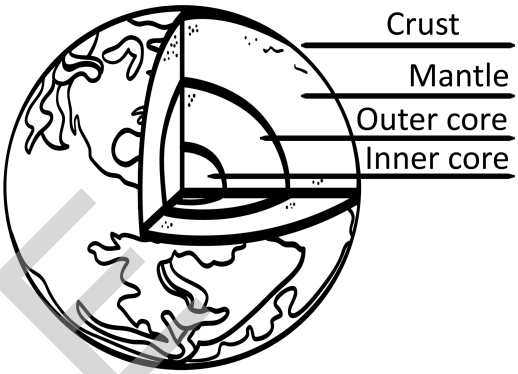
Volcanoes, Earthquakes & Plate Tectonics

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.

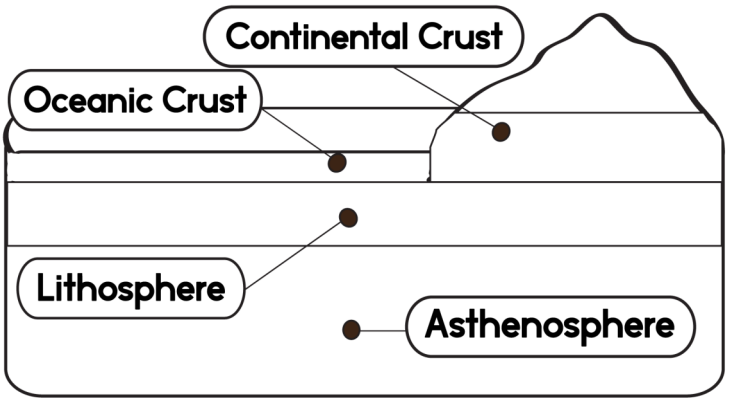
The next layer is the **mantle**. The mantle is made of rock, but it's a little bit different. The very top of the mantle is hard rock, but there is so much heat and pressure on the rock in the rest of the mantle that the rock isn't solid or hard, like we usually think of rock. This rock is sort of sticky 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.

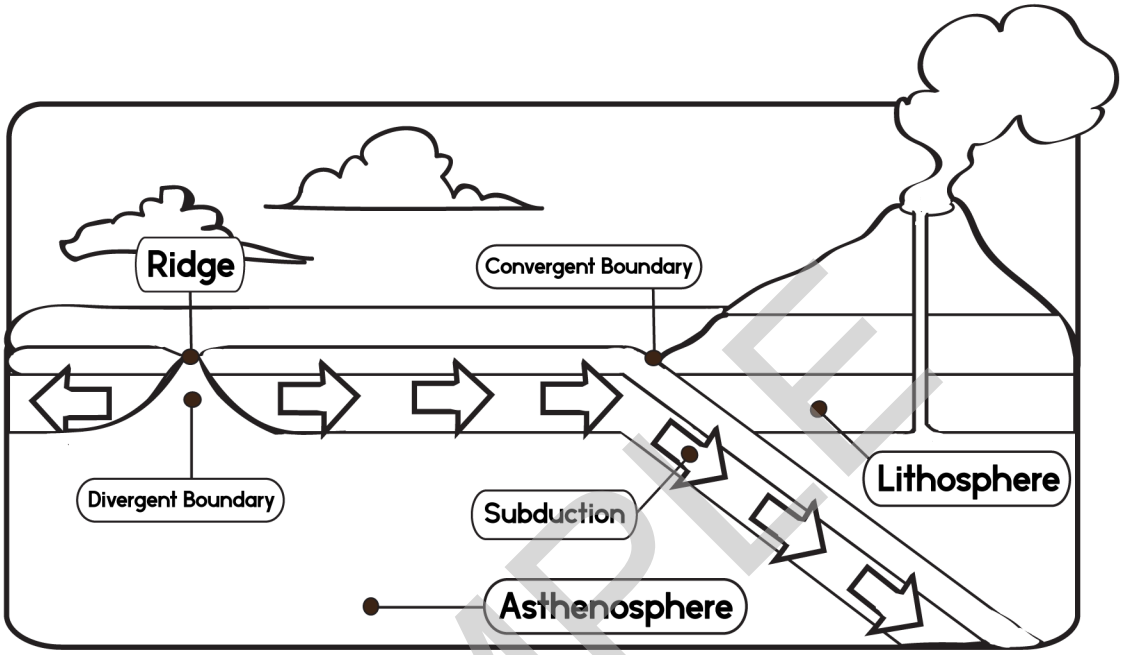
The deepest layer is called the **inner core**. Scientists think this layer is made of nickel and iron that form an extremely hard ball in the middle of the earth.

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**.

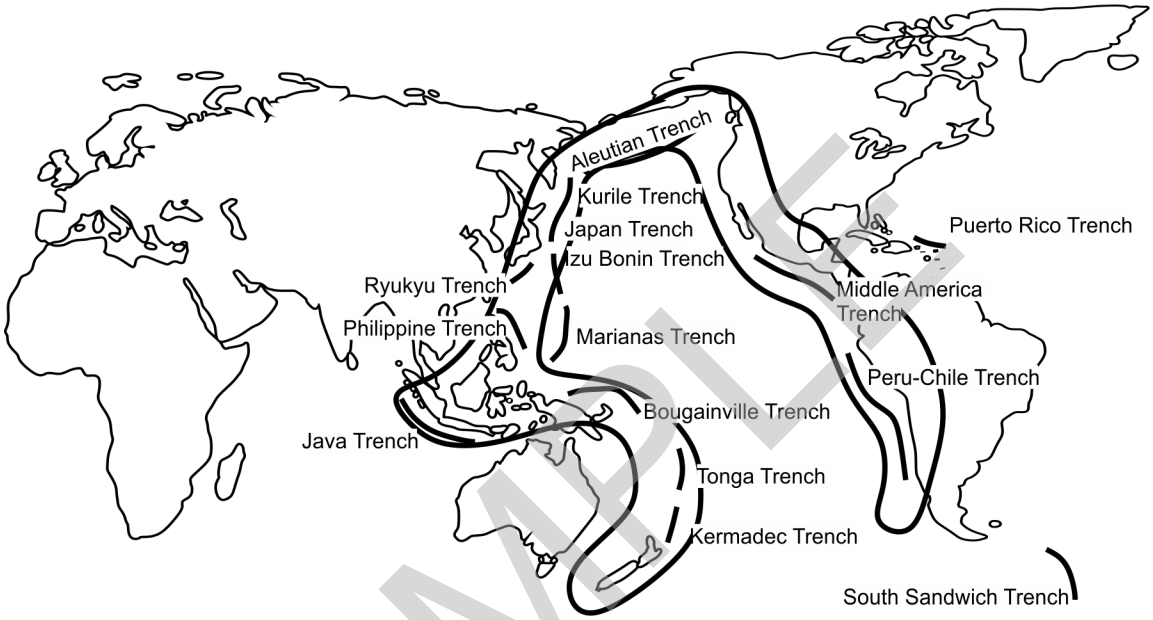
Let's take another look at how these parts work together. In this diagram, you can see a convergent boundary between the ocean and the continent. Subduction is happening where one plate is pushing beneath the other. A divergent boundary in the ocean is causing a ridge to form. The layer of crust and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

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.



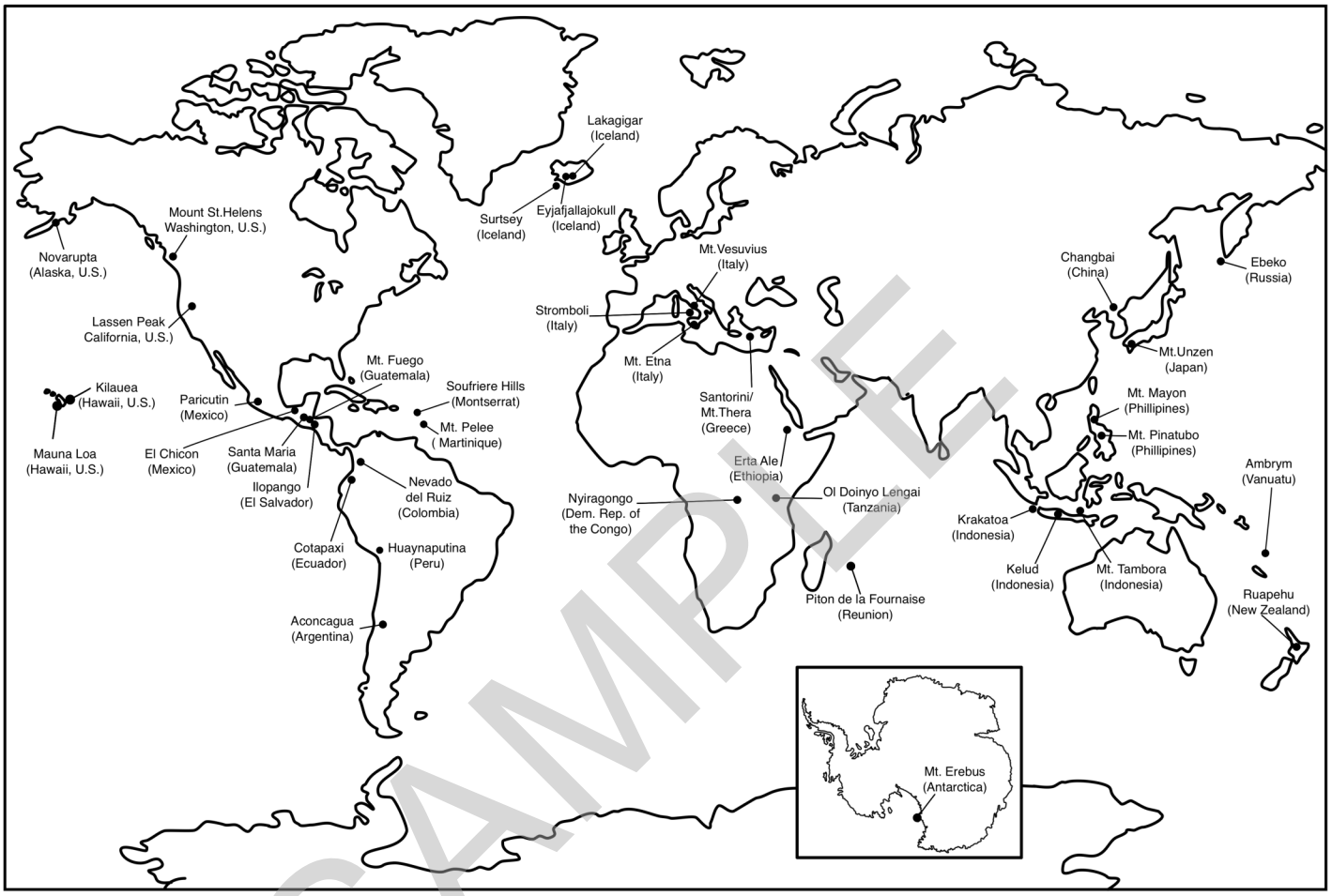
Even though it is a narrow strip, it is home to more than half of the world's active volcanoes, with about 350 along the ring. It is also the home of thousands of earthquakes every year. The most powerful volcanic explosion ever recorded happened at Mount Tambora in Indonesia in 1815. The explosion and 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.

