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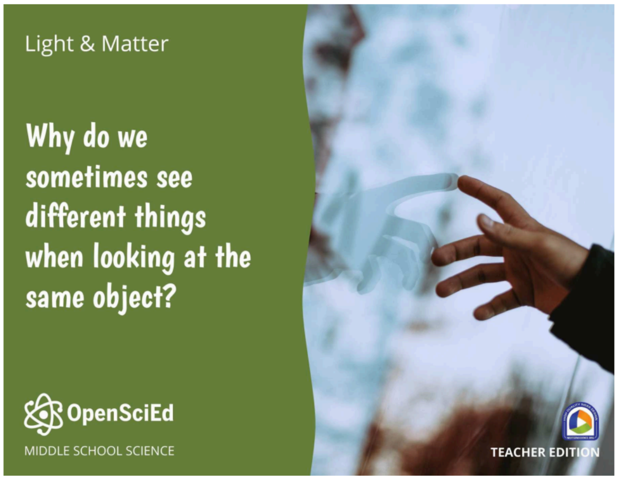
OpenSciEd 6th grade Scope and Sequence



Unit 6.1 During this 7-week unit, students figure out that the one-way mirror transmits about half the light and reflects about half the light that shines on it due to its microscale structures. This unit on light and matter prompts students to wonder: Why do we sometimes see different things when looking at the same object? The anchoring phenomenon includes observing one-way mirrors and how this material can act as a mirror and a window. Students directly observe and investigate the phenomenon using a scaled box model. They figure out that the one-way mirror acts like a mirror on the light side of the system and a window on the dark side

Driving question: Why do we sometimes see different things when looking at the same object?

Lesson Set 1: ***Why do we sometimes see different things when looking at the same object?***

Lesson 1

Students watch a video of an interesting object that acts as a mirror from one side and a window from the other side. They set up a box model to make observations and test ideas about the phenomenon.

Lessons 2-4

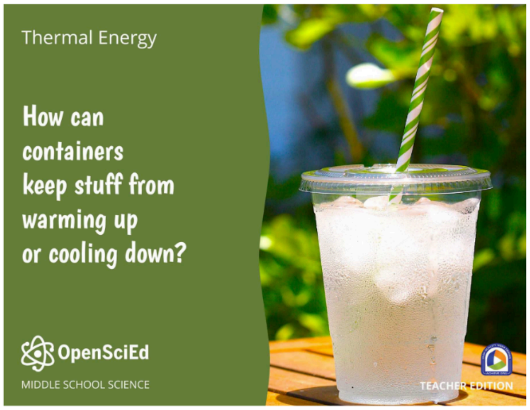
Students investigate how changing the light affects the phenomenon, how much light is transmitted through and reflected off the one-way mirror, and how the one-way mirror is structured.

Lessons 5-6

Students develop a model to explain how light interacts with the one-way mirror and then develop a more complete model to explain how the eye-brain system processes light inputs to the eye.

Lessons 7-8

Students construct an explanation for the one-way mirror phenomenon and apply ideas about the one-way mirror phenomenon to explain related phenomena they experience everyday.



Unit 6.2 In this 7-week students investigate the different cup features. They focus on thermal energy transfer; students test whether a new plastic cup sold by a store keeps a drink colder for longer than the regular plastic cup that comes free with the drink. Students find that the drink in the regular cup warms up more than the drink in the special cup. This prompts students to identify different cups' features, such as the lid, walls, and hole for the straw, that might explain why one drink warms up more than the other. Through a series of investigations and simulations, students find two ways energy is transferred into the drink: (1) the absorption of light and (2) thermal energy from the warmer air around the drink. They are then challenged to design their own drink container that can perform as well as the store-bought container, following a set of design criteria and constraints.

Driving question: How can containers keep stuff from warming up or cooling down?

Lesson Set 1: ***How do some cup features close off the system to keep a drink cold or warm and why does it still warm up?***

Lesson 1

Students test how well a regular cup performs against a fancy new cup in keeping an iced drink cold. They model how and why the fancy cup works better than the regular cup.

Lessons 2-3

Students test and gather evidence about which cup features are most important to keeping a drink cold or hot.

Lessons 4-6

Students develop diagrammatic and physical models to explain how matter moves between systems. A closed system that warms up motivates further investigation.

Lesson Set 2: ***How and why does energy from outside the system enter the cup system to warm up the cold water?***

Lessons 7-8

Students problematize other ways the water inside the cup warms up and test their ideas about light entering the cup. A closed cup system in the dark that still warms up motivates further investigation.

Lessons 9-14

Students conduct a series of lab investigations and investigations with computer simulations to figure out that energy enters the cup system via particle collisions and that energy transfers from warmer to cooler substances.

Lesson Set 3: ***How can we design a container to keep a substance cold?***

Lessons 15

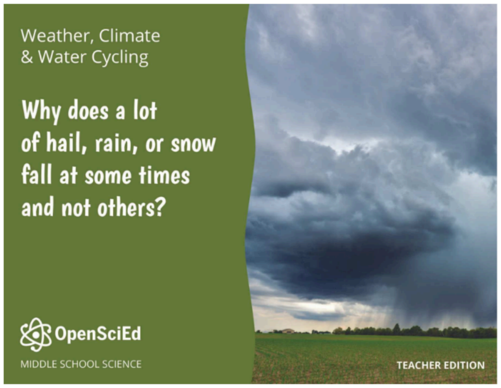
Students investigate different effective design features for their cups, like air-insulation, vacuum-insulation, and reflective surfaces.

Lessons 16-17

Students engage in two design cycles to design, build, and test their cups against agreed upon criteria and constraints.

