Science Curriculum

Grade Eight Unit Three:
FOSS Heredity & Adaptations
Course Description

The students in the eighth grade Science course will develop a conceptual understanding of Science topics using hands-on instruction, interactive notebooking, observations of and interactions with natural phenomena and the use of engineering and design processes to identify problems, plan, test and revise possible solutions. In Life Science, students will explore the interaction of human body systems to maintain stability, how growth and development can be affected by genetic factors in sexually reproducing organisms, and how organisms have changed over time due to environmental and genetic factors both by examining the fossil record and examining structural similarities between organisms. In Physical Science, students will explore wave motion, as well as how the force of gravity affects the kinetic energy of object on Earth’s surface. In Earth Science, students will explore Earth’s place in the Universe, as well as the unique characteristics of other celestial bodies.
Teachers may choose from a variety of instructional approaches that are aligned with 3 dimensional learning to achieve this goal. These approaches include:

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<th>Inquiry Kit Instruction (modified)</th>
<th>Challenge Based Instruction</th>
<th>5 E Instructional Model (BSCS)</th>
<th>Culturally Relevant Instruction</th>
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<tr>
<td>Project-Based Instruction</td>
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<td>Model-based Reasoning</td>
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<td>Meaningful Expertise Instruction</td>
<td>Emergent Investigations (RSS)</td>
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**Pacing Chart**

*Please note that pacing is based upon 240 minutes per 6 day cycle.*

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<th>Unit</th>
<th>Course Description</th>
<th>Days</th>
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<td>1</td>
<td>Course Introduction with Engineering and Design Practices</td>
<td>10</td>
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<td>2</td>
<td>FOSS Human Systems Interactions</td>
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<td>3</td>
<td>FOSS Heredity &amp; Adaptations</td>
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<td>4</td>
<td>FOSS Planetary Science</td>
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<td>5</td>
<td>FOSS Waves</td>
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<td></td>
<td>New Jersey Student Learning Assessment Science Review</td>
<td>10</td>
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<td></td>
<td>Final Project</td>
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**Unit Summary**

In this unit of study, students develop and use models to describe how gene mutations and sexual reproduction contribute to genetic variation. Students understand how genetic factors determine the growth of an individual organism. They also demonstrate understanding of the genetic implications of sexual and asexual reproduction. Students analyze graphical displays and gather evidence from multiple sources in order to develop an understanding of how fossil records and anatomical similarities of the relationships among organisms and species describe biological evolution. Students search for patterns in the evidence to support their understanding of the fossil record and how those patterns show relationships between modern organisms and their common ancestors.

Students construct explanations based on evidence to support fundamental understandings of natural selection and evolution. They will use ideas of genetic variation in a population to make sense of how organisms survive and reproduce, thus passing on the traits of the species. The crosscutting concepts of *cause and effect, patterns and structure and function* provide a framework for understanding how gene structure determines differences in the functioning of organisms and are called out as organizing concepts that students use to describe biological evolution. Students use the practices of *analyzing graphical displays, constructing explanations, obtaining, evaluating, and communicating information,* and *using mathematical and computational thinking.* Students are also expected to use these practices to demonstrate understanding of the core ideas.
### Student Learning Objectives

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<tr>
<td><strong>Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.</strong> [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.] (MS-LS3-1)</td>
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<td><strong>Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.</strong> [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.] (MS-LS3-2)</td>
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<td><strong>Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.</strong> [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.] (MS-LS4-1)</td>
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<tr>
<td><strong>Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.</strong> [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.] (MS-LS4-2)</td>
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<td><strong>Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.</strong> [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.] (MS-LS4-3)</td>
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<td><strong>Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment.</strong> [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations] (MS-LS4-4)</td>
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<td><strong>Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.</strong> [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.] (MS-LS4-5)</td>
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<td><strong>Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.</strong> [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.] (MS-LS4-6)</td>
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Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth’s history. Examples of Earth’s major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.] (MS-ESS1-4)

<table>
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<tr>
<th>NJDOE Learning Objective and Standard</th>
<th>Essential Questions</th>
<th>Content Related to DCI’s</th>
<th>Sample Activities</th>
<th>Resources</th>
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| **1. Investigation 1 Part 1: The Fossil Record** | What does the fossil record tell us about the history of life on Earth? | • The chronological fossil record documents the existence, diversity, extinction, and change of life-forms throughout the history of life on Earth.  
• The fossil record is incomplete because of the nature of fossilization.  
• Structural similarities between ancient and modern organisms are one piece of evidence from which we can infer relatedness. | Benchmark Assessment:  
Entry-Level Survey  
Students make observations of similarities and differences of fossils, construct a geologic timeline showing the chronology of fossils and investigate the causes of mass extinctions.  
Embedded Assessment:  
Science notebook entry | Science Resources Book:  
“Fossil Dating”  
“Mass Extinctions”  
Videos and Slide Shows:  
Biodiversity slide show  
Fossils slide show |
| **2. Investigation 1 Part 2: Transitions** | What does the fossil record tell us about how life has changed over time? | Students collect evidence regarding why organisms moved to land during the Devonian period, speculate on a gap filling organism, compare the structure of human limbs to that of other organisms.  
Embedded Assessment:  
Response Sheet | Benchmark Assessment:  
Investigation 1 I-Check | Science Resources Book:  
“An Interview with Jennifer Clack”  
“Transitions”  
Videos and Slide Shows:  
Fish with Fingers  
Great Transitions: The Origin of Tetrapods |
3. **Investigation 2 Part 1: Lines of Descent**
Students develop a model to explain evidence of common ancestry.

*MS-LS3-1, MS-LS3-2, MS-LS4-2, MS-LS4-4*

**How can a model help us understand the relationships among organisms?**

- A cladogram is a model that demonstrates evolutionary relationships among organisms.
- Embryo development can be used to identify relationships not evident in adults of different species.
- Heredity explains why organisms are similar but not identical to their parents.
- Genes on DNA code for proteins that are responsible for an organism’s traits.
- Variation of traits in a population is established in part as a result of sexual reproduction.