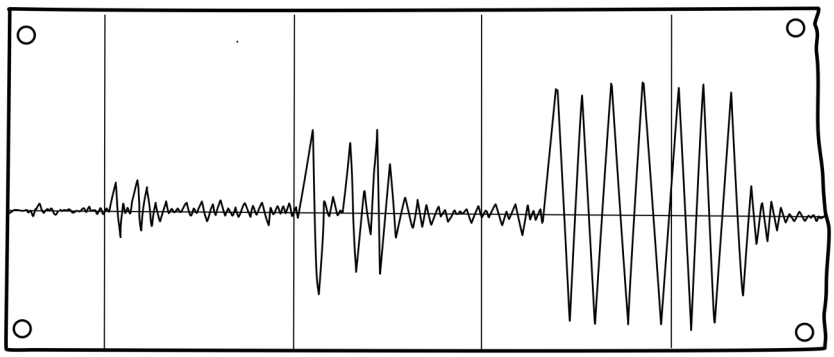
The 1980 eruption of Mount St. Helens was not the strongest volcanic eruption in United States history (that was Novarupta in Alaska in 1912), but it was the most destructive. The volcano blasted more than 1,000 feet (300 meters) of its top into

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: _____

_____

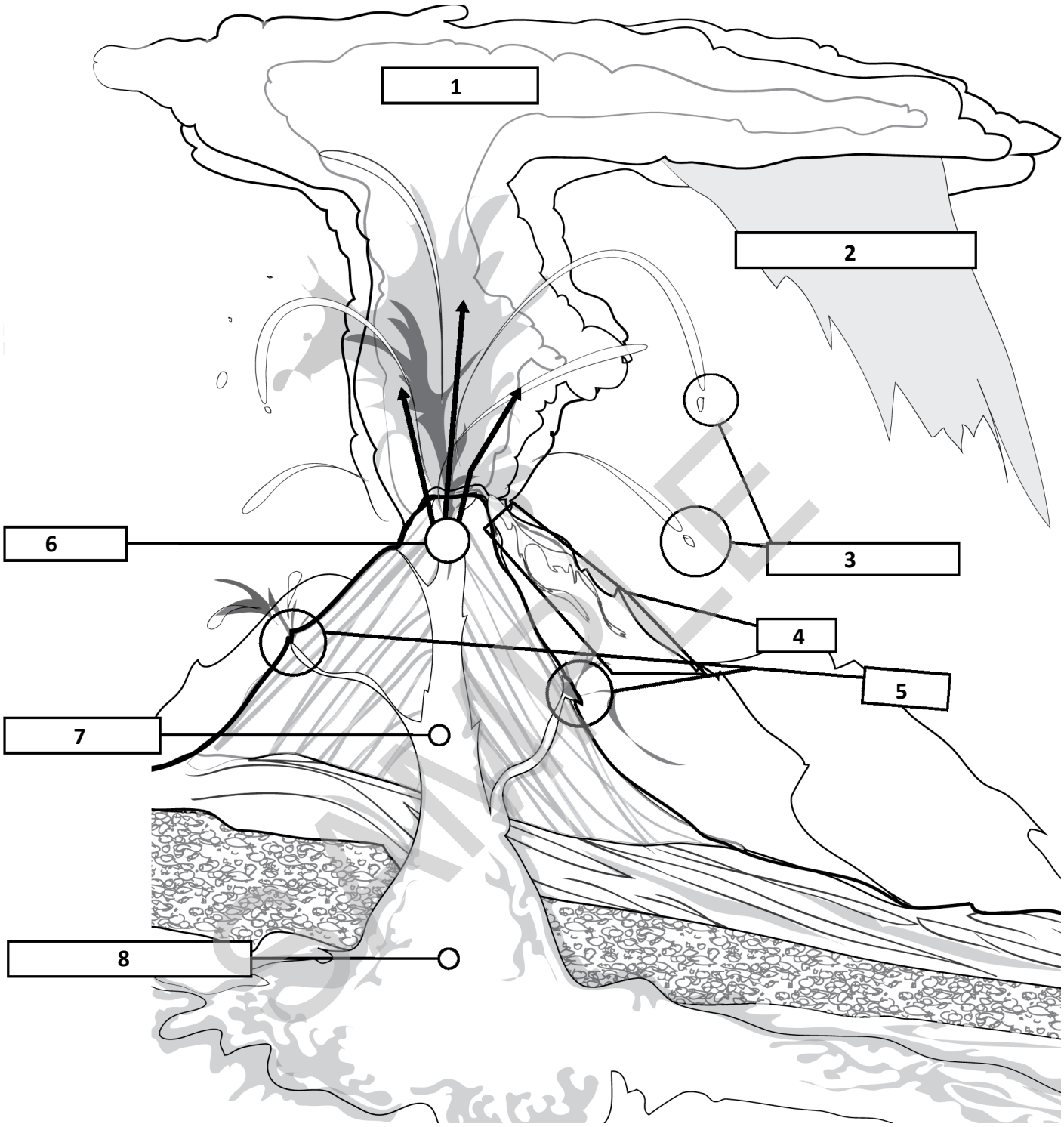
Liquefaction: _____

Fault: _____

Normal fault: _____

Reverse fault: _____

Transform fault: _____



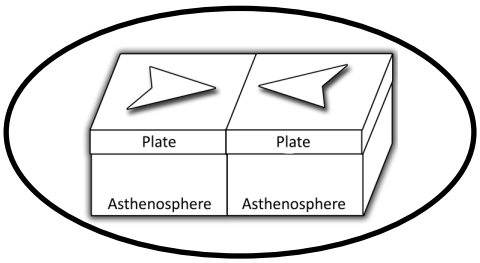
1. _____ 5. _____

2. _____ 6. _____

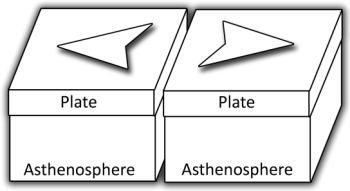
3. _____ 7. _____

4. _____ 8. _____

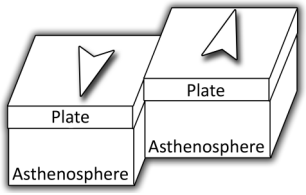
Which of the following shows a convergent boundary? Draw a circle around it.



Boundary

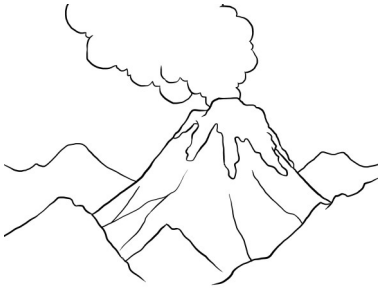


Boundary

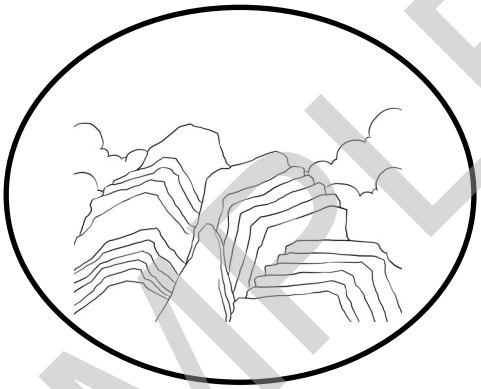


Boundary

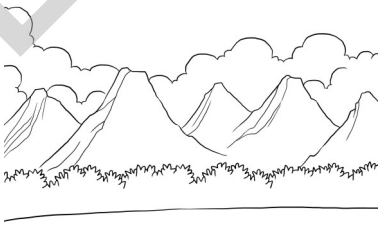
Which of the following show fold-thrust (folded) mountains? Draw a circle around it.



Mountains

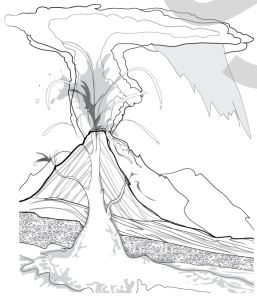


Mountains

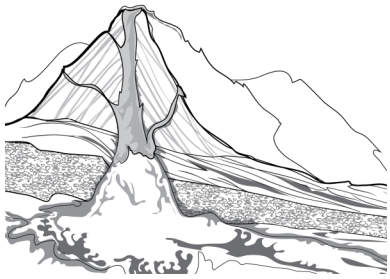


Mountains

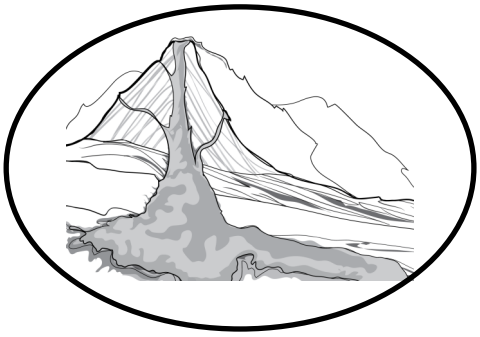
Which of the following is the name for a volcano scientists don't think will ever erupt again? Draw a circle around it.