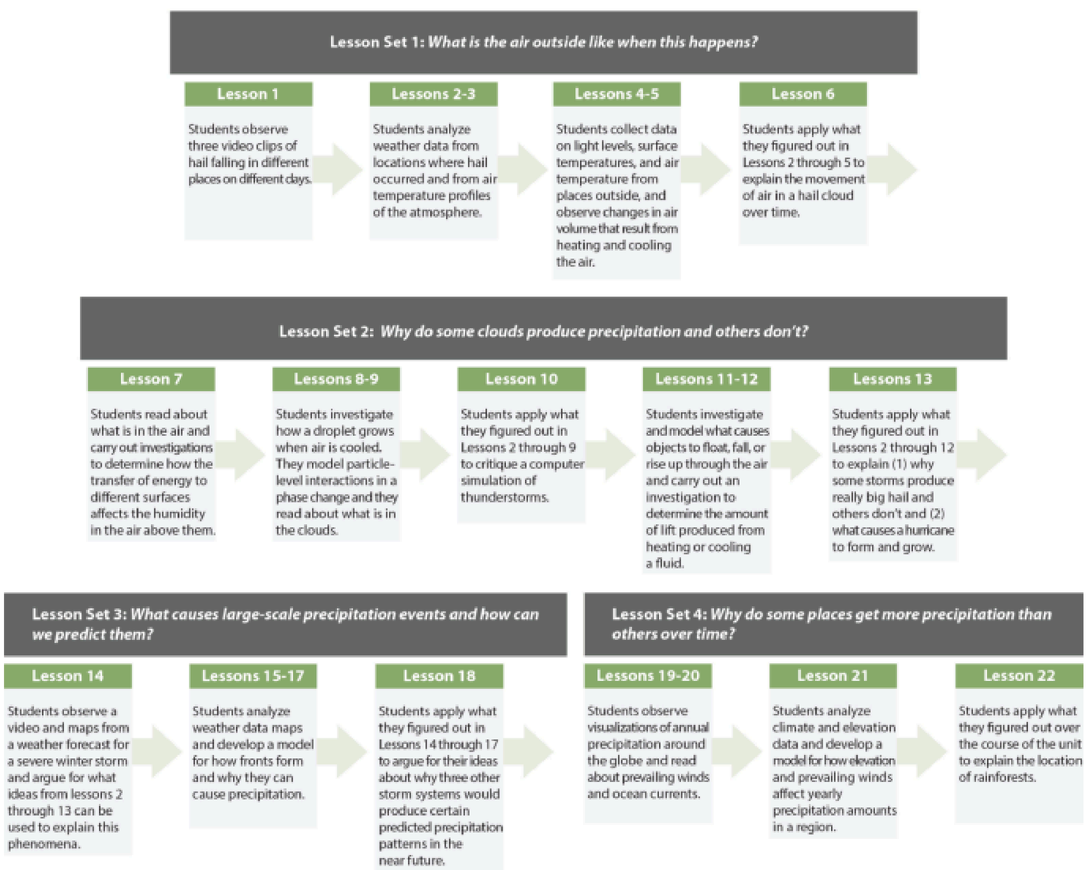
Lesson 18

Students draw conclusions from their design challenge and apply to related phenomena. They celebrate their learning in the unit.



Unit 6.3 In this first half of this eight-week unit, students investigate weather data specific to these events and the atmosphere's temperature profile above the Earth's surface. They investigate how sunlight affects the temperature of different surfaces and the air above them and how this contributes to cloud formation and growth. They work with manipulatives, simulations, and labs to figure out how molecules in different phases change under different conditions. Students conduct investigations into why air moves the way it does.

The second half of the unit focuses on exploring a weather report of a winter storm that affected large portions of the midwestern United States. The maps, transcripts, and video that students analyze show them that the storm was forecasted to produce large amounts of snow and ice accumulation in large portions of the country's northeastern part within the next day. This case sparks questions and ideas for investigations around trying to figure out what could be causing such a large-scale storm and why it would end up affecting a different part of the country a day latent phases change under different conditions. Students conduct investigations into why air moves the way it does.



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Unit 6.4 In this four-week unit, students consider the 2015 Himalayan earthquake at Mt. Everest that resulted in scientists from Nepal and China collaborating to determine what, if any, changes had occurred to Mt. Everest. Students find that Mt. Everest has grown in elevation over the years and is steadily moving to the NE every year. Students analyze data from five other mountain peaks and find that some mountains are also growing in elevation, while others are decreasing or not changing in elevation.

This unit supports students in developing a model of Earth that connects movement in the mantle with movement of plates at Earth's surface and determines causal and correlational relationships between plate movement, earthquakes, volcanoes, erosion, and magma movement along with their related energy sources. Students develop a model to show how plates collide or spread apart from one another over time.

Driving question: What causes Earth's surface to change?

Lesson Set 1: ***What causes mountains to grow and move?***

Lesson 1

Students read an article about scientists discovering that Mt. Everest has increased in elevation. Then they analyze data about different mountains around the world and find others are also growing and moving.

Lessons 2-9

Students investigate what could cause a mountain to form by figuring out more about Earth's surface and what is below the surface.

Lesson Set 2: ***What can cause other changes to mountain elevation and location?***

Lessons 10-12

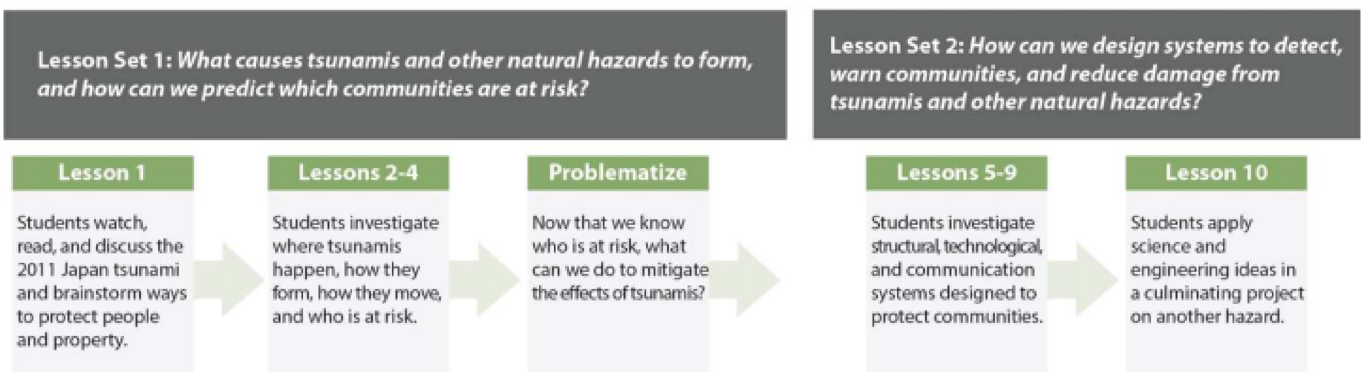
Students figure out where continents could have been and what mountains looked like in the past.

Lessons 13-14

Students investigate erosion rates and figure out that the elevation of different parts of the Earth is affected by both erosion and uplift rates. When erosion rates are higher than uplift rates, mountains can shrink. Students apply what they have figured out about how Earth's surface changes to explain how a fossil can be found exposed at the top of Mt. Everest.

Unit 6.5 This four-week unit begins with students experiencing an anchoring phenomenon, through text and video, a devastating natural event, the 2011 Great Sendai or Tōhoku earthquake, and the subsequent tsunami that caused Japan's major loss of life and property. Students think about ways to detect tsunamis, warn people, and reduce damage from the wave. As students design solutions to solve this problem, they begin to wonder about the natural hazard itself: what causes it, where it happens, and how it causes damage.

Driving question: Where do natural hazards happen and how do we prepare for them?

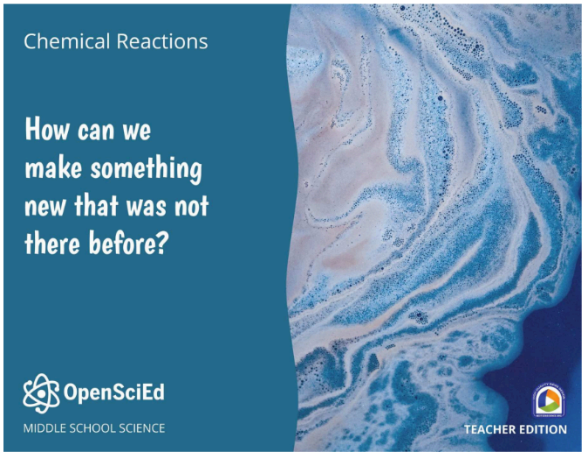


The first part of the unit focuses on identifying where tsunamis occur, how they form, and what happens as they approach the shore. Students use maps, graphs, physical models, videos, and simulations to forecast which communities are most at risk for a tsunami and why. The second part of the unit transitions students to consider combinations of engineering design solutions and technologies to mitigate the effects of tsunamis.

