5th Grade Science

for Utah SEEd Standards

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Utah State Board of Education OER

AUTHOR

USBE OER

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Students as Scientists

What does science look and feel like?

If you're reading this book, either as a student or a teacher, you're going to be digging into the "practice" of science. Probably, someone, somewhere, has made you think about this before, and so you've probably already had a chance to imagine the possibilities. Who do you picture doing science? What do they look like? What are they doing?

Often when we ask people to imagine this, they draw or describe people with lab coats, people with crazy hair, beakers and flasks of weird looking liquids that are bubbling and frothing. Maybe there's even an explosion. Let's be honest: Some scientists do look like this, or they look like other stereotypes: people readied with their pocket protectors and calculators, figuring out how to launch a rocket into orbit. Or maybe what comes to mind is a list of steps that you might have to check off for your science fair project to be judged; or, maybe a graph or data table with lots of numbers comes to mind.

So let's start over. When you imagine graphs and tables, lab coats and calculators, is that what you love? If this describes you, that's great. But if it doesn't, and that's probably true for many of us, then go ahead and dump that image of science. It's useless because it isn't you. Instead, picture yourself as a maker and doer of science. The fact is, we need scientists and citizens like you, whoever you are, because we need all of the ideas, perspectives, and creative thinkers. This includes you.

Scientists wander in the woods. They dig in the dirt and chip at rocks. They peer through microscopes. They read. They play with tubes and pipes in the aisles of a hardware store to see what kinds of sounds they can make with them. They daydream and imagine. They count and measure and predict. They stare at the rock faces in the mountains and imagine how those came to be. They dance. They draw and write and write and write some more.

Scientists — and this includes all of us who do, use, apply, or think about science — don't fit a certain stereotype. What really sets us apart as humans is not just that we know and do things, but that we wonder and make sense of our world. We do this in many ways, through painting, religion, music, culture, poetry, and, most especially, science. Science isn't just a method or a collection of things we know. It's a uniquely human practice of wondering about and creating explanations for the natural world around us. This ranges from the most fundamental building blocks of all matter to the widest expanse of space that contains it all. If you've ever wondered "When did time start?", or "What is the smallest thing?", or even just "What is color?", or so many other endless questions then you're already thinking with a scientific mind. Of course you are; you're human, after all.

But here is where we really have to be clear. Science isn't just questions and explanations. Science is about a sense of wondering and the sense-making itself. We have to wonder and then really dig into the details of our surroundings. We have to get our hands dirty. Here's a good example: two young scientists under the presence of the Courthouse Towers in Arches National Park. We can be sure that they spent some amount of time in awe of the giant sandstone walls, but here in this photo they're enthralled with the sand that's just been re-washed by recent rain. There's this giant formation of sandstone looming above these kids in the desert, and they're happily playing in the sand. This is ridiculous. Or is it?

How did that sand get there? Where did it come from? Did the sand come from the rock or does the rock come from sand? And how would you know? How do you tell this story?

Look. There's a puddle. How often is there a puddle in the desert? The sand is wet and fine; and it makes swirling, layered patterns on the solid stone. There are pits and pockets in the rock, like the one that these two scientists are sitting in, and the gritty sand and the cold water accumulate there. And then you might start to wonder: Does the sand fill in the hole to form more rock, or is the hole worn away because it became sand? And then you might wonder more about the giant formation in the background: It has the same colors as the sand, so has this been built up or is it being worn down? And if it's being built up by sand, how does it all get put together; and if it's being worn away then why does it make the patterns that we see in the rock? Why? How long? What next?

Just as there is science to be found in a puddle or a pit or a simple rock formation, there's science in a soap bubble, in a worm, in the spin of a dancer and in the structure of a bridge. But this thing we call "science" is only there if you're paying attention, asking questions, and imagining possibilities. You have to make the science by being the person who gathers information and evidence, who organizes and reasons with this, and who communicates it to others. Most of all, you get to wonder. Throughout all of the rest of this book and all of the rest of the science that you will ever do, wonder should be at the heart of it all. Whether you're a student or a teacher, this wonder is what will bring the sense-making of science to life and make it your own.

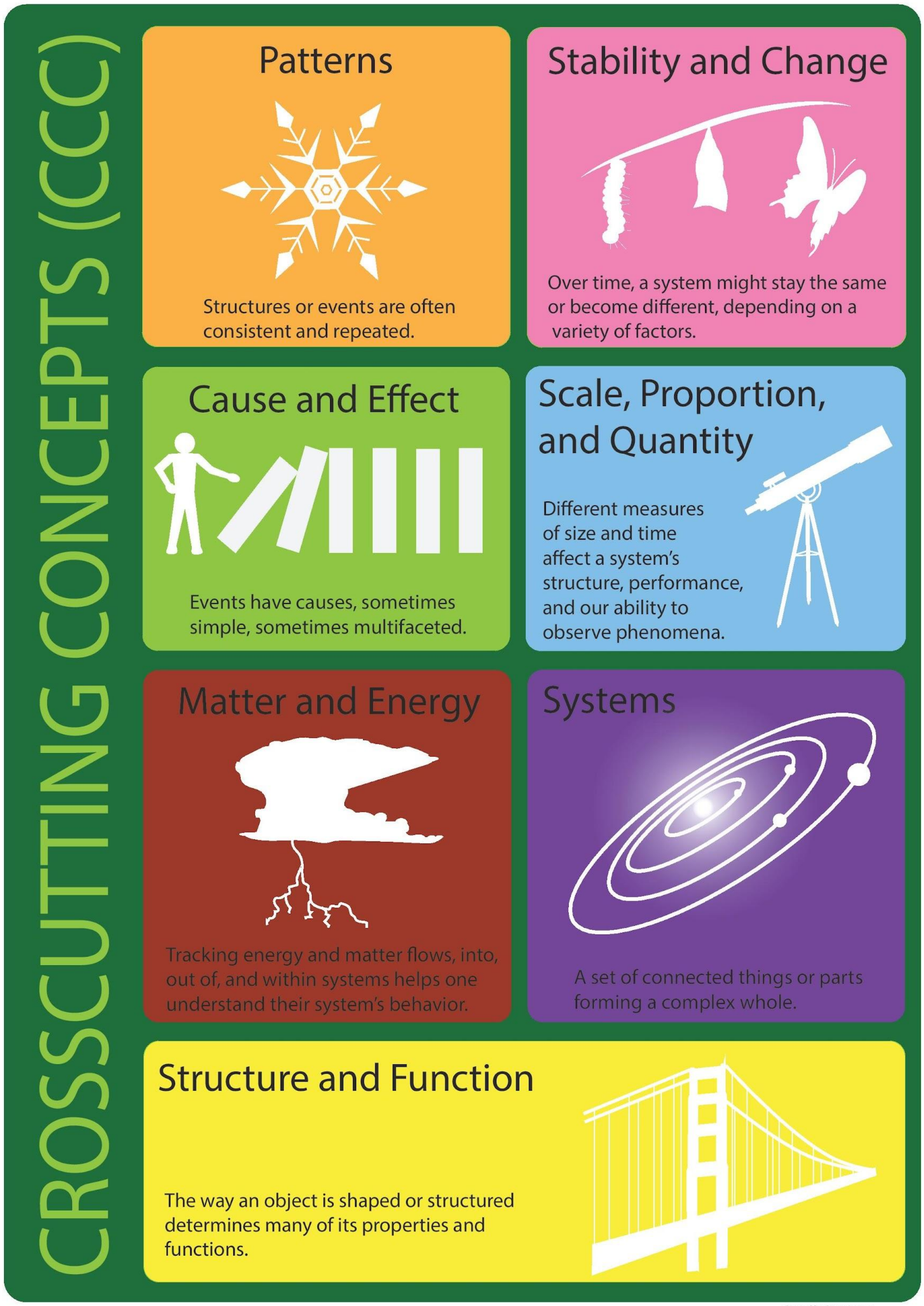
Adam Johnston
Weber State University

Science and Engineering Practices

Science and Engineering Practices are what scientists do to investigate and explore natural phenomena

Crosscutting Concepts

Crosscutting Concepts are the tools that scientists use to make sense of natural phenomena.



What is involved in Engineering Design?

Engineering is a creative process where each new version of a design is tested and then modified, based on what has been learned up to that point. This process includes a number of components:

1. Identifying the problem and defining criteria and constraints.
2. Generating ideas for how to solve the problem. Engineers use research, brainstorming, and collaboration with others to come up with ideas for solutions and designs.
3. Use criteria and constraints to evaluate possible design solutions to identify the one(s) that best address these parameters for the problem in context
4. Build and test the prototypes. Using data collected, the engineer analyzes how well prototypes meet the given criteria and constraints.
5. Suggest or make improvements to prototypes to optimize the design.

In the Science with Engineering Education (SEEd) Standards, specific engineering standards generally involve two types of tasks:

1. If the standard includes the idea of designing, then the design process will contain components of defining the problem (along with identifying the criteria and constraints), developing many possible solutions, and optimizing a solution (e.g., determining a best solution for the situation based on the criteria and constraints, testing the solution, refining the solution).
2. If the standard includes the idea of evaluating, then the design process will contain components of defining the problem (along with identifying the criteria and constraints) and optimizing a solution. The idea of developing many possible solutions is not included because various solutions will be provided. The idea of evaluating then means determining a best solution from the provided solutions for the situation based on meeting the criteria and constraints requirements.

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Strand 1: Characteristics and Interactions of Earth's Systems

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Image by Julius Silver, pixabay.com, CC0

Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways. Weathering and erosion are examples of interactions between Earth's systems. Some interactions cause landslides, earthquakes, and volcanic eruptions that impact humans and other organisms. Humans cannot eliminate natural hazards; solutions can be designed to reduce their impact.

1.1 Patterns in Earth's Features (5.1.1)

Phenomenon

In the Pacific Ocean there is a pathway of active volcanoes with frequent earthquakes, called the Ring of Fire. The dots represent active volcanoes.

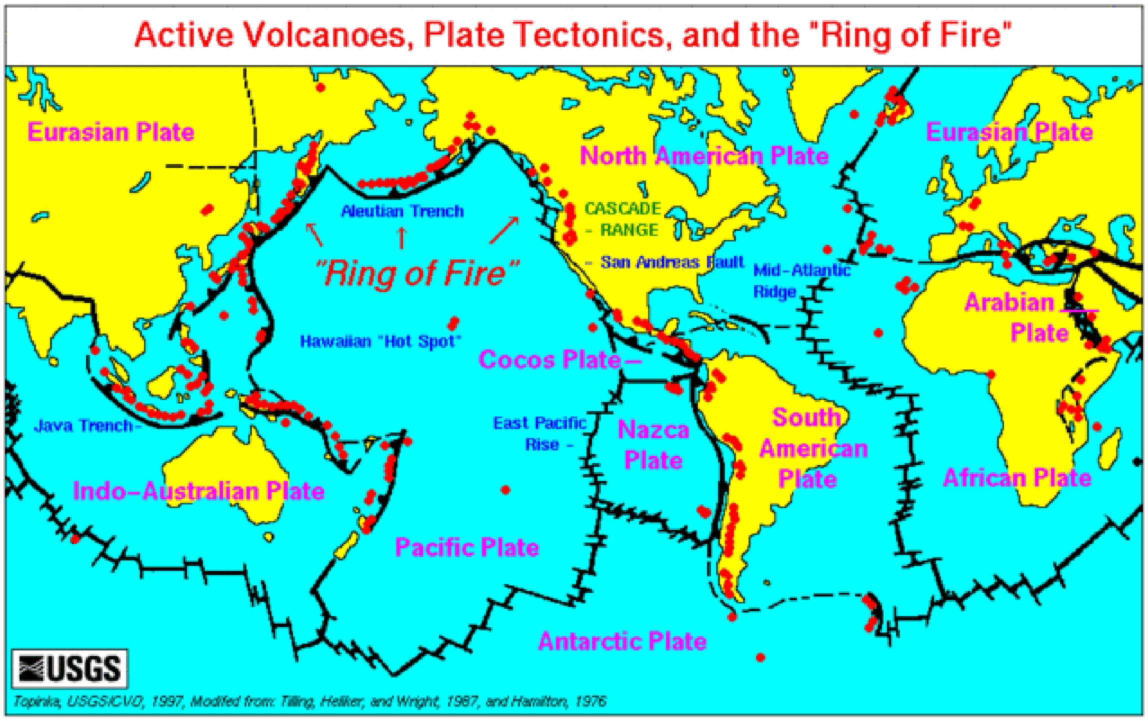


Image by USGS, https://commons.wikimedia.org/wiki/File:Map_plate_tectonics_world.gif; public domain

Observations & Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

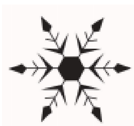
1. Where do you see the most volcanoes?

