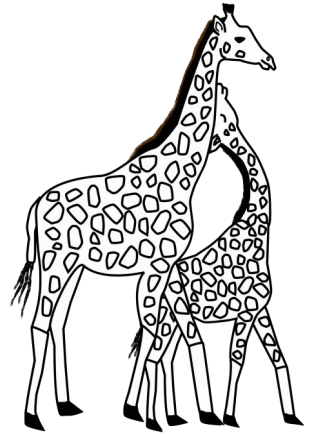


Animal Groups and Relationships

There are millions of animals in the world. They need food and shelter as well as many other things. But the world can be a dangerous place, so animals form relationships to survive. Animals might compete for a resource (fight against each other) or cooperate to help each other get the resources they need (work together). Scientists have many different names for the ways animals interact with each other, and we're going to take a look at a few of them.

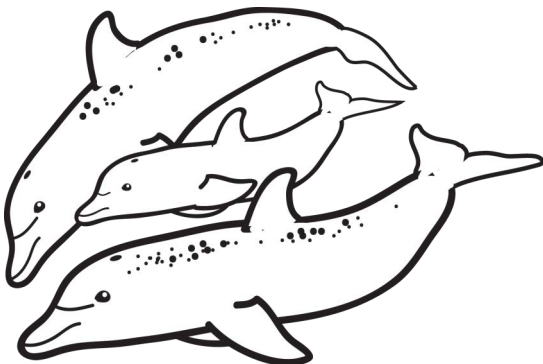
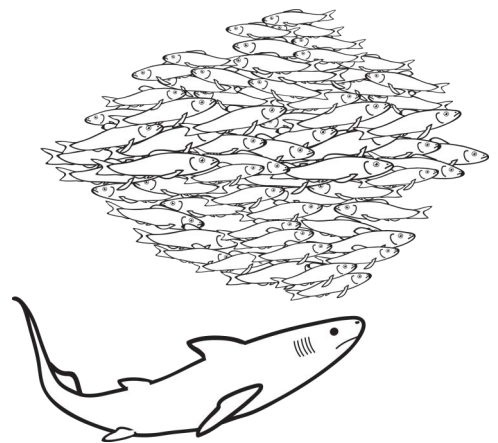


We'll start with **cooperation**. In the animal kingdom, cooperation isn't just working together, like a dog and a cat might work together if they live in the same home. In science, cooperation is two or more animals of the same species working together. There are lots of reasons animals of one species might work together.



One big reason is safety. When there are more animals together, some can watch out for danger while the others eat. Animals like meerkats live in groups called colonies. They assign the job of lookout to some members, and when the lookout spots danger, it calls out and warns the others.

Many types of fish eat in shoals. A shoal is simply a group of fish. When one senses danger, it moves quickly, sending vibrations through the water. The vibrations actually travel faster than the fish can, so all the fish are alerted very quickly.



Dolphins swim in pods of seventeen or eighteen animals to help keep each other safe.

Terminology

Using what you learned, define these words in the best way you can. Use the back of the page if you need more room.

Cooperation: _____

Migrate: _____

Symbiosis: _____

Mutualism: _____

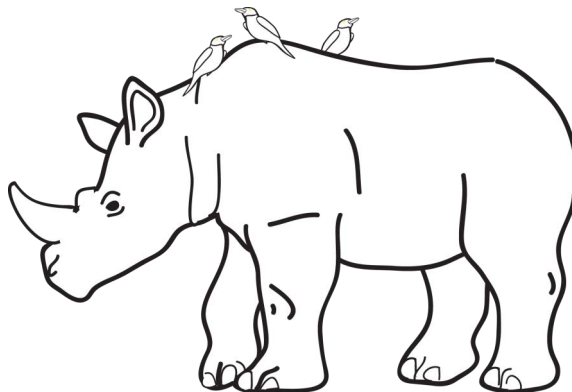
Commensalism: _____

Parasite: _____

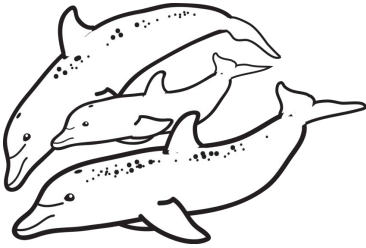
Ectoparasite: _____

Endoparasite: _____

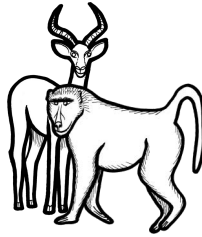
Brood parasite: _____



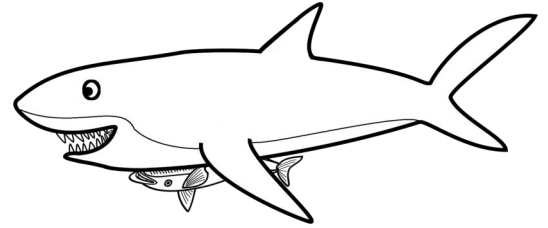
Which of the following is an example of mutualism? Draw a circle around it.



Pod of dolphins



Impala and baboon

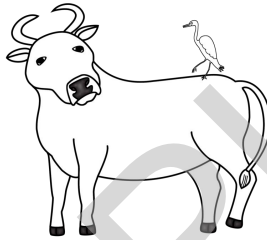


Shark and remora

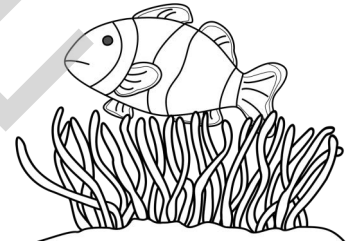
Which of the following is an example of commensalism? Draw a circle around it.



Cowbirds and cuckoos



Cattle egrets and cattle



Clownfish and sea anemone

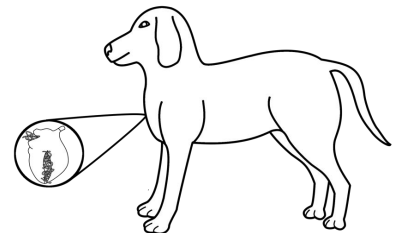
Which of the following is not an ectoparasite? Draw an X through it.



Flea



Tick

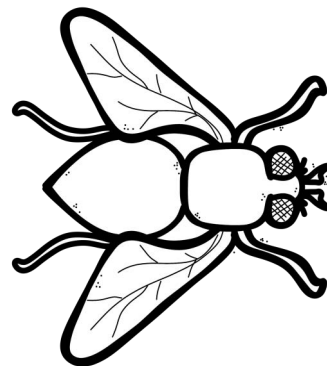


Heartworm

What are three reasons animals cooperate?

Classification of Living Things

In this unit, we're going to talk about how scientists **classify**, or group, living things. Before we start, let's talk about what it means to be alive. If you look around, it's easy to know what is alive and what isn't. The chair, the walls, and the books are not alive. The people, the flower in the window, and the fly buzzing around the room are alive. **Living things** grow and reproduce. They use energy and respond to their surroundings. Nonliving things cannot do any of these things.





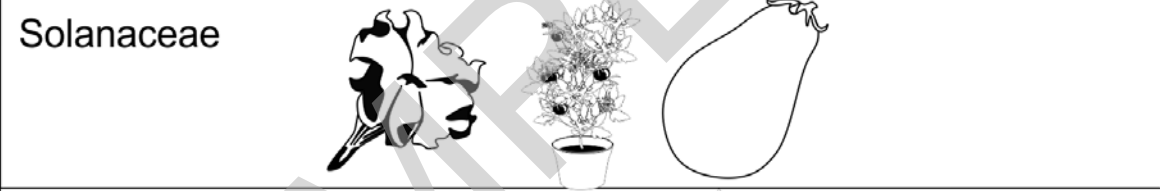
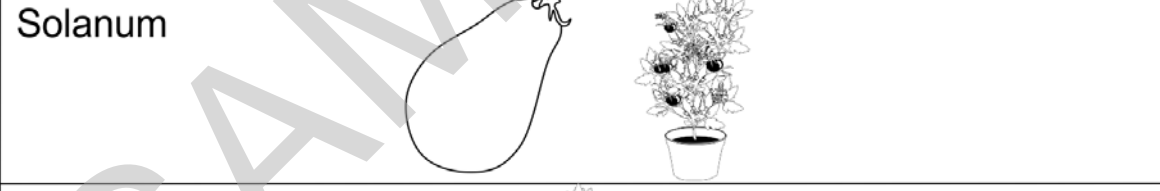



Living things also share many of the same needs. Most need food or energy, water, air, and a safe place to live. In order to study living things, scientists have developed a way to classify them into groups. The science of studying living things is called **biology**. Biology includes two fields of study. **Zoology** studies animals, and **botany** studies plants. The science of classifying organisms is called **taxonomy**.

Not all scientists agree on exactly how each level of classification should be defined, but we'll look at one of the most common ways to define them. At the very top of this classification system are three domains—Archaea, Bacteria, and Eukaryota. Domains weren't used as part of scientific classification until the very end of the twentieth century. Animals and plants are all a part of domain Eukaryota.



The next level is where many of the classification charts that you see start—the kingdoms. Scientists recognize five kingdoms: Animalia, Plantae, Fungi, Protista, and Monera. Some scientists, however, recognize a sixth kingdom because they separate archaea out of kingdom Monera and make kingdom Archaea. We're going to focus on kingdom Animalia and kingdom Plantae. As we move through the classification chart, we're going to work our way down through the levels until we reach a level of classification that is unique to just one kind of animal. That will also give us the animal's scientific name.

Kingdom	Plantae	
Division	Magnoliophyta	
Class	Magnoliopsida	
Order	Solanales	
Family	Solanaceae	
Genus	Solanum	
Species	<i>Solanum lycopersicum</i>	

So, you can see that there are a lot of steps to classifying a living thing, but once you do, it makes sense and is neat to see what things have in common. Human beings are part of the kingdom Animalia, phylum Chordate, class Mammalia, order Primates, family Hominidae, and genus Homo. Our scientific name is *Homo sapiens*. But, don't forget that human beings have very special characteristics that science can never classify or put a label on. Think of all the things that make you *you*. You are different than any human being who has ever lived in the past or who will ever live in the future. No one will ever contribute to the world what you alone can offer. When you get down to what matters, you are one-of-a-kind, and that is something special to celebrate.

Review

What are the 8 levels of scientific classification? Include both terms for the level that goes by a different name in the animal and plant kingdoms.

A vertical flowchart template for the 8 levels of scientific classification. It consists of eight empty rectangular boxes connected by arrows pointing downwards. A large 'SAMPLE' watermark is diagonally across the center.

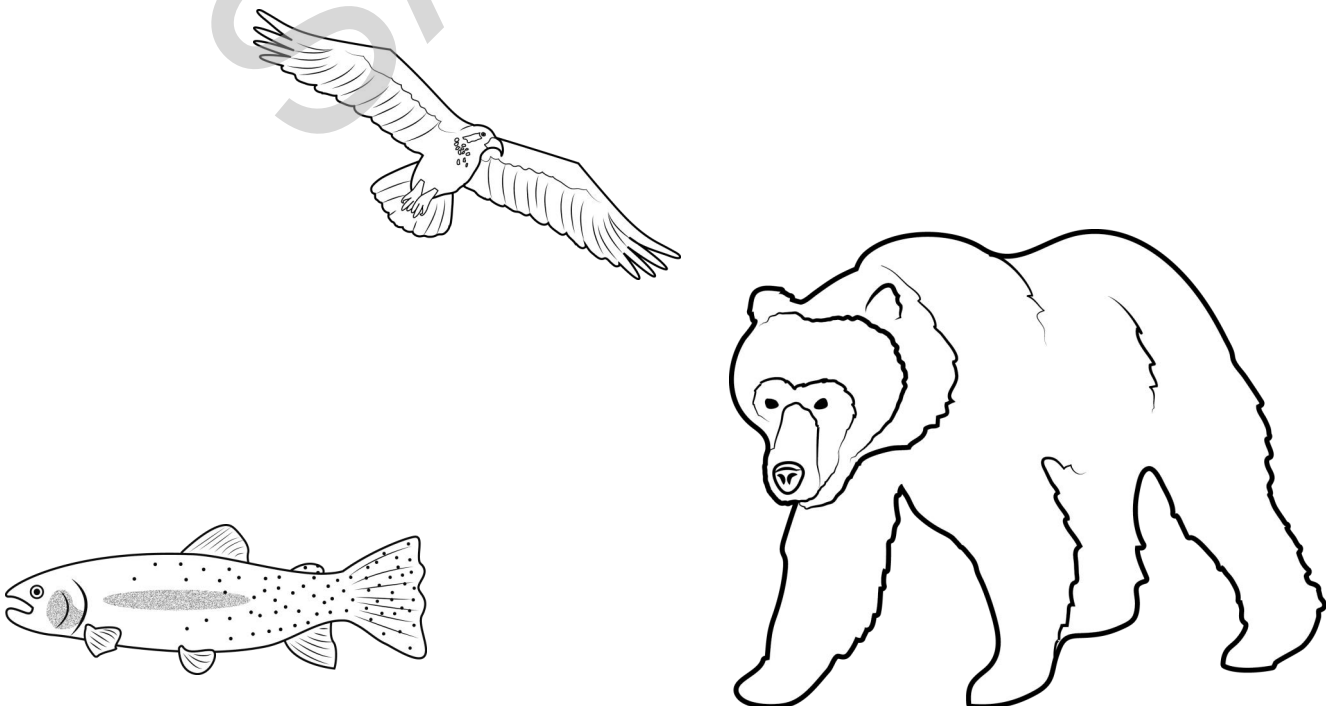
Ecosystems

Producers and consumers. Populations and communities. Decomposers, invasive species, and energy pyramids. These are just some of the terms related to ecosystems that we are going to explore in this unit, but before we sort all those terms out, let's start at the top. What is an ecosystem?

An **ecosystem** is everything in an area, both living and nonliving things. Think of it as a world within a world. We live on planet Earth, but we all live in very different places. Some places are hot and dry; other places are cold and wet. Some places are filled with forests; some places are filled with skyscrapers and apartment buildings. People don't all live in the same type of place, and neither do plants and animals. The easiest way to study plants and animals is to break them into ecosystems so we can study groups at a time. An ecosystem is the largest type of group. It includes everything—both living and nonliving—in an area.

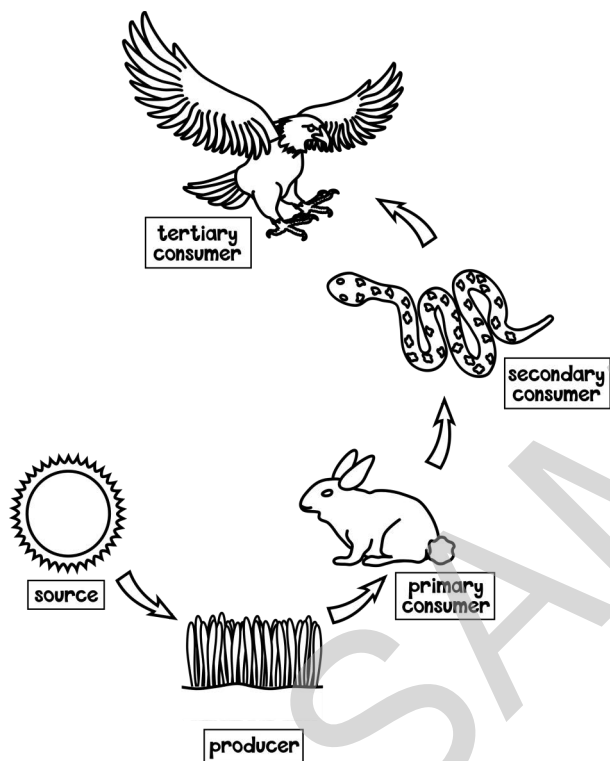
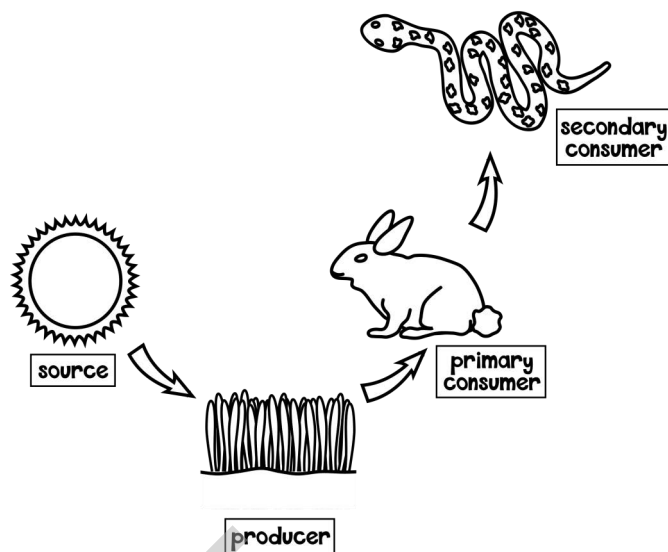


Let's look at an example. Yellowstone National Park is one area of North America in the United States. You can find all sorts of animals there, such as the Yellowstone cutthroat trout, the osprey, and the grizzly bear.



