4th Grade Science

2018-2019

4th Grade
Utah Science Standards

Utah State Board of Education OER

2018-2019

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We especially wish to thank the amazing Utah science teachers whose collaborative efforts made the book possible. Thank you for your commitment to science education and Utah students!

Students as Scientists

Making Science

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?

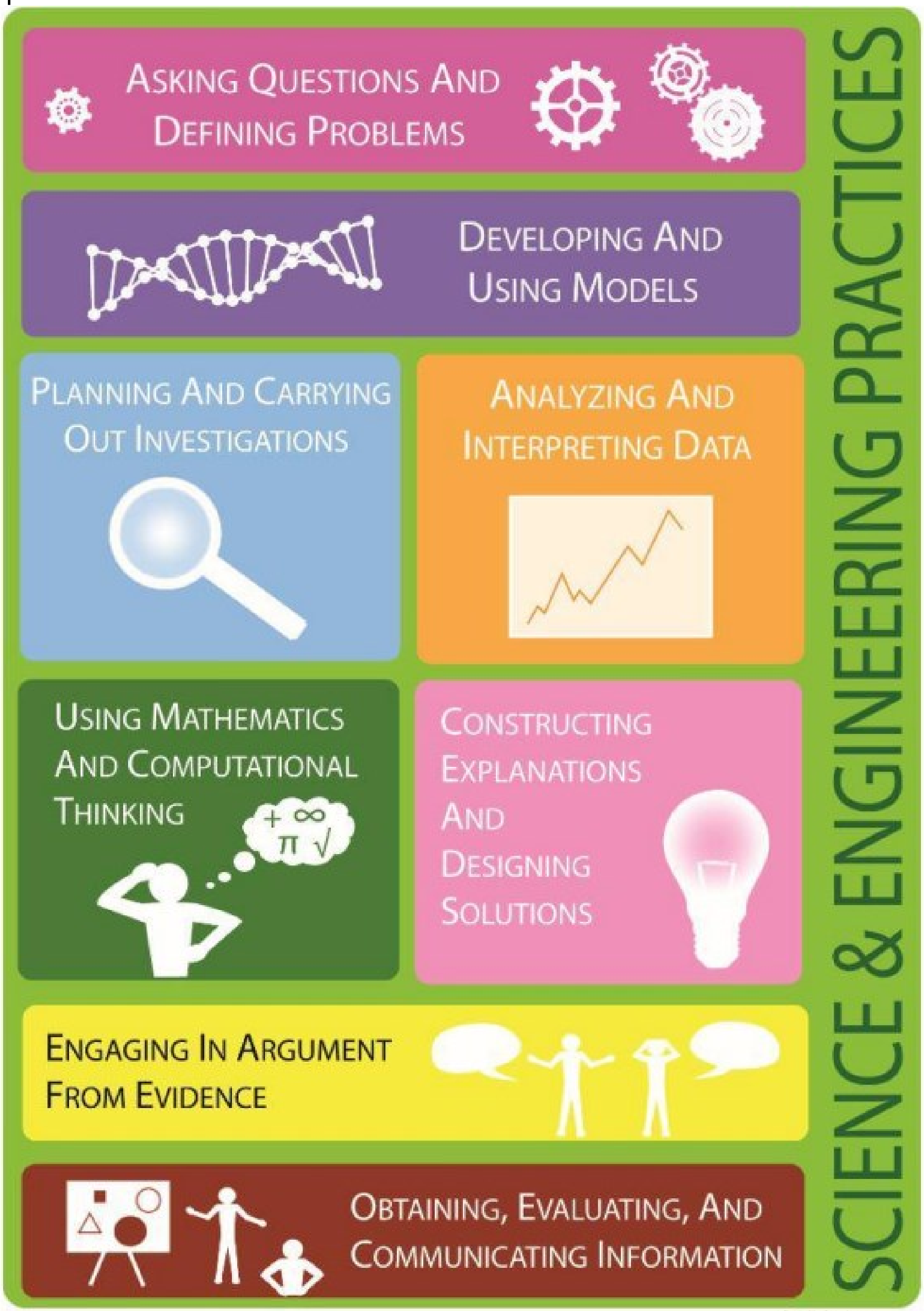
Just as there is science to be found in a puddle or a pit or a simple rock formation, there's science in a soap bubble, in a worm, in the spin of a dancer and in the structure of a bridge. But this thing we call "science" is only there if you're paying attention, asking questions, and imagining possibilities. 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

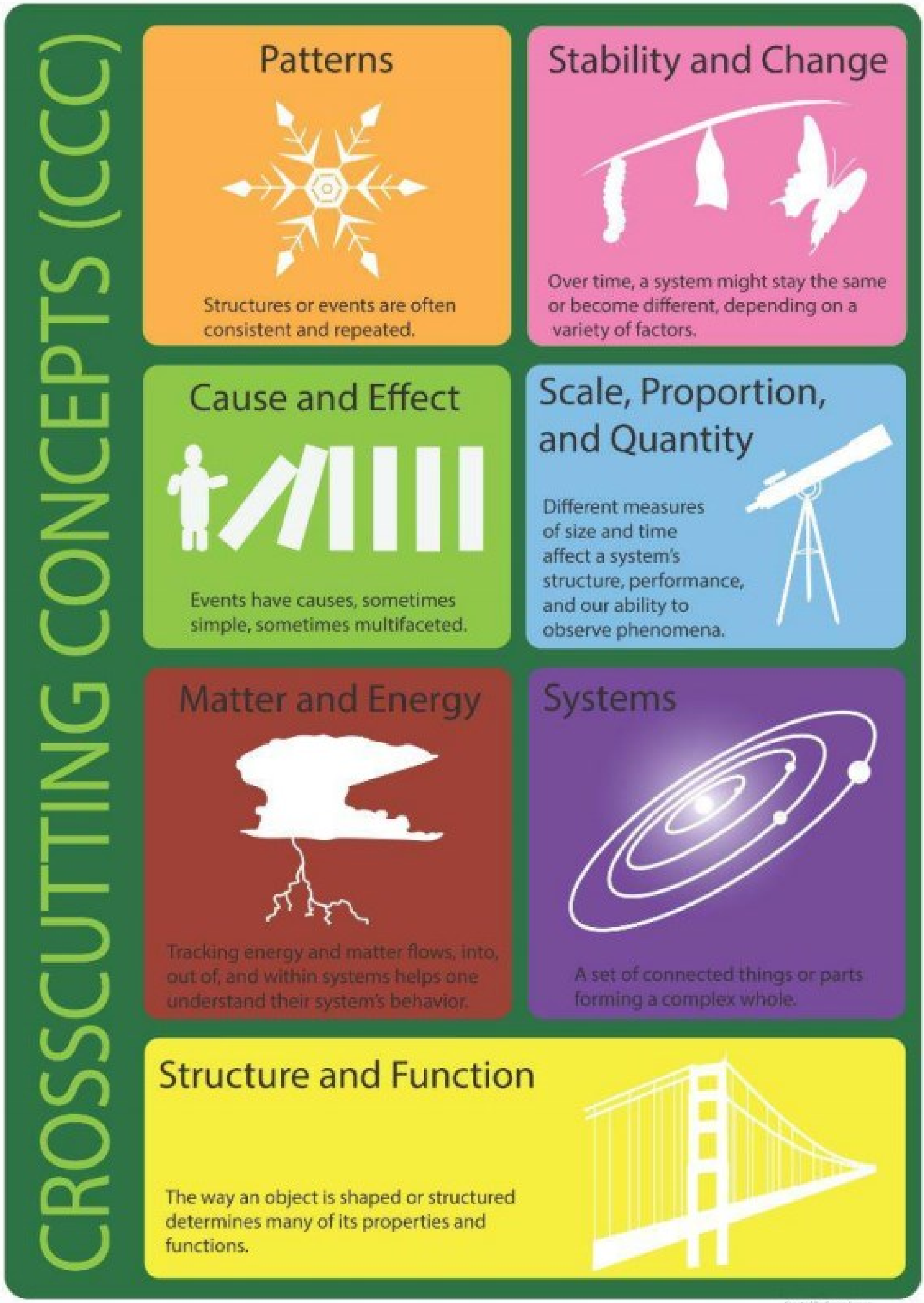
Science and Engineering Practices

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



Cross Cutting Concepts

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



A Note to Teachers

This Open Educational Resource (OER) textbook has been written specifically for students as a reputable source for them to obtain information aligned to the 3rd Grade Science Standards. The hope is that as teachers use this resource with their students, they keep a record of their suggestions on how to improve the book. Every year, the book will be revised using teacher feedback and with new objectives to improve the book.

If there is feedback you would like to provide to support future writing teams please use the following online survey: http://go.uen.org/b62

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CHAPTER 1

Standard 1: The Water Cycle

Chapter Outline

Standard 1: **Students will understand that water changes state as it moves through the water cycle.**

Objective 1: Describe the relationship between heat energy, evaporation and condensation of water on Earth.

a) Identify the relative amount and kind of water found in various locations on Earth (e.g., oceans have most of the water, glaciers and snowfields contain most fresh water).
b) Identify the Sun as the source of energy that evaporates water from the surface of Earth.
c) Compare the processes of evaporation and condensation of water.
d) Investigate and record temperature data to show the effects of heat energy on changing the states of water.

Objective 2: Describe the water cycle.

a) Locate examples of evaporation and condensation in the water cycle (e.g., water evaporates when heated and clouds or dew forms when vapor is cooled).
b) Describe the processes of evaporation, condensation, and precipitation as they relate to the water cycle.
c) Identify locations that hold water as it passes through the water cycle (e.g., oceans, atmosphere, fresh surface water, snow, ice, and groundwater).
d) Construct a model or diagram to show how water continuously moves through the water cycle over time.
e) Describe how the water cycle relates to the water supply in your community.

1.1 How Energy Affects Water

Is water more precious than gold?

My grandpa used to tell me wonderful stories as I trudged behind him through the fields of our farm. I thought he was very wise and knew just about everything. I remember one summer day we saw a beautiful rainbow after a soaking rain. The rainbow glimmered with all the beautiful colors of an artist's palette. My grandpa said there might not be a pot of leprechaun gold at the end of a rainbow, but rainbows hold another secret that most people do not know. He said, when we see a rainbow, we are seeing evidence that air contains water. Water droplets in the air break up sunlight into different colors. That is why we see a rainbow.

When I look at a globe, it seems as though much of our planet is covered with water. Grandpa explained that three-fourths of Earth is covered with water. But the amount of water we can use is small.

Most of Earth's water is in the ocean, or frozen in the polar ice caps. Just one percent of the water on Earth is fresh. Two percent is frozen in the ice caps and 97 percent is salty. When we think about Earth's water supply in those amounts, that's not much fresh, usable water for the six billion people living on Earth.

We live in a desert. Utah is the second driest state in the United States of America (USA). The driest state is Nevada. Our state receives about eleven inches of precipitation each year. Most of this precipitation falls in the mountains in the form of snow.

Grandpa said, “Water is more precious than gold.” Most of my friends think all they have to do to get water is turn on the tap. They don’t know where water really comes from or where it goes. We need to understand that we have the same amount of water on Earth today as when the dinosaurs were stomping around millions of years ago. We might be drinking the same water that a dinosaur drank long ago.

You might be asking yourself, “How can that be?” Let me explain. Grandpa said all the water that has been on Earth since the planet existed has been traveling around and around on an incredible journey called the **water cycle:** the continuous cycle by which water is circulated throughout the Earth and its atmosphere. A **cycle** is a process that “that repeats itself”. This cycle includes evaporation, condensation, and precipitation.

Water is a special substance. It is one of the few materials on Earth that exists naturally as a solid, liquid, or gas. Water can be in a solid form such as ice or snow. It can be in liquid form so we can drink it or use it for other reasons. It can also be in the form of a gas in the air where we can't even see it. This is called water **vapor:** liquid in the air in the form of a gas. But conditions need to be just right for water to change from one form to another. These changes are caused by changes in heat energy. When water is really cold, it becomes a solid. When water is cool or warm, it becomes a liquid. When water is hot, it becomes a gas.

These energy changes are measured by changes in the **temperature**: a measurement of how hot or cold something is. You have probably experienced these temperature changes when you were playing outside. All of these forms of water are considered part of the water cycle.

The sun is the energy source for these changes. Without the sun, the water cycle couldn't work. Now let's see how the water cycle works.

1.2 Water Cycle

During the water cycle, we can find water in oceans, lakes, streams, snow-capped mountains, glaciers, and groundwater. Water from these sources enter the water cycle through **evaporation:** the change of a substance from a liquid to a gas (vapor). This makes water vapor. Activities like watering our lawns on sunny days and splashing water at the swimming pool also add water vapor to the air. Can you think of other water activities you do in the summer where water evaporates?

When water evaporates into water vapor, it is pure water. All the sediments and minerals that were in the water, while the water was on the ground, stay on the ground. This means that the mud in puddles, the salt in the oceans (and the Great Salt Lake), and any pollutants in water stay on the surface of Earth.

Condensation: water vapor that cools and changes back into a liquid. Condensation can be observed on a cloudy bathroom mirror. Taking a bath or shower puts a lot of water vapor into the air. When warm water vapor hits the cold surface of the mirror, the water particles in the air collect or condense on the surface of the mirror and turn back to liquid as tiny water droplets.

Think about a tall glass filled with lemonade and ice cubes. Within minutes, water vapor in the warmer air will condense on the outside of the glass because the glass is a cold surface. This means there is water vapor in the air. When this water vapor hits any cold surface, water particles will form water droplets on the object.

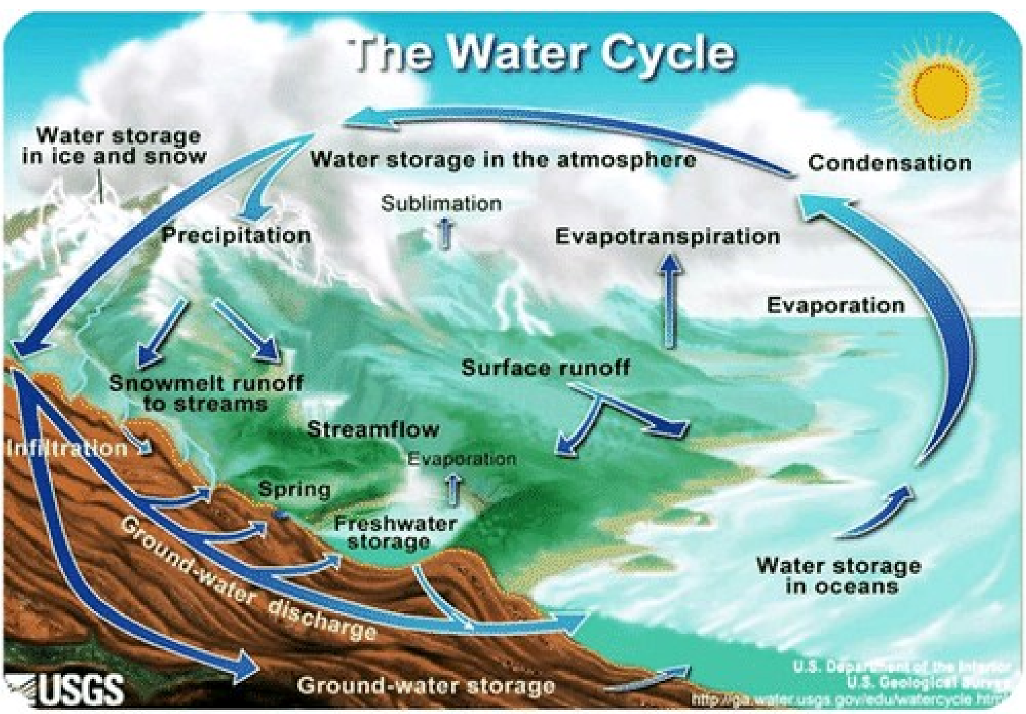
You have probably observed **dew**: condensation that occurs outdoors due to warmer air striking a colder surface on your lawns on some mornings. The ground was cold enough to condense the water vapor on the grass to create dew.

Clouds are formed from condensation. As the warmer water vapor rises into the air, it begins to cool and turn back into water droplets. The droplets attach themselves to dust particles in the air. This is how clouds are formed. Clouds are a collection of millions of tiny water droplets or ice crystals.

As warm water vapor cools high in the air, it condenses into a cloud. Grandpa said when the temperature in the clouds are cold enough, and as the water droplets connect to each other, they get heavy enough to fall to Earth's surface. The heavy water droplets fall to earth as rain, snow, sleet, or hail. This is called precipitation.

The water cycle does not have a real starting or ending point. It is an endless process that involves the oceans, lakes, and other bodies of water, as well as the land surfaces and the atmosphere. The steps in the water cycle are as follows, starting with the water in the oceans:

- Water evaporates from the surface of the oceans, leaving behind salts. As the water vapor rises, it collects and is stored in clouds.
- As water cools in the clouds, condensation occurs.
- Condensation creates **precipitation:** any form of water that falls from clouds onto Earth's surface–includes rain, snow, hail, and sleet. The precipitation allows the water to return again to the Earth's surface.
- When precipitation reaches land, the water can sink into the ground to become part of our underground water reserves, also known as groundwater. Much of this underground water is stored in **aquifers:** porous layers of rock that can hold water. The water can also become **runoff:** precipitation that is not absorbed by the soil and flows over the surface of the ground, and collect in existing lakes, rivers, streams, or other collections of water.



