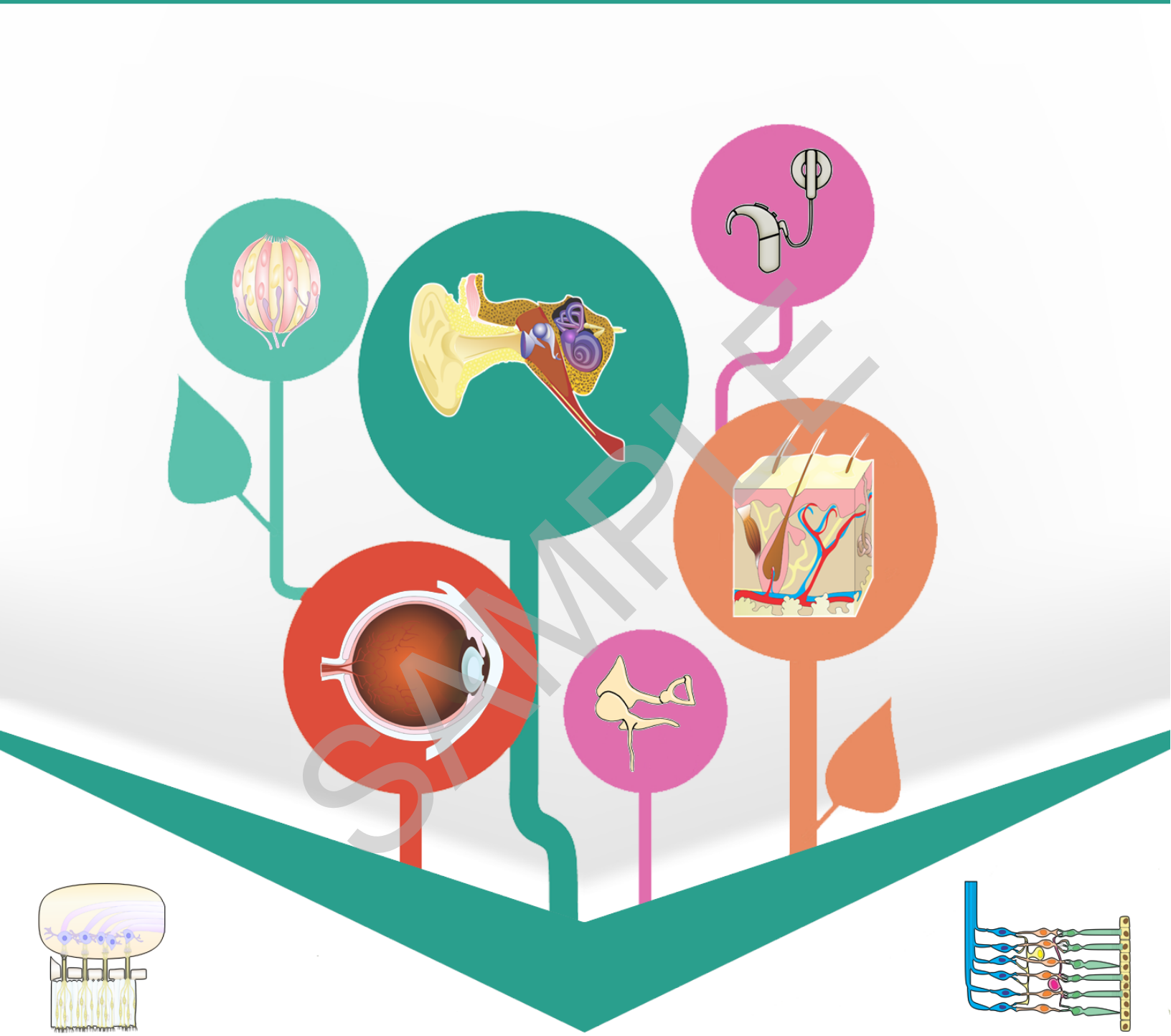
Life Science
Level 5



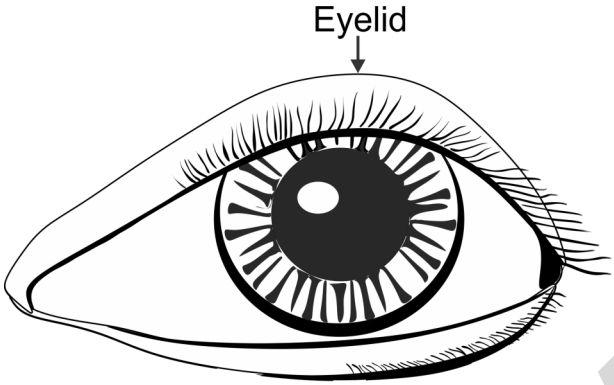
An In-Depth Look at How Our Senses Work

By Bonnie Rose Hudson

Write Bonnie Rose

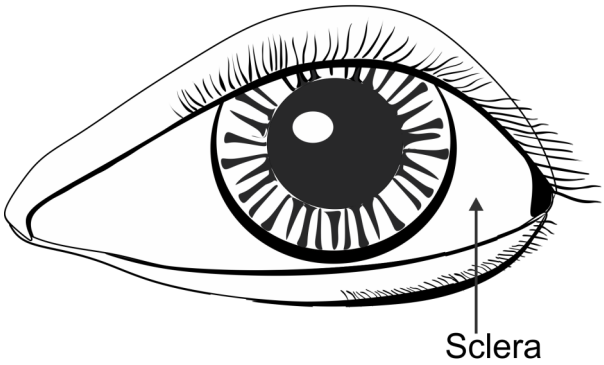
An In-Depth Look at How Our Senses Work

For many of us, one of the first things we learned in science is that we have five senses—sight, hearing, touch, taste, and smell. You've known that almost your whole life, but have you ever stopped to wonder *why*? Why do your eyes see? Why does your tongue taste? What causes sinusitis, and why does it make it so hard to smell or even breathe? Those are a few things we're going to look at in this unit. We'll look at the parts of each system and then look at how they work together and what happens when something goes wrong. We're going to start with our eyes.

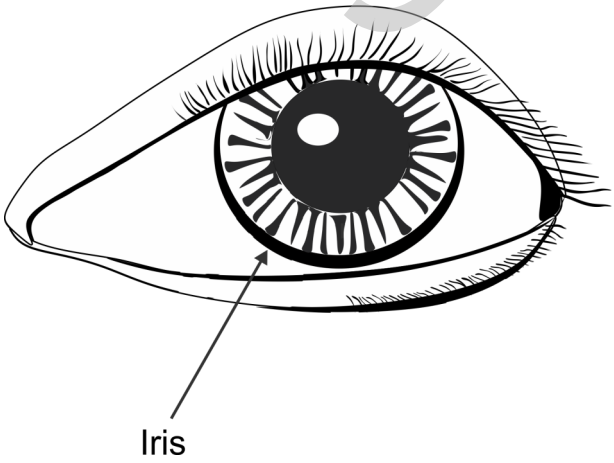


Our eyes rest in cavities in our skull called **orbits** or sockets. They are bordered by the brow and the cheekbone and are nearly surrounded by soft tissue that helps cushion the eyes.

Above our eyes are the eyelids. These protect our eyes, but they also do much more. The eyelashes on them keep a lot of dust and other particles out of our eyes. A membrane inside the eyelid continually coats our eyes with moisture to keep our eyes moist and clean.

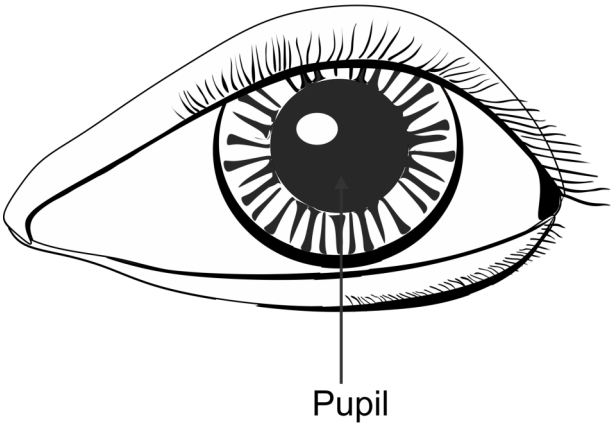


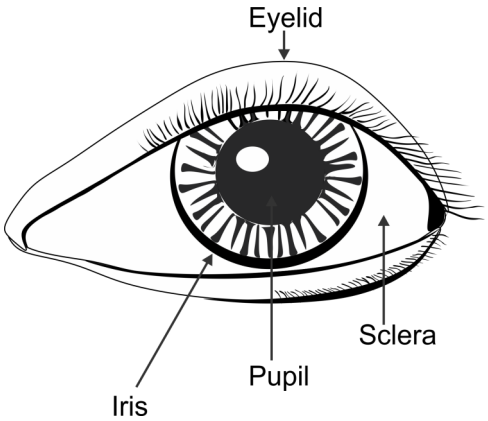
The **sclera** is the white part of our eyes. It is strong and somewhat leathery. It makes up about 5/6 of the outside of our eyes.

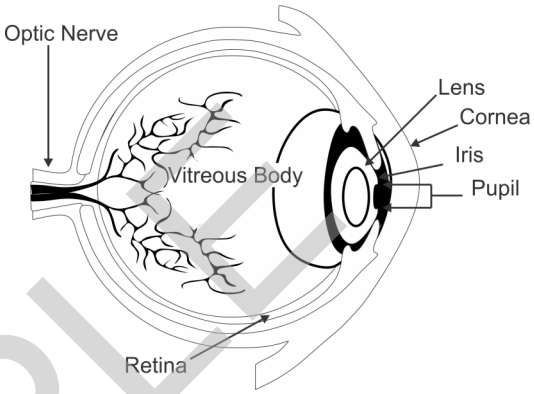


As we move in toward the middle of our eyeball, the next part is the **iris**. This is the colored part of our eyes. It has muscles that control the size of the pupil. **Melanin** is a pigment found in our bodies, and the more melanin there is in the iris, and the closer it is to the surface, the darker color our eyes are. Someone with brown eyes has more melanin and has it closer to the surface than someone with blue eyes. Melanin also helps protect our eyes because it absorbs strong light that could blur our vision or harm our eyes.

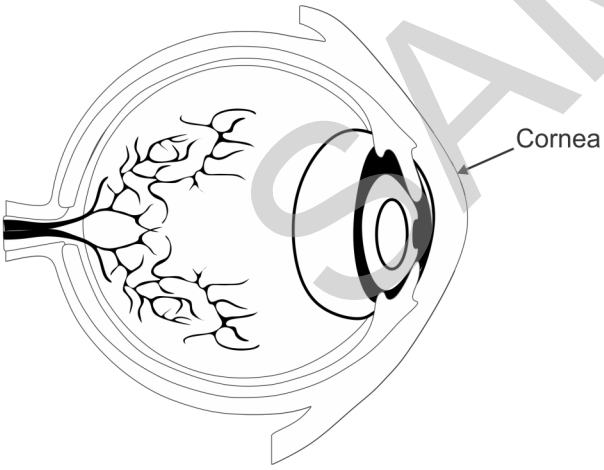
The **pupil** is the opening in the center of our eyes. Its job is to make sure the right amount of light enters our eyes at all times. When the light around us is dim, it enlarges to let in as much light as it can. When the light is bright, it shrinks to keep our eyes safe from too much light. It also helps our eyes focus on objects.





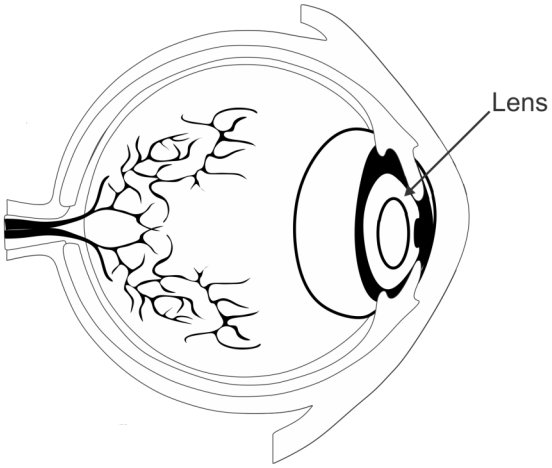


Now let's take a look at what the eye looks like on the inside. We're already talked about what the iris and pupil do. Let's take a look at the cornea.

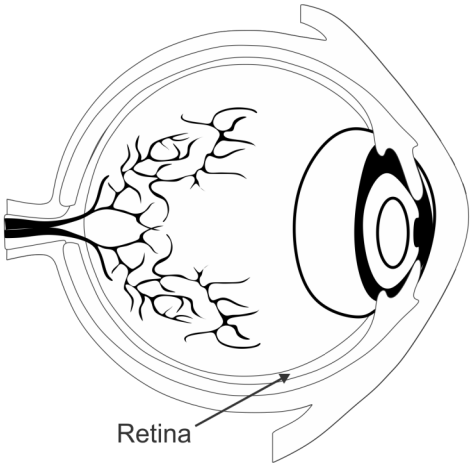


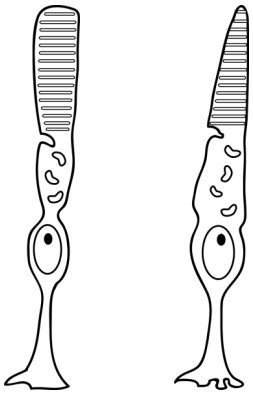
The **cornea** is made of transparent tissue, and it covers the iris, the remaining 1/6 of the eye that the sclera does not cover. It is the part of the eye that allows light to enter.

The **lens** is a transparent and flexible piece of the eye behind the iris that directs light to the retina. The ciliary body, which is around the lens, continually adjusts the shape of the lens so we can see clearly, whether we are looking at things close to us, far away from us, or looking back and forth like you might do when you are in car.



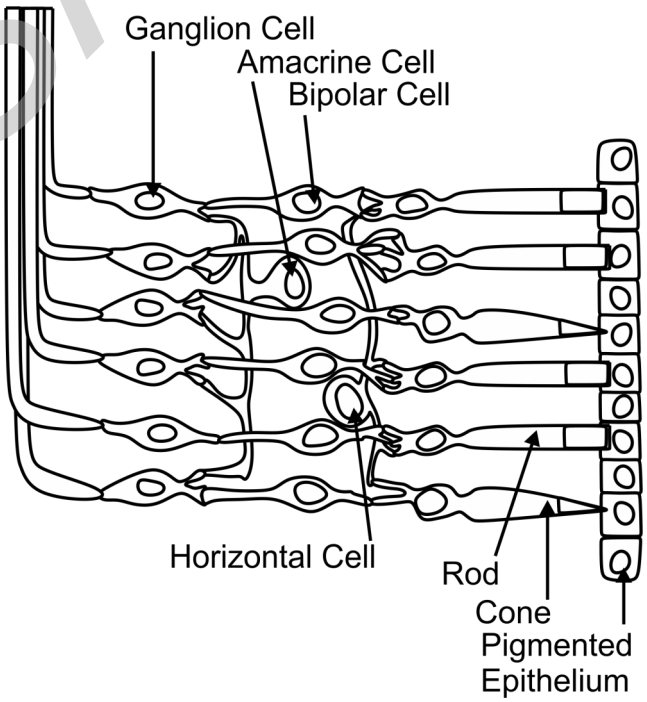
The **retina** is an extremely fragile piece of the eye. It's only about as strong as wet tissue paper, which is why it's deep in our eye and not out front. The retina is the part of the eye that changes the light we see into electrical signals our brains can process. To do this, it needs two special types of cells: rods and cones.