But, the food chain doesn't end with the rabbit. A snake might come along and eat the rabbit. If a living thing eats only other animals for food, it is a **secondary consumer**. Animals that only eat other animals are also called **carnivores**.

If a living thing, such as an animal or a person, eats both plants and animals, they are called **omnivores**.



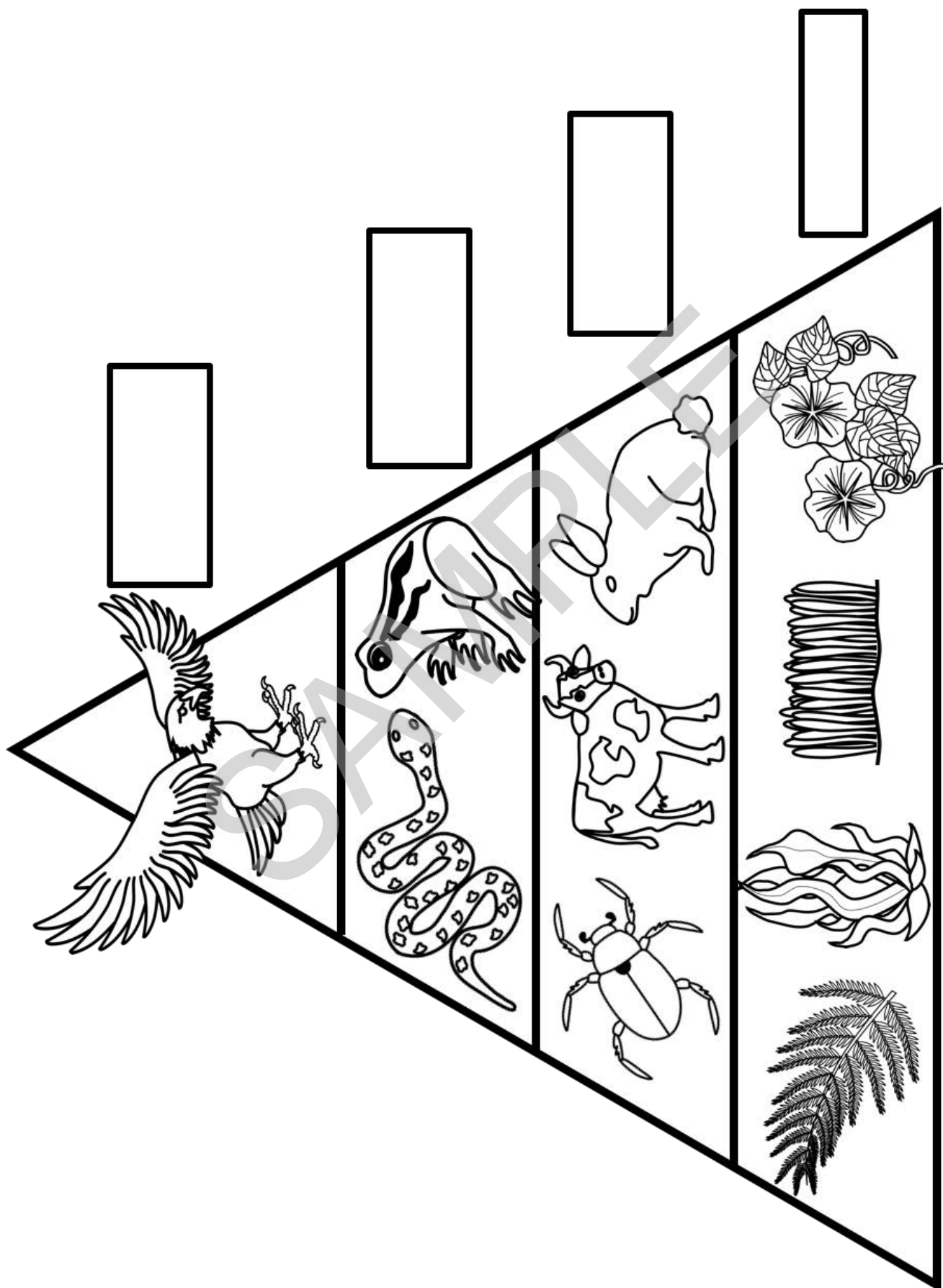
But some animals eat both the primary consumers and the secondary consumers. A hawk might eat a rabbit or a snake. An animal that eats both types of consumers is called a **tertiary consumer**.

There's one more type of creature that is critical to an ecosystem that you don't see on a food chain. Some creatures get their energy by eating dead animals or plants. It sounds rather disgusting, but without these **decomposers**, the world couldn't exist. The dead things would spread poison and toxins that would destroy everything that was left. When plants or animals die, decomposers go to work. Decomposers often live in the soil,

like earthworms. Fungi and some bacteria are also decomposers. When they break dead things down, they put important nutrients back into the soil that helps plants stay healthy.

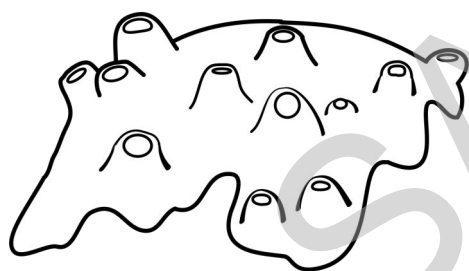
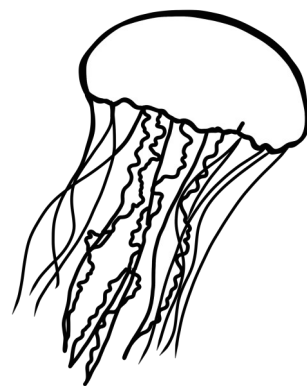
As we've seen in our food chain, the sun gives energy to plants, such as grass. The grass uses the energy to make food. Rabbits come along and eat the grass, using the energy from the grass to live. A snake comes along and eats the rabbit, using the energy from the rabbit to live. Then a hawk comes along and eats the snake or the rabbit and uses that energy to live. We can see this flow of energy by diagramming it in an **energy, or trophic, pyramid**.

Label the role of the living creatures in each level of the energy pyramid.



Invertebrates

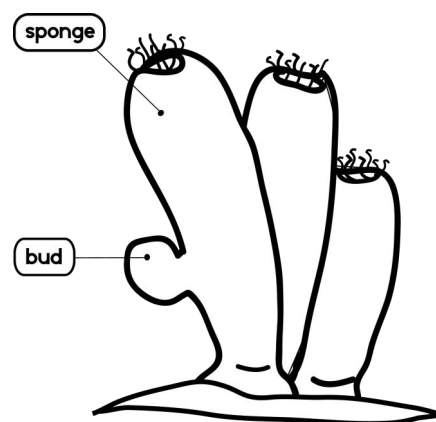
When scientists classify animals, the level beneath Kingdom Animalia is phylum. There are more than thirty different phyla (plural of phylum) scientists group animals into. One is *Chordata*. This is the phylum that all **vertebrates**, animals with backbones, are classified in. This includes animals such as mammals, fish, birds, and reptiles. All the other phyla are reserved for **invertebrates**, animals without a backbone. When you look at it that way, you might think there are a lot more invertebrates than there vertebrates. And, you'd be right! Of all the different species of animals in the world, invertebrates make up around 95%. That means if you had a room with 100 different species of animals in it, 5 of them could be types of dogs, elephants, fish, and birds. The other 95 would be things like jellyfish, sponges, corals, earthworms, starfish, snails, squids, clams, shrimp, crabs, centipedes, butterflies, beetles, spiders, scorpions, honeybees, ladybugs, crickets, and all sorts of other animals. That's a lot of different types of animals! At first glance, they don't have much in common. After all, how could you group a honeybee and a jellyfish together? Thankfully, scientists break the invertebrates into different phylum, and then classes, orders, and families to study animals that are similar, so that's what we're going to do. We'll look at some of the many different groups of animals that make up the world of invertebrates.

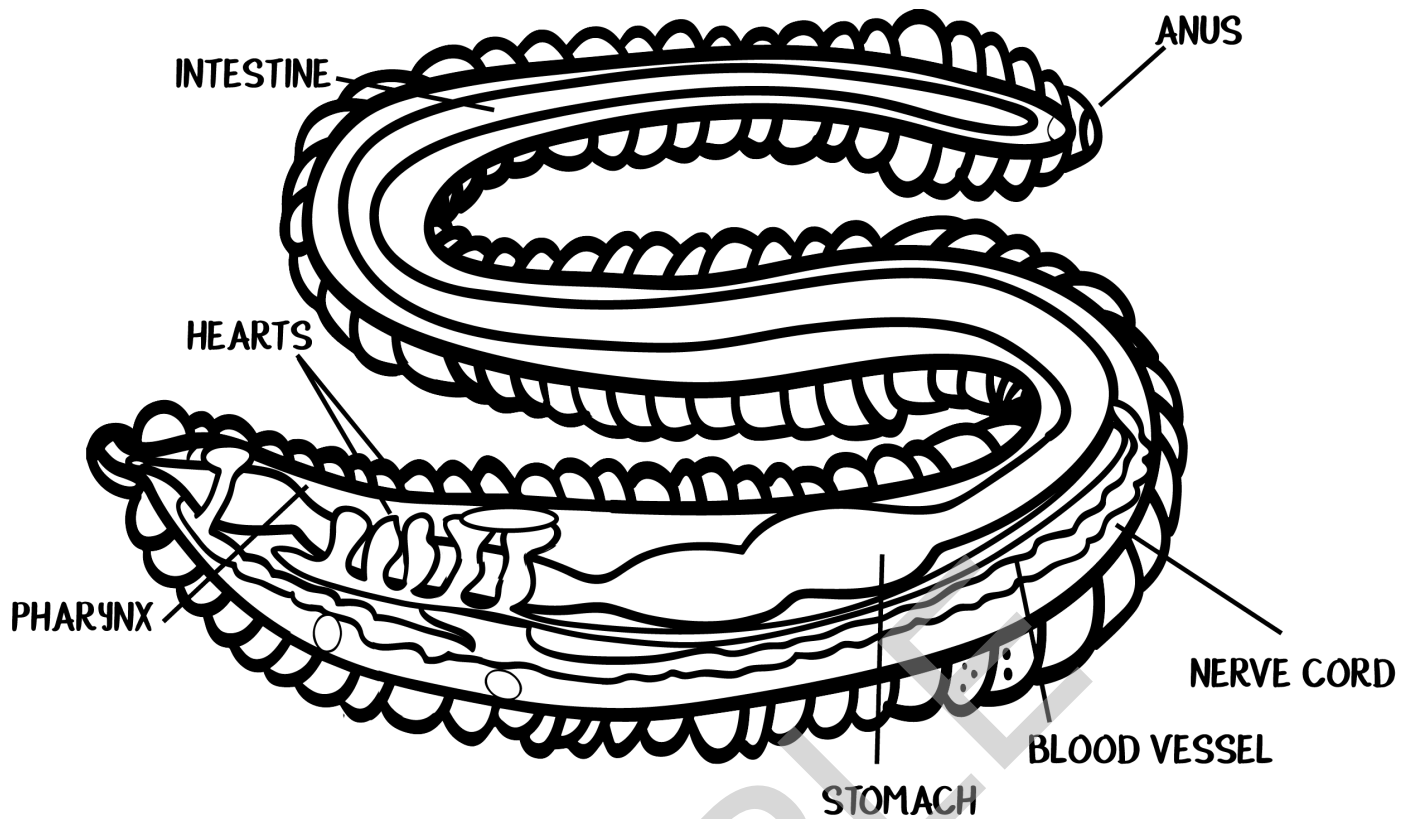


Phylum *Porifera* is made of pore-bearing animals called sponges. Most sponges live in the sea, but a few kinds live in fresh water. Sponges are unlike most other animals. They don't have heads, arms, or internal organs. The adults cannot move but stay anchored to one spot. A living sponge has two types of openings on its body. Ostia are small pores that

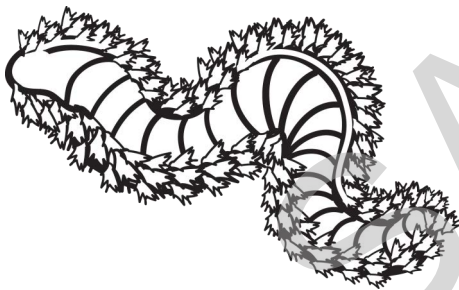
allow water into the sponge, and the osculum is a large pore that allows water to leave the body.

Sponges reproduce in several different ways. Like most animals, they can reproduce sexually when a male and female cell join. They can also reproduce asexually. One way they do that is by a process called budding. In budding, sponges grow a bud or branch filled with special cells called archaeocytes. These cells have the ability to grow into whatever types of cells the sponge needs. The bud can then break off or stay attached to the parent sponge and develop into a new sponge.





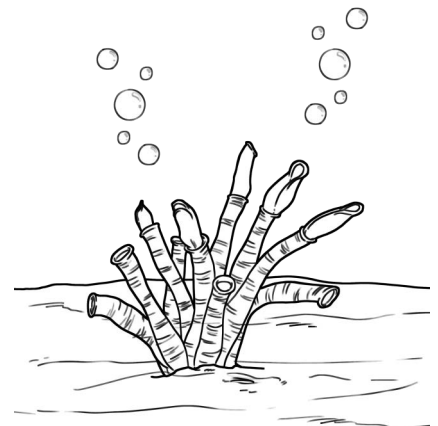
While earthworms might be the most recognizable **annelid**, they are not the only type of worm in this phylum. Bristle worms, pile worms, and tubeworms are also annelids.



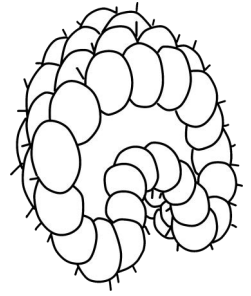
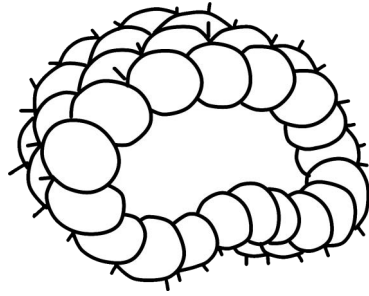
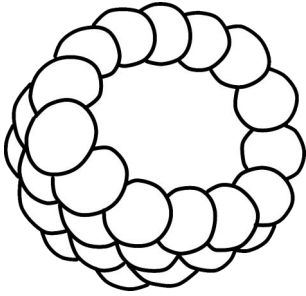
Bristle worms (also called pile worms or sand worms) can be 1 inch (2.5 cm) to 3 feet (90 cm) long. They have sharp jaws that they can retract, two tentacles, and tiny bristles they use for moving. A bristle worm can have more than two hundred segments, with almost every segment holding its own pair of bristles.