The water cycle is important to all living things. Without the continuous return of fresh water to the land, plants and animals couldn't exist. If you had been in the desert without water for a couple of days, and someone offered you gold or a large glass of water, which would you choose? Like Grandpa said, "Water is more precious than gold!" If we don't use it wisely, we won't have enough to go around. We can't create more water. The water that was here for the dinosaurs is all that's available for the people on our planet today. We need to always be thinking of ways to save our precious "liquid gold" or water. "Waste not, want not," my Grandpa said.

1.3 Summary Section

Science Language Students Should Know and Use

- Aquifers: porous layers of rock that can hold water.
- Clouds: a collection of millions of tiny water droplets or ice crystals.
- Condensation: water vapor that cools and changes back into a liquid.
- Dew: condensation that occurs outdoors due to warmer air striking a colder surface.
- Evaporation: the change of a substance from a liquid to a gas (vapor).
- Precipitation: any form of water that falls from clouds onto Earth's surface as rain, snow, sleet, or hail.
- Runoff: precipitation that is not absorbed by the soil and flows over the surface of the ground
- Temperature: a measurement of how hot or cold something is.
- Water cycle: the continuous cycle by which water is circulated throughout the earth and its atmosphere.
- Vapor: liquid in the air in the form of a gas.

Think like a Scientist

1. What is precipitation?
2. Name a form of precipitation.
3. What is evaporation?
4. What is water vapor?
5. What is a cycle?
6. What happens to rain that falls to the earth?
7. What is a cloud made of?
8. What happens when a cloud becomes too heavy with water vapor?
9. Does the water cycle ever stop?
10. What is accumulation/collection?
11. What is condensation?
12. Name all the parts of the water cycle.

CHAPTER 2

Standard 2: Weather

Chapter Outline

Standard 2: Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1: Observe, measure, and record the basic elements of weather.

a) Identify basic cloud types (i.e., cumulus, cirrus, stratus clouds).
b) Observe, measure, and record data on the basic elements of weather over a period of time (i.e., precipitation, air temperature, wind speed and direction, and air pressure).
c) Investigate evidence that air is a substance (e.g., takes up space, moves as wind, temperature can be measured).
d) Compare the components of severe weather phenomena to normal weather conditions (e.g., thunderstorm with lightning and high winds compared to rainstorm with rain showers and breezes).

Objective 2: Interpret recorded weather data for simple patterns.

a) Observe and record effects of air temperature on precipitation (e.g., below freezing results in snow, above freezing results in rain).
b) Graph recorded data to show daily and seasonal patterns in weather.
c) Infer relationships between wind and weather change (e.g., windy days often precede changes in the weather; south winds in Utah often precede a cold front coming from the north).

Objective 3: Evaluate weather predictions based upon observational data.

a) Identify and use the tools of a meteorologist (e.g., measure rainfall using rain gauge, measure air pressure using barometer, measure temperature using a thermometer).
b) Describe how weather and forecasts affect people's lives.
c) Predict weather and justify prediction with observable evidence.
d) Evaluate the accuracy of student and professional weather forecasts.
e) Relate weather forecast accuracy to evidence or tools used to make the forecast (e.g., feels like rain vs. barometer is dropping).

2.1 Elements of Weather

How do you decide what to wear each morning? Do you look outside and see what the atmosphere is?

Have you ever watched a weatherman on T.V. to see if he/she will predict rain or good weather for your birthday party or for the big game on Saturday? Do you check the weather? What sources can you use to get current weather information?

Weather affects our everyday lives. However, it is more important for some than others. For example, a pilot, a construction worker, a fisherman, or a farmer, all need weather information to do their jobs.

Forecasting: predicting the weather, is also necessary for our safety. It is important to be **accurate**: correct as possible when predicting the weather, to help give people plenty of warning for changes in the weather. When planning a vacation, wouldn't it be important to know if it was going to be sunny, rainy, windy, or snowy?

Consider this story

It was 12:15 PM on August 11, 1999. Fourth grade students at Rosamond Elementary School in West Jordan, Utah went outdoors to observe the weather to record information for their school's web site. Today's report would be different. A strange phenomenon was about to occur. The air temperature was 21˚Celsius (70˚F) under very windy conditions. Looking to the west, the students noticed dark clouds over Herriman, Utah. The students took two pictures of the dark clouds, then returned to class and entered their information into the computer. An hour later, the students were shocked to hear that a thunderstorm and a tornado had struck downtown Salt Lake City, causing much damage. As they watched the news, they realized the storm had begun with hailstones in Herriman at about 12:00 PM. Their pictures showed the beginning of the thunderstorm that formed the tornado.

Dark clouds over Herriman

Clouds are an important component of weather. When water evaporates from Earth's surface, it turns into water vapor in the atmosphere. Clouds form when the temperature of the air gets cooler. The water vapor condenses on dust particles into tiny water droplets.

There are three main types of clouds:

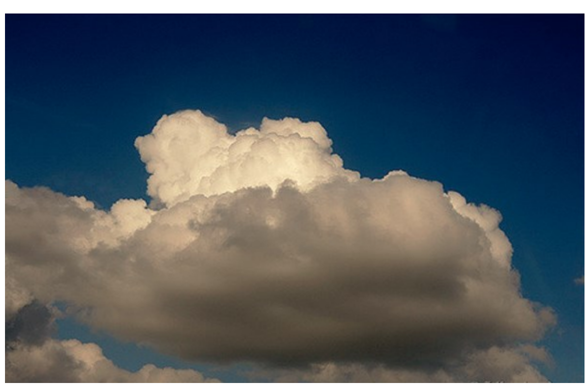
- cirrus
- stratus
- cumulus

Each of these cloud types are found with different types of weather.

Cirrus Clouds: thin and wispy (curly) clouds often appear when there is going to be a change in the weather.

Stratus Clouds: layered clouds are often gray and usually signal rainy weather.

Cumulus Clouds: thick puffy clouds and are called "fair weather" clouds because they appear on nice days. Sometimes cumulus clouds can grow into huge clouds, called cumulonimbus clouds and they can cause thunderstorms. Look at the next pictures and see if you recognize the three types of clouds.



Answers: Cirrus, Cumulus, Stratus

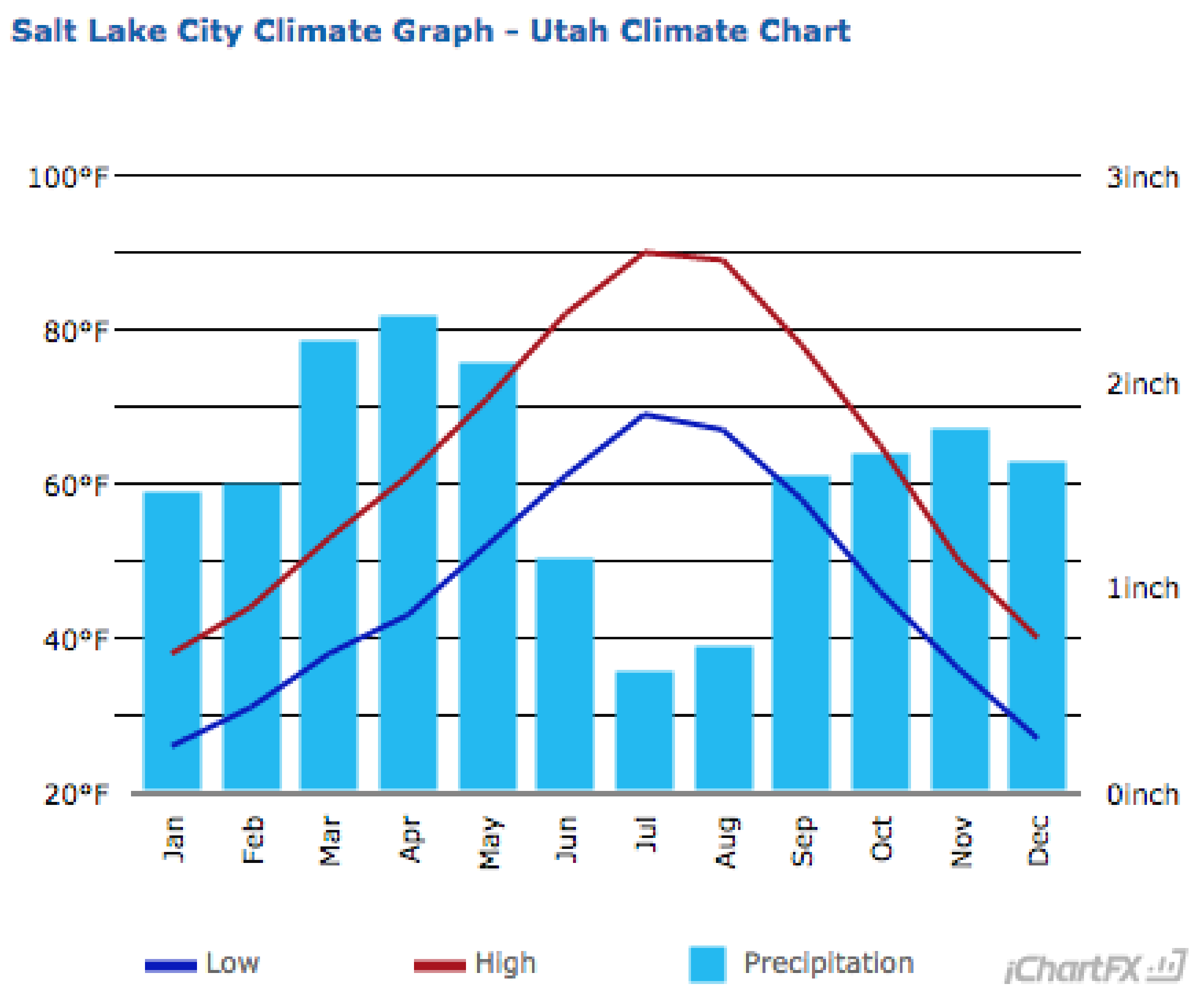
Meteorologists: scientists who study the weather. They measure the basic components of weather so they can predict what the weather will be. They measure: air temperature, wind speed, precipitation, and air pressure.

Measuring the air helps compare mild weather to **severe:** harsh or unusual, weather. Meteorologists have collected weather information for many years and know what weather is **seasonal:** normal for the time of year. Generally, we get warm, high temperatures, including some wind, rain, and lightning during the summer. Weather can be beautiful to watch and listen to. Occasionally during the summer, huge dark clouds bring in strong winds, huge lightning bolts, loud thunder, larger-sized hail, and a lot of rain. The wind may uproot trees and damage homes. Lightning may strike trees and houses.

Severe: storms cause damage. Sometimes fires are started by lightning. Hail can strip trees and crops of their fruits and leaves. Hail can also pit cars and ruin shingles on roofs. Rain can cause flash flooding that damages homes, yards, crops and roads. Weather that is hotter or colder and wetter or drier than usual can have a big effect on people. Occasionally farmers lose their crops because of freezing air temperatures. Other times farmers may lose their crops because it is too hot and there has not been enough rain.

2.2 Weather Patterns

Fortunately, these weather **phenomena: unusual events or facts that can be seen or sensed,** do not happen very often. Over the years as meteorologists have recorded weather data, they have noticed patterns.



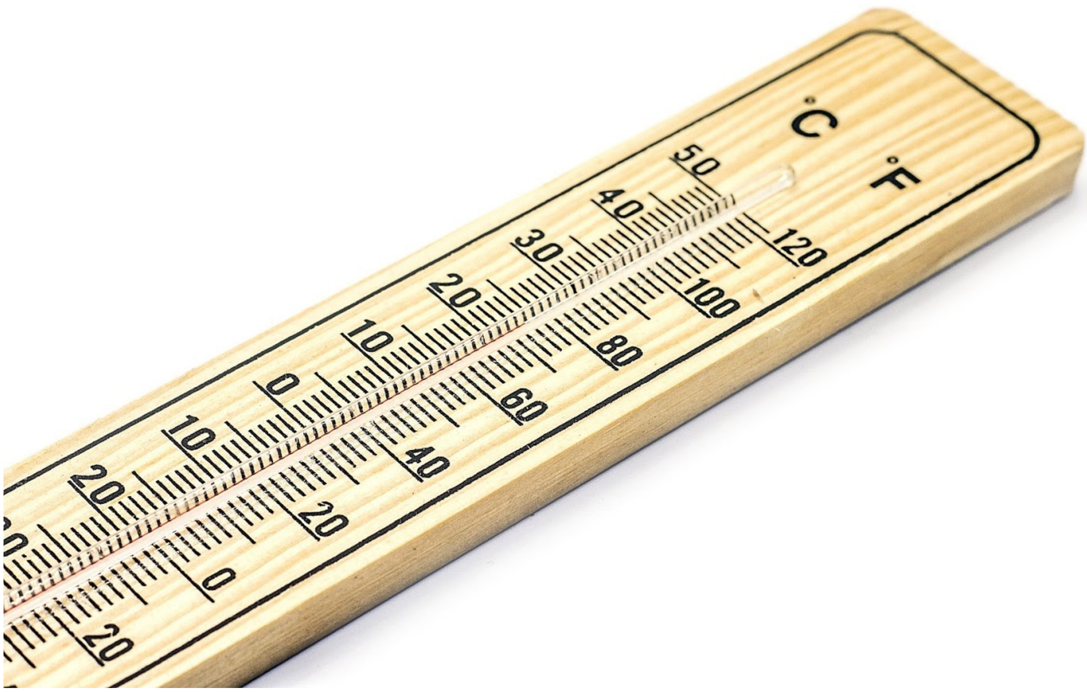
We could make a similar graph for rainfall. During what month do you think Utah receives the most rainfall? This rhyme might help: April showers bring May flowers. What do you think?

Part of a meteorologist's job is to make forecasts. A meteorologist notes all the weather information available. By looking at patterns and past weather conditions, a forecast is made. The people who watch the forecast hope it is accurate because people make plans according to the forecast. Sometimes a meteorologist's forecast is wrong. For example: winds, changing temperatures, and a low air pressure usually come before a storm in Utah. But sometimes, at the last minute, the storm takes a different path and misses us.

2.3 Weather Predictions

Meteorologists use different tools to help record weather data

Air Temperature



Thermometer

Air temperature: how hot or cold air is, can be measured using a **thermometer**: an instrument that measures temperature. Two types of thermometers may be used. A metric thermometer measures in degrees Celsius. The Fahrenheit thermometer measures temperature in degrees Fahrenheit. Room temperature is about 20º Celsius or 70ºF. Scientists use Celsius to measure temperature. Sudden changes in temperature help meteorologists predict what the weather will be in the near future.

Wind Direction and Speed

Wind direction is defined by the direction from which the wind is coming. Weather vanes are sometimes called wind vanes, the most common instrument used to find wind direction. You may have seen weathervanes on top of barns. The rooster points in the direction from which the wind is coming. Another common instrument is a windsock, an instrument used to show wind direction. Wind socks are commonly used at airports or on top of tall buildings in cities. Another way to find wind direction is to stand with your face toward the wind. If the wind is in your face and you are facing south, the wind is a south wind.

Weather Vane

Knowing from which direction the wind is coming can help predict what kind of storm to expect.

Wind speed: how fast the air is moving, is measured by an instrument called an anemometer that is moved by the wind. Strong winds often tell us there is a change in the atmosphere. Typically in Utah, a strong wind in the autumn, winter, or spring tells us a storm may be approaching, bringing colder temperatures.

Anemometer

Wind Sock

Precipitation

It’s important to know how much precipitation we get from storms. We measure precipitation in inches with a **rain gauge**: a container set outside to measure the amount of precipitation during a storm. By putting a straight-sided cup outside with the side marked in 14 inches, we can tell how many inches (or part of an inch) it rains during storms.

When the air temperature is **freezing**: at or below 0°C or 32°F, rain turns to snow. A ruler can be used to measure the amount of snow in inches. Usually, in Utah, the amount of rainfall in our valleys varies from 1/18th of an inch to one inch per storm. The amount of snowfall will vary from one inch to 12 inches. The mountains will get much more rain or snow than the valleys. Measuring rainfall and snowfall tells us how big a storm is compared to other storms of the past. You may even remember a big snowstorm when snow was measured in feet, not inches!

Rain Gauge

Air Pressure

Air pressure: the weight of air on Earth's surface, can be hard to understand because air is invisible. Air takes up space, moves as wind, and has a measurable temperature. You can prove to yourself that air is a substance by fanning your face with a piece of paper in your hand. What you feel on your cheek is air. Air comes in handy for us. We fill our lungs, car tires, playground balls, and balloons with air.

Since air above Earth is several miles thick, it is heaviest near the surface. The bottom layer of air, closest to Earth's surface, is like having a birthday cake with many layers. The layer on the bottom is holding up the weight of the other layers. The layer on the top isn't squished at all because it isn't holding up the weight of the cake layers below. Therefore, the air closest to Earth has greater air pressure because of the weight of the air on top of it. We don't notice the weight because we are used to it.

Changes in the air pressure occur constantly in the atmosphere. We don't notice this change because the change is too small. But even the slightest change in air pressure affects our weather.