2. Where do you see the least volcanoes?

3. What patterns do you see in the location of the active volcanoes?

5.1.1 Patterns in Earth's Features

Analyze and interpret data to describe patterns of Earth's features. Emphasize most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans while major mountain chains may be found inside continents or near their edges. Examples of data could include maps showing locations of mountains on continents and the ocean floor or the locations of volcanoes and earthquakes. (ESS2.B)



In this chapter, you will be looking at different patterns we see in Earth's Features.

Volcanoes, Earthquakes, and Ocean Floor

Volcanoes

Volcanoes are openings in the Earth's crust that allow hot, melted rock (magma), ash, and gases to erupt outward. Volcanoes change the Earth's surface in a short period of time. More than half of Earth's surface is made up of volcanic rock. Volcanoes are evidence that we live on an active, changing planet.

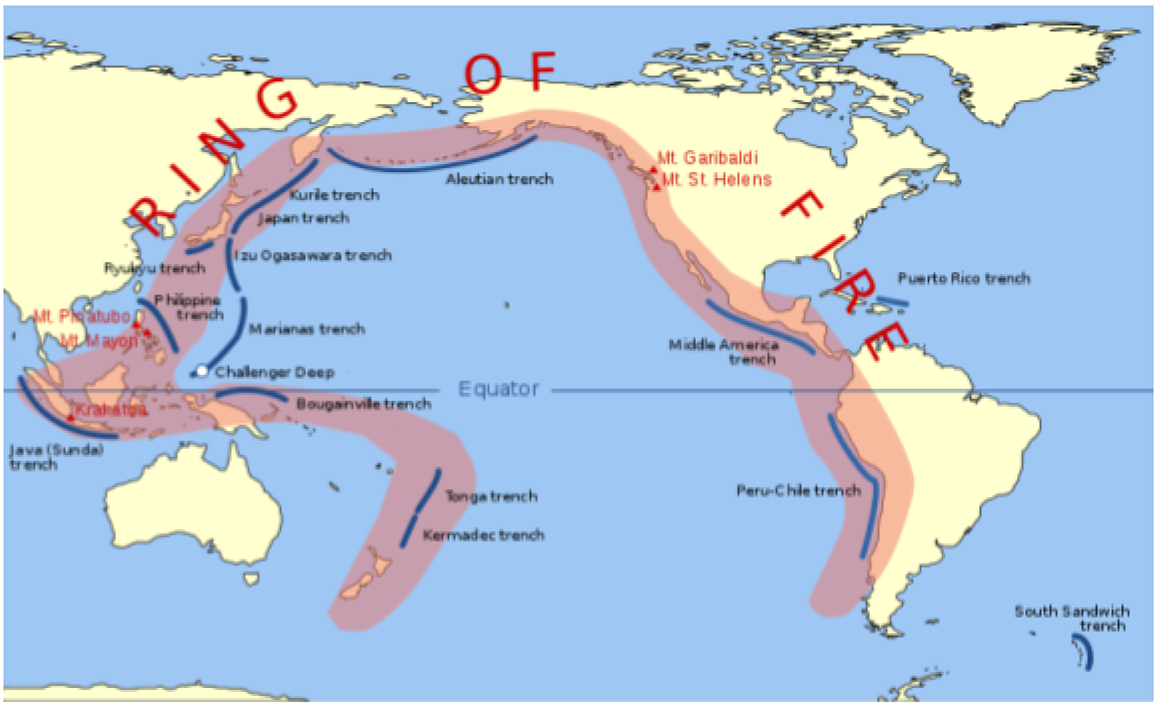
Do you know how a volcano forms? Far below Earth's surface, temperatures are hot enough to melt rock. The melted rock comes out of cracks in the Earth's crust, resulting in a volcano. Some eruptions pour out rivers of lava while other volcanoes have larger eruptions. Volcanoes can erupt underwater, forming huge ranges of volcanic mountains on the ocean floor.

Pacific Ring of Fire

This section is adapted from information at:
https://www.nationalgeographic.org/encyclopedia/ring-fire/
https://www.nationalgeographic.org/topics/resource-library-plate-tectonics/?q=&page=1&per_page=25

Most earthquakes and volcanic eruptions take place along the edges of the Pacific Ocean (see image below). The Earth's crust is broken up into a series of massive sections called plates. The movements of these plates can account for noticeable changes to the Earth, such as earthquakes, volcanic eruptions, and the building of mountains.

The many volcanoes and earthquakes along the Ring of Fire are caused by the amount of movement of tectonic plates in the area. Along the Ring of Fire, plates overlap. The magma near Earth's surface creates volcanic activity. The border between the Pacific and North American Plates (Phenomenon image) is a transform boundary, where plates move sideways past one another. This type of boundary generates a large number of earthquakes as tension in Earth's crust builds up and is released.



Pacific Ring of Fire by Gringer, https://en.wikipedia.org/wiki/File:Pacific_Ring_of_Fire.svg, public domain

Plates can also move away from each other within a continent. This is called continental rifting. When this happens, the crust thins, breaks, and then splits apart.

Earthquakes

Earthquakes are waves of energy that pass through Earth caused by a sudden shift of tectonic plates along fault lines, a long crack in the surface of the Earth. Earthquakes can cause sudden changes that alter the Earth's landscape dramatically. Tremendous forces under Earth's surface build up pressure, which is released in waves along a fault. Portions of Earth's crust move, creating waves. Some of the waves are surface waves because they travel along the surface of the Earth. Other waves, called body waves, travel through the Earth's interior. In an earthquake, body waves are responsible for the sharp jolts. Surface waves are responsible for the rolling motions that cause most of the damage.

Earthquakes can create landforms on the Earth's surface. Mountains can form during an earthquake as the edges of the tectonic plates push together. During an earthquake, a fault may slip deep underground and leave no evidence on the surface that an earthquake has occurred. Earthquakes in the ocean may cause a tsunami, a large ocean wave.

Ocean Floor

In the oceans, plates move apart at mid-ocean ridges, causing volcanoes, creating openings for lava to rise upward, erupt, and cool. As more lava erupts and pushes the original seafloor outward, the seafloor spreads and forms new oceanic crust. This is why there is a mountain range running through the oceans. The plates pulling apart cause earthquakes. Most mid-ocean ridges are located deep below the sea. The island of Iceland

Mid Atlantic Ridge by Mangwanani, public domain
The rift valley in Iceland is part of the Mid-Atlantic Ridge.

sits right on the Mid-Atlantic ridge.

Putting It Together

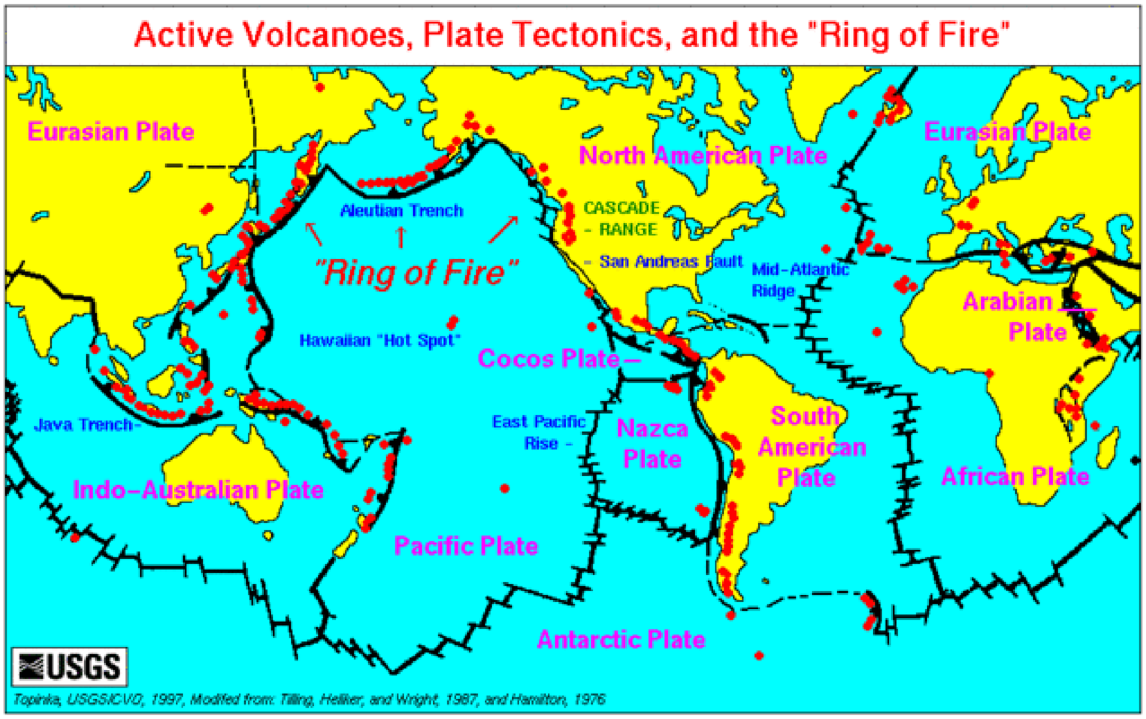


Image by USGS, https://commons.wikimedia.org/wiki/File:Map_plate_tectonics_world.gif; public domain

Focus Questions:

1. The dots represent active volcanoes. What do you notice about the location of most volcanoes shown?

2. The dark lines represent plate boundaries. What do we know about plate boundaries and earthquakes?

3. Based on what you know about volcanoes and earthquakes, what predictions can you make about changes to Earth's surface in the future?

Final Task:

Describe two patterns of change to Earth’s features and how they occur.

1.2 Earth's Water (5.1.2)

Phenomenon

Most of the water found on the Earth is saltwater, not freshwater.

Saltwater and freshwater

Most of the water on Earth is **saltwater** (97%), and only a little is **freshwater** (3%).

Observations & Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. The image above shows how water is distributed on Earth. How much water on Earth is salt water (saline water)?

