Bloomfield Public Schools
Bloomfield, New Jersey 07003

Curriculum Guide

Science
Honors - Grade 7

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Conforms to the Next Generation Science Standards and the NJSLS Standards

Board Approved: September 12, 2017

COURSE: Honors Science
GRADE LEVEL: 7

Introduction: The Seventh Grade Science course is a requirement for all students in the State of New Jersey and Bloomfield Middle School. The course is typically taught to 7th grade students over the course of one academic year.

The Seventh Grade Science curriculum builds on the concepts and skills acquired in kindergarten through sixth grade. The curriculum is designed to provide opportunities for scientific literacy: the practices and mindset of implementing science; the central concepts and patterns threaded throughout all disciplines of science; and the core ideas of the disciplines of chemistry and biology. Throughout the course, connections are made to mathematics, technology, social science, and communication skills.

This curriculum is aligned with the *New Jersey Student Learning Standards for Science*, *New Jersey Student Learning Standards for English Language Arts & Literacy in Science, the New Jersey Student Learning Standards for Math, and the New Jersey Student Learning Standards for Technology.*

This document is a tool that will provide an overview as to what to teach, when to teach it, and how to assess student progress. With considerations made for altered pacing, modifications, and accommodations; this document is to be utilized for all students enrolled in this course, regardless of ability level, native language, or classification. It is meant to be a dynamic tool that we, as educators, will revise and modify as it is used during the course of the school year.

Pacing: 89 instructional days (block format)

Unit 1: Structure and Properties of Matter	**10 instructional days**
Unit 2: Interactions of Matter and Chemical Reactions	**23 instructional days**
Unit 3: Structure, Function, and Body Systems	**15 instructional days**
Unit 4: Growth, Development, and Reproduction of Organisms	**23 instructional days**
Unit 5: Natural Selection and Adaptation	**18 instructional days**

Resources: Electronic and text resources are listed in each unit. Teachers will be able to access the curriculum document on the district website.

Textbook:

- McGraw-Hill Education. (2017). *Physical iScience.* McGraw-Hill. ISBN13: 9780076773053
- McGraw-Hill Education. (2017). *Life iScience.* McGraw-Hill. ISBN13: 9780076772841

Established Goals: New Jersey Student Learning Standards
Science: **http://www.nextgenscience.org/next-generation-science-standards**
New Jersey Math Student Learning Standards: **http://www.nj.gov/education/aps/cccs/math/**
New Jersey ELA Student Learning Standards: **http://www.nj.gov/education/aps/cccs/lal/**
Technology: **http://www.state.nj.us/education/cccs/2014/tech/**

Modifications:
- 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.   - Restructure lesson using UDL principles. (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Unit #: 1	Unit Name: Structure and Properties of Matter	Unit Length: 10 blocks

ESSENTIAL QUESTIONS:

- *If the universe is not made of Legos®, then what is it made of?*
- *Is it possible to tell if two substances mixed or if they reacted with each other?*

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Develop models to describe the atomic composition of simple molecules and extended structures.** *[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms. The substructure of atoms and the periodic table are learned in high school chemistry.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]*	MS-PS1-1
2	**Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.** *[Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]*	MS-PS1-2

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to predict and/or describe phenomena. (MS-PS1-1) **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2) --- - ***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-PS1-2)	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2)(MS-PS1-3) **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2), (MS-PS1-3),(MS-PS1-5)	**Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1) **Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2) -

Connections to other DCIs in this grade-band: **MS.PS3.D** (MS-PS1-2),(MS-PS1-6); **MS.LS1.C** (MS-PS1-2),(MS-PS1-5); **MS.LS2.A** (MS-PS1-3)**;** **MS.LS2.B** (MS-PS1-5); **MS.LS4.D** (MS-PS1-3); **MS.ESS2.A** (MS-PS1-2),(MS-PS1-5)**;** **MS.ESS2.C** (MS-PS1-1),(MS-PS1-4)**;** **MS.ESS3.A** (MS-PS1-3); **MS.ESS3.C** (MS-PS1-3)

Articulation across grade-bands: 5.PS1.A (MS-PS1-1); 5.PS1.B (MS-PS1-2),(MS-PS1-5); HS.PS1.A (MS-PS1-1),(MS-PS1-3),(MS-PS1-4),(MS-PS1-6); HS.PS1.B (MS-PS1-2),(MS-PS1- 4),(MS-PS1-5),(MS-PS1-6); HS.PS3.A (MS-PS1-4),(MS-PS1-6); HS.PS3.B (MS-PS1-6); HS.PS3.D (MS-PS1-6); HS.LS2.A (MS-PS1-3); HS.LS4.D (MS-PS1-3); HS.ESS1.A (MS-PS1- 1); HS.ESS3.A (MS-PS1-3)

Grade 7 Unit 2: Interactions of Matter and Chemical Reactions

- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)
- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2), (MS-PS1-3)
- The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)
- Some chemical reactions release energy, others store energy. (MS-PS1-6)

Articulation of DCIs across grade-bands:

By the end of Grade 5, students understand that:

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means.
- A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.

- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.
- Measurements of a variety of observable properties can be used to identify materials. *[Note: In the fifth grade, no attempt was made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.]*
- When two or more different substances are mixed, a new substance with different properties may be formed.