Students examine a human family tree and then build a vertebrate cladogram. They learn about common ancestors and deduce that the more recent common ancestor organisms share, the more closely related they are.

**Embedded Assessment:**
Science notebook entry

**Science Resources Book:**
“Tree Thinking”

4. **Investigation 2 Part 2: Inheriting Traits**
Students determine trait distribution within a given population.

*MS-LS3-1, MS-LS3-2, MS-LS4-2, MS-LS4-4*

**What leads to variation in a population?**

- Students explore the variation of four features to determine what traits they have. They determine the distribution of the traits in the class. Students then study a population of larkeys (a made up animal) to analyze their traits.

**Embedded Assessment:**
Science notebook entry

**Science Resources Book:**
“Understanding Heredity”
“A Larkey Yammer”

**Slide Show:**
Heredity
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<tr>
<td><strong>5. Investigation 2 Part 3: Modeling Heredity</strong></td>
<td>How can we model how genetic information passes from generation to generation?</td>
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<td>Students use simulations to model and predict variance in the inheritance of certain traits in a given population.</td>
<td>● A Punnett square is a model used to predict the probability of inheriting genotypes</td>
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<td><em>MS-LS3-1, MS-LS3-2, MS-LS4-2, MS-LS4-4</em></td>
<td>Students look at inheritance of traits in the larkey population using an online simulation.</td>
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<td><strong>Embedded Assessment:</strong></td>
<td><strong>Response Sheet</strong></td>
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<tr>
<td><strong>Online Activities:</strong></td>
<td>“A Model for Predicting Genetic Variation” “Larkey Impossible Traits”</td>
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| **6. Investigation 2 Part 4: Punnett Squares** | How can we predict the distribution of traits in a future generation? |
| Students compare probabilities in individual offspring and across populations using Punnett Squares. | Students use the Punnett square model to predict the probability of inheritance of a given trait when the genotypes of parents are known. |
| *MS-LS3-1, MS-LS3-2, MS-LS4-2, MS-LS4-4* | **Embedded Assessment:** |
| **Science notebook entry** | **Benchmark Assessment:** |
| **Investigation 2 I-Check** | **Science Resources Book:** |
| **Online Activities:** | “Mendel and Punnett Squares” “Mapping the Human Genome” |
| “Larkey Punnett Square” | **Online Activities:** |

| **7. Investigation 3 Part 1: Adaptation** | How do genetic mutations lead to variation in a population? |
| Students gather evidence to support a claim regarding the role that mutation can play in making a population better suited for survival. | ● Variation in a population can occur due to random genetic mutations, which can have harmful, helpful, or no effects. |
| *MS-LS3-1, MS-LS4-4, MS-LS4-5, MS-LS4-6* | ● An adaptation is an inherited trait that increases an organism’s chances of surviving in an |
| | Students determine whether mutations are adverse, advantageous or neutral for given organisms. |
| **Embedded Assessment:** | **Science notebook entry** |
| **Science Resources Book:** | “Adaptation” |
| **Online Activities:** | “Walking Sticks: Eat Insects” |
| 8. **Investigation 3 Part 2: Natural Selection**  
Students will gather evidence regarding how natural selection can affect a given population over several generations.  
**MS-LS3-1, MS-LS4-4, MS-LS4-5, MS-LS4-6** | How do populations change over time?  
environment long enough to pass on its genes.  
- Natural selection is a process by which individuals best adapted to their environment tend to survive and pass their traits to subsequent generations.  
- Change in populations by means of natural selection is the basis for the theory of evolution, which best explains the biodiversity on Earth.  
- Humans use genetic technologies to influence inheritance. | Using online activities, students track a population of walking sticks over five generations. They consider how natural selection affects the incidence of walking stick color over time.  
**Embedded Assessment:** Response Sheet  
**Benchmark Assessment:** Investigation 3 I-Check | Science Resources Book:  
“Natural Selection”  
“What Makes a Scientific Theory?”  
Online Activities:  
“Walking Sticks: Find Insects in Three Environments”  
“Larkey Natural Selection”  
Videos and Slide Show:  
The Making of the Fittest: Natural Selection and Adaptation  
The Origin of Species: The Beak of the Finch  
Biodiversity slide show |
|---|---|---|---|
| 9. **Investigation 3 Part 3: Genetic Technology**  
Students present their research on genetic technologies and judge how they might address current genetic issues.  
**MS-LS3-1, MS-LS4-4, MS-LS4-5, MS-LS4-6** | How are humans influencing inheritance? | Students will research various genetic technologies and assess how they might address current genetic issues.  
**Embedded Assessment:** Performance assessment  
**Benchmark Assessment:** Posttest | Science Resources Book:  
“Influencing Evolution”  
Online Activity:  
“Genetic Technology Resources” |
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<table>
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<th>Unit Project/Lab Performance Assessment</th>
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<td>The Genetic Technology project in Investigation 3 meets this criterion.</td>
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<th>What It Looks Like in the Classroom</th>
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<tr>
<td>Using models, such as electronic simulations, physical models, or drawings, students will learn that genes are located in the chromosomes of cells and each chromosome pair contains two variants of each gene. Students will need to make distinctions between chromosomes and genes and understand the connections between them. DNA will be introduced in high school. Students will learn that chromosomes are the genetic material that is found in the nucleus of the cell and that chromosomes are made up of genes. They will also learn that each gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual.</td>
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<td>Students should be given opportunities to use student-developed conceptual models to visualize how a mutation of genetic material could have positive, negative, or neutral impact on the expression of traits in organisms. Emphasis in this unit is on conceptual understanding that mutations of the genetic material may result in making different proteins; therefore, models and activities that focus on the expression of genetic traits, rather than on the molecular-level mechanisms for protein synthesis or specific types of mutations, are important for this unit of study. For example, models that assign genetic information to specific segments of model chromosomes could be used. Students could add, remove, or exchange genes located on the chromosomes and see that changing or altering a gene can result in a change in gene expression (proteins and therefore traits).</td>
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<td>Students will continue this unit of study by describing two of the most common sources of genetic variation, sexual and asexual reproduction. Students will be able to show that in sexual reproduction, each parent contributes half of the genes acquired by offspring, whereas in asexual reproduction, a single parent contributes the genetic makeup of offspring. Using models such as Punnett squares, diagrams, and simulations, students will describe the cause-and-effect relationship between gene transmission from parents(s) to offspring and the resulting genetic variation. Using symbols to represent the two alleles of a gene, one acquired from each parent, students can use Punnett squares to model how sexual reproduction results in offspring that may or may not have a genetic makeup that is different from either parent. Students can observe the same mixing of genetic information using colored counters or electronic simulations. Using other models, students can show that asexual reproduction results in offspring with the same combination of genetic information as the parents.</td>
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<td>Students can summarize the numerical data they collect during these activities as part of their description of why asexual reproduction results in offspring with identical genetic combinations and sexual reproduction results in offspring with genetic variations. As a culmination of this unit of study, students could make multimedia presentations to demonstrate their understanding of the key concepts. Students could participate in a short research project and cite the specific textual evidence used to support the analysis of any scientific information they gather. They could integrate quantitative or technical information as part of their presentation. For example, students can take data collected during investigations of genetic mutations and provide a narrative description of their results. They could use data collected during their investigation of sexual and asexual reproduction. They could also include diagrams, graphs, or tables to clarify their data.</td>
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Prior to middle school, students know that some living organisms resemble organisms that once lived on Earth. Fossils provide evidence about the types of organisms and environments that existed long ago. In this unit of study, students will build on this knowledge by examining how the fossil record documents the existence, diversity, extinction, and change of many life forms through Earth’s history. The fossil record and comparisons of anatomical similarities between organisms and their embryos enable the inference of lines of evolutionary descent.

