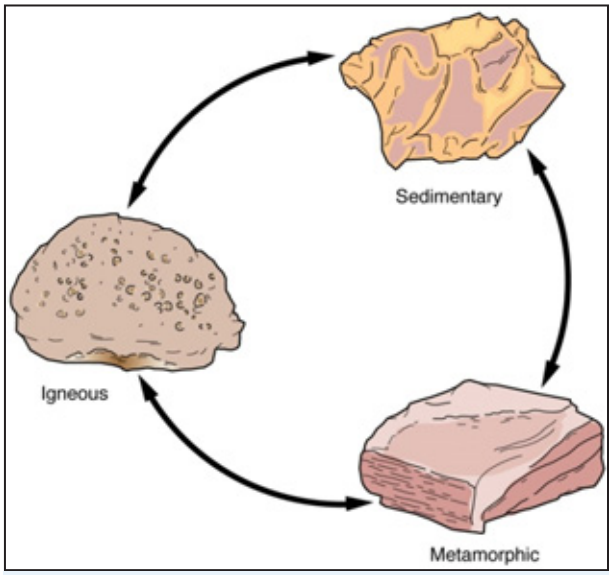
CLASSIFYING ROCKS

reflect

Have you ever looked out your window and wondered what your backyard may have looked like a million years ago? What kinds of animals and plants lived there? Was there a volcano, a river, or an ocean? Did massive glaciers pass through and carve up the land? Next time you pick up a rock, you might just be holding the key to unlocking these mysteries! Scientists called *geologists* study rocks to learn about Earth's history. What kinds of information do you think a geologist could learn from the rocks around you?



In the rock cycle, any type of rock can become any other type of rock.

There are three main types of rocks.
Geologists classify rocks into three main categories: sedimentary, igneous, and metamorphic. Rocks are separated into these three types based on how they were made. A rock's physical characteristics reflect the processes under which it formed. So does a rock's **mineral** composition.

When rocks undergo additional processes, they can change from one type of rock to another. Depending on the processes the rock goes through, any type of rock can become any of the other types. It could even become a new rock of the same type. For example, a sedimentary rock could become a metamorphic rock, an igneous rock, or a new type of sedimentary rock, depending on what happens to it. The processes by which rocks change into new rocks make up the *rock cycle*.

mineral: a naturally occurring, inorganic solid with a fairly constant chemical composition and fairly constant crystal structure

Igneous rocks have characteristics unique to how they form.
Igneous rocks are formed when lava or magma cools and solidifies. This solidification is known as *crystallization*. Lava and magma are both molten rock. Rocks that melt under Earth's surface are known as *magma*. When magma erupts out of a volcano, or seeps through cracks in Earth's crust, it becomes known as *lava*.

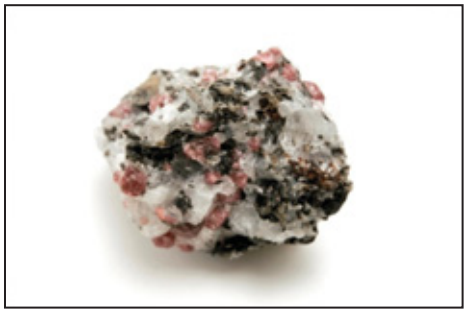
Igneous rocks have interlocking mineral crystals. These crystals vary in size depending upon how rapidly they cooled. When magma cools under Earth's surface, it solidifies very slowly. This gives mineral crystals a long time to grow. This allows the crystals to become quite large. Igneous rocks that cool slowly under Earth's surface are known as *intrusive* igneous rocks. (Think of "internal." Intrusive igneous rocks form in Earth's interior.)

CLASSIFYING ROCKS

It is much cooler on Earth's surface than it is below. When lava cools on Earth's surface, it solidifies very quickly. This does not give mineral crystals very much time to grow, so they will be quite small. Sometimes, they will cool so quickly that no crystals will form at all. In that case, the rock will have the characteristics of glass. A volcano may shoot blobs of lava into the air. These blobs can cool so quickly that they solidify before they even hit the ground. Igneous rocks that cool quickly on or above Earth's surface are known as *extrusive* igneous rocks. (Think of "external." Extrusive igneous rocks form on Earth's exterior.)

Sometimes, gases are dissolved in magma. When the magma rises to Earth's surface and becomes lava, the pressure of being underground is released. This allows the gases to escape, forming bubbles. You can observe this yourself by opening a brand new bottle of soda. When you first open the cap, you hear the pressure being released. You see all of the bubbles rising to the surface. Bubbles leave holes as the lava cools and becomes an extrusive igneous rock. Sometimes, the rock is so full of holes, it will even float in water!

