This scope and sequence document was developed to assist teachers with the implementation of the Louisiana Student Standards for Science. This tool is not full curriculum and will need to be further built out by science educators. It has been designed to help in the initial transition to the new standards.

This document is considered a "living" document, as we believe that teachers and other educators will find ways to improve it as they use it. Please send feedback to classroomsupporttoolbox@la.gov so that we may use your input when updating this tool.

Updated August 13, 2019

About the Sample Scope and Sequence Tools

The Louisiana Student Standards for Science represent the knowledge and skills needed for students to successfully transition to postsecondary education and the workplace. The standards call for students to:

- Apply content knowledge
- Investigate, evaluate, and reason scientifically
- Connect ideas across disciplines

This scope and sequence document is designed to assist teachers, schools, and districts with the development of instructional resources that align with the Louisiana Student Standards for Science. This scope and sequence is only a sample; it does not illustrate the only appropriate sequence to teach the standards or the only possible ways to bundle the standards. The bundles can be reorganized around different phenomenon, including phenomenon specific to Louisiana or to a region in Louisiana.

Based on the instructional shifts, this tool uses phenomena to drive 3-dimensional science instruction. The incorporated phenomena are observable events that occur in the universe and can be explained by science. They establish the purpose for learning and help students to connect their learning to real-world events.

- The standards are bundled into units.
- The units are built around an anchor phenomenon.
- One unit has been built out further to contain a series of investigative phenomena, which have been sequentially organized to reinforce one another and build toward the performance expectations.

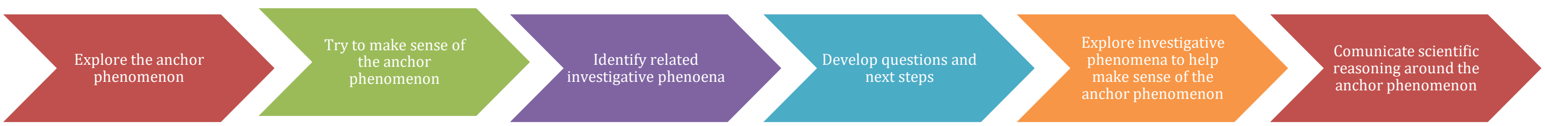
Throughout each unit, students should have multiple opportunities to apply the science and engineering practices, make sense of the crosscutting concepts, and develop a deep understanding of disciplinary core ideas.

Building out the Science Scope and Sequences for Classroom Instruction

How to Use the Anchor and Investigative Phenomena[1]

1. Explore the anchor phenomenon
2. Attempt to make sense of the phenomenon
3. Identify related phenomena
4. Develop questions and next steps
5. Explore investigative phenomena to help make sense of the anchor phenomenon
6. Communicate scientific reasoning around the anchor phenomenon

Instructional Process



Choosing an Anchor Phenomenon

Students should be able to make sense of anchoring phenomenon, but not immediately, and not without investigating it using sequences of the science and engineering practices. With instruction and guidance, students should be able to figure out, step by step, how and why the phenomenon works. [2]

A good anchor phenomenon[3]:

- ☐ is too complex for students to explain or design a solution for after a single lesson.
  - The explanation is just beyond the reach of what students can figure out without instruction.
  - Searching online will not yield a quick answer for students to copy.
- ☐ can be a case (pine beetle infestation, building a solution to a problem), something that is puzzling (why isn't rainwater salty?), or a wonderment (how did the solar system form?).
- ☐ has relevant data, images, and text to engage students in the range of ideas students need to understand. It should allow them to use a broad sequence of science and engineering practices to learn science through first-hand or second-hand investigations.
- ☐ will require students to develop an understanding of and apply multiple performance expectations while also engaging in related acts of mathematics, reading, writing, and

---

[1] adapted from How do we bring 3-dimensional learning into our classroom?

[2] Using Phenomena

[3] Qualities of a Good Anchor Phenomenon

communication.

- ☐ is observable to students. “Observable” can be with the aid of scientific procedures (e.g., in the lab) or technological devices to see things at very large and very small scales (telescopes, microscopes), video presentations, demonstrations, or surface patterns in data.