Students analyze images or data to identify patterns in the locations of fossils in layers of sedimentary rock. They can use their understanding of these patterns to place fossils in chronological order. Students may make connections between their studies of plate movement in grade 7 and the possible shifting of layers of sedimentary rock to explain inconsistencies in the relative chronological order of the fossil record as it is seen today.

Students can analyze data on the chronology of the fossil record based on radioactive dating. An explanation of radioactive dating can be provided to students along with data, but students are not expected to complete any calculations. Information can be provided in the form of data tables correlating fossil age with half-life. This information could also be presented in the form of a graph.

Students may analyze images from the fossil record to identify patterns of change in the complexity of the anatomical structures in organisms. For example, students can observe pictures of fossilized organisms with similar evolutionary histories in order to compare and contrast changes in their anatomical structures over time. Students may be placed in groups, with each group examining changes in anatomical structures over time within one evolutionary lineage (e.g., the whale, the horse, cycads). Once students have identified patterns of change within one evolutionary lineage, they can meet with students from other groups to discuss patterns of change across multiple evolutionary lineages. Students could then present their findings using a variety of media choices (PowerPoint, poster, short skit or play, comic strip, etc.). This activity would provide application of the real-world phenomenon that life on Earth changes over time.

Students could be provided with multimedia experiences in order to analyze visual displays of the embryological development of different species. They can analyze the linear and nonlinear relationships among the embryological developments of different species. For example, students can analyze data about embryological development to determine whether development across species shares a similar rate, similar size of embryos, or similar characteristics over a period of time. If these characteristics are consistent across species, a linear relationship can be inferred. At the point where the rate, size, or general characteristics of development diverge, the relationship can then be classified as nonlinear.

Students can integrate the patterns they identified in the fossil record by studying sedimentary rock images and radioactive dating data provided by the teacher and the relationships they discovered through their study of embryological development with evidence from informational texts to develop an explanation of changes in life forms throughout the history of life on Earth. This explanation could be presented in the form of a claim, with students required to cite evidence from their studies of diagrams, images, and texts to explain that life on Earth has changed over time.

Students will build on their prior knowledge by constructing explanations that describe how genetic variations increase some individuals’ probability of surviving and reproducing. Mathematical representations will be used to support explanations of how natural selection leads to increases and decreases of specific traits in populations over time. Students will analyze numerical data sets that represent a proportional relationship between some change in
the environment and corresponding changes in genetic variation over time. Students will summarize these numerical data sets and construct explanations for how the proportional relationship could impact the probability of some individuals surviving and reproducing in a specific environment.

Students will construct explanations based on evidence that describes how genetic variations can provide a survival and reproductive advantage over other traits. This evidence could be provided through activities that model these phenomena or by examining and analyzing data from informative texts. Based on their findings, students can write claims about how natural selection leads to a predominance of some traits in a population and the suppression of other traits. Students will pay attention to precise details in explanations from specific textual evidence and will cite this evidence to support their analysis and reflection on research that explains how genetic variation of traits in a population increases some individuals’ probability of surviving and reproducing in a specific environment. Students will compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading these texts and write informative/explanatory texts on how natural selection leads to the predominance of some traits and the suppression of others in a population.

Students will engage effectively in a range of collaborative discussions where they will present their claims and findings. These discussions may be one-on-one between students, in small groups, or teacher-led large group discussions. In these discussions, students will build on others’ ideas while expressing their own clearly. Claims must emphasize salient points in a focused, coherent manner, supported with relevant evidence, sound valid reasoning, and well-chosen details. Students must use appropriate eye contact, adequate volume, and clear pronunciation. There are multiple activities available that show students how one trait can provide a survival advantage over another in a specific environment. As part of these activities, students can analyze data and determine ratio relationships to provide evidence of cause-and-effect relationships. These ratios can be used to explain why some inherited traits result in individuals that have a survival advantage in a specific environment over time or why other traits in a population are suppressed. When an environment changes as a result of human influence and/or natural processes on Earth, traits that were present in populations of organisms and that led to a survival advantage in that environment before the change may no longer offer an advantage. Changes in environmental conditions can be the driving cause of the suppression of traits in populations.

