

Unit Summary		
<i>How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms?</i>		
<p>Students <i>constructing explanations</i> and <i>designing solutions</i>, <i>analyzing and interpreting data</i>, and <i>engaging in argument from evidence</i> investigate to make sense of the relationship between the environment and natural selection. Students also develop an understanding of the factors causing natural selection of species over time. They also demonstrate understandings of how multiple lines of evidence contribute to the strength of scientific theories of natural selection. The crosscutting concepts of <i>patterns</i> and <i>cause and effect</i> serve as organizing concepts for the disciplinary core ideas. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas.</p> <p>This unit is based on Disciplinary Core Idea LS4.C (Adaptation), HS-LS4-4, HS-LS4-3, HS-LS4-5, and HS-LS2-8.</p>		
Student Learning Objectives		
<p>Make predictions about the effects of artificial selection on the genetic makeup of a population over time. (LS4.C)</p>		
<p>Construct an explanation based on evidence for how natural selection leads to adaptation of populations. <i>[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.]</i> (HS-LS4-4)</p>		
<p>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. <i>[Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.]</i> <i>[Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]</i> (HS-LS4-3)</p>		
<p>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. <i>[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.]</i> (HS-LS4-5)</p>		
<p>Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. <i>[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.]</i> (HS-LS2-8)</p>		
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Unit Sequence	
Part A: How does natural selection lead to adaptations of populations?	
Concepts	Formative Assessment
<ul style="list-style-type: none"> 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. Empirical evidence is required to differentiate between cause and correlation and make claims about how natural selection leads to adaptation of populations. Empirical evidence is required to differentiate between cause and correlation and make claims about how specific biotic and abiotic differences in ecosystems contribute to change in gene frequency over time, leading to adaptation of populations. Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> 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 on 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, for how natural selection leads to adaptation of populations. Use data to differentiate between cause and correlation and to make claims about how specific biotic and abiotic differences in ecosystems contribute to change in gene frequency over time, leading to adaptation of populations.

Unit Sequence	
Part B: Why is it so important to take all of the antibiotics in a prescription if I feel better?	
Concepts	Formative Assessment
<ul style="list-style-type: none"> 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. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. 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 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. Analyze shifts in numerical distribution of traits and, using these shifts as evidence, support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. Observe patterns at each of the scales at which a system is studied to provide evidence for causality in explanations that organisms with an

<p>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.</p> <ul style="list-style-type: none"> • Adaptation also means that the distribution of traits in a population can change when conditions change. • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. 	<p>advantageous heritable trait tend to increase in proportion to organisms lacking this trait.</p>
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Unit Sequence

Part C: How are species affected by changing environmental conditions?

Concepts	Formative Assessment
<ul style="list-style-type: none"> • Changes in the physical environment, whether naturally occurring or human induced, have 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. • 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. • Empirical evidence is required to differentiate between cause and correlation and make 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. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> • 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. • Determine cause-and-effect relationships for how changes to the environment affect distribution or disappearance of traits in species. • Use empirical evidence to differentiate between cause and correlation and to make 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.

Unit Sequence

Part D: Why do some species live in groups and others are solitary?

Concepts	Formative Assessment
<ul style="list-style-type: none"> • Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. • Empirical evidence is required to differentiate between cause and correlation and to make claims about the role of group behavior in individual and species' chances to survive and reproduce. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> • Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. • Distinguish between group and individual behavior.

<ul style="list-style-type: none"> Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in the revision of an explanation about the role of group behavior on individual and species' chances to survive and reproduce. 	<ul style="list-style-type: none"> Identify evidence supporting the outcome of group behavior. Develop logical and reasonable arguments based on evidence to evaluate the role of group behavior on individual and species' chances to survive and reproduce. Use empirical evidence to differentiate between cause and correlation and to make claims about the role of group behavior on individual and species' chances to survive and reproduce.
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What It Looks Like in the Classroom

This unit builds on previous units. Earlier in the course, students learned that ecosystems have limits, which result from challenges such as predation, competition, and disease that limit the number of organisms in the population. Also in earlier units, students learned how resource availability has guided the development of human population. Students learned how environmental factors affect expression of traits and the probability of occurrences of traits in a population. Thus, the variation and distribution of traits observed depend on both genetic and environmental factors. These ideas support students' current learning, in which they are developing an understanding that phenotypic variation can influence the chances of survival.

Students begin this unit by developing an understanding of the way natural selection leads to adaptation in a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. Empirical evidence (including students' own investigations, models, theories, simulations, peer review) should be used to differentiate between cause and correlation and to make claims about how natural selection leads to adaptation of populations. Students should make sense of quantities and relationships between specific biotic and abiotic differences in ecosystems and their contributions to a change in gene frequency over time that leads to adaptation of populations, paying attention to proportional increases in organisms with advantageous heritable traits.