2. How much water on Earth is surface water (lakes, swamps, or rivers)?

3. What do you find surprising about this data?

5.1.2 Earth's Water

Use mathematics and computational thinking to compare the quantity of saltwater and freshwater in various reservoirs to provide evidence for the distribution of water on Earth. Emphasize reservoirs such as oceans, lakes, rivers, glaciers, groundwater, and polar ice caps. Examples of using mathematics and computational thinking could include measuring, estimating, graphing, or finding percentages of quantities. (ESS2.C)

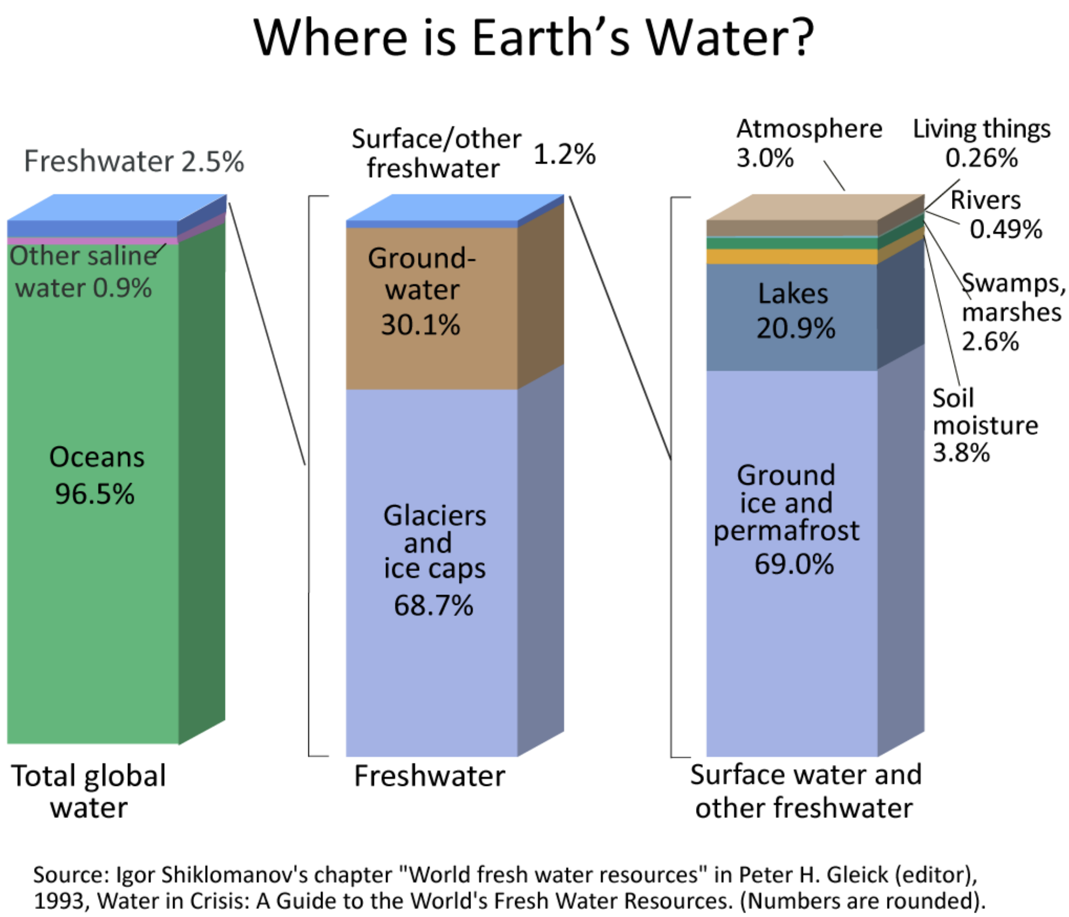
In this section, focus on comparing the quantity of saltwater with freshwater found on the Earth.

Where is Earth's Water?

Earth's water is (almost) everywhere: above the Earth in the air and clouds (atmosphere), on the surface of the Earth in rivers, oceans, ice (hydrosphere), plants, in living organisms (biosphere), and inside the Earth (geosphere).

Here is a chart showing the distribution of water on Earth.

- In the first column, notice that 2.5% of Earth's water is freshwater - the amount needed for life to survive.
- The middle column shows the breakdown of freshwater. Almost all of it is found in ice and in the ground. Only a little more than 1.2% of all freshwater is surface water, which provides most of life's needs.
- The right column shows the breakdown of surface freshwater. Most of the surface freshwater is found in ice, and another 20.9% is found in lakes. Rivers make up 0.49% of surface freshwater. Although rivers account for only a small amount of freshwater, rivers are the source of most usable water.



How Much Water is There On, In, and Above the Earth?

The Earth is a watery place. But just how much water exists on our planet? About 71 percent of the Earth's surface is covered with water, and the oceans hold about 96 percent of all Earth's water. Water also exists in the air (as water vapor), rivers and lakes, icecaps and glaciers, the ground (as soil moisture and in aquifers).

Freshwater

Even though you may only notice water on the Earth's surface, more freshwater is stored in the ground than there is in liquid form on the surface. In fact, some of the water you see flowing in rivers comes from water seeping into Earth's surface to become groundwater. Water from precipitation continually seeps into the ground to fill aquifers (underground reservoirs), while at the same time water in the ground continually fills rivers through seepage.

Humans make use of both surface water and groundwater. In the United States in 2010, we used about 275 billion gallons (1,041 billion liters) of surface water per day and about 79.3 billion gallons (300.2 billion liters) of groundwater per day. Although surface water is used more often to supply drinking water and to irrigate crops, groundwater is vital because it fills rivers and lakes and provides water for people in places where water is scarce, such as in desert towns of the western United States.

Putting It Together

Saltwater and freshwater

Most of the water on Earth is **saltwater** (97%), and only a little is **freshwater** (3%).

Focus Questions

1. List three places where freshwater is found on Earth.

2. What water resources contribute to Earth's surface water?

Final Task

Draw a bar graph to show salt water on Earth compared to freshwater on Earth.

1.3 Weathering and Erosion (5.1.3)

Phenomenon

A sidewalk is cracked.

Image by Tdorante10; https://commons.wikimedia.org/wiki/File:Bch_169th_St_Ft_Tilden_Riis_Park_td_06.jpg; CC BY-SA

Observations & Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. What can you see happening to the sidewalk?

2. How did the cracks happen?

5.1.3 Weathering and Erosion

Ask questions to plan and carry out investigations that provide evidence for the effects of weathering and the rate of erosion on the geosphere. Emphasize weathering and erosion by water, ice, wind, gravity, or vegetation. Examples could include observing the effects of cycles of freezing and thawing of water on rock or changing the slope in the downhill movement of water. (ESS2.A, ESS2.E)

In this section, you will explore the effects of weathering and erosion on the geosphere.

What is Weathering?

Weathering is the breaking down of Earth's materials into smaller pieces. This is

a process that takes a very long time. Weathering causes rocks on the Earth's surface to change form.

Change happens over a long period of time. Because it happens so slowly, we don't often see major changes in the environment. Even though we can't see major changes, there is evidence that changes have occured.

Weathering is caused by powerful forces, including wind, water, temperature, and living organisms.

- Wind: Wind erosion moves soil and sand in the air from place to place and against rock surfaces. This is especially true in arid climates like Utah. Particles moved by the wind hit other landforms, weathering their surfaces.

Image from pixabay.com, CC0

Image by Sven Lachmann (seaq68), pixabay.com, CC0

- Water: Rocks are made of minerals. Some minerals in rocks break down easier than others. When water hits against a rock, this causes some minerals in the rocks to break into smaller pieces. This can happen in lakes, rivers, and streams.

Image by Massimiliano Pappalardo, pixabay.com, CC0

- Living Organisms: Sometimes biological elements cause weathering. A plant's roots may grow into a crack in a rock. As the roots grow larger, they wedge open the crack. Burrowing animals can also cause weathering. By digging for food or creating a hole to live in, the animal may break apart rock.

- Freezing**:** Weathering by freezing (sometimes referred to as ice wedging) is common in locations where the temperatures are above and below freezing (32℉). Weathering by freezing happens when water seeps into cracks in rocks and then freezes. As the water freezes (turns from a liquid to a solid) it expands, pushing the rock apart. This creates a larger crack. Water gathers in the larger crack and freezes, causing an even larger crack. This is how ice wedging works. When liquid water changes into solid ice, it increases in volume. You can see this when you fill an ice cube tray with water and put it in the freezer. The ice cubes expand to a higher level in the tray than what the water level originally was.

Erosion

Erosion is the movement of Earth's materials from one place to another.

This also contributes to Earth's changing landscape.

Image by US Department of Agriculture; public domain

Water is the most powerful erosional force on Earth. Rain carries soil away as it washes over the land, creating gullies (trenches), valleys, and canyons. As water moves through rivers, it may erode the banks and change the path of the river.

Rivers and streams have formed many natural wonders including arches, curved rock formations, which are formed by a combination of erosional forces.

Ice, rain, and wind continue to weather the arches found in Utah's Arches National Park. One well-known arch is Delicate Arch. Someday, erosion will cause the arches to collapse, but until that time, we can enjoy their spectacular beauty.

Image by Free-Photos, pixabay.com, CC0

Running water from streams and rivers can form a butte—an isolated hill with steep, even sides, and a flat top. A butte begins as a plateau or mesa, a flat raised piece of land. Over time, rivers enter the land and erode the softer soil. Hard rock remains in the form of a butte.

Image by Piero Di Maria (pdimaria), pixabay.com, CC0

Canyon Lands by Sathish J, https://flic.kr/p/oXrbmt, CC-BY-NC-ND

Water erosion from rivers and streams can cut through layers of rock to form deep canyons. Examples of canyons are found in the Grand Canyon and in Canyonlands National Park.

Image by Adrian Lang, pixabay.com, CC0

Glaciers are slow-moving, large masses of snow, ice, rocks, and dirt. In cold regions, snowfall does not melt and oftentimes causes erosion. After thousands of years, it turns to ice and becomes very heavy.

Gravity can pull the glacier slowly down a mountain slope. As it inches along, the glacier erodes the surface beneath. Valleys form as boulders and rock, carried in the ice, scrape the rock beneath the glacier. Glaciers also polish and scratch the land beneath them as they travel across its surface.

Putting It Together

Image by Tdorante10; https://commons.wikimedia.org/wiki/File:Bch_169th_St_Ft_Tilden_Riis_Park_td_06.jpg; CC BY-SA

Focus Questions:

1. What weathering and/or erosion events could have caused the cracks in the sidewalk?

2. What evidence supports your answer?

Final Task

Construct an explanation with two examples of what caused the cracks in the sidewalk.

1.4 Interactions between Systems (5.1.4)

Phenomenon

Over millions of years, hoodoos, a tall, thin spire of rock, have formed at Bryce Canyon National Park. Hoodoos are also called a tent rock, fairy chimney or an Earth pyramid.

THE LIFECYCLE OF A HOODOO

Image by *Brian Roanhorse/NPS,* https://www.nps.gov/brca/learn/nature/hoodoos.htm

Observations & Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. What Earth systems do you see working together?

2. How do these system interactions affect Earth's surface?

5.1.4 Interactions between Systems

Develop a model to describe interactions between Earth's systems including the geosphere, biosphere, hydrosphere, and/or atmosphere. Emphasize interactions between only two systems at a time. Examples could include the influence of a rainstorm in a desert, waves on a shoreline, or mountains on clouds. (ESS2.A)

In this section, you will describe Earth's systems and their interactions.

Bryce Canyon

Bryce Canyon by Andy Gippetti, https://flic.kr/p/UJFBZE, CC-BY-NC

Hoodoos are spires of soft rock capped with erosion-resistant rock found in arid regions. Weathering and erosion are the two forces of nature that work together to sculpt Bryce Canyon's hoodoos. The main natural forces of weathering and erosion that create the hoodoos are ice and rain. The elevation in which Bryce Canyon is located receives both above freezing temperatures and below freezing temperatures over 200 nights out of the year. That is more than half of the days in a year in which Bryce Canyon reaches above/below freezing temperatures on the same night! This is crucial to creating the hoodoos.