Students will examine a variety of environmental factors that may influence the natural selection that is taking place in populations. Students will need to use simple probability statements and proportional reasoning to explain why each factor may or may not be responsible for the changes being observed. Students will compare and contrast the information gained from experiments, simulations, video, or multimedia sources with information gained from reading science and technical texts to support their explanations. After students have constructed their explanations, they will participate in collaborative discussions in small groups; in larger, teacher-led groups, or in pair.

After students have developed a strong understanding of natural selection, they will need to begin gathering evidence from multiple sources, including print and digital, to support analysis of information about technologies that have changed how humans can influence the inheritance of desired traits in organisms (artificial selection). Students need to examine current technologies as well as the technologies that have led to these scientific discoveries. Students will cite the information they gathered and quote or paraphrase relevant data and conclusions from their resources to describe the impact that current technologies have on society. Some of the influences of humans on genetic outcomes in artificial selection that students can examine include genetic modifications, animal husbandry, and gene therapy.
Students can be provided with multiple sources to determine the credibility, accuracy, and possible bias of the resources. In order to determine the best sources, students can investigate and describe how information in these resources is supported or not supported by evidence. Once students have determined appropriate sources, they can begin to synthesize information about the technologies that have changed how humans can influence the inheritance of desired traits in organisms (artificial selection). Students can quote or paraphrase the data and conclusions and provide basic bibliographic information. They can do this in a variety of ways (e.g., in writing, verbal discussion, debate, Socratic seminar, etc.).
### Modifications for differentiation at all levels

(Notes: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

- Restructure lesson using UDL principals ([http://www.cast.org/our-work/about-udl.html#VXmoXcfD_UA](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

When asked to explain how physical traits are passed from parents to offspring, elementary-school, middle-school, and some high-school students express the following misconceptions: Some students believe that traits are inherited from only one of the parents (for example, the traits are inherited from the mother, because she gives birth or has most contact as children grow up; or the same-sex parent will be the determiner). Other students believe that certain characteristics are always inherited from the mother and others come from the father. Some students believe in a "blending of characteristics." It may not be until the end of 5th grade that some students can use arguments based on chance to predict the outcome of inherited characteristics of offspring from observing those characteristics in the parents.

Early middle-school students explain inheritance only in observable features, but upper middle-school and high-school students have some understanding that characteristics are determined by a particular genetic entity which carries information translatable by the cell. Students of all ages believe that some environmentally produced characteristics can be inherited, especially over several generations.
By the end of 5th grade, students know that babies result from the fusion of sperm and eggs. However, they often don’t understand how the fusion brings new life. Before students have an early understanding of genetics, they may believe that the baby exists in the sperm but requires the egg for food and protection, or that the baby exists in the egg and requires the sperm as trigger to growth.

Some research suggests that students' understanding of evolution is related to their understanding of the nature of science and their general reasoning abilities. Findings indicate that students who cannot argue with evidence tend to retain nonscientific beliefs such as "evolutionary change occurs as a result of need" because they fail to examine alternative hypotheses and their predicted consequences, and they fail to comprehend conflicting evidence. Thus, they are left with no alternative but to believe their initial intuitions or the misstatements they hear. 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.

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 5, students understand that:

- Many characteristics of organisms are inherited from parents.
- Other characteristics result from individuals’ interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.
- Different organisms vary in how they look and function because they have different inherited information.
- The environment also affects the traits that an organism develops.
- Some kinds of plants and animals that once lived on Earth are no longer found anywhere.
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.
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- Different organisms vary in how they look and function because they have different inherited information.
- The environment also affects the traits that an organism develops.
- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.
- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

**Future Learning**

**Life science**

- Systems of specialized cells within organisms help the organisms perform the essential functions of life.
- 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.
- 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.
- Feedback mechanisms maintain a living system’s internal conditions, within certain limits, and mediate behaviors, allowing the system to remain alive and functional even as external conditions change, within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (through negative feedback) what is going on inside the living system.
- 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.
- 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, as yet, no known function.
- 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.
<table>
<thead>
<tr>
<th>Grade Eight Unit Three: FOSS Heredity &amp; Adaptations</th>
<th>Instructional Days: 36</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Genetic information 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.</td>
<td></td>
</tr>
<tr>
<td>• Ecosystems have carrying capacities, which are limits on the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources, 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.</td>
<td></td>
</tr>
<tr>
<td>• 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, the ecosystem may return to its original status, more or less (i.e., 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. Moreover, anthropogenic changes (i.e. 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.</td>
<td></td>
</tr>
<tr>
<td>• 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.</td>
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<td></td>
</tr>
<tr>
<td>• Natural selection occurs only if there is both (1) variation in the genetic information among 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.</td>
<td></td>
</tr>
<tr>
<td>• The traits that positively affect survival are more likely to be reproduced and thus are more common in the population.</td>
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</tr>
<tr>
<td>• 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.</td>
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</tr>
<tr>
<td>• 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. 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.</td>
<td></td>
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<tr>
<td>• Adaptation also means that the distribution of traits in a population can change when conditions change.</td>
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<tr>
<td>• 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</td>
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</tr>
</tbody>
</table>
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.

Earth and space science

- Continental rocks, which can be more than 4 billion years old, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.
- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history.
- Humanity faces major global challenges today—such as the need for supplies of clean water and food and for energy sources that minimize pollution—which can be addressed through engineering.
- These global challenges also may have manifestations in local communities.