No matter what reaction or change in properties occurs, the total mass of the substances does not change. *[Note: Mass and weight were distinguished in 5th grade.]*

In Grade 7, students build upon their previously developed understandings of particles and physical properties with new understanding of molecular structure and chemical properties. Their learning during this unit will set the foundation for future learning in the high school areas of:

Chemistry

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons surrounded by electrons.
- The periodic table orders elements horizontally according to the number of protons in the atom's nucleus; it organizes elements with similar chemical properties vertically, in columns. The repeating patterns of this table reflect patterns of outer electron states.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- A stable molecule has less energy than the same set of atoms separated; at least this much energy must be provided in order to take the molecule apart.

Earth and space science

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- The Big Bang theory is supported by observations of distant galaxies receding from our own, by the measured composition of stars and nonstellar gases, and by the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

- Chemical processes, their rates, and whether or not they store or release energy can be understood in terms of collisions of molecules and rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Connections to Math and ELA:

ELA:

Cite specific textual evidence to support analysis of science and technical texts. (MS-PS1-2) **RST.6-8.1**

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-PS1-1),(MS-PS1-2) **RST.6-8.7**

MATH:

Reason abstractly and quantitatively. (MS-PS1-1),(MS-PS1-2) **MP.2**

Model with mathematics. (MS-PS1-1) **MP.4**

Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1),(MS-PS1-2) **6.RP.A.3**

Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1) **8.EE.A.3**

Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (MS-PS1-2) **6.SP.B.4**

Summarize numerical data sets in relation to their context. (MS-PS1-2) **6.SP.B.5**

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.

Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
• matter • atom • molecule • atomic composition • state of matter • solid • liquid • gas • heat • temperature • pressure • thermal energy • kinetic energy • physical property • density • melting point • boiling point • solubility • odor • chemical property • flammability • pure substance • crystal • natural resource • synthetic materials	• analyze • describe • determine • interpret • characteristic • model • evaluate • communicate • cause and effect • scale • proportion • quantity • structure • function • engineering • technology	• McGraw-Hill iScience: *Physical iScience* • http://www.nextgenscience.org/next-generation-science-standards • PhET Website • Khan Academy

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Represent or build 3D models of molecules using real life materials (pg. 21). (beads / clay / Playdoh)	SLO #1: Develop models to describe the atomic composition of simple molecules and extended structures. (MS-PS1-1) Engineering Practices: Developing and Using Models
	Observe and infer the identities of several different powders that share some similar physical properties but have different physical and chemical properties. Design an experiment to tell the difference among the powders.	SLO #2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred (MS-PS1-2) Engineering Practices: Analyzing and Interpreting Data
	Observe a colored column of substances.	SLO #2: see above (MS-PS1-2) Engineering Practices: Analyzing and Interpreting Data
EXPLORE	**Examples of Exploring Activities:**	
	Identify the similarities and differences among the various types of molecules that were modeled. Research the identity and properties of different molecules that consist of the same atoms.	SLO #1: see above (MS-PS1-1) Engineering Practices: Developing and Using Models
	Test each powder for interactions with other substances. Record observations after testing each powder	SLO #2: see above (MS-PS1-2) Engineering Practices: Analyzing and Interpreting Data
	Investigate and predict why the layers are forming in the colored column.	SLO #2: see above (MS-PS1-2)

		Engineering Practices: Analyzing and Interpreting Data
EXPLAIN	**Examples of Explaining Activities:**	
	Build a model of a more advanced molecule (extended structure).	SLO #1: see above (MS-PS1-1) Engineering Practices: Developing and Using Models
	Use reference materials to make a conclusion about the identity of the unknown powders.	SLO #2: see above (MS-PS1-2) Engineering Practices: Analyzing and Interpreting Data
	Use the Phet Simulator on Density to answer what is density, how is it measured, how is it unique to a specific substance? (How does density help us to identify a substance?)	SLO #2: see above (MS-PS1-2) Engineering Practices: Developing and Using Models
ELABORATE	**Examples of Elaborating Activities:**	
	Determine the similarities and differences between proteins and carbohydrates.	SLO #1: see above (MS-PS1-1) Engineering Practices: Engaging in Argument
	Explain why properties might be important in identifying a spilled chemical or how properties might help when having to store chemicals properly.	SLO #2: see above (MS-PS1-2) Engineering Practices: Engaging in Argument
	Perform density calculations for different substances.	SLO #2: see above (MS-PS1-2) Engineering Practices: Analyzing and Interpreting Data
EVALUATE	**Examples of Evaluating Activities:**	
	Assessment involving models of two molecules that are similar in structure but vary greatly in properties. Students	SLO #1: see above (MS-PS1-1)

	will explain how the structure of matter affects its properties.	Engineering Practices: Developing and Using Models, Engaging in Argument
	Write a scientific explanation that uses collected data to justify why the powders must be different.	SLO #2: see above (MS-PS1-2) Engineering Practices: Engaging in Argument
	Given several pieces of data, calculate the density at which an egg will float "within" a column of water. Justify the calculation with an explanation and a real life test. Reflect on the precision of the calculation.	SLO #2: see above (MS-PS1-2) Engineering Practices: Analyzing and Interpreting Data, Engaging in Argument

Unit #: 2	Unit Name: Interactions of Matter and Chemical Reactions	Unit Length: 23 blocks

ESSENTIAL QUESTIONS:

- *How can you tell what the molecules are doing in a substance?*
- *How can we trace synthetic materials back to natural ingredients?*
- *What happens to the atoms when I bake a cake?*
- *How can a device be designed, constructed, tested, and modified that either releases or absorbs thermal energy by chemical processes?*

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.** *[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]*	MS-PS1-3
2	**Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.** *[Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]*	MS-PS1-4
3	**Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.** *[Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]*	MS-PS1-5
4	**Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. *** *[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve*	MS-PS1-6

	chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]	
5	**Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**	MS-ETS1-3

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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-PS1-3) **Developing and Using Models** ● Develop a model to predict and/or describe phenomena. (MS-PS1-4) ● Develop a model to describe unobservable mechanisms. (MS-PS1-5) **Constructing Explanations and Designing Solutions** ● Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets	**PS1.A: Structure and Properties of Matter** ● Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3) ● Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) ● In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4) **PS1.B: Chemical Reactions** ● Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the	**Structure and Function** ● Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3) **Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) - ***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,

specific design criteria and constraints. (MS-PS1-6) **Analyzing and Interpreting Data** ● Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) - - **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)	original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-3), (MS-PS1-5) ● The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) ● Some chemical reactions release energy, others store energy. (MS-PS1-6) **PS3.A: Definitions of Energy** ● The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. *(secondary to MS-PS1-4)* ● The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of	and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3) **Influence of Science, Engineering and Technology on Society and the Natural World** ● The uses of technologies and any limitation on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3) **Energy and Matter** ● Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5) ● The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)

	a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. *(secondary to MS-PS1-4)* **ETS1.B: Developing Possible Solutions** ● A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (*secondary to MS-PS1-6*) ● There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-3) ● Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) **ETS1.C: Optimizing the Design Solution** ● Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of those characteristics may be incorporated into the new design. (*secondary to MS-PS1-6*)	

	• The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (secondary to MS-PS1-6)	

Connections to other DCIs in this grade-band:

Grade 7 Unit 1: Properties of Matter

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2)
- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2)

Articulation of DCIs across grade-bands:

By the end of Grade 5, students understand that:

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.
- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.
- Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)
- When two or more different substances are mixed, a new substance with different properties may be formed.

- No matter what reaction or change in properties occurs, the total weight of the substances does not change. *[Note: Mass and weight are not distinguished by the end of 5^{th} grade.]*

In Grade 7, students build upon their previously developed understandings of particles and physical properties with new understanding of molecular interactions, chemical reactions, and the role of energy in reactions. Their learning during this unit will set the foundation for future learning in the high school areas of:

Chemistry

- Each atom has a charged substructure consisting of a nucleus made of protons and neutrons surrounded by electrons.
- The periodic table orders elements horizontally by the number of protons in nucleus of the element's atoms and arranges elements with similar chemical properties vertically in columns. The repeating patterns of this table reflect patterns of outer electron states.
- Electrical forces within and between atoms determine the structure and interactions of matter at the bulk scale.
- A stable molecule has less energy than the same set of atoms separated; at least this energy must be provided in order to take the molecule apart.
- Chemical processes, their rates, and whether or not they store ore release energy can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with in kinetic energy.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Physics

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position) of the particles.

- In some cases, the relative position of energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.
- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).
- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.

Life science

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- Humans depend on the living world for resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- Resource availability has guided the development of human society.
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Connections to Math and ELA:
ELA:

Cite specific textual evidence to support analysis of science and technical texts. (MS-PS1-3) **RST.6-8.1**

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-PS1-4)* **RST.6-8.7**

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-PS1-3) **WHST.6-8.8**

Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-3) **RST.6-8.1**

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6) **RST.6-8.3**

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-PS1-5) **RST.6-8.7**

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-ETS1-3) **RST.6-8.9**

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS1-6) (MS-ETS1-3) **WHST.6-8.7**

MATH:

Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS1-4) **6.NS.C.5**

Reason abstractly and quantitatively. (MS-PS1-5) (MS-ETS1-3) **MP.2**

Model with mathematics. (MS-PS1-5) **MP.4** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-3) **7.EE.3** Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-5) **6.RP.A.3**
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
• pure substance • atom • molecule • compound • physical property • chemical property • chemical change • physical change • chemical reaction • reactant • product • inert • density • melting point • boiling point • solubility • flammability • odor	• modeling • analyze • interpret • explaining • design • evidence • phenomena • theory • patterns • energy • matter • design process • engineering • technology	• McGraw-Hill iScience: *Physical iScience* • http://www.nextgenscience.org/next-generation-science-standards • PhET Website • Khan Academy

• conservation of matter • concentration • solution • temperature • thermal energy • heat • kinetic energy • endothermic reaction • exothermic reaction		