Active



Dormant



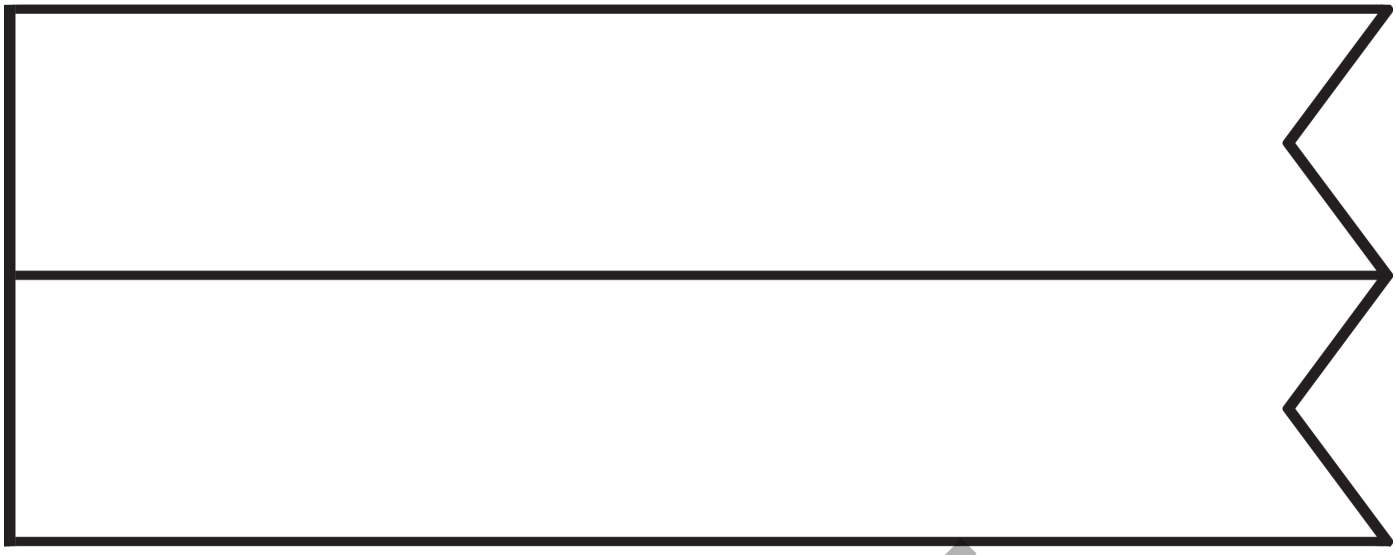
Extinct

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

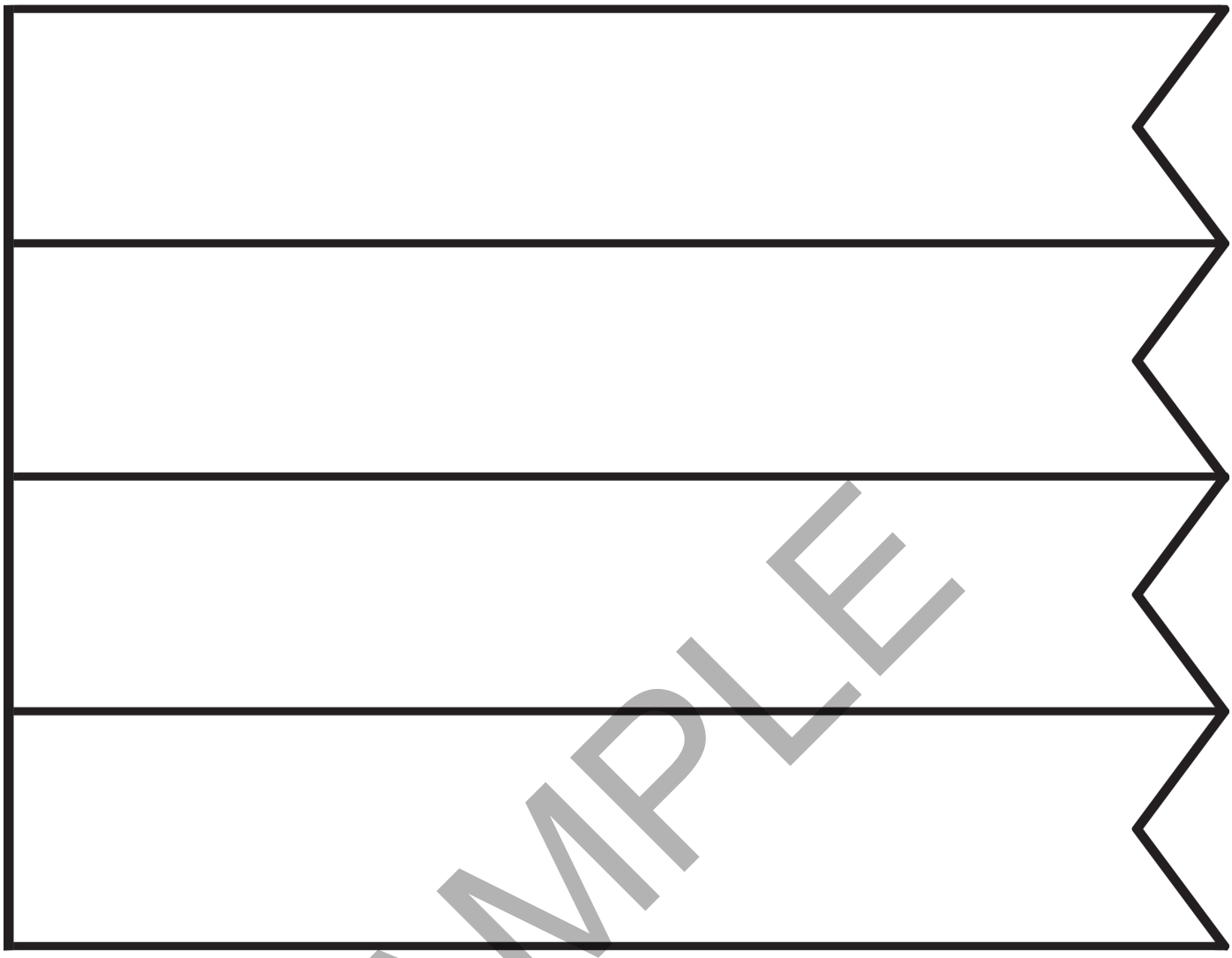
Illustrate and label the four layers of the Earth.

Summarize what you learned about each one.



Illustrate and label the continental crust, oceanic crust, lithosphere, and asthenosphere.

On the next page, summarize what you learned about each one.