Choosing Investigative Phenomena

Students should be able to make sense of investigative phenomenon, but not immediately, and not without investigating it using sequences of the science and engineering practices. With instruction and guidance, students should be able to figure out, step-by-step, how and why the phenomenon works.[4]

A good investigative phenomenon:

- ☐ helps students make sense of one or two parts of the anchor phenomenon.
- ☐ has relevant data, images, and text to engage students in the range of ideas students need to understand.
- ☐ can be understood or explained by students using the science and engineering practices.

Investigating the Phenomena

When a phenomenon is introduced, whether anchor or investigative, students should have the opportunity to make observations, discuss current understandings, and pose questions about the phenomenon. Once questions are compiled, it may be helpful to categorize questions as follows:

- Questions that can be investigated by our class
- Questions that can be investigated but not with our current resources and equipment
- Questions that can be researched
- Questions that cannot be answered (due to current technologies or scientific limitations)

Other Useful Questions When Designing a Sequence of Learning[5]

- How do we kick off investigations in a unit?
- How do we work with students to motivate the next step in an investigation?
- How do we help students use practices to figure out the pieces of the science ideas?
- How do we push students to go deeper and revise the science ideas we have built together so far?
- How do we help students put together pieces of the disciplinary core ideas and crosscutting concepts?

---

[4] Using Phenomena

[5] Questions to Guide the Development of a Classroom Culture That Supports “Figuring Out”

Eighth Grade Science Standards Overview

The eighth grade course focuses on the study matter and its interactions, energy, Earth's place in the universe, Earth's systems, Earth and Human Activity, from molecules to organisms: structures and processes, heredity: inheritance and variation of traits, and biological evolution: unity and diversity

	Science and Engineering Practices									
Crosscutting Concepts		Asking Questions and Defining Problems	Developing and Using Models	Planning and Carrying Out Investigations	Analyzing and Interpreting Data	Using Mathematics and Computational Thinking	Constructing Explanations and Designing Solutions	Engaging in Argument from Evidence	Obtaining, Evaluating, and Communicating Information	All Domains
	Patterns				8-MS-ESS2-3 8-MS-ESS3-2 8-MS-LS4-1 8-MS-LS4-3		8-MS-LS4-2			
	Cause and Effect					8-MS-LS4-6	8-MS-ESS3-1 8-MS-ESS3-3 8-MS-LS1-5	8-MS-LS1-4		
	Scale, Proportion and Quantity		8-MS-PS1-1				8-MS-ESS1-4 8-MS-ESS2-2			
	Systems and System Models									
	Energy and Matter						8-MS-PS1-6 8-MS-PS3-3	8-MS-PS3-5		
	Structure and Function		8-MS-LS3-1						8-MS-PS1-3	
	Stability and Change		8-MS-ESS2-1							

Overview of Sample Units

	Unit 1 Earth's Processes	Unit 2 Natural Hazards	Unit 3 Biological Evolution	Unit 4 Embryological Similarities	Unit 5 Genetics and Traits	Unit 6 Energy and Matter
Anchor Phenomenon	Pangaea was a supercontinent that existed approximately 335 million years ago; it eventually separated into different continents.	Lava from the Kawah Ijen volcano appears blue at times.	Archosaurs, sauropods and tyrannosaurs were anatomically different from organisms of today.	Chickens and cows have embryological similarities; yet, they are two different organisms.	Charles Darwin's Finches on Galapagos Island were identical to mainland finches but had different beaks.	In 2011, the Great East Japan Earthquake caused catastrophic damage. Despite the massive devastation, people in one small area continued to receive power.
Standards	8-MS-ESS2-1 8-MS-ESS2-2 8-MS-ESS2-3 8-MS-PS1-1*	8-MS-ESS3-1 8-MS-ESS3-2 8-MS-PS1-1*	8-MS-ESS1-4 8-MS-LS4-1 8-MS-LS4-2*	8-MS-LS4-2* 8-MS-LS4-3	8-MS-LS1-4 8-MS-LS1-5 8-MS-LS3-1 8-MS-LS4-6 8-MS-ESS3-3	8-MS-PS1-3 8-MS-PS1-6 8-MS-PS3-3 8-MS-PS3-5

* The performance expectation is only partially addressed using the identified phenomenon. The performance expectation is addressed in other unit(s).