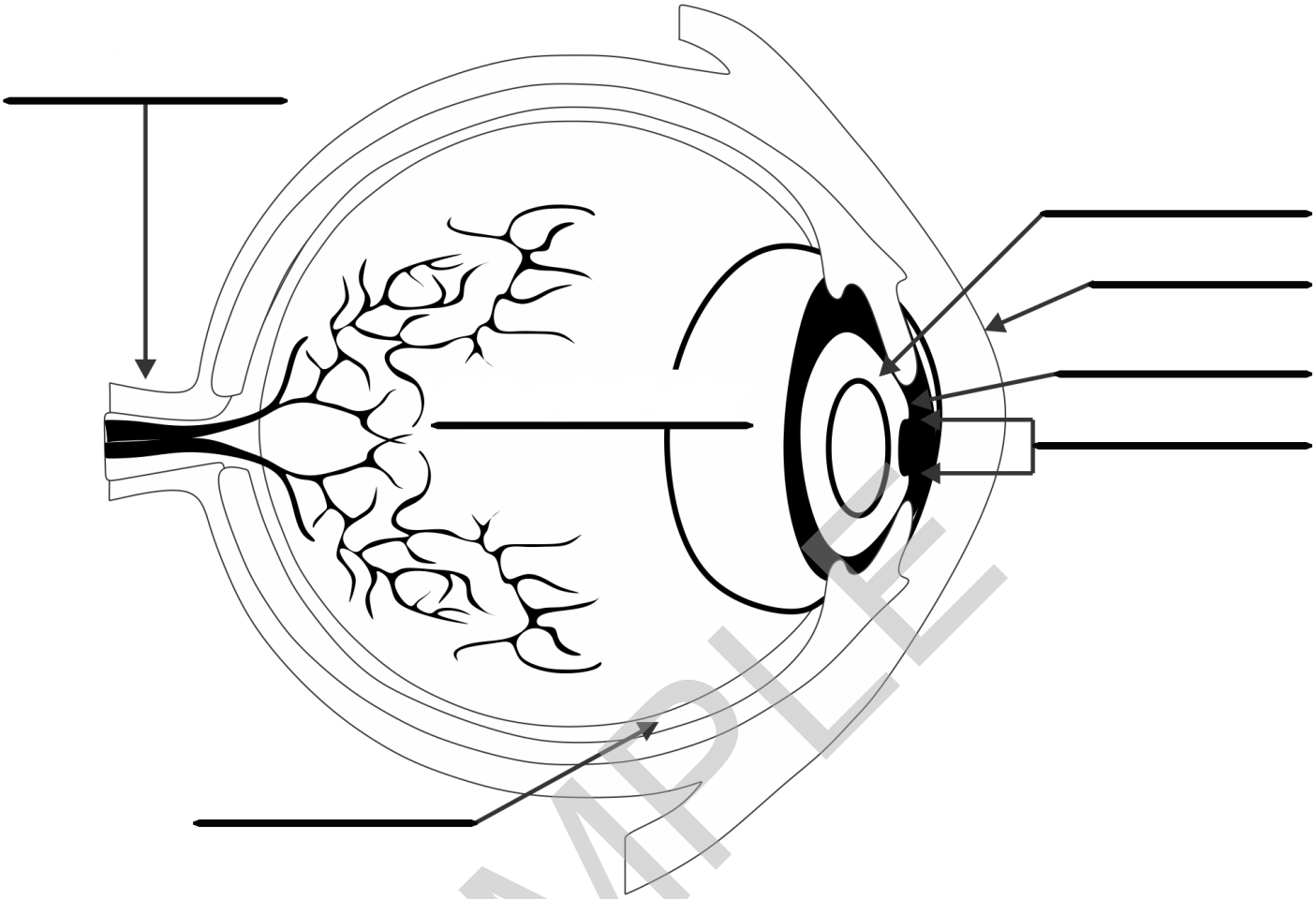


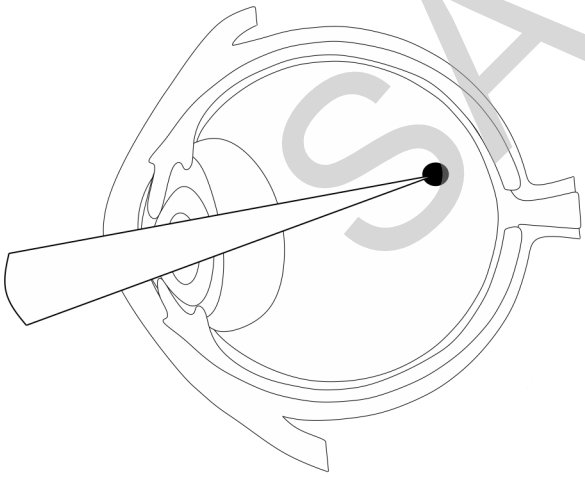


Rods and cones are cells that are extremely sensitive to light. They get their names from their shape. You can see the difference between the rod (on the left) and the cone (on the right). They have pigments inside that can detect the smallest particle of light that hits the retina. They allow us to see color and shades of gray, and they allow us to see when there isn't a lot of light. Defects in these pigments cause color blindness, which is when you aren't able to tell certain colors apart.

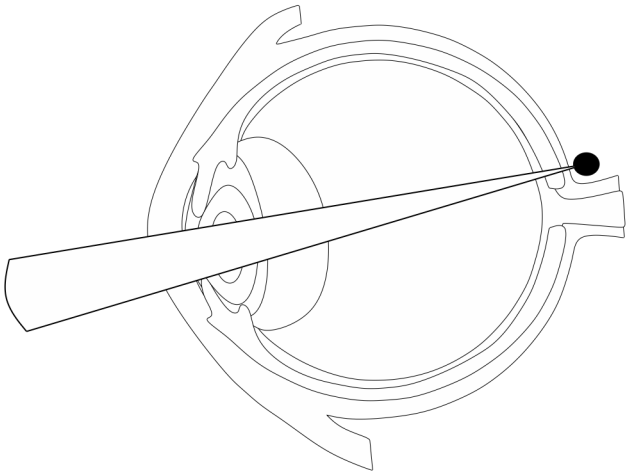
Our retinas actually have five layers, with different types of cells in each layer. Scientists are still studying to understand exactly how some of the types of cells work, and we won't try to memorize all the layers right now. But it's important to understand just how incredibly complex our eyes and the simple act of seeing really are. You can see the rods and cones in the diagram below.





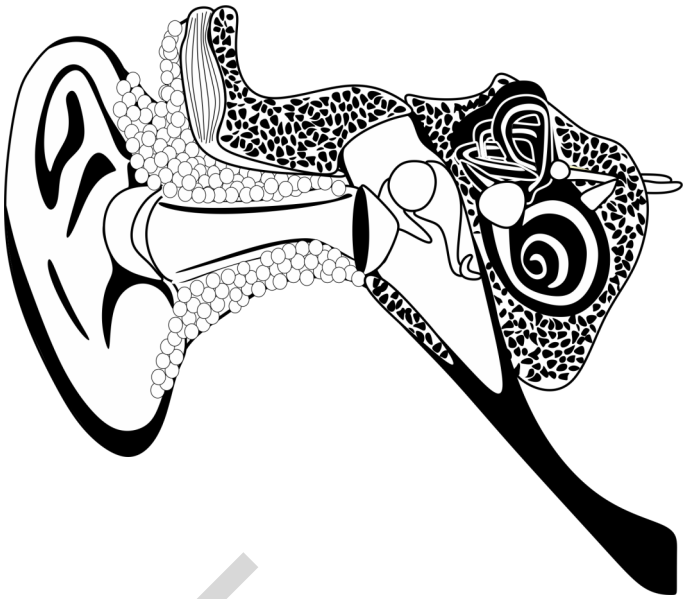


Focal point is before the retina

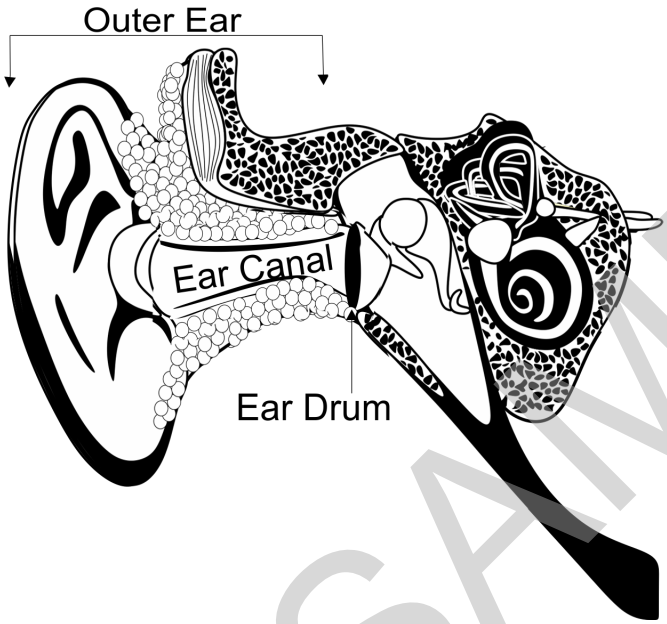


Focal point is after the retina

The next sense we're going to look at is the sense of hearing. Like our eyes and our sense of sight, our ears and our sense of hearing are made of many parts that have to work together to function properly.



We normally divide the ear into three sections—the outer ear, the middle ear, and the inner ear. The fleshy part of the ear on the outside of your head is called the **auricle**. The small piece at the bottom is the earlobe.

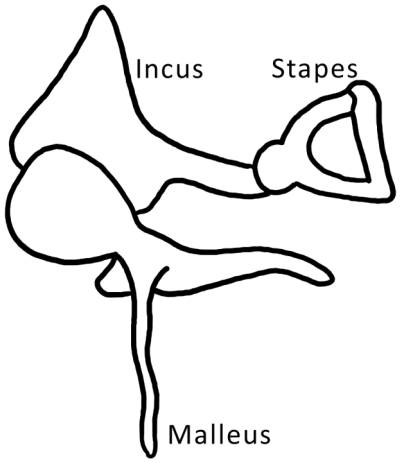


The **auditory canal**, or ear canal, is the path you see when you look inside your ear. In the first part of the canal, the part closest to the outside of your body, there are hairs and glands that work together to keep the ear clean. The glands produce wax, and the wax and hairs trap dirt that could get in your ears. The canal leads to the eardrum.

The temporal bone surrounds the rest of the canal and is the hardest bone in the body. It also surrounds the middle and inner ear.

The **eardrum** is a very thin membrane that is stretched tightly in the ear. It is very small, only about 2/5 inch (10 millimeters) around. It is also called the tympanic membrane, and it separates the outer ear from the middle and inner ear.

The middle ear is made of three bones called the malleus (or hammer), the incus (or anvil), and the stapes (or stirrup). The malleus is the largest of the three. One end of it attaches to the eardrum, and the other attaches to the incus.



The incus connects the malleus and the stapes. The stapes is the smallest bone in the entire body. It is actually smaller than a grain of rice. Part of the stapes is attached to a membrane called the oval window, which is the path to the inner ear.

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.

Orbits: _____

Sclera: _____

Iris: _____

Melanin: _____

Pupil: _____

_____

Cornea: _____

Lens: _____

Retina: _____

Rods and cones: _____

_____

Optic nerve: _____

Vitreous body: _____

_____

Visual acuity: _____

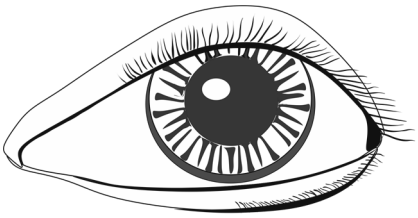
Myopia: _____

Hyperopia: _____

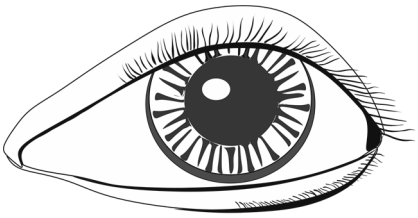
Auricle: _____

Auditory canal: _____

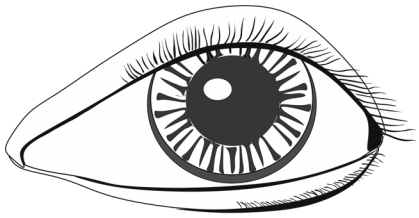
Which of the following is the name of the pigment responsible for eye color? Draw a circle around it.



Calcium



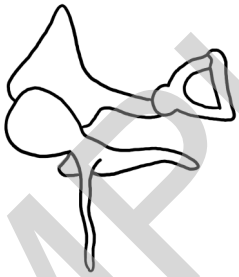
Melanin



Sulphur

Which middle ear bone gets its name from its anvil-like shape? Draw a circle around it.

Malleus



Incus

Stapes

Which of the following words is related to our sense of smell? Draw a circle around it.

Optical

Auditory

Visual

Olfactory

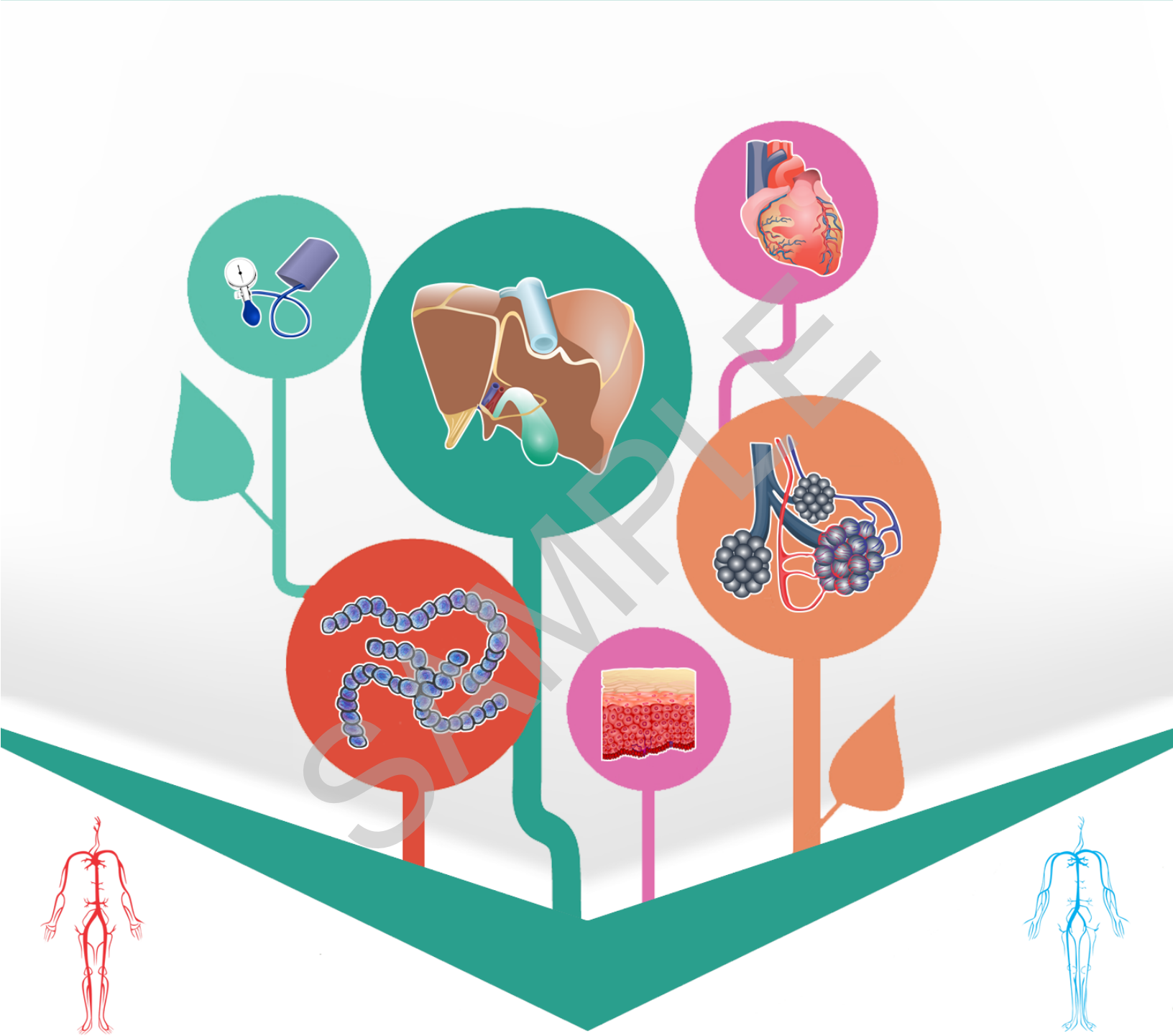
Subcutaneous

Tactile

What are the three layers of the skin?