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Examine several advertisements featuring common consumer products.	SLO #1: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. (MS-PS1-3) Engineering Practices: Asking and Defining Problems
	Investigate the states of matter of water using the online PHeT simulator.	SLO #2: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. (MS-PS1-4) Engineering Practices: Developing and Using Models
	Predict what might happen to the temperature of water as it is heated starting from a solid form.	SLO #2: see above (MS-PS1-4) Engineering Practices: Asking and Defining Problems
	Observe different classroom stations that demonstrate chemical changes (Chemical Changes Stations) resulting from a chemical reaction.	SLO #3: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. (MS-PS1-5) Engineering Practices: Developing and Using Models
	View a clip of a survival situation where the power has gone out and the temperature is low. Brainstorm solutions to the problem.	SLO #4: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal

		energy by chemical processes. (MS-PS1-6) Engineering Practices: Asking and Defining Problems
EXPLORE	**Examples of Exploring Activities:**	
	Brainstorm where the products come from and what they might be made of.	SLO #1: see above (MS-PS1-3) Engineering Practices: Asking and Defining Problems
	Visualize the movement of molecules of water (pg. 334) as it is heated.	SLO #2: see above (MS-PS1-4) Engineering Practices: Developing and Using Models
	Record temperature data as water changes state.	SLO #2: see above (MS-PS1-4) Engineering Practices: Asking and Defining Problems
	Build virtual models of reactants, products, or leftovers of an observed reaction.	SLO#3: see above (MS-PS1-5) Engineering Practices: Developing and Using Models
	Observe the temperature of different reactions that either release or absorb heat.	SLO #4: see above (MS-PS1-6) Engineering Practices: Asking and Defining Problems
EXPLAIN	**Examples of Explaining Activities:**	
	Research the life cycle of a chosen consumer product. Draw a cartoon or write a paragraph to describe the natural resources used and the amount of processing that takes place.	SLO #1: see above (MS-PS1-3) Engineering Practices: Developing and Using Models

	Complete a T-chart or Venn diagram to compare and contrast the 3 states of matter and the properties of each state.	SLO #2: see above (MS-PS1-4) Engineering Practices: Developing and Using Models
	Analyze temperature data using Excel and identify points in the resulting graph that represent changes in state.	SLO #2: see above (MS-PS1-4) Engineering Practices: Analyzing and Interpreting Data
	Using class resources, draw a cartoon or describe in writing why reactants and products are equal in their number and type of atoms.	SLO#3: see above (MS-PS1-5) Engineering Practices: Developing and Using Models
	Analyze the temperature and duration data for the different reactions and rank which might be best for either heating or cooling an object.	SLO#4: see above (MS-PS1-6) Engineering Practices: Analyzing and Interpreting Data
ELABORATE	**Examples of Elaborating Activities:**	
	Conduct a Socratic seminar: Should the school cafeteria switch to metal silverware from plastic ware?	SLO #1: see above (MS-PS1-3) Engineering Practices: Engaging in Argument
	Research other instances of phase change (sublimation, deposition).	SLO #2: see above (MS-PS1-4) Engineering Practices: Developing and Using Models
	Identify changes in state of several other substances based on graphical data.	SLO #2: see above (MS-PS1-4) Engineering Practices: Analyzing and Interpreting Data
	Design an investigation to prove the conservation of mass.	SLO#3: see above (MS-PS1-5)

		Engineering Practices: Asking and Defining Problems, Engaging in Argument
	Create and present a design for either a chemical "Hand warmer" or a "Chemical Icepack" using data from experiments and other research.	SLO #4: see above (MS-PS1-6) Engineering Practices: Analyzing and Interpreting Data
EVALUATE	**Examples of Evaluating Activities:**	
	Compare and contrast two products that are derived from the same natural source. In writing, justify why one product is "better" than another based on how it is processed and disposed of.	SLO #1: see above (MS-PS1-3) Engineering Practices: Engaging in Argument
	Construct a storybook change of state model.	SLO #2: see above (MS-PS1-4) Engineering Practices: Developing and Using Models
	Write a conclusion explaining why there is no change in temperature during a change of state, even though a substance is being heated.	SLO #2: see above (MS-PS1-4) Engineering Practices: Engaging in Argument
	Create a visual model using 2D illustrations that demonstrates the law of conservation of mass in a particular chemical reaction. Write a version of the law in one's own words to accompany the model.	SLO#3: see above (MS-PS1-5) Engineering Practices: Developing and Using Models
	Evaluate the efficacy of proposed designs of hand warmers and icepacks. Re-design the original project to incorporate improvements. Write or present a justification for the re-design.	SLO#5: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)

		Engineering Practices: Engaging in Argument

Unit #: 3	Unit Name: Structure, Function, and Body Systems	Unit Length: 15 blocks

ESSENTIAL QUESTIONS:

- *How will astrobiologists know if they have found life elsewhere in the solar system?*
- *How do the functions of cells support an entire organism?*
- *What is the evidence that a body is actually a system of interacting subsystems composed of groups of interacting cells?*
- *How do organisms receive and respond to information from their environment?*

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.** *[Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.]*	MS-LS1-1
2	**Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.** *[Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.]*	MS-LS1-2
3	**Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.** *[Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.]* [Assessment Boundary: Assessment does not include the	MS-LS1-3

	mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.*]*	
4	**Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.** *[*Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.*]*	MS-LS1-8

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations ● Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1) **Developing and Using Models** ● Develop and use model to describe phenomena. (MS-LS1-2) **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-LS1-8) **Engaging in Argument from Evidence** ● Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)	**LS1.A: Structure and Function** ● All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1) ● Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) ● In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3) **LS1.D: Information Processing** ● Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in	**Scale, Proportion, and Quantity** ● Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1) **Structure and Function** ● Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2) **Systems and System Models** ● Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3) **Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8) -

	immediate behaviors or memories. (MS-LS1-8)	***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-LS1-1) - ***Connections to Nature of Science*** **Science is a Human Endeavor** ● Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

Connections to other DCIs in this grade-band:

Grade 7 Unit 4: Growth, Development, and Reproduction of Organisms

- 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)

- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)
- 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)

Articulation of DCIs across grade-bands:

By the end of Grade 5, students understand that:

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

In Grade 7, students build upon their previously developed understandings of plant and animal structures with new understandings of the composition of those structures as units of interworking cells. Their learning during this unit will set the foundation for future learning in the high school area of:

Life science

- Systems of specialized cells within organisms help cells 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.

