DISTRICT OF COLUMBIA
PUBLIC SCHOOLS

High School Biology Scope and Sequence for the

NEXT GENERATION SCIENCE STANDARDS

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A Guide to Reading the DCPS Science Scope and Sequence

In response to the adoption of the Next Generation Science Standards (NGSS)[1] by the State Board of Education in December 2013, the District of Columbia Public Schools (DCPS) Office of Teaching and Learning convened a group of science teachers – the STEM Master Teacher Corps – to develop a new scope and sequence (SAS) for science for grades K-12. The inaugural STEM Master Teacher Corps consisted of the following dedicated educators:

- Gloria Allen – Hardy Middle School
- Erica Banks – Cardozo Education Campus
- Sydney Bergman – School Without Walls High School
- Jessica Buono – DCPS Office of Teaching and Learning
- Megan Fisk – Eastern High School
- Rabiah Harris – Kelly Miller Middle School
- Trilby Hillenbrand – Jefferson Middle School Academy
- Leslie Maddox – Wilson High School
- Amanda Oberski – Ludlow-Taylor Elementary School
- Lola Odukoya – Langdon Education Campus
- Ericka Senegar-Mitchell – McKinley Technology High School
- Stephen Sholtas – Brookland Education Campus
- Molly Smith – Cardozo Education Campus
- Angelique Sykes – Dunbar High School

The principal goal was to reorganize the complex NGSS architecture into instructional units that would make the most sense to teachers.

All scope and sequences begin with a **Grade Level/Course overview** that summarizes what students will learn for the year, followed by a **"School Year at a Glance"** that summarizes the order of the units and a suggested timeline for their implementation. All SAS assume a full year of science for a minimum of 225 minutes per week for all grade levels.

[1] A full copy of the NGSS can be downloaded from the NGSS website at http://www.nextgenscience.org.

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Following the grade level/course overview and year at a glance, each unit is broken out into several sections beginning with the **Disciplinary Core Ideas (DCIs)** and **Crosscutting Concepts** (**"What to Teach"**) and the **Science and Engineering Practices** (**"What Students Do"**) for that unit. This was done to emphasize that the Science and Engineering Practices are the way that students experience the content so that they think, speak, act, and write the way scientists and engineers do. Teachers should also refer to Appendix F of the NGSS to learn more about how these practices are articulated across grade levels.

Student Performance Expectations follow the Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices section of the unit breakdown. Student performance expectations provide a brief explanation of what students who demonstrate understanding of the content are able to do.

Links to the **Common Core State Standards (CCSS) for ELA/Literacy and Mathematics** (including the Standards for Mathematical Practice) are included in every unit breakdown to emphasize the connections between CCSS and the NGSS so that teachers can more readily identify entry points for integration of science across subject areas. Teachers should also refer to the full NGSS document for additional connections to other DCIs and for information about articulation of DCIs across grade levels.

Finally, connections to the ***former*** **DC Science Standards** are included with every unit to serve as an unofficial crosswalk between the NGSS and the former standards. Teachers should be advised that inclusion of these standards does not imply that they are exactly parallel to the NGSS, but rather are related in some way to the Disciplinary Core Ideas, Crosscutting Concepts, and/or Science and Engineering Practices that make up the NGSS Performance Expectation(s) for that unit. More importantly, teachers should know that inclusion of the former standards is not intended for the purpose of continuing to teach with these standards, but rather so that teachers can more readily see how the content in the NGSS differs from that of the former standards.

A list of resources to help teachers plan to teach each unit of the scope and sequence are available in the **digital version** of this document, located on the **Elementary and Secondary Science Educators Pages of the DCPS Educator Portal**[2]. Be sure to check the Educator Portal frequently for subsequent updates to this document.

For more information about the NGSS, please contact James Rountree, Science Curriculum Specialist (e-mail: james.rountree@dc.gov, phone: 202-442-4643).

[2] To access the Educator Portal, visit http://www.educatorportalplus.com.

High School Biology
Overview and Scope and Sequence SY14-15

Course Overview: Students in high school develop an understanding of key concepts that will help them make sense of life science. The ideas are built upon students' understanding of disciplinary core ideas, science and engineering practices, and crosscutting concepts from earlier grades. There are four life science disciplinary core ideas in high school:

1. Ecosystems: Interactions, Energy, and Dynamics
2. Biological Evolution: Unity and Diversity
3. From Molecules to Organisms: Structures and Processes
4. Heredity: Inheritance and Variation of Traits

The performance expectations for high school life science blend core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge that can be applied across the science disciplines.