_____

Life Science
Level 5



Human Anatomy & Diseases, Pt. 1

Respiratory, Circulatory, Digestive, Excretory & Urinary, and Integumentary Systems

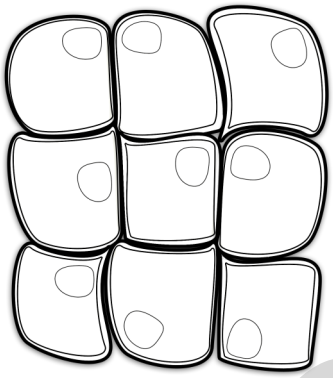
By Bonnie Rose Hudson

Write Bonnie Rose

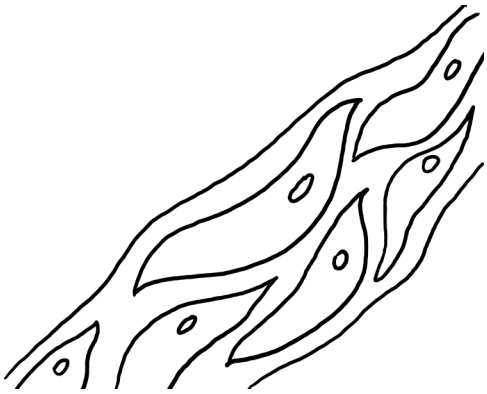
Human Anatomy and Diseases, Pt. 1

No matter how you feel about it at times, your body is amazing. It is made up of more than 200 bones, over 600 muscles, countless nerve endings, and more than 10 trillion cells. Most of the time, all of these pieces work together and keep things running smoothly without you ever having to think about it. We're going to look at many different parts of the body in this unit and some of the things that can go wrong at times. To do this, we need to get organized first.

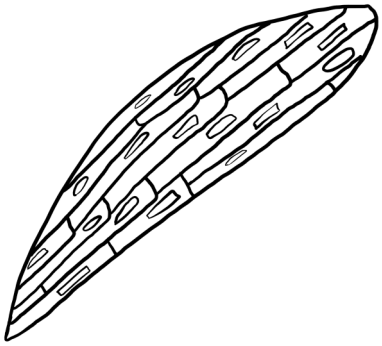
Scientists organize our bodies into **systems** that each include various organs working together to perform one or more functions. Each organ, like your heart, brain, lungs, and kidneys, is made of groups of tissues. Tissues are groups of cells that work together to do one type of job. First we'll look at the four main types of tissues in your body.



Human beings have epithelial tissue, connective tissue, muscles, and nerve cells. **Epithelial tissue** is a little bit like a wall. There is very little material between the cells because they are tightly packed. They make many of the membranes in our body, including our skin. They also form some of our glands and line certain parts of the body such as the digestive tract and the blood vessels.

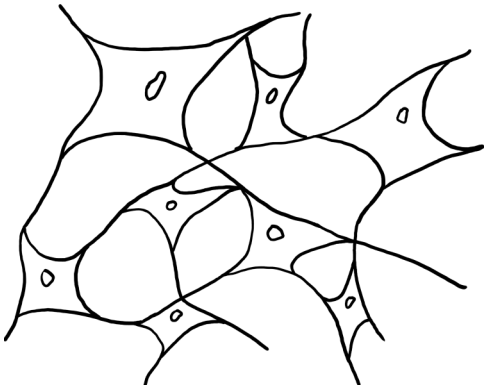


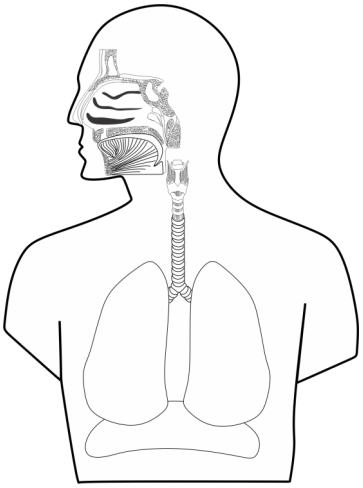
Connective tissue has a lot of substance between the cells. The substance is usually made of fibers and a clear fluid. Connective tissues do the job of surrounding and connecting tissues and organs. Two examples of connective tissue are bones and cartilage. You can see how your bones work to connect the parts of your body.



There are several different types of **muscle tissue** in our bodies because of the various jobs they have to do. One characteristic that they all share is the ability to contract and relax, which enables our bodies to move in many different ways.

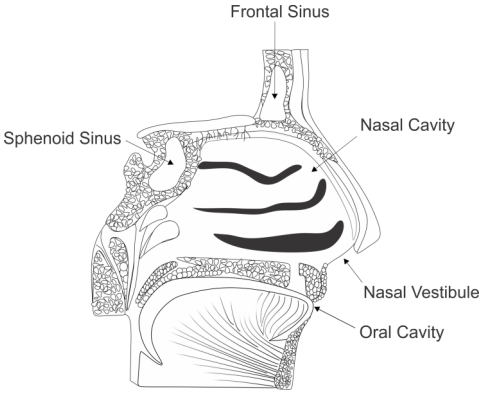
The last type of tissue in our bodies is **nervous tissue**. This tissue is made of nerve cells that transmit information throughout our bodies, moving countless impulses every second. They transmit both conscious thoughts and commands we give our bodies as well as involuntary ones that we do not have to think about.

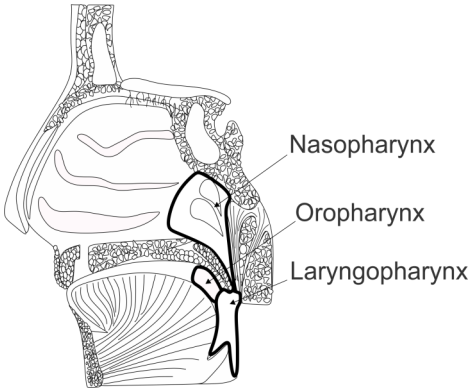




The first system we're going to look at is the respiratory system. The main job of the respiratory system is to bring oxygen into the body and get rid of carbon dioxide our bodies do not need. You know we need air to breathe, but have you ever wondered why? The cells in our body need energy. They get this energy from glucose, which is a simple sugar. But to get the energy out of the glucose, they go through a process called cellular respiration. What do you think is a critical component of cellular respiration? Right. Oxygen. Without oxygen, the cells in our bodies couldn't get the energy they need to keep going.

We get that oxygen from the air we breathe. **Inhalation**, or breathing in, starts with our **diaphragm**, a long muscle in the chest and the abdomen. When it contracts, we inhale, or breathe in, pulling air into our bodies through our nose and mouth. The mouth is the **oral cavity**. The very front of the nose is the **nasal vestibule**. Four groups of sinuses connect to our nasal cavity. You can see two of them in the picture on the right, the frontal sinus and the sphenoid sinus. The nasal cavity's job is to warm, moisten, and filter the air we breathe. Once it is through the nasal cavity, it moves on to the pharynx.

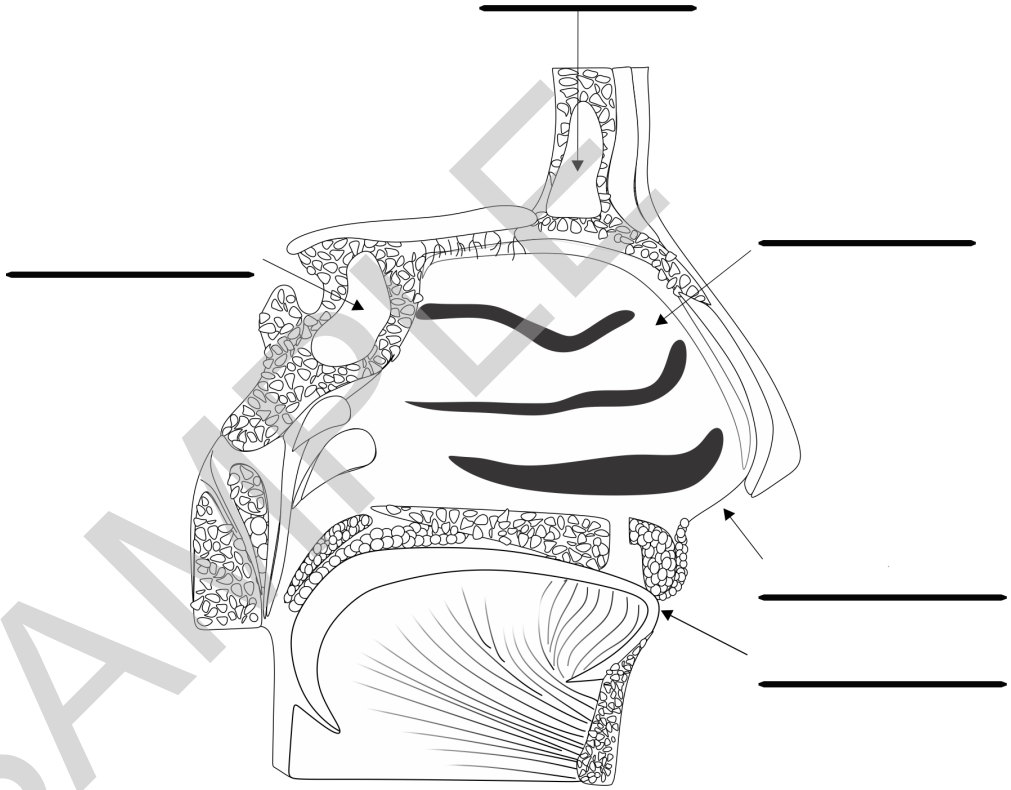


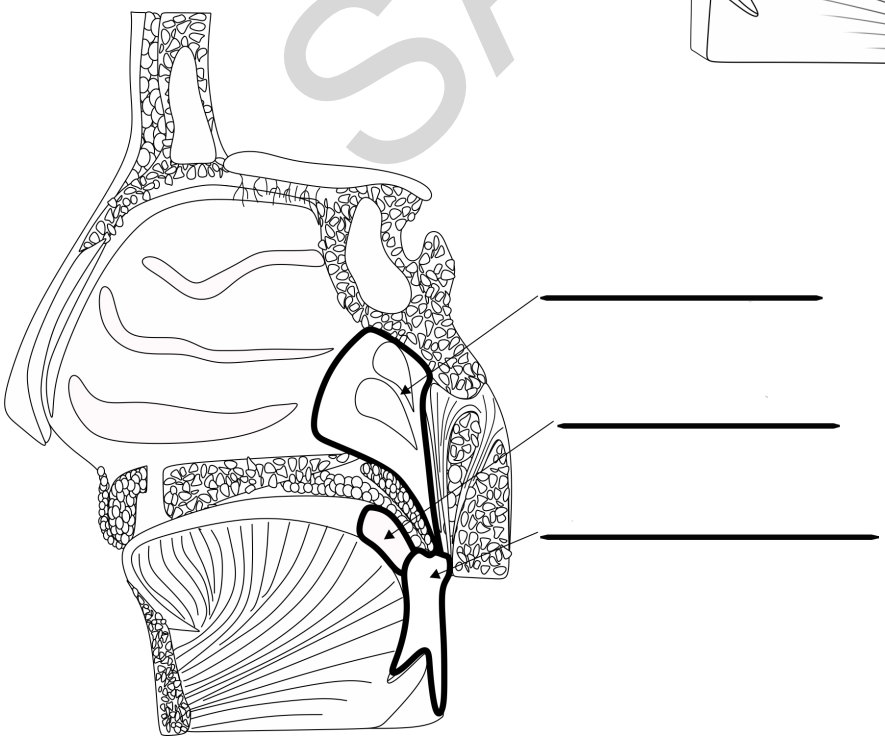


The **pharynx**, which comes from the Greek word for "throat" is a muscular funnel. It's made of muscle and connective tissue. It has three main sections called the nasopharynx, the oropharynx, and the laryngopharynx. Those names sound confusing, but they are not hard to tell apart if you look at what each one connects to.

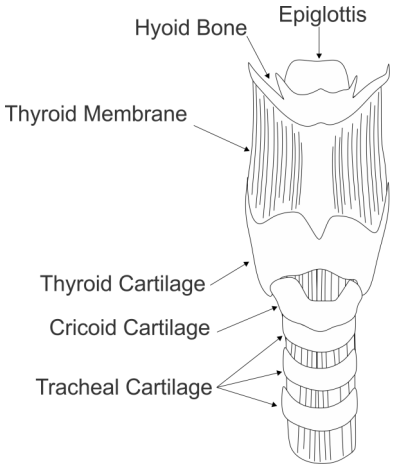
The nasopharynx is the part behind the nose. Since we know the area behind the nose is the nasal cavity, we know the highest part of the pharynx is the *nasopharynx*. The next section of the pharynx begins at the mouth or the *oral cavity*, so the next part of the pharynx is the *oropharynx*. The oropharynx travels down to the epiglottis and *larynx*, which is where the third part of the pharynx gets its name. The *laryngeal pharynx* (or *laryngopharynx)* starts at the epiglottis and goes to the esophagus.

Let's label the parts of the nose, mouth, and pharynx before we move on.





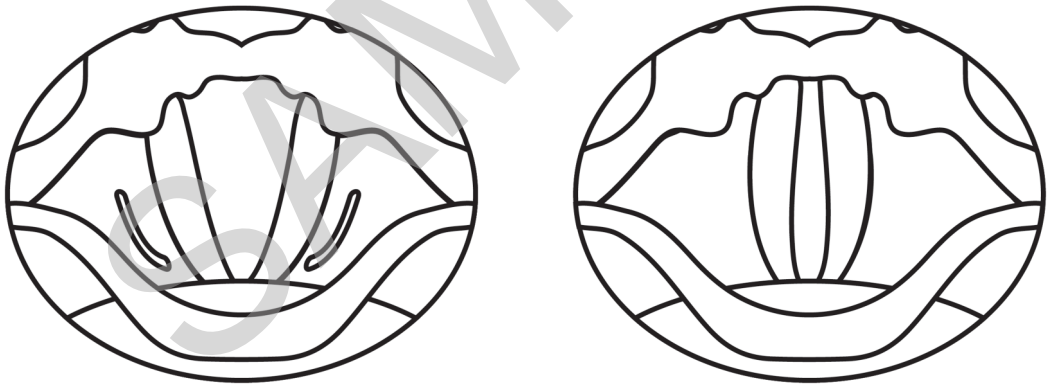
We just mentioned the **epiglottis** and the **larynx**, so let's look at them now in more detail. The epiglottis is at the top of the larynx. It is a flap of cartilage that has the job of "directing traffic." It directs food to the esophagus and keeps it from entering the respiratory tract.