Connections to Math and ELA:
ELA:

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-LS1-1) **WHST.6-8.7**

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2) **SL.8.5**

Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3) **RST.6-8.1**

Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.(MS-LS1-3) **RI.6.8**

Write arguments focused on discipline content. (MS-LS1-3) **WHST.6-8.1**

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-LS1-8) **WHST.6-8.8**

MATH:

Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-1),(MS-LS1-2) **6.EE.C.9**

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan

Content Vocabulary	Academic Vocabulary	Required Resources
• organism • cells • unicellular • multicellular • structure • function • homeostasis • cell membrane • cell wall • organelle • nucleus • chloroplasts • mitochondria • structure • function • tissue • organ • system • circulatory system • excretory system • respiratory system • digestive system • muscular system • nervous system • stimuli • response • signal • nerve	• model • investigate • argumentation • evaluating • communicating • cause • effect • scale • proportion • quantity • system • structure • function • engineering • technology	• McGraw-Hill iScience: *Life iScience* • http://www.nextgenscience.org/next-generation-science-standards • PhET Website • Khan Academy

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Sort entry cards with living/nonliving things.	SLO#1: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. (MS-LS1-1) Engineering Practices: Engaging in Argument
	Observe prepared slides of living things. Draw/sketch the observed tissue.	SLO#1: see above (MS-LS1-1) SLO#2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. (MS-LS1-2) Engineering Practices: Developing and Using Models
	Predict the function of an organelle given an image of that organelle.	SLO#2: see above (MS-LS1-2) Engineering Practices: Developing and Using Models
	Build a virtual or life-size copy of an assigned organ system using reference materials.	SLO#3: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. (MS-LS1-3) Engineering Practices: Developing and Using Models
	Watch a video clip of a frightening moment.	SLO#4: Gather and synthesize information that sensory receptors respond to stimuli

		by sending messages to the brain for immediate behavior or storage as memories. (MS-LS1-8) Engineering Practices: Developing and Using Models
EXPLORE	**Examples of Exploring Activities:**	
	Compare both a living thing and a nonliving thing to a burning fire.	SLO#1: see above (MS-LS1-1) Engineering Practices: Engaging in Argument
	Create a chart comparing the similarities and differences among the observed tissue.	SLO#1: see above (MS-LS1-1) SLO#2: see above (MS-LS1-2) Engineering Practices: Engaging in Argument
	Create a mini-presentation describing the function of one organelle.	SLO#2: see above (MS-LS1-2) Engineering Practices: Developing and Using Models
	Present the built organ system to your group mates.	SLO#3: see above (MS-LS1-3) Engineering Practices: Developing and Using Models
	Discuss with group mates a personal moment that was frightening or shocking.	SLO#4: see above (MS-LS1-8) Engineering Practices: Developing and Using Models
EXPLAIN	**Examples of Explaining Activities:**	
	Jigsaw a guided reading describing the properties of living and nonliving things.	SLO#1: see above (MS-LS1-1)

		Engineering Practices: Analyzing and Interpreting Data
	Jigsaw using various stations to compile and take notes about the properties of plant versus animal cells.	SLO#1: see above (MS-LS1-1) SLO#2: see above (MS-LS1-2) Engineering Practices: Analyzing and Interpreting Data
	Present mini-presentation in a group. Each group member takes notes as an organelle presentation is given so that there is a final master note sheet.	SLO#2: see above (MS-LS1-2) Engineering Practices: Developing and Using Models
	Build the nervous system together as a class.	SLO#3: see above (MS-LS1-3) Engineering Practices: Developing and Using Models
	Jigsaw a guided reading about the different aspects of the fight or flight response.	SLO#4: see above (MS-LS1-8) Engineering Practices: Developing and Using Models
ELABORATE	**Examples of Elaborating Activities:**	
	Conduct a Socratic seminar: Are robots living?	SLO#1: see above (MS-LS1-1) Engineering Practices: Engaging in Argument
	Create wet mounts of animal and plant specimens. Observe and sketch them.	SLO#1: see above (MS-LS1-1) SLO#2: see above (MS-LS1-2) Engineering Practices: Developing and Using Models

	Create an analogy comparing each organelle of a cell to subsystem of an office/school/organization. Present systems analogies to the class.	SLO#2: see above (MS-LS1-2) Engineering Practices: Developing and Using Models
	Teach organ system to group mates with a small presentation and group notes.	SLO#3: see above (MS-LS1-3) Engineering Practices: Developing and Using Models
	Classify the response to different sensory inputs in a fight or flight situation. Research the effect of different neurotoxins and neuroactives on responses.	SLO#4: see above (MS-LS1-8) Engineering Practices: Analyzing and Interpreting Data
EVALUATE	**Examples of Evaluating Activities:**	
	Justify in writing why a living and a nonliving thing have been sorted into a specific category.	SLO#1: see above (MS-LS1-1) Engineering Practices: Engaging in Argument
	Label an animal and plant drawing. Visually identify either on an exit ticket.	SLO#1: see above (MS-LS1-1) SLO#2: see above (MS-LS1-2) Engineering Practices: Developing and Using Models
	Identify the problem that would occur in a system if a subsystem or part was damaged or missing. Make a link to a specific organelle and describe how homeostasis of a cell would be affected if that organelle was damaged or missing.	SLO#2: see above (MS-LS1-2) Engineering Practices: Engaging in Argument
	Summarize the interaction of organ systems and how they maintain homeostasis.	SLO#3: see above (MS-LS1-3) Engineering Practices: Developing and Using Models