Tubeworms live on the ocean floor. Once a tubeworm has chosen its spot to grow, it stays there the rest of its life. The outside tube can be made of mucus strengthened with mud, sand, and shell fragments. The tube can also be made of calcium carbonate. Some tubes are long while others are coiled.

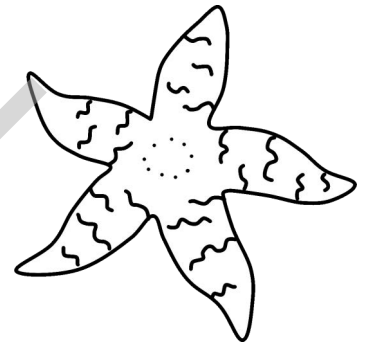
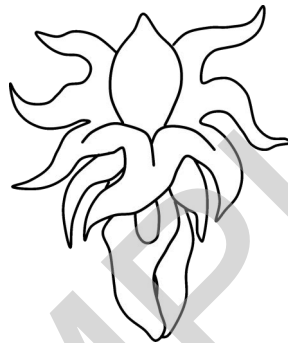
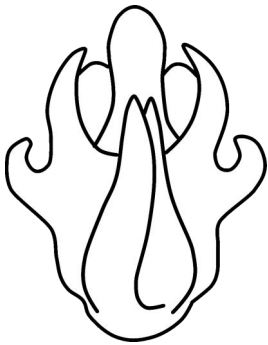
Tubeworms have feathery radioles, which are like arms they use to trap food from the water. Whenever a tubeworm is alarmed, it pulls itself safely back inside its tube. Some tubeworms even have a special piece they use to block the "door" to the tube to help protect themselves.



The young starfish continues dividing, growing larger and larger.

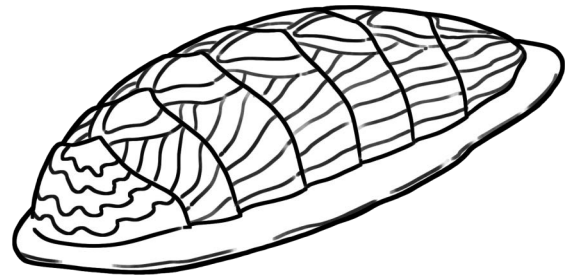


In time, the starfish will grow into larvae. Each larva will find a place on the bottom of the sea to finish growing into a young starfish.

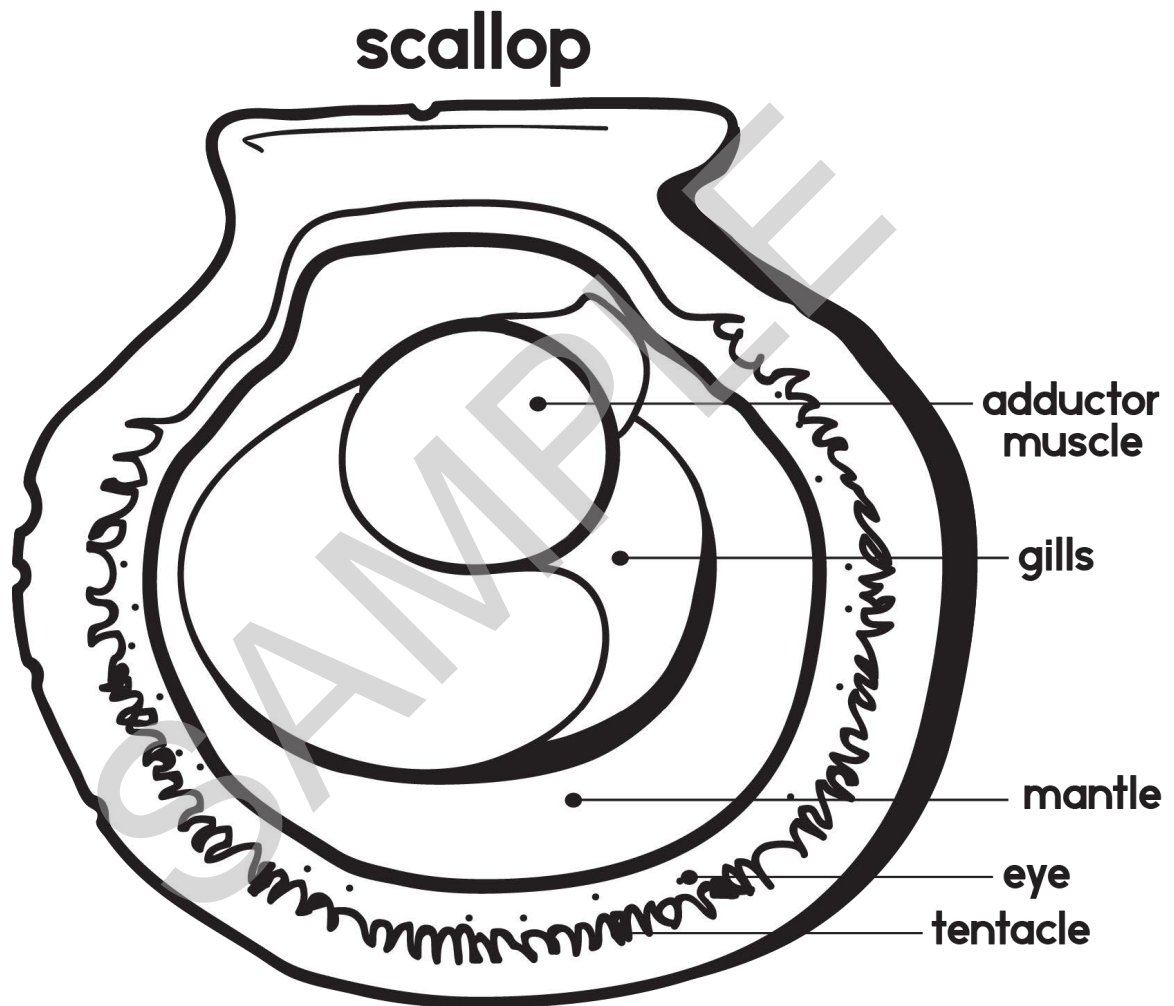


The next group of animals we're going to look more closely at is phylum *Mollusca*. There are more than 100,000 different species of mollusks in the world, and they include a very large variety of creatures, from tiny snails to giant squid. Many mollusks are protected by a hard outer shell, but some like squids, just have a special layer called a mantle to keep them safe. Remember that when scientists classify animals, the level beneath phylum is class. We're going to look at four different classes of mollusks. We'll start with class Polyplacophora.

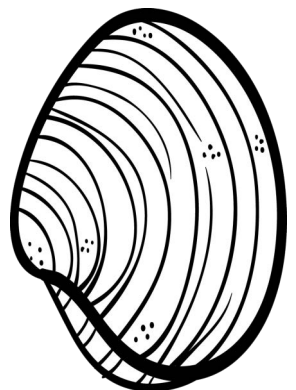
Polyplacophora is the class of chitons. There are hundreds of types of chitons, and they live in many places all around the world. Most of the chitons that live in warmer waters live fairly close to the surface, but chitons that live in colder waters live much deeper, even as far as 13,000-23,000 feet (4,000-7,000 meters) beneath the surface. They have a row of eight overlapping plates on their top and move by using one large foot.



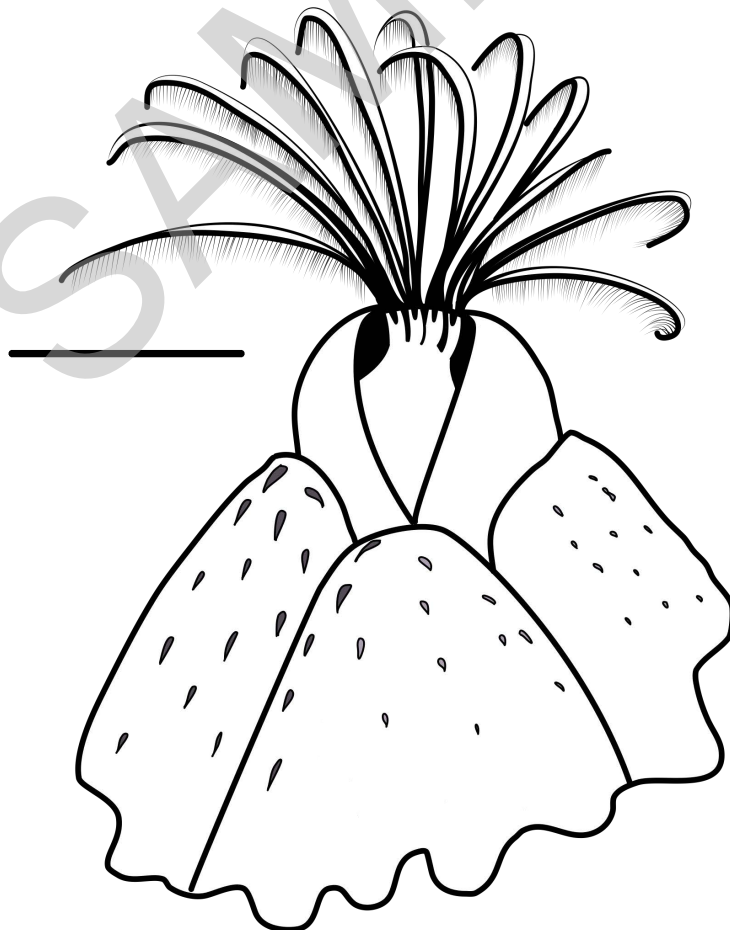
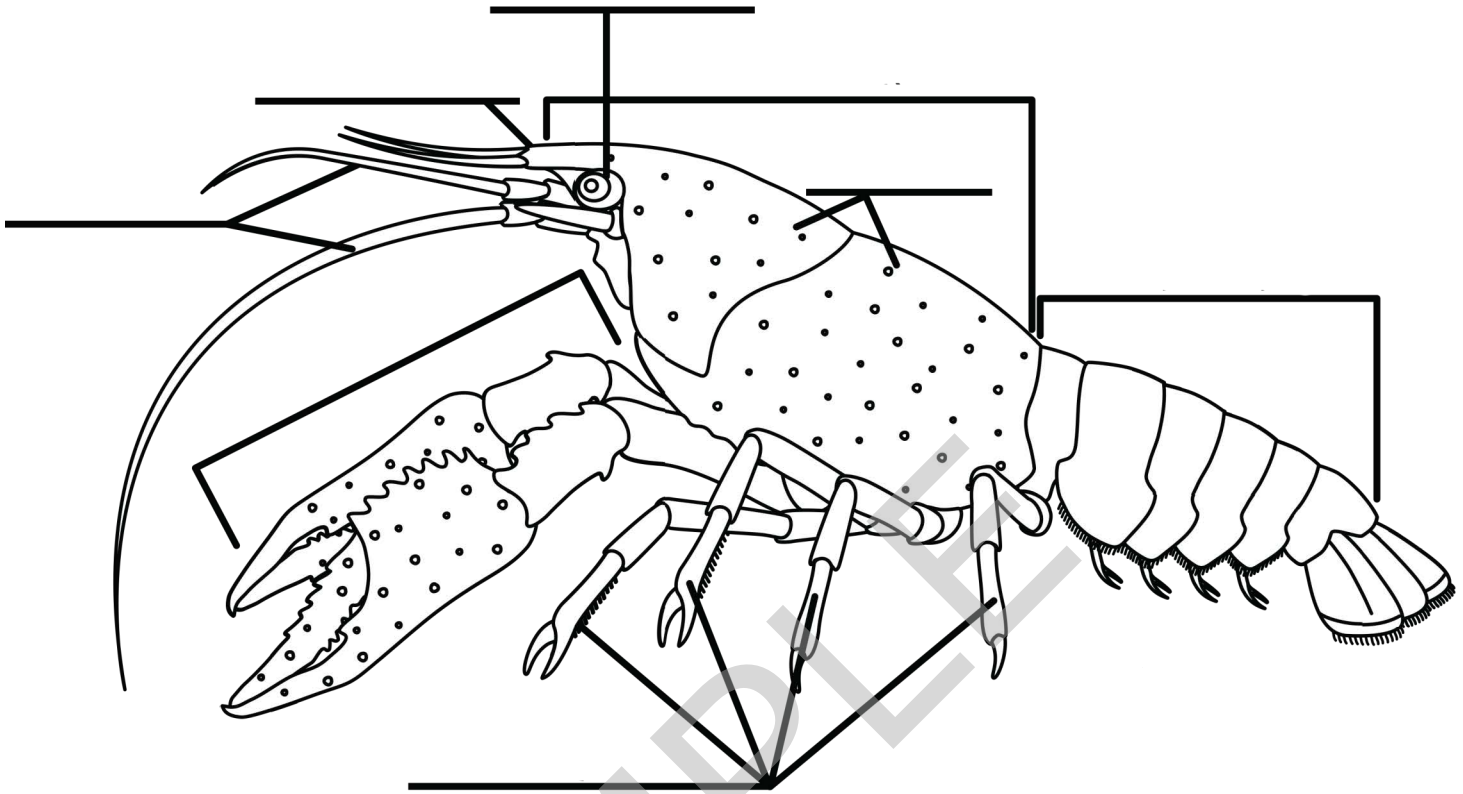
Scallops are able to do something different than the other bivalves we've looked at, though. They can swim by opening and closing their shells quickly. This forces water out of the mantle area, pushing the scallop through the water. It doesn't move all the time like people usually do, but it's an option when it feels threatened by a predator, such as a starfish. We don't think of starfish as particularly frightening, but they can be deadly to scallops. The starfish wraps its arms around the scallop and uses the suction of its tube feet to pull the scallop open. Then it sticks its stomach in between the valves and eats the inside of the scallop!

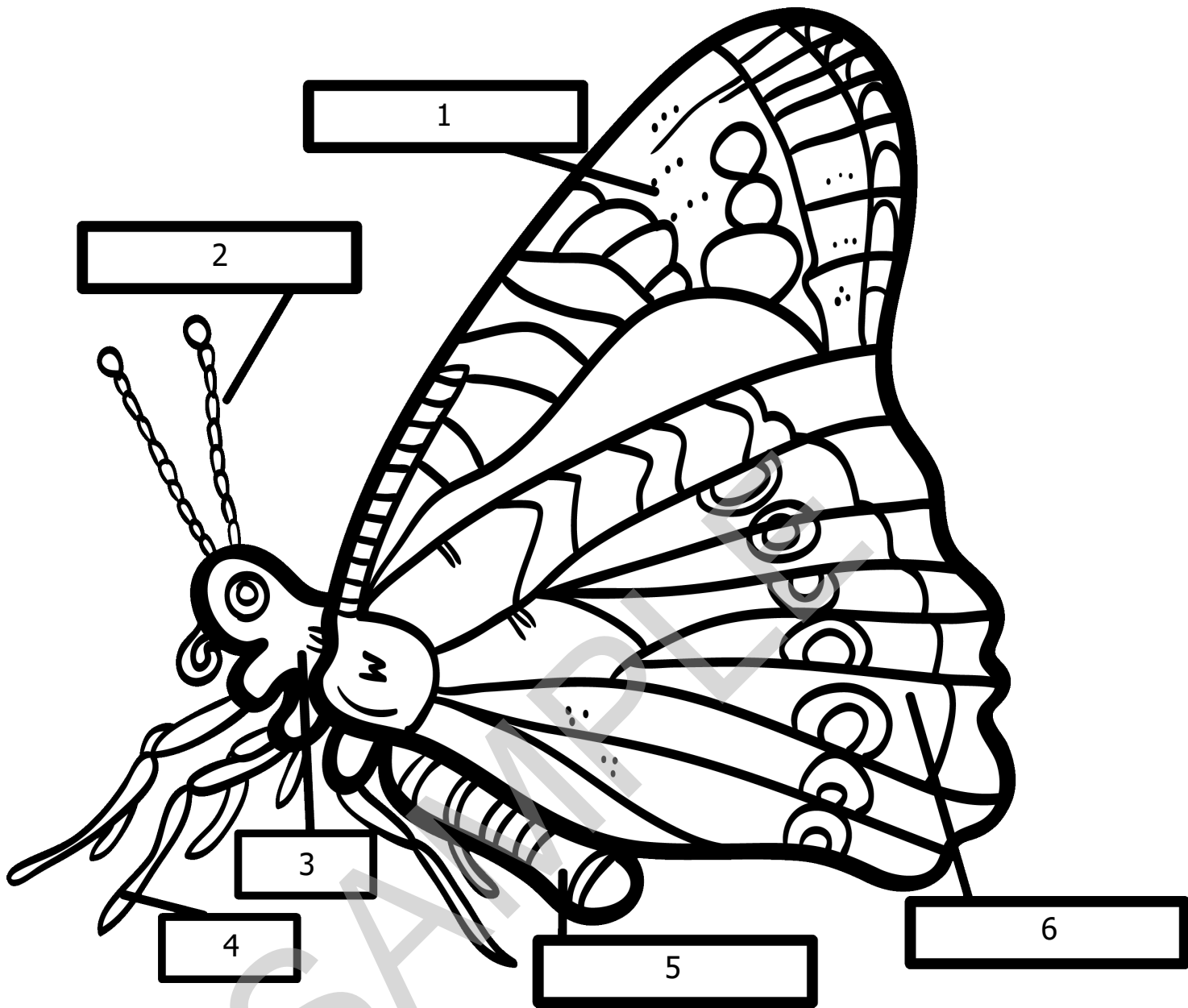


The last bivalve we're going to look at is the clam. The clam has two valves, a ligament, and an adductor muscle like the other bivalves we've looked at. Clams live all over the world, in both fresh water and marine environments. There are hard-shell clams and soft-shell clams. Some types of clams have a layer of mother-of-pearl beneath their mantle, just like mussels.