When water (from either rain or snow that has melted) seeps its way into the cracks in the rock, it stays there. Hours later, when Bryce Canyon is met with freezing temperatures, the water trapped inside the rock begins to freeze into ice. When water freezes into ice, it expands. This expansion into ice causes tremendous pressure on the surrounding rock, and causes it to break apart. This process is known as "ice wedging", because the ice is literally wedging apart the rocks. From a plateau, eventually the rocks break down into walls, windows, and then as individual hoodoos. Refer to the image to see the formation process of a hoodoo.

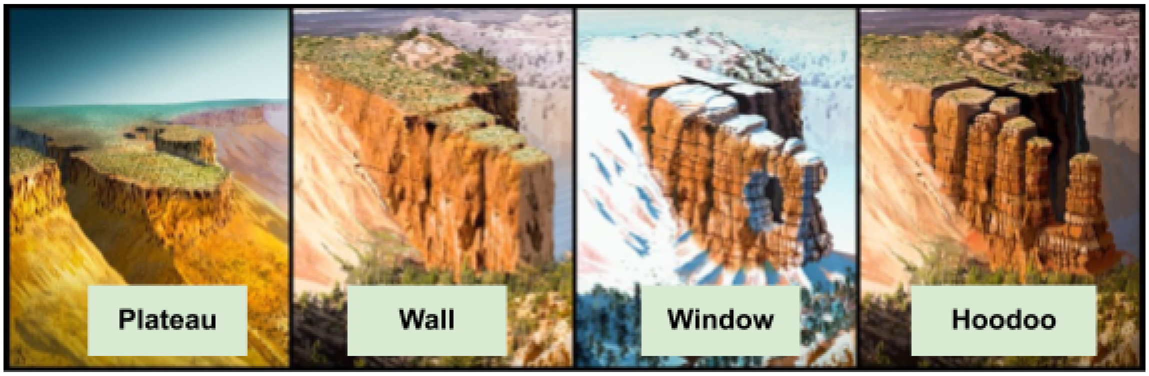


Image by *Brian Roanhorse/NPS,* https://www.nps.gov/brca/learn/nature/hoodoos.htm

Earth's Interactions

Hoodoos are one example of how Earth's systems interact with each other to affect Earth's surface materials and processes. The atmosphere (air), hydrosphere (water and ice), geosphere (solid and molten rock, soil, and sediments), and biosphere (living things, including humans) are all part of Earth's systems. The spheres are so closely connected that a change in one sphere often results in a change in one or more of the other spheres, causing Earth's surface to be constantly changing.

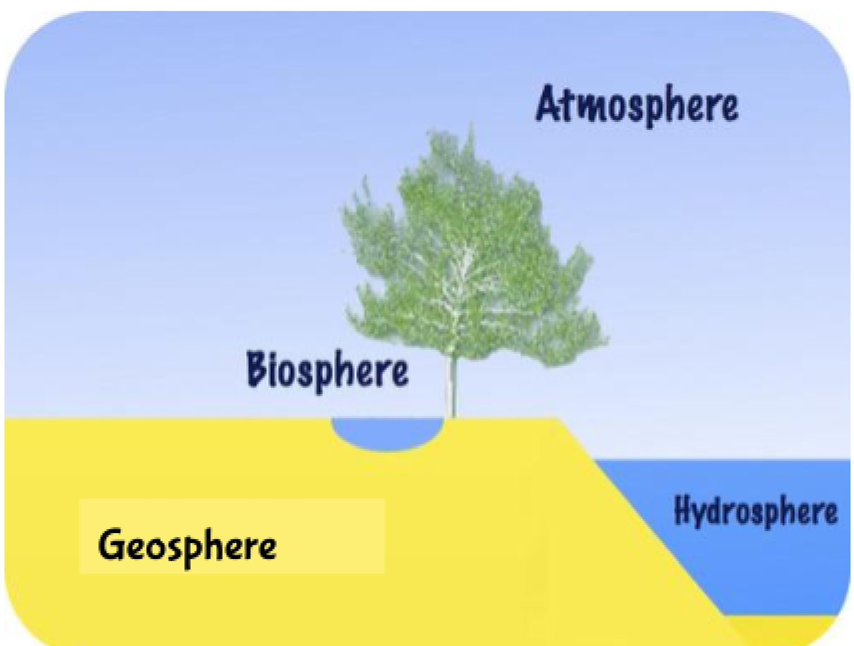


Image by CK-12 Foundation, CC-BY-NC 3.0

A few examples of Earth's systems interacting are:

- wave action (hydrosphere) carries sand that polishes rocks on the beach (geosphere).
- water vapor (hydrosphere) condenses to form clouds (atmosphere).
- clouds (atmosphere) produce rain (hydrosphere).
- wind (atmosphere) generates waves (hydrosphere).
- Humans (biosphere) built a dam out of rock materials (geosphere).
- Water in the lake (hydrosphere) seeps into the cliff walls (geosphere) behind a dam, becoming groundwater (geosphere), or evaporating into the air (atmosphere).

Putting It Together

THE LIFECYCLE OF A HOODOO

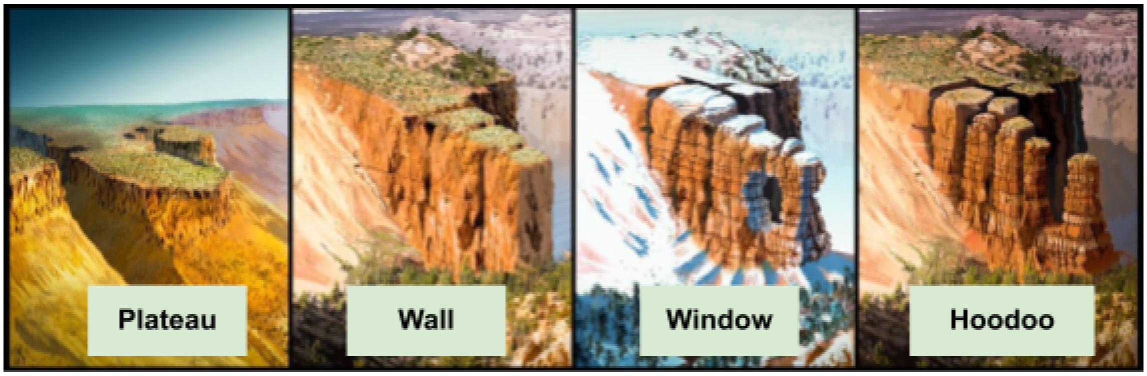


Image by *Brian Roanhorse/NPS*, https://www.nps.gov/brca/learn/nature/hoodoos.htm

Focus Questions

1. Which of Earth's systems helped change the wall into the window?

2. Which two of Earth's systems interact to create hoodoos?

Final Task

Develop a model to explain how two of Earths' systems interact to create hoodoos. Remember to include images, captions, and short explanations.

1.5 Impact on Humans (5.1.5)

Authentic Situation

Landslides cause a lot of damage, impacting humans.

Image from pixabay.com, CC0

Observations and Wonderings:

1. What is the problem in this situation?

2. What are possible criteria (positive outcomes) to this situation?

3. What are constraints (limitations) with this situation?

Focus Questions:

1. What causes landslides?

2. What are the effects of landslides?

5.1.5 Impact on Humans

Design solutions to reduce the effects of naturally occurring events that impact humans. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data from testing solutions, and propose modifications for optimizing a solution. Emphasize that humans cannot eliminate natural hazards, but they can take steps to reduce their impacts. Examples of events could include landslides, earthquakes, tsunamis, blizzards, or volcanic eruptions. (ESS3.B, ETS1.A, ETS1.B, ETS1.C)

In this section, you will design solutions to reduce the effects of naturally occurring events that impact humans.

Landslides

This landslide in California in 2008 blocked Highway 140.
Ferguson-slide by Eeekster, https://commons.wikimedia.org/wiki/File:Ferguson-slide.jpg, CC-BY

Landslides are the most dramatic, sudden, and dangerous examples of Earth materials moved by gravity. When large amounts of rock suddenly break loose from a cliff or mountainside, they move quickly and with tremendous force. Air trapped under the falling rocks acts as a cushion that keeps the rock from slowing down. Landslides can move as fast as 100-150 miles per hour.

Landslides are exceptionally destructive. Homes may be destroyed as hillsides collapse. Landslides can even bury entire villages and may create lakes when the rocky material dams a stream. If a landslide flows into a lake or bay, it can trigger a tsunami.

Mudflows


A-frame buried in mudflow. Mount St. Helens National Volcanic Monument

Mudflows are wet landslides. They are created when the land is wet and becomes loose from the mountainside or cliff. This can happen when areas with little vegetation to hold the soil in place receive high precipitation. The water loosens the soil and causes it to flow downhill. Mudflows can wash out bridges, trees, and homes that are in their path.

Contributing Factors and Solutions

There are several factors that increase the chance that a landslide will occur, such as water, undercutting, and lack of vegetation; some of these we can prevent and some we cannot.

Water

A little bit of water helps to hold grains of sand or soil together. For example, you can build a larger sandcastle with slightly wet sand than with dry sand. However, too much water causes the sand to flow quickly away. When mountains receive rapid rainfall or snow on a mountaintop melts quickly, it adds extra water to the soil, making a landslide more likely to occur.

Humans cannot prevent water saturation in soil from precipitation and snowmelt. We can help drain excess water out of the soil and keep it dry. This drainage can help slopes near roads or houses not become saturated with water, helping to reduce landslides.

Building

Sometimes people want to build a road or home where a mountain or hill is present. To do this, they need to cut into the mountain. This is called undercutting.

When construction workers cut into slopes for homes or roads, they must stabilize the slope to help prevent a landslide. They can use materials such as rocks, bricks, and metal to create a retaining wall. The wall helps hold the land in place to prevent landslides.

A rock wall stabilizes a slope that has been cut away to make a road.
Retaining walls in Finland Utsjoki by Timo Saarenketo, https://flic.kr/p/edQe41, CC-BY

Tree roots or even grasses can bind the soil together. Planting grass and trees in the land above a slope can help stabilize the land and reduce landslides.

To help reduce destruction from landslides, humans can make choices about where to build structures. When a building is near the edge of a cliff or a steep mountainside, erosion may cause the ground to be unstable and cause damage to the building. Structures built near rivers and lakes are more likely to have wetter soil underneath them. This soil may not be strong enough to support the building and may cause damage. Humans can choose areas to build that will have soil strong enough to support the structure and reduce the impact of landslides.

Vegetation

Vegetation helps hold soil together and reduce the impact of landslides. When trees are removed from land without replanting them (deforestation), this may leave the land more susceptible to a landslide. Humans can help reduce the impact of deforestation on landslides by planting trees when they cut them down.

When fire burns through an area on a slope, it removes the vegetation and can lead to a landslide. Humans can help replace vegetation where fire has occurred. This will help reduce the impact of landslides in those areas.