Unit 6.6 This 5-week unit on cells and systems begins with students reflecting on activities and a time when something happened inside their body. Students obtain information from doctor's notes and images about an injury and recovery of a middle school student. Students develop an initial model to explain what happens during the healing process.

Students investigate the structures impacted by injury in the foot to figure out that when one part of the system is injured or broken, the whole system is affected. Students use medical images and cross-sections to figure out how the parts of the foot interact and discover that blood and nerves are present in each of the parts of the body they investigate. Students investigate the structure and function of blood and nerves, skin, bone, and muscle, gathering evidence for what is happening inside the healed or uninjured body. Students develop an understanding that there are similarities in cells across tissue types.

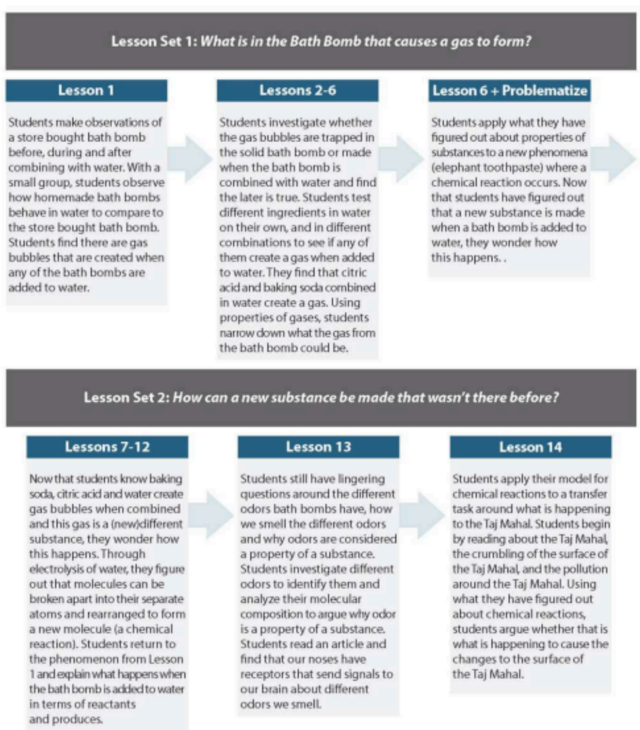
OpenSciEd 7th grade Scope and Sequence

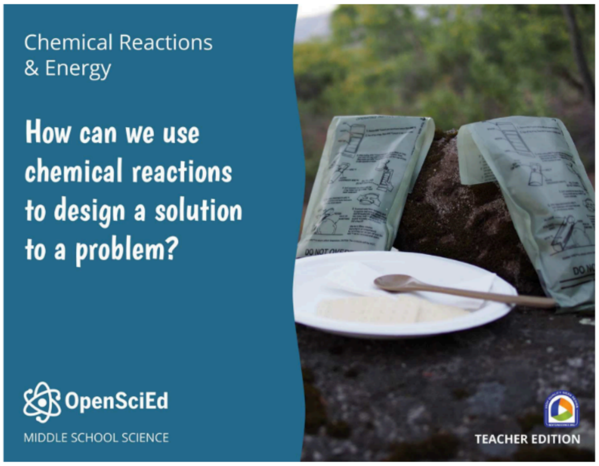


Unit 7.1 This unit on chemical reactions and matter transformations begins as students consider what happens to a bath bomb when added to water. They develop a model to explain what they think happened to the matter in the bath bomb and what caused the gas bubbles to appear. Related phenomena (adding a solid to water resulted in gas bubbles appearing) lead to a broader set of students' questions: How can we make something new that was not there before?

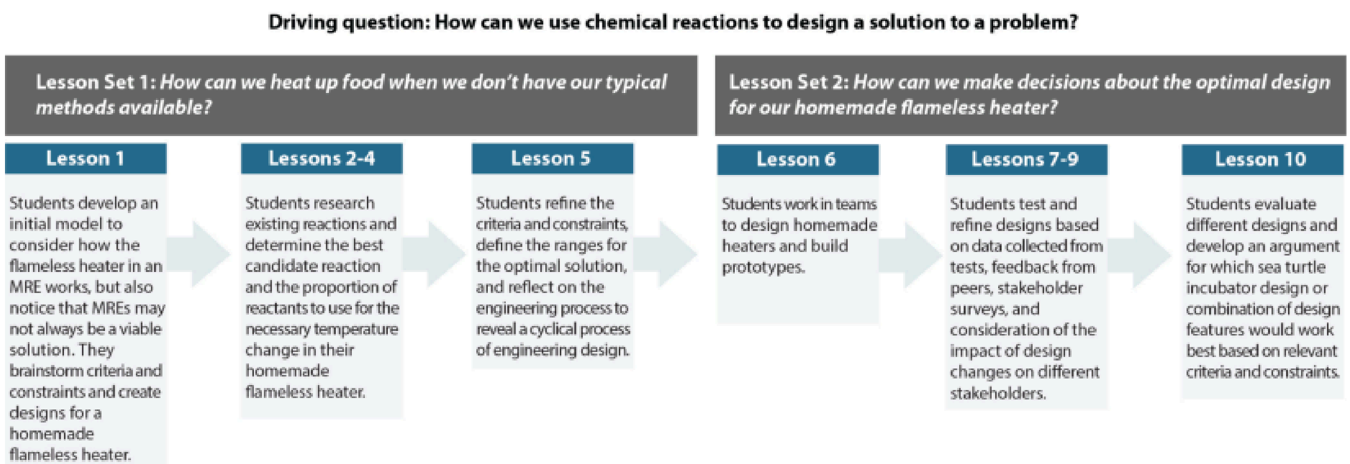
During this five-week unit, students analyze data about bath bombs, including what happens to the amount of matter, the properties of the substances that make up the bath bomb, and the gas produced. They develop models to explain how new particles can appear from old particles and conduct investigations with water to determine if it has undergone a physical change or chemical reaction. Students revisit their initial models and explanations of the bath bomb to explain what substances could have been produced, why the mass of the matter in the system wouldn't change, and test to determine whether a particular substance was produced.

Driving question: How can we make something new that was not there before?





Unit 7.2 This four to five-week unit on chemical reactions and energy starts with students thinking about how they would heat food without typical methods. Then they see images from a real situation, after Superstorm Sandy in New York, when people ate Ready-to-Eat (MREs) that can heat food by just adding water. The class explores the flameless heater from the MRE in action, which seems like a chemical process or possibly a chemical reaction.



Students develop an initial model to consider how a flameless heater works, but they notice some problems with prepackaged MREs. To solve some of the issues identified, the class decided to help people in situations in which typical heating methods aren't available to heat food by designing a homemade flameless heater with instructions that others could follow. After brainstorming criteria and constraints, they create designs for a homemade flameless heater and compare designs with classmates. Comparing designs motivates the class to gather investigations to guide their work to create a successful homemade flameless heater.

Unit7.3 This six-week unit on metabolic reactions in the human body starts with students exploring a real case study of a middle-school girl named M'Kenna, who reported alarming symptoms to her doctor. Her symptoms included an inability to concentrate, headaches, stomach issues when she ate, and a lack of energy for everyday activities and sports that she used to play regularly. She also reported noticeable weight loss over the past few months, despite consuming what appeared to be a healthy diet. Students investigate data specific to M'Kenna's case in the form of doctor's notes, endoscopy images and reports, growth charts, and micrographs. They also draw from their laboratory experiments on the chemical changes involving food processing and from digital interactives to explore how food moves, is transformed, stored, and used across different body systems in all people. Through this work of figuring out what is causing M'Kenna's symptoms, the class discovers what happens to the food we eat after it enters our bodies.