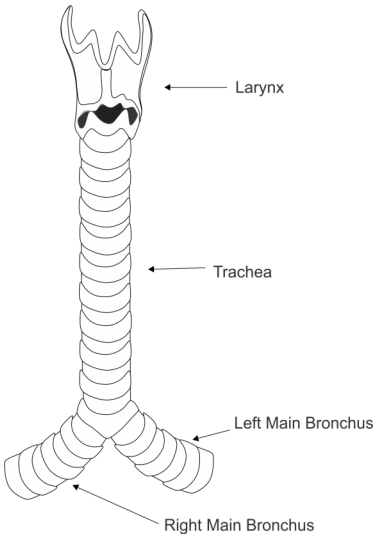


The hyoid bone is a U-shaped bone that serves as an anchor for the tongue. It moves with the larynx and tongue each time you swallow.

The larynx connects the passage between the tongue and the trachea. It houses the vocal cords and is made of nine sections of cartilage. The thyroid membrane connects the hyoid bone to the first set of cartilage, the thyroid cartilage. The thyroid cartilage has two wing-like plates that form the sides of the larynx. Where they meet forms the Adam's apple. Next is a ring-like section of cartilage called cricoid cartilage. The remaining sections of cartilage are called tracheal cartilage because of where the larynx connects to the trachea.

The larynx also houses the vocal cords. These are folds in the mucous membrane that line the larynx. They open for us to breathe and partly close when we talk. The air we breathe out vibrates the vocal cords and produce the sounds we use to speak.

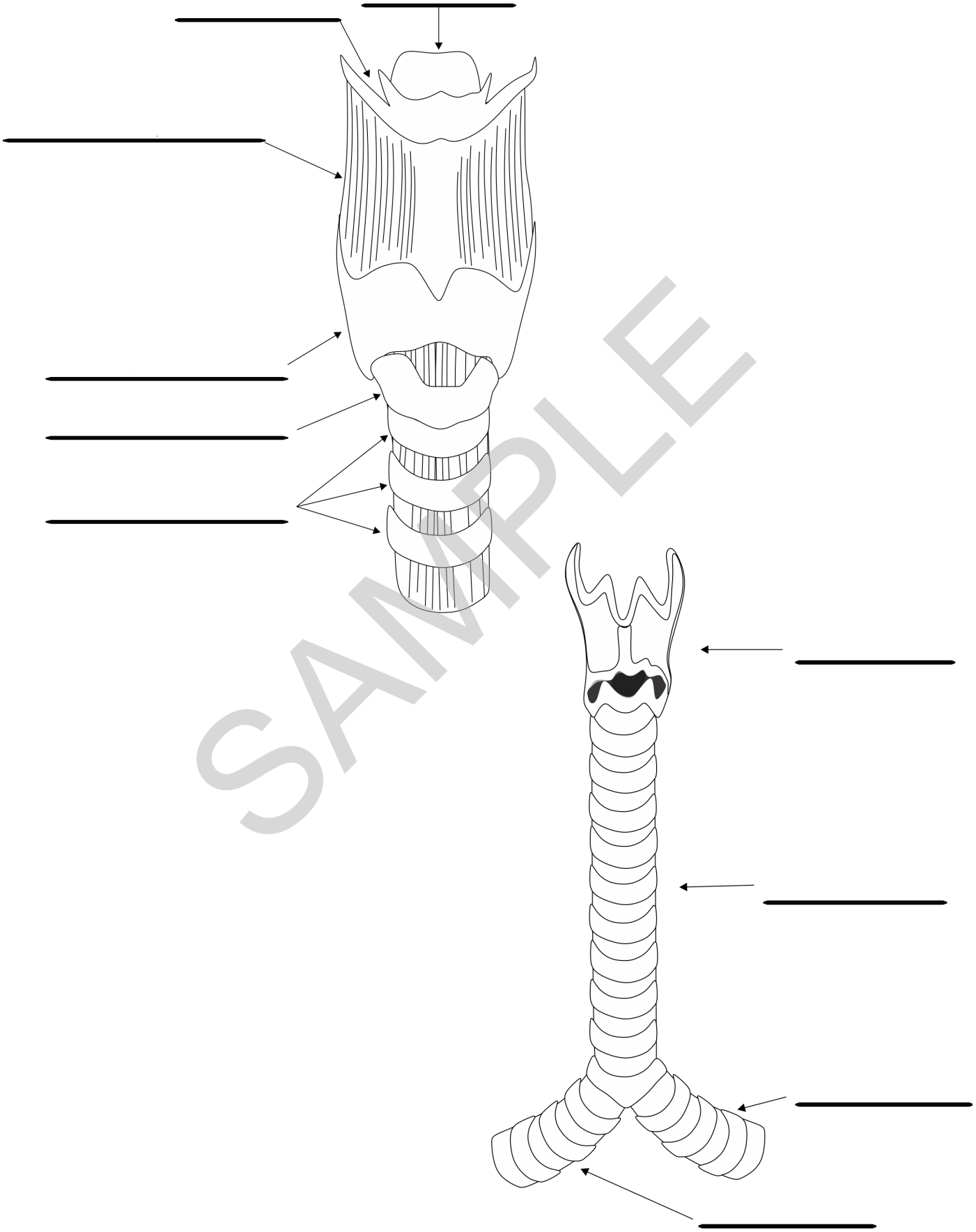




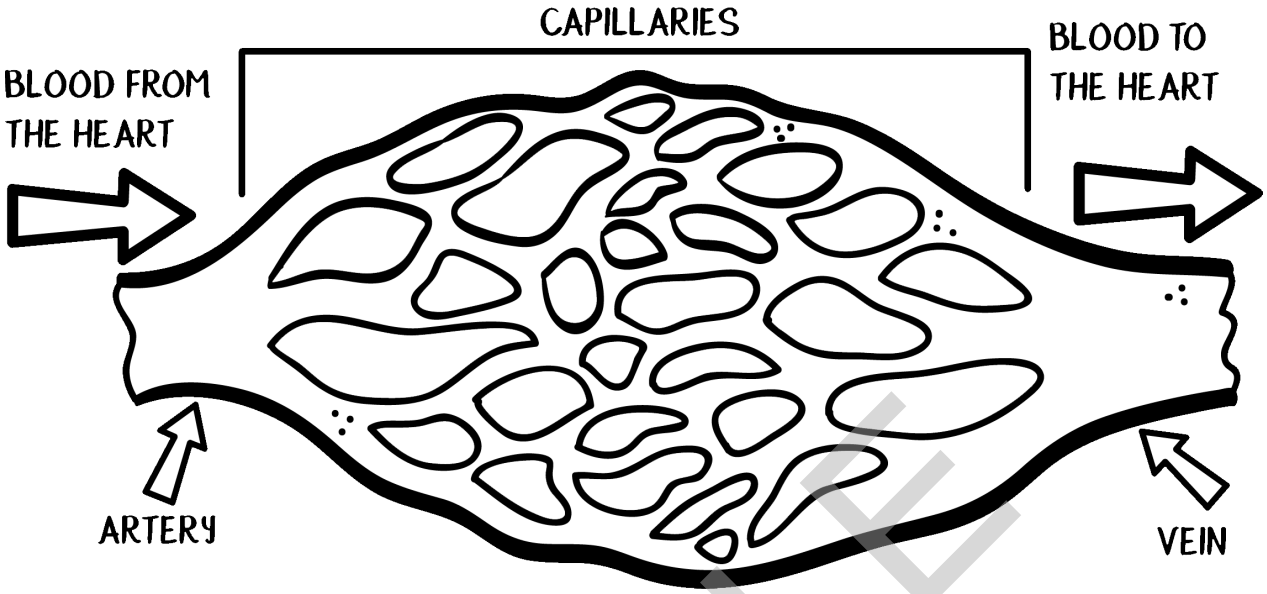
Once air has passed through your larynx, it travels to the **trachea**, which is also called the windpipe. The trachea is about 5 inches (13 centimeters) long and a little less than 1 inch (2.5 centimeters) in diameter in an adult. The trachea is ringed by rows of cartilage that hold it open.

The end of the trachea branches into two **bronchi**, or tubes, that transport the air to our lungs. They are simply called the left main bronchus and the right main bronchus.

Let's label the parts of the larynx and trachea before we move on to the lungs.

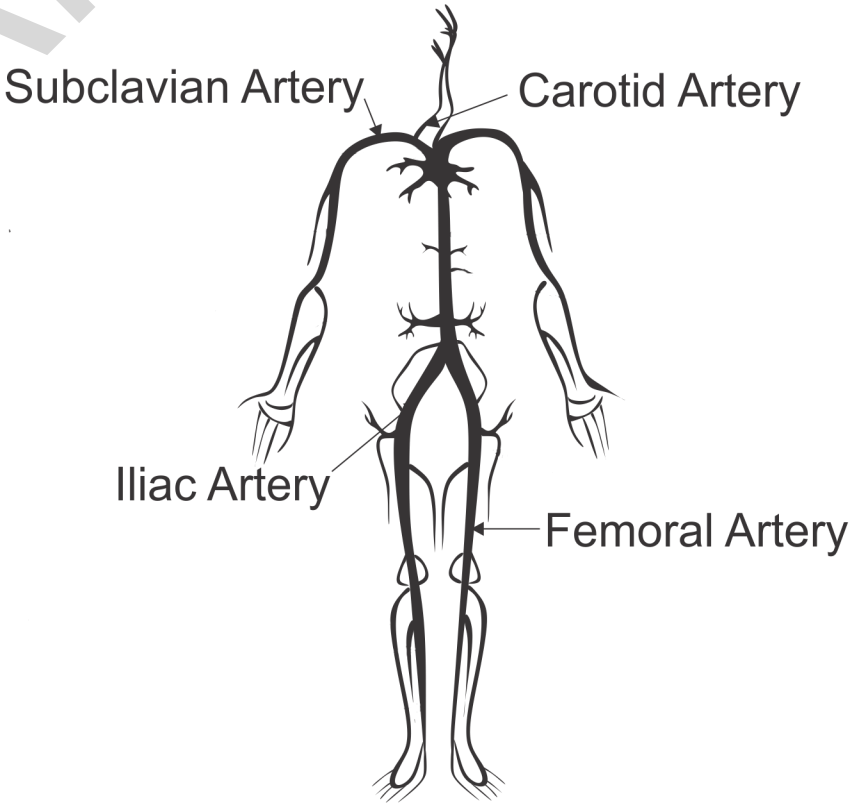


As we've already learned, there are three main types of blood vessels: arteries that carry oxygenated blood, veins that bring the blood back to the heart after it has distributed its oxygen, and **capillaries**.

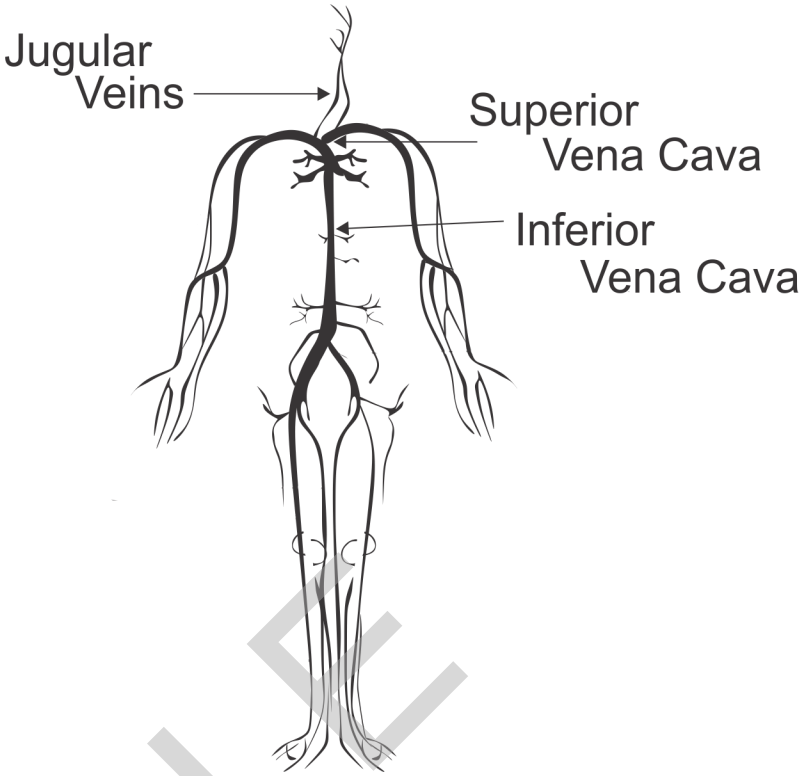


Capillaries are the tiniest blood vessels in our bodies. They connect the veins and arteries, allowing the blood cells to travel through them, though many are so small that the blood cells can only fit through one at a time. They also have thin walls, allowing nutrients to flow through them into the tissues and allowing waste tissue to travel into the blood for disposal.

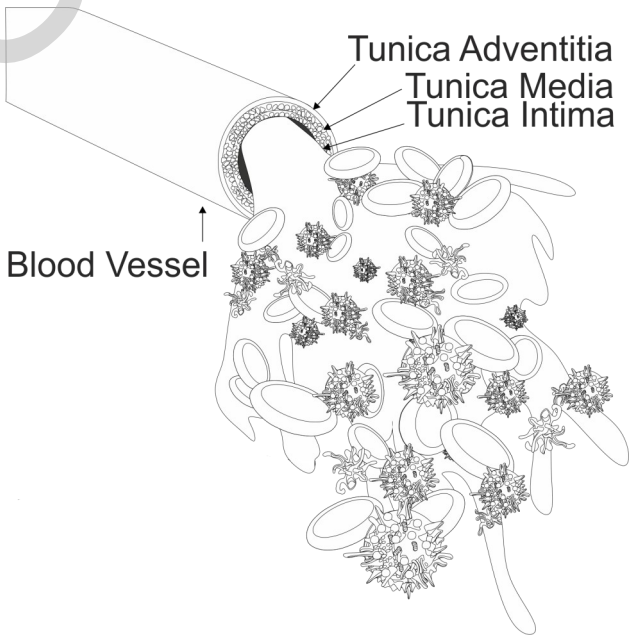
The largest artery in your body is the aorta, which we looked at when we studied the heart. Arteries run through your body, but a few of the most important are the carotid arteries, which carry blood to the head and neck; the subclavian arteries, which carry blood to the shoulders and arms; the iliac arteries, which go through the abdominal area and takes blood to the organs in the pelvis; and the femoral arteries, which carry blood through your legs.