What comes together to form the lithosphere? _____

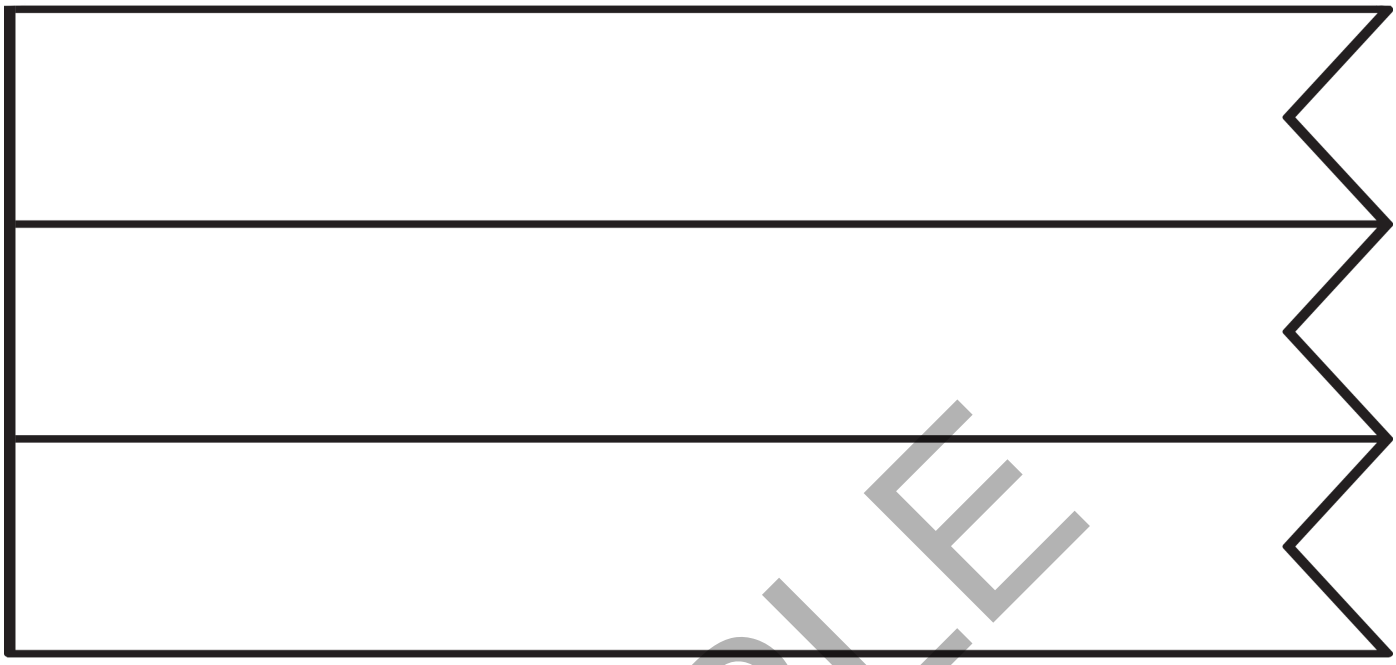
_____

What do these plates move on? _____

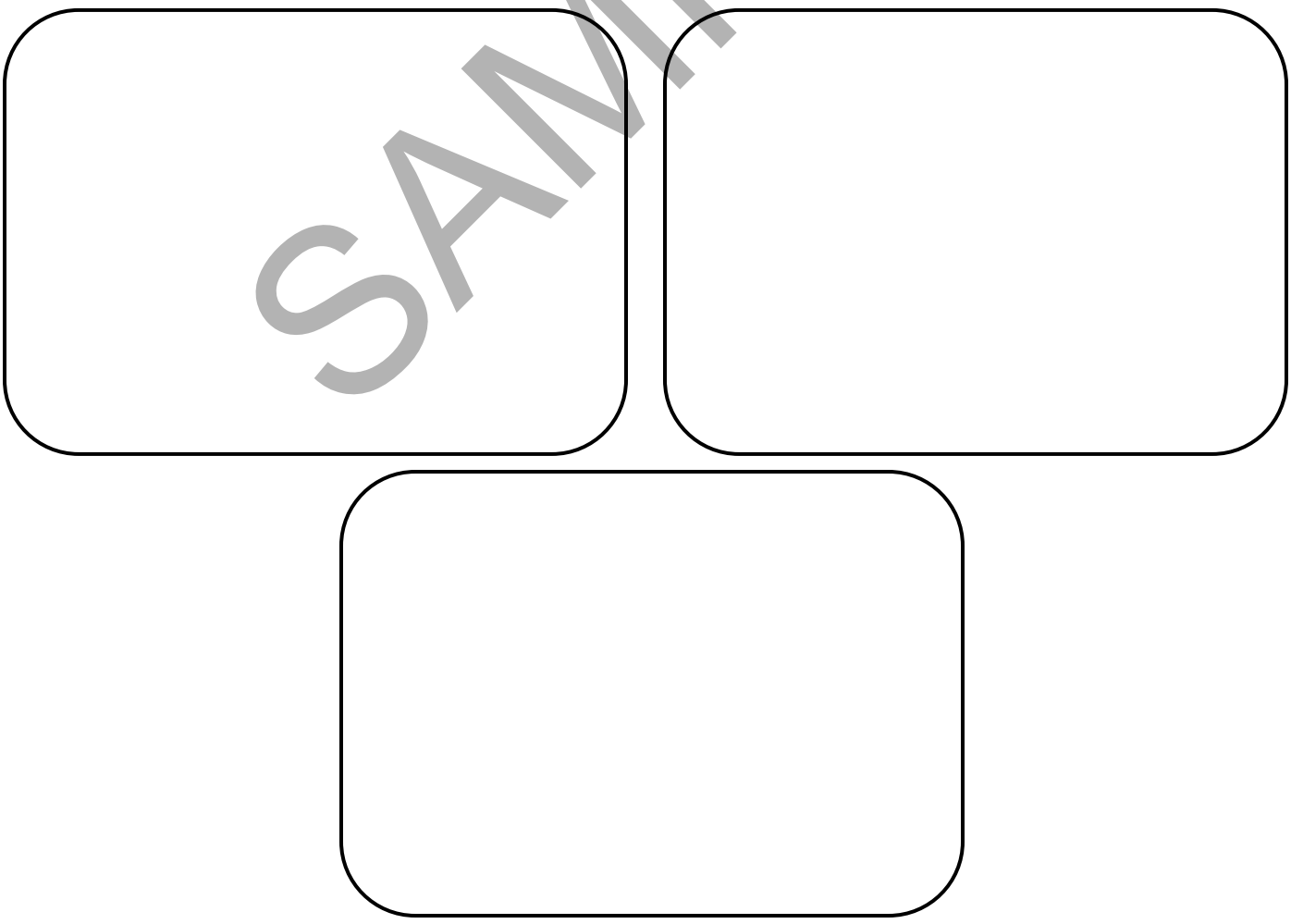
_____

On the next page, draw the map that shows one way to divide the earth into tectonic plates and label each plate.

Name the three ways tectonic plates come together and explain what each way means.



Illustrate and label the three ways tectonic plates come together.



Where are divergent boundaries the most common? _____

_____

What creates more ocean floor? _____

_____

_____

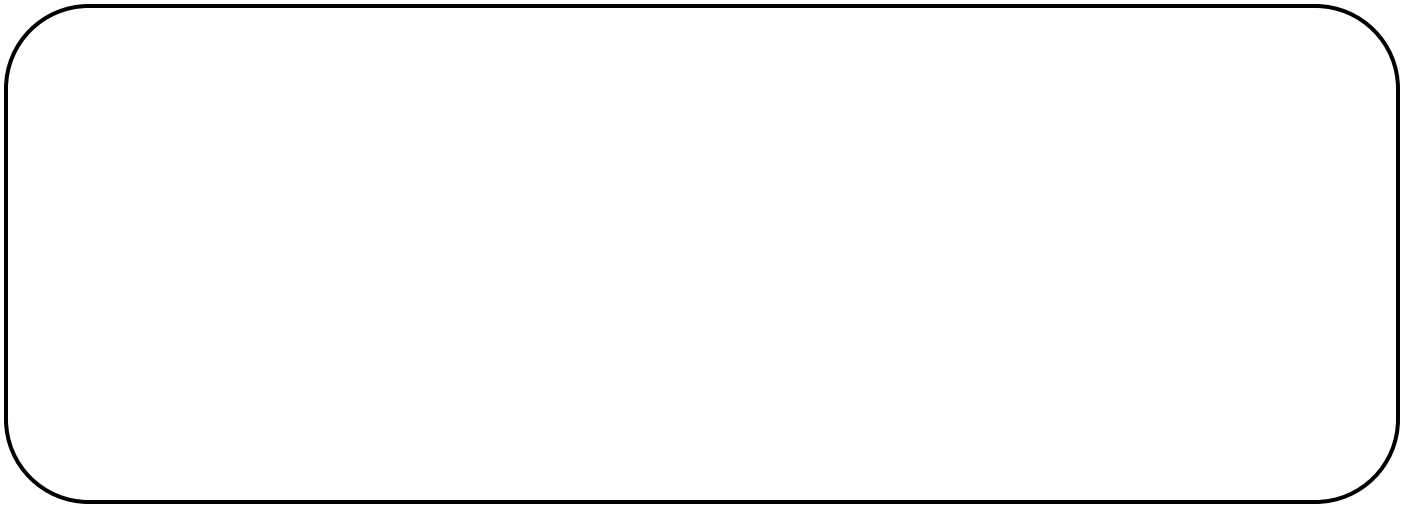
Illustrate and label what happens along a divergent boundary in the ocean.

What happens when boundaries diverge on a continent? _____

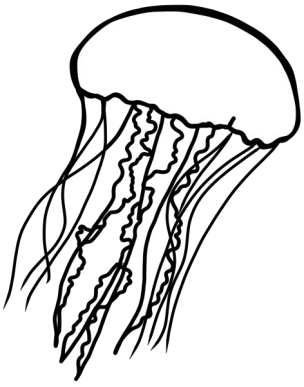
_____

_____

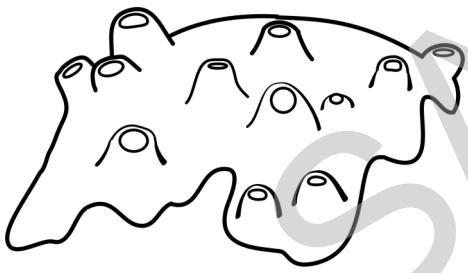
Illustrate and label what happens along a divergent boundary on a continent.



Invertebrates

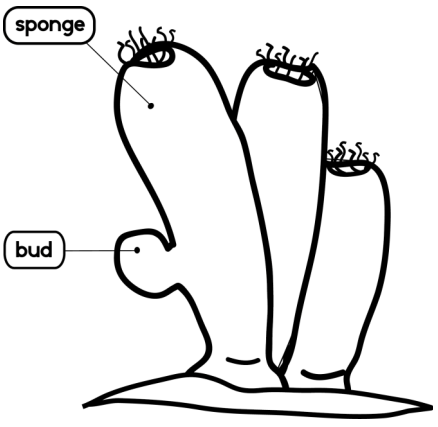


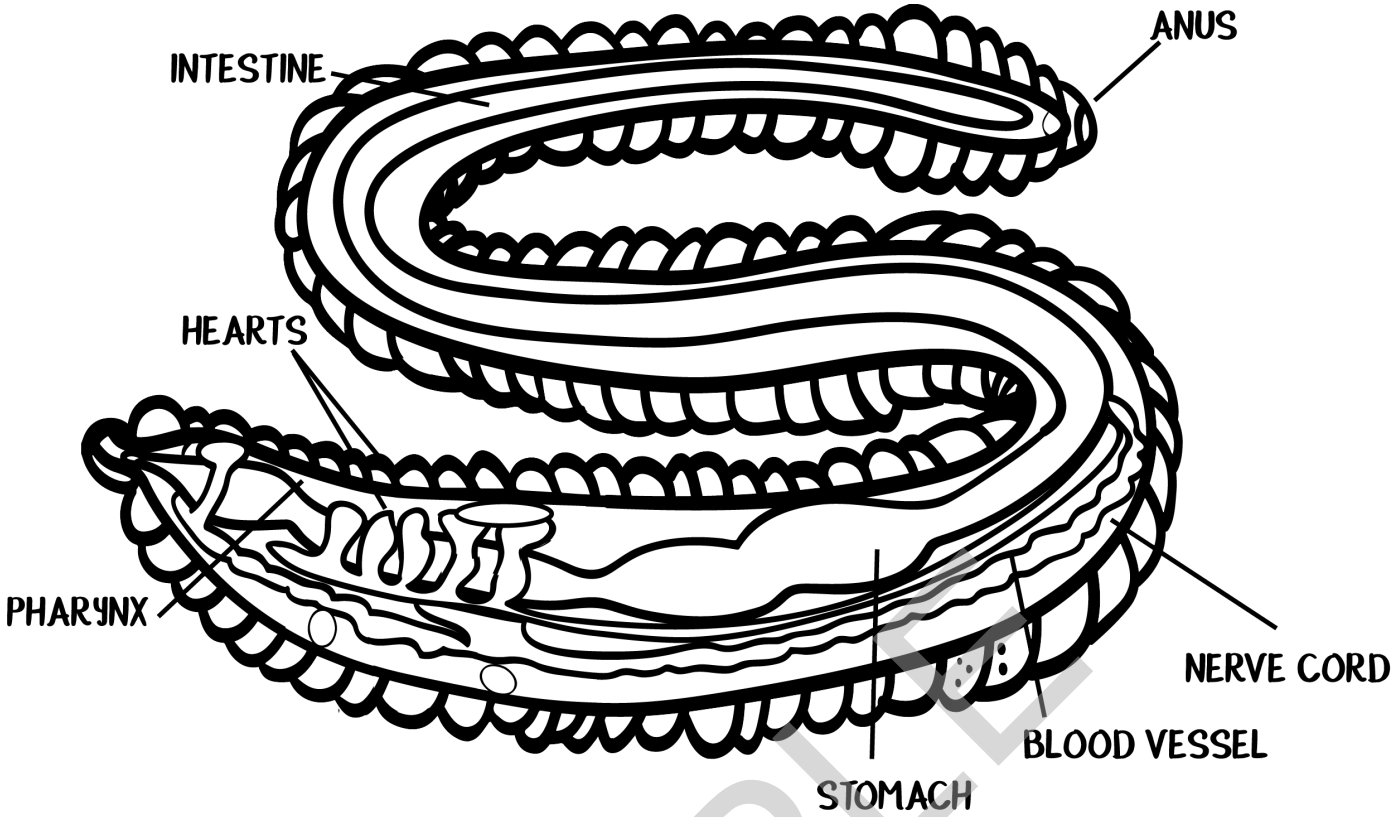
When scientists classify animals, the level beneath Kingdom Animalia is phylum. There are more than thirty different phyla (plural of phylum) scientists group animals into. One is *Chordata*. This is the phylum that all **vertebrates**, animals with backbones, are classified in. This includes animals 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.