Driving question: How do things inside our bodies work together to make us feel the way we do?

Lesson Set 1: What happens to the food we eat and does that work differently in M'Kenna's body?

Lesson 1
Students explore a real case study of a middle-school girl named M'Kenna who is experiencing unusual symptoms.

Lessons 2-5
Students conduct investigations and analyze data about changes in different food molecules as they move through the digestive system in a healthy person and M'Kenna.

Lessons 7-8
Students build written arguments about which conditions M'Kenna is most likely to have or not have based on the evidence they have collected.

Lesson Set 2: How can a problem in one body system cause problems in other systems?

Lesson 9
Students ask questions in order to problematize investigating the other symptoms they cannot yet explain, such as weight loss and fatigue.

Lessons 10-12
Students investigate what happens when fat is burned and explore gas movement within the body to discover metabolic reactions.

Lesson 13
Students put pieces together to show how food is rearranged for energy, stored for later use, and used for growth within a body system.

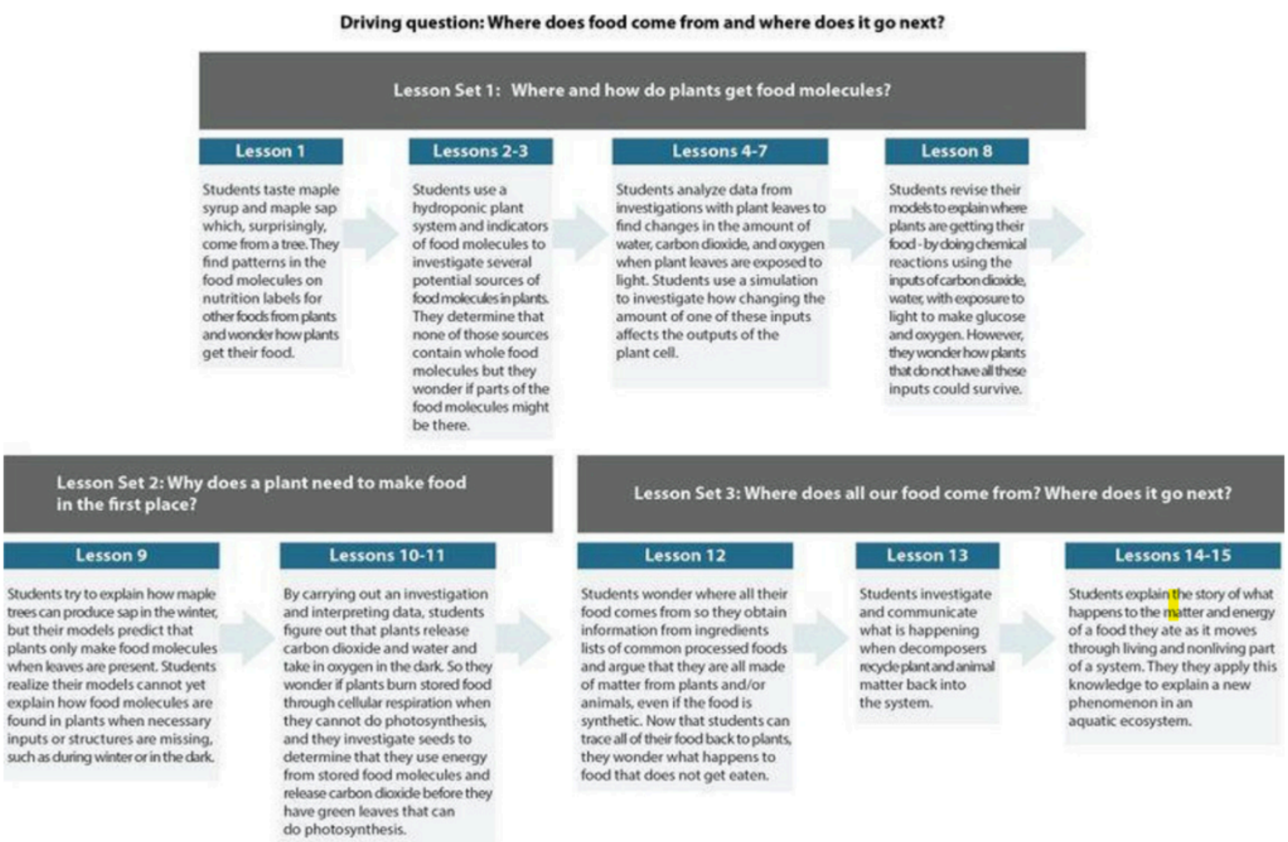
Lesson Set 3: Do all animals use chemical reactions to get energy from food like humans?

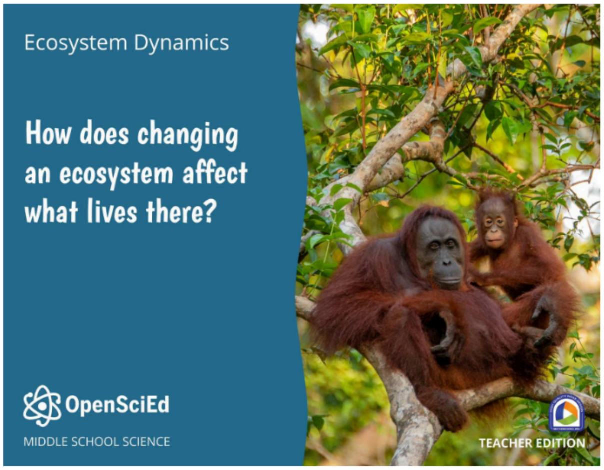
Lesson 14
Students argue that organisms might have different structures that have a similar function of obtaining energy through chemical reactions.

Lesson 15
Students apply scientific ideas and evidence to explain a new phenomenon of bear survival during hibernation.