Let's review for a minute and label the diagrams of the crayfish and barnacle.





1. _____

4. _____

2. _____

5. _____

3. _____

6. _____

Terminology

Using what you learned, define these words in the best way you can. Use the back of the page if you need more room.

Vertebrates: _____

Invertebrates: _____

Nematocysts: _____

Radially symmetrical: _____

Cnidarians (*Cnidaria*): _____

Setae: _____

Annelid (*Annelida*): _____

Echinoderms: _____

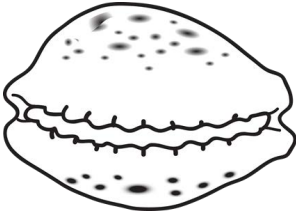
Bivalve (*Bivalvia*): _____

Cilia: _____

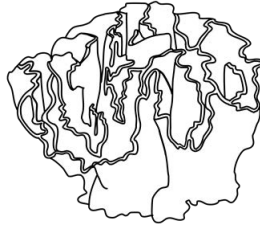
Byssus threads: _____

Cephalopods (*Cephalopoda*): _____

Which of the following animals is not a cnidarian? Draw an X through it.



Cowrie



Coral

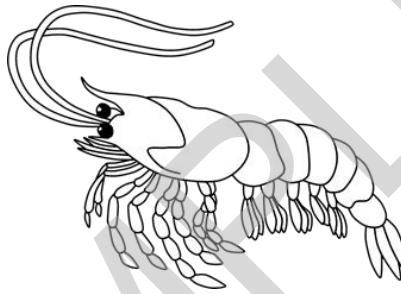


Jellyfish

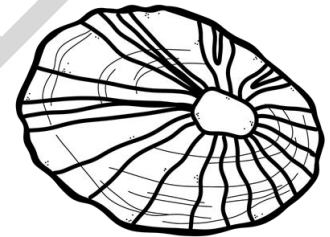
Which of the following animals is not a gastropod? Draw an X through it.



Conch



Shrimp

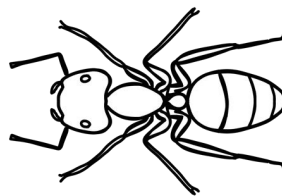


Limpet

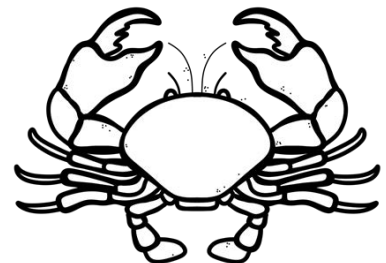
Which of the following animals is a crustacean? Draw a circle around it.



Octopus



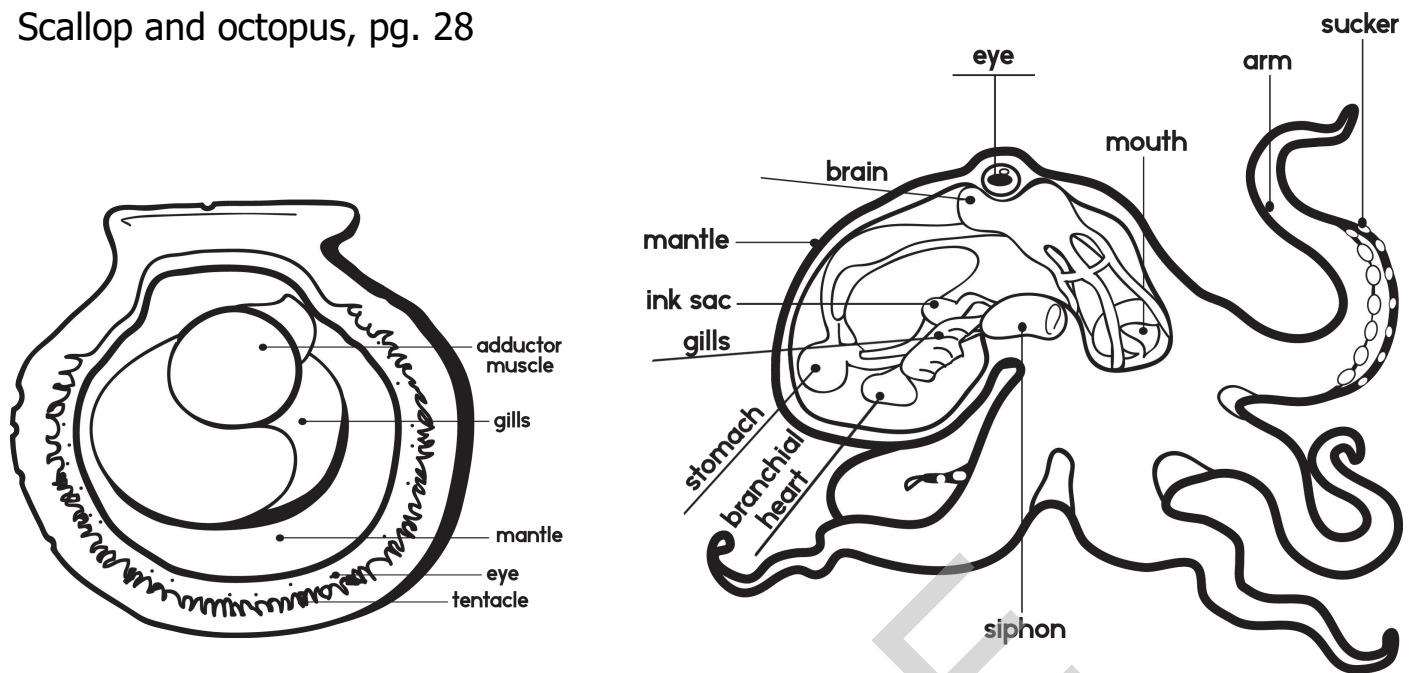
Ant



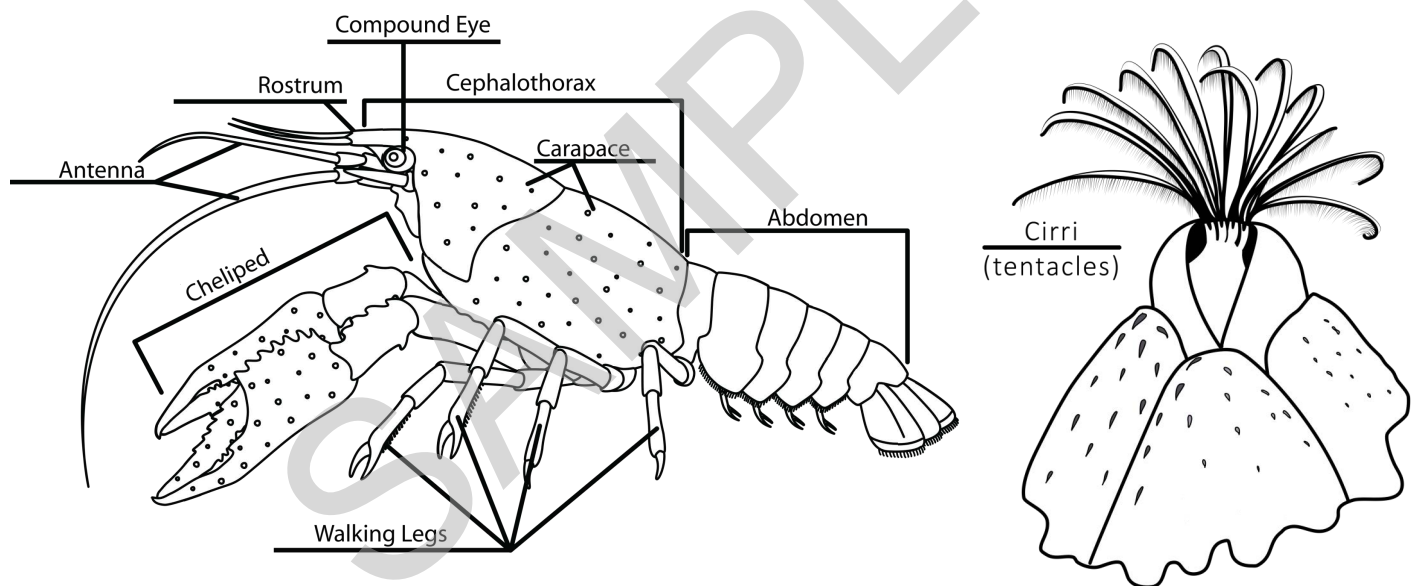
Crab

Can you name two differences between moths and butterflies?

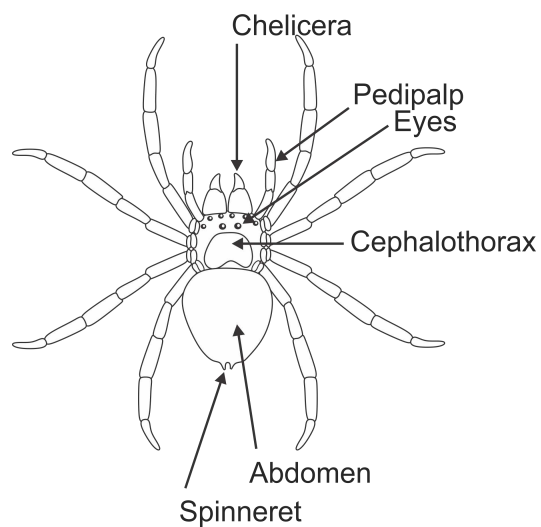
Scallop and octopus, pg. 28



Crayfish and barnacle, pg. 37



Spider, pg. 65

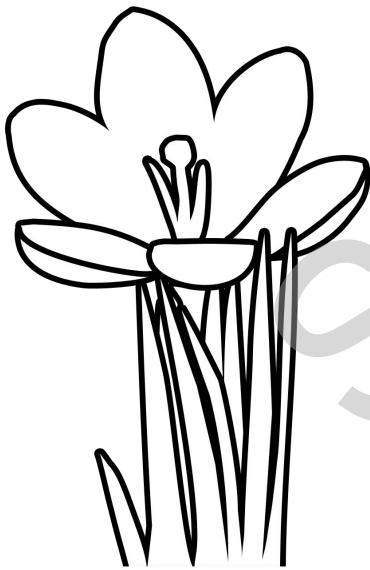


Plant Life Cycles, Pollination, and Reproduction

As you can probably guess from the name, this study is going to explore life cycles, pollination, and reproduction in plants. But that looks different for different types of plants. So first, we'll look at some ways we can classify plants. One of the simplest ways to classify plants are **green plants** and **nongreen plants**. Green plants have chlorophyll, which allows them to make their own food by photosynthesis. Nongreen plants do not have chlorophyll and have to get their food by another method.



Green plants include **vascular plants** and **simple green plants**. Vascular plants are plants that have tubes that carry liquid through the plant. These tubes are called vascular bundles. You can see these tubes if you cut a piece of celery. The tiny holes you see at the end of the stalk are the vascular bundles. Most vascular plants live on land. They have roots that hold them in the soil, their stems support them, and their leaves capture the sunlight needed for photosynthesis. There are many different types of vascular plants, but we can group them loosely as ferns, flowering seed plants, and nonflowering seed plants.



Flowering seed plants are also called **angiosperms**. Flowering plants are everywhere and include wildflowers, fruit trees, and many vegetables.

Nonflowering plants are also called **gymnosperms**. Gymnosperms produce uncovered (or naked) seeds, mostly in cones. Conifers like pine trees and redwoods are gymnosperms.

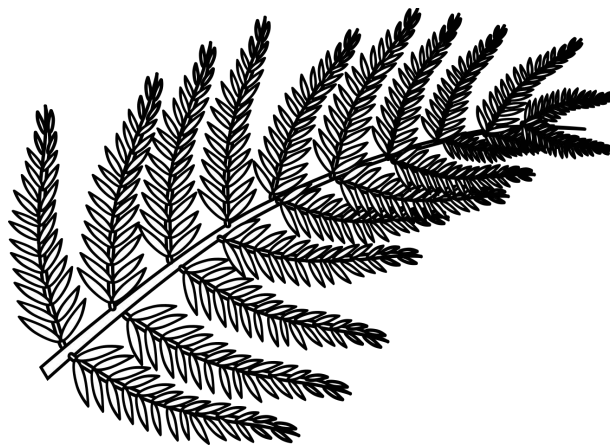
Simple green plants do not have vascular bundles and all the parts found in vascular plants. They include plants such as algae and moss. They use other means for getting the nutrition they need for photosynthesis.

Nongreen plants include lichens as well as fungi such as yeasts, molds, and mushrooms.

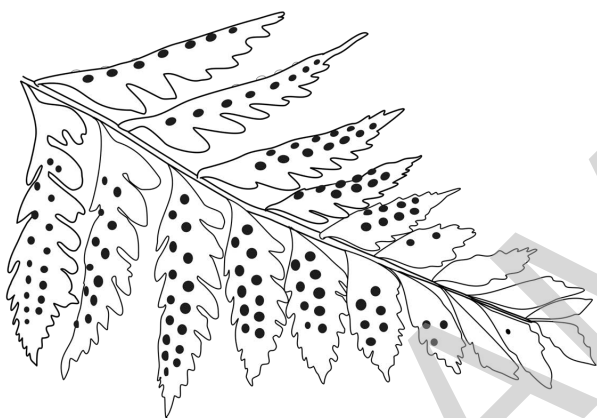
Now that we know the major groups of plants we'll be looking at, let's take a closer look at what we're going to learn about them.



The last vascular plants we're going to study are ferns. Ferns usually grow in moist places. Their stems and root-like branches generally grow beneath or close to the ground. Their leaves, called **fronds**, are the part we see above ground.



Instead of seeds, ferns use spores to reproduce. Spores are cells that contain the food and all the ingredients needed to grow a new plant. Ferns also use both sexual reproduction and asexual reproduction in a special way called **alternation of generations**. The best way to understand what that means is to think about what each term means. To "alternate" means to switch back and forth. A "generation" is a parent and a child. So when we say ferns use alternation of generations, we mean that one generation uses asexual reproduction and the next generation uses sexual reproduction.