Take a look at these two photographs. Both show igneous rocks. The igneous rock pictured on the left has very large interlocking crystals. It is an intrusive (form in Earth's interior) igneous rock. The igneous rock pictured on the right has very small interlocking crystals. It is an extrusive (form on Earth's exterior) igneous rock.



what do you think?

As part of the rock cycle, old igneous rocks can form new igneous rocks. How do you think this can happen? (Recall that igneous rocks form when rocks that have melted cool and solidify.)

Sedimentary rocks have characteristics unique to how they form.
Forces on Earth's surface can break down rocks. This process is called *weathering*. Rocks can be broken down through physical weathering or chemical weathering. *Physical weathering* breaks down rocks into smaller pieces through physical processes. For example, other materials can scratch or scrape them. *Chemical weathering* breaks down rocks through chemical processes. For example, they can be dissolved by acid rain. Once rocks are broken down, the smaller pieces are called *sediments*.

Sediments can be carried from place to place. This process is called *erosion*. Erosion carries sediments through wind, water, gravity, or other means. For example, sediments can travel downstream in a river. They can also roll downhill in a landslide. Eventually, sediments stop moving and settle into layers. This process is called *deposition*.

Layers of sediment can be crushed together as more sediment is deposited on top. This crushing is called *compaction*. Sometimes, water will fill in the tight spaces between the grains of sediment. Eventually, the water evaporates. When this happens, any minerals that were dissolved in the water are left behind. Small mineral crystals grow while the water evaporates. These crystals "glue" the sediment grains together in a process called *cementation*. Once the sediment grains are bound together, they become a *sedimentary rock*.

These hills are made of layers of sedimentary rock called sandstone. These layers of sandy sediment were deposited one on top of another.

Some sedimentary rocks contain fossils like this fish. Minerals replaced the remains of the fish, leaving its shape behind.

Sometimes minerals will grow in the spaces left behind by the bodies of dead animals or plants. This creates fossils in some sedimentary rocks. Some fossils form when minerals fill footprints and other traces of living things.

CLASSIFYING ROCKS

After rocks are dissolved through chemical weathering, crystals can grow as the water evaporates. This is a different kind of deposition. This results in sedimentary rocks called *evaporites*. Salt is one of the main minerals that forms evaporites. When many salt crystals grow together, a sedimentary rock called rock salt forms.

Rock salt forms when many individual salt crystals grow together.

Many evaporite sedimentary rocks are made of only one mineral. Sedimentary rocks that are created through deposition and cementation of sediment are typically made of more than one mineral. Cementation occurs when minerals grow in between other grains of sediment and glue them together.

Metamorphic rocks have characteristics unique to how they form.
Rocks are often buried in Earth's crust. Sometimes sediment is deposited on top of them over time. Sometimes they are buried through the movement of **tectonic plates**. As they become buried deeper and deeper, the weight of the crust above puts pressure on the rocks. In addition, as the rocks get closer to the **mantle**, their temperatures increase.

tectonic plates: the solid pieces of Earth's crust that float and move on top of the asthenosphere

mantle: the solid layer of Earth between the crust and the core

A rock is defined by its texture, as well as its *composition*—the minerals of which it is made. Therefore, if a process changes a rock's texture, its composition, or both, the rock will become a new and different rock. When rocks are buried deep in Earth's crust, heat and pressure can cause the buried rocks to be altered to form new rocks. These are called *metamorphic rocks*. Metamorphic rocks are often characterized by wavy layers of mineral crystals or by the presence of unusual minerals.

See the wavy layers in this metamorphic rock? The minerals were squeezed together into these wavy layers by pressure. This metamorphic rock is called gneiss.

Pressure can change an existing rock into a new metamorphic rock by changing the rock's texture. Sometimes the sediment grains of a sedimentary rock or the crystals of an igneous or other metamorphic rock will be squeezed tightly together. This can change the rocks into new, denser metamorphic rocks. Many sedimentary rocks already contain parallel layers. These parallel layers can be squeezed by pressure and become the wavy layers of a metamorphic rock.