Unit 1: Earth's Processes

About the Standards

Performance Expectations

- 8-MS-ESS2-1 Earth's Systems: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
- 8-MS-ESS2-2 Earth's System: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- 8-MS-ESS2-3 Earth's Systems: Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.
- 8-MS-PS1-1* Matter and its Interactions: Develop models to describe the atomic composition of simple molecules and extended structures.

* The performance expectation is only partially addressed using the identified phenomenon. The performance expectation is addressed in other unit(s).

Disciplinary Core Ideas

DCI	Partial Unpacking of the DCI
All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produced chemical and physical changes in Earth's materials and living organisms. (DCI: MS-ESS-2A.a; PE: 8-MS-ESS2-1)	• Earth processes include melting, weathering, sedimentation, crystallization • Weathering is the breaking down of rocks, soil, and minerals • Weathering can be caused by physical, chemical, or biological factors • Different Earth processes (melting, sedimentation, crystallization) drive matter cycling through observable chemical and physical changes • The movement of energy that originates from the Earth's hot interior causes the cycling of matter through different Earth processes (melting, crystallization, and deformation) • Energy flowing from the sun causes matter cycling via processes that produces weathering, erosion, and sedimentation (e.g. wind, rain) • Earth processes operate over temporal and spatial scales
Water's movements-both on the land and underground-cause weathering and erosion,	• The slow and large-scale motion of Earth's plates cause Earth's surfaces to change over a time period of millions

which change the land's surface features and create underground formations. (DCI: MS-ESS-2C.e; PE: 8-MS-ESS2-2) The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (DCI: MS.ESS2A.b; PE: 8-MS-ESS2-2)	to billions of years (e.g. modifying mountains and canyons, and the distribution of continents) • Surface weathering, erosion, movement, and the removal of sediment from large to microscopic scales causes Earth's surfaces to change over a time period of years to hundreds of millions of years (e.g mountains, canyons or new features) • Earthquakes, volcanoes, and meteors cause Earth's surfaces to change over a very short period of time in comparison to other geoscience processes • A surface feature is the result of geoscience processes; they will continue to change over time
Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (DCI: MS.ESS1C.c; 8-MS-ESS2-3) Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. DCI: MS.ESS2B.a; PE: 8-MS-ESS2-3)	• Regions of different continents share similar fossils and similar rocks, which suggest that in the past those sections of continents were once attached and have since separated • The shapes of continents, which roughly fit together suggest that the seven continents were once joined together and have since separated • The separation of continents by the formation of a new sea floor is inferred by age patterns in oceanic crust, which increases in age from the center of the ocean to the edges of the ocean • The distribution of seafloor structures (volcanic ridges and trenches at the edges of continents) and the patterns of ages of rocks of the seafloor supports the interpretation that new crust forms at the ridges and then moves away from the ridges as new crust continues to form
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. (DCI: MS.PS1A.a; 8-MS-PS1-1) Solids may be formed from molecules, or they may be	• Individual atoms combine to form molecules, which can be made up of the same type or different types of atoms • Some molecules bind to other molecules • In some molecules, the same atoms of different elements repeat; in other molecules, the same atom of a single element repeats

extended structures with repeating subunits. (DCI: MS.PS1A.e; 8-MS-PS1-1)

Science and Engineering Practices

- Develop and/or use a model to predict and/or describe phenomena.
- 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 would operate today as they did in the past and will continue to do so in the future.
- Analyze and interpret data to provide evidence for phenomena.

Crosscutting Concepts

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.

Putting the Standards into Practice

Sample Anchor Phenomenon: Pangaea was a supercontinent that existed approximately 335 million years ago; it eventually separated into different continents.