A **barometer:** an instrument that measures air pressure, is used to measure changes in air pressure. If the air pressure is less than usual, it is called a low. A low pressure usually brings in a storm. If the air pressure is greater than usual, it is called high pressure. High air pressure often brings clear skies. Barometers help us forecast what the weather will be in the next few days.

Barometer

Air Pressure Explained: http://goo.gl/gQCOM

People sometimes make forecasts based on non-scientific evidence, such as how their knees or other body joints feel. Sometimes they are right, but most of the time, knees are not accurate scientific tools. Weather is important for all of us to learn about and use as we plan our daily events. Won't you look smart when you are the only one with an umbrella on a rainy day?

2.4 Summary Section

Science Language Students Should Know and Use

- Accurate: correct as possible when predicting the weather
- Air pressure: the weight of air on Earth's surface
- Air temperature: how hot or cold air is
- Atmosphere: air around Earth
- Barometer: an instrument that measures air pressure
- Cirrus: thin, and wispy (curly) clouds often appear when there is going to be a change in the weather
- Cumulus: thick, puffy clouds
- Freezing: temperatures at or below 0˚C or 32˚F
- Forecast: predicting the weather
- Meteorologist: a scientist who studies weather
- Phenomenon: an unusual event or fact that can be seen or sensed
- Precipitation: water that falls from clouds in the form or rain, snow, hail or sleet
- Rain gauge: a container set outside to measure the amount of precipitation during a storm
- Severe: harsh or unusual
- Seasonal: normal for the time of year
- Stratus: layered clouds are often gray and usually signal rainy weather
- Thermometer: device used to measure temperature
- Wind speed: how fast the air is moving

Think like a Scientist

1. Explain why having knowledge of the weather is important to our lives.

2. List three things you have learned about the weather.

3. Collect your own weather/temperature data and graph the data.

4. Write a short report on the data you have collected.

CHAPTER 3

Standard 3: Rocks and Soil

Chapter Outline

Standard 3: Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 1: Identify basic properties of minerals and rocks.

a. Describe the differences between minerals and rocks.

b. Observe rocks using a magnifying glass and draw shapes and colors of the minerals.

c. Sort rocks by appearance according to the three basic types: sedimentary, igneous and metamorphic (e.g., sedimentary-rounded-appearing mineral and rock particles that are cemented together, often in layers; igneous-with or without observable crystals that are not in layers or with or without air holes or glass like; metamorphic - crystals/minerals, often in layers).

d. Classify common rocks found in Utah as sedimentary (i.e., sandstone, conglomerate, shale), igneous (i.e., basalt, granite, obsidian, pumice) and metamorphic (i.e., marble, gneiss, schist).

Objective 2: Explain how the processes of weathering and erosion change and move materials that become soil.

a. Identify the processes of physical weathering that break down rocks at Earth's surface (i.e., water movement, freezing, plant growth, wind).

b. Distinguish between weathering (i.e., wearing down and breaking of rock surfaces) and erosion (i.e., the movement of materials).

c. Model erosion of Earth materials and collection of these materials as part of the process that leads to soil (e.g., water moving sand in a playground area and depositing this sand in another area).

d. Investigate layers of soil in the local area and predict the sources of the sand and rocks in the soil.

Objective 3: Observe the basic components of soil and relate the components to plant growth.

a. Observe and list the components of soil (i.e., minerals, rocks, air, water, living and dead organisms) and distinguish between the living, nonliving, and once living components of soil.

b. Diagram or model a soil profile showing topsoil, subsoil, and bedrock, and how the layers differ in composition.

c. Relate the components of soils to the growth of plants in soil (e.g., mineral nutrients, water).

d. Explain how plants may help control the erosion of soil.

e. Research and investigate ways to provide mineral nutrients for plants to grow without soil (e.g., grow plants in wet towels, grow plants in wet gravel, grow plants in water).

3.1 Rocks and Minerals

Is it a Rock or Mineral?

We live on a rocky world! Rocks are all around us. We live on rocks even though we can't always see them. These rocks are sometimes hidden deeply beneath our feet, and sometimes they are exposed on Earth's surface so we can see them. On mountaintops, where the soil is very thin, rocks often poke through.

All rocks are made of mixtures from different **minerals: substances occurring in nature usually with a defined crystal structure**. Minerals are the building blocks from which rocks are made. People who study rocks make observations of rocks they discover. They identify the different minerals in the rocks they find. How can they do this?

Each mineral has a certain color (or colors), appearance, shape, hardness, texture, crystal pattern, and possibly a smell that sets it apart from another. As scientists test each mineral's characteristics, they are able to tell which minerals are in the rocks.

Rocks can change over a period of time. The rocks we see today may have looked differently millions of years ago. How rocks change depends on the type of rock and where it is found on Earth.

Types of Rock

There are three types of rocks:

- Sedimentary Rocks
- Igneous Rocks
- Metamorphic Rocks

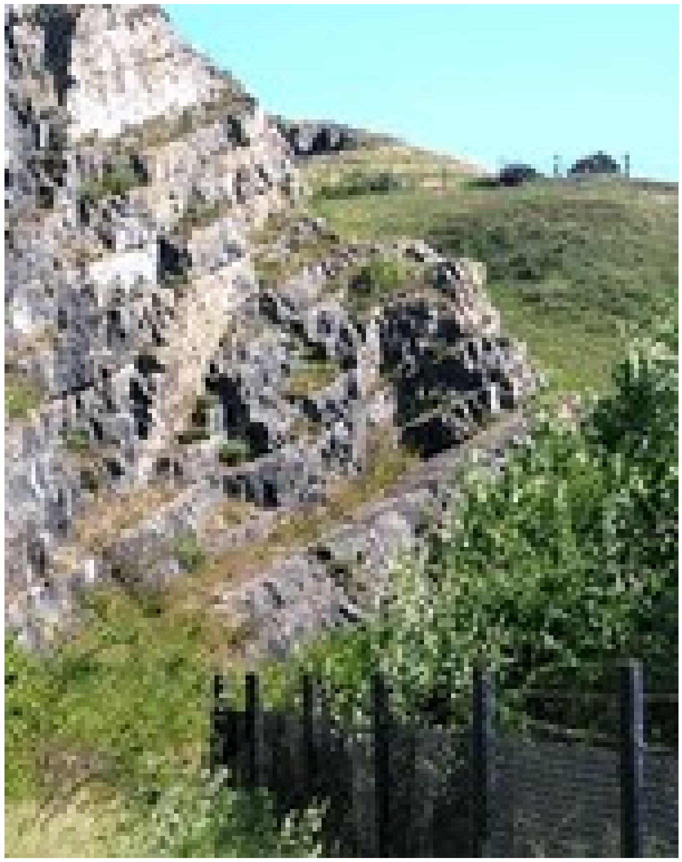
Sedimentary Rocks

When sand grains and other materials collect on top of each other, they form a layer of sediment. Over time, new layers of sediment are deposited on the previous layers. Over a very long time, these sediments compact, harden, and become a **sedimentary** rock. This happens because the sediments become glued together. The weight of more sediments press down, applying pressure to lower layers. We can actually see these layers in sedimentary rock; they are sometimes different colors. Find the layers in the next pictures below.

How many different colored layers in this sedimentary rock do you see?

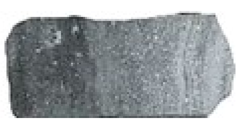
Look at these layers in this sedimentary rock known as shale.

Sandstone sedimentary rock.



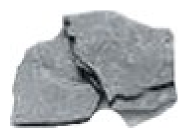
Layers of limestone sedimentary rock.

Sedimentary rocks usually have rounded sediments, or particles, and are often layered. Some common types of sedimentary rocks found in Utah are: sandstone, conglomerate, and shale.



Sandstone

Conglomerate



Shale

Igneous Rocks

Magma is melted rock beneath the Earth's crust. Lava is melted rock that reaches the Earth's crust. **Igneous** rock is formed when magma and lava cools. The appearance of an igneous rock is determined by two things: the composition of the melted rock, and how fast it cools. The rate of cooling also determines the texture of the rock.

It may take many years for magma to cool. As it slowly cools, the igneous rock formed may have crystals, which are very easy to see. Lava cools quicker than magma. Because the surface of the rock cools rapidly, these rocks may have air holes in them or appear glass-like. They hardly ever form crystals and are never layered.

Many igneous rocks are found in Utah. The following pictures are four igneous rocks that are very common in Utah: obsidian, granite, pumice, and basalt. Obsidian looks like black glass. Native Americans often used this rock to make spears and arrowheads.

Granite is often used as a building material. It has visible crystals in it. Pumice floats on water because there are air pockets in this rock. Basalt is a heavy, dark rock because it has the element, iron, in it. Basalt may have air holes throughout it also, but it doesn't float. Many people use this rock for decoration in their yards. Which of these igneous rocks formed inside the Earth? Which ones formed on Earth's surface?




Obsidian Granite Pumice Basalt

Metamorphic Rocks

Metamorphic rocks begin as one of three kinds of rock. The starting rock can be igneous, sedimentary, or even another metamorphic rock. Heat and/or pressure then change the rock into a **metamorphic** rock.

Heat comes from volcanoes and hot rocks under Earth's surface. The pressure comes from the layers of rock pressing down on all the rock layers below them. Both heat and pressure must exist at the same time to form metamorphic rocks. These rocks may have crystals or layers. Sometimes we call the crystals gems because they are rare or valuable. Some of the most valuable gemstones like rubies, sapphires, and garnets are found in metamorphic rocks. Other kinds of metamorphic rocks may be used in buildings, jewelry, and art, because of their beauty.

Metamorphic rocks found in Utah are marble, gneiss (pronounced “nice”), and schist. Marble starts out as limestone. Under heat and pressure, the crystals in limestone recrystallize, making marble harder and stronger than limestone. Marble is used in buildings and carving statues.

Gneiss begins as granite. Under heat and pressure the minerals line up with each other, giving the rock a banded appearance.

Schist began as clay sediment. Erosion transported the clay sediments through water to the bottom of a lake or shallow sea. As pressure increased and mineral cementing took place, the clay turned into shale, a sedimentary rock. When heat is added, it turns shale into slate, a metamorphic rock. If the heat and pressure continues, mica crystals begin to form in the slate. These mica crystals grow together, giving schist a very shiny and sparkly appearance.

3.2 Weathering and Erosion

What is Weathering?

Weathering changes solid rock into sediments. Sediments are different sizes of rock particles. Boulders are sediments; so is gravel. Silt and clay are also sediments, but much smaller in size compared to boulders or gravel. Weathering causes rocks on the Earth's surface to change form.

It takes a long time for a rock or a mountain to weather. Roads can weather quicker than a rock in nature. If you live in a part of the world that has cold winters, you might only have to wait one year to see a new road start to weather.

Physical Weathering

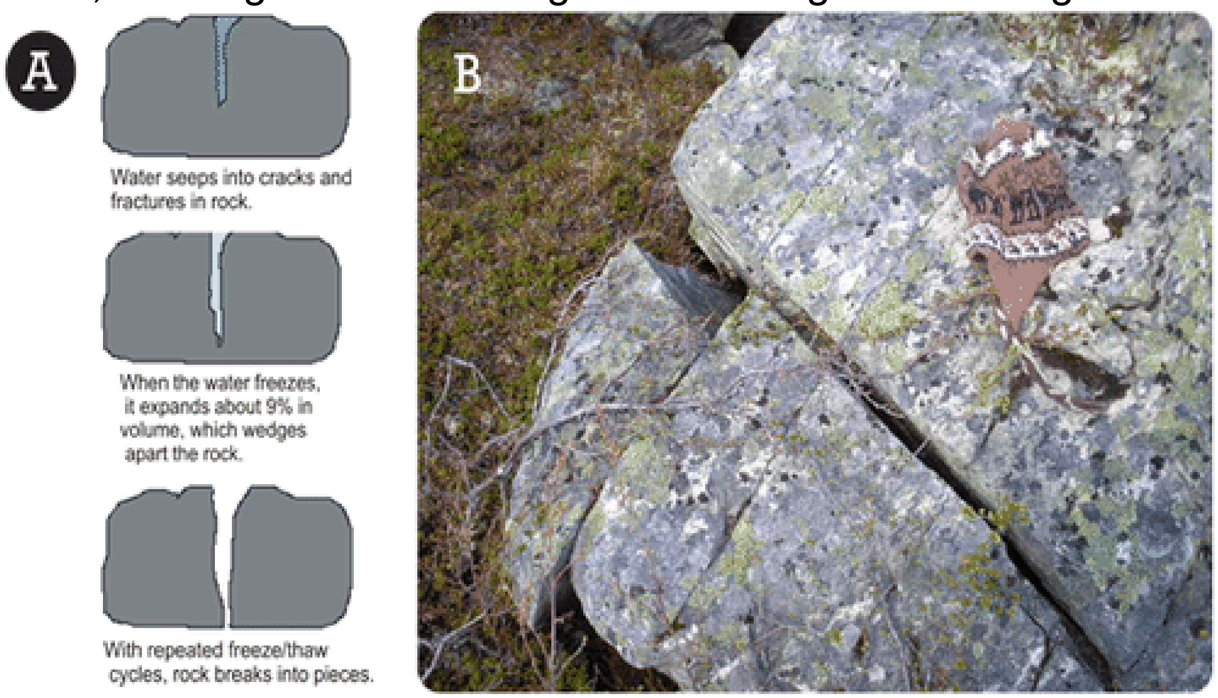
Physical **weathering** breaks rock into smaller pieces called sediments. These smaller pieces are just like the bigger rock but smaller! The rock has broken without changing its composition. The smaller pieces have the same minerals. You could use the idiom "a chip off the old block" to describe physical weathering! The main agents of physical weathering are water movement, freezing, plant growth, and wind.

Water Movement

As precipitation strikes against rock, some minerals break down easier than others. This causes rocks to break into smaller pieces. This breakdown of sediments can also be caused by other water sources such as streams, lakes, and rivers.

Freezing

Weathering by freezing (sometimes referred to as ice wedging) is common where the temperature goes above and below freezing. 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, allowing more water to gather creating an even larger crack.



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(A) Diagram showing ice wedging. (B) Ice wedging along the joints in this rock helped to break it apart.

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. You may also have seen this if you put a can of soda into the freezer so that it cools down quickly. If you leave the can in the freezer too long, the liquid expands so much that it bends or pops the can.

You can find large piles of broken rock at the base of a slope. These rocks were broken up by freezing water.

Plants and Animals in Weathering

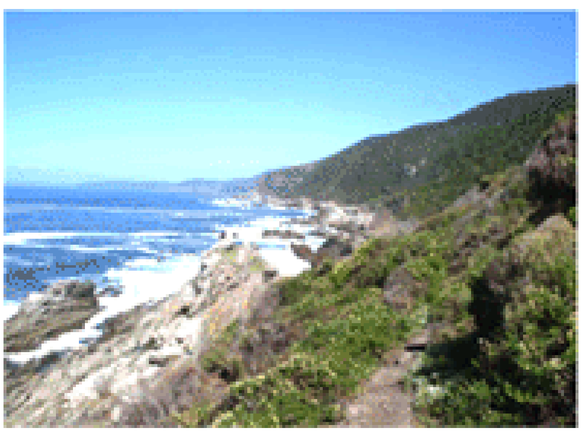
Sometimes biological elements cause mechanical weathering. This can happen slowly. A plant's roots may grow into a crack in a rock. As the roots grow larger, they wedge open the crack. Burrowing animals can also cause weathering. By digging for food or creating a hole to live in, the animal may break apart rock. Today, human beings do a lot of mechanical weathering wherever we dig or blast into rock. This is common when we build homes, roads, tunnels, or quarry stone for construction or other uses.

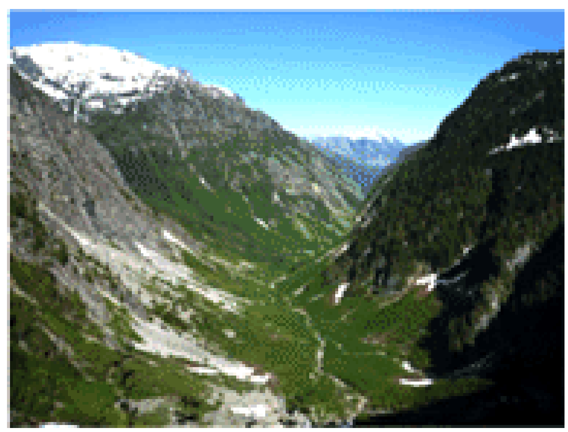
Gravity and moving water causes rocks to bump against each other causing rocks to break down. Strong winds also cause weathering by blowing sand against rock surfaces. Finally, the ice in moving glaciers can cause weathering. Pieces of rock embedded in ice at the bottom of a glacier scrape against the rock below as the glacier slowly moves downhill.

If you have ever collected beach glass or pebbles from a stream, you have witnessed another example of weathering. Rocks on a beach are worn down by weathering as passing waves cause them to strike each other.

Erosion

The broken rock or sediments resulting from weathering may not stay in one place very long. They may be carried away by wind, moving water, or moving ice. This is called **erosion:** the movement of rock fragments from one place to another.