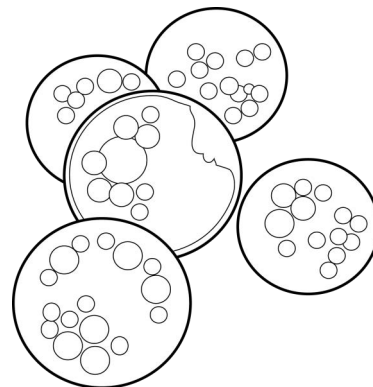


The ferns in the cycle of asexual reproduction are the ones we usually think of when we picture a fern. The long fronds stretch out and can grow cases of spores on the underside. Each case can hold many spores, and a single fern can produce millions of spores. The wind disperses the spores, but only a few of these spores ultimately find the right conditions they need to grow.

The new plant produces male and female cells instead of spores. When these cells come together, fertilization happens and an embryo is formed. The embryo grows and develops the first leaf, root, and stem of a new fern, and the cycle begins again.

Now that we've explored green vascular plants, it's time to look at types of simple green plants. These plants don't have typical roots, stems, or even leaves. They have to get the nutrients needed for photosynthesis in other ways. Let's take a closer look at algae and moss.

There are many different species of algae. They can be extremely small or grow into underwater forests. They reproduce by sexual reproduction, asexual reproduction, or both methods. Some scientists separate algae from plants and classify them in kingdom Protista. One kind of algae, called chlorella, are single-celled organisms.



Terminology

Using what you learned, define these words in the best way you can. Use the back of the page if you need more room.

Green plants: _____

Nongreen plants: _____

Vascular plants: _____

Simple green plants: _____

Angiosperms: _____

Gymnosperms: _____

Reproduction: _____

Receptacle: _____

Petals: _____

Sepals: _____

Stamen: _____

Pistil: _____

Anther: _____

Filament: _____

Stigma: _____

Style: _____

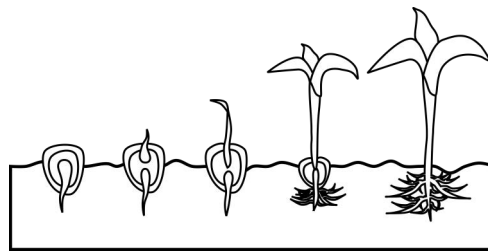
Sperm: _____

Ovary: _____

Which of the following is not a method of seed dispersal? Draw an X through it.



Wind

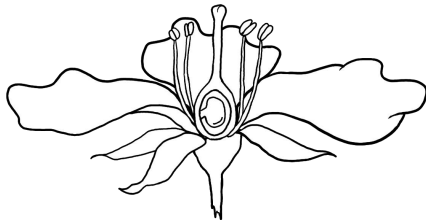


Germination



Animal Ingestion

Which is not a form of asexual reproduction? Draw an X through it.



Pollination

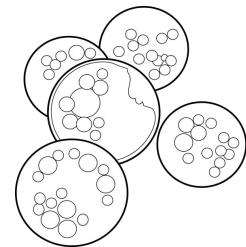
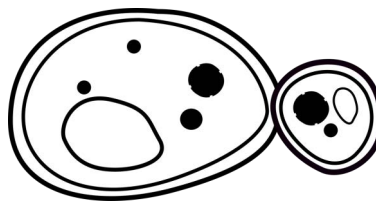
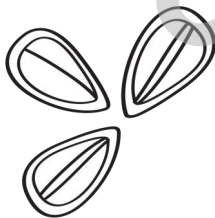


Runners



Fragmentation

Which is an example of budding? Draw a circle around it.



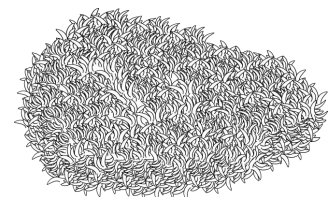
Which is not a fungus? Draw an X through it.



Mold



Mushroom

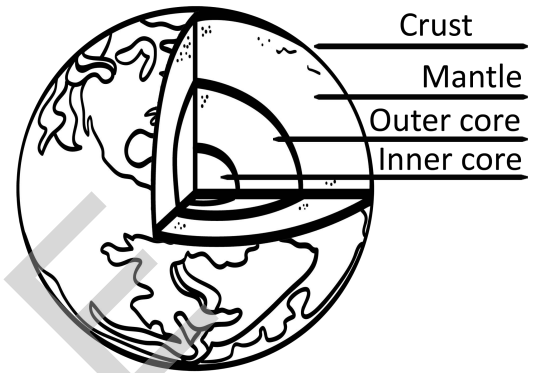


Moss

Volcanoes, Earthquakes & Plate Tectonics

You are probably already familiar with the layers of the Earth, but we're going to review them quickly just so we remember. The **crust** is the very top layer of the Earth. It's made of rock and includes the ground we stand on, the ocean floor, and miles and miles of rock and dirt. Scientists think it is about 5 to 25 miles (8 to 40 kilometers) thick.

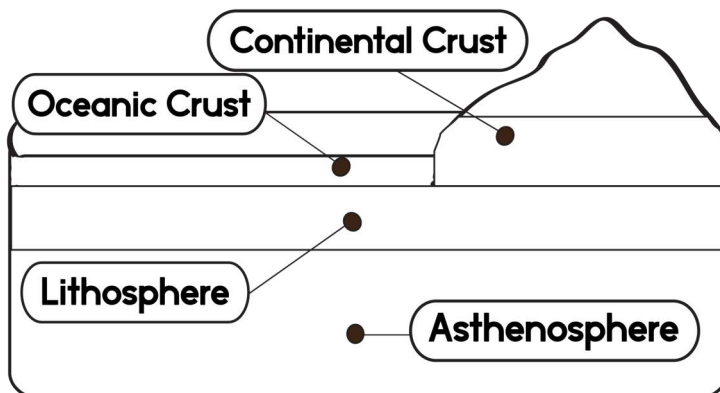
The next layer is the **mantle**. The mantle is made of rock, but it's a little bit different. The very top of the mantle is hard rock, but there is so much heat and pressure on the rock in the rest of the mantle that the rock isn't solid or hard, like we usually think of rock. This rock is sort of sticky and gooey, a little like caramel. It's not totally solid, and it's not totally liquid. It can move and flow from place to place, and scientists think it is about 1,800 miles (2,900 kilometers) thick.



The next layer of the earth is called the **outer core**. This layer is liquid iron, and the earth's mantle rests on top of it. Scientists think this layer is about 1,400 miles (2,250 kilometers) thick.

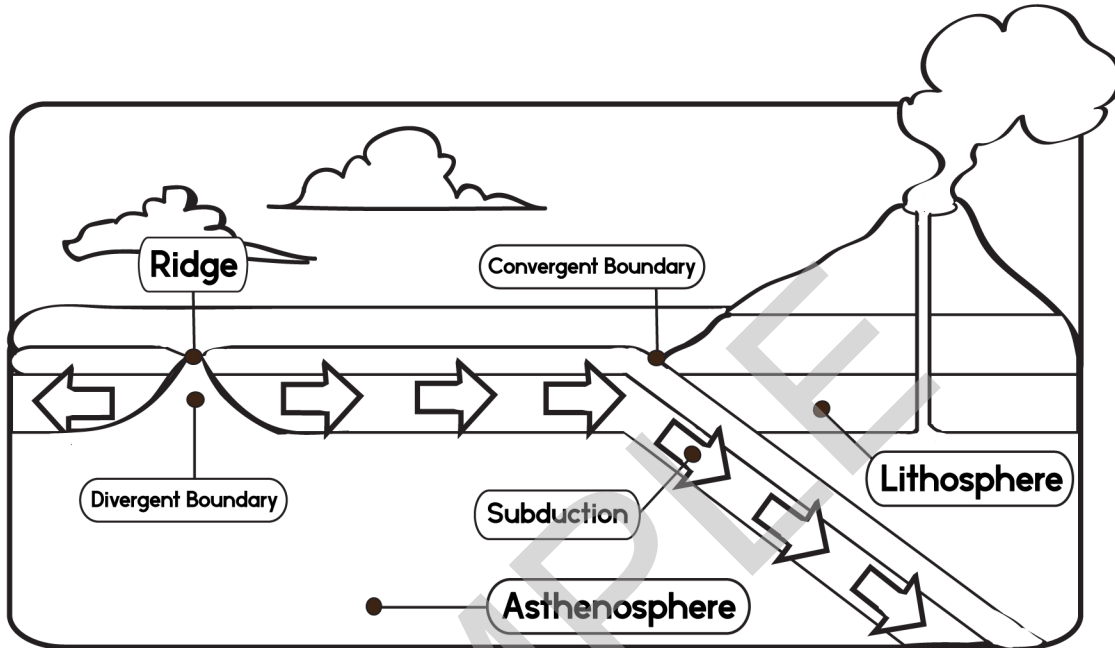
The deepest layer is called the **inner core**. Scientists think this layer is made of nickel and iron that form an extremely hard ball in the middle of the earth.

Scientists have even more categories and ways to separate the different layers near the surface of the Earth that will be helpful as we learn about earthquakes and volcanoes. The crust isn't the same everywhere. We call the part of the crust that the continents are on the **continental crust**. It's very thick, reaching about 30 miles (50 kilometers) beneath the continents. The **oceanic crust** is the ocean floor. It is much thinner and reaches about 3-6 miles (5-10 kilometers) beneath the ocean. The deepest spot in the ocean we've found is called the Mariana Trench. It stretches 35,840 feet (10,924 meters) deep, which is less than 7 miles (11 kilometers).



The crust and the very top part of the mantle together are called the **lithosphere**. The rest of the mantle beneath them is called the **asthenosphere**.

Let's take another look at how these parts work together. In this diagram, you can see a convergent boundary between the ocean and the continent. Subduction is happening where one plate is pushing beneath the other. A divergent boundary in the ocean is causing a ridge to form. The layer of crust and upper mantle where the plates are is the lithosphere, and the gooey mantle beneath is the asthenosphere.



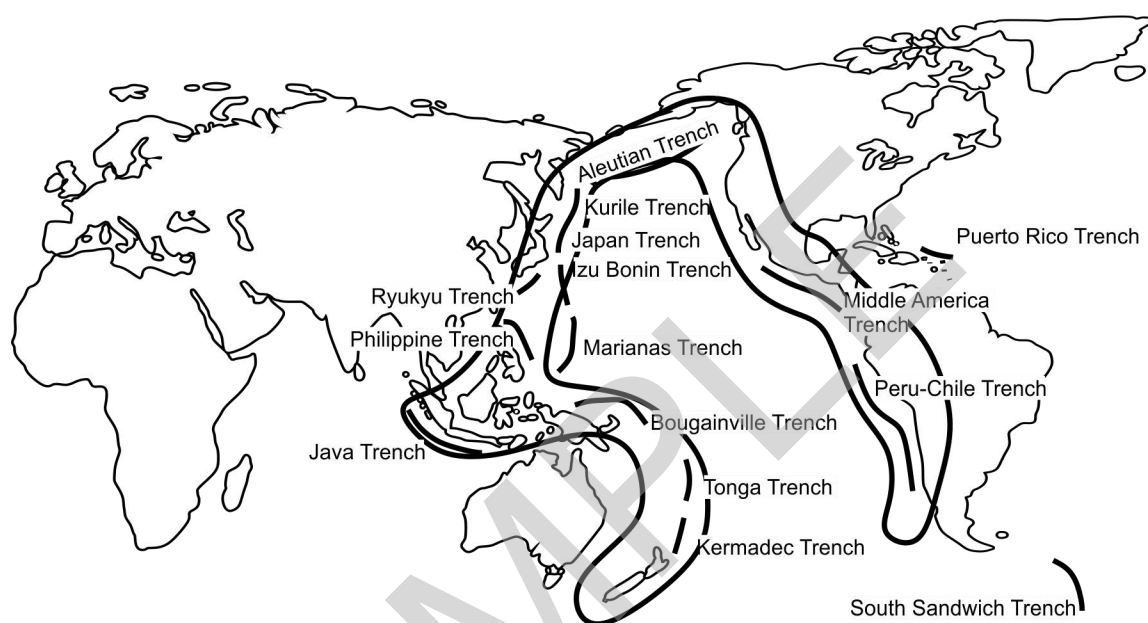
As you might imagine, when tectonic plates move, it can cause a lot of problems for people. After all, typically, the ground shouldn't move a lot under our feet. When it does, it can cause buildings to shake, gas lines to break, power lines to fall, and many other dangerous situations. As the plates interact with each other, we get earthquakes. Most are far too small to be noticed, but some are major catastrophes.



Earthquakes can also cause tsunamis, which are series of powerful ocean waves we'll read about in few minutes. They can even cause something called **liquefaction**. Liquefaction is when the soil acts like a liquid instead of a solid, causing things to sink.

LIQUEFICATION

There have been many major volcanic eruptions throughout history, including the eruption of Mount Vesuvius that buried Pompeii, Italy, in the year AD 79. But many of the worst disasters have happened along the **Ring of Fire**. It's an area in the Pacific Ocean that involves several tectonic plates, including the Pacific Plate, the Philippine Plate, the Cocos Plate, and the Nazca Plate. The deepest spot on Earth, the Marianas Trench, is also found in the Ring of Fire. The Ring of Fire is shaped like a horseshoe that starts in New Zealand and stretches up to the Philippines, Japan, and Alaska, then south to the western United States, Mexico, and the Andes Mountains in South America. It's about 25,000 miles (40,000 kilometers) long.



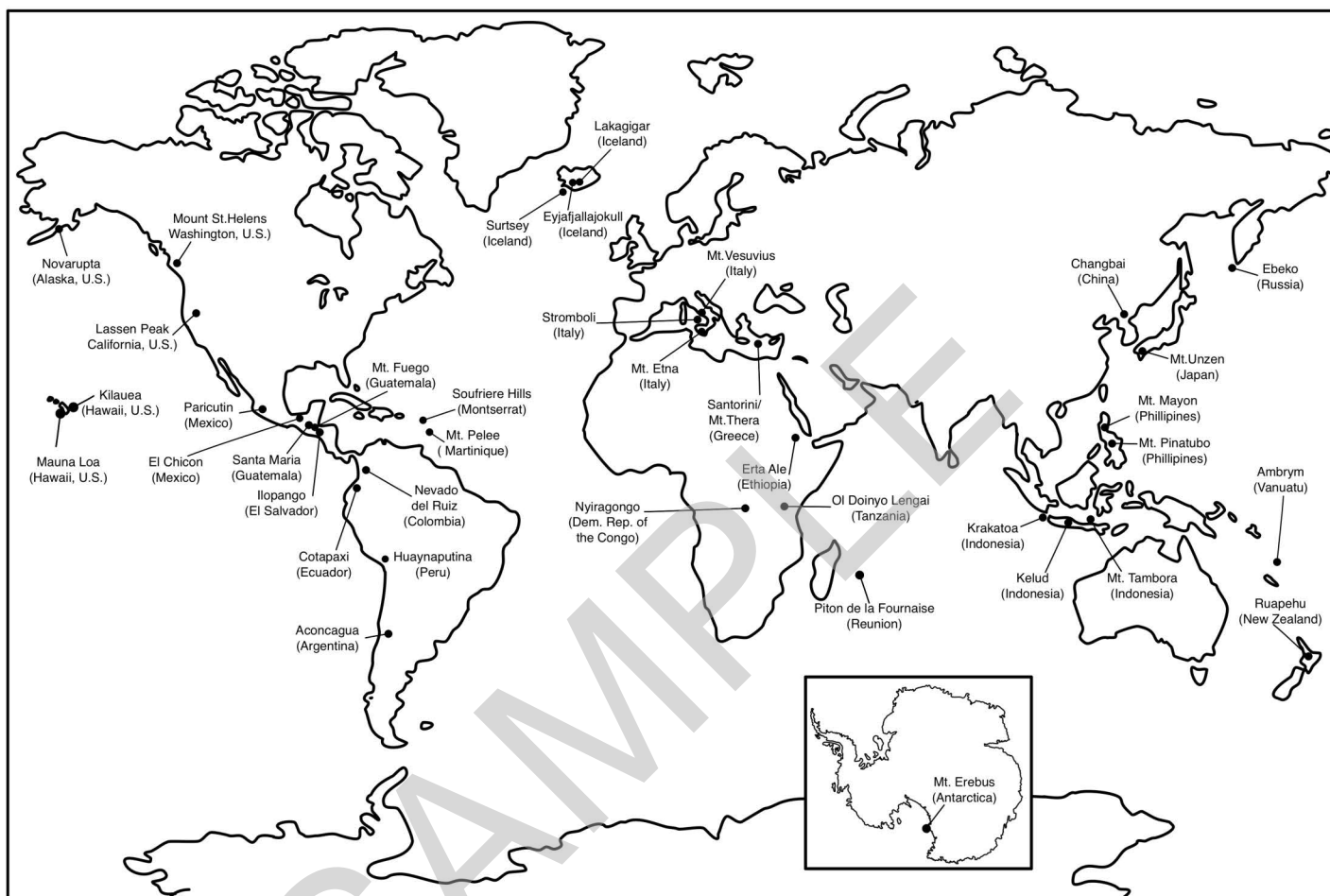
Even though it is a narrow strip, it is home to more than half of the world's active volcanoes, with about 350 along the ring. It is also the home of thousands of earthquakes every year. The most powerful volcanic explosion ever recorded happened at Mount Tambora in Indonesia in 1815. The explosion and the tsunami that followed devastated the area. The volcano was about 14,000 feet (4,300 meters) high before the eruption, but it is only 9,354 feet (2,851 meters) high today following the major eruption and several smaller ones. The caldera the eruption left behind is about 3.7 miles (6 kilometers) across.