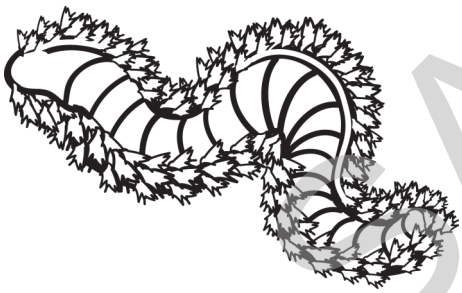
Phylum *Porifera* is made of pore-bearing animals called sponges. Most sponges live in the sea, but a few kinds live in fresh water. Sponges are unlike most other animals. They don't have heads, arms, or internal organs. The adults cannot move but stay anchored to one spot. A living sponge has two types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



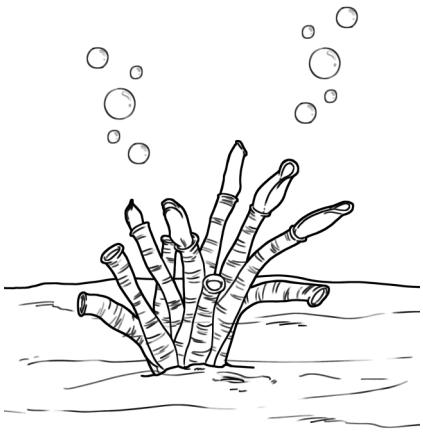


While earthworms might be the most recognizable **annelid**, they are not the only type of worm in this phylum. Bristle worms, pile worms, and tubeworms are also annelids.



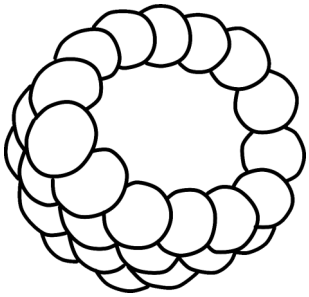
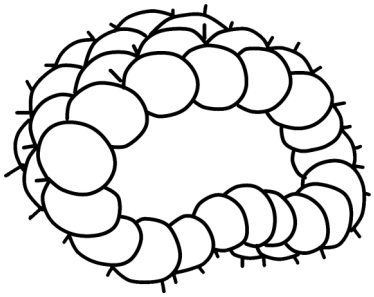
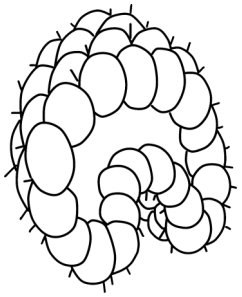
Bristle worms (also called pile worms or sand worms) can be 1 inch (2.5 cm) to 3 feet (90 cm) long. They have sharp jaws that they can retract, two tentacles, and tiny bristles they use for moving. A bristle worm can have more than two hundred segments, with almost every segment holding its own pair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

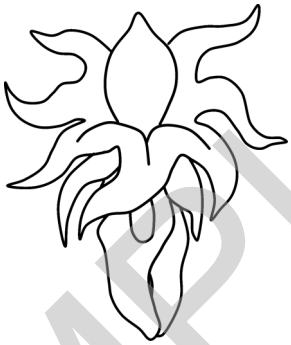
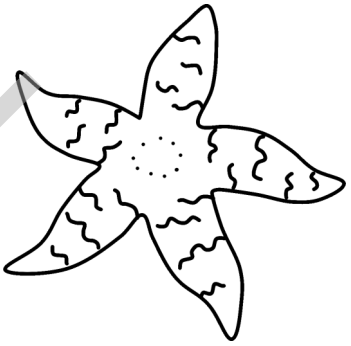


Tubeworms have feathery radioles, which are like arms they use to trap food from the water. Whenever a tubeworm is alarmed, it pulls itself safely back inside its tube. Some tubeworms even have a special piece they use to block the "door" to the tube to help protect themselves.

The young starfish continues dividing, growing larger and larger.

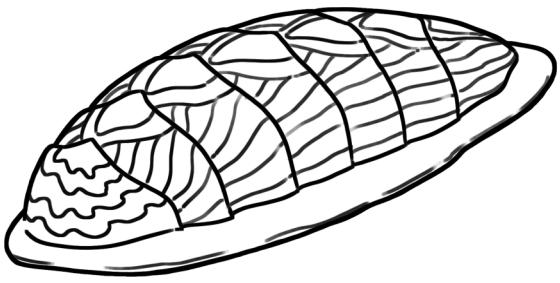




In time, the starfish will grow into larvae. Each larva will find a place on the bottom of the sea to finish growing into a young starfish.

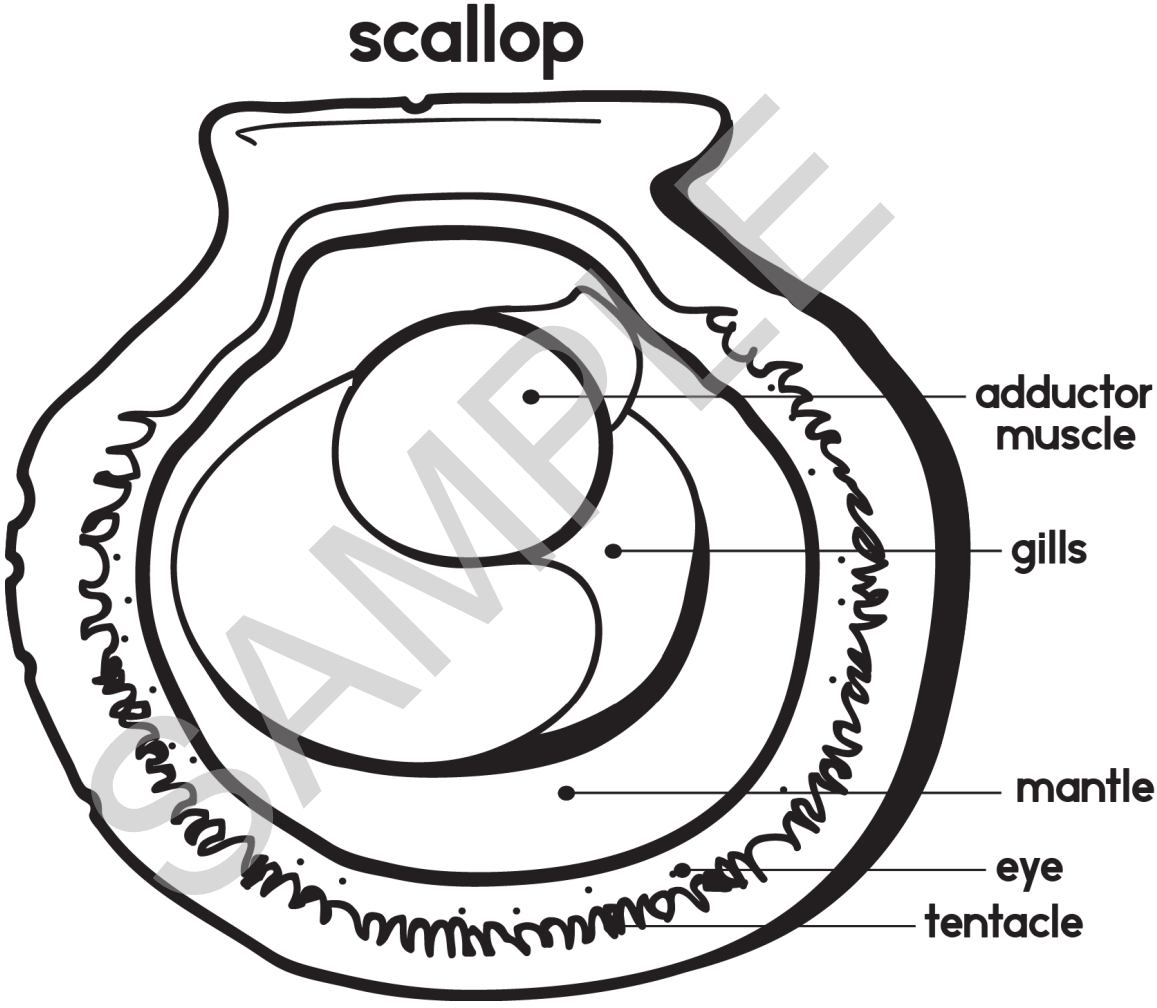




The next group of animals we're going to look more closely at is phylum *Mollusca*. There are more than 100,000 different species of mollusks in the world, and they include a very large variety of creatures, from tiny snails to giant squid. Many mollusks are protected by a hard outer shell, but some 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.