Explore the anchor phenomenon

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with eighth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

Phet: Plate Tectonic Simulation
Continental Drift Pangaea
Geology and Biology agree on Pangaea supercontinent breakup dates
Coal Formation Linked to Assembly of Supercontinent Pangaea
Reading the Weather from Inside a Seashell
Read Works: How Plates Affect Our Planet (article set)
Read Works: Our Changing Earth (article set)
Read Works: Sea Monsters

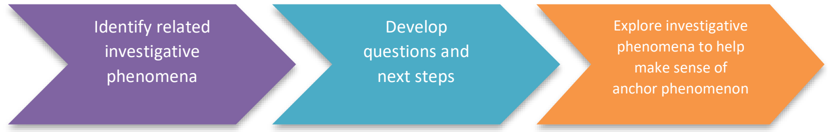
Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What caused Pangaea to break apart?
- What evidence supports that the continents were once together?
- How was life on earth impacted when the continents broke apart?
- Will the continents every move back together?
- Are the continents continuing to break further apart?
- Did volcanoes impact the breaking apart of Pangaea?

Teachers should provide Investigative Phenomenon based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Investigative Phenomena



Sample 1: Scientists identify a 5.16 carat diamond at Arkansas' Crater of Diamonds Park.

Sample questions for students to investigate:

- What are the characteristics and properties of diamonds and other minerals?
- How can scientists use the physical properties of minerals to distinguish one from another?
- Is the hardness of different minerals the same?
- What are the physical and chemical properties of diamonds and other minerals?
- What type of model best illustrates properties of different minerals?

3-D learning opportunities:

SEP: Develop and use a model

DCI: MS.ESS2A.a; MS.PS1A.a; MS.PS1A.e

CC: Scale, proportion and quantity; Stability and change

Sample 2: The world's largest cave, discovered in 2009, is over 5.5 miles long.

Sample questions for students to investigate:

- Is wind or water faster at breaking down earth materials?
- Is the cave still growing in size?
- Does life in the cave contribute to erosion or the changing of its size over time?
- How have physical and chemical processes changed the cave?
- How has erosion and deposition impacted Earth's surface and contributed to the formation of caves?
- Are there other caves on the Earth that were formed in similar ways to this one?
- How can tourists enjoy the beauty of the cave without damaging the structure, function, and life inside it? What solutions could be designed to prevent ecotourism damage?
- How has Earth's surface changed over time due to erosion and weathering?
- Can we learn anything from this cave that may have impacted the breaking apart of Pangaea?

3-D learning opportunities:

SEP: Develop and use a model; Construct an explanation and design a solution

DCI: MS.ESS2A.a; MS.ESS2C.e

CC: Scale, proportion and quantity; Stability and change

Sample 3: Microplates created the Himalayan Mountains.

Sample questions for students to investigate:

- What causes tectonic plates to move?
- What determines the direction of movement of the tectonic plates?
- What landforms have been formed by the movement of tectonic plates?
- How do tectonic processes impact Earth's ocean seafloors?
- Do some tectonic plates move more than others? How is that movement changing today?
- How has Earth remained the same and how has it changed over time due to plate tectonics?
- How can evidence be used to support the theory of continental drift?

3-D learning opportunities:

SEP: Develop and use a model; Construct an explanation; Analyze and interpret data

DCI: MS.ESS2A.a; MS.ESS2A.b; MS.ESS1C.c; MS.ESS2B.a

CCC: Patterns; Scale, proportion and quantity; Stability and change

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- How did Earth's processes cause Pangaea to break apart?
- How did the movement of energy and matter through Earth's surface impact the breakup of Pangaea?
- Develop a model showing the changing Earth from the time of Pangaea to current time.
- Write a scientific explanation including data and the interpretation of that data that supports the changing of Earth's surface over time.

Unit 2: Natural Hazards

About the Standards

Performance Expectations

- 8-MS-ESS3-1 Earth and Human Activity: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
- 8-MS-ESS3-2 Earth and Human Activity: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- 8-MS-PS1-1* Matter and Its Interactions: Develop models to describe the atomic composition of simple molecules and extended structures.

* The performance expectation is only partially addressed using the identified phenomenon. The performance expectation is addressed in other unit(s).

Science and Engineering Practices

- 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.
- Develop and/or use a model to predict and/or describe phenomena
- Analyze and interpret data to provide evidence for phenomena.

Crosscutting Concepts

- Graphs, charts, and images can be used to identify patterns in data.
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Putting the Standards into Practice

Explore the anchor phenomenon

Sample Anchor Phenomenon: Lava from the Kawah Ijen volcano appears blue at times.