School Year At a Glance

Advisory	Units	Timeline
Advisory 1	Unit 1: Ecosystems: Interactions, Energy, and Dynamics	9 weeks
Advisory 2	Unit 2: Biological Evolution: Unity and Diversity	9 weeks
Advisory 3	Unit 3: From Molecules to Organisms: Structures and Processes	9 weeks
Advisory 4	Unit 4: Heredity: Inheritance and Variation of Traits	9 weeks

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Advisory 1

<table>
<tr><th colspan="3">Unit 1: Ecosystems</th></tr>
<tr><th colspan="2">What to Teach</th><th>What Students Do</th></tr>
<tr><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th><th>Science & Engineering Practices</th></tr>
<tr>
<td>LS2.A: Interdependent Relationships in Ecosystems
Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS- LS2-2)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)
Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy</td>
<td>Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)
Scale, Proportion, and Quantity
The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1).
Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS-2)
Systems and System Models
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)
Energy and Matter
Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6)
Energy cannot be created or destroyed—it only moves between</td>
<td>Developing and Using Models
Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5), (HS-LS1-7)
Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)
Using Mathematics and Computational Thinking
Use mathematical and/or computational representations to support explanations. (HS-LS2-1)
Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)
Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)
Constructing Explanations and Designing Solutions
Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws</td>
</tr>
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Unit 1: Ecosystems		
in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) • Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e.,	one place and another place, between objects and/or fields, or between systems. (HS-LS1-7), (HS-LS2-4) • Energy drives the cycling of matter within and between systems. (HS-LS2-3) **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)	that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS2-3) • Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7) - ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** • Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2), (HS-LS2-3) • Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)

Unit 1: Ecosystems		
the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6) • Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) **LS2.D: Social Interactions and Group Behavior** • Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **LS4.D: Biodiversity and Humans** • Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(Secondary to HS-LS2-7)* • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation,		

Unit 1: Ecosystems		
habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(Secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)* **PS3.D: Energy in Chemical Processes** • The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(Secondary to HS-LS2-5)* **ETS1.B: Developing Possible Solutions** • When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(Secondary to HS-LS2-7)*		

What to Assess:
Student Performance Expectations

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. [**Clarification Statement**: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include

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Unit 1: Ecosystems	
graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [**Assessment Boundary:** Assessment does not include deriving mathematical equations to make comparisons.] **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.** [**Clarification Statement:** Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [**Assessment Boundary:** Assessment is limited to provided data.] **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.** [**Clarification Statement:** Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [**Assessment Boundary:** Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.] **HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** [**Clarification Statement:** Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [**Assessment Boundary:** Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.] **HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.** [**Clarification Statement:** Examples of models could include simulations and mathematical models.] [**Assessment Boundary:** Assessment does not include the specific chemical steps of photosynthesis and respiration.] **HS-LS2-6. Evaluate the 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.** [**Clarification Statement:** Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.] **HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** [**Clarification Statement:** Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. **HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** [**Clarification Statement:** Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]	
Integrated Common Core State Standards	
For ELA/Literacy **RST.9-10.8** Assess the extent to which the reasoning and evidence in	**For Mathematics** **MP.2** Reason abstractly and quantitatively. (HS-LS2-1), (HS-LS2-

<table>
<tr><th colspan="2">Unit 1: Ecosystems</th></tr>
<tr><td>a text support the author’s claim or a recommendation for solving a scientific or technical problem.
(HS-LS2-6), (HS-LS2-7), (HS-LS2-8)
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3), (HS-LS2-6), (HS-LS2-8)
RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)
RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1), (HS- LS2-2), (HS-LS2-3)
WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-3)
WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7)</td><td>2),(HS-LS2-4), (HS-LS2-6), (HS-LS2-7)
MP.4 Model with mathematics. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
HSS-ID.A.1 Represent data with plots on the real number line. (HS-LS2-6)
HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)
HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)</td></tr>
<tr><th colspan="2">Connections to Former DC Science Standards</th></tr>
<tr><td colspan="2">Chemical Change: B.5.1
Environmental Impact on Evolution: B.11.1
Classification of Systems: B.16.1
Dynamics of Ecosystems: B.17.1-4
Stability of Dynamic Systems: B.18.1-2</td></tr>
</table>

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Unit 1: Ecosystems
Pollution: B.19.1-2

Advisory 2

<table>
<tr><th colspan="3">Unit 2: Biological Evolution</th></tr>
<tr><th colspan="2">What to Teach</th><th>What Students Do</th></tr>
<tr><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th><th>Science & Engineering Practices</th></tr>
<tr>
<td>LS4.A: Evidence of Common Ancestry and Diversity
• Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)
LS4.B: Natural Selection
• Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)
• The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-</td>
<td>Patterns
• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1), (HS-LS4-3)
Cause and Effect
• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2), (HS-LS4-4), (HS-LS4-5), (HS-LS4-6)
- -
Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
• Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1), (HS-LS4-4)</td>
<td>Analyzing and Interpreting Data
• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3)
Using Mathematics and Computational Thinking
• Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)
Constructing Explanations and Designing Solutions
• Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2), (HS-LS4-4)
Engaging in Argument from Evidence
• Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)</td>
</tr>
</table>