3.3 Soil

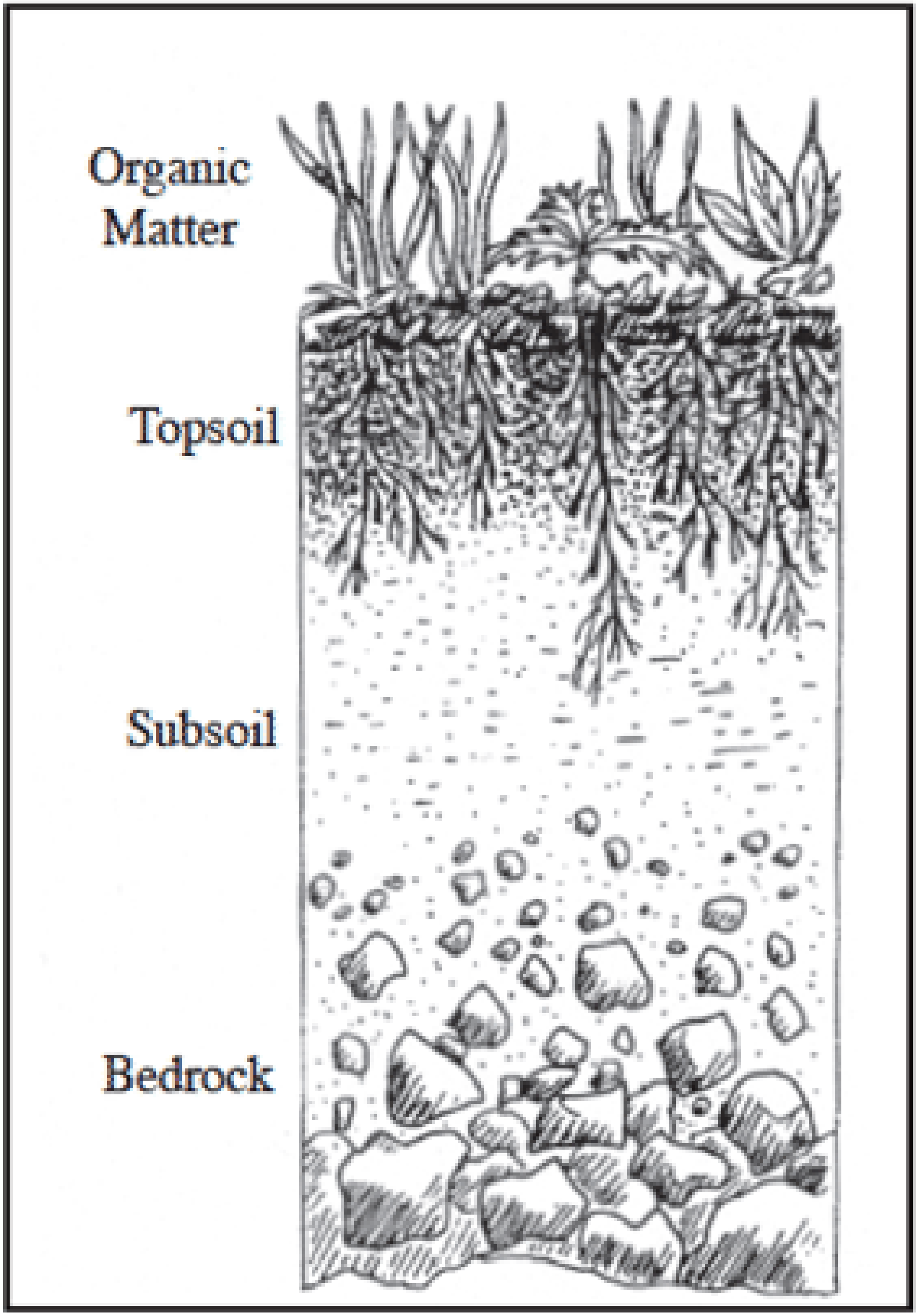
What are the Characteristics of Soil?

Soil forms as a result of weathered rock. Soil is partially made up of particles of rocks and minerals. Rocks and minerals are soil components. The particles of rocks and minerals found in soil have broken away from larger pieces of rocks and minerals. Most of the particles are in very small pieces but of different sizes.

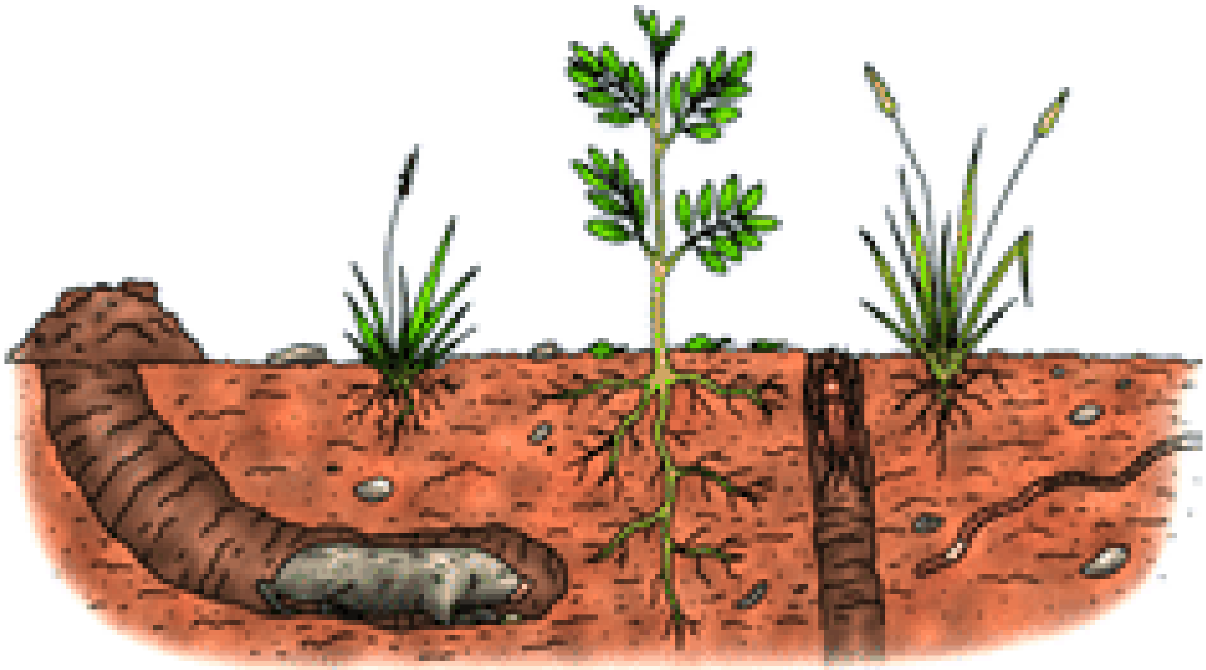
The best soils for growing crops have equal amounts of large, medium, and small-sized particles. Other parts of soil are water and air. Water and air are important for plant growth.

Soil also contains organisms. Living **organisms:** (living plant or animal life), are an important part of soil. Living organisms break down or decompose dead plants and dead animals. This makes soil rich and healthy for plants to grow in. Look at the **soil profile:** (a side view "slice" of the different layers of earth) to the right. If you dug a hole into the soil, you would see that it has layers like this one. An average soil profile consists of three layers: topsoil, subsoil, and bedrock.

Soil Profile

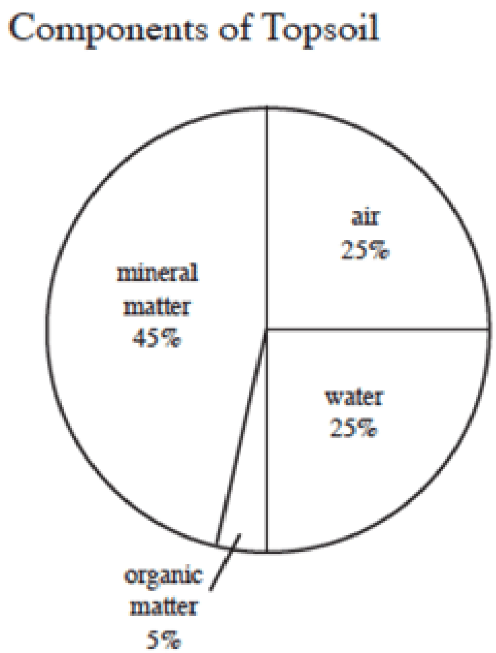


Topsoil



The top layer of soil is called **topsoil**. This layer of soil contains living organisms and **nonliving;** never lived, things. This layer is usually darker in color because it contains many living and dead organisms. Because the topsoil is rich in nutrients, creatures like earthworms, insects, and snails live in this layer. **Nutrients** are substances that organisms need in order to survive and grow. When these living creatures decompose dead plant and animal material, more nutrients are added into the soil. These nutrients become small enough to be absorbed by the roots of plants. The topsoil layer is where plants can absorb water, mineral nutrients, and air. All animals live off this layer. Without this layer, life on Earth would be impossible. It takes about one thousand years to create about one inch of topsoil.

The following circle graph shows the percentage of the materials in topsoil.



Subsoil

The middle layer is the **subsoil**. This layer is below the topsoil. It has larger rocks and minerals and is usually lighter in color. Plants do not grow well in subsoil because it is packed tightly and has very few nutrients.

Bedrock

The bottom layer of a soil profile is **bedrock**. The bedrock layer has not yet been broken down. Bedrock is made up of different rocks in different places. It is the bedrock that erodes and eventually becomes topsoil. Bedrock can be within a few inches of the surface or many feet below it.

Activity 1: Soil Observation: Document your findings.

Materials:

- A clean quart size freezer Ziploc bag. Fill the bag halfway full of moist topsoil (moist means it is a little wet to touch).
- A magnifying glass or hand lens.
- White paper to cover desks (white bulletin board paper).
- Toothpicks, tweezers, or other objects that you may use to move and sort your soil.

Instructions:

- Smell your soil. Does your soil have a smell?
- Pour about a 1/4 cup of the topsoil on the paper and spread it out.

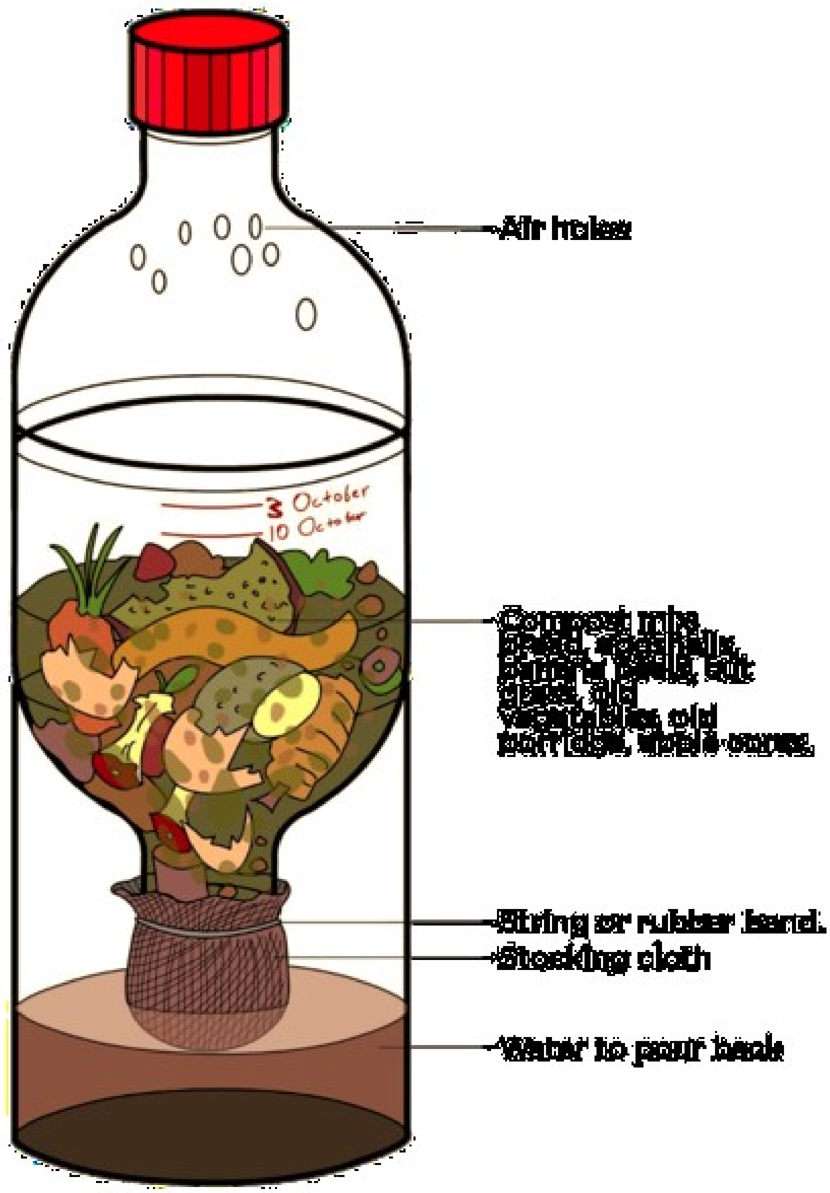
- Use your toothpick or other object to move the soil looking for what you might find.
- Look at the soil with the magnifier.
- Sort the soil into piles of bits that look the same.

Observe your soil sample:

- Sort your soil by size of rock grains. You will find small, medium, and larger pieces of rock.
- Next, sort your soil by pieces of plants, sticks, leaves, and roots.
- Your last sort will include small pieces of animals including bug shells, legs, wings, and other items.
- You may even find small live animal like ants or worms!

Activity 2: Making a model compost:

- Review the video: “Homemade Composter. http://go.uen.org/b8i
- Thunderbolt Kids website has more great resources. http://go.uen.org/b8j



This activity will help you through the process of making compost to add to topsoil. After completing this activity, you may add the compost to your soil to grow a plant.

Materials:

- 3 liter-sized soda pop bottles like the one in the picture
- An old sock
- A strong rubber band
- Felt-tip pens that will write on plastic
- A big needle
- A pair of scissors
- Scraps of vegetables and fruit, leftover oatmeal, cut grass, enough to fill a big bottle to the top
- 8 oz of water

Instructions:

- Ask an adult to cut the plastic bottles as shown. Join them together as you see in the picture.
- Cut a piece of your sock to fit over the neck of the bottle that is upside down. The sock will stop the vegetable peels from falling through the hole, but it will let water go through.
- Add the vegetable peels, old bread, and leaves.
- Slowly pour in a cup of water. Let the water go down through the sock, into the bottom container.
- Use the needle to make air holes in the top bottle, as you see in the picture.
- Mark the height of the compost column on the plastic. Write the date next to the mark.
- Each Friday, mark the height of the compost column again, and write the date on the bottle.
- Take out the bottom container with the water in it, and pour the water into a cup or can.
- Use the cup or can to pour all the water slowly back into the compost. This will stop the compost from drying out.

- Begin a class journal to keep track of your observations and measurements. A journal is a book in which you write down what happens on a day.

In the beginning, you might think the compost looks ugly, or is just a lot of rotting food and leaves. It might have a smell. As the weeks go by, you may notice changes in the color of the compost, and also in the color and size of the small pieces. You can also see some things begin to grow in the compost. The smell will change. You may also see insects appear from the compost. Remember that it takes one thousand years to create an inch of topsoil.

The gray hairy things you see growing in the vegetable peels are fungi, and they help to break down the peels. There are many kinds of fungi and they can have different colors.

When you see insects in the compost column, they could come from two places. They may be fruit flies that can get in through the air holes, but they may also be hatching from eggs that insects laid in the peels and leaves before you put them into the plastic bottles. After about four weeks, your compost will be a dark color and the big pieces will have broken down into small pieces. You can pour out the compost and mix an equal amount of sand with the compost. Now you have made a little soil.

Now, use this soil to grow a plant.

Again remember, it takes one thousand years to create an inch of topsoil.

Activity 3: Finding the three types of soil

Have you ever noticed how many different colors and textures soil can have? Even if you are just walking around your school grounds, you may come across many different types of soil. This is because soil is made up of different particles. These particles can vary in amounts and therefore make up different types of soils. Some particles are bigger, others are smaller; whereas some are in between. A soil sample normally has a lot of particles either bigger, smaller or in between, and has a smaller portion of the other sizes.

There are three main types of particles that make up soil.

- Clay
- Silt
- Sand

If the soil was formed from a very hard rock, then it has bigger particles. If the soil was formed from a soft rock, then the particles will be smaller.

We want to find out how much sand, silt and clay there is in soil found in two different places.

Prediction: (what you think you will find out)

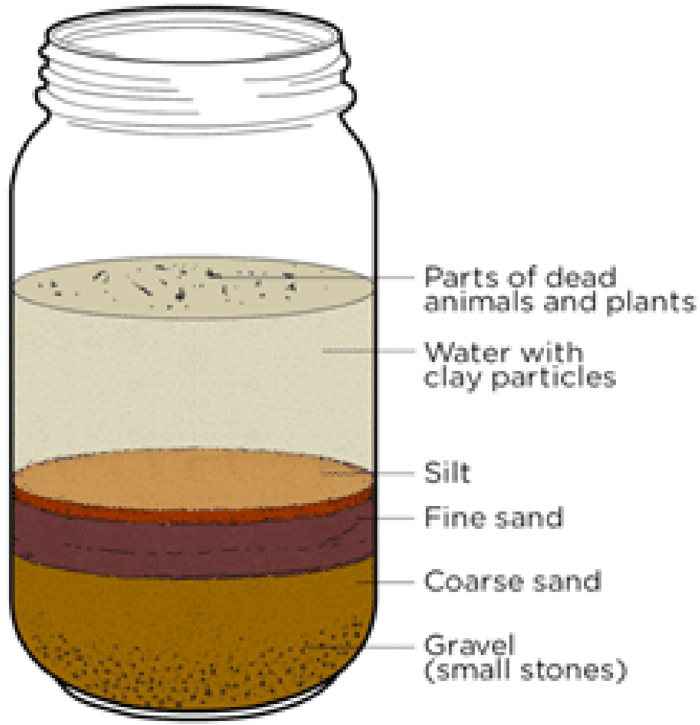
The soil from _______ will have more _______, and the soil from _______ will have more _______.