Another serious volcanic eruption in Indonesia happened in 1883 when Krakatoa exploded. It created a cloud of ash that reached 50 miles (80 kilometers) high. The explosions were heard in Australia, and the tsunami waves reached to Hawaii and South America. The largest wave, which struck the Indonesian towns of Java and Sumatra soon after the explosion, was 120 feet (37 meters) high.

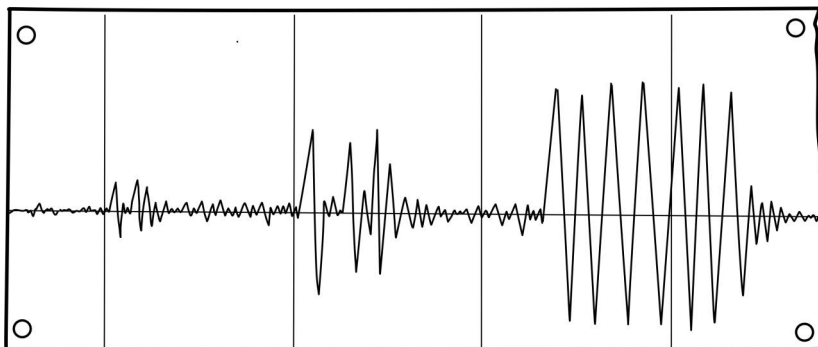
The 1980 eruption of Mount St. Helens was not the strongest volcanic eruption in United States history (that was Novarupta in Alaska in 1912), but it was the most destructive. The volcano blasted more than 1,000 feet (300 meters) of its top into

the air, destroying buildings and roads, flattening trees, covering crops in ash, and killing dozens of people.

Look at the map and see how many of the worst volcanic eruptions in history have happened around the Ring of Fire.



As scientists continue to study earthquakes, tsunamis, and volcanoes, we can hope they will find new ways of predicting when these disasters will happen so many more people can be kept safe. Maybe *you* will be the one to find the answers.



Terminology

Using what you learned, define these words in the best way you can. Use the back of the page if you need more room.

Crust: _____

Mantle: _____

Outer core: _____

Inner core: _____

Continental crust: _____

Oceanic crust: _____

Lithosphere: _____

Asthenosphere: _____

Divergent boundary: _____

Convergent boundary: _____

Transform boundary: _____

Subduction: _____

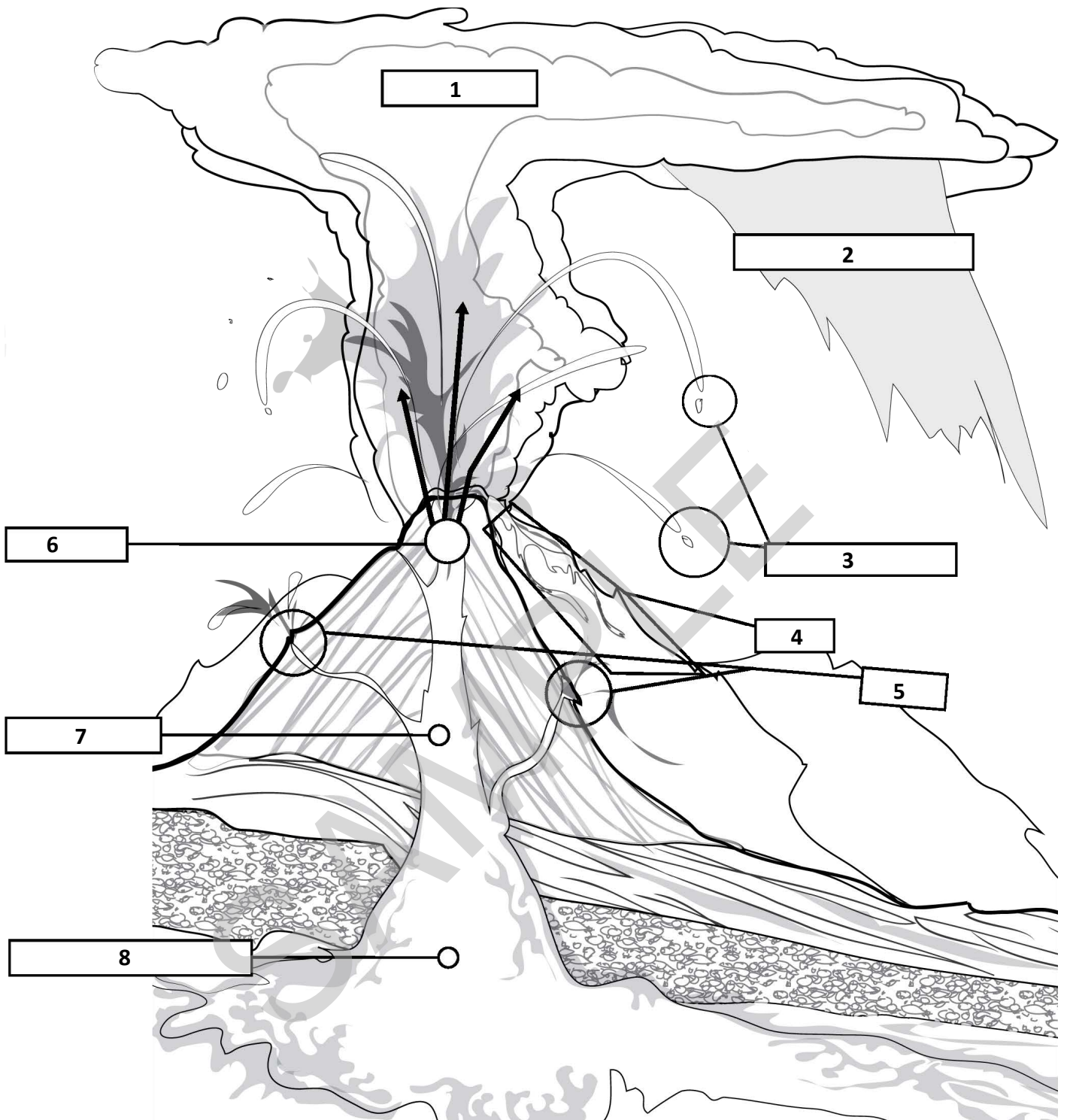
Liquefaction: _____

Fault: _____

Normal fault: _____

Reverse fault: _____

Transform fault: _____



1. _____

5. _____

2. _____

6. _____

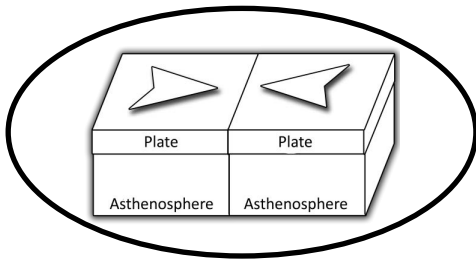
3. _____

7. _____

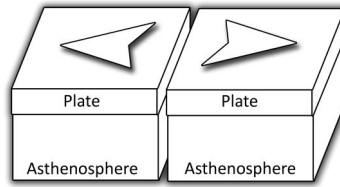
4. _____

8. _____

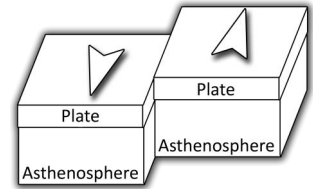
Which of the following shows a convergent boundary? Draw a circle around it.



Boundary



Boundary

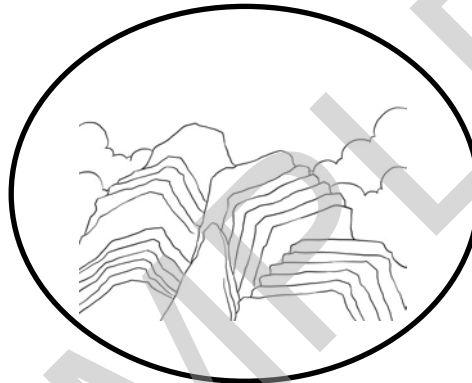


Boundary

Which of the following show fold-thrust (folded) mountains? Draw a circle around it.



Mountains

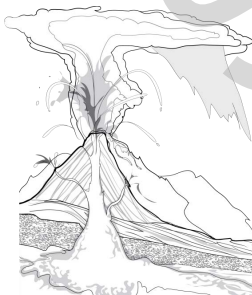


Mountains

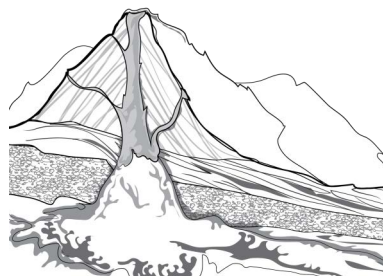


Mountains

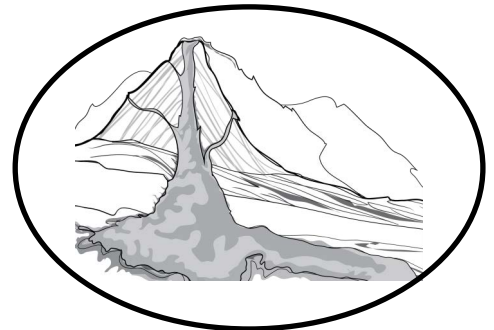
Which of the following is the name for a volcano scientists don't think will ever erupt again? Draw a circle around it.



Active



Dormant



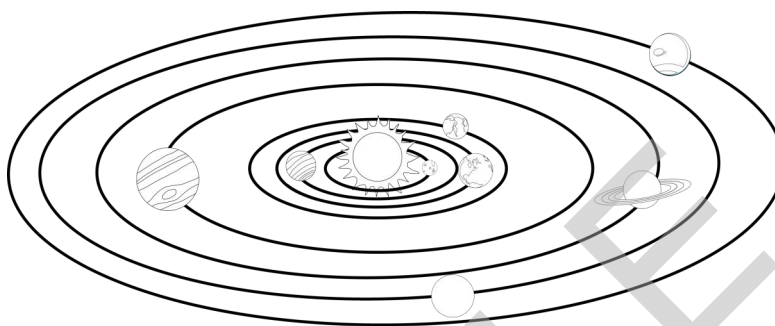
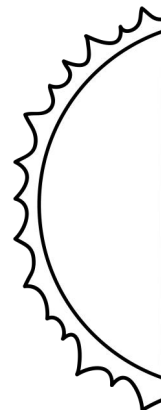
Extinct

Can you name two signs a volcano may erupt soon?

Extremely hot water in rivers and lakes; gas leaking into hot springs that smells like rotten eggs; change in temperature of the gas at a fumarole or dead plants; landslide; change in shape

Earth's Sun and Moon and Their Patterns

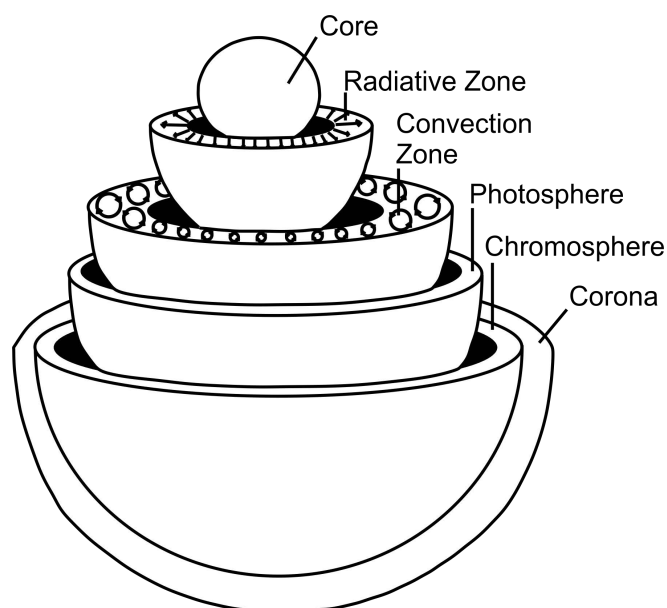
No matter where you are on the Earth, there are two things you can see in the sky at some point during the year—the sun and the moon. They may look different at different times of the year, and some places can go weeks without seeing the sun, but if it weren't for these two objects, we wouldn't have life as we know it on Earth. We're going to see what we can find out about these two heavenly bodies, learn about what they do, and see how they affect us on planet Earth.



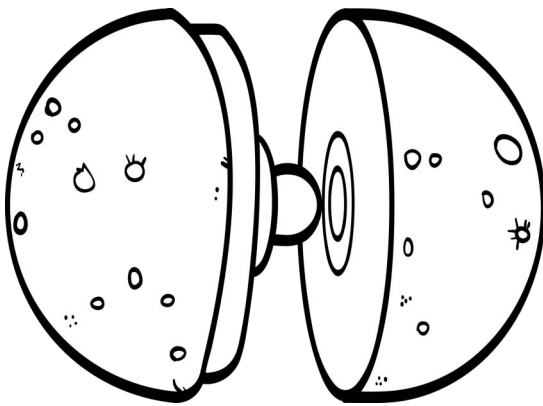
The sun is at the center of our solar system. The planets, plus asteroids and comets, revolve around the sun. It gives Earth the light, heat, and other energy living things need to survive, even though it is about 93 million miles (149 million kilometers) away. If we were even 5% of the distance closer, it would cook our oceans and kill everything on Earth. If we were 5% farther away, we would freeze.

The sun doesn't have a crust like we have on the Earth. The sun is made of gas. Most of this gas is sensitive to magnetism, making it a special kind of gas called **plasma**. We'll learn more about why this magnetism is important in a little bit. Even though the sun doesn't have a crust, it does have layers, and that's where we're going to start.

The interior of the sun has three layers—the core, the radiative zone, and the convection zone. The sun's atmosphere also has three layers—the photosphere, the chromosphere, and the corona. Since obviously we have never been able to visit the sun, there are things about the sun scientists can't be sure of. They've had to observe and study what we can know to try to understand what we can't know for sure.

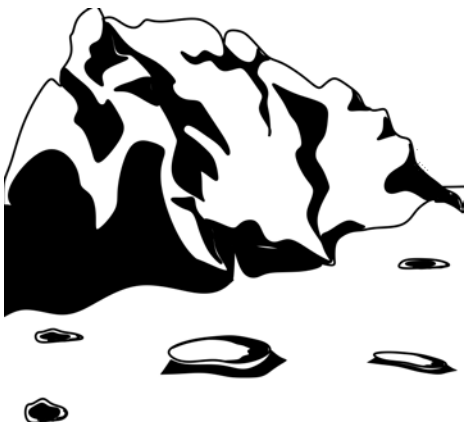


Now let's take a look at the moon. Though the moon might seem about the same size as the sun when you look up at it, it's actually much smaller. It only looks about the same size because it is much closer. Instead of being 93 million miles (149 million kilometers) away like the sun, the moon is only about 239,000 miles (385,000 kilometers) away.