Interdisciplinary Connections

English Language Arts

- Cite specific textual evidence to support analysis of science and technical texts about structural changes to genes (mutations) located on chromosomes that may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- Determine the meaning of symbols, key terms, and other domain-specific phrases as they are used to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- Integrate quantitative or technical information about why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism that is expressed in words with a version of that information expressed visually in a flowchart, diagram, model, graph, or table.
- Include multimedia components and visual displays in presentations about structural changes to genes (mutations) located on chromosomes that may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism to clarify claims and findings and emphasize salient points.
- Cite specific textual evidence for why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation to support analysis of science and technical texts.
- Determine the meaning of symbols, key terms, and other domain-specific phrases as they are used to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
• Integrate quantitative or technical information that describes why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation that is expressed in words with a version of that information that is expressed visually in a flowchart, diagram, model, graph, or table.

• Include multimedia components and visual displays in presentations that describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation to clarify claims and findings and emphasize salient points.

• Cite specific textual evidence to support the analysis of patterns found in the fossil record to document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth.

• Use scientific, precise details in the explanations.

• Integrate quantitative or technical information about the fossil record that is expressed in words into a version of that information expressed visually in the form of a flowchart, diagram, model, graph, or table.

• Attending to the precise details of explanations or descriptions, cite specific textual evidence to support analysis of science texts’ information on the relationships between the anatomical similarities and differences among modern organisms and between modern and fossil organisms and their fossil relationships.

• Write informative/explanatory text examining anatomical similarities and differences among modern organisms and between modern and fossil organisms and their fossil relationships. The text should convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

• Draw evidence from informational texts to support an analysis of, reflection on, and research about anatomical similarities and differences among modern organisms and between modern and fossil organisms used to infer evolutionary relationships.

• Engage in a range of collaborative discussions about the anatomical similarities and differences among modern organisms and between modern and fossil organisms used to infer evolutionary relationships. Discussions must provide opportunities for students to clearly express their own ideas and exchange ideas with others. The discussions may be one on one, in groups, or led by the teacher.

• Present claims and findings to explain the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. Emphasize the important points in a focused, coherent manner with relevant evidence, valid reasoning, and well-chosen details. During the presentation, students must use appropriate eye contact, adequate volume, and clear pronunciation.

• Cite specific textual evidence to support the analysis of pictorial data comparing patterns of similarities in embryological development across multiple species to identify relationships not evident in the fully formed anatomy. Attention must be paid to the precise details of explanation or descriptions.

• Integrate quantitative or technical information about general patterns of relatedness among embryos of different organisms expressed in words in a text with a version expressed in a flowchart, diagram, model, graph, or table.
<table>
<thead>
<tr>
<th>Grade Eight Unit Three: FOSS Heredity &amp; Adaptations</th>
<th>Instructional Days: 36</th>
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</table>
| • Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with the information gained from reading a text about embryological development across multiple species in order to identify relationships not evident in the fully formed anatomy.  
• Cite specific textual evidence to support analysis of scientific and technical texts about how genetic variations in a population increase some individuals’ probability of surviving and reproducing in a specific environment. Attention must be paid to precise details of explanations or descriptions. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with information gained from reading a text on how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment.  
• Write informative/explanatory texts examining how natural selection leads to the predominance of some traits in a population and the suppression of others. Convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.  
• Draw evidence from informational texts to support the analysis, reflection, and research used to construct an explanation of how genetic variation of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment.  
• Engage effectively in a range of collaborative discussions with diverse partners to discuss how natural selection leads to the predominance of certain traits in a population and the suppression of others. Discussions may be one-on-one, in groups, or teacher-led; in these discussions, students should build on others’ ideas while expressing their own clearly.  
• Present claims and findings about how natural selection leads to the predominance of certain traits in a population and the suppression of others. Claims must emphasize salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details. Students must use appropriate eye contact, adequate volume, and clear pronunciation.  
• Cite specific textual evidence to support analysis of information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection).  
• Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others about technologies that have changed the way humans influence the inheritance of desired traits. Avoid plagiarism and provide basic bibliographic information for sources. |

**Mathematics**

| • Use mathematics to model why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.  
• Summarize numerical data sets that describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation in relation to their context.  
• Use variables to represent numbers and write expressions to represent patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearances in the rock record to document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth, under the assumption that natural laws operate today as in the past. Understand that a variable can represent an unknown number or, depending on the purpose at hand, any number in a specified set. |
- Use variables to represent numbers and write expressions showing patterns that can be used to identify cause-and-effect relationships among the anatomical similarities and differences among modern organisms and between modern and fossil organisms. This representation will be used to infer evolutionary relationships. Understand that a variable can represent an unknown number or, depending on the purpose at hand, any number in a specified set.
- Understand the concept of a ratio and use ratio language to describe a ratio relationship between specific genetic variations in a population and the probability of some individuals in that population surviving and reproducing in a specific environment.
- Summarize numerical data sets about a ratio relationship between genetic variations in a population and the probability of some individuals in that population surviving and reproducing in a specific environment.
- Recognize and represent proportional relationships in trends in changes to populations over time.
- Use mathematical models to support explanations of trends in changes to populations over time.
- Understand the concept of a ratio and use ratio language to describe a ratio relationship between natural selection and decreases of specific traits in populations over time.
- Summarize numerical data sets to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