Materials:

- Two types of soil that look different from one another and are from two different places, such as:
    - Near the top of a slope/hill and near the bottom, or
    - Soil from under a tree and soil from an area with wild grass.
- One sheet of white paper.
- A few sheets of newspaper to keep the desks clean.
- Two large see-through jars that are the same size.

Instructions:

- Collect two cans of soil from places you choose. These are samples of each kind of soil (a sample is a little bit to study).
- Feel the two samples in your hand. In what ways do they feel different? In what ways do they smell different?
- Spread a teaspoonful of each sample on the white paper. In what ways do they look different?
- Put your soil samples into the glass jars. Pour in water to make the jars almost full, cover the top tightly and shake each jar to mix the soil and water.
- Leave the two jars to stand until the next day. The jars must be kept very still because the water must not move.
- In the morning you will see something like the picture below. In each jar, the water has let the large grains settle at the bottom, the very small grains are on top, and the clay grains are so small they are still mixed with the water. You may see some plant parts floating on the water.
- Your two jars will show different layers. In one jar, you might see a lot of sand, and in the other jar you might see less sand.



Observations:

Draw the two jars, showing the layers in your two sand samples. Give your drawings labels and a heading.

- What do you see that is different between the two soil samples?
- What is your conclusion?

You will see that your soil contains grains of different sizes. Some are grains of sand, some are grains that are smaller than sand, and some are grains that are so small you can't even see them without a microscope.

- Sand - you know how it feels between your fingers.
- Silt has much smaller grains than sand but you can still feel that it is a bit rough.
- Clay has such small grains that when you rub it between your fingers, it feels like paint. In fact, you can paint with it. When clay dries, it becomes very hard.

Since topsoil is very precious, we want to make sure wind or water doesn't erode it away. Soil that has plants on it will not erode away. When plants are growing, the roots grow down into the soil. This helps prevent soil erosion. When we receive precipitation, it falls on hillsides with and without plants. The hillsides without plants will erode in a rainstorm, causing huge gullies and landslides. The hillsides with plants will keep the soil in place. When the wind blows, the soil without plants will blow away. The soil with the plants will stay.

Preventing Erosion:

How can we prevent soil erosion from happening? Have you ever noticed hillsides next to roads and freeways have plants on them? They were planted there so during storms the soil wouldn't wash away or blow off. Another way to prevent soil erosion is to place a retaining wall on a slope. Boulders, logs, bricks, and cement are materials used to hold back the soil from falling downhill.

Plants grow best when the supply of water, air, light, and nutrients are always available for them. Soil provides a holding place for water and nutrients. Soil also gives plants structural support so they won't tip over.

Plants can grow without soil if they have other ways of getting water, minerals, nutrients, and something else to hold them up, like gravel or a wire cage.

Today, some food crops are grown entirely without soil. This is called hydroponics. Farmers who grow their crops using hydroponics use various support systems. They carefully monitor the nutrients so the plants will produce fruits and vegetables. You might enjoy sprouting seeds without soil. Seeds will grow on a moist paper towel in a plastic bag. Try it!

3.4 Summary Section

Science Language Students Should Know and Use

- Bedrock: solid rock that lies underneath the subsoil that has not yet been broken down.
- Erosion: the movement of rock fragments from one place to another.
- Freeze: a substance turned from a liquid to a solid.
- Igneous: rocks formed from cooled magma or lava.
- Metamorphic: a rock that has been changed by heat and pressure.
- Minerals: substances occurring in nature, usually with a defined crystal structure.
- Non-living: never lived.
- Nutrients: substances that organisms need in order to survive and grow.
- Organisms: living plant or animal life.
- Sedimentary: rocks formed from sediments that have settled into layers.
- Soil profile: a side view “slice” of the different layers of Earth.
- Structural support: rock material that helps to anchor a plant.
- Subsoil: the layer below the topsoil.
- Thaw: becoming liquid or soft from warming.
- Topsoil: the top layer of soil that contains living organisms and nonliving things.
- Weathering: the breaking down of rocks into smaller pieces called sediments.

Think like a Scientist

1. Explain the process of weathering.

2. Explain the process of erosion.

3. Describe how the different rocks are formed.

4. Explain the characteristics that make up soil.

5. Explain why topsoil is so important to plants.

6. Explain the importance of preserving soil.

CHAPTER 4

Standard 4: Fossils

Chapter Outline

Standard 4 Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1 Describe Utah fossils and explain how they were formed.

a. Identify features of fossils that can be used to compare them to living organisms that are familiar (e.g., shape, size and structure of skeleton, patterns of leaves).

b. Describe three ways fossils are formed in sedimentary rock (i.e., preserved organisms, mineral replacement of organisms, impressions or tracks).

c. Research locations where fossils are found in Utah and construct a simple fossil map.

Objective 2 Explain how fossils can be used to make inferences about past life, climate, geology, and environments.

a. Explain why fossils are usually found in sedimentary rock.

b. Based on the fossils found in various locations, infer how Utah environments have changed over time (e.g., trilobite fossils indicate that Millard County was once covered by a large shallow ocean; dinosaur fossils and coal indicate that Emery and Uintah County were once tropical and swampy).

c. Research information on two scientific explanations for the extinction of dinosaurs and other prehistoric organisms.

d. Formulate questions that can be answered using information gathered on the extinction of dinosaurs.

4.1 Fossils

What Can Fossils Tell Us About the Past?

Do you like mysteries? If you do, then you will love to learn about fossils—the remains or evidence of ancient organisms.

This is an old photograph of people searching for fossils.

These people are splitting open pieces of rock called shale. They are looking for fossils in the rock. The layers of the shale split apart, and occasionally reveal the shape of a leaf or an animal in the rock. The shape is called a **fossil:** the remains or evidence of an ancient organism.

Fossils provide clues to Earth's history. Fossils provide important evidence that helps determine what happened and when it happened in prehistoric times. Fossils can be compared to one another, and to organisms of today. For example, finding fossils of organisms can help paleontologists (scientists who study fossils) figure out what the organisms may have looked like to compare them with organisms of today. This information can be used to make predictions about past environments.

This is a picture of some marine fossils that look very similar to the shells of today.

Here is a photo of a fossil of the head of a Massospondylus, a **Dinosaur:** fossil reptile of the Mesozoic era, often reaching an enormous size, that lived about 200 million years ago.

The next image shows you what scientists think the Massospondylus looked like:

How do scientists use fossils to learn about the history of the Earth? For recent history dating back thousands of years ago, we have written information in books that have many recorded events. This means we can read what people who lived long ago wrote about during certain time periods. However, no human was around millions of years ago to record what really happened.

Scientists have to use other ways to find out about what life was like on Earth millions of years ago. To do this, scientists use fossils. Fossils are actually our most valuable source of information about the ancient past!

Fossils can tell us much more than what **Organisms:** a living thing that carries out basic life functions on its own**,** lived millions of years ago. By studying fossils of plants and animals, scientists can also gather information on how these organisms matured, what they ate, their environment, their climate, and how they interacted.

The bones of the Tyrannosaurus Rex tell us it was very, very big!

Dinosaur Footprints

A hard footprint can tell a lot of things about a **Prehistoric:** animal belonging to a period of time before recorded history, l such as how much it weighed, how big it was, and even what speed at which it was running!

Scientists can determine what the **Climate:** a pattern of weather over a period of time, was like in prehistoric times for many plants and animals. We now know there were ice ages that lasted thousands of years, and when there were droughts caused by warmer weather.

This may look like a colorful rock, but it is actually petrified wood that went through the process of **Mineral Replacement**. This process happens when an organism's hard parts are dissolved and replaced by other minerals. It was created millions of years ago when a forest was buried under mud.

Fossils are usually preserved in sedimentary rocks. For an organism or parts of an organism to become a fossil, it needs to be buried by sediments where it will be safe from nature's elements such as rain, snow, wind, cold, heat, water, or ice. If covered by sediments, the organism will eventually turn into sedimentary rocks. When that happens, the organism or parts of an organism can go through the process of becoming a fossil. The sediments harden and the organism is preserved. It would then take thousands or even millions of years for the organism to become a fossil.

Paleontologists look for fossils in sedimentary rock. They never know whether they will find a fossil or not. They have to split open the rock layers to uncover fossils.

Sometimes an organism or parts of an organism can become a fossil if it is buried by ashes of a volcano. It can also be covered with ice, tar, or tree sap. (The sap will eventually turn into amber.) So, no matter how it became a fossil, it has to be buried.

Paleontologists have found that there are three different ways fossils are formed. The three different forms are impression fossils, mineral replacement, and preservation.

Impression Fossils

Let's first learn how nature makes impression fossils. **Impression fossils**: a mark or design made on a surface by pressure, were made by living organisms millions of years ago and show detailed outlines of these organisms. Nature uses these impressions in sediments to make three types of impression fossils. The three types of impression fossils are:

- trace fossils
- imprint fossils
- cast fossils.

Trace Impression Fossils

Trace fossils show the activities of ancient life. These include footprints, teeth marks, tracks, trails, burrows, body outlines, and tail drag marks. It would be similar to leaving your footprint in sand or even in cement as you were walking home.

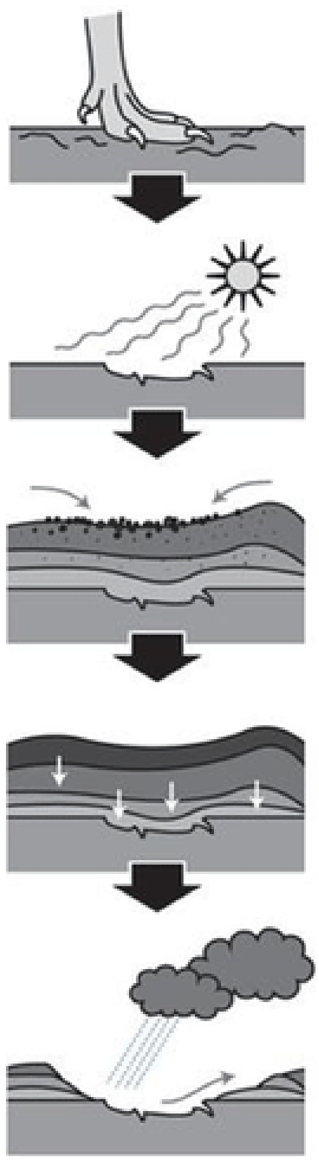
This is a footprint that has hardened in the cement.

For a footprint to become a trace fossil, an impression needs to be left in soft sediment, such as the dinosaur footprint left in the sediments below.

Some ancient animals, like dinosaurs, may have walked across wet mud and left footprints in the mud, like in the next picture. The dinosaur left a trace behind. Over millions of years, this footprint was preserved and became a trace fossil. A dinosaur left its footprints in the mud, and the mud turned to rock. This is a trace fossil.

After the dinosaur left its footprints in the sediments, the sediment hardened. The footprint dried up too, leaving it hard. Then, the footprint got covered with more sediment, which preserved it by preventing the footprint from being destroyed by outside forces. Over time, the sediments on the footprint hardened and became a sedimentary rock, making the footprint a fossil. Eventually, the sedimentary rock covering the footprint weathered and then eroded away. The footprint then became exposed. It looks just as it did when it was first made by the dinosaur.

Study this next diagram to see how this process works.



- A dinosaur made a footprint in sediments.
- The sun dried up the sediments and made the print hard.
- Mud filled up the footprints and preserved it for millions of years because nature’s elements didn’t wash it away.
- The sediments on the footprint hardened.
- Weathering and erosion of the rock finally exposed the footprint.

Imprint Impression Fossils

Imprint fossils were created when thin plants and small animals died in sediments and rotted, leaving behind a dark print (carbon) on the impression. Plants, leaves, feathers, and fish are common examples of imprint fossils.

Here are some examples of imprint fossils. Can you see the carbon on the impression made by the decomposing leaves?

Cast Impression Fossils

Casts are impression fossils made by larger organisms. When an organism died, it was covered by sediment, and the organism slowly decomposed. A cavity (hole) was left in its place in the sediments. If the cavity filled up with sediment, it could produce a cast fossil. The cast fossil will physically look like the original organism on the outside.

Here is how to make a model of a cast fossil.

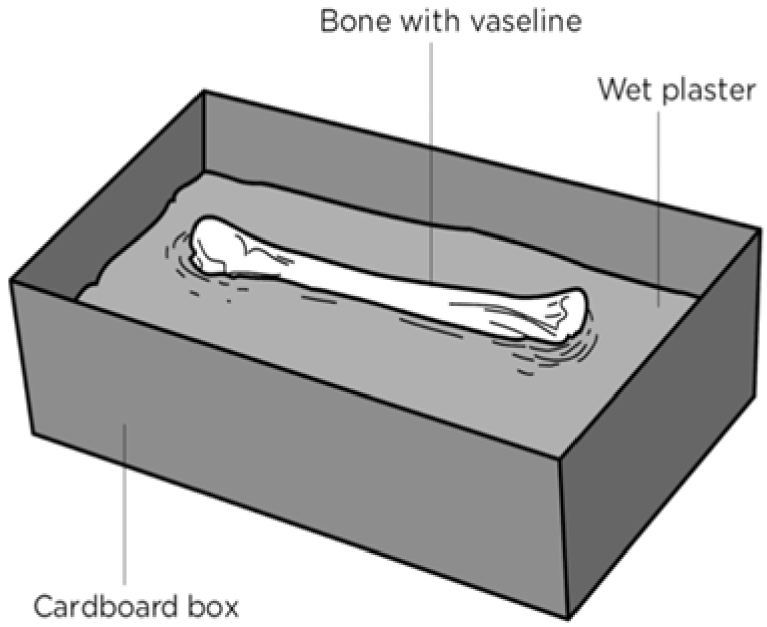
Materials:

- Small container: a plastic dish that you can cut up, or the bottom of a milk carton.
- A leaf with ribs that stand out, or
- A clean, dry animal bone, for example, a chicken bone.
- A small amount of petroleum jelly (Vaseline).
- Plaster of Paris.

Instructions:

Day One:

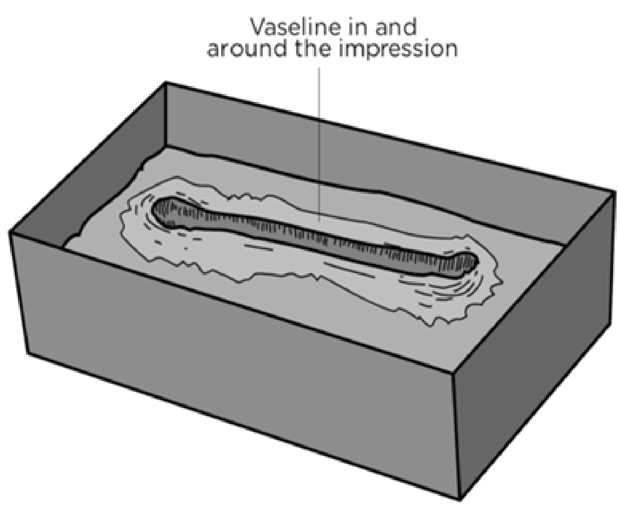
- Spread Vaseline over the back of your leaf or your chicken bone.
- Take your cardboard container (milk carton) to your teacher. Pour the fresh plaster of Paris mixture into the container. The plaster of Paris will begin to set hard in about 10 minutes, so you must be ready with your bone or leaf.
- Place your leaf or bone onto the top of the wet plaster of Paris, and press it gently into the plaster. The bone must go in only halfway as seen in the picture below. The leaf must go only far enough to leave the shapes of its ribs in the plaster.



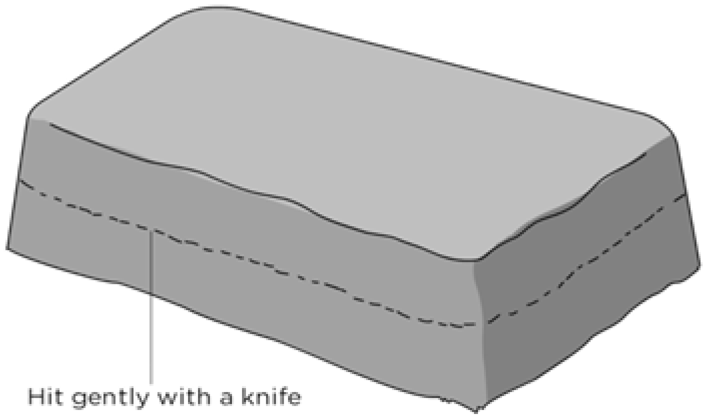
- Press the bone only halfway into the plaster.
- Leave the plaster to set (to get hard). Notice how hot your container becomes while the plaster is setting.