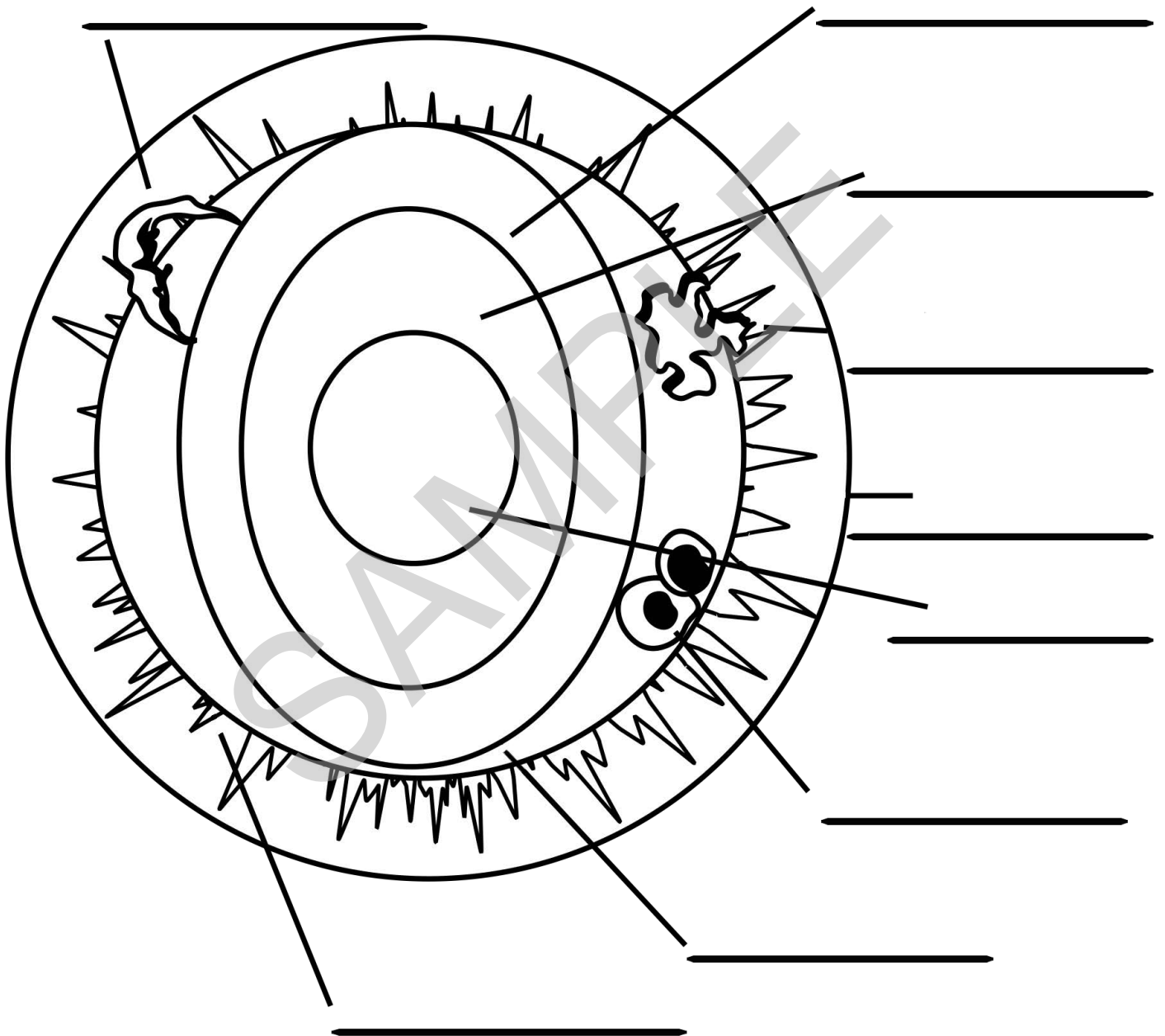


The moon has three interior layers—the crust, mantle, and core. It doesn't have an atmosphere like Earth, though there are some gasses above the surface of the moon that scientists call an **exosphere**. The moon's interior layers are very different than the Earth's. Scientists think the moon's core is very small and made mostly of iron and possibly sulfur and other elements. The mantle is made of dense rocks containing much iron and magnesium. The crust is covered by dips called **craters**.

The moon's craters were probably mostly formed by meteoroids, asteroids, and comets hitting it. The craters can be very small, no more than 6 miles (10 kilometers) across, or they can be as large as 120 miles (200 kilometers) or more across. We call a crater a **basin** when it is more than 190 miles (300 kilometers) across. Some are shaped like a bowl.



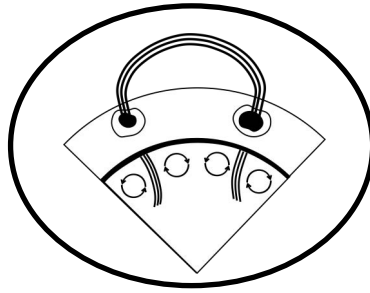
Crushed rocks that were blasted out of the moon by the impact of another object often surround the craters and basins. Sometimes these rocks can even form tall **lunar mountains**.



Which of the following is a dark spot on the sun? Draw a circle around it.



Prominence

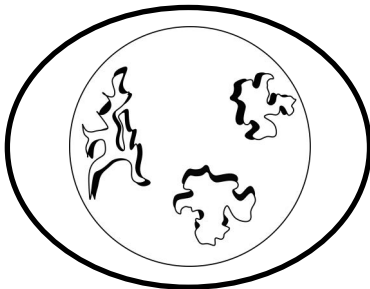


Sunspot

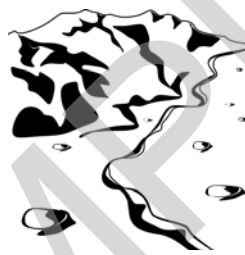


Maria

Which of the following is when part of the sun's atmosphere suddenly gets very bright and superheats part of the sun's corona? Draw a circle around it.



Solar flare



Rilles



Prominence

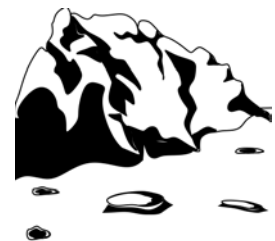
Which of the following are the dark areas formed by lava that cools in a crater? Draw a circle around it.



Rilles



Maria



Lunar mountains

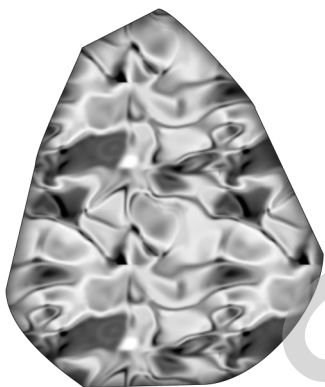
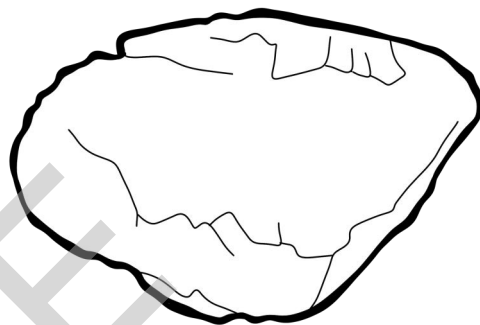
Can you name four of the eight phases of the moon?

Any four of the following: new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, third quarter, waning crescent

Electricity, Circuits & Safety

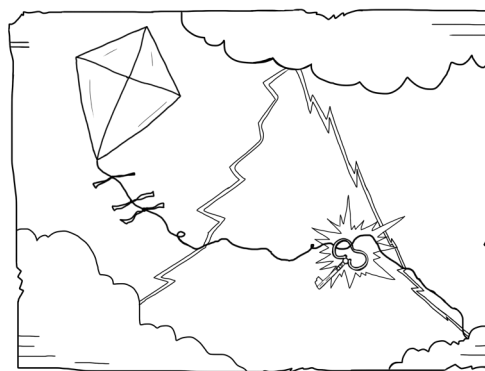
We're going to take a closer look at electricity in this unit, but before we get started, there's something we have to talk about. Electricity is a lot of fun to learn about, and I can't wait to dive in. But real electricity is very serious business. It's dangerous, and it can very easily hurt you or someone else if you don't handle it properly. It's very important that you never play with or experiment with electricity or anything that uses electricity without a parent or teacher telling you what is safe.

Are you ready to dive in? In order to learn about electricity, we need to learn about a few people who were key to helping us understand what electricity is and find ways to use it. When you think of people who taught us about electricity, you might think of Thomas Edison because of the incandescent light bulb. But people were learning about electricity as far back as ancient Greece. The Greek philosopher Thales, in the 500s BC, observed that if you rubbed a piece of amber with a cloth, it attracted small pieces of straw. What he was observing is what we call "static electricity" today.



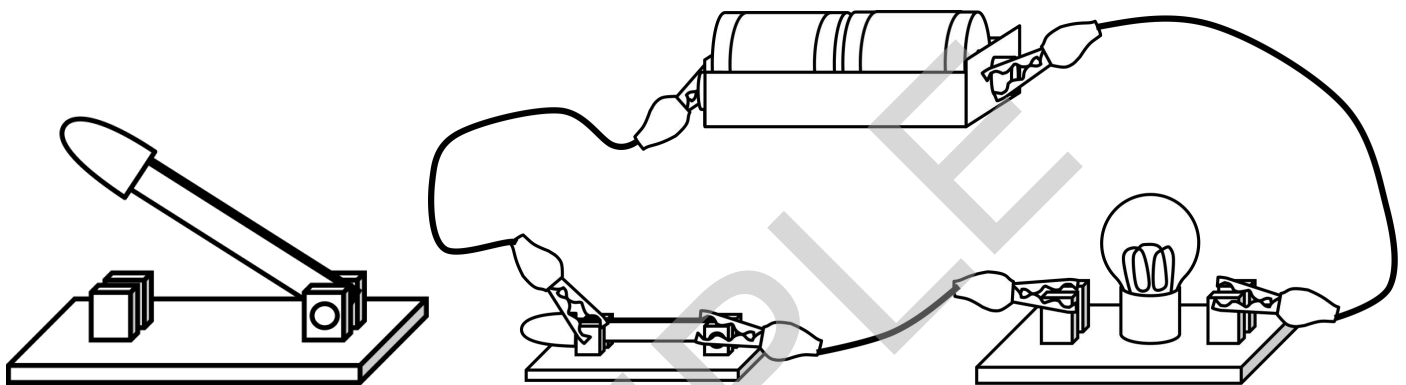
In 1551, Jerome Cardan, an Italian mathematician, observed that while amber attracted a variety of lightweight objects, loadstone, a magnetic black rock, attracted only iron. He was learning about magnetism, which can work with electricity under certain conditions.

Scientists continued to observe and study static electricity and magnetism, but Benjamin Franklin was one of the first scientists to conduct actual experiments with electricity—experiments that nearly killed him at least once. One of his most famous experiments was the one he conducted in 1752 when he flew a kite during a thunderstorm. He wanted to prove lightning was actually electricity, so he tied a key to the end of the kite string, and when the lightning struck wire on the kite, it traveled down the string and caused a spark at the key.



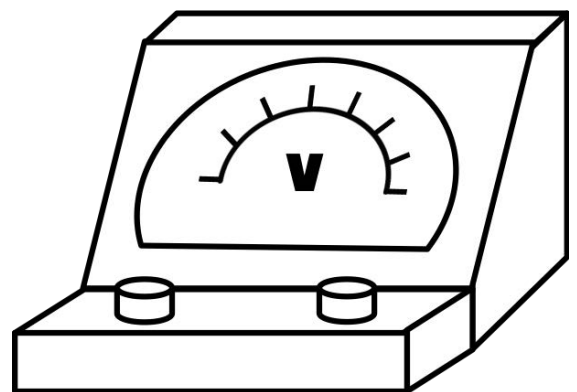
Static electricity is when electrons build up and then discharge (or “jump”) to something with a positive charge. A switch opens and closes a circuit. An open switch or an open circuit means the electricity cannot flow. The power is off. A closed switch or a closed circuit means the electricity can flow and the power is on.

A circuit is made up of at least three parts—a power source, a device, and wires. A series circuit has everything on one loop, so that the power goes the whole way through the circuit or cannot move through it at all. A parallel circuit has branches so that even if the electricity cannot move through the circuit one way, it can still make a complete loop by going another way.



Measuring things is an important part of a scientist’s work because it allows you to record what is happening with numbers that other people can understand. There are four important ways scientists measure electricity: amp, volt, ohm, and watt. There are also ways to control how much electricity can flow through a circuit.

The electrons in an atom form an electric field around the atom. The ability of this field to give energy is measured in **volts**, and a **voltmeter** measures voltage. Another way to explain volts is to say voltage measures the amount of force the electricity is traveling with through the circuit. Think of it as if you could give electricity a push like you would push a ball across the floor. If you push it gently, it has low voltage. If you push it as hard as you can, it has high voltage. Volts were given their name to honor Count Alessandro Volta and the work that he did studying electricity.



Crocodile clips: _____

Volt: _____

Voltmeter: _____

Resistors: _____

Ohm: _____

Ampere (amp): _____

Ammeter: _____

Watt: _____

Fuse: _____

Fluorescent lamp: _____

Halogen lamp: _____

LED light: _____

Turbine: _____

Fossil fuels: _____

Forces and Motion

We're going to take a look at how and why things move the way they do. We'll look at how they change from being in one place to ending up in another place, which we call **motion**. We'll also look at some of the forces that affect their motion. But in order to understand motion, we have to get to know a man named Isaac Newton.



Isaac Newton was a brilliant scientist from England who lived from 1642 to 1727. Scientists were learning a lot about how things worked during this time, and Newton had a special gift for discovering and understanding new things about science. He taught us about how light and color work, made important discoveries about gravity, and invented calculus.

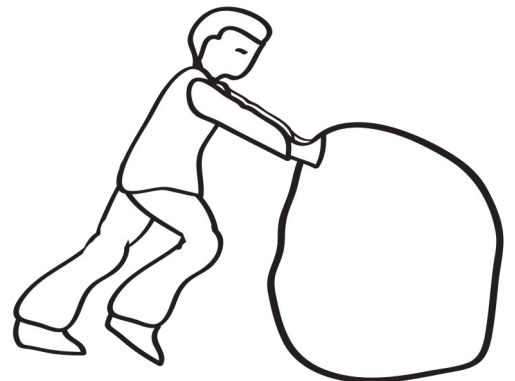
Isaac Newton developed three laws of motion that continue to be a part of our understanding of science today. His first law is called the **law of inertia**. It explains that if a body is moving, it tends to keep moving unless it's acted on by an outside force. It also explains that if a body is not moving, it won't start moving without a force acting on it. We'll look at the second part of that law first.



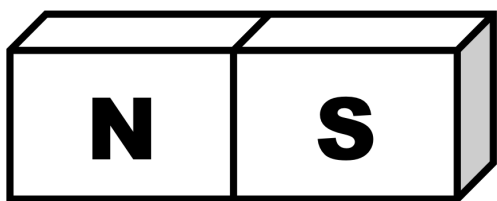
If an object isn't moving, it can't start moving on its own. It needs something to act on it. It needs a force. If an apple is sitting on your kitchen table, it will keep on sitting there until someone or something moves it. Your dog might come by and bump it with its nose. You might come past and pick it up. Someone might bump into the table and jostle it. But the apple won't suddenly move from the table to another place without being acted on by a force.

The same is true of a rock. If there is a rock sitting on the ground, it will stay there, in the same place, until something exerts a force on it and makes it move. The force could be you pushing the rock, or the force could be the moving of the ground from an earthquake. But if left completely alone, the rock won't move.