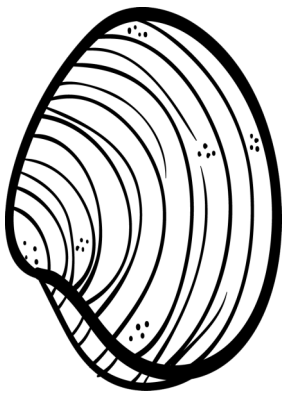
Polyplacophora is the class of chitons. There are hundreds of types of chitons, and they live in many places all around the world. Most of the chitons that live in warmer waters live fairly close to the surface, but chitons that live in colder waters live much deeper, even as far as 13,000-23,000 feet (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.



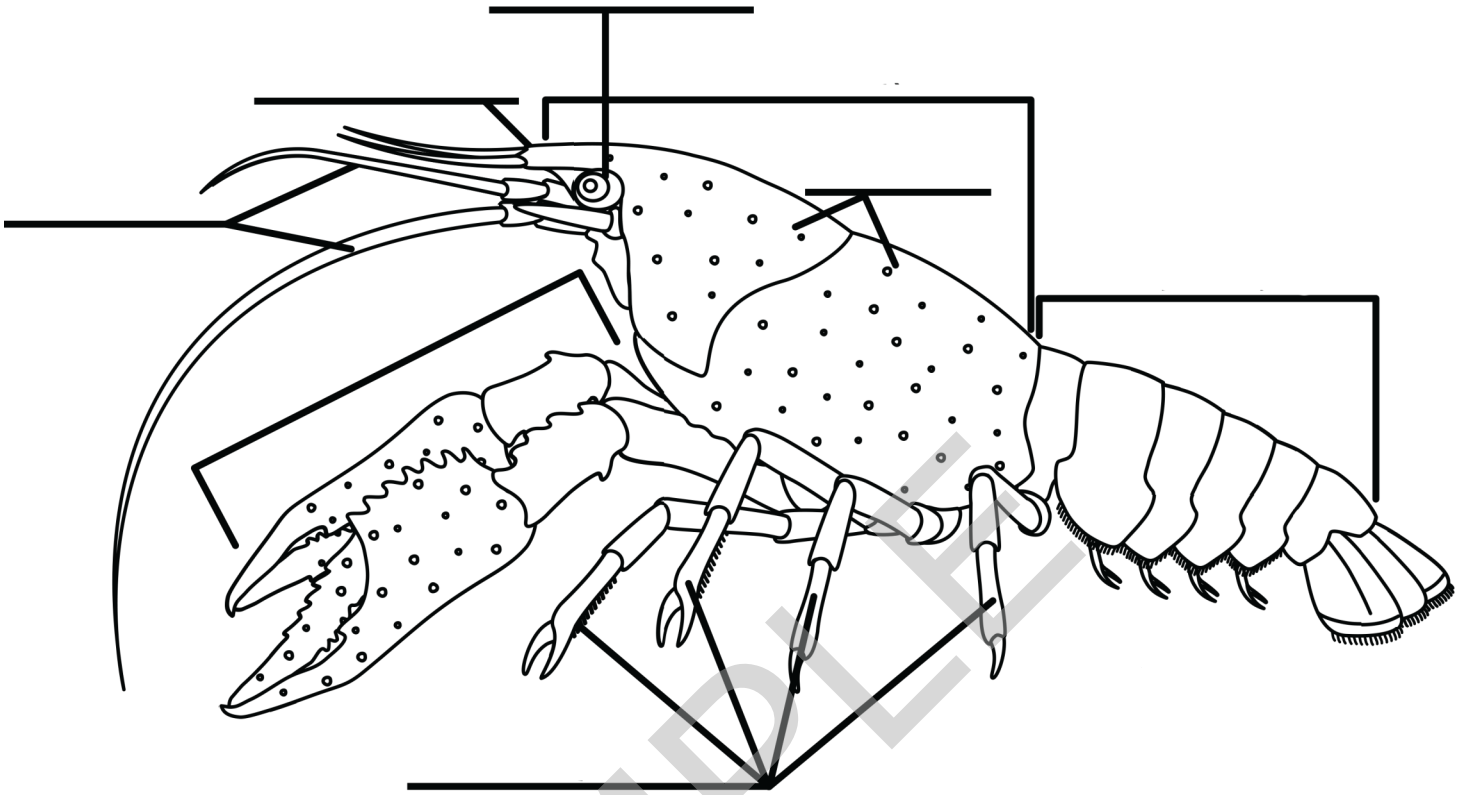
Scallops are able to do something different than the other bivalves we've looked at, though. They can swim by opening and closing their shells quickly. This forces water out of the mantle area, pushing the scallop through the water. It doesn't move all the time like people usually do, but it's an option 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!

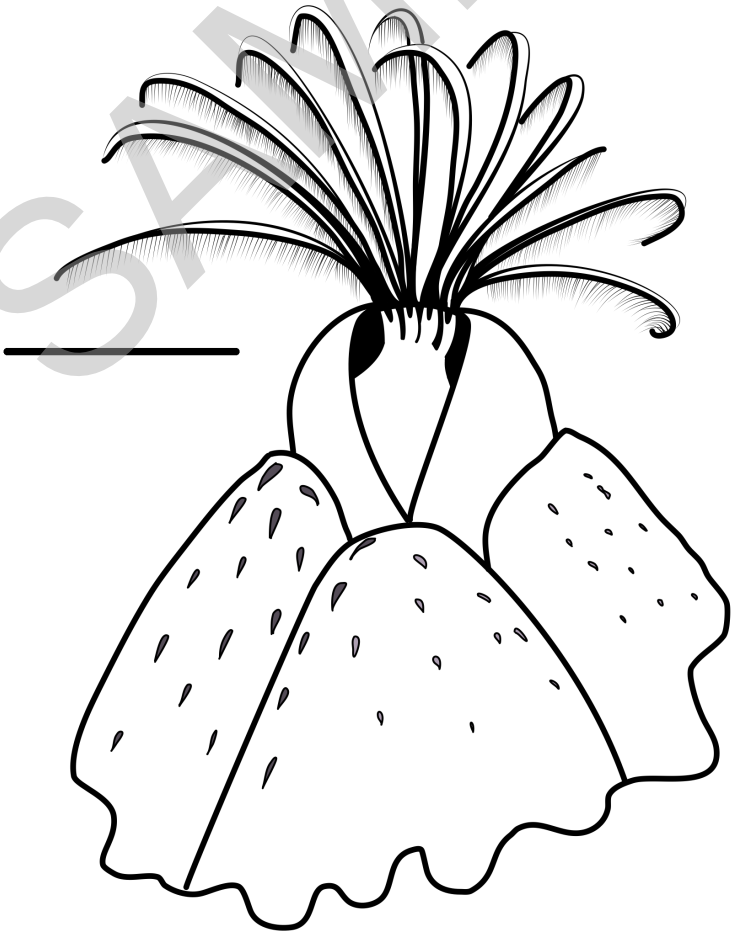


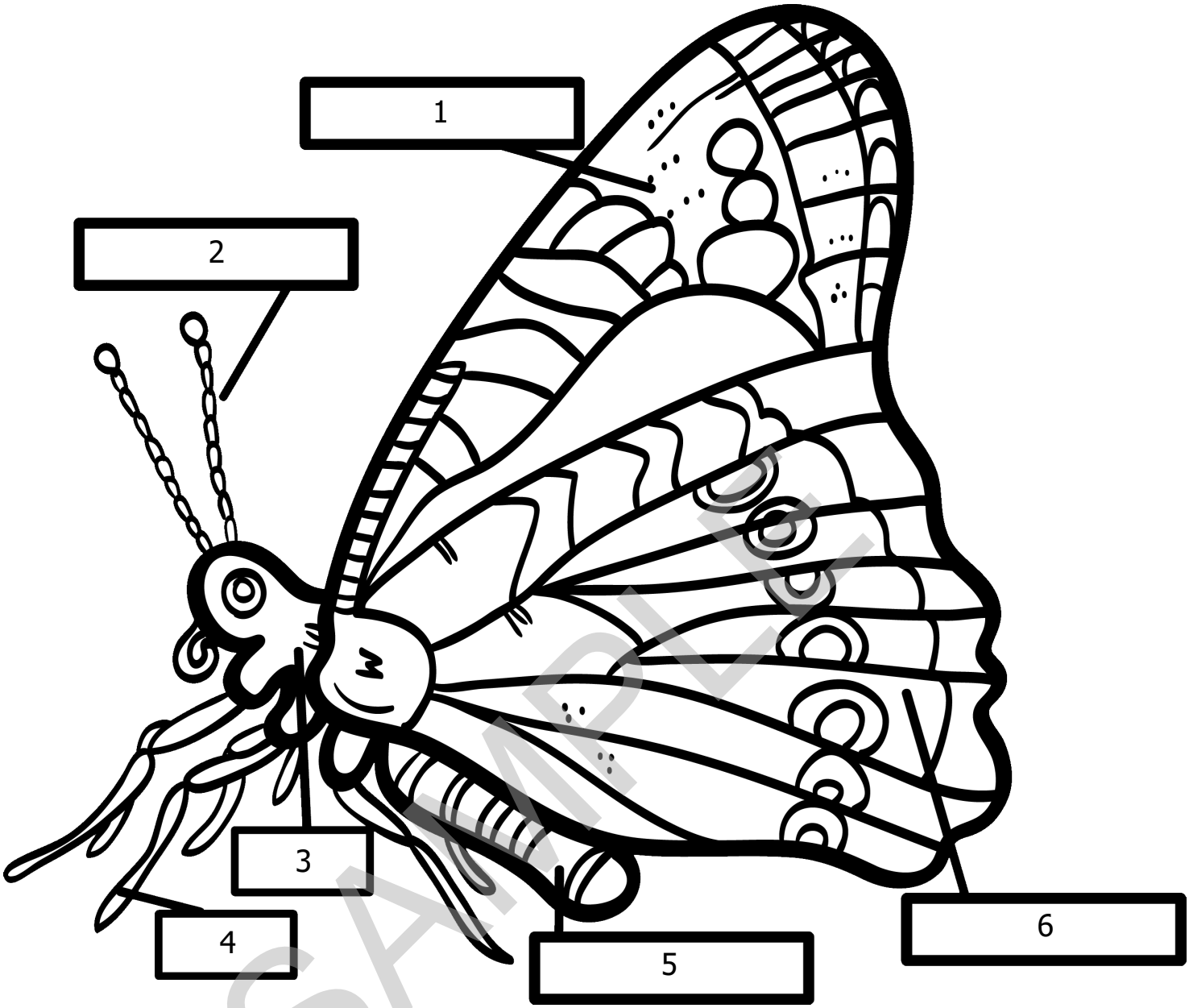
The last bivalve we're going to look at is the clam. The clam has two valves, a ligament, and an adductor muscle like the other bivalves we've looked at. Clams live all over the world, in both fresh water and marine environments. There are hard-shell clams and soft-shell clams. Some types of clams have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