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with eighth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

Volcano with Blue Lava
Burning Blue: Indonesia's Psychedelic Sulfur
Kawah Ijen: The Beauty and Nightmare of the Electric Blue Lava
Photo Essay: A Day in the Sulfur Mines of Kawah Ijen
The Mystery of Blue Lava and the Kawah Ijen Volcano
Why Does This Indonesian Volcano Burn Bright Blue?
National Geographic: Stunning Electric-Blue Flames Erupt From Volcanoes
Facts About Sulfur

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What is causing the Kawah Ijen volcano lava to appear blue?
- What is the yellow substance that is surrounding the volcano?
- How are miners being impacted by the volcano?
- What substance is being mined on the volcano?
- How often does the Kawah Ijen volcano erupt?
- Are ecosystems being impacted by the volcano?

Teachers should provide Investigative Phenomena based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- How are Earth's resources and minerals impacted by geoscience processes such as volcanoes?
- Explain how scientists use data to predict future catastrophic events such as volcanoes?
- Develop a model to describe the atomic composition of sulfur and other simple molecules and extended structures.

Unit 3: Biological Evolution

About the Standards

Performance Expectations

- 8-MS-ESS-1-4 Earth's Place in the Universe Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's geologic history.
- 8-MS-LS4-1 Biological Evolution: Unity and Diversity 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.
- 8-MS-LS4-2* Biological Evolution: Unity and Diversity: 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.

* The performance expectation is only partially addressed using the identified phenomenon. The performance expectation is addressed in other unit(s).

Science and Engineering Practices

- Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
- Analyze and interpret data to determine similarities and differences in findings.
- 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.

Crosscutting Concepts

- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Putting the Standards into Practice

Sample Anchor Phenomenon: Archosaurs, sauropods and tyrannosaurs were anatomically different from organisms of today.

Explore the anchor phenomenon

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with eighth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

How did Dinosaurs Evolve?
Triassic, Jurassic, and Cretaceous Periods
Natural Selection Simulation
Phet: Radioactive Dating
A Curious Exodus from Europe for Mesozoic dinosaurs
The Food Industry and Mass Extinction
Oxygen-Depleted Toxic Ocean and Mass Extinction
Read Works: Mammals around the World

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- How have plants and animals changed over time?
- How is evidence from rock strata used to determine Earth's geologic history?
- How do paleontologists use fossil records from the Triassic, Jurassic and Cretaceous time period to determine the evolutionary history of life forms?
- How is the geologic time scale used to organize Earth's geologic history?

Teachers should provide Investigative Phenomena based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Construct an explanation for the anatomical similarities and differences among modern organisms and fossil organisms that lived during the Triassic, Jurassic, and Cretaceous periods.
- Explain how patterns in the fossil record are used to document the existence, diversity, extinction, and change in life forms during the Triassic, Jurassic, and Cretaceous periods?
- How do life forms in the Cenozoic era compare to life forms in the Mesozoic era.

Unit 4: Embryological Similarities

About the Standards

Performance Expectations

- 8-MS-LS4-2* Biological Evolution: Unity and Diversity: 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.
- 8-MS-LS4-3 Biological Evolution: Unity and Diversity: 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.

* The performance expectation is only partially addressed using the identified phenomenon. The performance expectation is addressed in other unit(s).

Science and Engineering Practices

- Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
- Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.

Crosscutting Concepts

- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data.

Putting the Standards into Practice

Sample Anchor Phenomenon: Chickens and cows have embryological similarities; yet, they are two different organisms.

Explore the anchor phenomenon

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with eighth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

Comparative Vertebrae Embryology
Similarities in the Embryonic Development of Various Animal Species
Evolutionary Embryology
Comparative Embryology: The Vertebrate Body

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What is embryology?
- How can embryology be used to identify, analyze, and interpret relationships among organisms?
- How can patterns of similarities in chicken and cow embryos be used to determine evolutionary relationships?
- How are anatomical and embryological similarities and differences among organisms used to infer evolutionary relationships?
- How are cows and chickens anatomically similar and different?
- How do the embryos of chickens and cows change over time?

Teachers should provide Investigative Phenomena based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Analyze displays of pictorial data to compare patterns of similarities in the embryological development of cows and chickens to identify relationships not evident in the fully formed anatomy.
- Construct an explanation for the embryological similarities and differences among organisms to infer evolutionary relationships.