<table>
<thead>
<tr>
<th>Vocabulary</th>
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<tbody>
<tr>
<td>atom</td>
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<tr>
<td>body fossil</td>
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<tr>
<td>brachiopod</td>
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<tr>
<td>era</td>
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<tr>
<td>evolution</td>
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<tr>
<td>fossil record</td>
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<tr>
<td>fossil</td>
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<tr>
<td>geologic time</td>
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<tr>
<td>geologist</td>
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<tr>
<td>isotope</td>
</tr>
<tr>
<td>organism</td>
</tr>
<tr>
<td>paleontologist</td>
</tr>
<tr>
<td>particle</td>
</tr>
<tr>
<td>principle of superposition</td>
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<tr>
<td>radioactive isotope</td>
</tr>
<tr>
<td>sediment</td>
</tr>
<tr>
<td>genome</td>
</tr>
<tr>
<td>heredity</td>
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<tr>
<td>homozygous</td>
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<tr>
<td>infer</td>
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<tr>
<td>inherited characteristic</td>
</tr>
<tr>
<td>mutation</td>
</tr>
<tr>
<td>natural selection</td>
</tr>
<tr>
<td>theory</td>
</tr>
<tr>
<td>artificial selection</td>
</tr>
<tr>
<td>genetically modified organism (GMO)</td>
</tr>
<tr>
<td>tetrapod</td>
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<tr>
<td>Punnett square</td>
</tr>
<tr>
<td>related</td>
</tr>
<tr>
<td>trait</td>
</tr>
<tr>
<td>adaptation</td>
</tr>
<tr>
<td>natural selection</td>
</tr>
<tr>
<td>theory of evolution</td>
</tr>
<tr>
<td>gene therapy</td>
</tr>
<tr>
<td>transgenic organism</td>
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<tr>
<td>sedimentary rock</td>
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</table>
### Educational Technology Standards

<table>
<thead>
<tr>
<th>Educational Technology Standards</th>
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<tbody>
<tr>
<td>8.1.8.A.1, 8.1.8.B.1, 8.1.8.C.1, 8.1.8.D.1, 8.1.8.E.1, 8.1.8.F.1</td>
</tr>
</tbody>
</table>

#### Technology Operations and Concepts
- Create professional documents (e.g., newsletter, personalized learning plan, business letter or flyer) using advanced features of a word processing program.

**Example:** Create a brochure to advertise your levee design.

#### Creativity and Innovation
- Synthesize and publish information about a local or global issue or event on a collaborative, web-based service.

**Example:** Publish a blog regarding hurricane preparedness.

#### Communication and Collaboration
- Participate in an online learning community with learners from other countries to understand their perspectives on a global problem or issue, and propose possible solutions.

**Example:** Use empathico.org to collaborate with students from other countries who have experienced hurricanes.

#### Digital Citizenship
- Model appropriate online behaviors related to cyber safety, cyber bullying, cyber security, and cyber ethics.

**Example:** Use Diigo.com to have a monitored and appropriate online conversation about an article.

#### Research and Information Literacy
- Gather and analyze findings using data collection technology to produce a possible solution for a content-related or real-world problem.

**Example:** Use NOAA or AMS websites to gather data about hurricane frequency, location, etc.

#### Critical Thinking, Problem Solving, Decision Making
- Use an electronic authoring tool in collaboration with learners from other countries to evaluate and summarize the perspectives of other cultures about a current event or contemporary figure.

**Example:** Utilize Voicethread to create a narrative account of a hurricane event.

### Career Ready Practices

Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study.

**CRP1. Act as a responsible and contributing citizen and employee**

Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them.
They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

**Example:** Participate as an active an ethical member of class discussions and projects. Teacher can explore how decision making and behaviors can impact the broader community in specific science related examples, such as limiting littering, choosing to recycle, etc.

**CRP4. Communicate clearly and effectively and with reason.**
Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others’ time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

**Example:** Students can develop and present well supported arguments via short presentations, during group work and gallery walks.

**CRP5. Consider the environmental, social and economic impacts of decisions.**
Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.

**Example:** Participate as an active an ethical member of class discussions and projects. Teacher can explore how decision making and behaviors can impact the broader community in specific science related examples, such as limiting littering, choosing to recycle, etc.

**CRP6. Demonstrate creativity and innovation.**
Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

**Example:** Engineering tasks provide many opportunities for student to use creative and innovative approaches.

**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.**
Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

**Example:** Gather evidence to support a claim and identify reasoning that is being applied.

**CRP11. Use technology to enhance productivity.**
Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

**Example:** Utilize Google Apps for Education suite to access and complete assignments. The teacher can use Google Classroom to identify age and subject appropriate resource materials that can be linked directly. A variety of apps or web based platforms (Tellagami, PowToons, Glogster, Padlet) can be used to generate multimedia content.

**CRP12. Work productively in teams while using cultural global competence.**

Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

**Example:** Students must be given regular opportunities to work with groups in a variety of settings for discussion, projects, etc.
**WIDA Proficiency Levels**: At the given level of English language proficiency, English language learners will process, understand, produce or use:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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</table>
| 6- Reaching | - Specialized or technical language reflective of the content areas at grade level  
- A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse as required by the specified grade level  
- Oral or written communication in English comparable to proficient English peers |
| 5- Bridging | - Specialized or technical language of the content areas  
- A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse, including stories, essays or reports  
- Oral or written language approaching comparability to that of proficient English peers when presented with grade level material. |
| 4- Expanding | - Specific and some technical language of the content areas  
- A variety of sentence lengths of varying linguistic complexity in oral discourse or multiple, related sentences or paragraphs  
- Oral or written language with minimal phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written connected discourse, with sensory, graphic or interactive support |
| 3- Developing | - General and some specific language of the content areas  
- Expanded sentences in oral interaction or written paragraphs  
- Oral or written language with phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written, narrative or expository descriptions with sensory, graphic or interactive support |
| 2- Beginning | - General language related to the content area  
- Phrases or short sentences  
- Oral or written language with phonological, syntactic, or semantic errors that often impede of the communication when presented with one to multiple-step commands, directions, or a series of statements with sensory, graphic or interactive support |
| 1- Entering | - Pictorial or graphic representation of the language of the content areas  
- Words, phrases or chunks of language when presented with one-step commands directions, WH-, choice or yes/no questions, or statements with sensory, graphic or interactive support |
# Language Development Supports for English Language Learners