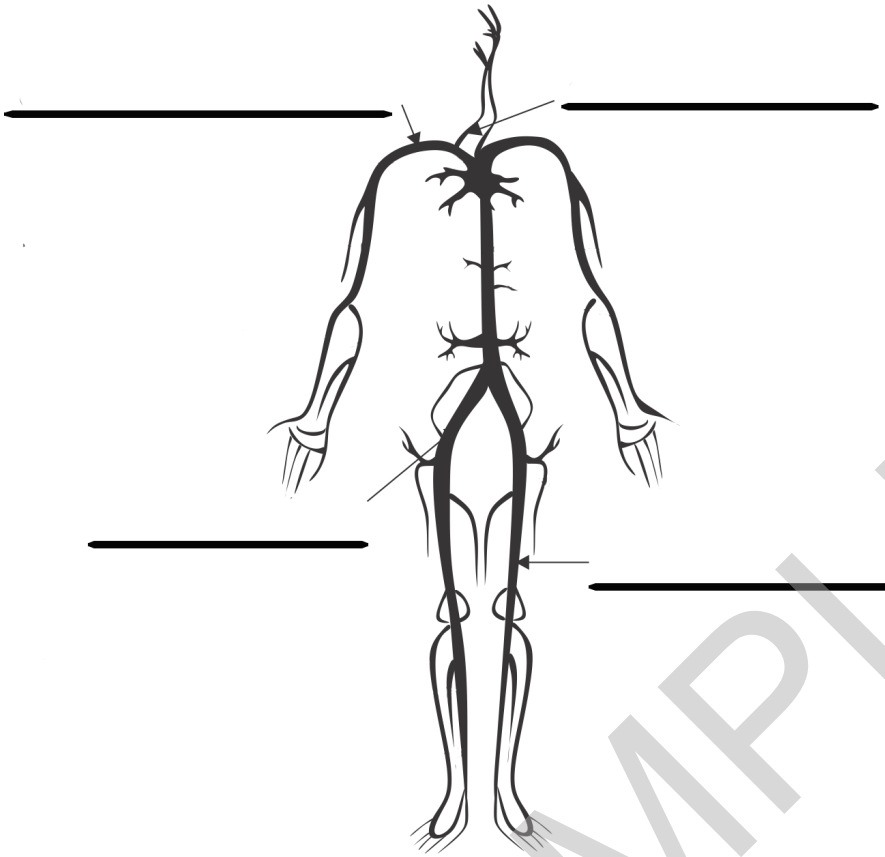
Veins, like arteries, run throughout your body, often running parallel to the arteries. Their destination is always the heart. The superior vena cava carries blood from your head and arms. The inferior vena cava carries it from your legs and trunk (the section of your body in the center, without the head, arms, and legs). The jugular veins carry blood from your brain, face, and neck.

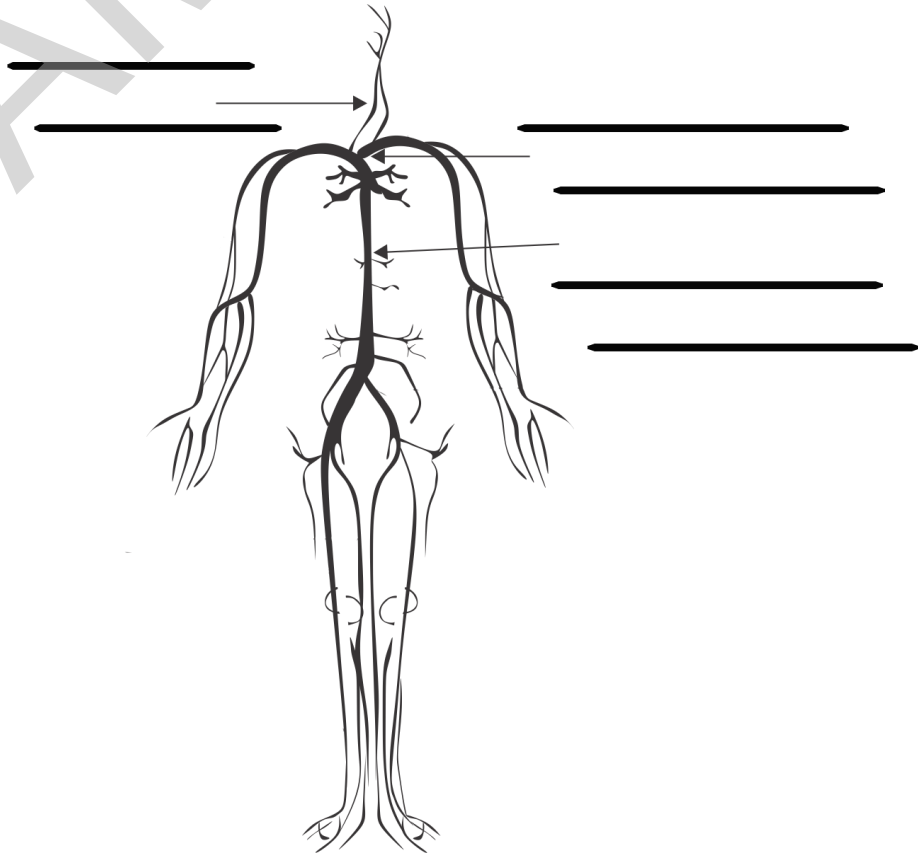


Both the arteries and veins are made of layers. The outermost layer, the tunica adventitia, is made of elastic fibers that expand to allow the blood to travel through. They also contract, pushing the blood further along. This helps the heart not to have to work as hard because the blood vessels themselves are helping to keep the blood moving. The middle layer is made of smooth muscle cells and additional elastic fibers, and it is called the tunica media. The innermost layer, the tunica intima is made of connective tissue and more elastic fibers. To help remember the names, remember that "tunica" is from the Latin word that means "tunic" or "coat." Each tunica is a layer or coat. "Media" means "middle" in Latin, and "intima" means "inmost." "Adventitia" is harder, but it means "arrived from afar" or "foreign."



Before we look at what our blood is made of, let's review the major arteries (the top picture) and veins (the bottom picture) and their layers.





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.

System: _____

Epithelial tissue: _____

_____

Connective tissue: _____

_____

Muscle tissue: _____

Nervous tissue: _____

Inhalation: _____

Diaphragm: _____

Oral cavity: _____

Nasal vestibule: _____

Pharynx: _____

Epiglottis: _____

_____

Larynx: _____

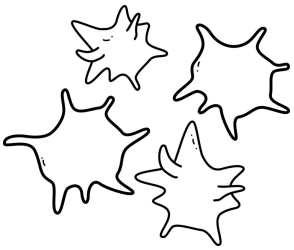
_____

Trachea: _____

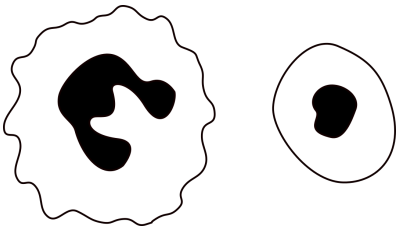
Bronchi: _____

Alveoli: _____

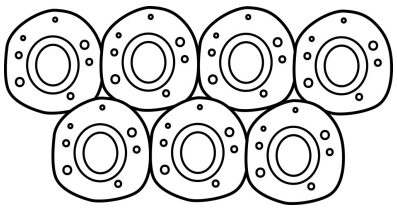
Which of the following is not a type of blood cell? Draw an X through it.



Platelet

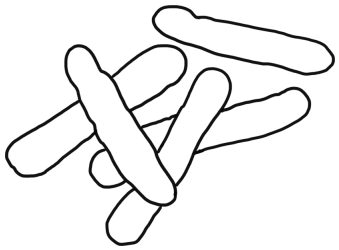


Leukocyte

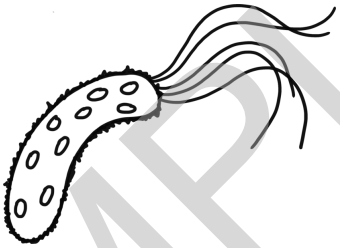


Hepatocyte

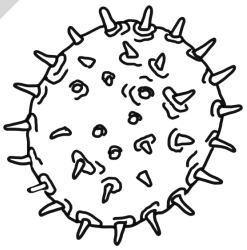
Which of the following viruses or bacteria is responsible for chickenpox? Draw a circle around it.



Tubercle bacilli



Vibrio cholerae



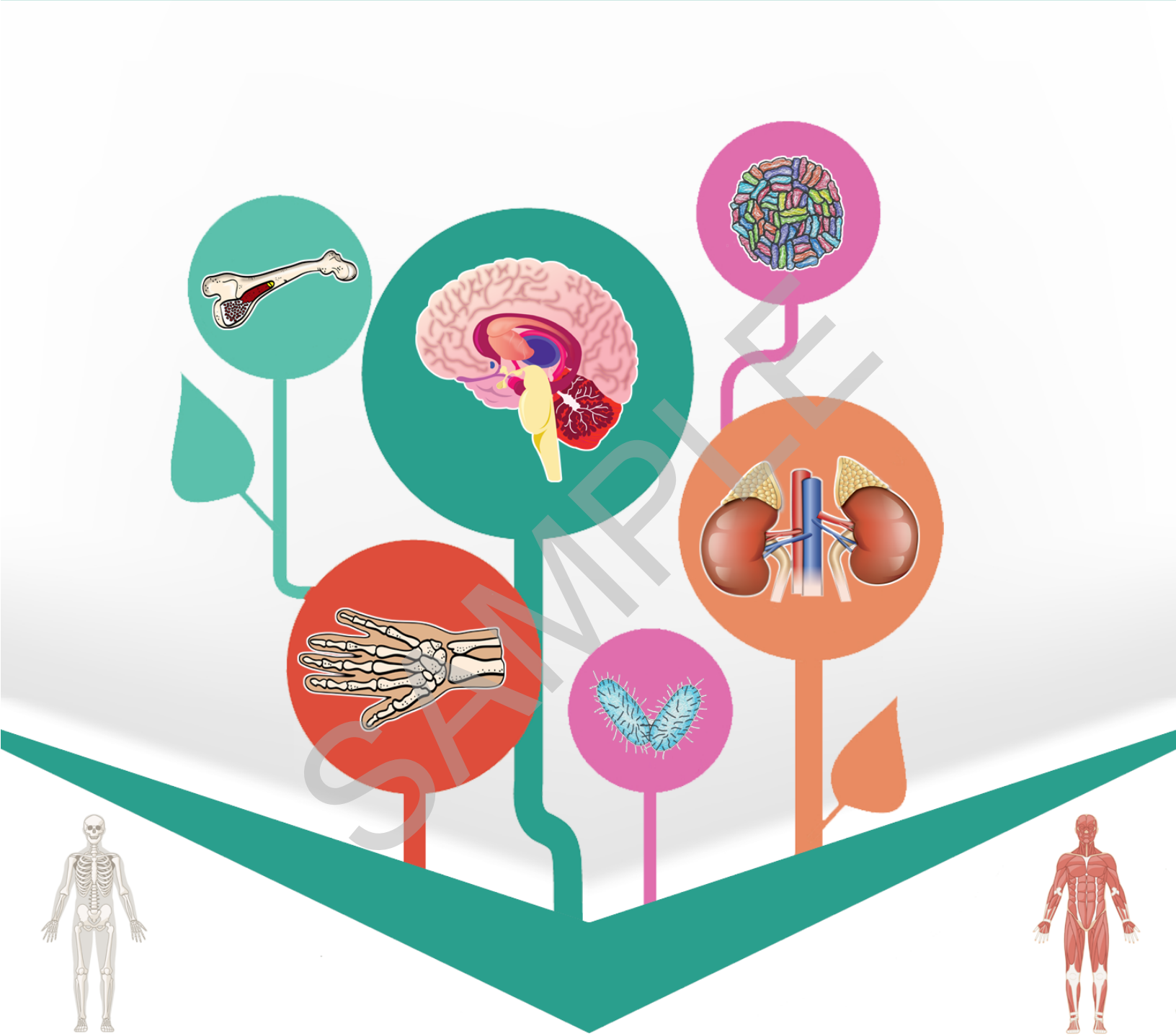
Varicella-zoster virus

Name six of the major parts of the digestive system:

Describe the three different degrees of burns we discussed.

_____

Life Science
Level 5



Human Anatomy & Diseases, Pt. 2

Skeletal, Muscular, Endocrine, Immune & Lymphatic, and Nervous Systems

By Bonnie Rose Hudson

Write Bonnie Rose

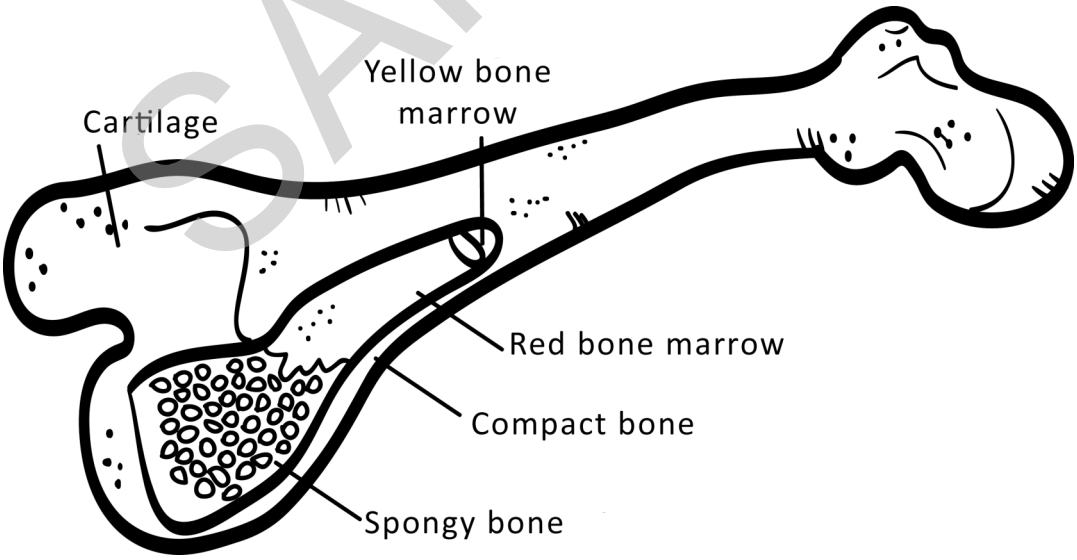
Human Anatomy and Diseases, Pt. 2

It's hard to imagine how many different pieces our bodies are made of. More than 10 trillion cells work together to form tissues, organs, and systems. We're going to look at several systems in this unit, and we're going to start with two we think of when we think about moving—the skeletal system and the muscular system. As we look at each system, we'll also look at some of the diseases and things that can go wrong in each one.

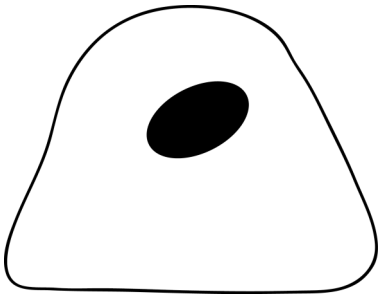
The first system we'll look at is the skeletal system. Not only does it include more than 200 bones, it also includes joints, ligaments, and cartilage that all work together to give your body structure.

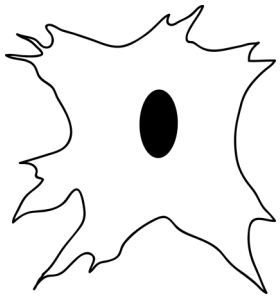
Just like the rest of your body, bones are made of smaller parts. Most bones have a layer of **compact bone** (also called cortical bone) on the outside and **spongy bone** (also called cancellous or trabecular bone) beneath it. The spongy bone transfers the weight from the ends of the bones to the center. At the end of a type of bones called long bones, you'll find cartilage, which is a smooth tissue.

Most bones also have bone marrow inside. **Red bone marrow** is responsible for making blood cells. **Yellow blood marrow** is mostly made of fat.

