The student will be able to:

a. Discuss the water, carbon, and nitrogen cycles.
b. Explain how energy flows through an ecosystem.
c. Explain dissipation of energy and trophic levels.

Goal 3. The student will demonstrate the ability to analyze the interrelationships and interdependencies among different organisms and explain how these relationships contribute to the stability of the ecosystem. *EL*

Objectives - The student will be able to:

a. Classify and organize organisms within the biosphere into communities and populations.
b. Analyze ecosystems to determine factors that contribute to stability.
c. Explain how an ecosystem returns to a state of stability after a catastrophic disaster:
   - Primary succession
   - Secondary succession.

Goal 4. The student will demonstrate the ability to investigate how natural changes in environmental conditions and human activity will affect individual organisms and the dynamics of populations. *EL*

Objectives - The student will be able to:

a. Predict the effect of naturally occurring environmental events on ecosystems.
b. Discuss the impact of natural changes and human activity on given ecosystems.
c. Propose solutions for the negative consequences of natural changes and human activity on given ecosystems (i.e., pollution by nitrates).

Goal 5. **The student will demonstrate the ability to illustrate how all organisms are parts of and depend on two major global food webs.** ***EL***

Objectives - The student will be able to:

a. Describe the oceanic food web.
b. Describe the terrestrial food web.

Goal 6. **The student will demonstrate the ability to explain why curiosity, honesty, openness, and skepticism are highly regarded in science.** ***EL***

Objectives - The student will be able to:

a. Recognize that real problems have more than one solution, and decisions to accept one solution over another are made on the basis of many issues.
b. Modify or affirm scientific ideas according to accumulated evidence.
c. Critique arguments that are based on faulty, misleading data or on the incomplete use of numbers.