

# Howard County Public School System

## Curriculum for High School Science

### Grade 9: Biology G/T

#### Overview:

High school Biology G/T will equip students to address the following essential questions as identified within the Next Generation Science Standards:

1. How do organisms live and grow?
2. How and why do organisms interact with their environment, and what are the effects of those interactions?
3. How are characteristics of one generation passed to the next? How can individuals of the same species and even siblings have different characteristics?
4. What evidence shows that different species are related?
5. How and why is Earth constantly changing? How do Earth's surface processes and human activities affect each other?

The high school Performance Expectations (PEs) in the life sciences and the Earth sciences address essential questions about life and the Earth and build on middle school ideas and experiences. They blend Disciplinary Core Ideas (DCI) with Scientific and Engineering Practices (SEP) and Crosscutting Concepts (CCC) to support students in developing usable knowledge to explain real-world phenomena. In Biology G/T, students regularly engage in asking scientific questions that drive their investigations and lead to increasingly sophisticated evaluation of data and their presentation. Students also have opportunities to learn and apply engineering-specific practices such as designing solutions to identified problems. Read the full [NGSS storyline](#) for Life Science and the full [NGSS storyline](#) for Earth Science.

The learning sequence in Biology G/T is organized around a series of driving questions that provide the context and motivation for learning. While exploring each driving question, students engage in unique learning experiences that are carefully designed to immerse them in the SEPs as they construct their understanding of important concepts. These experiences are carefully sequenced so that students encounter ideas that are developmentally and cognitively appropriate. By the end of the learning experiences, students will be able to meet the NGSS performance expectations and address the driving questions.

Students in Biology G/T will participate in the Watershed Report Card (WRC) program as a ninth grade science experience. Through hands-on activities in the field and the classroom, students will analyze the health of the Howard County watershed. The study will culminate in development of an advocacy and action plan to enhance the health of the watershed. The WRC supports students' development of environmental literacy and is conducted in partnership with the Howard County Conservancy.

## Performance Expectations:

The Next Generation Science Standards (NGSS), adopted as the Maryland Science Standards (MSS), are very different than previous standards documents. NGSS purposely combine the three dimensions of science learning into single, target statements for student learning known as Performance Expectations (PE). The three dimensions of science learning are: Science and Engineering Practices (SEP), Crosscutting Concepts (CCC), and Disciplinary Core Ideas (DCI). Earlier science standards treated the three dimensions as separate and distinct. This treatment led to assessment and instruction that emphasized one dimension preferentially over the others. The combination of SEP, CCC, and DCI in each PE is not intended to limit instruction. Instead, the PEs are designed to guide assessment of student learning. The performance expectations for High School Biology G/T support student learning in six main areas: *Structures and Processes; Ecosystems; Heredity; Biological Evolution; Earth's Systems; and Earth and Human Activity*. The performance expectations for high school Biology G/T are listed below:

### [HS-LS1 From Molecules to Organisms: Structures and Processes](#)

Students who demonstrate understanding can:

HS-LS1-1.	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
HS-LS1-2.	Develop and use a model to illustrate the hierarchical organization of interaction systems that provide specific functions within multicellular organisms
HS-LS1-3.	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
HS-LS1-4.	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
HS-LS1-5.	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
HS-LS1-6.	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
HS-LS1-7.	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

### [HS-LS2 Ecosystems: Interactions, Energy, and Dynamics](#)

Students who demonstrate understanding can:

HS-LS2-1.	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
HS-LS2-2.	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
HS-LS2-3.	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
HS-LS2-4.	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
HS-LS2-5.	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cyclin of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
HS-LS2-6.	Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-LS2-7.	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-LS2-8	Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.

### [HS-LS3 Heredity: Inheritance and Variation of Traits](#)

Students who demonstrate understanding can:

HS-LS3-1.	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
HS-LS3-2.	Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
HS-LS3-3.	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

### [HS-LS4 Biological Evolution: Unity and Diversity](#)

Students who demonstrate understanding can:

HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
HS-LS4-2	Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
HS-LS4-5	Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individual of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

### [HS-ESS2: Earth's Systems](#)

Students who demonstrate understanding can:

HS-ESS2-1.	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
HS-ESS2-2.	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
HS-ESS2-3.	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
HS-ESS2-4.	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ESS2-5.	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
HS-ESS2-6.	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
HS-ESS2-7.	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

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[HS-ESS3: Earth and Human Activity](#)

Students who demonstrate understanding can:

HS-ESS3-1.	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
HS-ESS3-2.	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
HS-ESS3-3.	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
HS-ESS3-4.	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-5.	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
HS-ESS3-6.	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

**HCPSS Learning Sequence:**

Students will continue to develop their understanding of the disciplinary core ideas in the Biology and the Earth/Space sciences throughout the school year. The high school performance expectations in Biology and Earth/Space science allow high school students to explain more in-depth phenomena central to these disciplines as well as to the physical sciences. These performance expectations blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain ideas across the science disciplines. While the performance expectations shown in high school Biology and Earth/Space science couple particular practices with specific disciplinary core ideas, instruction will include the use of many science and engineering practices that lead to the performance expectations.

The Biology G/T course is organized into four units.

<b>Unit 1:</b>	<b>Unit 2:</b>	<b>Unit 3:</b>	<b>Unit 4:</b>
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<b>Ecology and Earth's Systems</b> <i>EL</i>	<b>Cell Biology</b>	<b>Genetics</b>	<b>Evolution</b>
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*EL* indicates that Maryland Environmental Literacy Standards are including within this learning sequence.

Students develop understanding of a wide range of topics in Biology and the Earth/Space sciences by using the science and engineering practices and crosscutting concepts. In Unit 1: *Ecology and Earth's Systems*, students will use investigations to understand the cycling of matter and energy in Earth's ecosystems through the lens of Earth's processes and interactions among organisms. Students will also participate in field work to collect and analyze data in support of the Watershed Report Card (WRC).

In Unit 2: *Cell Biology*, students will use science and engineering practices to explore the relationship between energy and matter in the context of molecular structure and function. Students will also consider organismal structure and function.

In Unit 3: *Genetics*, students will use the science and engineering practices to investigate how proteins are built and how traits move from one generation to the next. Students will explore the relationship between biotechnology and global food supply concerns.

In Unit 4: *Evolution*, students will explore how and why the genetic makeup of populations changes over time. In addition, students will analyze the evidence for common ancestry and how speciation and extinction affect biodiversity.