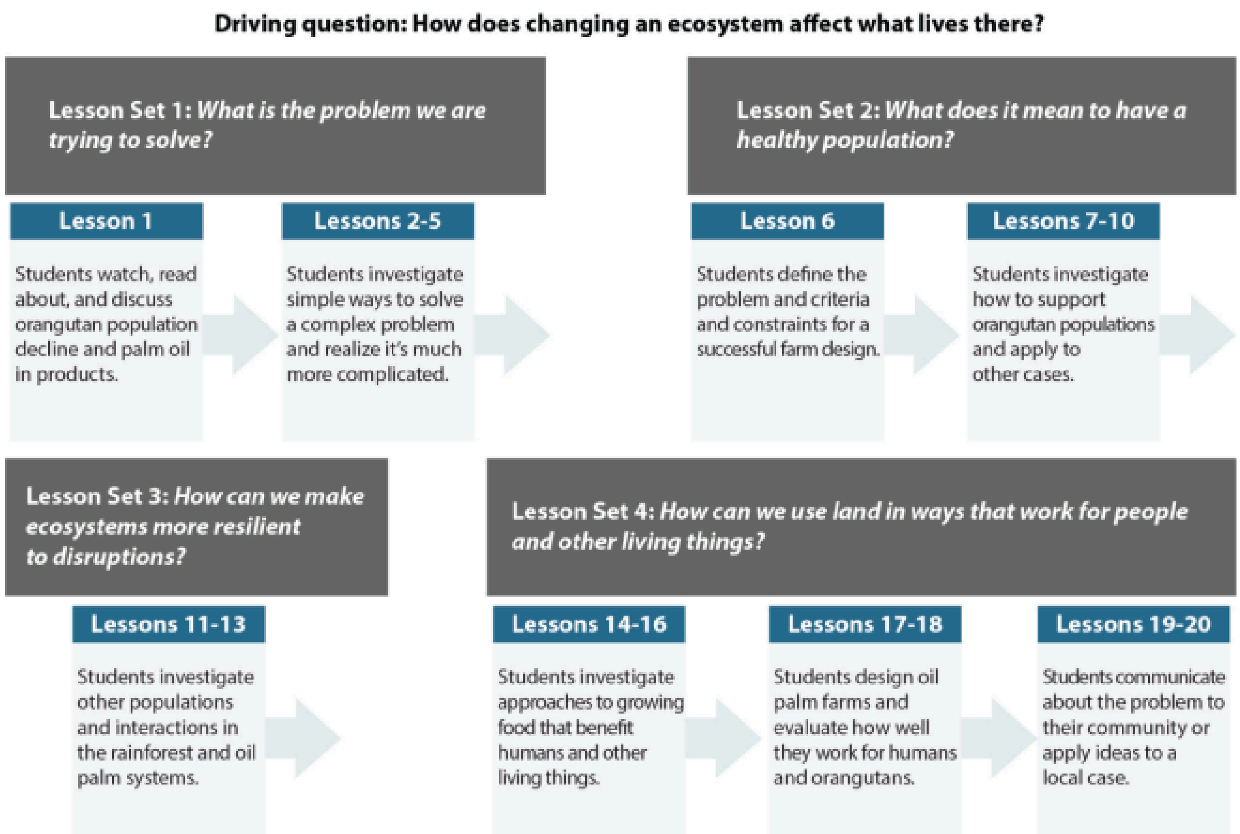
Unit 7.4 This six-week unit on matter cycling and photosynthesis begins with students considering what they eat for breakfast. They explore what they might eat from plants. They taste a common breakfast food, maple syrup. They see how trees are tapped for their sap; water is boiled away to leave only syrup. and compare it to the maple syrup they tasted earlier.

Students argue (based on the preceding unit) that they know what happens to sugar in syrup or other foods when they consume it -- it is absorbed into the circulatory system and transported to all cells of their body for growth or fuel. Students explore what else is in food and discover that foods from plants they ate, like bananas, peanut butter, beans, avocado, and almonds, have sugars and proteins, and fats. Students wonder about these molecules in plants: How are plants getting these food molecules? Why does a plant need food in the first place? What is the plant's source of food?





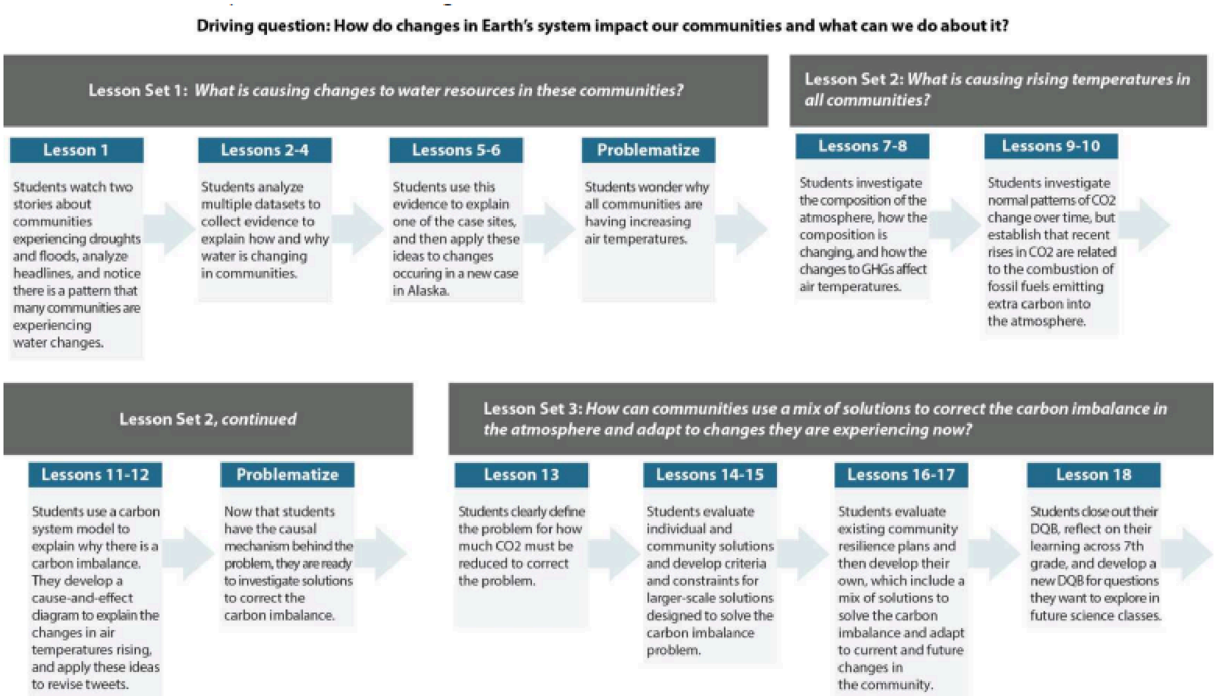
Unit 7.5 This eight-week unit on ecosystem dynamics and biodiversity begins with students reading headlines that claim that the future of orangutans is in peril and that the purchasing of chocolate may be the cause. Students then examine the ingredients in popular chocolate candies and learn that one of these ingredients--palm oil--is grown on farms near the rainforest where orangutans live. This prompts students to develop initial models to explain how buying candy could impact orangutans.



Students spend the first lessons better understanding the complexity of the problem. Students figure out that palm oil is derived from the palm trees that grow near the equator. These trees are both land-efficient and provide stable income for farmers, making finding a solution to the palm oil problem more challenging and not solvable with simple solutions. Students establish the need for a better design for oil palm farms, which will support both orangutans and farmers. This design serves as a launching point as students investigate what orangutans need to survive.