2. _____

3. _____

4. _____

5. _____

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: _____

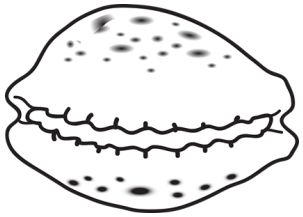
Byssus threads: _____

_____

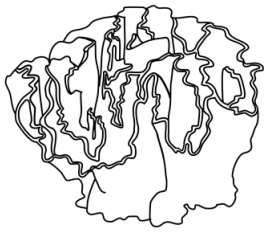
Cephalopods (Cephalopoda): _____

_____

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



Cowrie

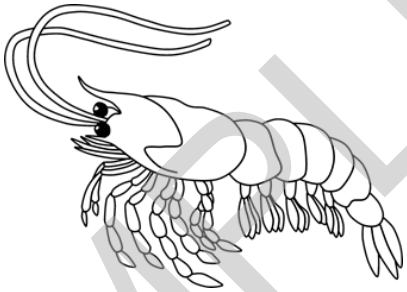


Coral

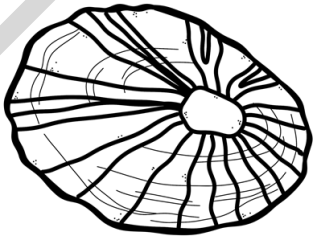
Jellyfish

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

Conch



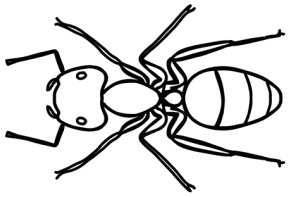
Shrimp



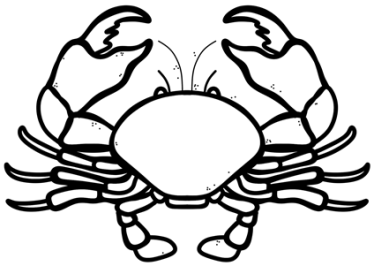
Limpet

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

Octopus



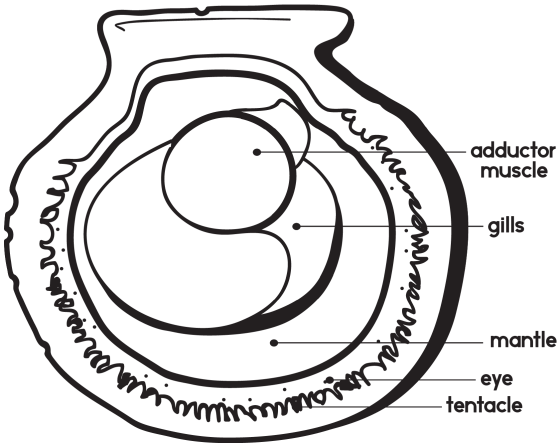
Ant

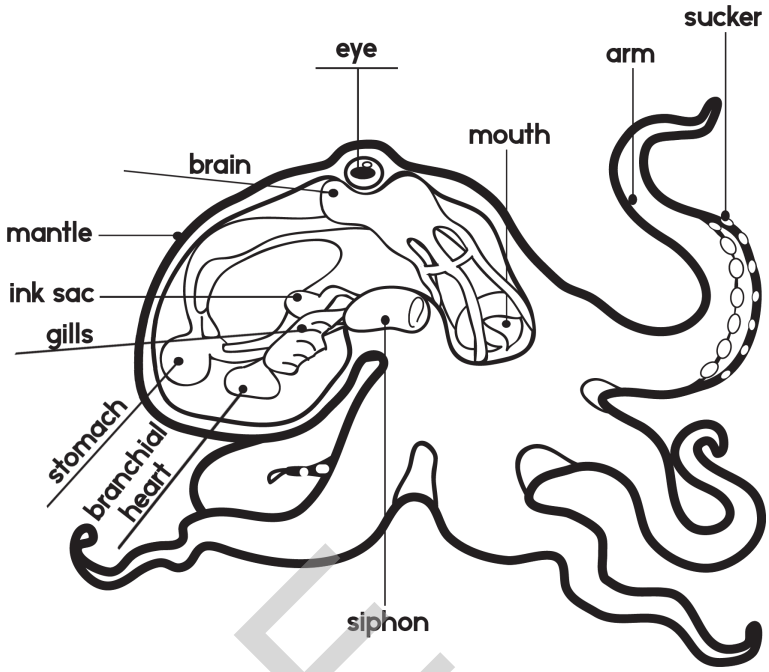


Crab

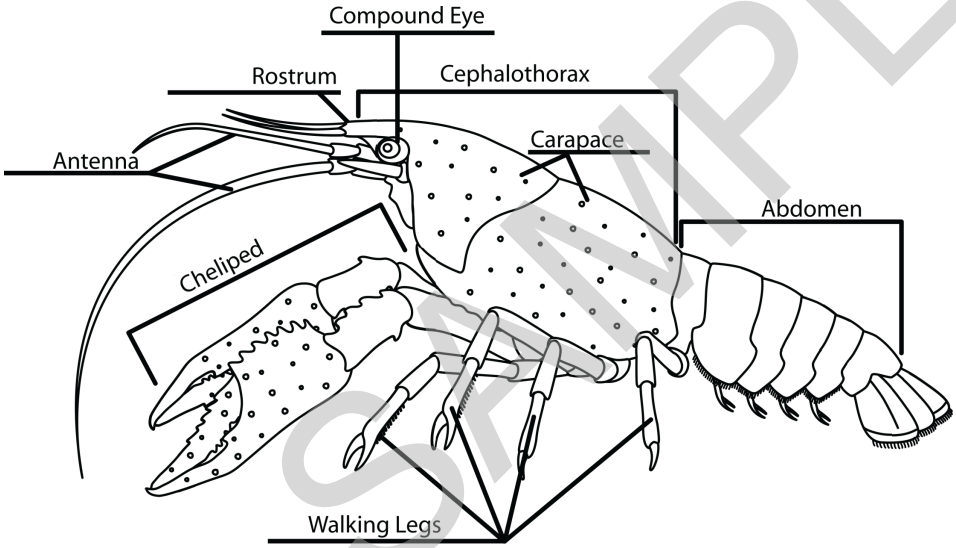
Can you name two differences between moths and butterflies?

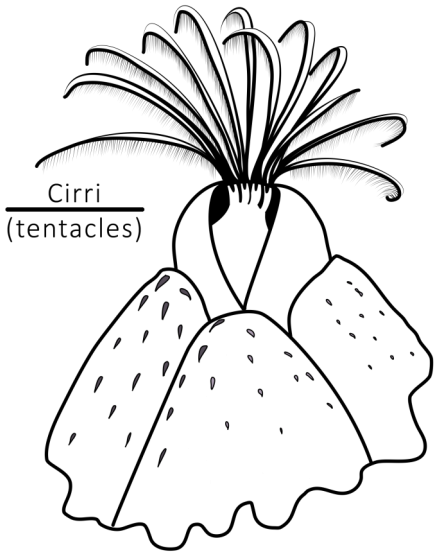
Scallop and octopus, pg. 28



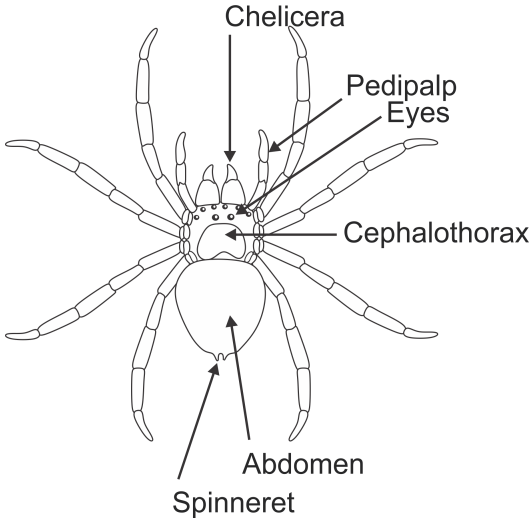


Crayfish and barnacle, pg. 37





Spider, pg. 65



Invertebrates Notebook

All the phyla in animal classification are dedicated to invertebrates except how many for vertebrates?