Students should use 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. To enhance understanding, students should examine scientific text and cite specific textual evidence to support analysis and explanations for how natural selection leads to change in populations over time. Students need to connect current learning to past events to enhance understanding that scientific knowledge is based on natural laws that operate today as they did in the past and will continue to do so in the future.

Students will build on their knowledge of the factors that contribute to the variations of different traits within a population. Students should examine how individuals possessing certain forms of inherited traits may have a survival advantage over others in the population. Increased survival and reproductive success in these individuals can cause advantageous traits to become more common in the population. In other words, the population adapts to its environment. This process of change over time, as the environment "selects" for advantageous forms of heritable traits, is called natural selection. This process could be experienced by students through a variety of hands-on experiments, such as simulations of Kettlewell or peppered moth studies and industrial melanism. Many computer simulations are available that allow students to manipulate changes in the environment and observe how the population changes as individuals with advantageous traits survive and reproduce, while those lacking these traits die in greater numbers before reproducing. From experiments such as these, students can collect numerical data and observe that while the total number of individuals in the population may remain relatively constant, the traits represented in that population can change in response to environmental change. As an extension, students may apply the HWE theorem to analyze shifts in allele frequencies over several generations. Students could make predictions as to what environmental factor exerted the selection pressure responsible for the shift. In further studies students could predict how future environmental change such as global warming could drive changes in dominant traits as conditions change. Emphasis is on statistical and graphical analysis of

numerical distribution of traits and using shifts as evidence to support explanations.

Human influence can cause changes to the physical environment. Naturally occurring or human-induced behaviors can also contribute the expansion of some species such as zebra mussels, fire ants, or Africanized bees. Students might research migratory patterns of Africanized bees or West Nile virus using CDC data. They might also focus on how species decline and sometimes become extinct using data from research. Species extinction can also result from faster or drastic changes limiting the possibilities of species evolution. Students can investigate claims in order to support how environmental conditions may result in an increase in the number of species, emergence of new species over time, or in the extinction of other species.

Students should determine the cause-and-effect relationships involved in how changes in the environment affect the distribution or disappearance of traits in a specific species. Addressing how changes to the environment affect the distribution or disappearance of traits in a species could be explained from a cause-and-effect perspective. Possible outcomes of human interactions include changes in the number of individuals of some species, emergence of new species over time, and the extinction of other species.

Students can research the influence of eutrophication of the Hudson River, Delaware River, and Raritan Bay. The recent increase in Raritan Bay temperature has negatively influenced the distribution of species, contributing to the disappearance of some species. Because of increased Bay temperatures, lower reproductive rates among flounder have resulted, suggesting that water temperatures have negatively affected reproductive rates. In their research, students should evaluate hypotheses, data, analysis, and conclusions about how changes in environmental conditions may result in changes in the numbers of some species. They should support their findings with evidence.

Group behavior of organisms has evolved because membership can increase the chance of survival for individuals and their genetic relatives. Students should collect empirical data that differentiates between cause and correlation relating to the survival rate of species and group behaviors. Students should develop logical and reasonable arguments to clarify the strength of the relationship and interactions between ideas and evidence that may be used to explain the role of group behavior on survival rate. Students might use models of schooling and flocking behavior of organisms as a role that increases species survival. Students might also consider the role of behaviors such as herding, cooperative hunting, migrating, and swarming. Individual and group survival behaviors can be studied to determine their survival advantages, (mimicry, camouflage, flocking, swarming, etc.) Evidence supporting the benefits of group behavior such as predation and life expectancy could be used to illustrate concepts.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Cite specific textual evidence to support analysis of science and technical texts describing how natural selection leads to adaptation of populations, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Write informative/explanatory texts describing how natural selection leads to adaptation of populations, including the narration of historical events, scientific procedures/experiments, or technical processes.
- Draw evidence from informational texts to support analysis, reflection, and research about how natural selection leads to adaptation of populations.
- Cite specific textual evidence to support analysis of science and technical texts that provide explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

- Write informative/explanatory texts about explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait, including the narration of historical events, scientific procedures/experiments, or technical processes.
- Draw evidence from information texts to support analysis, reflection, and research about organisms with an advantageous heritable trait and their proportional increase as compared to organisms lacking this trait.
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text 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, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- Draw evidence from information texts making 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 to support analysis, reflection, and research.
- Assess the extent to which the reasoning and evidence in a text support the author's claim about the role of group behavior on individual and species' chances to survive and reproduce.
- Cite specific textual evidence to support analysis of science and technical texts about the role of group behavior on individual and species' chances to survive and reproduce.
- Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address the role of group behavior on individual and species' chances to survive and reproduce.
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text about the role of group behavior on individual and species' chances to survive and reproduce, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Mathematics

- Represent how natural selection leads to adaptation of populations symbolically, and manipulate the representing symbols. Make sense of quantities and relationships between specific biotic and abiotic differences in ecosystems and their contributions to a change in gene frequency over time that leads to adaptation of populations.
- Represent symbolically the proportional increase in organisms with an advantageous heritable trait as compared with organisms lacking this trait, and manipulate the representing symbols. Make sense of quantities and relationships between the proportional increase in organisms with an advantageous heritable trait as compared with the numbers of organisms lacking this trait.