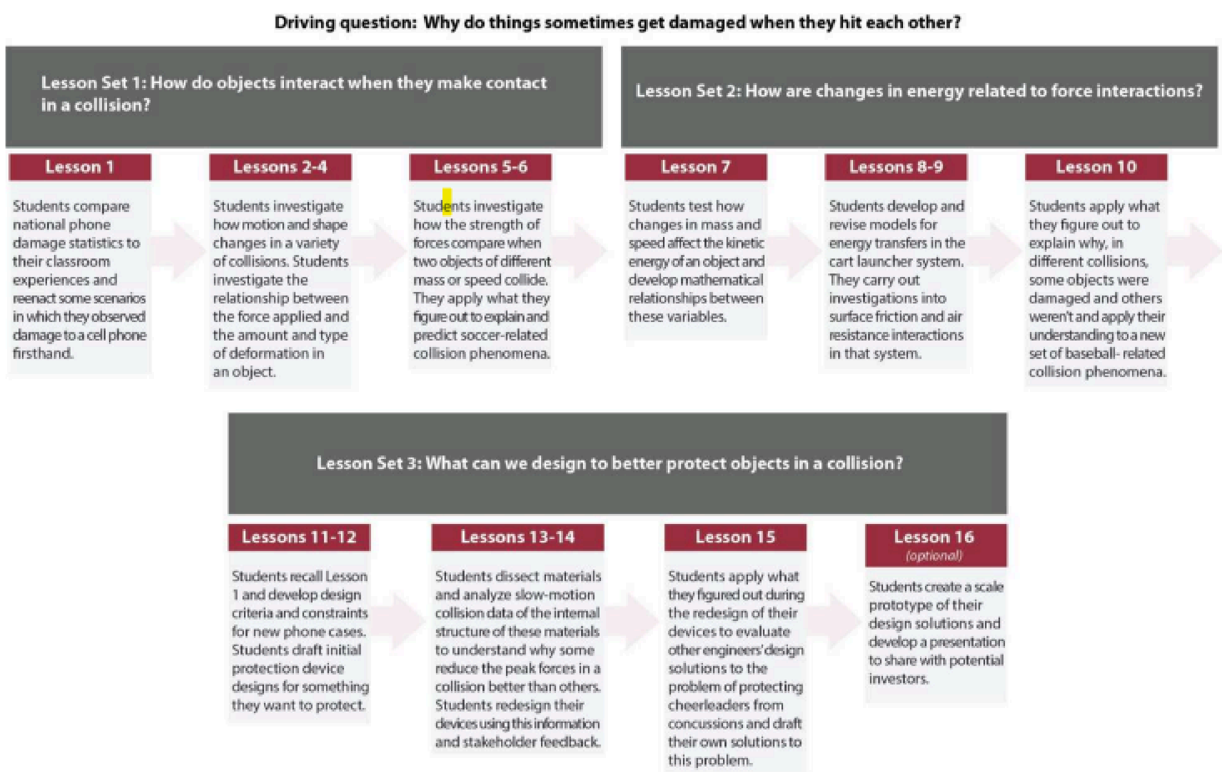
Unit 7.6 This five-week unit on Earth's resources and human impact begins with students observing news stories and headlines of drought and flood events across the United States. Students figure out that these drought and flood events are not typical and that both kinds of events seem to be related to rising temperatures. Students develop an initial model to explain how rising temperatures could cause droughts and floods and questions about what could cause rising temperatures.

Students begin to ask the question: How do Earth's system changes impact our communities, and what can we do about it? Students gather evidence for how a change in temperature affects evaporation, precipitation, and other parts of Earth's water system to support a scientific explanation that two climate variables (temperature and precipitation) change precipitation patterns in the investigated case sites. Students apply these ideas to related phenomena—sea ice decline and wildfires—in the Arctic. They analyze data about atmospheric gas concentrations, how gases relate to atmospheric temperature, and how present-day human activities change the concentration of those gases.



OpenSciEd 8th grade Scope and Sequence

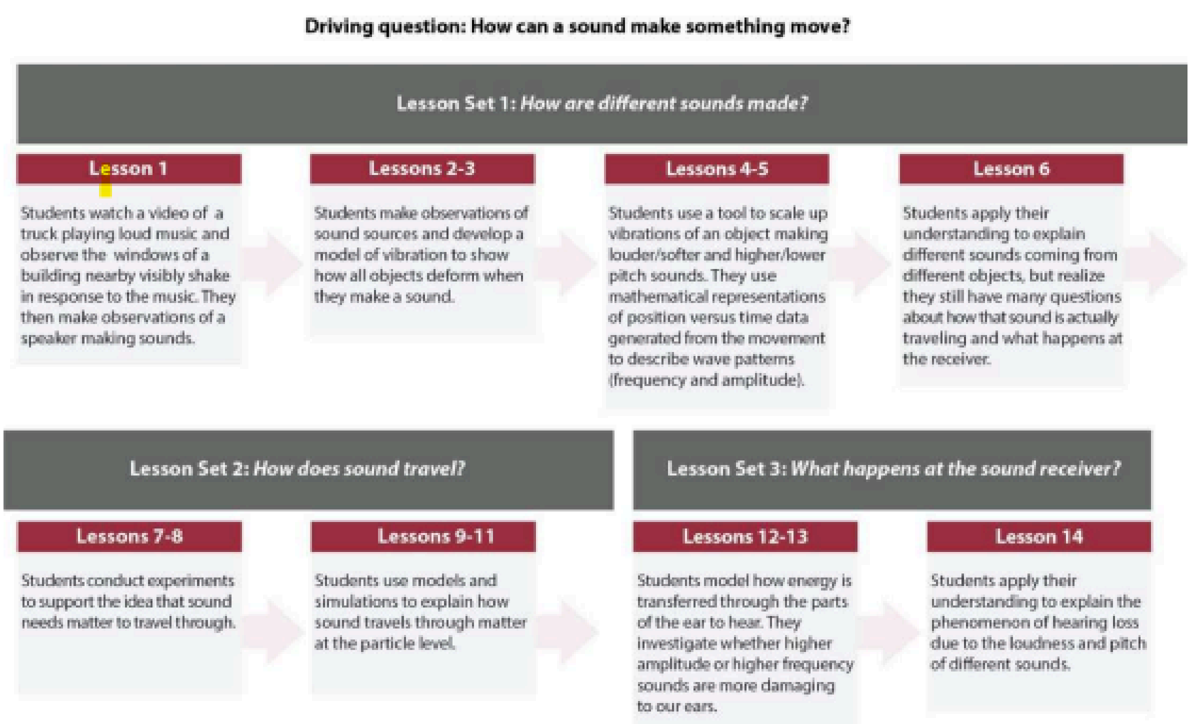
Unit 8.1 This unit on contact forces begins as students consider situations in which they have seen their phones break. They contrast these situations with others where something else collided with another object and either broke or, surprisingly, did not. Students investigate factors that contribute to damage occurring in some but not all collisions and spark a series of questions and ideas for investigations around the question: Why do things sometimes get damaged when they hit each other?



In the second part of this 6-7 week unit, students design solutions to protect an object of their choice in a collision. They gather design input from stakeholders to refine the criteria and constraints for their design solution and work together as a class to carry out a series of investigations to answer the questions they have about optimizing their design solutions. The final part of the unit re-anchors around a related question and a design problem to figure out what kinds of solutions we can design to protect fragile things from breaking.

Unit 8.2 Students begin the sound unit by considering an interesting phenomenon: a truck is playing loud music in a parking lot, and the windows of a building across the parking lot visibly shake in response to the music. Students generate questions about three aspects of sound phenomena: 1) What makes sound? 2) How does sound get from the truck to the window? 3) Why does the window shake as it does?

In this 5-week unit, students engage in model-based reasoning, argumentation, and computational and mathematical reasoning to develop models to explain three aspects of sound phenomena. They investigate loudness and pitch to create a model of vibration that captures important ideas about changes in the frequency and amplitude of vibrations. By testing various materials and using interactive computer models, students figure out how sound travels from one location to another. They also figure out how sounds can be absorbed and transmitted and answer their initial questions about how objects that are not touching a sound source can shake in response to sound.