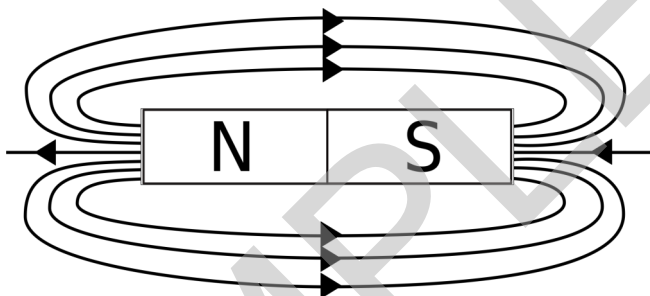
But maybe you're thinking that this doesn't really have anything to do with force. Maybe you're thinking it's because an apple and a rock aren't living things. They can't decide to move on their own because they aren't alive. What if I told you that you couldn't move without using force either?



Every magnet has two poles, called the north pole and the south pole. If you cut a magnet in half, each piece would still have two poles. On a bar magnet, you can find a pole on each end. On a horseshoe magnet, the poles are at the ends of its "arms."

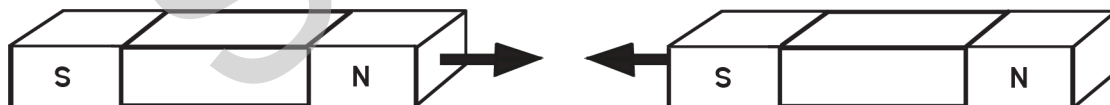


Every magnet is surrounded by a magnetic field. The stronger the magnet, the stronger its magnetic field. This field is strongest at the two poles.



When a magnetic field touches a magnetic object, it causes tiny magnetic particles inside the object to line up. Then it draws the object to itself.

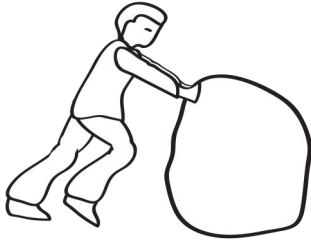
But the north pole of a magnet can only attract a south pole, and a south pole can only attract a north pole.



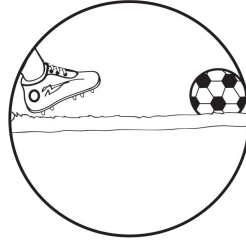
If you try to line up the same poles, they repel, or push each other away.



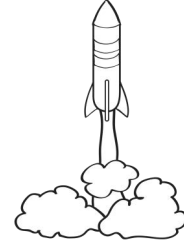
Which of Newton's laws explains inertia? Draw a circle around it.



First

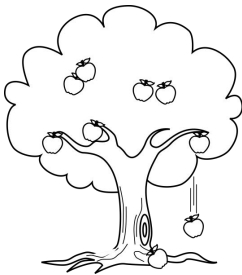


Second

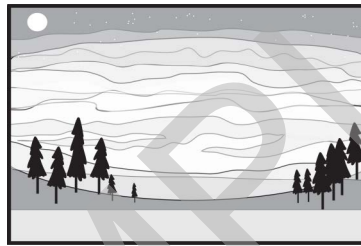


Third

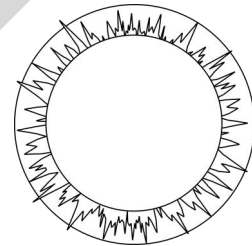
Which of the following is gravity not responsible for? Draw an X through it.



Things falling to the ground

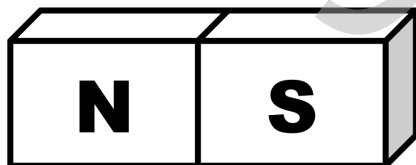


Auroras



Holding the sun together

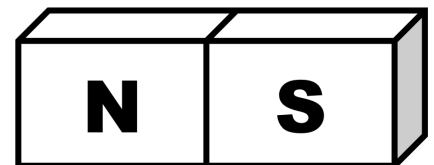
Where is a magnetic field the strongest? Draw a circle around it.



In the middle



Nowhere; it's equally strong at all points

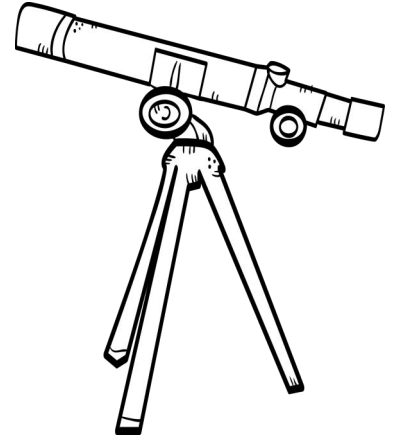


At the poles

What combines to form electromagnetism?

Understanding Stars, Comets & Other Wonders of Space

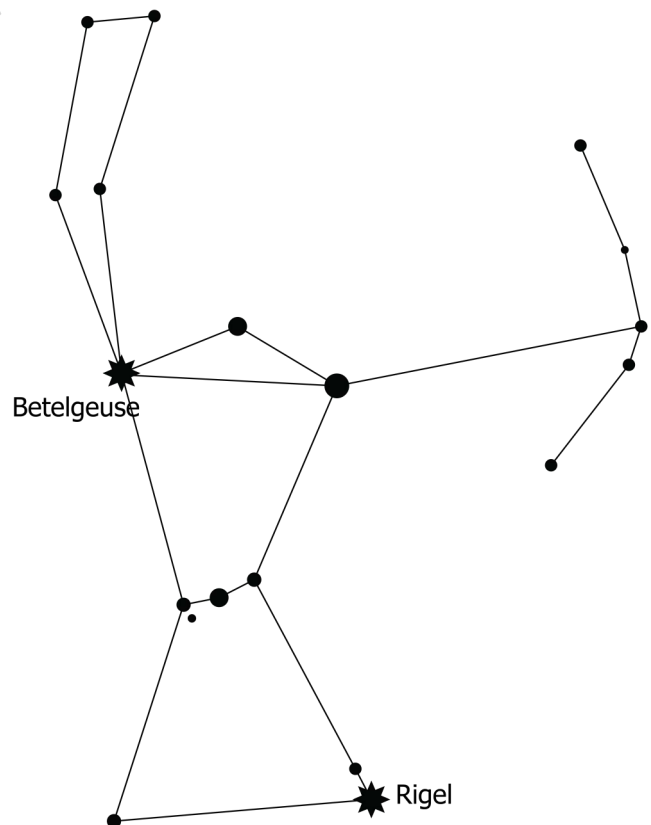
Our universe is full of amazing things to study, and scientists still haven't found or understood them all yet. You know about moons and planets, but do you know about nebulas, supernovas, asteroids, meteors, and black holes? Those are a few of the wonders we're going to take a closer look at in this unit.



We'll start by looking at the difference between stars, planets, and moons. After all, when you look at a picture of the universe, it's hard to see much difference between one dot and another. But stars can do something planets and moons cannot do. Stars produce their own light and heat, but all planets and moons can do is reflect light. Stars have a special and complicated process called **nuclear fusion** where they join atoms together and convert some mass to energy. That's why our sun is called a star, but we call Earth a planet.

Scientists have ways to classify stars based on their brightness, temperature, and size based on the amount of energy they produce. They don't go by how bright the star is in the sky, though, because that can change depending on where in the world you are. They analyze the light coming from the stars and study it to determine how bright the star actually is.

Most of the time, the brightest stars are also the hottest and largest stars. The hottest are classified as **blue stars** and are class O, B, or A stars. Two class B blue stars you can see in the sky are Spica and Rigel. You can find Spica in the constellation Virgo, and its surface temperature is almost 33,000 °F (18,300 °C). Remember, the term **constellation** just means a group of stars people have connected in a special pattern, usually to look like a person, animal, or creature from a myth. You can find Rigel in the constellation Orion. It has a surface temperature around 19,300 °F (10,700 °C) and gives off about 40,000 times more light than our sun does.

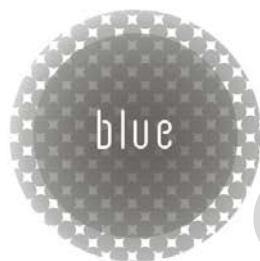
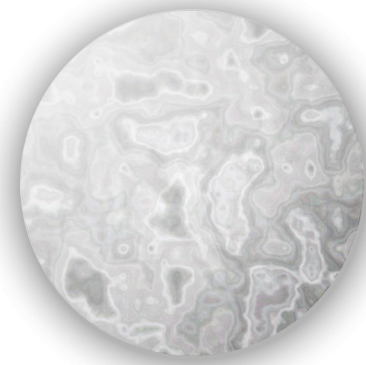


The next set of stars are white (class F), yellow (class G), or orange (class K). They are not quite as hot as the blue stars. Procyon in Canis Minor is about 11,000 °F (6,000 °C) on its surface. Our sun is about 10,000 °F (5,500 °C) on its surface and is a yellow, or class G star.

Stars are also classified by their size, which is determined by the amount of energy they release. This scale is given in Roman numerals. The largest stars are a I, which is called a supergiant. The smallest stars are a VII, which is called a white dwarf.

★ Procyon

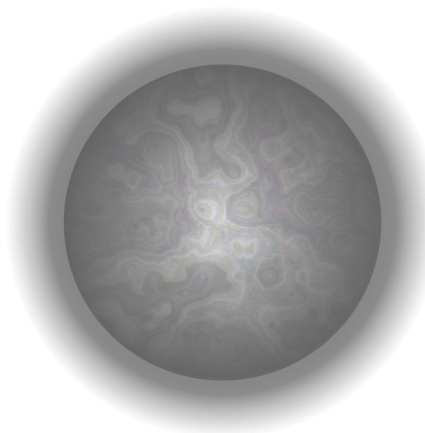
Stars that follow the pattern where a star is brighter, hotter, and bigger or dimmer, cooler, and smaller are called **main sequence stars**.



Hottest

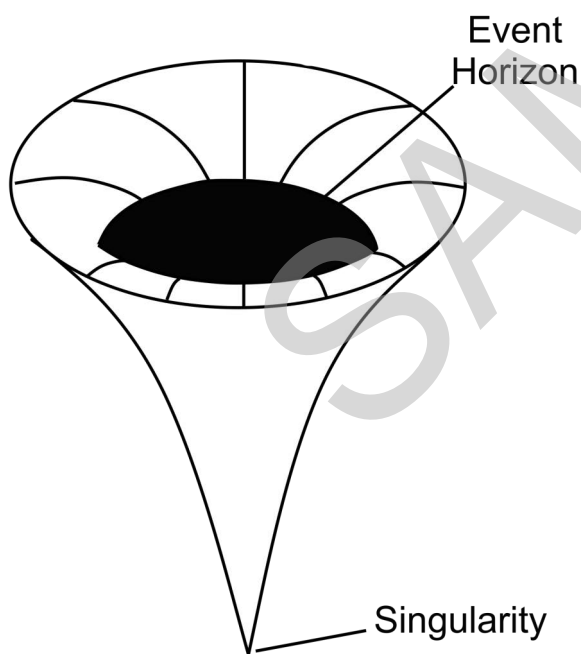
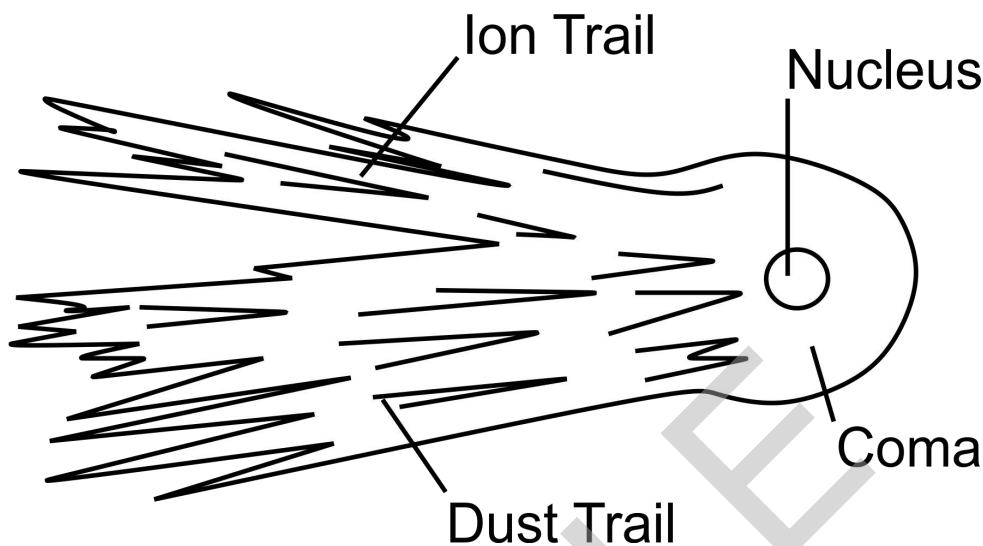


Coollest



But there are some stars that break these rules. Two of these stars are Antares and Betelgeuse. Their temperatures are even cooler than the class K stars, which should make them an orange or a dull red class M star. But they are very bright and large. This makes them red giants, or red supergiants.

As a comet heats up, the ice in the nucleus starts to crack and release gas. This cloud of gas is called the coma. Then radiation pushes some of the dust away from the coma and forms the dust tail. While this is happening, solar wind changes some of the gas into charged particles called ions and forms the ion trail.

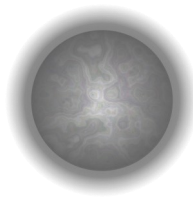


Do you remember at the beginning of the unit how we said that stars use a complicated process called nuclear fusion to join atoms together? Well, eventually, a star can run out of the fuel it needs for this process. When it does that, the star starts to collapse. A **black hole** forms when the star collapses so completely that only the tiniest point, called the **singularity**, is left. All the matter concentrates down into this single point. We've never been able to study a singularity because it is so dense and powerful that not even light can escape it. We have been able to start studying the surface of a black hole. This is called the **event horizon**. The first picture of an event horizon was announced on April 10, 2019.

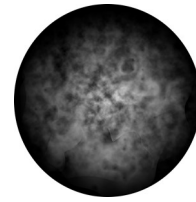
Antares and Betelgeuse are very bright but are cooler than class K stars. They are what kind of star? Draw a circle around it.



White dwarfs

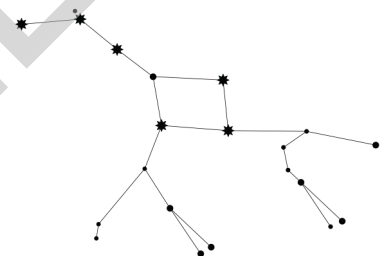
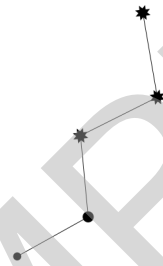
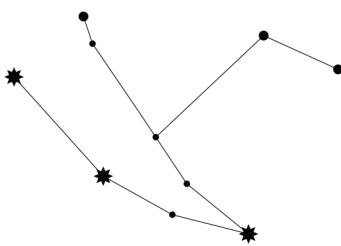


Red giants/red supergiants



Supernovas

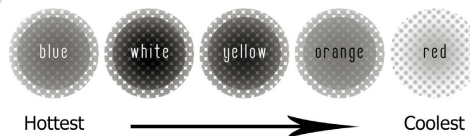
Which of the following constellations is Ursa Major? Draw a circle around it.



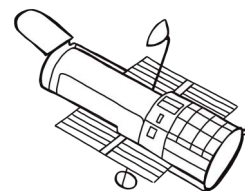
Which of the following includes a nucleus, coma, ion trail, and dust trail? Draw a circle around it.



Comet



Main sequence star



Hubble Space Telescope

Which of the wonders of space was your favorite to read about and why?

Review Answer Key

On the following diagrams, label the stages of a meteoroid, the parts of a comet, and the parts of a black hole.