_____

What percentage of the world's animals are invertebrates? _____

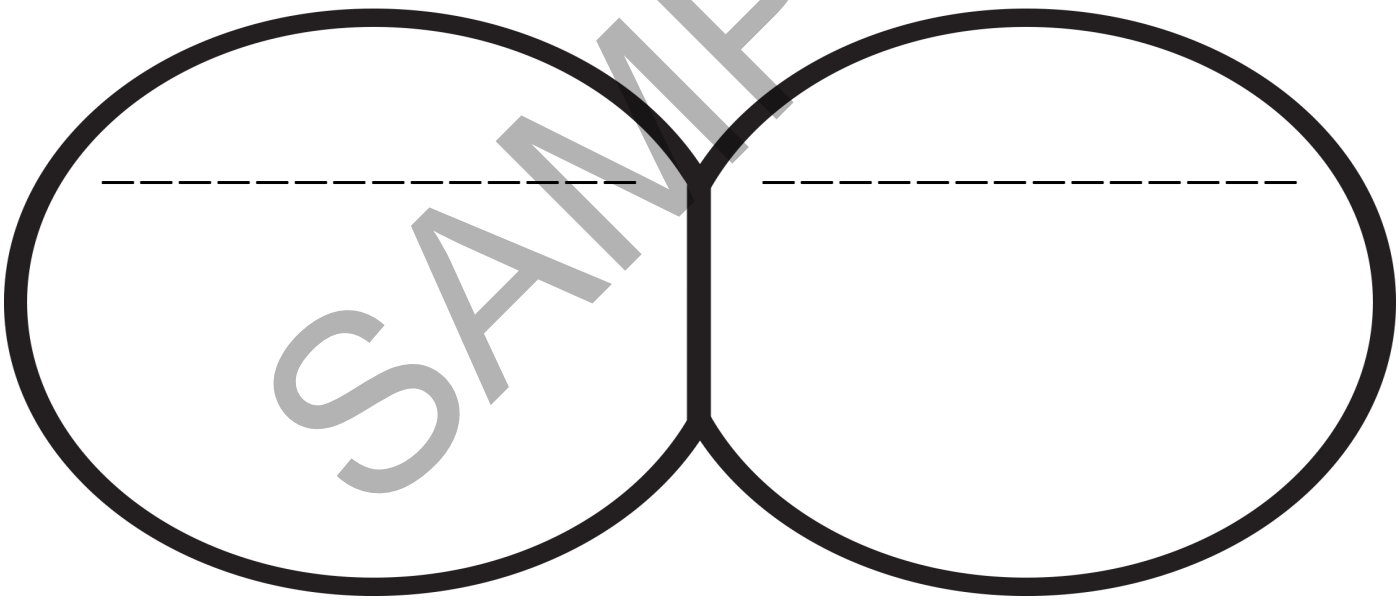
_____

Sponges belong to what phylum? _____

What body parts are sponges missing that most animals have? _____

_____

List the two types of openings sponges have and what each one does.



How do sponges reproduce asexually? _____

_____

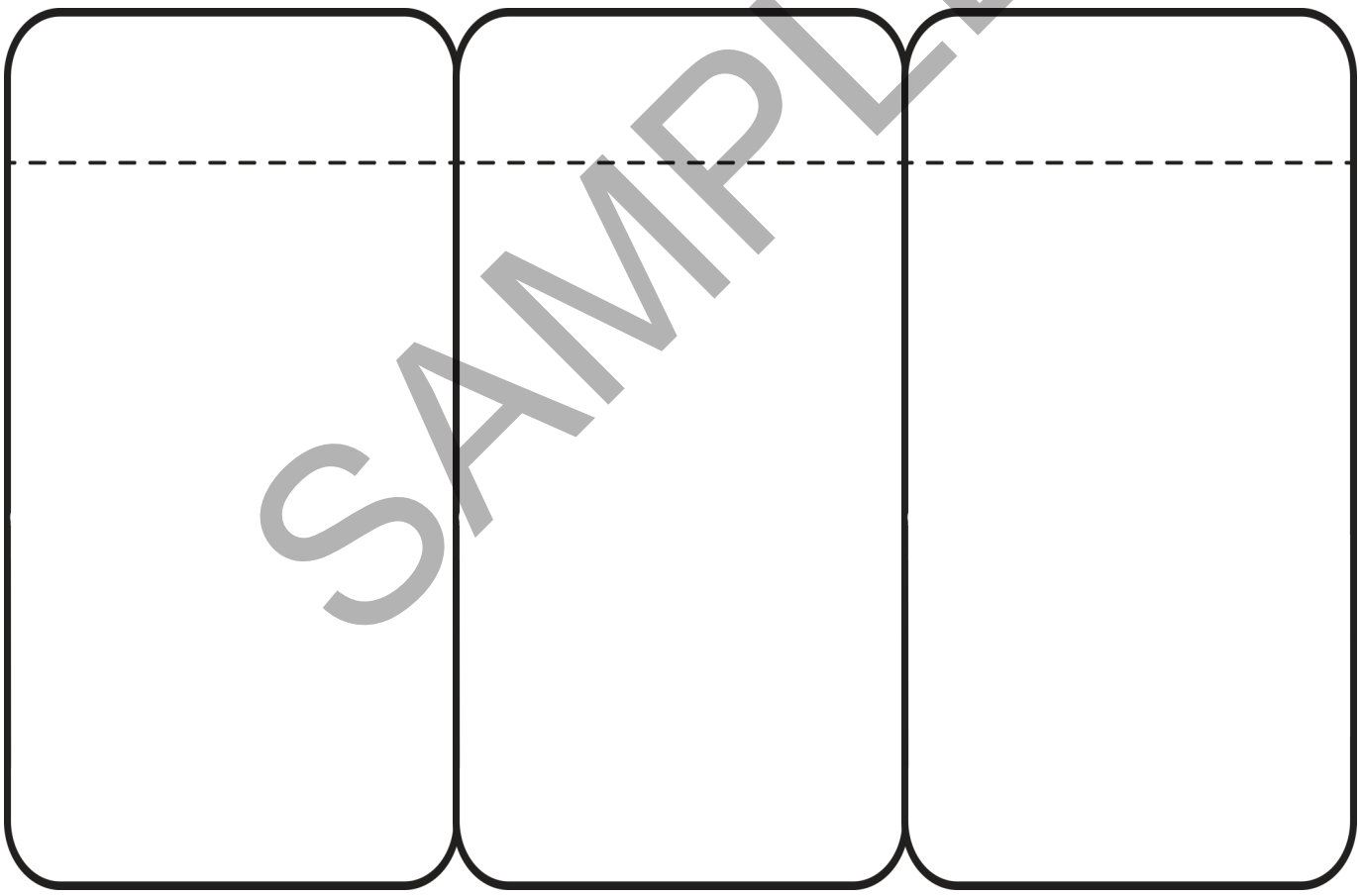
_____

_____

_____

Illustrate and label a sponge and its bud.

List and illustrate the three types of cnidarians discussed.



What do all cnidarians have? _____

_____

What does it mean to be radially symmetrical? _____

_____

_____

How long can a cnidarian's tentacles be? _____

_____

How does a jellyfish move through the water? _____

_____

_____

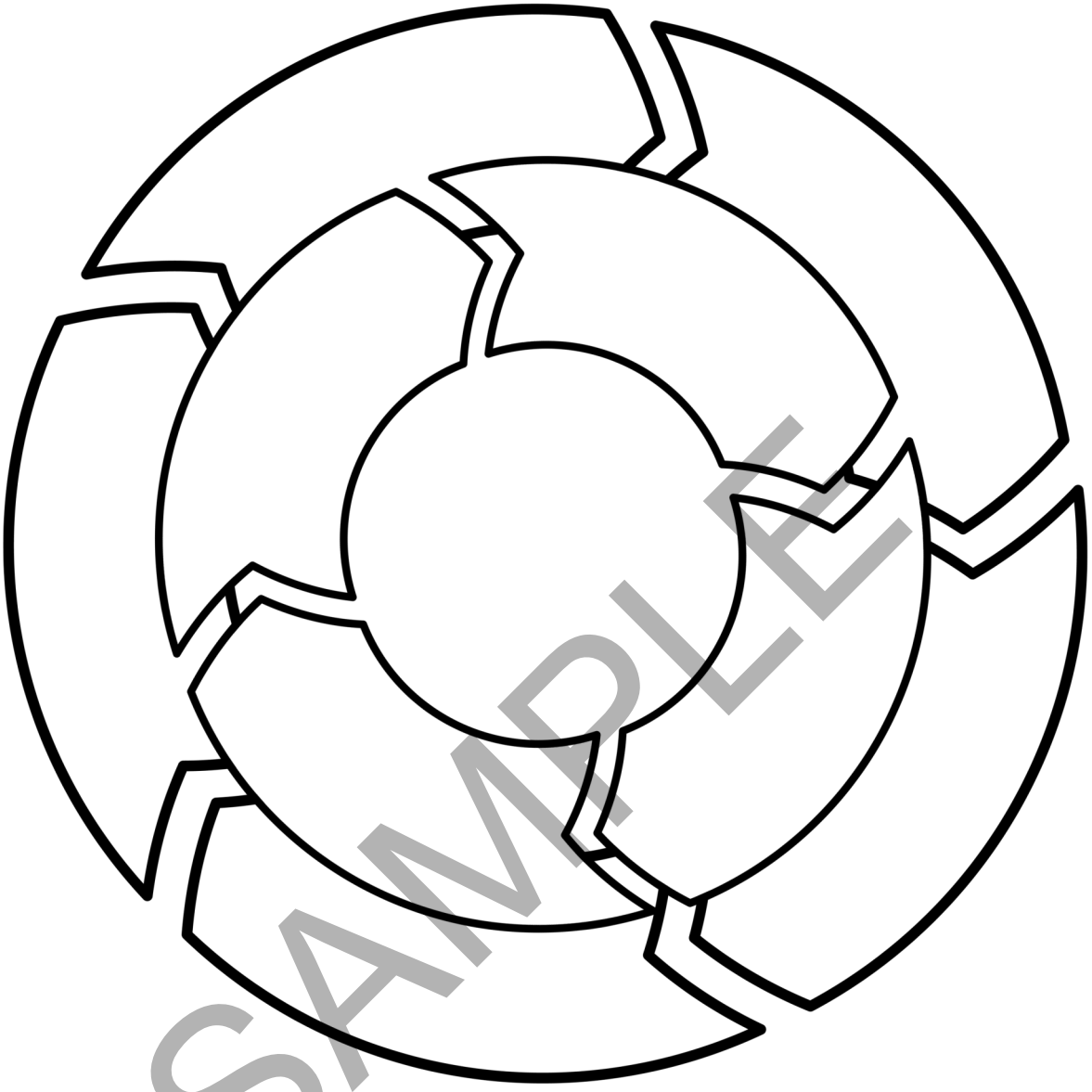
Why does a jellyfish sting its prey? _____

What kind of jellyfish is even more deadly than a snake? _____

_____

Illustrate the stages of the life cycle of some types of jellyfish.

List the nine phyla of worms mentioned in the unit.



List and illustrate the three annelids, members of the Annelida phylum, shown in this unit.

What is the name for the rings that make up an earthworm's body? _____

_____

What help the earthworm move through the soil without slipping? _____

_____

_____

On the next page, illustrate the stages of an earthworm's life cycle.