To Increase Comprehension and Communication Skills

**Environment**

- Welcoming and stress-free
- Respectful of linguistic and cultural diversity
- Honors students' background knowledge
- Sets clear and high expectations
- Includes routines and norms
- Is thinking-focused vs. answer-seeking
- Offers multiple modalities to engage in content learning and to demonstrate understanding
- Includes explicit instruction of specific language targets
- Provides participation techniques to include all learners
- Integrates learning centers and games in a meaningful way
- Provides opportunities to practice and refine receptive and productive skills in English as a new language
- Integrates meaning and purposeful tasks/activities that:
  - Are accessible by all students through multiple entry points
  - Are relevant to students' lives and cultural experiences
  - Build on prior mathematical learning
  - Demonstrate high cognitive demand
  - Offer multiple strategies for solutions
  - Allow for a language learning experience in addition to content

**Sensory Supports***

- Real-life objects (realia) or concrete objects
- Physical models
- Manipulatives
- Pictures & photographs
- Visual representations or models such as diagrams or drawings
- Videos & films
- Newspapers or magazines
- Gestures
- Physical movements
- Music & songs

**Graphic Supports***

- Graphs
- Charts
- Timelines
- Number lines
- Graphic organizers
- Graphing paper

**Interactive Supports***

- In a whole group
- In a small group
- With a partner such as *Turn-and-Talk*
- In pairs as a group (first, two pairs work independently, then they form a group of four)
- In triads
- Cooperative learning structures such as *Think-Pair-Share*
- Interactive websites or software
- With a mentor or coach

**Verbal and Textual Supports**

- Labeling
- Students' native language
- Modeling
- Repetitions
- Paraphrasing
- Summarizing
- Guiding questions
- Clarifying questions
- Probing questions
- Leveled questions such as *What? When? Where? How? Why?*
- Questioning prompts & cues
- Word Banks
- Sentence starters
- Sentence frames
- Discussion frames
- Talk moves, including *Wait Time*

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**Grade Eight Unit Three: FOSS Heredity & Adaptations**

**Instructional Days:** 36

**Building Equity in Your Teaching Practice**

How do the essential questions highlight the connection between the big ideas of the unit and equity in your teaching practice?

<table>
<thead>
<tr>
<th>CONTENT INTEGRATION</th>
<th>KNOWLEDGE CONSTRUCTION</th>
<th>PREJUDICE REDUCTION</th>
<th>EQUITABLE PEDAGOGY</th>
<th>EMPOWERING SCHOOL CULTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers use examples and content from a variety of cultures &amp; groups.</td>
<td>Teachers help students understand how knowledge is created and influenced by cultural assumptions, perspectives &amp; biases.</td>
<td>Teachers implement lessons and activities to assert positive images of ethnic groups &amp; improve intergroup relations.</td>
<td>Teachers modify techniques and methods to facilitate the academic achievement of students from diverse backgrounds.</td>
<td>Using the other four dimensions to create a safe and healthy educational environment for all.</td>
</tr>
</tbody>
</table>

This unit / lesson is connected to other topics explored with students.

This unit / lesson provides context to the history of privilege and oppression.

This unit / lesson addresses power relationships.

This unit / lesson helps students to develop research and critical thinking skills.

This curriculum creates windows and mirrors* for students.

The instruction has been modified to meet the needs of each student.

Students feel respected and their cultural identities are valued.

Additional supports have been provided for students to become successful and independent learners.

Opportunities are provided for student to reflect on their learning and provide feedback.

There are opportunities for students to connect with the community.

My classroom is welcoming and supportive for all students?

I am aware of and sensitive to the needs of my students and their families.

There are effective parent communication systems established. Parents can talk to me about issues as they arise in my classroom.

*windows and mirrors: Pedagogical tools that allow students to see themselves and their experiences in the curriculum, enhancing cultural competence and inclusivity.

Culturally Relevant Pedagogy Examples

<table>
<thead>
<tr>
<th>Everyone has a Voice: Create a classroom environment where students know that their contributions are expected and valued.</th>
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<tbody>
<tr>
<td><strong>Example</strong>: Norms for sharing are established that communicate a growth mindset for mathematics. All students are capable of expressing mathematical thinking and contributing to the classroom community. Students learn new ways of looking at problem solving by working with and listening to each other.</td>
</tr>
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<tr>
<th>Run Problem Based Learning Scenarios: Encourage scientifically productive discourse among students by presenting problems that are relevant to them, the school and/or the community.</th>
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<tbody>
<tr>
<td><strong>Example</strong>: Using a Place Based Education (PBE) model, students explore science concepts while determining ways to address problems that are pertinent to their neighborhood, school or culture.</td>
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<thead>
<tr>
<th>Encourage Student Leadership: Create an avenue for students to propose problem solving strategies and potential projects.</th>
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<tbody>
<tr>
<td><strong>Example</strong>: Students can deepen their understanding of engineering criteria and constraints by creating design challenges together and deciding if the problems fit the necessary criteria. This experience will allow students to discuss and explore their current level of understanding by applying the concepts to relevant real-life experiences.</td>
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<tr>
<th>Present New Concepts Using Student Vocabulary: Use student diction to capture attention and build understanding before using academic terms.</th>
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<tbody>
<tr>
<td><strong>Example</strong>: Teach science vocabulary in various modalities for students to remember. Use multi-modal activities, analogies, realia, visual cues, graphic representations, gestures, pictures and cognates. Directly explain and model the idea of vocabulary words having multiple meanings. Students can create the Word Wall with their definitions and examples to foster ownership.</td>
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Appendix A: NGSS-S and Foundations for the Unit

<table>
<thead>
<tr>
<th>Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.] (MS-LS3-1)</th>
</tr>
</thead>
</table>

<p>| Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.] (MS-LS3-2) |</p>
<table>
<thead>
<tr>
<th>Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.] (MS-LS4-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.] (MS-LS4-2)</td>
</tr>
<tr>
<td>Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.] (MS-LS4-3)</td>
</tr>
<tr>
<td>Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations] (MS-LS4-4)</td>
</tr>
<tr>
<td>Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.] (MS-LS4-5)</td>
</tr>
<tr>
<td>Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.] (MS-LS4-6)</td>
</tr>
<tr>
<td>Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth’s history. Examples of Earth’s major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.] (MS-ESS1-4)</td>
</tr>
</tbody>
</table>