	Create a cartoon that illustrates the path of a stimulus and corresponding bodily reaction.	SLO#4: see above (MS-LS1-8) Engineering Practices: Developing and Using Models

Unit #: 4	Unit Name: Growth, Development, and Reproduction	Unit Length: 23 blocks

ESSENTIAL QUESTIONS:

- *How do characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively?*
- *How do environmental and genetic factors influence the growth of organisms?*
- *How do structural changes to genes (mutations), located on chromosomes, affect proteins or affect the structure and function of an organism?*
- *How do asexual reproduction and sexual reproduction affect the genetic variation of offspring?*

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.** *[Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]*	MS-LS1-4
2	**Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.** *[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]*	MS-LS1-5

3	**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
4	**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

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence ● Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4) **Constructing Explanations and Designing Solutions** ● Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5) **Developing and Using Models** ● Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)	**LS1.B: Growth and Development of Organisms** ● Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4) ● Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4) ● Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) ● 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	**Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-4),(MS-LS1-5) ● Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4),(MS-LS1-5) **Structure and Function** ● Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts; therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-4), (MS-LS1-5)

	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 may be identical or may differ from each other. (MS-LS3-2) ● 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)	

Connections to other DCIs in this grade-band:

Grade 7 Unit 3: Structure, Function, and Body Systems

- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.

Articulation of DCIs across grade-bands:

By the end of Grade 5, students understand that:

- Reproduction is essential to every kind of organism.
- Organisms have unique and diverse life cycles.
- Organisms have both internal and macroscopic structures that allow for growth, survival, behavior, and reproduction.
- 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.

In Grade 7, students build upon their previously developed understandings of reproduction and behavior with new understandings of how the two areas interrelate in organisms' life cycles. Their learning during this unit will set the foundation for future learning in the high school area of:

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.
- As successive subdivisions of an embryo's cells occur, programmed genetic instructions and small differences in their immediate environments activate or inactivate different genes, which cause the cells to develop differently—a process called differentiation.
- 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.
- In sexual reproduction, a specialized type of cell division called meiosis occurs that results in the production of sex cells, such as gametes in animals (sperm and eggs), which contain only one member from each chromosome pair in the parent cell.
- 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.

Connections to Math and ELA:
ELA:

Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4),(MS-LS1-5),(MS-LS3-1),(MS-LS3-2) **RST.6-8.1**

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-5) **RST.6-8.2**

Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (MS-LS1-4) **RI.6.8**

Write arguments focused on discipline content. (MS-LS1-4) **WHST.6-8.1**

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-5) **WHST.6-8.2 → (W.7.1)**

Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-5) **WHST.6-8.9**

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) **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**

MATH:

Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-4),(MS-LS1-5) **6.SP.A.2**

Summarize numerical data sets in relation to their context. (MS-LS1-4),(MS-LS1-5),(MS-LS3-2) **6.SP.B.4**

Model with mathematics. (MS-LS3-2) **MP.4**

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
• dominant • recessive • trait • allele • gene • genotype • phenotype • Punnett Square • homozygous • heterozygous • heredity • chromosome • DNA • RNA • sexual • asexual • offspring • mutation • pure bred • hybrid	• modeling • explaining • designing • evaluating • communicating • cause and effect • structure • function • engineering • technology	• McGraw-Hill iScience: *Life iScience* • http://www.nextgenscience.org/next-generation-science-standards • PhET Website • Khan Academy

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Dissect and observe female and male pine cones as well as female, male, and hermaphroditic flowers.	SLO#1: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. (MS-LS1-4) Engineering Practices: Analyzing and Interpreting Data
	Research an event such as the lead crisis in Newark/Flint or the nuclear fallout in Hiroshima/Chernobyl and its impact on the development of children in the area.	SLO #2: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (MS-LS1-5) Engineering Practices: Analyzing and Interpreting Data
	Create an object according to a given set of instructions. Compare the finished product with classmates who have been given directions that have one error or difference.	SLO #3: 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. (MS-LS3-1) Engineering Practices: Developing and Using Models
	Lay out a small family tree according to a given account of an organism.	SLO #4: 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. (MS-LS3-2) Engineering Practices: Developing and Using Models
EXPLORE	**Examples of Exploring Activities:**	
	List, sort, label, as a group the differences in the observed structures.	SLO#1: see above (MS-LS1-4) Engineering Practices: Developing and Using Models
	Jigsaw with a group and summarize the cause and effect of the organisms' development.	SLO#2: see above (MS-LS1-5) Engineering Practices: Analyzing and Interpreting Data
	Discuss with group mates why the created products were different. Discuss as a class how cells do similar things when creating protein.	SLO#3: see above (MS-LS3-1) Engineering Practices: Developing and Using Models
	Visit stations with different accounts of sexually and asexually reproducing organisms.	SLO#4: see above (MS-LS3-2) Engineering Practices: Analyzing and Interpreting Data
EXPLAIN	**Examples of Explaining Activities:**	
	Jigsaw a guided reading of the differences in reproductive structures between coniferous and deciduous plants.	SLO#1: see above (MS-LS1-4) Engineering Practices: Developing and Using Models
	Visit stations and summarize the cause and effect of organism development in other cases such as fish growth in large versus small ponds or plant growth with tall genes versus short genes.	SLO#2: see above (MS-LS1-5) Engineering Practices: Engaging in Argument