Pressure can also change an existing rock into a new metamorphic rock by changing the rock's mineral composition. A mineral is defined by the elements of which it is made and by its *crystal structure*. The crystal structure is the internal arrangement of the atoms that make up the crystal. Sometimes the pressure is great enough that it will change the internal arrangement of atoms by crushing the atoms together. Because this changes the crystal structure, it changes the minerals. Changing the minerals into different minerals changes the mineral composition of the rock. Changing the mineral composition of a rock changes it into a new metamorphic rock.

Heat can also change an existing rock into a new metamorphic rock by changing the rock's mineral composition. Heat can cause chemical reactions that change minerals into new minerals. Heat can also cause water or other chemicals to evaporate out of certain minerals. These chemical reactions change the mineral composition of the existing rock into a new metamorphic rock with a different mineral composition.

look out!

When heat changes an existing rock into a new metamorphic rock, the rock may become soft. This makes it easier for pressure to change the rock's texture. However, the rock will still be in solid form. Suppose the heat is great enough to actually melt the rock into liquid form. When the rock solidifies again, it will become an *igneous rock*, not a metamorphic rock.

Heat changing rocks is like candle wax. A little bit of heat will make the wax soft enough for you to mold it into a new shape.

How is a melting candle similar to a rock in the rock cycle?

However, the wax will remain a solid. This represents the way heat softens rock so that pressure can change its texture, creating a metamorphic rock. A lot of heat will cause the wax to melt into a liquid. Eventually, the wax will cool again and become solid. This would represent the way rock melts and solidifies, creating an igneous rock.

Career Corner: Petrologist

Petrology is a branch of geology that specifically focuses on the textures, composition, and formation of rocks. Geologists who primarily focus on petrology are called petrologists. While some petrologists study all types of rocks, many petrologists will focus specifically on igneous, metamorphic, or sedimentary rocks. Petrologists sometimes do chemical testing on rocks to determine their mineral compositions. They can also polish rock samples until they are so thin that light can pass through them! This allows petrologists to examine the rocks using special light microscopes called petrographic microscopes. Petrologists can learn detailed information about the compositions and textures of rocks by examining these thin sections.

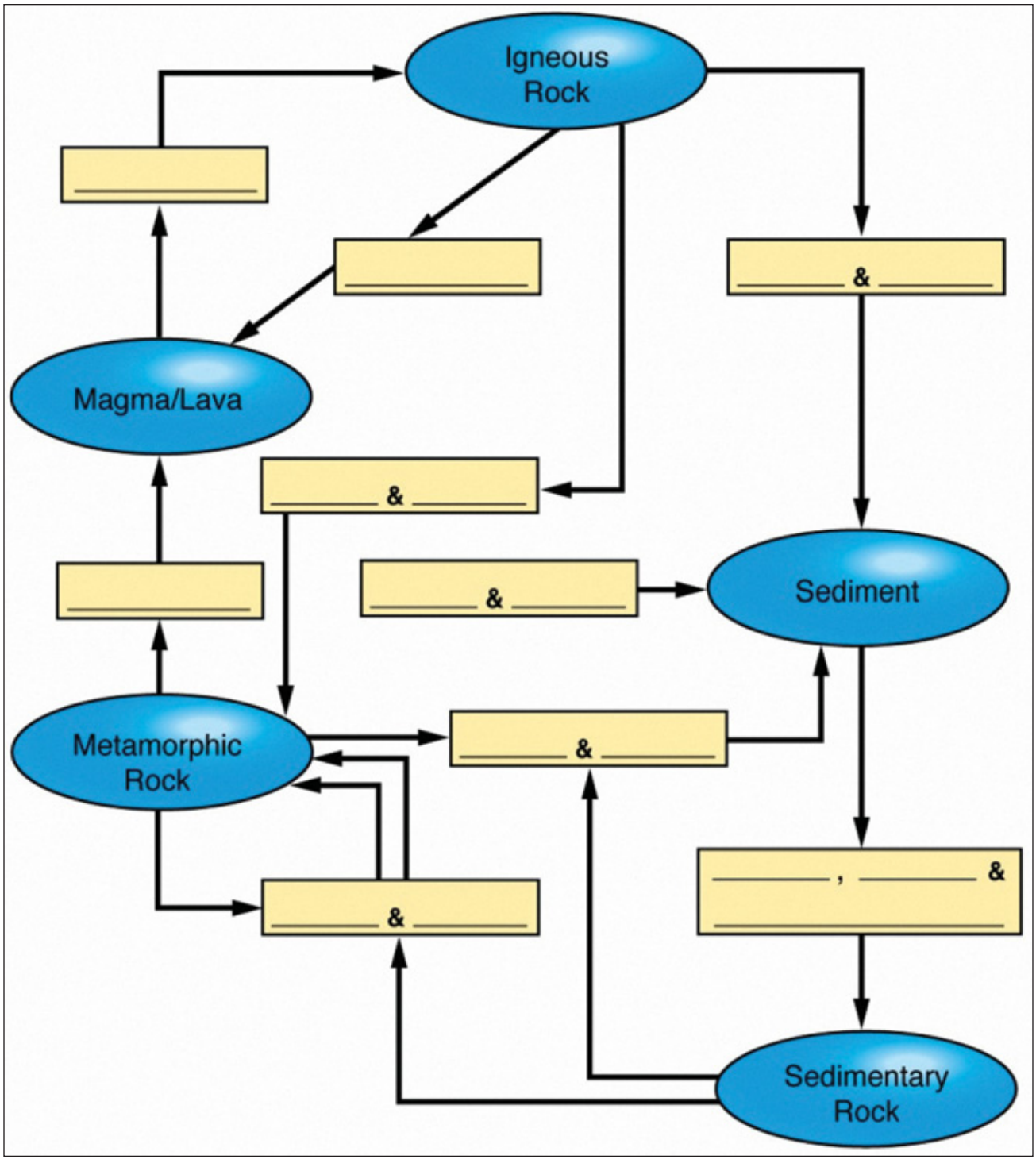
Petrologists are experts on the rock cycle. As rocks move through the rock cycle, their mineral compositions and physical structures change to reflect the processes under which they are formed. By studying the textures and compositions of rocks, petrologists can learn a lot about how the rocks formed. The physical structures and chemical properties of the solid Earth provide evidence of Earth's evolution over time. Investigation of Earth's layers, tectonic activity, and the rock cycle reveals Earth's history. Petrologists play a major role in revealing Earth's history by studying the rock cycle.