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*
### Developing and Using Models
- Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)

### Analyzing and Interpreting Data
- Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3)
- Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1)

### Constructing Explanations and Designing Solutions
- Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2)
- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

### Obtaining, Evaluating, and Communicating Information
- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)

### Using Mathematics and Computational Thinking

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### LS1.B: Growth and Development of Organisms
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary to MS-LS3-2)*

### LS3.A: Inheritance of Traits
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)

### LS3.B: Variation of Traits
- 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

### Structure and Function
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

### Patterns
- Patterns can be used to identify cause and effect relationships. (MS-LS4-2)
- Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1),(MS-LS4-3)

### Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4),(MS-LS4-5),(MS-LS4-6)
### Grade Eight Unit Three: FOSS Heredity & Adaptations

<table>
<thead>
<tr>
<th>Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)</th>
<th>may be identical or may differ from each other. (MS-LS3-2)</th>
</tr>
</thead>
</table>
| 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. (MS-LS3-1) | **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1),(MS-LS4-2) |
| **Connections to Nature of Science**
**Scientific Knowledge is Based on Empirical Evidence** |
| Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1) | **Connections to Engineering, Technology, and Applications of Science**
**Interdependence of Science, Engineering, and Technology**
- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5) |
| **LS4.A: Evidence of Common Ancestry and Diversity** |
| The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1) | **Connections to Nature of Science**
**Science Addresses Questions About the Natural and Material World**
- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5) |
| Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2) |}

Comparison of the embryological development of different species also reveals similarities that
**LS4.B: Natural Selection**

- Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)
- 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. (MS-LS4-5)

**LS4.C: Adaptation**

- 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. (MS-LS4-6)

<table>
<thead>
<tr>
<th>English Language Arts</th>
<th>Mathematics</th>
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<tbody>
<tr>
<td>Cite specific textual evidence to support analysis of science and technical texts. (MS-LS3-1),(MS-LS3-2), (MS-LS4-1),(MS-LS4-2),(MS-LS4-3), (MS-LS4-4),(MS-LS4-5) <strong>RST.6-8.1</strong></td>
<td>Model with mathematics. (MS-LS3-2), (MS-LS4-6) <strong>MP.4</strong></td>
</tr>
</tbody>
</table>
Grade Eight Unit Three: FOSS Heredity & Adaptations

| Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics. (MS-LS3-1),(MS-LS3-2) **RST.6-8.4** |
| Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1),(MS-LS3-2), (MS-LS4-1),(MS-LS4-3) **RST.6-8.7** |
| Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS3-1),(MS-LS3-2) **SL.8.5** |
| Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-LS4-3), (MS-LS4-4) **RST.6-8.9** |
| Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS4-2), (MS-LS4-4) **WHST.6-8.2** |
| Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2), (MS-LS4-4) **WHST.6-8.9** |
| Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly. (MS-LS4-2), (MS-LS4-4) **SL.8.1** |
| 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. (MS-LS4-2), (MS-LS4-4) **SL.8.4** |
| Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5) **WHST.6-8.8** |

Instructional Days: 36

Summarize numerical data sets in relation to their context. (MS-LS3-2), (MS-LS4-4),(MS-LS4-6) **6.SP.B.5**

Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1),(MS-LS4-2) **6.EE.B.6**

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4),(MS-LS4-6) **6.RP.A.1**

Recognize and represent proportional relationships between quantities. (MS-LS4-4),(MS-LS4-6) **7.RP.A.2**

Educational Technology

Standards: 8.1.8.A.1, 8.1.8.B.1, 8.1.8.C.1, 8.1.8.D.1, 8.1.8.E.1, 8.1.8.F.1
## Grade Eight Unit Three: FOSS Heredity & Adaptations

### Technology Operations and Concepts
- Create professional documents (e.g., newsletter, personalized learning plan, business letter or flyer) using advanced features of a word processing program.

### Creativity and Innovation
- Synthesize and publish information about a local or global issue or event on a collaborative, web-based service.

### Communication and Collaboration
- Participate in an online learning community with learners from other countries to understand their perspectives on a global problem or issue, and propose possible solutions.

### Digital Citizenship
- Model appropriate online behaviors related to cyber safety, cyber bullying, cyber security, and cyber ethics.

### Research and Information Literacy
- Gather and analyze findings using data collection technology to produce a possible solution for a content-related or real-world problem.

### Critical Thinking, Problem Solving, Decision Making
- Use an electronic authoring tool in collaboration with learners from other countries to evaluate and summarize the perspectives of other cultures about a current event or contemporary figure.

## Career Ready Practices

Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study.

<table>
<thead>
<tr>
<th>CRP1. Act as a responsible and contributing citizen and employee</th>
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<tbody>
<tr>
<td>Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.</td>
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<table>
<thead>
<tr>
<th>CRP2. Apply appropriate academic and technical skills</th>
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<tbody>
<tr>
<td>Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.</td>
</tr>
</tbody>
</table>
CRP4. Communicate clearly and effectively and with reason - Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others’ time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP5. Consider the environmental, social and economic impacts of decisions - Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.

CRP6. Demonstrate creativity and innovation - Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

CRP7. Employ valid and reliable research strategies - Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them - Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

CRP9. Model integrity, ethical leadership and effective management - Career-ready individuals consistently act in ways that align personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the directions and actions of a team or organization, and they apply insights into human behavior to change others’ action, attitudes and/or beliefs. They recognize the near-term and long-term effects that management’s actions and attitudes can have on productivity, morals and organizational culture.
CRP10. **Plan education and career paths aligned to personal goals** - Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.

CRP11. **Use technology to enhance productivity** - Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

CRP12. **Work productively in teams while using cultural global competence** - Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

### Suggested Field Trips

| American Museum of Natural History |