Day Two:

- Pull out the leaf or the bone. It will come out easily because the plaster does not stick onto the Vaseline.
- Now you have an impression of the leaf or the bone. An impression is like a footprint in mud.
- Spread a very thin layer of Vaseline into the impression and around the impression, as you see in the next picture.



- Collect some runny wet plaster of Paris from your teacher and pour it over the Vaseline to cover the old plaster and fill the container almost to the top. Let the new plaster set for a day.



Day Three:

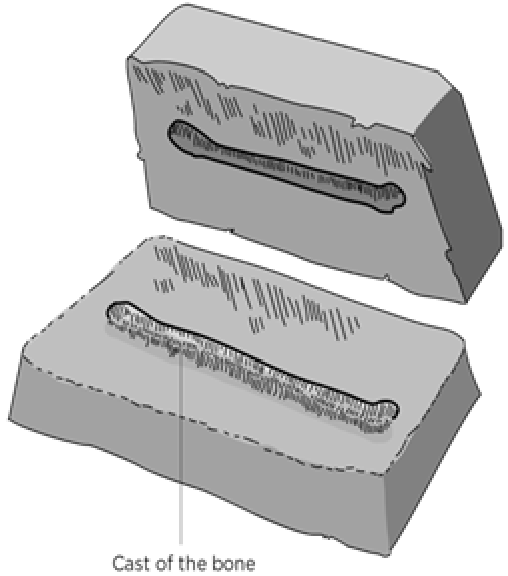
- Tear off the cardboard or plastic container from the plaster “rock” you have made. The fossil is hidden inside. You can paint the plaster to look like a rock.

Get a plaster “rock” from another group, and tap gently on the side of their “rock”.

- Now give your “rock” to another group and get a different rock from them. Do not tell the other group what fossil is in your “rock”.
- Use the side of your desk to tap gently on the edge of the “rock”. Use a stick to tap on the back of a plastic butter knife in between the two layers, so you do not hit too hard.

You should find a cast of the bone.

- Your “rock” should split open if you tap in the right place. When it splits open, you should find a cast of the bone. You will see a cast of a leaf or a bone on the top layer. The cast has the shape of the impression, but the impression goes inward and the cast stands up.



Mineral Replacement Fossils

Another type of fossil is a mineral replacement (petrified) fossil. These fossils were formed from hard body parts. The most common mineral replacement fossils found were formed from bones, teeth, claws, or shells. Fossils of soft tissues are very rare because soft body parts didn’t petrify well. When a plant or animal died, the soft parts quickly rotted or were eaten. For this type of fossil to form, the hard body parts needed to be gently and quickly buried by sediments. If the remains were buried rapidly after the animal died, the parts were less likely to be eaten, decomposed, or scattered around.

The head of this dinosaur is a fossil that has gone through mineral replacement. The fossil shape is the head of a Massospondylus, a dinosaur that lived about 200 million years ago.

Fossil Skull

So, how does mineral replacement work? Let's take an example of a bone. For a bone to go through mineral replacement, it needed to be gently and quickly buried by sediment.

Over time, more and more sediment settled over the bone. After a long time, the bone underwent a series of changes. Replacement took place. As the bone slowly dissolved, water filled with minerals seeped into the bone and replaced the bone with a rock-like material, creating a fossil. This fossil has the same shape and size as the original object, but is harder and heavier because it is now made of minerals. The fossil will be the color of the mineral it was made of. This process can petrify wood, also.

Preservation Fossils

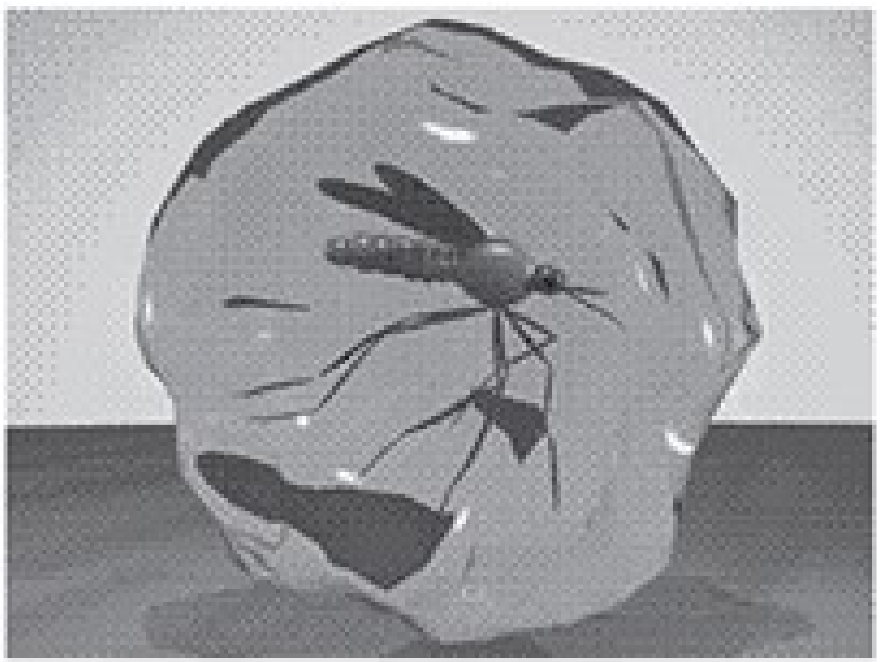
Have you ever taken a strawberry out of your freezer to eat and it looked or tasted just like a strawberry you picked out of a garden? Have you had peaches or pears from a bottle or can that looked and tasted just like a peach or pear that you picked off a tree? Even though those foods were picked months before, the reason we can eat those foods is they have been preserved.

Animals can be preserved if the conditions are just right. They won't decay or change in any way. They will be exactly as they were when they died, even though they died more than 100,000 years ago. For animals to be preserved, they need to be covered in amber, ice, or tar. When they are found, they will be fossils.

Let's see how the three preservation processes work.

Amber

Small organisms have been preserved in amber. Many insects became trapped in sticky tree sap. If the conditions were right, the sap eventually hardened, fell to the ground, and was buried by sediments. Over thousands or even millions of years, the tree sap turned into amber and preserved the insects inside the amber.



Insect in Amber

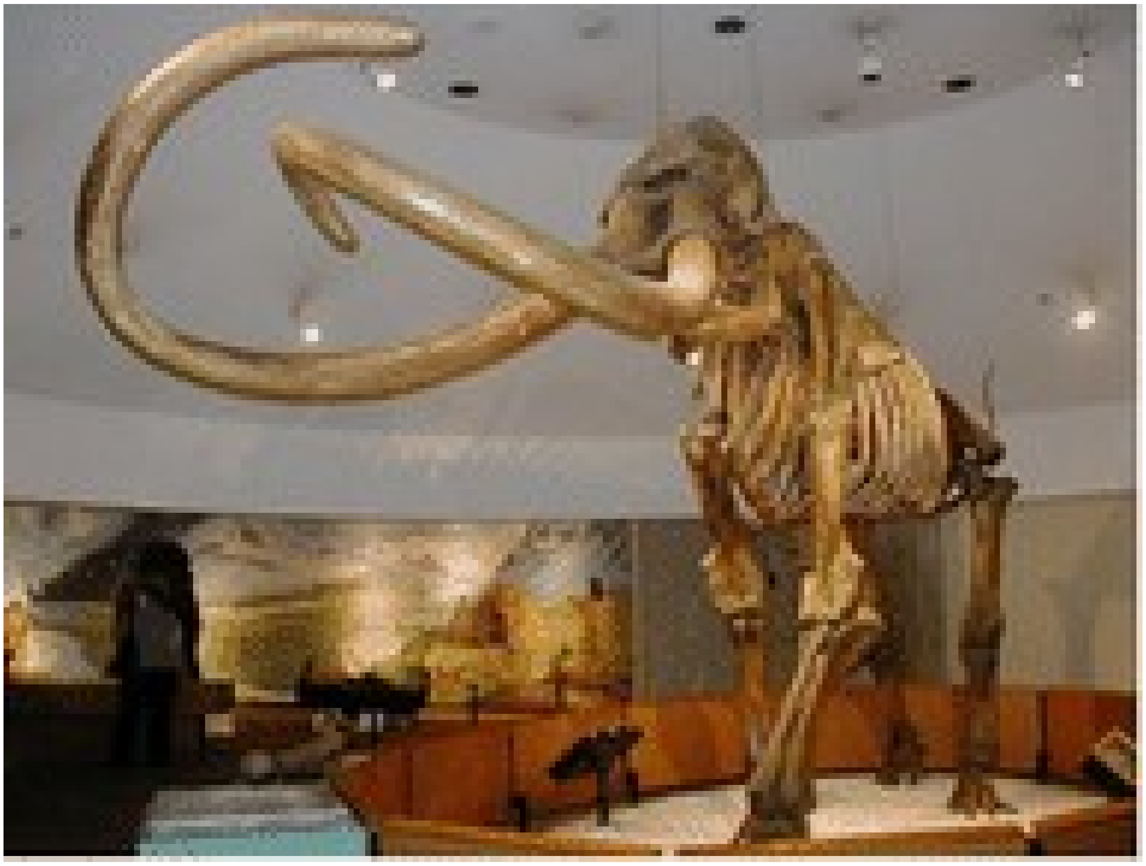
Frozen Water and Frozen Soil

Larger organisms were preserved by frozen surroundings. Sometimes animals fell into water or mud that was very cold. If the water or mud covered them up completely and a cold climate was not part of their environment, the cold water or mud would kill the animals. If the water or mud froze completely, the frozen ice or frozen mud preserved the animals. Preserved mammoths along with other animals have been found in ice and frozen ground in parts of Asia and North America. Even fish and other water animals could get caught in ice if the water they were in froze quickly.

Picture of a sloth fossil recovered from ice.

Tar Pits

Larger organisms were preserved when they fell into tar pits. Sometimes animals were looking for food or being chased by animals and did not notice that they walked or ran into a tar pit. Once they got stuck in a tar pit, they wouldn’t be able to get out, no matter how hard they struggled. It was too sticky to pull out their feet. After they died, often while standing there, they would eventually fall over and be covered with the tar. The tar preserved their bodies until they were found.



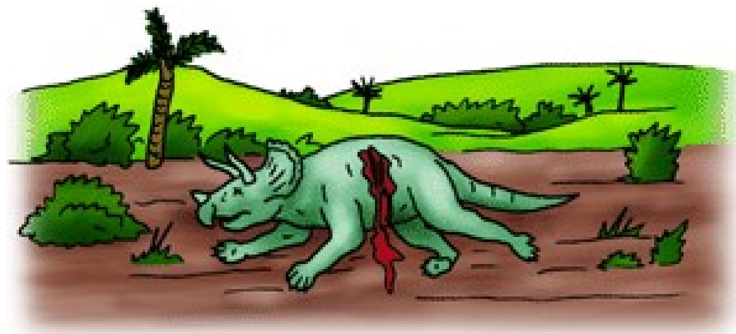
Mammoth fossil found in a tar pit.

Have you ever wondered how people find fossils? Fossils are mostly discovered in sedimentary rocks on Earth's surface. Sometimes sedimentary and other kinds of rocks are forced upward by pressure inside Earth, forming mountains. These rocks have been eroded by water and wind, exposing the fossils. People who collect fossils go to those places. There are many types of fossils that have been found. Of course, some fossils will stay buried and remain undiscovered.

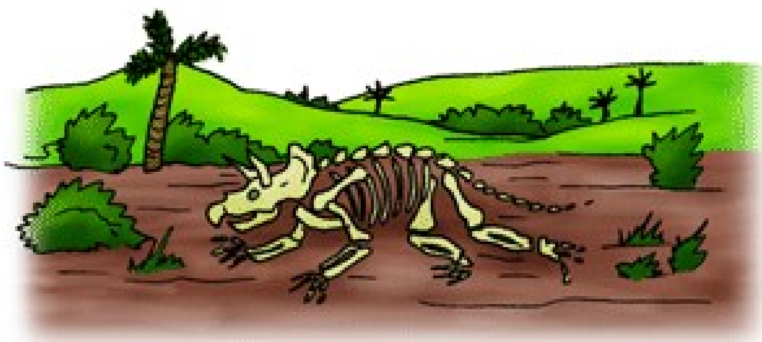
4.2 Fossils Tell About History

Let's have a closer look at how a dinosaur fossil was made millions of years ago.

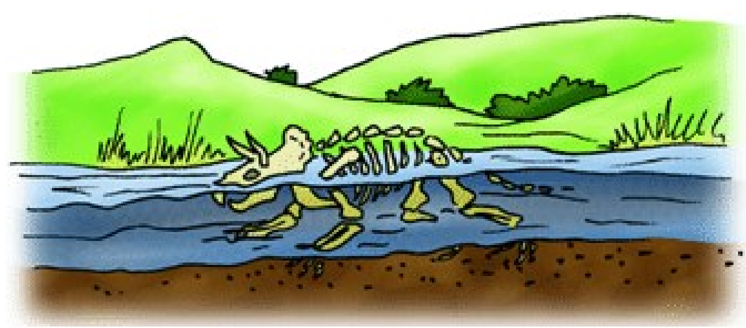
- Long, long ago, a dinosaur died on the banks of a river, such as the Ttriceratops in this picture.



- The flesh of the dinosaur decomposed, or other animals ate it so only the skeleton remained.

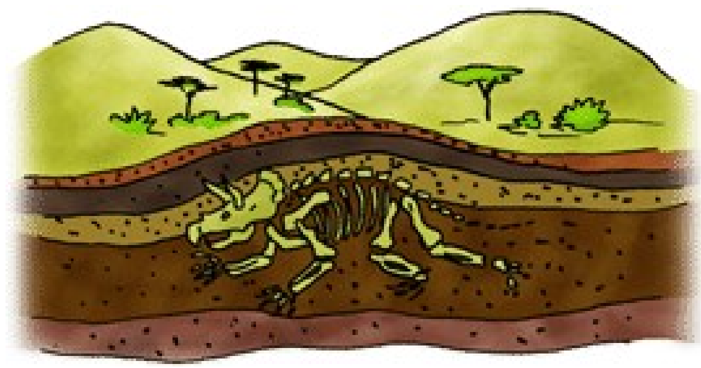


- There was a flood and the river rose, covering the skeleton with mud and sand.



- Over time, more floods deposited more layers of sand and mud over the skeleton. Over thousands of years, the bottom layers became more compacted and turned into sedimentary rock. Under the ground, water carried minerals from rocks into each little space where a bone had been. Minerals took the place of the bones. We say the bones went through mineral replacement. A fossil bone has the same shape as the original bone but is much heavier than the original.

- Millions of years later, the conditions of the environment above the skeleton changed. The rock eroded and weathered over time by wind and water, then the fossil was exposed on the surface. A scientist found the fossil and made a great discovery!



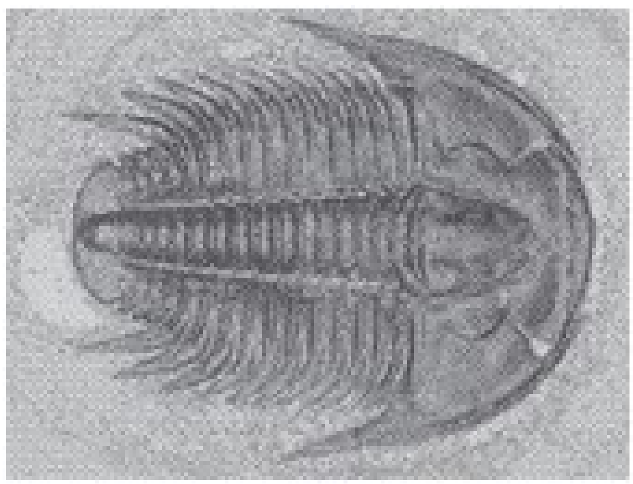
- Other scientists joined in and excavated the fossil by carefully removing the rock and sand around the skeleton. The fossils are packed carefully and taken to a museum or research center where the scientists will study them to see what they can learn about prehistoric life. They will try to reassemble the bones into a full skeleton - this may take many months or years to complete.

Here in Utah, there are many places where fossils have been discovered. Some are listed below:

County	Types of Fossils	Ancient Environment of Organisms
Millard County	Trilobites	Shallow seas
Box Elder County	Trilobites	Shallow seas
Tooele County	Seas lilies, seashells, coral	Shallow seas
Iron County	Shells	Shallow seas
Garfield County	Mollusks (snails)	Warm, moist land environments
Uintah County	Dinosaurs' skeletons and footprints	Warm, moist land environments
Grand County	Dinosaurs such as the Utah raptor, dinosaur tracks	Warm, moist land environments
Wayne County	Petrified wood, dinosaur tracks	Warm, moist land environments
Sanpete County	Mammoth	Cold climate, most recent fossils
Summit County	Saber-toothed cat	Cold climate, most recent fossils
Washington County	Dinosaur footprints	Warm, moist land environments
Emery County	Dinosaur skeletons and eggs, Allosaurus	Warm, moist land environments

Scientists compare fossils to other fossils to see if they belong to a certain family of organisms. If a match is not found, there is a possibility that an unknown type of organism that existed long ago has been discovered. Scientists also like to see if the fossil they found is like any of the organisms that exist today. They compare the shape, size, and structure of fossils they have found to see if they match any organisms found today. If they don't, then those organisms have become extinct or no longer exist.