	Visit different stations to identify striking/noticeable mutations in humans such as albinism, polydactyly, or dwarfism. Take notes on the causes of the mutations.	SLO#3: see above (MS-LS3-1) Engineering Practices: Developing and Using Models
	Jigsaw a guided reading on the advantages and disadvantages of sexual and asexual reproduction.	SLO#4: see above (MS-LS3-2) Engineering Practices: Analyzing and Interpreting Data
ELABORATE	**Examples of Elaborating Activities:**	
	Watch video clips of various animal mating rituals and child-rearing behaviors. Discuss the advantages of each.	SLO#1: see above (MS-LS1-4) Engineering Practices: Developing and Using Models
	Watch a video on sickle cell anemia. Discuss as a class the pros and cons of having the gene for sickle cell anemia in a family.	SLO#2: see above (MS-LS1-5) Engineering Practices: Engaging in Argument
	Socratic seminar: What are the risks and benefits of gene therapy technology?	SLO#3: see above (MS-LS3-1) Engineering Practices: Developing and Using Models
	Research one example of a complex trait in organisms and create a small presentation about it.	SLO#4: see above (MS-LS3-2) Engineering Practices: Developing and Using Models
EVALUATE	**Examples of Evaluating Activities:**	
	Justify the success of a reproductive strategy by comparing its pros and cons in terms of the probability of reproduction and the average survival rate of the offspring.	SLO#1: see above (MS-LS1-4) Engineering Practices: Engaging in Argument
	Create a travel ad or brochure advertising the benefits of a particular environment for an organism's development.	SLO#2: see above (MS-LS1-5)

		Engineering Practices: Engaging in Argument
	Create a digital story/presentation that tells the tale of a person with a genetic mutation, including symptoms, potential causes, diagnosis, and treatments.	SLO#3: see above (MS-LS3-1) Engineering Practices: Developing and Using Models
	Create a small alien family tree for an asexually reproducing species as well as a sexually reproducing species. The family tree demonstrates the inheritance of traits in each.	SLO#4: see above (MS-LS3-2) Engineering Practices: Developing and Using Models

Unit #: 5	Unit Name: Natural Selection and Adaptation	Unit Length: 18 blocks

ESSENTIAL QUESTIONS:

- *How do we know when an organism (fossil) was alive?*
- *How do we know that birds and dinosaurs are related?*
- *How can changes to the genetic code increase or decrease an individual's chances of survival?*
- *How can the environment effect natural selection?*
- *Are Genetically Modified Organisms (GMO) safe to eat?*

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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
2	**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
3	**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
4	**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**	MS-LS4-4

	environment. *[Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations]*	
5	**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
6	**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

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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)	**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) ● 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 show relationships not evident in the fully-formed anatomy. (MS-LS4-3) **LS4.B: Natural Selection** • Natural selection leads to the predominance of certain traits in a	**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** ● 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) - **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) -

Using Mathematics and Computational Thinking ● Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6) - **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)	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 onto 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)	***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) - ***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)

Connections to other DCIs in this grade-band:

Grade 7, Unit 4: Growth, Development, and Reproduction

- 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)
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)
- 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)

Articulation of DCIs across grade-bands:

By the end of Grade 5, students understand that:

- 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.
- 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.

In Grade 7, students build upon their previously developed understandings of fossils and inherited traits with new understandings of their basis for the theory of evolution. Their learning during this unit will set the foundation for future learning in the high school areas of:

Life Science and Environmental Science

- 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.

- 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.
- 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.
- 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 the expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed in a population depends on both genetic and environmental factors.
- 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.
- The traits that positively affect survival are more likely to be reproduced and thus are more common in the population.
- 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.
- 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.

- Adaptation also means that the distribution of traits in a population can change when conditions change.
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new, distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. 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.

Connections to Math and ELA:
ELA:

Cite specific textual evidence to support analysis of science and technical texts, (MS-LS4-1),(MS-LS4-2),(MS-LS4-3),(MS-LS4-4),(MS-LS4-5) **RST.6-8.1**

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-LS4-1),(MS-LS4-3) **RST.6-8.7**

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**

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**

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** **MATH:** 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** Model with mathematics. (MS-LS4-6) **MP.4** 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** Summarize numerical data sets in relation to their context. (MS-LS4-4),(MS-LS4-6) **6.SP.B.5** Recognize and represent proportional relationships between quantities. (MS-LS4-4),(MS-LS4-6) **7.RP.A.2**
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
• fossil • fossil record • carbon dating • trait	• analyze • computation • explain • design	• McGraw-Hill iScience: *Life iScience* • http://www.nextgenscience.org/next-generation-science-standards • PhET Website

• embryo • anatomy • dominance • species • population • extinct • evolution • diversity • adaptation • natural selection • reproduction • genes • probability	• evidence • cause and effect • interdependence • patterns • order • natural systems	• Khan Academy