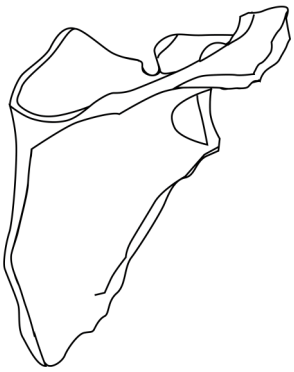


Bone tissues have special cells that help the bone with its many functions. Your bones are made of minerals and also organic material such as **collagen**. Collagen is a fiber-like protein. Osteoblasts (below on the left) help build the collagen and deposit the minerals. Osteocytes (below in the middle) help balance the minerals in your body and help whenever there is stress on your bones from physical activity. Osteoclasts (below on the right) help with growth and healing.



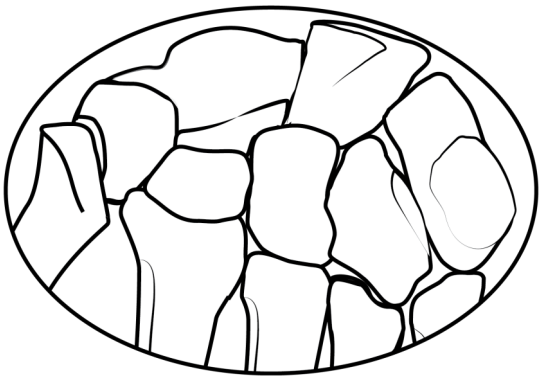


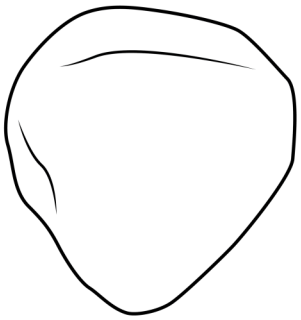
There are five different types of bones in your body because different bones have different jobs to do. Flat bones, like the one on the right, work as shields to protect internal organs. You find them in places like the skull, rib cage, and pelvis.



Long bones are designed to support weight and help you move. They include bones that make up most of the length of our arms and legs as well as bones in the fingers and other places.

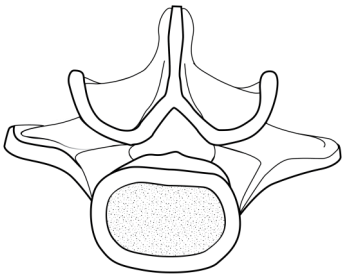
Short bones are found in our wrists and ankles. They are about the same distance long as they are wide. They help stabilize these busy parts of our bodies and allow for movement.





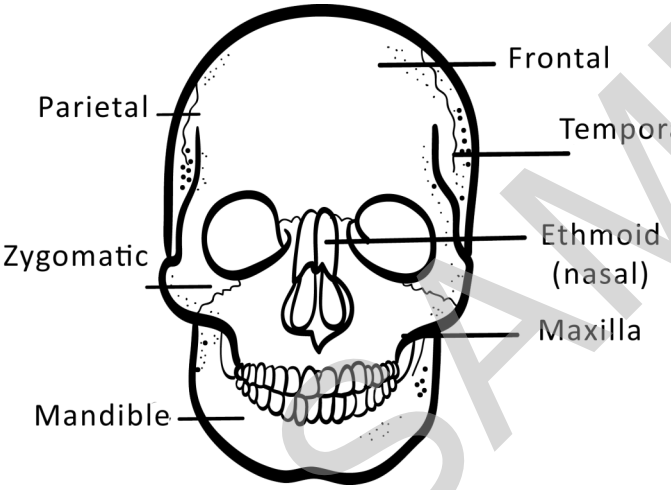
Sesamoid bones are found in tendons and help protect the tendons. The kneecap is a great example of a sesamoid bone.

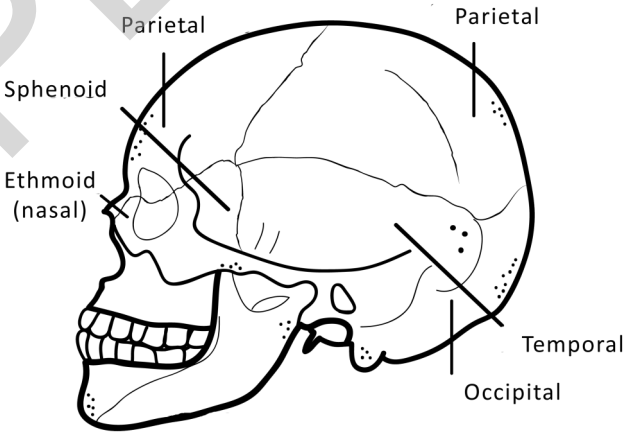
There is also a group of irregular bones that don't fit any of the other categories but each have a special shape based on the job they need to do.



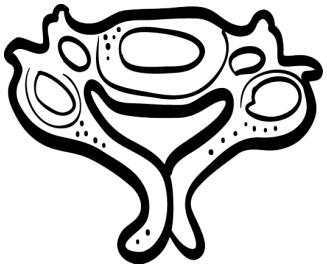
Now let's look closer at some specific bones throughout our bodies. We'll start at the top with our skulls. We have eight bones that have the job of protecting our brains. Those are the occipital, sphenoid, frontal, ethmoid, two temporal bones, and two parietal bones. Together, these bones are called **cranial bones**. The frontal bone is at our forehead, and the occipital is at the back of our skull.

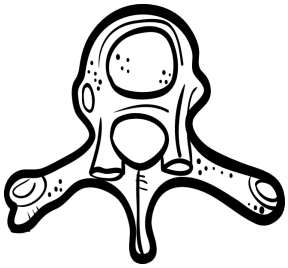
Our faces are made of fourteen bones. We won't diagram them all here, but it's interesting to know that of all the bones in our skull, only one can move. That's the **mandible**, our lower jaw. And it's a good thing it can move, or eating would definitely be a problem! The zygomatic bone is our cheekbone, and the maxilla is part of our jaw. The ethmoid bone is part of our nose.



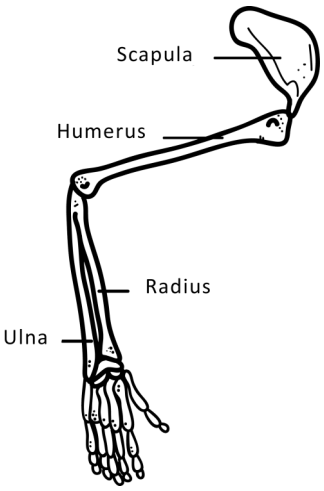


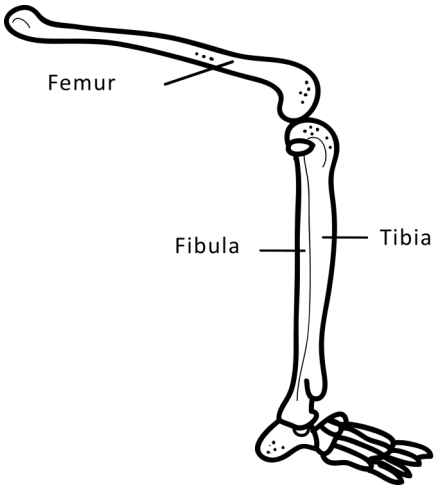
Your backbone has 33 vertebrae in it, though some join together in adults. These bones protect your spinal cord. There are different types of vertebrae, and they differ in size depending on where they are in the backbone. Seven cervical vertebrae (below on left) make up the first section of your backbone. Beneath that are twelve thoracic vertebrae (below on right) that reach to the top of your lower back.





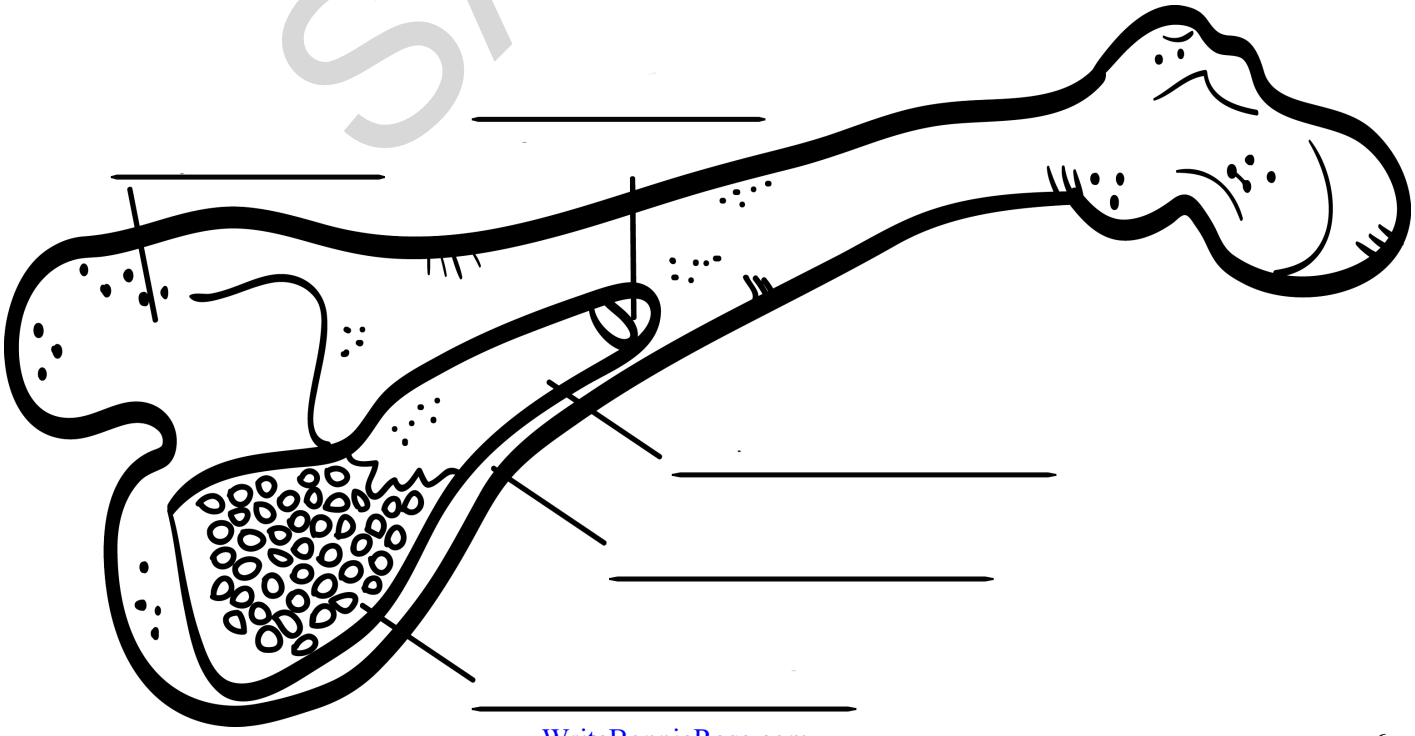
Each of our arms have four major bones. The scapula is the shoulder blade. The humerus is the bone of our upper arm. Technically, the humerus is the only bone in our arm because the arm is officially just the part between the shoulder and the elbow. Beneath that is the forearm, which is made of two bones, the radius and the ulna. If you hold your palm facing up, the ulna is the bone on the inside of your arm, nearest your little finger. The outside bone is the radius.