Possible Solutions

Possible Solutions	Pros	Cons
Reduce undercutting (try to not cut into mountains for roads and houses)	● Less likely for a landslide to happen because humans are not cutting into the land to make it unstable	● Land may be less stable and more likely for a landslide to occur ● Limits where people can build structures
Build barriers to protect roads and houses after undercutting	● Land is usable for humans as roads and houses	● Retaining walls can be expensive and need to be checked regularly ● Limits where people can build roads and homes
Build away from edges of slopes, rivers, and lakes	● Less likely to have a building damaged by a landslide	● More likely for a structure to be damaged by a landslide ● Limits where people can build
Reroute drainage	● Land is less wet and can support buildings better ● Landslide materials can follow drainage route away from buildings	● Land may be wetter and more likely to cause a landslide ● May take a lot of time and money
Avoid cutting down trees on mountain sides without replacing them	● Vegetation helps stabilize land more and reduce impact of landslides	● May cost a lot of money and time to replant vegetation
Replant vegetation lost from fires on mountain sides		

Putting It Together

Image from pixabay.com, CC0

Focus Questions

1. What causes landslides?

2. What are the effects of landslides?

Final Task

What would be a possible solution to reduce the impact of landslides on humans? Describe a solution and include the following:

- Criteria (what the solution needs to be successful)
- 2 Constraints (limitations to solving the problem)
- How the solution reduces the impact of landslides on humans

CHAPTER 2

Strand 2: Properties and Changes of Matter

Chapter Outline

Image by Bokskapet, pixabay.com, CC0

All substances are composed of matter. Matter is made of particles that are too small to be seen but still exist. Substances can be identified by their specific properties. When two or more different substances are combined, a new substance with different properties may be formed. The total amount of matter is always conserved, whether a change results in a new substance or not.

2.1 Too Small to See (5.2.1)

Phenomenon

You make lemonade on a hot summer day by mixing lemon juice, sugar, and water together. When you look in the pitcher you see a liquid, but no particles of sugar and lemon.

Images from pixabay.com, CC0

Observations and Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. What happened to the lemon juice after it was added to the pitcher?

2. What happened to the sugar after it was added to the pitcher?

3. Draw an initial model of what is happening in the pitcher.

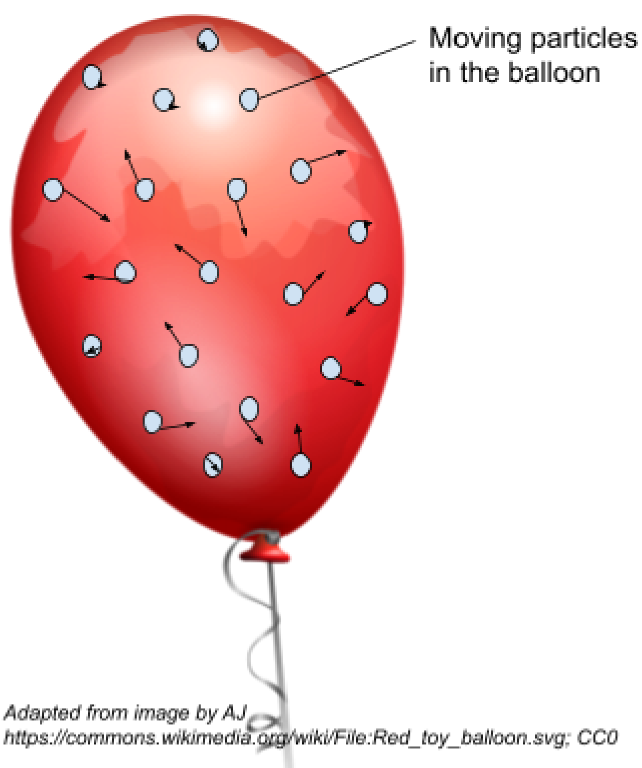
5.2.1 Too Small to See

Develop and use a model to describe that matter is made of particles on a scale that is too small to be seen. Emphasize making observations of changes supported by a particle model of matter. Examples could include adding air to expand a balloon, compressing air in a syringe, adding food coloring to water, or dissolving salt in water and evaporating the water. The use of the terms atoms and molecules will be taught in Grades 6 through 8. (PS1.A)

In this section, focus on the scale of particles too small to be seen.

Matter

Matter is any substance that has mass. Everything you can see and touch is made of matter, including you! Some matter is so small you cannot see it with your eyes, like air and other gases, but you can observe how it interacts with other matter around it.



Adapted from image by AJ https://commons.wikimedia.org/wiki/File:Red_toy_balloon.svg; CC0

Mass is the measurement of the amount of matter an object has. Everything that has mass, no matter how small, is considered matter. When you blow air into a balloon, you cannot see the air with your eyes, but you notice the balloon expands as you blow into it. This is evidence that air is matter because particles are filling the balloon and making it larger.

When you mix salt and water together, the particles of salt dissolve in the water. When you look at the saltwater, you no longer see the particles of salt because their particles are too small to see. If you evaporate the water, the salt crystals will remain and you will observe them again.

Image by Ri Butov, pixabay.com, CC0

Matter can exist as a solid, liquid, or gas. Matter cannot be created or destroyed, but it can undergo changes that you can observe.

States of Matter

Matter can be found in different states, or forms. In each state of matter the particles can't be seen.

Solid

A solid is made of matter particles that are organized together and hold their shape. Tables and chairs are solid objects. The floor under the tables and chairs is solid.

Inn on the Park dining chairs by Katherine Esposito, https://flic.kr/p/amFB2D, CC-BY-NC

Liquid

Image by anokarina, https://flic.kr/p/UWVEZk, CC-BY-SA

A liquid is made of matter particles that take the shape of the container. As you can see in this image, the water curves with the sides of the glass. Water, milk, and juice are all examples of liquids.

Gas

A gas is made of matter particles that are too small to see and are moving freely all around us. It makes up the air we breathe, the steam coming off of a boiling pot, and smoke from a fire. Oxygen is a gas that humans need to breathe and live. Trees use carbon dioxide, another common gas. Gases are necessary for many living things to survive.

Putting It Together

Images from pixabay.com, CC0

Focus Questions:

1. Why did the lemon juice and sugar seem to disappear in the water?

2. What could you do to prove the particles of lemon, sugar, and water are still in the lemonade?

Final Task

Draw a model to explain what happened to the matter particles of sugar, water, and lemon juice when they were combined in the pitcher.

2.2 Identifying Substances (5.2.2)

Phenomenon

Three different substances are sitting on a table. They are all white. Substance 1 and 3 dissolve in water, but substance 2 does not.

Substance 1	Substance 2	Substance 3
 *Image by EBS, http://uci.or.kr/G903:PI0-000752400; CC BY*	 *Image by Mudd1; https://commons.wikimedia.org/wiki/File:Flours.jpg; CC BY-SA*	 *Image by 422737; pixabay.com, CC0*

Observations & Wonderings:

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. What patterns do you see in the substances?

2. How are they similar and different?

5.2.2 Identifying Substances

Ask questions to plan and carry out investigations to identify substances based on patterns of their properties. Emphasize using properties to identify substances. Examples of properties could include color, hardness, conductivity, solubility, or a response to magnetic forces. Examples of substances could include powders, metals, minerals, or liquids. (PS1.A)

In this section, you use patterns of properties to analyze similarities and differences of substances.

Properties of Matter

When you encounter an unknown substance (physical material of which something is made), you can use its properties (any characteristic that can be measured) to help you identify the substance. Let's imagine you evaporated water from two different mixtures but don't remember what mixture was in which dish. The crystals have the same white color, so you cannot use the property of color to differentiate them. You then decide to examine the crystals under a microscope to see if their shapes are the same. They are different! You compare the cube-like shapes of one and the elongated shapes of the other to determine one substance is salt and one is sugar. In this case, the property of shape helped you determine the identity of the substances.

Broken glass by Jef Poskanzer, https://commons.wikimedia.org/wiki/File:Broken_glass.jpg, CC-BY

When a large piece of glass breaks, its appearance changes. Instead of one solid sheet of glass, it has holes and cracks. It is still the same color and hardness, but it has changed in other ways.

Some properties of matter always are the same whether you have a small amount or a large amount of it as shown in the table.

Properties	Example
color	Aluminum metal is gray-colored.
taste	Lemon juice tastes sour.
magnetism	Iron is attracted to magnets.
boiling point	The boiling point of water is 100℃
solubility	Salt dissolves in water.
hardness	Diamond is the hardest substance known.
conductivity	A copper wire allows heat or electricity to move from one side to the other.
odor	Baking bread has a distinctive smell.

- Color: Different substances have different colors. Rust is a red color and salt is white.
- Taste: Substances have different flavors, such as salt and sugar. Taste can be used to identify substances. Be careful to not taste unknown substances.
- Magnetism: Some substances are magnetic and some are not. For example, aluminum foil is not magnetic and paper clips are.
- Boiling point: Water boils at 100℃. Different liquids boil at different temperatures. If you are unsure if a liquid is water, you can boil it to find out if it boils at 100 degrees Celsius or not.
- Solubility: Some substances dissolve in water, such as sugar or salt. Some are not soluble, meaning they do not dissolve in water, such as flour.
- Hardness: Minerals do not all have the same hardness. Some of them are hard and some are soft. Refer to the hardness scale image.
- Conductivity: Some substances allow electricity to pass through them easily, such as a copper wire, while others do not, like wood. Some substances allow heat to pass through them easily, such as metal, and others do not, such as styrofoam.

Some properties of matter will vary depending on the amount or size of a substance. Some examples of properties that will vary include mass, weight, volume, and length.

Putting It Together

Substance 1	Substance 2	Substance 3
 *Image by EBS, http://uci.or.kr/G903:PI0-0007 52400; CC BY*	 *Image by Mudd1; https://commons.wikimedia.org/wiki/File:Flours.jpg; CC BY-SA*	 *Image by 422737; pixabay.com, CC0*

Focus Questions

1. What properties of matter help you identify substances?

2. Which properties of matter would you test to identify the three substances in the images above?

Final Task

You decide to investigate the three substances by testing the properties in the table below. Based on the information in the table, identify each substance and describe how the properties helped you identify it.

	Solubility	Taste	Crystal Shape	Odor
Substance 1	dissolves in water	tastes bitter	regular crystal	none
Substance 2	does not dissolve in water	no flavor, turns into paste when tasted	powder	none
Substance 3	dissolves in water	tastes sweet	irregular crystal	slightly sweet odor

2.3 Combining Substances (5.2.3)

Phenomenon

A glow stick lights up when you bend it.

Image by Paul Barlow, pixabay.com, CC0

Observations & Wonderings:

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

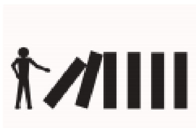
Focus Questions:

1. What happened to make the tubes glow?

2. How did the substance inside the tube change?

5.2.3 Combining Substances

Plan and carry out investigations to determine the <u>effect</u> of combining two or more substances. Emphasize whether a new substance is or is not created by the formation of a new substance with different properties. Examples could include combining vinegar and baking soda or rusting an iron nail in water. (PS1.B)



In this section, you will look for the cause and effect of combining two or more substances.

Combining Substances

Matter can exist as a solid, liquid, or gas and can change in different ways. In some changes, the substances are nearly the same and retain their properties. For example, if you cut a carrot and a stalk of celery into three pieces each and mix them together, you will still have the substances of carrot and celery. The celery is still green and the carrots are still orange. The carrots still taste like carrots and celery still tastes like celery. The three pieces of carrot and three pieces of celery will weigh the same as the original carrot and celery stalk. If you dissolve a half cup of dirt in a cup of water, your resulting substance will be a cup and a half of the mixture which will retain the original properties of dirt and water.

Melting is another type of change. The shape of an ice cube changes as it melts and becomes a liquid. However, the matter does not change. It still has the same substance in a different form (solid to liquid). Other examples of this include evaporation (liquid to gas), freezing (liquid to solid), and condensation (gas to liquid).