What do you know?

Over time, through the various processes of the rock cycle, Earth's rocks change from one type into another. Read the processes in the box below. Write each process in the correct place of the rock cycle diagram on the next page.

Rock Cycle Processes	
• Erosion	• Cementation
• Pressure	• Crystallization
• Meltings	• Weathering
• Heat	• Deposition
	• Compaction

CLASSIFYING ROCKS



CLASSIFYING ROCKS

connecting with your child

Exploring the Rock Cycle at Home

To help students learn more about the rock cycle, try exploring rocks together. Rocks are classified into sedimentary, igneous, and metamorphic rocks. Each class of rock is defined by the processes of its formation. The texture and mineral composition define different types of rocks; they are also determined by the processes by which the rocks formed. Over long periods of time, Earth's rocks change from one type into another through various processes as described in the rock cycle. The processes that form sedimentary rock include weathering, erosion, deposition, compaction, and cementation. The processes that form igneous rock include melting and crystallization. The processes that form metamorphic rock include changing heat and pressure.

- Sedimentary rocks are formed when particles of other rocks are deposited in layers and undergo compaction (crushing together) and cementation (binding of the sediments). Some sedimentary rocks contain fossils.
- Igneous rocks are formed when lava or magma cools and solidifies. They are characterized by interlocking mineral crystals that vary in size depending upon how rapidly they cooled.
- Metamorphic rocks are formed deep underground where heat and pressure cause existing rocks to be altered. Metamorphic rocks are often characterized by wavy layers of mineral crystals or by the presence of unusual minerals.

Take your child on a walk outside. Pick up any rocks you find along the way. Take a close look at the rocks. Discuss any observations your child makes about the rocks, paying particular attention to the textures, layers, grain sizes, or other features, such as fossil evidence. Although it may not be possible to identify the rocks, have your child explain whether the rock is igneous, sedimentary, or metamorphic. Your child should also explain why the rock fits into that category.

If you live in an urban area, your child might mistake concrete or asphalt for different types of rocks. These products typically include crushed rocks and sediments such as sand, concrete, and asphalt; however, these materials do not form naturally as part of the rock cycle. Humans make them by binding crushed materials with various pastes (such as cement). In this respect, concrete and asphalt are similar to sedimentary rocks formed by cementation, but they are not actually rocks.

Here are some questions to discuss with students:

- What features do you see in this rock?
- Do you see grains of sediment or crystals?
- Do you see any layers? Are they parallel or wavy?
- What size crystals do you see in this rock?
- What kind of rock do you think this is (sedimentary/igneous/metamorphic)? Why do you think so?