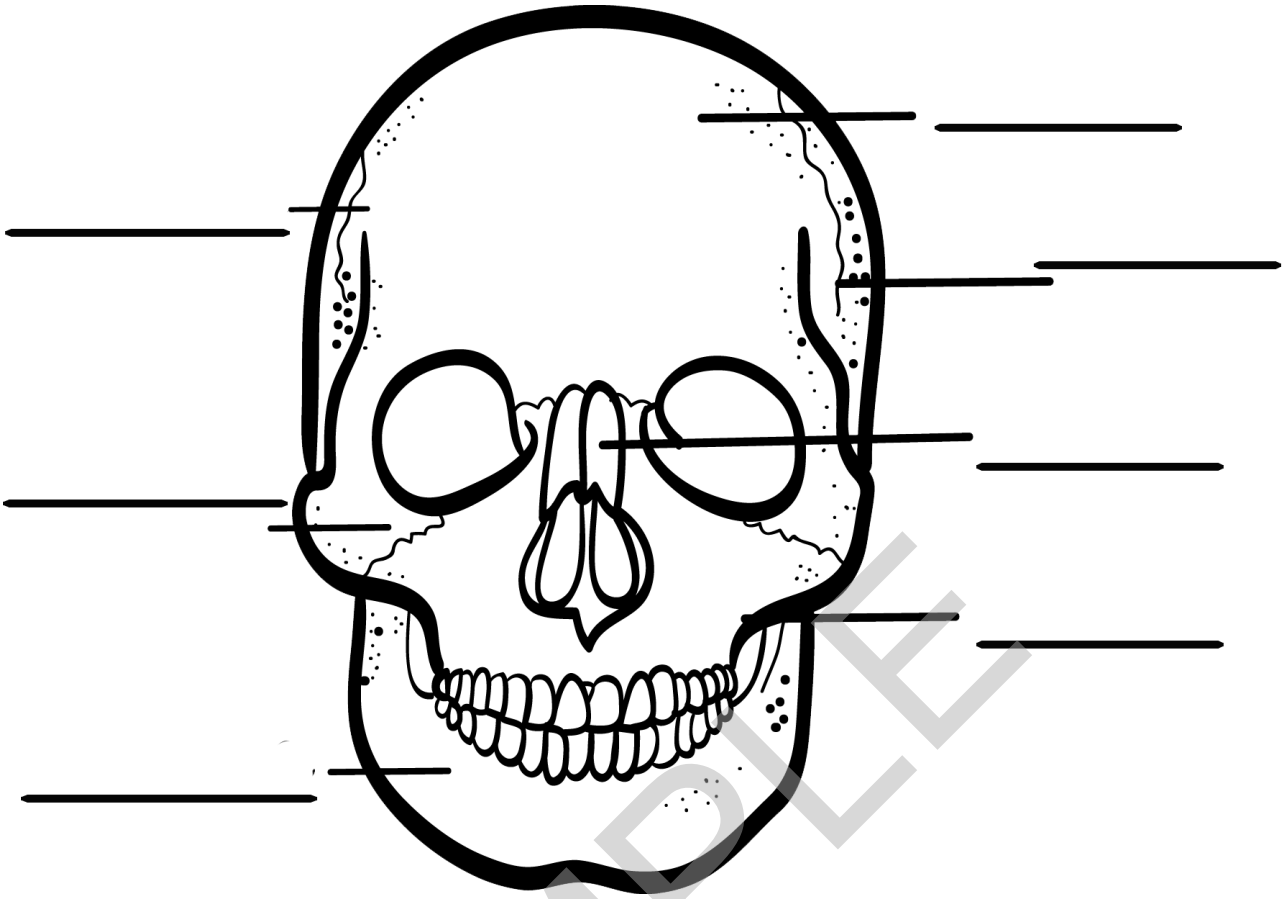


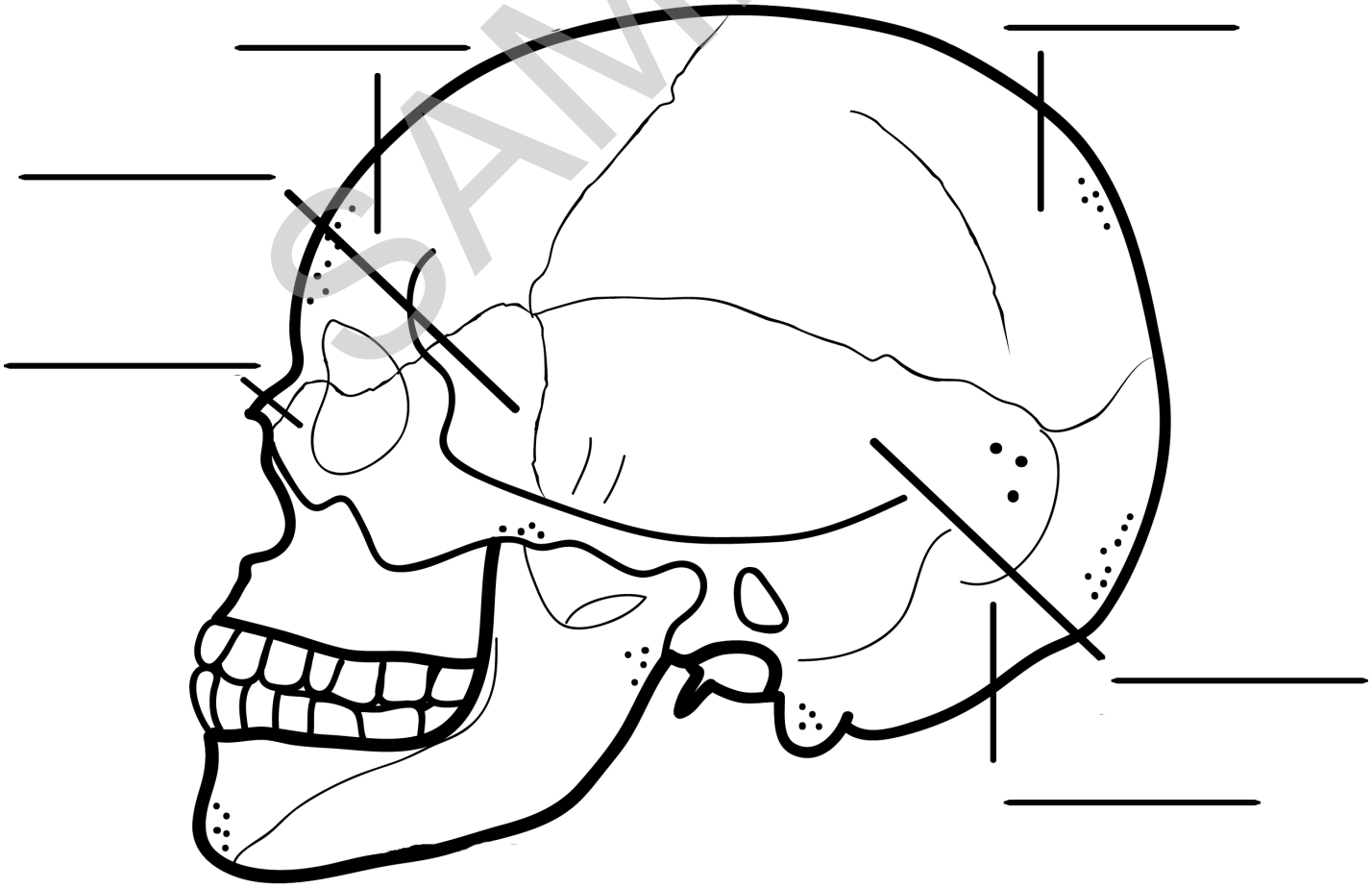


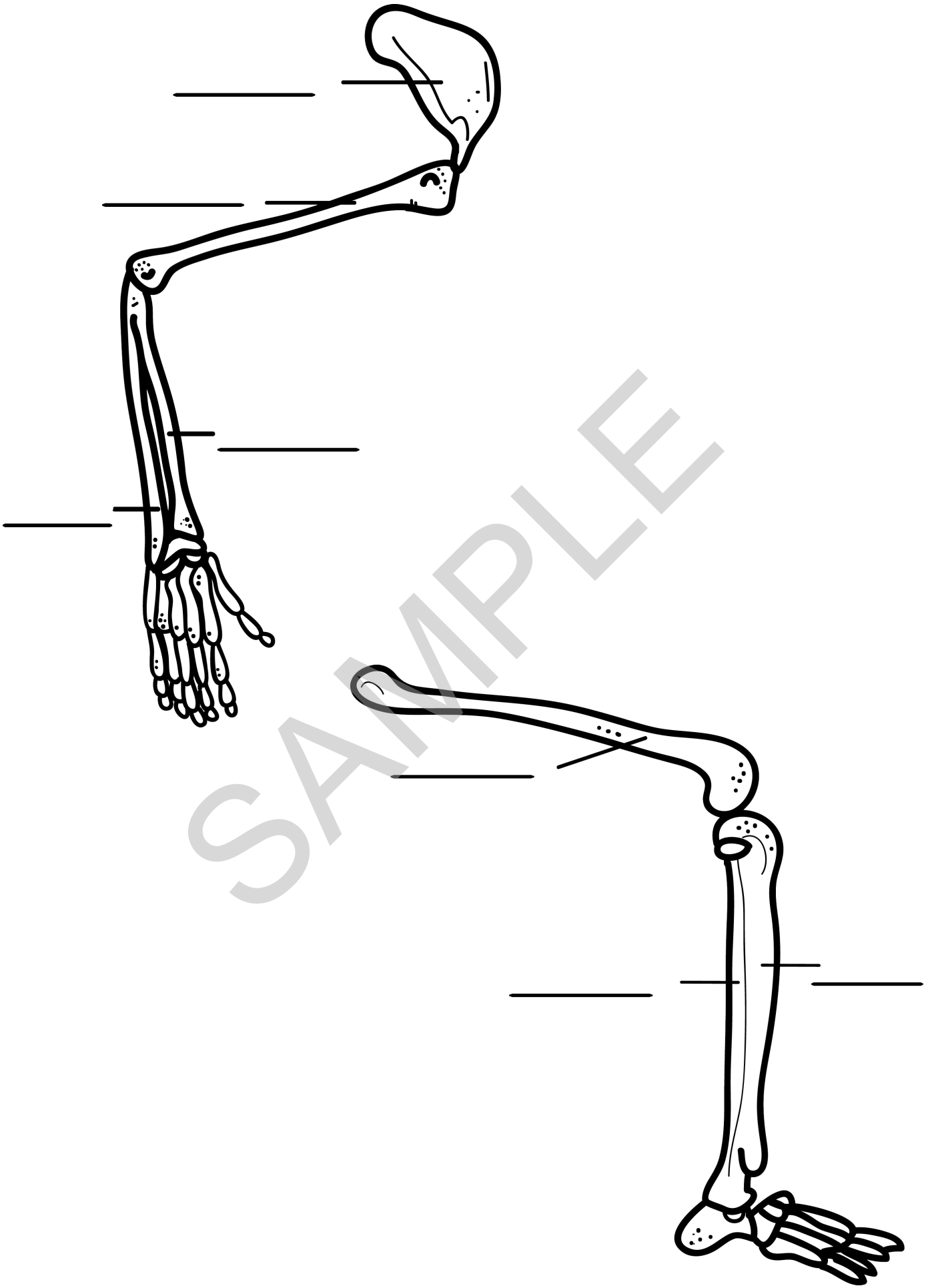
The leg is technically the section between the ankle and the knee. The section between the knee and hip is the thigh, though we often just call both together the leg. The thigh consists of the **femur** bone. The femur is the longest bone in the entire body. The tibia and fibula make up the bones of the leg. The tibia is also called the shinbone and can be felt at the front of the leg. You can feel your fibula at the side of your leg.

Before we take a closer look at the bones of our hands and feet, let's review the parts of bones and the names of the bones we've learned so far.









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.

Compact bone: _____

Spongy bone: _____

_____

Red bone marrow: _____

Yellow bone marrow: _____

Collagen: _____

Cranial bones: _____

_____

Mandible: _____

Femur: _____

Opposable thumbs: _____

Carpals: _____

Metacarpals: _____

Phalanges: _____

Tarsals: _____

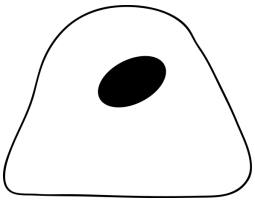
Metatarsals: _____

Clavicle: _____

Patella: _____

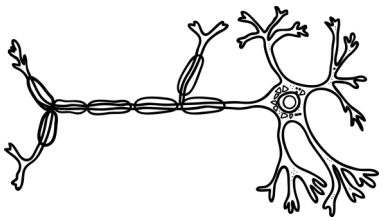
Simple fracture: _____

Which of the following is not a type of bone cell? Draw an X through it.



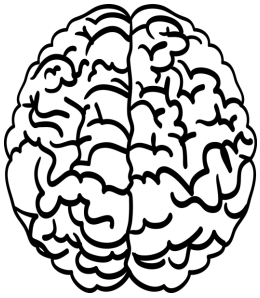
Osteoblast

Osteoclast

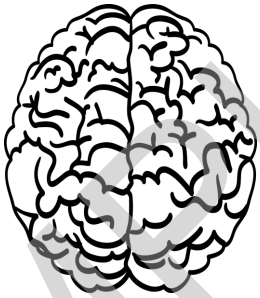


Neuron

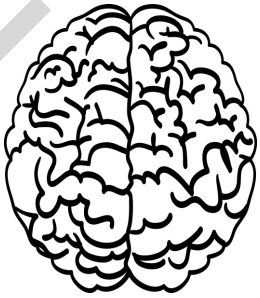
Which of the following is the largest part of the brain? Draw a circle around it.



Cerebrum



Hypothalamus



Cerebellum

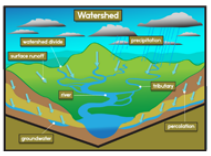
Name four ways your body tries to prevent becoming infected with a virus or bacteria:

Name three of the seven types of bone fractures we discussed.

_____

Earth Science
Level 5

Earth's Cycles and Systems



By Bonnie Rose Hudson

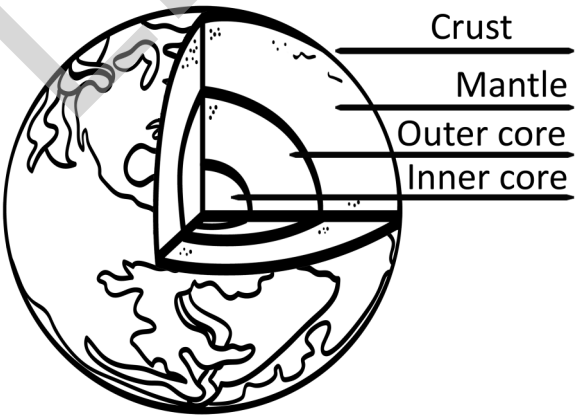
Write Bonnie Rose

Earth's Cycles and Systems

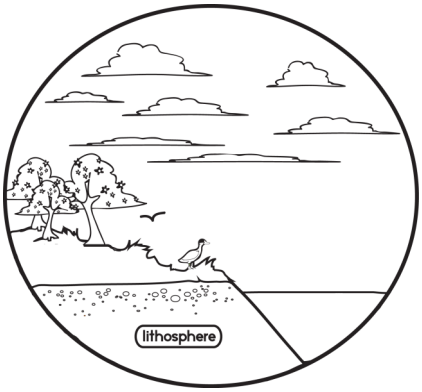
Everywhere around us, there are cycles happening that we can't see. We breathe oxygen in and breathe carbon dioxide out. Plants use the carbon dioxide in photosynthesis. Larger animals feed on smaller animals. Changes deep beneath the surface of the earth produce earthquakes and volcanoes on the surface. So many things are working together in incredible ways that we don't normally notice. We're going to take a look at a few of those important cycles, but in order to better understand them, we need to first look at some of the systems our world is made up of.

A **system** is just a group of things that are working together like a whole unit. The organs of your respiratory system work together in a system, just like the organs of your digestive system work together. Scientists divide the world around us into systems, too. The four main spheres are the lithosphere, biosphere, hydrosphere, and atmosphere. These spheres are systems that work together

To understand what the lithosphere is, we need to quickly review the layers of the earth. The first layer of the earth is the **crust**. It includes the dry land that makes up the continental crust and the ocean floor, the oceanic crust. The crust is thought to be between 5 to 25 miles (8 to 40 kilometers) thick. The deepest place in the ocean ever discovered—the Mariana Trench—is only 35,840 feet (10,924 meters) deep. That's less than 7 miles (11 kilometers).

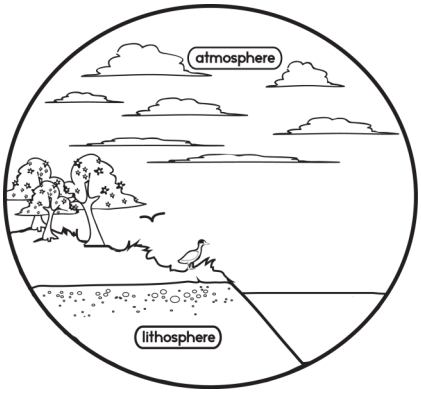


The next layer of the earth is called the **mantle**. The mantle is made of rock, but it's a little bit different. The very top of the mantle is hard rock, but there is so much heat and pressure on the rock in the rest of the mantle that the rock isn't solid or hard, like we usually think of rock. This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



The **lithosphere** is the crust of the earth and the hard top part of the mantle. The final two layers of the earth are the outer core and inner core. The outer core is liquid iron, and scientists think this layer is about 1,400 miles (2,250 kilometers) thick. The very heart of the earth, the deepest layer, is called the inner core. Scientists think this layer is made of nickel and iron that form an extremely hard ball.

We've studied the ground beneath our feet, so let's study the sphere above us, the **atmosphere**. The atmosphere can be divided into five layers. The higher the altitude, the thinner the air is.



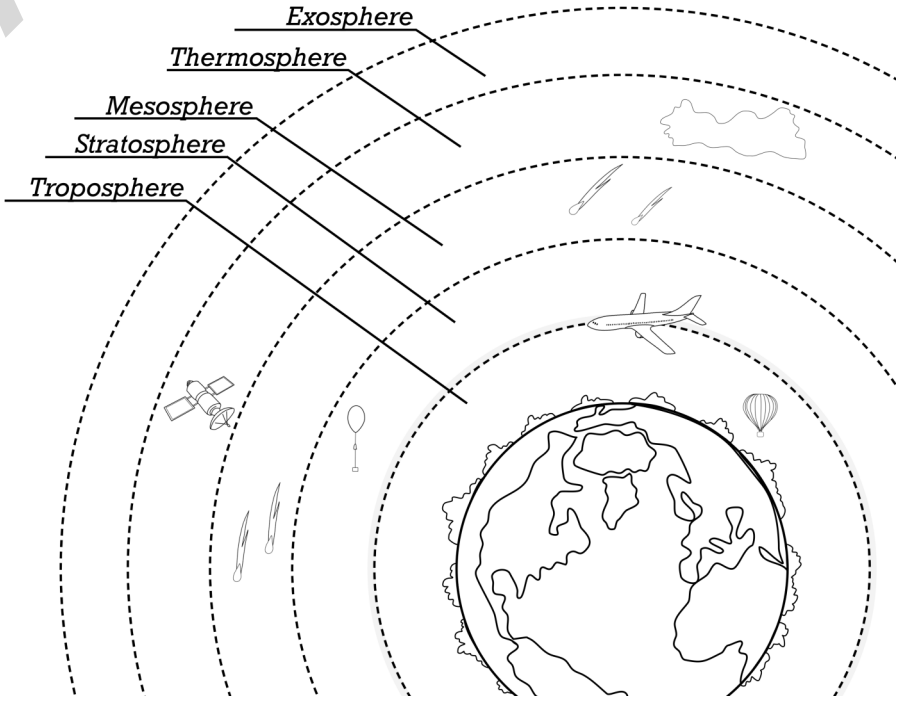
The **troposphere** is the layer closest to the ground. This is where almost all of our weather happens as the air is heated by the sun, rises, cools, and sinks again. The troposphere is also the level where hot air balloons travel.