When two or more substances are combined, sometimes they produce a new substance with different properties. Burning a piece of paper, combining baking soda and vinegar, lighting fireworks, and baking a cake are all examples of creating a new substance after combining two or more substances. When you begin with the ingredients for the cake, you have flour, sugar, eggs, liquid, and flavoring which all have unique properties. The directions for the cake specify that you should bake it for a certain period of time at a specific temperature. The properties of the finished cake are different from the original ingredients.

Sometimes when substances combine and create a new substance they produce heat, light, an odor, change color, or change the state of matter (liquid to solid or gas).

Image by Ondrejk; https://commons.wikimedia.org/wiki/File:Bratislava_New_Year_Fireworks.jpg; Public Domain

Putting It Together

Image by Paul Barlow, pixabay.com, CC0

Focus Questions

1. The stick contained a liquid and a small capsule also filled with a different liquid. What happened when the liquids combined?

2. Was a new substance formed? How do you know?

Final Task

Construct an explanation with evidence to determine if a new substance was created when the liquids inside the glow stick were combined.

2.4 Conservation of Matter (5.2.4)

Phenomenon

A cup of ice is taken out of the freezer and left on the counter.

Ice in a drink glass by Steve Johnson, https://flic.kr/p/83sd2y, CC-BY

Image by Borist Trost, pixabay.com, CC0

Observations & Wonderings:

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions:

1. What are the differences in states of matter of the ice and the water?

2. How are the ice and water the same? How are they different?

5.2.4 Conservation of Matter

Use mathematics and computational thinking to provide evidence that regardless of the type of change that occurs when heating, cooling or combining substances, the total weight of matter is conserved. Examples could include melting an ice cube, dissolving salt in water, and combining baking soda and vinegar in a closed bag. (PS1.A, PS1.B)

In this section, you will explore the conservation of matter.

Conservation of Mass

Image from pixabay.com, CC0

The law of conservation of matter means that no matter what, the matter cannot be created or destroyed. This law applies to ALL changes.

Imagine that you made a paper airplane. After making it, you decided to measure the mass of the paper airplane using a balance. Now imagine that you crumpled the paper airplane into a ball and measured the mass again. Would the mass be different? Why or why not?

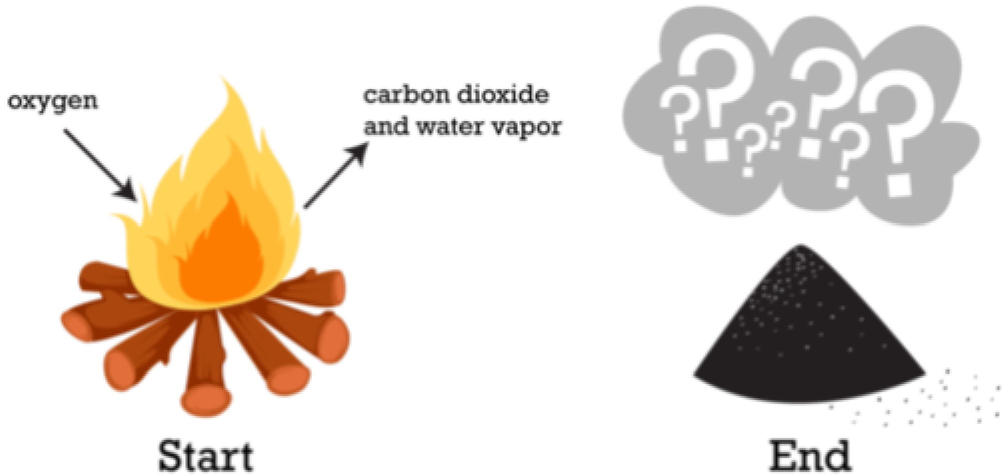


Image by Christopher Auyeung, Douglas Heriot, CK-12 Foundation, CC-BY-NC-SA 3.0

This burning campfire illustrates a very important law in science: the law of conservation of mass. This law states that matter cannot be created or destroyed. Even when matter goes through a change, the total mass of matter always remains the same. If you were to weigh the oxygen and wood you started with, it would weigh the same as the ash and all the gases that were made when it was burned.

A Lego set released in 2013, "Gold Getaway", based on the Lego Castle theme, https://en.wikipedia.org/wiki/Lego#/media/File:Lego_Castle_70401-Gold_Getaway.jpg, CC-BY-SA 4.0

When creating a model with your favorite building materials, you put the pieces together. Begin with a pile of building materials, weigh those materials individually. After putting the materials together, weigh the entire model. Even when the materials change form, the amount of matter is conserved, weighing the same before and after building.

Putting It Together

Ice in a drink glass by Steve Johnson, https://flic.kr/p/83sd2y, CC-BY

Image by Borist Trost, pixabay.com, CC0

Focus Questions

1. What happened to the ice?

2. The cup ice weighs 1 lb when taken out of the freezer. How much will it weigh after it melts?

Final Task

Complete the table to show the weight of each item after it was changed.

Change	Weight Before Change	Weight After Change
a piece of paper was folded into a paper airplane	1 oz	
bag of chips was crumpled	½ lb	
baking soda and vinegar are combined	½ oz + ½ oz	(include gas created from reaction)
cookie ingredients baked into cookies	cookie dough 5 lb	all cookies made from dough

CHAPTER 3

Strand 3: Cycling of Matter in Ecosystems

Chapter Outline

Image by Bruno Glätsch, pixabay.com, CC0

Matter cycles within ecosystems and can be traced from organism to organism. Plants use energy from the Sun to change air and water into matter needed for growth. Animals and decomposers consume matter for their life functions, continuing the cycling of matter. Human behavior can affect the cycling of matter. Scientists and engineers design solutions to conserve Earth's environments and resources.

3.1 Building Plants (5.3.1)

Phenomenon

Ivy, a type of plant, can grow on a house.

Image by Jörg Blobelt; https://commons.wikimedia.org/wiki/File:20040609200DR_Dresden-Striesen_Eisenacher_Stra%C3%9Fe_13.jpg; CC BY-SA

Observations and Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. What do plants need to grow?

2. Where did the matter for the ivy come from to help it grow

5.3.1 Building Plants

Construct an explanation that plants use air, water, and energy from sunlight to produce plant matter needed for growth. Emphasize photosynthesis at a conceptual level and that plant matter comes mostly from air and water, not from the soil. Photosynthesis at the cellular level will be taught in Grades 6 through 8. (LS1.C)

In this section, we will explore how energy and matter affect plants.

Plant Growth

Have you ever planted a seed and watched it grow? Where does all the plant matter come from? It starts as a small seed and soon becomes a much larger plant. What does a plant need to grow? You probably thought of sunlight, water, air, and soil. While all of these help a plant grow, plant matter comes mostly from air and water, not soil.

Image by truthseeker08, pixabay.com, CC0

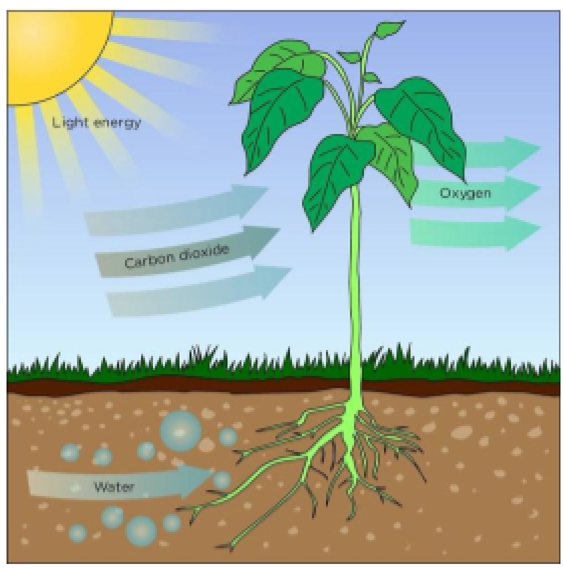


Image from Thunderbolt Kids, http://www.thunderboltkids.co.za/Grade6/01-life-and-living/chapter1.html, CC-BY-ND

Plants start as a small seed. When seeds have water, they sprout and start to grow. Once they use up all the matter and energy stored in the seed, they need to obtain it from their environment. The energy that starts this process comes from the Sun. This is known as photosynthesis.

Plants and Food

As sunlight enters a plant, so does the surrounding air. Air is composed mostly of nitrogen, oxygen, and carbon dioxide. Plants use water, energy from sunlight, and carbon dioxide from the air to create a chemical reaction that results in matter, called sugars, for the plant to use as food. They also recycle the air and make oxygen for us to breathe.

The Process of Photosynthesis

Photosynthesis is the process that plants use to change light energy from the Sun into food energy. There are some important requirements for photosynthesis to happen:

Sunlight: Sunlight has energy. Plants use this energy to make sugars from water and carbon dioxide. Plants use the sugars (matter) as food to help them grow.

Water: The roots of a plant absorb water and nutrients from the soil. They move minerals and nutrients up from the roots. They move sugars to different parts of the plant.

Air (Carbon dioxide): The plant absorbs, takes in, carbon dioxide from the air through pores (small holes) found all over the plant, mostly under the leaves.

Is Soil Necessary for Plant Growth?

Think back to the ivy at the beginning of this chapter. It was growing on the house with little to no soil. Just like the ivy, some plants can grow with little to no soil. Another example is weeds growing in the sidewalk cracks or bamboo that grows only in water.

Image (left) by Ethan2039; https://commons.wikimedia.org/wiki/File:Weeds_growing_on_edge_of_concrete.jpg; CC BY-SA 4.0

Image (right) by Toby Lee Spiegel; https://flic.kr/p/6EMrGR; CC BY

A class wanted to study and see if the soil was giving plants the matter they needed to grow. To do so, they grew three plants in soil and weighed the plants and soil before starting. After 14 days, they weighed the plants and the soil again. The plants weighed more and the soil weighed almost the same. This showed that the plants did not not gain their matter from the soil. If they had, the soil would weigh much less. This experiment helped prove that the soil was not transferring matter to the plant. Instead, it provided nutrients to help the plants grow.

Think about what you need to grow. Your body needs nutrition from a variety of healthy foods to grow correctly. Plants are the same. Soil helps to give plants the nutrients they need to be healthy.