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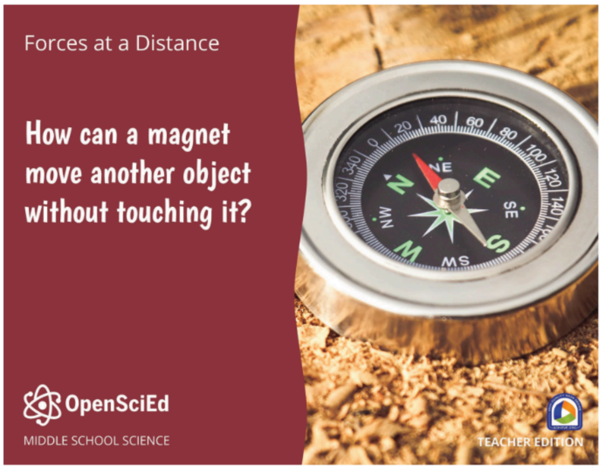
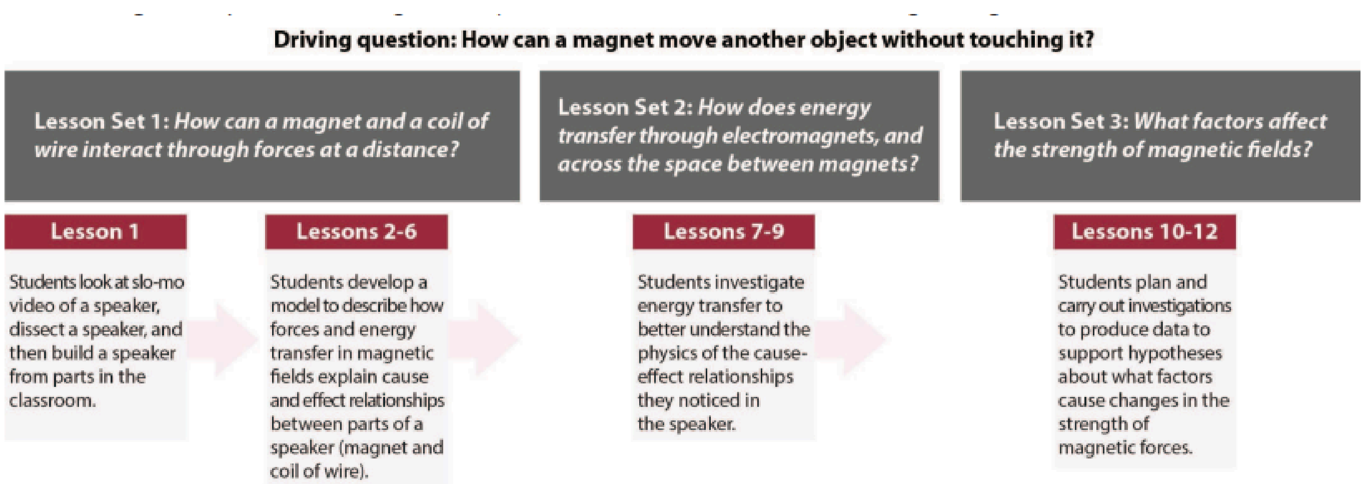


Unit 8.3 In this six-week unit, students are presented with an anchoring phenomenon focusing on the vibration of a speaker and asked to think about what causes this vibration. The vibration of a speaker connects to a model of sound students have developed previously. Still, this new unit opens the door for students to investigate the cause of a speaker's vibration instead of the effect.

Students dissect speakers to explore the inner workings and build homemade cup speakers to manipulate the parts of the speaker. They identify that speakers of all kinds have the same features--a magnet, a coil of wire, and a membrane. Students investigate each of these parts to figure out how they work together in the speaker system. Along the way, students manipulate the parts (e.g., changing the strength of the magnet, number of coils, current direction) to see how this technology could be modified to apply to systems in very different contexts, like MagLev trains, junkyard magnets, and electric motors.



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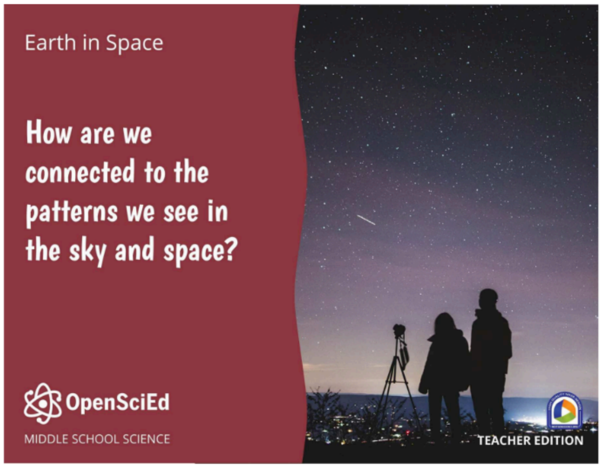


Unit 8.4 Students begin observing the biannual repeating pattern of the Sun setting aligned between buildings in New York City along particular streets and then connecting, exploring, and trying to explain different patterns in the sky that they and others have observed. Students draw on their own experiences and the stories of family or community members to brainstorm a list of patterns in the sky. Students obtain information about objects in the sky and space that connect to observations made by other cultures and people throughout history.

They listen to a series of podcasts highlighting indigenous astronomies from around the world that emphasize how patterns in the sky set the rhythms for their lives, their communities, and all life on Earth. They explore scale and develop a model of the solar system and figure out that gravity is the driving force behind the patterns of motion of these objects and the organization of the solar system as well as the driving force behind the organization of more distant systems (galaxies) that we cannot see with unaided eyes from Earth.

Driving question: How are we connected to the patterns we see in the sky and space?

Lesson Set 1: How can we explain the patterns of the Sun we see and connect to in the sky and space?

Lesson 1

Students analyze how the sunset has aligned with human-made structures and consider other interesting patterns in the sky from their own experiences, community members' ideas, and additional cultures' stories about how these patterns are connected to the rhythms of human life.

Lessons 2-4

Students investigate patterns they and others have observed in the sky related to the Sun and stars, then analyze seasonal temperature data and to explain seasonal temperature variation and determine why the seasons are opposite in Australia from the United States.

Lesson 5

Students use what they have figured out about the Earth and Sun system to model and explain the sunset alignment phenomena from Lesson 1.

Lesson Set 2: How can we explain the patterns of the Moon we see and connect to in the sky and space?

Lessons 6-7

Students investigate patterns they and others have noticed in the shape of the moon over time for lunar phases and eclipses and develop a physical model of the earth, sun, moon system to explain and predict these patterns.

Lesson Set 3: Why do we see colors change in the sky and space?

Lesson 8

Students analyze images of lunar eclipses, list possible causes for the unexpected changes in color and dimness in its appearance. They brainstorm other color related phenomena for object and add additional color-related questions and ideas for investigations.

Lessons 9-12

Students investigate what happens to the color, brightness, and bending of light as it moves from its source to their eyes (or other detectors) and then apply what they have figured out to lunar eclipses and to a new phenomenon: light changes underwater.

Lesson Set 4: How can gravitational forces explain the patterns in the organization of the Solar System, galaxies, and the universe?

Lesson 13

Students investigate patterns of objects beyond the Earth, Sun, and Moon because many of their unanswered questions pertain to patterns in objects and the motion of those objects in the sky and space.

Lessons 14-16

Students want to know why objects in space move the way they do, so they investigate the gravitational forces influencing the movement of those objects and the formation of the Solar System.