Unit 5: Genetics and Traits

About the Standards

Performance Expectations

- 8-MS-LS1-4: From Molecules to Organisms: Structures and Processes: Construct and use argument(s) based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of survival and successful reproduction of animals and plants respectively.
- 8-MS-LS1-5: From Molecules to Organisms: Structures and Processes: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- 8-MS-LS3-1: Heredity: Inheritance and Variation of Traits: 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.
- 8-MS-LS4-6: Biological Evolution: Unity and Diversity: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations of species over time.
- 8-MS-ESS3-3: Earth and Human Activity: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

Science and Engineering Practices

- Construct, use, and/or present 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.
- Develop and/or use a model to predict and/or describe phenomena.
- Use mathematical representations to describe and/or support scientific conclusions and design solutions.
- Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

Crosscutting Concepts

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its

parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

Putting the Standards into Practice

Sample Anchor Phenomenon: Charles Darwin's Finches on Galapagos Island were identical to mainland finches but had different beaks.

Explore the anchor phenomenon

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with eighth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

Phet: Natural Selection
Smithsonian: The Evolution of Charles Darwin
Galapagos Finches: Famous Beaks
National Geographic: DNA Reveals How Darwin's Finches Evolved
Evolution of Darwin's Finches and Their Beaks
How Darwin's Finches Got Their Beaks?
What's So Special About Darwin's Finches?

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

Who is Charles Darwin?
Where are the Galapagos Islands?
What is natural selection?
How were the finches on Galapagos Islands different from one another?
Were the beaks of the fiches the only structures that were different from one another?
How did Charles Darwin determine that the birds that he studied on his voyage were all finches if the beaks of the birds were different from one another?
Do finches still reside on Galapagos Islands?
How have the Galapagos Islands changed over time?
How have human activities contributed to changes on Galapagos Islands?

Teachers should provide Investigative Phenomena based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Construct an 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 survival and successful reproduction of animals and plants on Galapagos Islands.

- Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of finches on Galapagos Islands.
- 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 finches on Galapagos Islands.
- Describe how natural selection may lead to increases and decreases of specific traits in populations of finches on Galapagos Island over time.
- Apply scientific principles to design a method for monitoring and minimizing human impact on Galapagos Islands.

About the Standards

Performance Expectations

- 8-MS-PS1-3: Matter and Its Interactions: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- 8-MS-PS1-6: Matter and Its Interactions: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
- 8-MS-PS3-3: Energy: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- 8-MS-PS3-5: Energy: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Science and Engineering Practices

- 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.
- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.
- Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
- Construct, use, and/or present 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.

Crosscutting Concepts

- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.
- The transfer of energy can be tracked as energy flows through a designed or natural system.
- Energy may take different forms (e.g. energy in fields, thermal energy, and energy of motion).

Putting the Standards into Practice

Sample Anchor Phenomenon: In 2011, the Great East Japan Earthquake caused catastrophic damage. Despite the massive devastation, people in one small area continued to receive power.

Explore the anchor phenomenon

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with eighth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

- ABC: Japan Earthquake Pictures, Video
- National Geographic: Japan Tsunami
- Japan Earthquake and Tsunami of 2011
- Great Tohoku, Japan Earthquake and Tsunami
- Microgrids at Berkeley Lab: About Microgrids
- A Microgrid That Wouldn't Quit
- Microgrids at Berkeley Lab: The Sendai Microgrid
- The Sendai Microgrid Operational Experience in the Aftermath of the Tohoku Earthquake

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What caused the March 2011 earthquake in Japan?
- How did people maintain power after the earthquake?
- What is a microgrid?
- How do microgrids store energy over time?
- What is the maximum energy storage capacity of the Sendai Microgrid?
- How much energy does the Sendai Microgrid store per day?
- How long did the Sendai Microgrid provide energy during the 2011 earthquake?

Teachers should provide Investigative Phenomena based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Describe that synthetic materials come from natural resources and impact society.
- Design a project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
- Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- Make a claim supported by evidence that when the kinetic energy of an object changes energy is transferred to or from the object.