Several extinct organisms have been found in Utah. Trilobites, which are an extinct ocean shellfish, are probably the most common fossils collected in Utah. They range in size from as small as a dime to as large as a dinner plate.



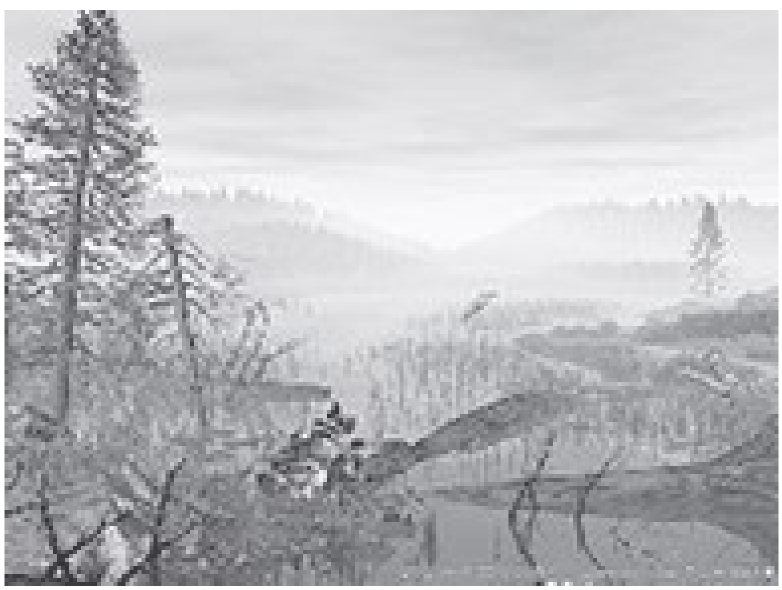
Extinct Trilobites

One set of extinct animals you've probably heard about are dinosaurs. But how do we know so much about them if they are extinct? It's because trace and mineral replacement fossils of dinosaurs have been found in Utah. There are several dinosaur quarries in Utah. Dinosaur National Monument in Uintah County is one of the sites. This site has produced several complete dinosaur skeletons as well as thousands of bones, including fossils of sea creatures that are two or three times older than the dinosaurs.

The Cleveland-Lloyd Dinosaur Quarry in Emery County is one of the world's most important sources of dinosaur fossils. Two-thirds of the petrified bones uncovered there are from the Allosaurus. The Allosaurus is Utah's State Fossil.

Allosaurus Skeleton

We have learned a great deal about how fossils are formed and where they are found in Utah. Now like a great detective, we need to take these clues from Earth's history and use them to make inferences about Utah's past. The environment of Utah long ago was very different from what it is today.



A Prehistoric Environment

Using the fossils found in various locations of Utah, we can infer how Utah's environments have changed over time. We can infer that much of Utah was once covered with a shallow sea. We can determine this because many sea-life fossils have been found in Utah, including trilobites. Fossils of coral have also been found in our state, and coral only lives in warm, shallow bodies of water.

Dinosaur fossils and coalfields help us infer that parts of Utah were once tropical, a very hot and moist climate. These were conditions suitable for dinosaur life. Dinosaurs could not live in the dry environment of today.

Fossils also help us to infer why dinosaurs and other organisms became extinct. Fossils tell us there was a mass extinction or loss of an entire type of organism. Dinosaurs became extinct about 65 million years ago, along with more than half of all the other prehistoric animal and plant species. There are several ideas about what caused the extinction. All these ideas are based on fossil evidence. There are four possible explanations scientists think may have caused dinosaur extinction.

Some scientists think a giant asteroid hit the Earth. This resulted in a change in the climate a pattern of weather over a period of time. A dusty, gaseous smoke cloud was created, causing sunlight to be blocked. This caused dark and cold periods. Without sunlight, plants could not survive. Without plants, dinosaurs could not survive. Other scientists think many huge volcanoes erupted, creating a cloud of smoke, dust, and ash that blocked the sunlight causing a change in the climate. The temperature cooled and plant production dropped. Dinosaurs and many other organisms died. Others think the climate change was a result of moving continents and changes in the environment. Climates became cooler and drier. Less food was produced and the dinosaurs died.

Dinosaurs may have starved and died because other smaller mammals ate the same food as dinosaurs ate. Over time, there were more small mammals than dinosaurs. These small mammals also ate the dinosaur eggs.

Asteroid Impact

It may have been one of these events or many of these events together that caused the extinction of dinosaurs. The exact cause may never be known, but as more information is gathered from fossils, ideas change and we can come closer to finding out what really happened.

Fossils show us that life on Earth has changed. Fossils tell us about past environments. We can find out which parts of the world were once colder or warmer than they are now. We know where rivers, lakes or seas once existed. A piece of sandstone with wave-like ripples lets us know that a beach was once located here. We can find out how long ago some plants and animals lived and how they lived and died. Fossils are the record keepers of Earth. Not all the records are easy to read. Some may be lost, others may be just a part of a record, but still they provide clues to what happened in the past and why Earth is as it is today. Working as detectives, we can look at the clues, put the pieces together, and infer what happened in the past.

4.3 Summary Section

Science Language Students Should Know and Use

- Climate: a pattern of weather over a period of time.
- Dinosaur: an extinct organism.
- Environment: the surroundings and conditions in which an organism lives.
- Extinct: no longer exists.
- Extinction: loss of an entire type of organism.
- Fossil: the remains or evidence of an ancient organism.
- Impression: a mark or design made on a surface by pressure.
- Infer: a process of reasoning from something known or assumed.
- Mineral: a natural solid material that has a particular crystal structure.
- Organism: a living thing that carries out basic life functions on its own.
- Prehistoric: belonging to a period of time before recorded history.
- Preserved: kept from harm or change.
- Replacement: the process of an organism's hard parts being dissolved and replaced by other minerals.
- Sedimentary: formed from mud, sand, small pieces of rock or other sediments that are pressed and naturally cemented to form a rock.
- Trilobite: an extinct ocean shellfish.
- Tropical: very hot and moist climate.

Think like a Scientist

1. How can fossils help us understand the past?

2. What is an impression fossil, and how was it made?

3. What is a mineral replacement fossil, and how was it made?

4. How were whole organisms preserved by freezing, amber, and tar pits?

5. Why would fossils be found in one area of Utah and not in another area of Utah?

6. Describe two scientific explanations of how dinosaurs became extinct.

CHAPTER 5

Standard 5: Utah Habitats

Chapter Outline

Standard 5 **Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.**

Objective 1 Describe the physical characteristics of Utah's wetlands, forests, and deserts.

a. Compare the physical characteristics (e.g., precipitation, temperature, and surface terrain) of Utah's wetlands, forests, and deserts.
b. Describe Utah's wetlands (e.g., river, lake, stream, and marsh areas where water is a major feature of the environment) forests (e.g., oak, pine, aspen, juniper areas where trees are a major feature of the environment), and deserts (e.g., areas where the lack of water provided an environment where plants needing little water are a major feature of the environment).
c. Locate examples of areas that have characteristics of wetlands, forests, or deserts in Utah.
d. Based upon information gathered, classify areas of Utah that are generally identified as wetlands, forests, or deserts.
e. Create models of wetlands, forests, and deserts.

Objective 2 Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.

a. Identify common plants and animals that inhabit Utah's forests, wetlands, and deserts.
b. Cite examples of physical features that allow particular plants and animals to live in specific environments (e.g., duck has webbed feet, cactus has waxy coating).
c. Describe some of the interactions between animals and plants of a given environment (e.g., woodpecker eats insects that live on trees of a forest, brine shrimp of the Great Salt Lake eat algae and birds feed on brine shrimp).
d. Identify the effect elevation has on types of plants and animals that live in a specific wetland, forest, or desert.
e. Find examples of endangered Utah plants and animals and describe steps being taken to protect them.

Objective 3 Use a simple scheme to classify Utah plants and animals.

a. Explain how scientists use classification schemes.
b. Use a simple classification system to classify unfamiliar Utah plants or animals (e.g., fish/amphibians/reptile/bird/mammal, invertebrate/vertebrate, tree/shrub/grass, deciduous/conifers).

Objective 4 Observe and record the behavior of Utah animals.

a. Observe and record the behavior of birds (e.g., caring for young, obtaining food, surviving winter).
b. Describe how the behavior and adaptations of Utah mammals help them survive winter (e.g., obtaining food, building homes, hibernation, migration).
c. Research and report on the behavior of a species of Utah fish (e.g., feeding on the bottom or surface, time of year and movement of fish to spawn, types of food and how it is obtained).
d. Compare the structure and behavior of Utah amphibians and reptiles.
e. Use simple classification schemes to sort Utah's common insects and spiders.

5.1 Utah Habitats

How do Utah's plants and animals adapt to the unique habitats found in Utah?

Animals usually live naturally in areas where they can survive. Different kinds of plants grow naturally in these areas too. Plants and animals will choose where they live because of the water, food, and climate of an area. The physical environment also plays a part in an organism's choice of **habitat**: —the place that a plant or animal lives in.

For example, plants prefer certain types of soil in a habitat to grow in. You can easily see if a plant does not like to grow in a specific area because it will stay small and have few leaves. If a plant is in an area that it likes, it will grow big and strong and have lots of leaves.

A pond is a natural habitat to many different animals, such as fish, birds, snakes, frogs, and other small mammals.

A habitat is the physical area where the animal or plant lives. An organism's natural habitat has everything it needs to live. There are many kinds of habitats that plants and animals like to live in. The animals and plants of Utah have **adaptations**: body parts or behavior to survive—that allow them to live in these habitats.

Utah has three major habitats: wetlands, forests, and deserts. The animals and plants of Utah have **adaptations**—a body part or behavior to survive—that allow them to live in these habitats.

Some plants and animals live in Utah's deserts. These plants and animals do not need as much water as other types of plants. The driest habitats are deserts. Deserts receive less than 25 centimeters (10 inches) of rain per year. They may be covered with sand dunes or be home to sparse, but hardy, plants. With few clouds, many deserts have hot days and cool nights. Some animals and plants live in a forest habitat because they prefer cooler, shady areas.

Many animals rely on Utah's wetlands as a source of water, food, and shelter. A **wetland**: – an area that is saturated with water, seasonally or permanently, - is an area that is saturated with water or covered by water for at least one season a year.

The water may be freshwater or saltwater. Wetlands are extremely important habitats for several reasons. They store excess water from floods and slow down runoff, which helps prevent erosion. Wetlands also remove excess nutrients from runoff before it empties into rivers and lakes. Many plants live in wetlands where the water meets the land. This is because they need a wet environment, but they are also able to live on land. Wetlands provide a safe, lush habitat for many species of animals.

Wonderful Wetlands

It is late afternoon. The sun is sinking, and the water trickles down the slow-moving river. On the banks of the river are tall grasses. Brown fuzzy cattails blow in the breeze as insects buzz nearby. As you look very closely at the water's edge, you see a very unusual insect that seems to be skating on top of the water. The sounds of birds chirping and twittering are heard from the trees along the river. Small birds dart and skim over the water, and a larger one glides overhead.

There are many interesting plants growing near the river: some with delicate white flowers and others with bright purple furry blossoms; some that have bristles and others that feel as soft as feathers. On the bottom of the river, plants can be seen bobbing up and down with the gently moving water. Even with the hum of activity all around, this is a place of great beauty and peace. This is a wetland.

The wetland is wet most of the year because the soil soaks up water and holds it. Most wetlands lie between dry land and open water, along rivers, lakes, streams, or places where the land is low. Wetlands may not always appear wet because of the tall plants, or low water level.

Regardless of a wetland size or where it is found, there are three things they all have in common: water, wet soil, and water-loving plants. Only special kinds of plants can live in soil that is always wet. Wetlands are found throughout Utah. Many of them are marshy areas around the Great Salt Lake where streams of fresh water flow slowly into the lake.

The warm temperatures of these marshes are very favorable to wildlife. In places where the temperatures are colder, there are fewer plants and animals that can survive, such as in the high mountain areas of Utah.

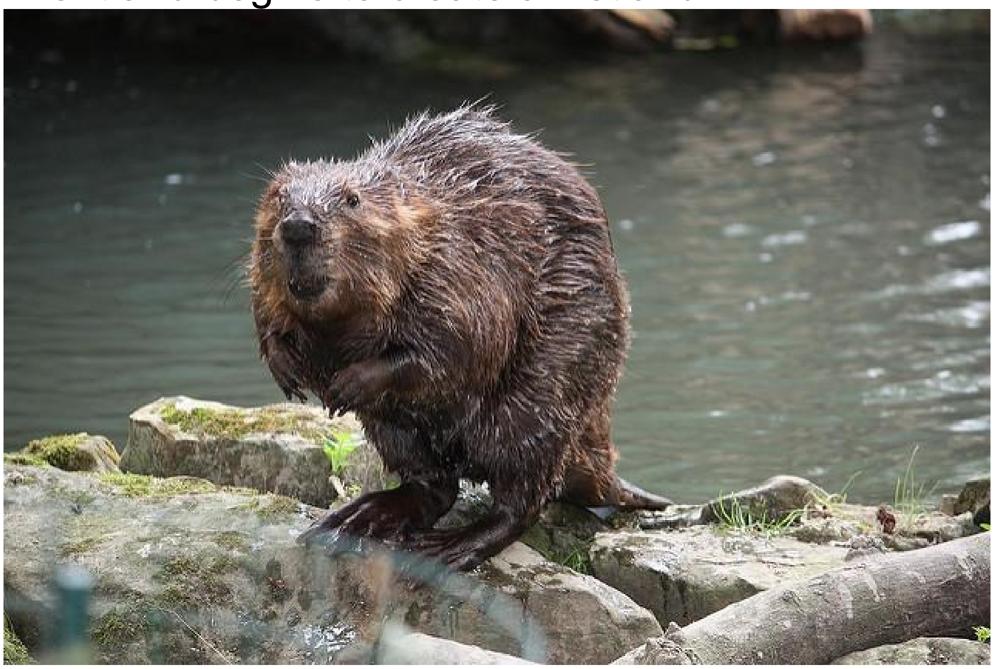
The amount of water a wetland receives is very important. If there is too little rain or too little water coming into a wetland, it will dry up. If there is too much rain or flooding, it can damage the wetland habitat and threaten the lives of the animals living there. A healthy wetland has a good balance of precipitation and dry weather.

People have discovered that wetlands have valuable resources for a healthy environment. They are great places to learn and enjoy. They also help control flooding, clean the water, are rich in natural resources, and are the home for more living things than any other habitat.

The wetlands of Utah are rich in natural resources and plants. Large numbers of fish, insects, birds, and other animals live there. They depend upon the wetland habitat to supply them with food, shelter, and water.

Many animals rely on the protection and security of the large number of plants for raising their young. The wetlands are also used by thousands of migrating birds as nesting and resting places. Plants that live in wetlands are cattail (- long-leafed plant with stiff sticks containing brown fuzzy sections that look like a cat’s tail), and bulrush (- spiked leafy plant that clusters together and sometimes has flowers with six bristles). These two wetland plants root in the soil of shallow water. They are often seen growing along lakes, rivers, and marshes. These tall plants provide food and protection for wildlife living in the wetlands. Some birds build their nests above ground on these plants so they can hide from their predators. The roots of cattails are the main food source for muskrats.

If you spent your life in the water or on the wet ground of the wetlands, you would need special body parts. The beaver is a wetland animal with unique adaptations for this environment. Beavers have thick coats of fur with an oily covering, a layer of fat under the skin, and a special circulation system that helps keep them warm during summer and winter. Did you know when a beaver hears running water, it begins to build a dam of mud and wood to stop the flow? Stopping the water changes the environment and begins to create a wetland.



Beavers are master builders and use their long front teeth for gnawing on aspen trees. They eat the top tender leaves and use the rest to build their lodges. They also store a supply of small trees, branches, and twigs at the bottom of their homes to help them survive the winter months. A beaver's back feet are webbed for swimming. Beavers can stay underwater for up to fifteen minutes! The front paws, much like human hands, are made for holding food, working on dams, and digging. Beavers use their broad flat tails to steer when swimming, for support when sitting, and to slap the water as a warning to others when danger is near.

There are many other animals that have adapted to the wetland habitat. Muskrats use cattails for food and for building lodges. Moose feed on many wetland plants and grow a thicker coat of fur before winter to survive the cold temperatures in high mountain elevations. Tiger salamanders live in the moist areas around streams and burrows beneath the ground to escape the extreme temperatures of summer and winter. Frogs go into **hibernation**: – an inactive, sleep- like state during the winter, - at the bottom of streams and ponds where water does not freeze. Birds of the wetlands are also well adapted to this habitat with bills or beaks designed to catch fish, small animals, or insects that live in the wetlands.

The Great Salt Lake is a unique wetland because of its salty water. The lake is one of the saltiest bodies of water in the world and can be up to eight times saltier than the ocean. Only a few animals are able to live in the Great Salt Lake because of the salty water. Brine shrimp and brine flies are two insects that live in the lake. Brine shrimp hatch from tiny eggs which float on top of the water. One hundred and fifty eggs can fit on the head of a pin! They are **invertebrates**: - an animal without a backbone, - that only grow to one-fourth inch long and feed on very small life forms. These insects have adapted to the salty water of the Great Salt Lake. As a brine shrimp drinks the water, the salt is removed from its body through the gills.