Unit 2: Biological Evolution		
3) **LS4.C: Adaptation** • Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2) • Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4) • Adaptation also means that the distribution of traits in a population can change when conditions change.		**Obtaining, Evaluating, and Communicating Information** • Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1) - ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)

Unit 2: Biological Evolution		
(HS-LS4-3) • Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5), (HS-LS4-6) • Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5) **LS4.D: Biodiversity and Humans** • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids		

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Unit 2: Biological Evolution		
humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6) (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(Secondary to HS-LS4-6)* • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *(Secondary to HS-LS4-6)*		

What to Assess:
Student Performance Expectations

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. [Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.]

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential

Unit 2: Biological Evolution	
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. [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.] **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.** [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.] **HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading 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 individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.] **HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*** [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.] The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.	
Integrated Common Core State Standards	
For ELA/Literacy **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4) **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of	**For Mathematics** **MP.2** Reason abstractly and quantitatively. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5) **MP.4** Model with mathematics. (HS-LS4-2)

Unit 2: Biological Evolution	
information. (HS-LS4-5) **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS4-1), (HS-LS4- 2), (HS-LS4-3), (HS-LS4-4) **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS4-6) **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS4-6) **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5) **SL.11-12.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-LS4-1), (HS-LS4-2)	
Connections to *Former* DC Science Standards	
Theories of Inheritance: B.6.2, B.6.4 **Genetics:** B.7.3-4 **Evolution:** B.10.1-4 **Environmental Impact on Evolution:** B.11.1-3	

Advisory 3

Unit 3: From Molecules to Organisms		
What to Teach		What Students Do
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science & Engineering Practices**
LS1.A: Structure and Function • Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)* • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2) • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) **LS1.B: Growth and Development of**	**Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2), (HS-LS1-4) **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) • Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7) **Structure and Function** • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1) **Stability and Change** • Feedback (negative or positive) can	**Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2) • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4), (HS-LS1-5), (HS-LS1-7) **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own

Unit 3: From Molecules to Organisms		
Organisms • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4) **LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) • The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.	stabilize or destabilize a system. (HS-LS1-3)	investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1) • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6) - ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

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Unit 3: From Molecules to Organisms		
(HS-LS1-6) • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6), (HS-LS1-7) • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)		

What to Assess:
Student Performance Expectations

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. [*Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.*]
HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [*Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.*]

Unit 3: From Molecules to Organisms

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [*Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.*]

HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [*Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.*]

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [*Assessment Boundary: Assessment does not include specific biochemical steps.*]

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. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [*Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.*]

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. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [*Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.*]

Integrated Common Core State Standards

For ELA/Literacy	For Mathematics
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1), (HS-LS1-6) **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1), (HS-LS1-6) **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6)	**MP.4** Model with mathematics. (HS-LS1-4) **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-LS1-4) **HSF-BF.A.1** Write a function that describes a relationship between two quantities. (HS-LS1-4)

Unit 3: From Molecules to Organisms	
WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3) **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3) **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1), (HS-LS1-6) **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2), (HS-LS1-4), (HS-LS1-5), (HS-LS1-7)	
Connections to *Former* DC Science Standards	
Biochemistry: B.1.1-5 **Cells**: B.2.1-6 **Reactions of Life**: B.3.1-7 **Biological Structure and Organization**: B.4.1-5	

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Advisory 4

<table>
<tr><th colspan="2">Unit 4: Heredity</th><th></th></tr>
<tr><th colspan="2">What to Teach</th><th>What Students Do</th></tr>
<tr><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th><th>Science & Engineering Practices</th></tr>
<tr>
<td>LS1.A: Structure and Function
All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (Secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)
LS3.A: Inheritance of Traits
Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)
LS3.B: Variation of Traits
In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic</td>
<td>Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1), (HS-LS3-2)
Scale, Proportion, and Quantity
Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)
- -
Connections to Nature of Science

Science is a Human Endeavor
Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)
Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)</td>
<td>Asking Questions and Defining Problems
Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)
Analyzing and Interpreting Data
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3)
Engaging in Argument from Evidence
Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)</td>
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Unit 4: Heredity		
combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) • Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2), (HS-LS3-3)		

What to Assess:
Student Performance Expectations

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. [*Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.*]

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. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [*Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.*]

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RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-LS3-1)
WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-LS3-2)</td><td>For Mathematics
MP.2
Reason abstractly and quantitatively. (HS-LS3-2), (HS-LS3-3)</td></tr>
<tr><th colspan="2">Connections to Former DC Science Standards</th></tr>
<tr><td colspan="2">Theories of Inheritance: B.6.1-5
Genetics: B.7.1-6
Structure and Function of Genes: B.8.1-3</td></tr>
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