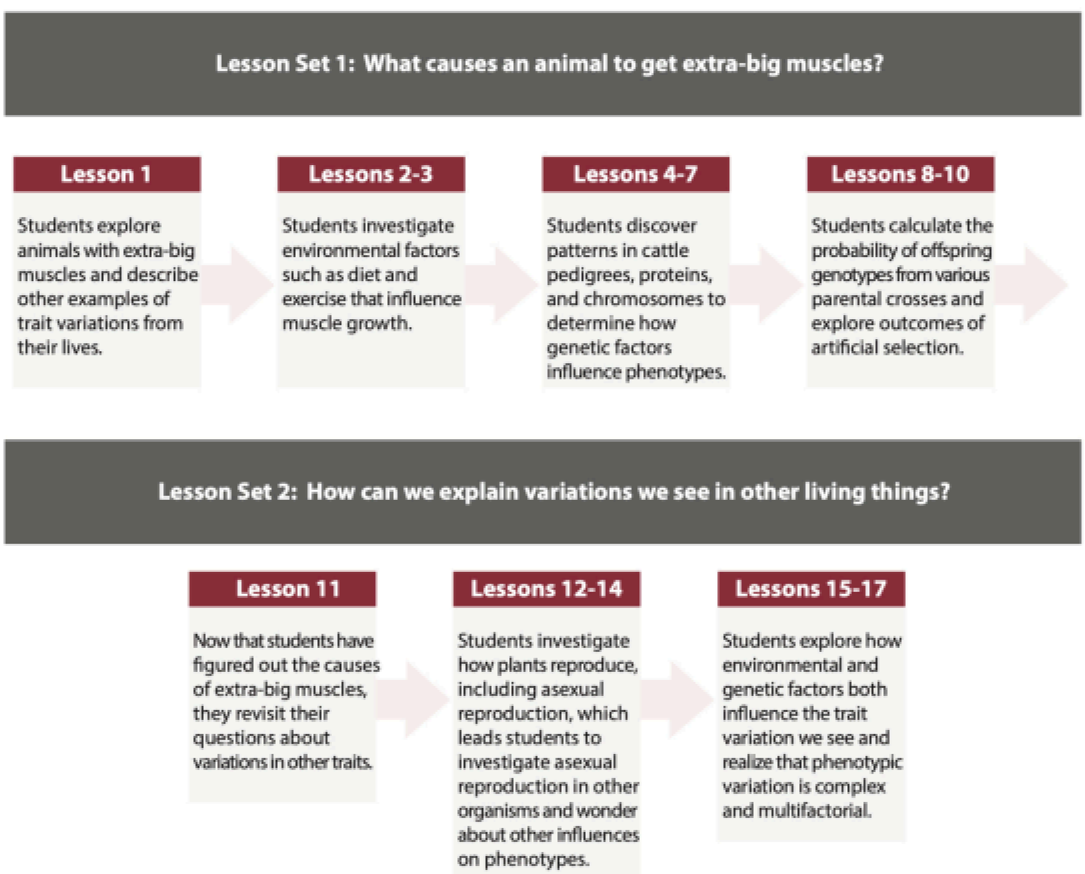
Lessons 16-17

Students zoom out to a galactic scale and then back down to the Earth-Moon-Sun System to make connections between the systems of the universe at different scales with regards to gravity.

Unit 8.5 This six-week genetics unit starts with students noticing and wondering about photos of two cattle, one of whom has significantly more muscle than the other. The students then observe photos of other animals with similar differences in musculature: dogs, fish, rabbits, and mice. After developing initial models for the possible causes of these differences in musculature, students explore a collection of photos showing a range of visible differences.

Students use videos, photos, data sets, and readings in the first lesson set to investigate what causes an animal to get extra-big muscles. Students figure out how muscles typically develop due to environmental factors such as exercise and diet. Students work with cattle pedigrees, including data about chromosomes and proteins, to figure out genetic factors that influence the heavily muscled phenotype and explore selective breeding in cattle. They investigate plant reproduction, including selective breeding and asexual reproduction in plants and other organisms. Students figure out that environmental and genetic factors play a role in the differences we see among living things.

Driving question: Why are living things different from one another?



Unit 8.6 Students investigate the connections between ancient and modern organisms in this seven-week unit. In the four lesson sets, students develop a model for natural selection and use it to account for patterns between the body structures and behaviors of ancient organism fossils and similar organisms living today. Students begin by hearing about the surprising fossil of an ancient penguin (nicknamed "Pedro") in a podcast from the researchers who found and identified the fossil. Students also read a photo journal from their research.

Students question how penguins living today could be connected to this fossil of a much larger penguin from long ago and record their noticings and wonderings. Students then explore the different species of penguins alive today through videos and data cards. Students develop initial explanations for how today's penguins could be related to Pedro or other penguins from long ago. Students develop models to explain where all the ancient penguins went and where all the different species of modern penguins developed? Students consider other types of organisms that lived long ago and look different from similar types of organisms alive today.

Driving question: How could things living today be connected to the things that lived long ago?

Lesson Set 1: How are modern organisms connected to ancient organisms?

Lesson 1
Students notice and wonder about the fossil of an ancient giant penguin found in present-day Peru, analyze data about modern penguins, and develop initial explanations of how these penguins could be connected. They brainstorm about (1) Where did all the ancient penguins go? (2) Where did all the different species of modern penguins come from? and (3) What other organisms alive today might also be connected to organisms that lived long ago?

Lessons 2-4
To figure out whether modern penguins are related to ancient penguins, students investigate heritable body structures and behaviors in modern penguins, look for patterns, and infer connections between modern and ancient penguins.

Lessons 5-6
Students investigate whether the patterns of connections they saw between ancient and modern penguins also exist in other organisms. Students then argue for how modern organisms are connected to ancient organisms through lines of descendants and propose possible explanations for those connections.

Lesson Set 2: How does our General Model for Natural Selection help us explain changes to populations of organisms?

Lesson 7
To figure out the cause of changes in the populations they have observed, students explore five cases where trait distributions in the population changed over a few generations. They analyze data from different studies and develop a system model that explains the cause of the shift in trait distribution over time for their case.

Lessons 8-10
Students compare each of the case-specific system models (for finches, moths, swallows, fish, and plants) and argue for which model parts and interactions these cases have in common, then develop a general model to explain what causes changes in the population. Students carry out two investigations using computer simulations and argue for why they get different outcomes when they change the environment.

Lesson 11
Students test their General Model for natural selection on a new phenomenon, explaining how the traits in a population of green lizards can change over time.

Lesson Set 3: How can we use natural selection to explain changes in species over millions of years?

Lesson 12
To explain how new trait variations can enter a population, students add mutation to their General Model for natural selection and use it to explain changes in horses and horseshoe crabs over time.

Lesson 13
Students use what they know about natural selection and mutation to develop a model to show how modern penguins could be connected to each other and to ancient penguins. They construct a hypothetical explanation for how the penguins are connected and compare their explanations with others.

Lesson Set 4: How can we use additional evidence for how modern organisms are connected to ancient organisms to explain more of our related phenomena?

Lesson 14
Students analyze sketches of embryos at different points in development for a variety of living things such as a chicken, a turtle, a rabbit, and a human. They construct an argument and raise questions about how and why different organisms share so many physical traits in common in their embryological development.

Lesson 15
Students identify the questions from the DQB that they can now answer. They celebrate all that we have learned in this unit and across the school year. Students spend time identifying the questions that they did not answer and build a new DQB of questions to be answered in future years.