Brine flies also live in the Great Salt Lake. The adult flies group together on the shore of the lake. There can be 370 million per mile of the beach. These tiny insects do not bite, but they can be very annoying.

The **migration**: – the movement of species for survival, - of huge numbers of birds, such as geese, ducks, pelicans, and gulls can be seen during the warmer months of the year at the Great Salt Lake. Both brine shrimp and brine flies serve as food for millions of birds that migrate to the wetlands areas around the Great Salt Lake.

Most of the wetlands of Utah are found around the Great Salt Lake. Marshes have formed where rivers and streams bring freshwater into the lake. Although there are very few living things that can live in the salty water of Great Salt Lake, there are many plants and animals that make their home in the marshes near the lake. In the spring, thousands of birds migrate to Utah and live in the freshwater marshes of Great Salt Lake.

The great blue heron is one of the largest birds that live in the marshes of the Great Salt Lake. It has long thin legs and stands very still until it spies something to eat. The great blue heron uses its long pointed bill to catch fish, frogs, or snakes. When the weather gets cold, these birds migrate to warmer areas.

The wetlands of Utah are a valuable resource to control flooding and help to keep our water clean. They are the home to many plants and animals. They also provide beauty and enjoyment for many people.

Fantastic Forests

Every summer people in Utah look forward to camp-outs in **forests:** large areas of land that are covered with trees. The drive up the canyon is beautiful and cool. Trees seem to whiz by. Animals are seen off in the distance. The shady slope of the mountain that faces north is covered with aspen trees. Aspen trees are **deciduous**:, trees and shrubs that drop their leaves before the cold or dry season, lose their leaves in the fall, and grow new leaves in the spring. When the weather gets colder, the leaves turn brilliant colors before falling to the ground. The trunks of the trees are white with grayish black marks running through the bark. Not only do birds use the aspen for nesting, but some animals also use it as food.

On the mountain slope that faces south, the hot rays of the sun warm the ground. This side of the mountain is drier with grasses, sagebrush, and only a few trees growing. Most of the trees are Utah juniper trees. Juniper trees, like other plants that are **coniferous**: - trees and shrubs that have needle-like or scaly leaves which stay green all year and sometimes have cones, - are green all year and never lose their leaves. The needles of the coniferous trees use less water than the broader leaves of deciduous trees. The scrub oak tree, a deciduous tree, is also found on the drier south slope. Scrub oak trees do not get very tall. They drop acorns in the fall that many animals eat.

The porcupine is a forest animal that feasts on the leaves and branches of the quaking aspen. It also eats the bark of the trees to survive the winter months. It weighs on average 20 pounds, and is also an excellent climber. The porcupine's body is covered with quills that are weapons used for protection against coyotes, bobcats, and other predators. When a porcupine becomes frightened, it shakes its body. Loose quills come out and stick into the attacker's skin.

Mule deer live on the slopes of the mountains and eat plants, such as aspens, junipers, and sagebrush. They can be difficult to spot when they stand very still among the trees. Although the mule deer prefer to stay in higher elevations, during the winter they will migrate to lower elevations near the valley.

As your drive continues up the canyon, ponderosa pine trees are now mixed in with the aspen trees. The ponderosa pine is one of the most common trees of the Rocky Mountains and has adapted to dry, cold climates.

Still further up the canyon, there is a campsite waiting. It is tucked in the shadows of giant spruce and fir trees. These trees are tall and narrow, so in the winter the snow will slide off the branches without breaking them. They grow close together, protecting one another from the wind. Pinecones and pine needles are scattered on the ground under the huge trees. The air smells cool and moist.

Wild animals are fun to watch in the forest. Squirrels are furry-tailed little animals that scamper about on the ground or in trees looking for berries, nuts, and seeds. They store their food in holes in the ground or trees. They are especially busy in the autumn gathering food for the winter. They stay in their dens on cold days where they sleep and nibble on the food they have stored. Animals of the forests are able to adapt to different foods during different seasons.

In the forest, there are always interesting things to see. It is exciting to see a moose eating in a marsh. They are huge and can move rapidly. When the wildflowers bloom, bees, butterflies, and hummingbirds busily collect nectar. There are many insects in the forest that are fascinating to watch. There are common insects such as house flies and ants, but there are also many strange-looking insects.

Just like the wetlands, forests are very important. Forests help to reduce gases that are put into the air from cars and factories. In return, the trees give out large amounts of oxygen that we breathe. Forests also help keep our water clean and prevent soil erosion. When it rains in the forests, the leaves allow the water to slowly drip to the ground and the roots hold the soil in place. However, when a forest is cut down, the rain falls on the unprotected soil and dirt is washed into the streams making them dirty. The water is then unhealthy for fish and other living things.

Over the years forests have been cut down for lumber, golf courses, shopping malls, and many other things. People have learned that when the trees disappear, so does everything that depends on them, from tiny insects to large animals. However, with careful planning we can protect the forests so we can continue to enjoy this beautiful and peaceful habitat.

Dazzling Deserts

Take a look outside. What is it like where you live? You may see grass, large pine trees, or green leafy trees around your school and neighborhood. The water we use for these plants comes from streams, rivers, lakes, and deep underground wells. This is how people living in Utah maintain their beautiful yards and gardens. Yet, Utah is the second driest state in the United States. Nevada is the driest. Imagine if all the water sprinklers were shut off for several years. The environment would look much different because many of the trees and other plants would die. Eventually, plants that are adapted to drier climates would return. Most of Utah's natural state is **desert: -** an area of land that receives less than ten inches of rainfall a year.

Throughout the desert of Utah, there are a large variety of plants that survive through long hot summers and cold winters. Many plants have small leaves that need less water; while others store water in their leaves, stems, and roots.

The prickly pear cactus has adaptations to help it survive the hot desert habitat. The leaves have a thick waxy covering, which helps keep the water inside the plant longer. The spines of needles on the cactus protect it from sun and wind. The prickly pear cactus blossoms, in the spring with pink, yellow, and orange blossoms providing nectar for bees and moths.

Sagebrush is a very common desert plant throughout Utah. It grows about four feet tall and gives off a very strong odor. Sagebrush is used by some animals for shade, protection from predators, and food for mule deer, caterpillars, and other animals. When land is cleared for houses or other buildings, sagebrush is destroyed. It is very slow to reproduce, and animals that depend on sagebrush die.

Other plants that are often found in dry areas are scrub oak cactus, Utah Juniper, and Pinyon Pine. They provide shelter, food, and protection for many desert animals. Although the desert is a very dry climate, many animals have adapted to this habitat. The desert animals include insects, spiders, reptiles, birds, and mammals. Many animals find cooler places to stay during the hot hours of the day. They burrow into the ground or find shady spots by rocks or plants. Some animals of the desert do not require large amounts of water. They get the water they need from plants or possibly from a water hole.

The jackrabbit is a common desert animal of Utah. To keep out of the sun on hot days, the jackrabbit stays hidden under shrubs or near clumps of grass. The jackrabbit uses “ear-conditioning” to lose one-third of its body heat through its very large ears. This helps it to keep cool in the hot desert. In the cooler morning and evenings it feeds on prickly pear cactus. The jackrabbit can run up to 35 miles per hour to escape predators such as coyotes, foxes, and large snakes.

Reptiles, such as snakes and lizards, are important to the desert habitat. A rattlesnake lives in rocky areas and stays in the shade of a tree or bush during the day. However, at night it becomes very active as it hunts for food. The rattlesnake usually bites a small animal, such as the kangaroo rat, with its poisonous fangs, and swallows the animal whole. To survive the winter, rattlesnakes hibernate within a large group in underground holes. The desert tortoise lives in the hot desert. It moves very slowly across the desert sand. Prairie dogs dig holes and burrow under the ground, where it is cooler. Both the desert tortoise and the prairie dog are endangered and protected by laws.

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Elevations

One of the physical characteristics of environments is **elevation:** – distance above sea level. Elevation affects climate and temperature. These things determine where plants and animals live. Generally higher elevations have lower average temperatures than lower elevations. Most plants and animals live within certain elevations.

Endangered Species

There are many **species**: – a group of living organisms with similar characters, – of animals living in Utah. Some of them are thriving and doing well. Others are struggling to exist. Many things can change an environment. The introduction of an invasive species, – living organisms that are not native to that habitat, - can overpower and kill natural resources that the native species needs. Changes in the weather is another reason a habitat can change. This may affect the native species because their adaptations are specific to live in one habitat.

Human population growth has a huge impact in consuming resources for natural habitat. Many species are seeing their habitat dangerously altered. These species are becoming threatened or endangered. Species adaptations are designed for the survival on the specific habitat.

You can find a list of endangered plants and animals that live in Utah at: http://go.uen.org/b8k

5.2 Classification

Classification

Scientists have developed a system known as classification, a way to group things, and it shows relationships between living things that are alike in some ways. Classification requires us to look at similar characteristics in organisms. You can look at the outward appearance or look inside the animal. Outward appearances can include the texture, shape, size, and color of an animal.

There are two large groups of living things on Earth: plants and animals. Think of some ways plants and animals are alike or different. How do you know if you are an animal or a plant?

Classifying plants

When classifying plants, you need to observe the shapes, quantity, and size of the parts of a plant (roots, stems, flowers, leaves, seeds, or fruit).

Look at the photos of the aspen tree and the Utah juniper to. Compare and contrast the characteristics of these two plants.


Aspen Tree **Juniper Tree**

Utah Juniper Tree

When we compare plants, it is sometimes easier to use the different plant structures to compare the plants. We can look at the leaves, for example, in the aspen tree and the juniper tree, and compare them. The aspen tree has wide, flat leaves while the juniper has small, waxy, scale- like leaves.

Grouping Animals

Have you ever wondered why a trout is known as a fish, yet a whale is known as a mammal? When we group similar things together, it is called classifying. Some animals cannot be classified by outward appearance. Scientists must also look inside the animal.

For example, the skeleton and the way bones are joined are clues to classify or group animals. A whale has many internal parts that are the same as other mammals. Even though whales live in the ocean, they look more like mammals on the inside than they look like a trout.

Scientists must look inside animals to classify them into groups. Most animals can be divided up into two main groups: **vertebrates: -** an animal with a backbone, – and **invertebrates: -** an animal without a backbone. The backbone supports the whole body. Examples of animals that are vertebrates are humans, fish, horses, snakes, and whales.

Animals that do not have a backbone are called invertebrates. Some invertebrates have a hard outer shell such as crabs, crayfish, snails, insects, and spiders. The shell protects and supports their bodies. A worm is an invertebrate that does not have any bones or shell for its body.

We can classify animals into two more groups: cold-blooded and warm-blooded animals. A cold-blooded animal's body temperature will change with the temperature of its surroundings. A snake's body temperature could get as low as 40˚F at night because the night air is at 40˚F. In the morning when the sun comes out, a snake will move to an open space and warm its body with the sunlight. This will make the snake's body temperature rise as the temperature in the air rises.

Warm-blooded animals will maintain the same body temperature no matter what temperature surrounds their bodies. Your normal body temperature stays at 98.6˚F. It does not drop very low or go extremely high no matter what the temperature is outside.

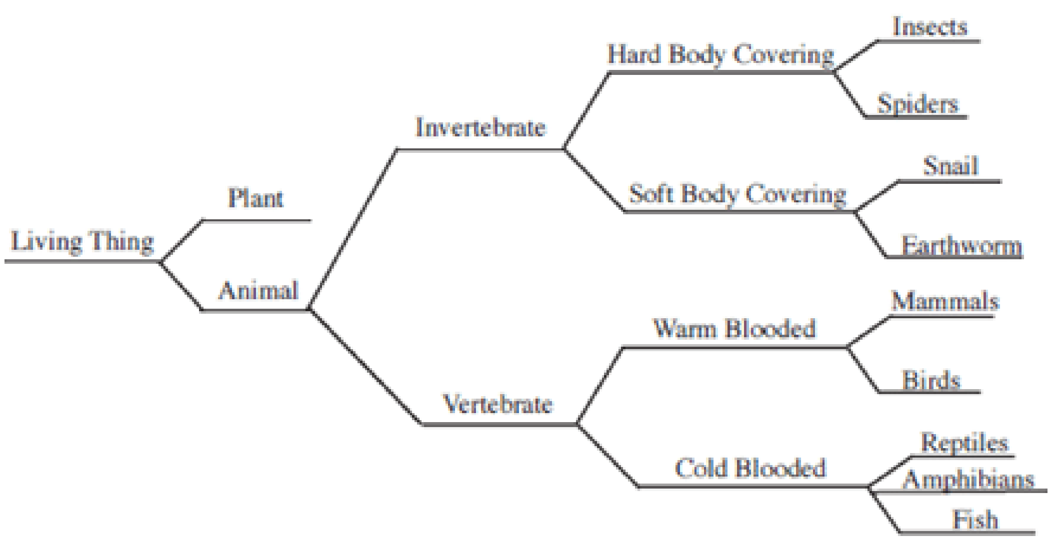
Using characteristics such as the presence of a backbone and whether an organism is warm or cold blooded has led scientists to develop animal groups. Most of the animals you know about are birds, mammals, insects, fish, reptiles, amphibians, and spiders.

This chart will help you see what each group is like.

Characteristics of Organisms	**Examples that Live in Utah**
Birds: warm-blooded, hatch from eggs, feathers cover their bodies, two legs and two wings	Red-tailed hawk, barn owl, lark, robin, pinyon jay, magpie, crow
Mammals: warm-blooded, give birth to live young, provide milk for babies, fur or hair body covering, four limbs, large brains	Jackrabbit, cottontail rabbit, red fox, coyote, mule deer, elk, moose, cougar, bobcat, deer mouse, kangaroo rat, muskrat, beaver, gopher
Insects: cold-blooded, six legs, three body sections, wings, antennae	Grasshopper, ant, moth, butterfly, house fly, bee, wasp, pill bug, millipede
Fish: cold-blooded, hatch from eggs, breathe through gills, live in water, scales cover their bodies	Catfish, carp, trout
Reptiles: cold-blooded, hatch from eggs laid on land, scales cover their bodies	Gopher snake, rattlesnake, lizard, tortoise
Amphibians: cold-blooded, hatch from eggs, smooth moist skin, start life with gills that change to lungs, lives near water	Frog, salamander, toads
SpidersArachnids: cold blooded, invertebrates, have eight jointed legs, an exoskeleton, two body parts	Spiders, daddy long legs, ticks, mites, scorpions Black Widow, Brown Recluse, Tarantula, Hobo

Classifying diagrams

Scientists use tools to classify organisms. Below is a diagram we can use to classify a lizard. Look at the previous picture of a lizard on a previous page. You may already know what group a lizard is in, but, let's try to use the system to find out.



Find “living things” and follow the line to the next choice. Would you say a lizard is a plant or an animal? It moves and needs to find its own food so it must be an animal.

Follow the line until there are two choices again. Now we must decide if our object is an invertebrate or a vertebrate. If we could look inside the lizard, we would be able to see a backbone. So, the lizard is a vertebrate animal. Follow the line from vertebrate to the next two choices.

The two choices are warm-blooded and cold-blooded. How does our lizard warm its body? It will move to a warm area to warm its body and cool its body by moving to a cooler area. This is a characteristic of a cold-blooded animal.

From cold-blooded, there are three choices. Look closely at the lizard. What kind of external structures does it have? Did you notice that there are no gills or fins and it does not live in water? So, this object is not a fish.

Our lizard does not have wet, smooth skin either. Notice that the lizard has scales on its skin, which is characteristic of reptiles. Based on our classification system, the lizard belongs to the reptile group. Correctly classifying living things helps us to understand how they are related. It gives us a way to group and name them. It gives us a chance to observe and study animals and plants.

5.3 Summary Section

Science Language that Students Should Know and Use

- Adaptation: body part or behavior to survive in a habitat.
- Amphibian: an animal that lives near water and as an adult has lungs.
- Bird: animal with feathers.
- Coniferous: trees and shrubs that have needle-like or scaly leaves which stay green all year and sometimes have cones.
- Deciduous: trees and shrubs drop their leaves before the cold or dry season.
- Desert: an area of land that receives less than ten inches of rainfall a year.
- Elevation: distance above sea level
- Fish: a scaly animal that lives in the water.
- Forest: a large area of land that is covered with trees.
- Habitat: the place that a plant or animal lives in
- Hibernation: an inactive, sleep-like state during winter.
- Insect: small, six-legged animal with three body parts, wings, and antennae.
- Invertebrate: an animal without a backbone.
- Mammal: animals with fur or hair that give birth to live young.
- Migration: the movement of species for survival.
- Reptile: animals that mostly lay eggs on land and has scales.
- Species: a group of living organisms with similar characteristics
- Spider: an eight legged animal with an external skeleton.
- Vertebrate: an animal with a backbone.
- Wetland: an area that saturated with water, seasonally or permanently.

Supporting Language for ELL

- Classification: a way to group things.
- Diagram: a drawing intended to explain how something works.
- Organism: a living thing.
- Species: a class of individuals having some common characteristics or qualities.

Think like a Scientist

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1. Why do scientists need to classify plants and animals?

2. Why are wetlands so important to the plants and animals of Utah?

3. Why are some species in Utah endangered?


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