Modifications

Teacher Note: Teachers identify the modifications that they will use in the unit.

- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html# VXmoXcfD_UA)
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

Research on Student Learning

High-school students, even after some years of biology instruction, have difficulties understanding the notion of natural selection. A major hindrance to understanding natural selection appears to be students' inability to integrate two distinct processes in evolution, the occurrence of new traits in a population and their effect on long-term survival. Many students believe that environmental conditions are responsible for changes in traits, or that organisms develop new traits because they need them to survive, or that they over-use or under-use certain bodily organs or abilities. By contrast, students have little understanding that chance alone produces new heritable characteristics by forming new combinations of existing genes or by mutations of genes. Some students believe that a mutation modifies an individual's own form during its life rather than only its germ cells and offspring (see almost any science fiction movie). Students also have difficulties understanding that changing a population results from the survival of a few individuals that preferentially reproduce, not from the gradual change of all individuals in the population. Explanations about "insects or germs becoming more resistant" rather than "more insects or germs becoming resistant" may reinforce these misunderstandings. Specially designed instruction can improve students' understanding of natural selection.

High-school students may have difficulties with the various uses of the word "adaptation". In everyday usage, individuals adapt deliberately. But in the theory of natural selection, populations change or "adapt" over generations, inadvertently students of all ages often believe that adaptations result from some overall purpose or design, or they describe adaptation as a conscious process to fulfill some need or want. Elementary- and middle-school students also tend to confuse non-inherited adaptations acquired during an individual's lifetime with adaptive features that are inherited in a population ([NSDL, 2015](#)).

Prior Learning

By the end of *Grade 8*, students understand that:

Life science

- Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with nonliving factors.
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
- Growth of organisms and population increases are limited by access to resources.
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may cause the organisms involved to become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.
- Natural selection leads to the predominance of certain traits in a population and the suppression of others.
- In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.
- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.
- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.

Earth and space science

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Connections to Other Units

Life science

- 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 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.
- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic 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.
- 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.

Biology or Environmental Science

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.
- Resource availability has guided the development of human society.
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these.

Sample of Open Education Resources

HHMI Pocket Mouse Evolution: This activity serves as an extension to the HHMI short film *The Making of the Fittest: Natural Selection and Adaptation* and a means of reinforcing the concepts of variation and natural selection. Students explain how variation, selection, and time fuel the process of evolution by comparing, integrating, and evaluating sources of information presented in different media or formats. They analyze and organize data, comparing and contrasting various types of data sets (both self-generated and archival).

Bunny Population Growth: Students will develop and use models to simulate the growth of a rabbit population in order to support explanations about the role of limiting factors and variation in maintaining or destroying the population.

Appendix A: NGSS and Foundations for the Unit		
<p>Make predictions about the effects of artificial selection on the genetic makeup of a population over time. (LS4.C)</p>		
<p>Construct an explanation based on evidence for how natural selection leads to adaptation of populations. <i>[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.]</i> (HS-LS4-4)</p>		
<p>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. <i>[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.]</i> (HS-LS4-3)</p>		
<p>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. <i>[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.]</i> (HS-LS4-5)</p>		
<p>Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. <i>[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.]</i> (HS-LS2-8)</p>		
<p>The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:</p>		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze 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) 	<p>LS1.A: Structure and Function</p> <ul style="list-style-type: none"> 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) <p>LS4.B: Natural Selection</p> <ul style="list-style-type: none"> 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 	<p>Cause and Effect</p> <p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-4)</p> <p>Patterns</p> <p>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-LS4-3)</p>

<p>Constructing Explanations and Designing Solutions</p> <ul style="list-style-type: none"> 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-LS4-4) <p>Engaging in Argument from Evidence</p> <ul style="list-style-type: none"> Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5) 	<p>performance among individuals. (HS-LS4-3)</p> <ul style="list-style-type: none"> The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HLS4-3) Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) <p>LS4.C: Adaptation</p> <ul style="list-style-type: none"> 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-LS4-4) <p>LS2.D: Social Interactions and Group Behavior</p> <ul style="list-style-type: none"> Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HSL2-8) 	
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English Language Arts	Mathematics
<p>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. WHST.9-12.7 (HS-LS4-5)</p> <p>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. SL.11-12.5 (HS-LS1-2)</p>	<p>Reason abstractly and quantitatively. MP.2 (HS-LS4-5)</p>

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. **RST.11-12.8** (HS-LS4-5)

Draw evidence from informational texts to support analysis, reflection, and research. **WHST.9-12.9** (HS-LS4-5)

Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem **RST.9-10.8**. (HS-LS2-8)

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. **RST.11-12.1** (HS-LS2-8)

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. **RST.11-12.7** (HS-LS2-8)

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. **RST.11-12.8** (HS-LS2-8)