Putting It Together

Image by Jörg Blobelt; https://commons.wikimedia.org/wiki/File:20040609200DR_Dresden-Striesen_Eisenacher_Stra%C3%9Fe_13.jpg; CC BY-SA

Focus Questions

1. How does the ivy use air, water, and sunlight to survive?

2. How does the ivy grow with little to no soil?

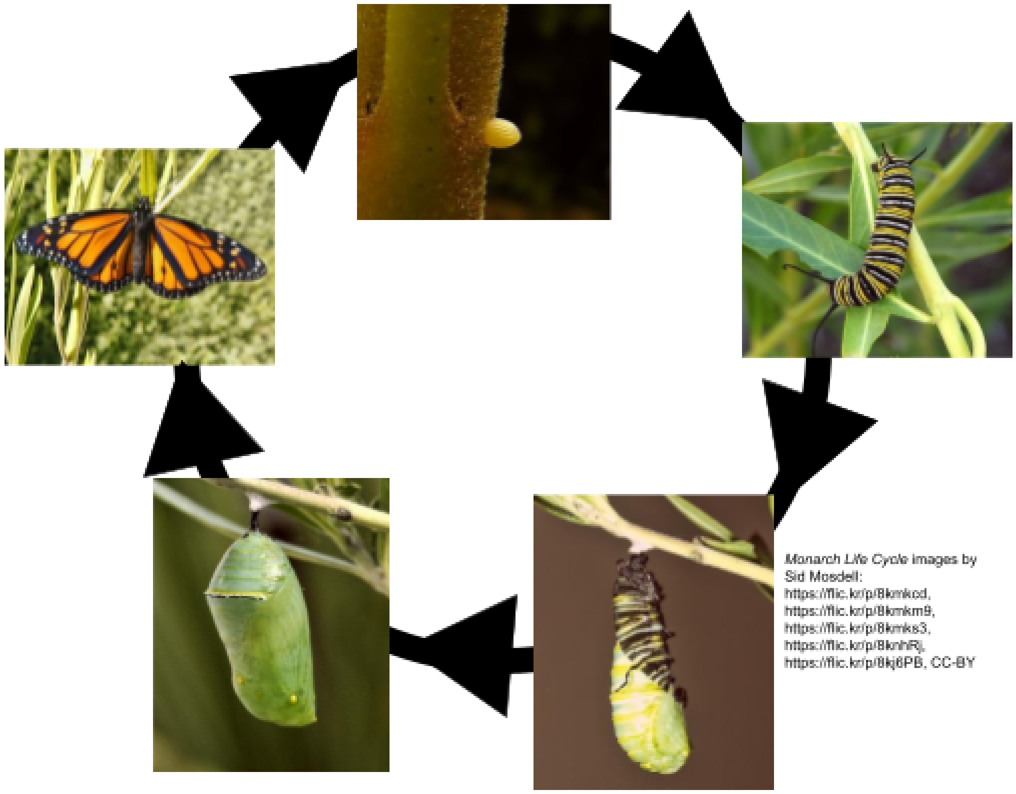
Final Task

Construct an explanation that plants use air, water, and energy from sunlight to produce plant matter needed for growth.

3.2 Consuming Food (5.3.2)

Phenomenon

Caterpillars grow rapidly into butterflies.



Monarch Life Cycle images by Sid Mosdell: https://flic.kr/p/8kmkcd, https://flic.kr/p/8kmkm9, https://flic.kr/p/8kmks3, https://flic.kr/p/8knhRj, https://flic.kr/p/8kj6PB,

Observations and Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. Using the image above, describe the life cycle of a butterfly.
2. Where does the matter come from to help the butterfly grow?
3. Where does the energy come from to help the butterfly grow?

5.3.2 Consuming Food

Obtain, evaluate, and communicate information that animals obtain energy and matter from the food they eat for body repair, growth, and motion and to maintain body warmth. Emphasize that the energy used by animals was once energy from the Sun. Cellular respiration will be taught in Grades 6 through 8. (PS3.D, LS1.C)

In this section, matter and energy used by animals will be explored.

Obtaining Energy and Matter

All living things constantly use energy and matter to survive. For example, it takes energy to move and stay warm. Organisms use matter for growth and body repair. Energy and matter can't be created or destroyed. They can only change form or be transferred. How do animals obtain matter and energy needed for survival?

Energy and Matter from Food

Animals obtain energy and matter needed for survival from their food. When an animal eats a plant or another animal, it obtains some of the energy and matter the plant or animal has stored. In this way, the energy and matter pass from one organism to another.

Energy used by animals can be traced back to the Sun through plants. Plants convert sunlight (energy) into food through photosynthesis. Plants can store energy and matter in many different places, such as the leaves, stem, and roots. Some animals eat the plants and obtain matter from them. Some animals eat other animals. This continues as other organisms, called decomposers, break down matter and return it to the soil. The plants use the nutrients from the soil to help them grow. In this way, matter continually cycles through an ecosystem.

Why Do Animals Need Energy and Matter?

Both energy and matter are needed for organisms to grow and move. Think of the caterpillar after it has hatched. It needed to eat and gain matter to continue growing and become a butterfly. The matter it gained as it grew came from the food it ate. Additionally, the butterfly gained the energy it needed to move from the food it ate.

Have you ever gotten a paper cut and noticed that it healed within a few days? Your body uses the energy and matter inside of itself to heal it. That energy and matter comes from the food you eat.

What do you do when you are cold outside? You might run in place to warm up or stand close to friends to get warmer. Animals need to maintain their body temperatures to not get too hot or too cold. When food is digested, it releases energy. When an animal uses energy, heat is produced. This heats the body and the surrounding environment. As your body uses the matter it consumes, it produces the energy that makes your body warm.

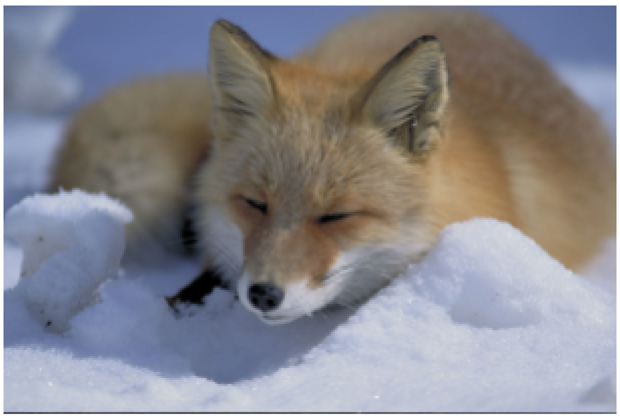


Image by Shiretoko-Shari Tourist Association; https://commons.wikimedia.org/wiki/File:Vulpes_vulpes_laying_in_snow.jpg; CC BY

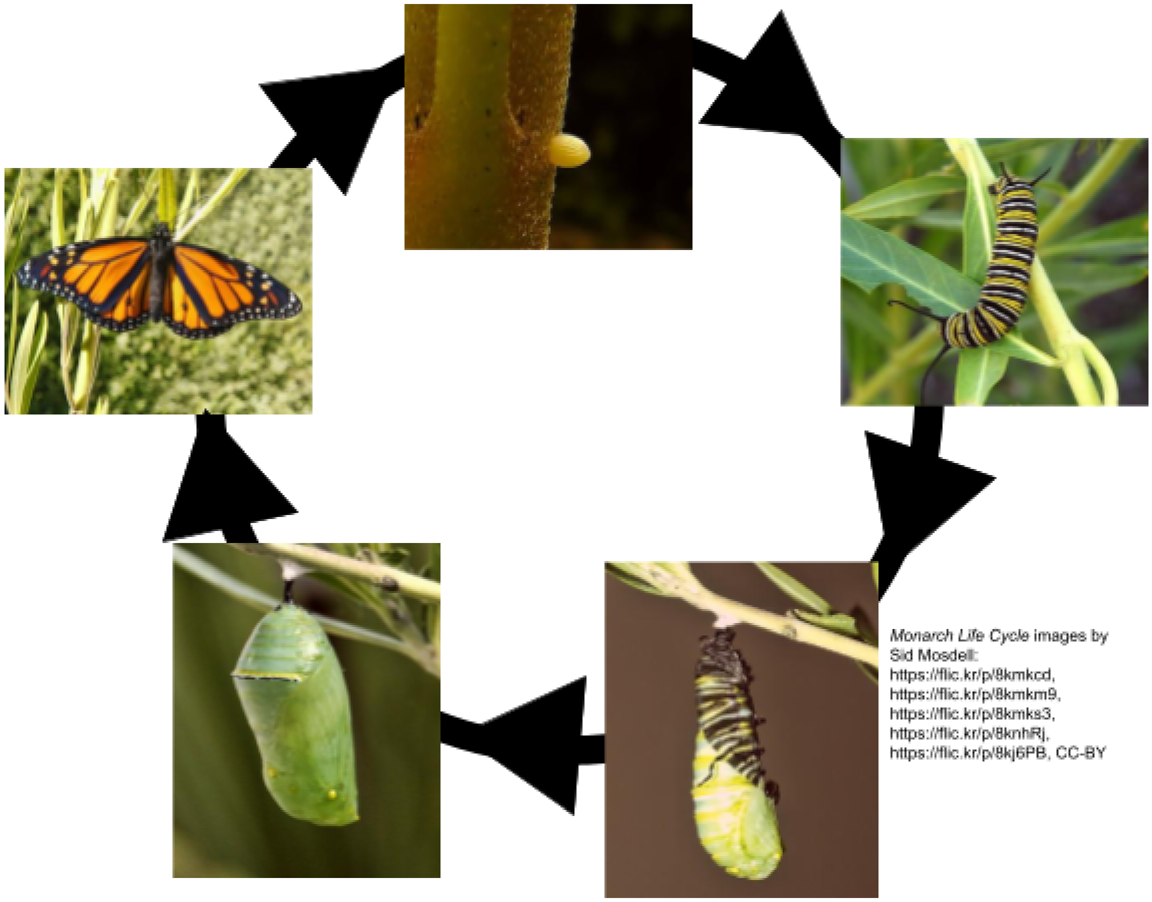
Animals use energy to maintain body warmth. Warm-blooded animals, such as mammals, can maintain their body temperature. This means their body temperature is the same whether they are in cold or warm environments. To maintain their body temperature, they use the energy they obtained from food.

Cold-blooded animals cannot maintain their body temperature. Their body temperature changes, depending on their surroundings. These organisms, such as reptiles, rely on their environment to help keep them from overheating or getting too cold. Because their body cannot maintain its own temperature, they do not need to eat as often or as much as warm-blooded animals.

Image by Noly Noble; CC BY 3.0 https://commons.wikimedia.org/wiki/File:500px_photo_(41741304).jpeg;

Since all food can eventually be traced back to plants, all of the energy that animals use for body repair, growth, motion, and to maintain body temperature is energy that once came from the Sun.

Putting It Together



Monarch Life Cycle images by Sid Mosdell: https://flic.kr/p/8kmkcd, https://flic.kr/p/8kmkm9, https://flic.kr/p/8kmks3, https://flic.kr/p/8knhRj, https://flic.kr/p/8kj6PB, CC-BY

Caterpillars grow rapidly into butterflies.

Focus Questions:

1. What did the butterfly use to grow rapidly?

2. How did the butterfly use energy and matter during its life cycle?

3. In what ways do organisms use energy and matter they obtain from food?

Final Task

Construct an explanation about how animals use energy and matter for growth, movement, body repair and maintaining body temperature. Be sure to include how they obtain the energy and matter.

3.3 Movement of Matter (5.3.3)

Phenomenon

An owl eats other organisms to stay alive.

Owl with rat by Fish and Wildlife Research Institute, https://flic.kr/p/AiT4DJ,

Observations and Wonderings

1. What are you observing about this phenomenon?

2. What are you wondering about this phenomenon?

Focus Questions

1. How does the owl obtain energy needed to survive?

2. How does the owl obtain matter needed to survive

5.3.3 Movement of Matter

Develop and use a model to describe the movement of matter among plants, animals, decomposers, and the environment. Emphasize that matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Examples could include simple food chains from ecosystems such as deserts or oceans or diagrams of decomposers returning matter to the environment. Complex interactions in a food web will be taught in Grades 6 through 8. (LS2.A, LS2.B)

In this section, the movement of matter among air, soil, plants, animals, and microbes will be explored.

Producers, Consumers, and Decomposers

Image by Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation, CC-BY-NC 3.0

Animals cannot use sunlight, water, and carbon dioxide to make food the way plants do. Animals need to eat plants or other animals for energy and matter to carry out their life processes.