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Create a fossil using plaster of Paris. (pg. 19)	SLO #1: 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. (MS-LS4-1) Engineering Practices: Developing and Using Models
	Participate in a simulation of a fossil hunt.	SLO #2: 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. (MS-LS4-2) Engineering Practices: Developing and Using Models
	View different stages of embryo development within a phylum using normal plate images.	SLO #3: 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. (MS-LS4-3) Engineering Practices: Analyzing and Interpreting Data
	Watch a video on animal camouflage. Discuss (as a class) the advantages and disadvantages of camouflage.	SLO #4: 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. (MS-LS4-4) Engineering Practices: Asking and Defining Problems
	Watch a video about dog breeding and genetic engineering in dogs.	SLO #5: Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. (MS-LS4-5) Engineering Practices: Developing and Using Models
	Conduct a predation simulation.	SLO #6: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. (MS-LS4-6) Engineering Practices: Analyzing and Interpreting Data
EXPLORE	**Examples of Exploring Activities:**	
	Using reference materials, place the created fossil in the stratified layer that it belongs.	SLO #1: see above (MS-LS4-1) Engineering Practices: Developing and Using Models
	List, sort, and label organisms from the fossil hunt that may be evolutionarily related due to the occurrence of common structures.	SLO #2: see above (MS-LS4-2) Engineering Practices: Analyzing and Interpreting Data

	Sort the different stages of development in chronological order.	SLO #3: see above (MS-LS4-3) Engineering Practices: Analyzing and Interpreting Data
	Design and run a model to test the advantages and disadvantages and their impact on an insect population exposed to predation pressure.	SLO #4: see above (MS-LS4-4) Engineering Practices: Developing and Using Models
	Create a pros and cons chart comparing traditional dog breeding and genetic engineering.	SLO #5: see above (MS-LS4-5) Engineering Practices: Engaging in Argument
	Analyze collected data from the predation simulation to explain why one species was more likely to survive.	SLO #6: see above (MS-LS4-6) Engineering Practices: Analyzing and Interpreting Data
EXPLAIN	**Examples of Explaining Activities:**	
	Create a flipbook of illustrations that demonstrate the timeline of how the fossil arrived at its stratified layer.	SLO #1: see above (MS-LS4-1) Engineering Practices: Developing and Using Models
	Create a set of 3 Fossil Trading Cards that show an evolutionary progression and share with a partner.	SLO #2: see above (MS-LS4-2) Engineering Practices: Engaging in Argument
	View and sort different stages of embryonic development across two or three different phyla using normal plate images.	SLO #3: see above (MS-LS4-3) Engineering Practices: Analyzing and Interpreting Data
	Analyze data to see which bugs survived and reproduced better in the environment with the predator present.	SLO #4: see above (MS-LS4-4) Engineering Practices: Analyzing and Interpreting Data

	Create a presentation about other genetically modified organisms.	SLO #5: see above (MS-LS4-5) Engineering Practices: Developing and Using Models
	Jigsaw a guided reading on a predator/prey relationship.	SLO #6: see above (MS-LS4-6) Engineering Practices: Developing and Using Models
ELABORATE	**Examples of Elaborating Activities:**	
	Participate in the Dino Data simulation to create hypotheses about dinosaurs based on presented data.	SLO #1: see above (MS-LS4-1) Engineering Practices: Analyzing and Interpreting Data
	Research evidence of an evolutionary tree in the birds and turtles of the Galapagos Islands.	SLO #2: see above (MS-LS4-2) Engineering Practices: Analyzing and Interpreting Data
	Create a cladogram that demonstrates how related the different phyla are (that were viewed in the normal plate images).	SLO #3: see above (MS-LS4-3) Engineering Practices: Analyzing and Interpreting Data
	Make and record predictions about how bug color traits might change over several generations and under different conditions. Test these predictions against the model.	SLO #4: see above (MS-LS4-4) Engineering Practices: Developing and Using Models
	Participate in a Socratic Seminar on genetically modified organisms.	SLO #5: see above (MS-LS4-5) Engineering Practices: Engaging in Argument
	Create a presentation that demonstrates the factors leading to a species being marked as endangered.	SLO #6: see above (MS-LS4-6) Engineering Practices: Asking and Defining Problems

EVALUATE	Examples of Evaluating Activities:	
	Examine a record of certain fossils and identify the likely linking piece based on time and location	SLO #1: see above (MS-LS4-1) Engineering Practices: Analyzing and Interpreting Data
	Complete an evolutionary tree diagram, placing different modern and fossil organisms at likely branching points.	SLO #2: see above (MS-LS4-2) Engineering Practices: Engaging in Argument
	Write an explanation justifying different points in the cladogram. (what point in embryonic development data allows the two species to be related)	SLO #3: see above (MS-LS4-3) Engineering Practices: Engaging in Argument
	Construct a scientific explanation with group members to make a claim about organism selection, provide evidence of it, and justify the argument. Critique arguments with other groups.	SLO #4: see above (MS-LS4-4) Engineering Practices: Engaging in Argument
	Write a position statement for or against the biotechnology of genetically modified organisms.	SLO #5: see above (MS-LS4-5) Engineering Practices: Engaging in Argument
	Draw conclusions about the likelihood of survival of a presented species along with a set of data similar to the hole punch predation simulation.	SLO #6: see above (MS-LS4-6) Engineering Practices: Engaging in Argument