Living things that get their energy and matter by eating either plants or animals are called consumers. There are many types of consumers. Some consumers eat just producers (herbivores). Others eat both producers and other organisms (omnivores), and some just eat other organisms (carnivores).

The organisms that produce food for those consumers are extremely important in every ecosystem. Organisms that produce their own food are called producers. They produce food through photosynthesis.

Another group of organisms are called decomposers. They eat dead animals and other organic materials, like fallen trees. They break the matter into tiny pieces that can go back into the soil as nutrients and minerals. Examples of decomposers include: worms and microorganisms, such as fungi and bacteria.

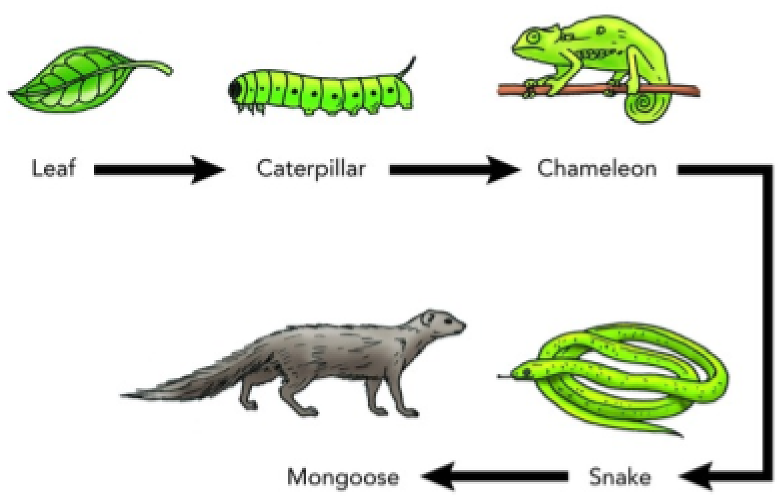
Feeding Relationships in an Ecosystem

An ecosystem consists of organisms that live in the same area and interact with each other and the environment. There is a feeding relationship between producers, consumers, and decomposers. We call this relationship a food chain. Plants are the producers and animals are the consumers. When the animal dies, decomposers return the matter back into the soil. Plants use the nutrients from the soil to help them grow and continue cycling the matter throughout the ecosystem.

To survive, one must eat to obtain energy and matter. Food chains describe the transfer of energy and matter within an ecosystem, from one organism to another. A food chain can describe how energy and matter are passed from one organism to the next.

When drawing a food chain an arrow (→) is used between organisms to show that energy is transferred from one organism to the next. Matter is also transferred from one organism to the next.

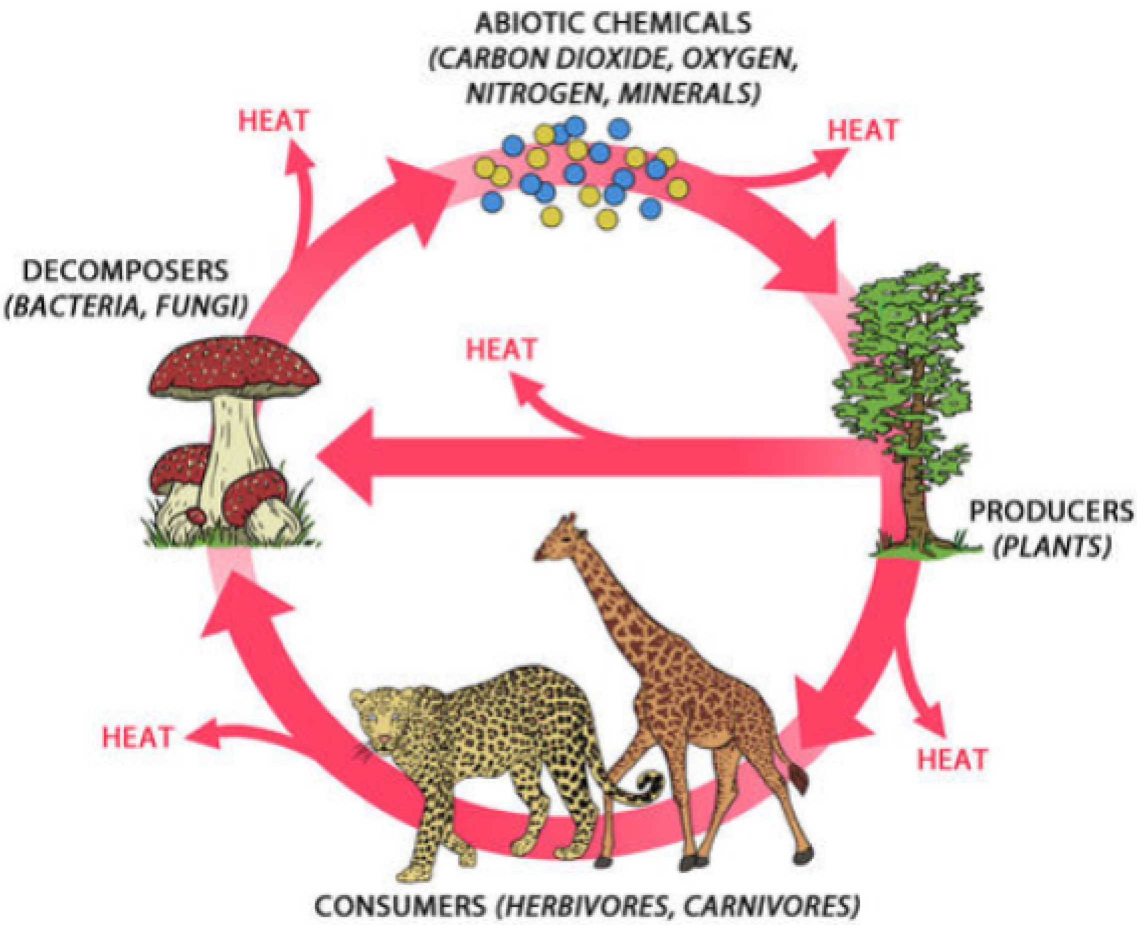
A simple food chain is: grass → cow → human → worms.



leaf to mongoose food chain by Siyavula Education, https://flic.kr/p/mFTVmg, CC-BY

A food chain represents a pathway by which energy flows and matter cycles through an ecosystem. When one organism eats another, matter is transferred to the consumer or decomposer. Some of the matter is used for bodily functions for the organism to survive, some is stored, and some is given off as waste. Matter continues to cycle through living organisms as one organism eats another or is broken down by decomposers. Some of the energy transfers, as well, and some of it is given off as heat.

Food chains are generally simpler than what really happens in nature. Their interactions are far more complex.



Putting It Together

Owl with rat by Fish and Wildlife Research Institute, https://flic.kr/p/AiT4DJ, CC-BY-NC-ND

Focus Questions:

1. How does matter cycle in an ecosystem?

2. How do decomposers help matter move through an ecosystem?

3. Owls are consumers that only eat other animals. What is the relationship between an owl, a mouse, and a plant?

Final Task

Develop and use a model to describe the movement of matter among plants, animals, decomposers, and the environment.

3.4 Conserving Resources (5.3.4)

Authentic Situation

Humans use wood for basic needs, such as building homes. This wood comes from forests around the world. Deforestation can have natural consequences.

Weyerhaeuser Millicoma Tree Farm by Francis Eatherington; https://flic.kr/p/4YQ7gP; CC BY-NC

Observations and Wonderings:

1. What is the problem in this situation?

2. What are possible criteria (positive outcomes) to this situation?

3. What are constraints (limitations) with this situation?

Focus Questions

1. How do humans use wood?

2. How can removing trees impact the land?

5.3.4 Conserve Resources

Evaluate design solutions whose primary function is to conserve Earth's environments and resources. Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution. Emphasize how humans can balance everyday needs (agriculture, industry, and energy) while conserving Earth's environments and resources. (ESS3.A, ESS3.C, ETS1.A, ETS1.B, ETS1.C)

In this section, solutions will be designed whose primary function is to conserve Earth's environments and resources.

Deforestation

Deforestation is when people remove trees from a forest. This happens for a variety of reasons, including making space for farming, animal grazing, using wood for fuel, manufacturing, and construction.

Text adapted from National Geographic: https://www.nationalgeographic.org/encyclopedia/deforestation/#:~:text=Deforestation%20is%20the%20purposeful%20clearing,altered%20landscapes%20around%20the%20world.

Many places across the world have lost trees, due to deforestation. In parts of Europe there are areas with only 34% forests that used to be 80% covered by forests. Additionally, over 18 million acres of forest are lost each year. Much of today's farmland used to be forests. Some experts estimate that we lose 27 football fields of forest each minute. At that rate, the world's rainforests could disappear in the next 100 years.

Much of the deforestation happens in the tropical rainforests of the world. Farmers use methods that burn the trees to make the ground good for farming for a few years. After that, they move their farms to other areas.

Trees help to remove carbon dioxide from the atmosphere. When they are cut down, this can result in more carbon dioxide in the air. This can cause an imbalance of gases in the atmosphere and have other consequences for Earth's environment.

Deforestation also threatens the animals and plants that live in tropical rainforests. Many animals make their homes among the trees and have to find new homes when the trees are cut down. This can also cause extinction in some species of animals or plants whose natural habitat is in rainforests.

Trees hold a lot of water in them. When they are cut down, this changes the flow of water in soil and leaves. This can lead to drought and flooding. Tree roots help hold the soil in place. When they are no longer present, it may lead to soil erosion and landslides.

Forests can be replanted (reforestation), but it can take 20-30 years for the trees to grow to full height. Even then, it takes much longer for the other plant and animal life to return back to their original state.

Forests help people with more than just wood. People enjoy spending time in forests to vacation and explore. A lot of food comes from trees, such as fruit, nuts, and maple syrup. Cork is made from tree bark and is used in shoe insoles, safety helmet liners, bulletin boards, golf balls, baseballs and more. Rubber comes from sap of some trees and is used in tires, shoes, toys, and erasers.

Image by Calibas; https://commons.wikimedia.org/wiki/File:Clearcutting-Oregon.jpg; CC BY-SA

Why Do We Need Wood?

Look around you to see where wood is used. You will find it in the paper on your desk, in the pencil in your hand, and in furniture in the classroom. Humans use wood on a daily basis for many reasons. Uses of wood in daily life include:

- Building homes and fences
- Cooking utensils
- Musical Instruments
- Art, Crafts
- Toys
- Furniture
- Shipbuilding
- Fuel
- Pencils, paper, books, notebooks, etc.
- Magazines, newspapers
- Fast food packaging, paper bags
- Envelopes, mail

Possible Solutions

Deforestation is a complex issue. Many possible solutions exist to help save our forests, while still providing us with the wood we need on a daily basis. Below are some possible solutions.

- Create laws to protect forestland
- Replant cut trees
- Reduce paper use
- Reuse items as long as possible before buying new items
- Recycle paper, cardboard, plastic, etc.
- Use recycled products, when possible
- Avoid wasting paper or other wood products
- Use other materials for building (cement, brick, steel, bamboo)
- Help educate others about how they can help save forests

Putting It Together

Weyerhaeuser Millicoma Tree Farm by Francis Eatherington; https://flic.kr/p/4YQ7gP; CC BY-NC

Focus Questions

1. Why do humans keep cutting down forests?

2. How does it affect the environment?

3. What are three possible solutions to deforestation?

Final Task

What would be the optimal solution to help balance the need for wood in everyday life while protecting the forests? Describe the solution and include the following:

- Criteria (what the solution needs to be successful)
- 2 Constraints (limitations to solving the problem)
- How the solution balances human needs with conserving forests