The next layer is the **stratosphere**. This layer is home to many larger jets as well as weather balloons. Though there is wind, there are not generally large storms, making it a good place for the jets to fly. The **ozone layer**, where ultraviolet light from the sun reacts with oxygen to form ozone, lies in the upper stratosphere. The ozone layer protects Earth from much of the dangerous ultraviolet rays.

The **mesosphere** is the next layer, and it is the coldest layer of the atmosphere. The ozone layer beneath it keeps heat closer to earth, but it isn't close enough to the sun to pick up enough heat to warm it up. The is the layer where meteors generally break up as they pass through the atmosphere.

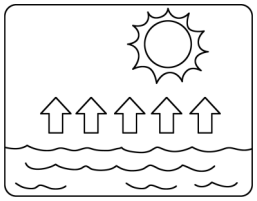
The next layer is sometimes considered the last layer of atmosphere because this is the last layer that has air, though the air is extremely thin. The air in the **thermosphere** warms up as it soaks up radiation from the sun. This is also the layer where space shuttles and satellites orbit. It is home to the **auroras**, incredible displays of light that we see as the magnetic field around the earth interacts with the solar wind from the sun and deflects it.

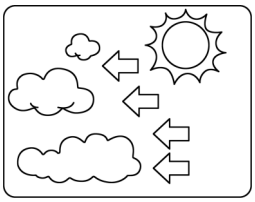
The final layer is the **exosphere**, and this is the layer where what is left in our atmosphere fades into outer space.



Now let's look at some of the interactions that happen between systems. Some involve living things and some involve nonliving things. We'll start by looking at the water cycle, which is also called the **hydrologic cycle**. I'm sure you've studied it before, but let's quickly review the major parts so we can dig deeper into what happens to the water once it hits the ground.

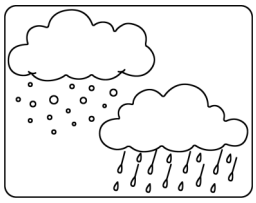
The first step is evaporation. The sun heats the earth, warming the water in the ocean. The water evaporates as water vapor into the air.

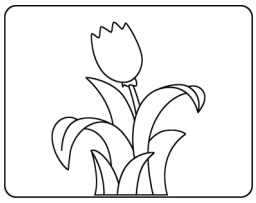




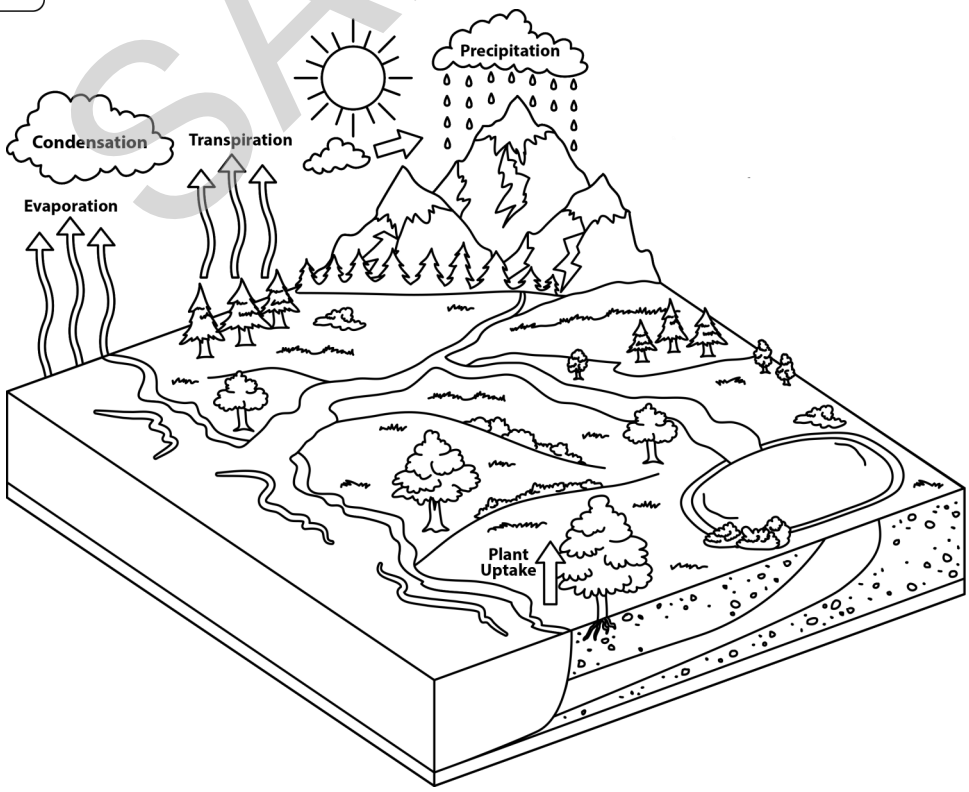
As the water vapor rises into the air, it cools and turns back into drops of water. Those drops of water come together to form clouds. The process of water vapor cooling and turning into drops of water is called **condensation**. You can see it when you set a cold can of soda out of the refrigerator.

Once enough water droplets accumulate in clouds, it comes back down to earth as precipitation. It can come down as rain, sleet (pieces of ice), hail (larger pieces of ice), or snow (ice crystals).

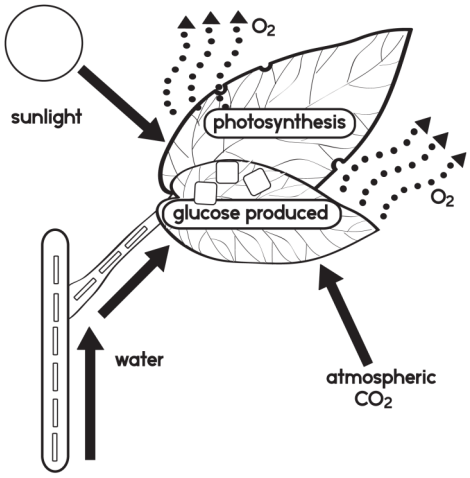




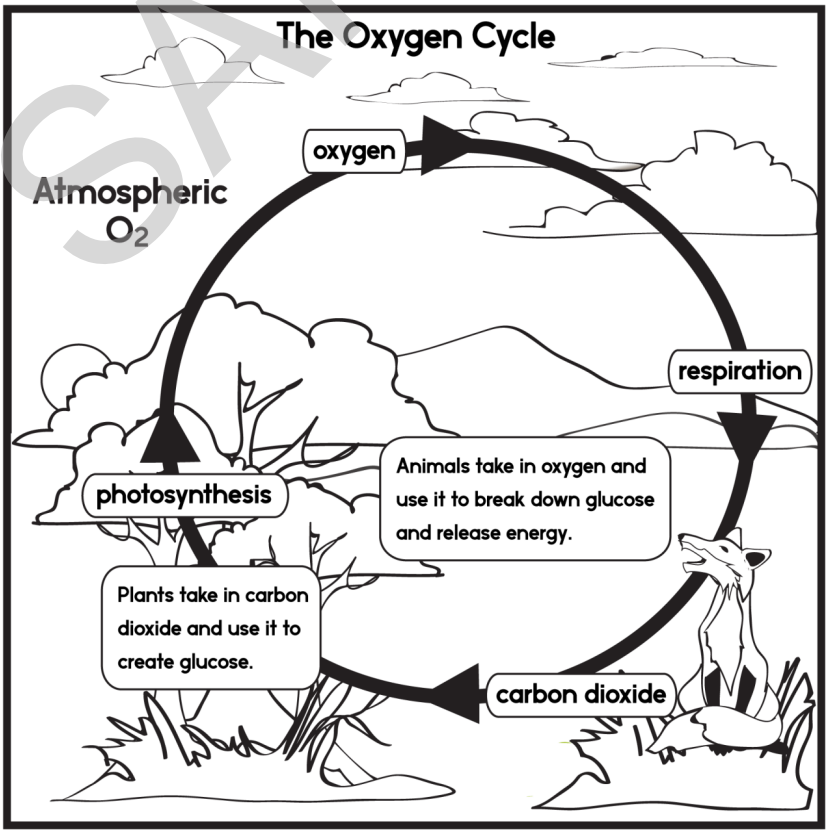
Some of the precipitation that falls will eventually be absorbed by plants. Plants give water vapor back into the air through the process of transpiration. The water vapor then starts collecting in clouds again.



Now that we've explored the water cycle, let's look at the oxygen cycle. Just like water never stays in one place forever, neither does oxygen. People breathe in the air, which contains oxygen. Our lungs and respiratory system process that air, pulling out the oxygen our bodies need to survive. Getting and using oxygen is called **respiration**. Our cells use oxygen to break down the food we eat, which includes glucose that we get from many different plants and animals. We breathe out carbon dioxide. Many animals use similar processes. They breathe air in and use the oxygen to fuel their cells and process the food they've eaten.



Plants take carbon dioxide in out of the air. Through photosynthesis, they use the carbon dioxide, water, and sunlight to produce glucose and give off oxygen into the atmosphere. The oxygen is then available for people or animals to breathe again. The glucose in the plants will give energy to people and animals when we eat them.



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.

System: _____

Crust: _____

_____

Mantle: _____

Asthenosphere: _____

Lithosphere: _____

Atmosphere: _____

Troposphere: _____

_____

Stratosphere: _____

_____

Ozone layer: _____

Mesosphere: _____

_____

Thermosphere: _____

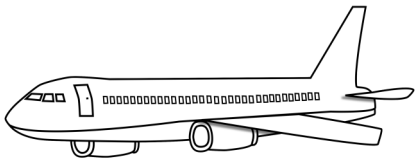
_____

Auroras: _____

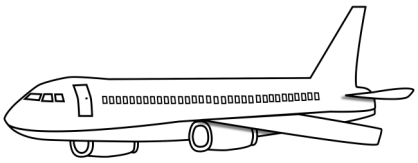
_____

Exosphere: _____

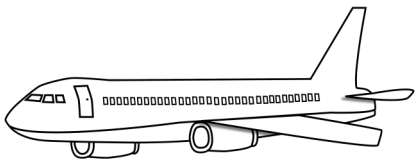
Which layer of the atmosphere is home to many jets? Draw a circle around it.



Stratosphere

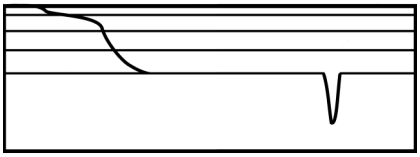


Mesosphere



Exosphere

Which layer of the ocean includes the surface? Draw a circle around it.



Midnight

Abyssal

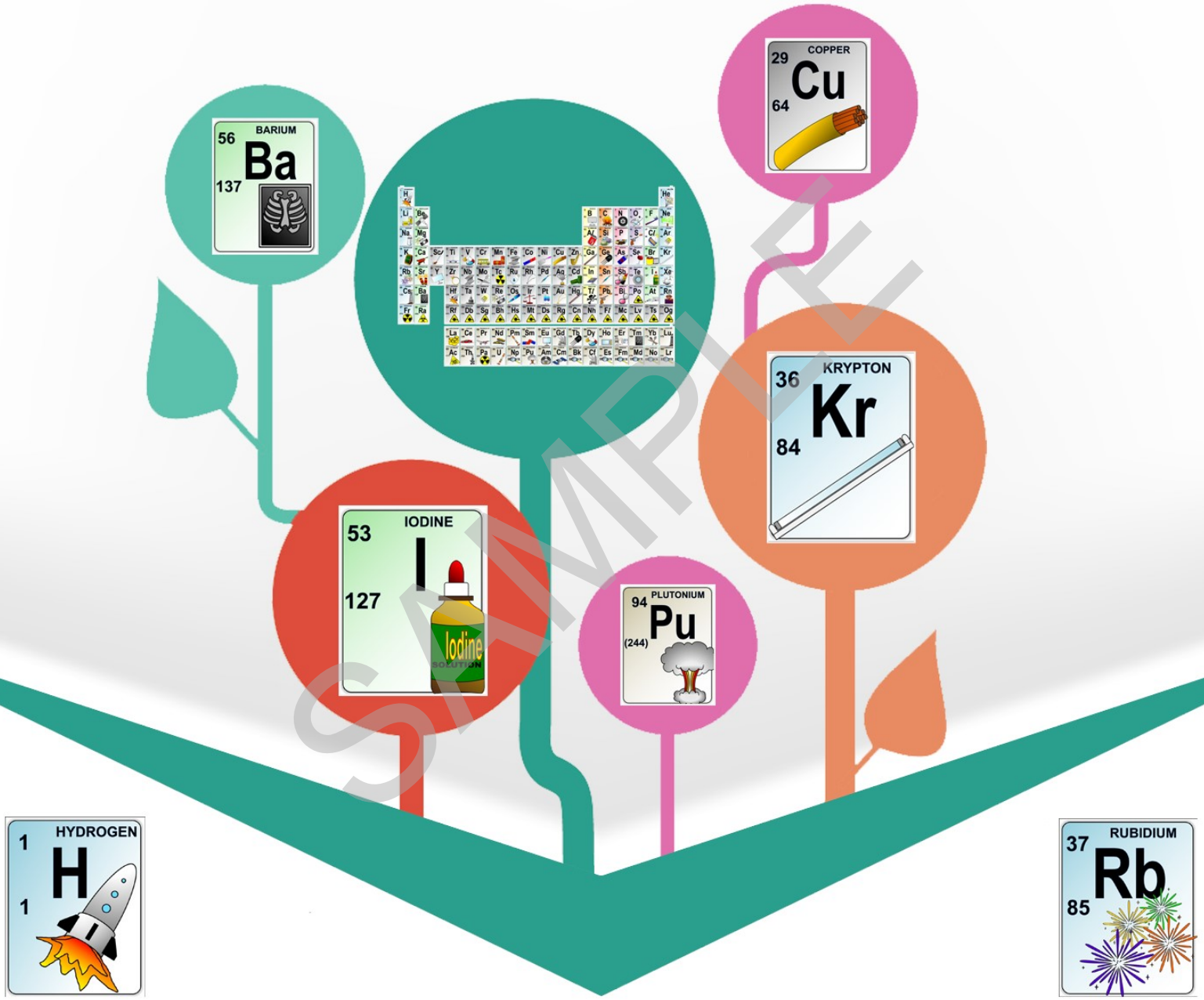
Sunlight

Name six of the parts of the water cycle:

What two methods of nitrogen fixation did we discuss?

_____

Physical Science
Level 5



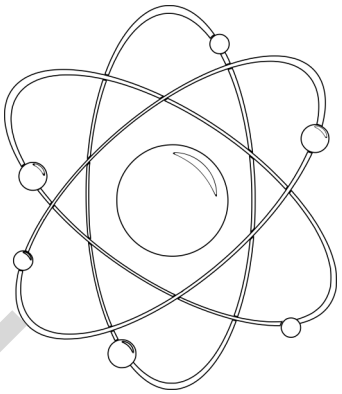
Elements, Compounds, and the Periodic Table

By Bonnie Rose Hudson

Write Bonnie Rose

Elements, Compounds, and the Periodic Table

The world around us is made of matter, but why is there such a huge variety of substances around us? For example, you breathe oxygen and drink water. One is a gas, and one is a liquid. You may put table salt on food to give it flavor. Some things, like salt, dissolve in water, but other things do not. What makes all these things so different from each other?

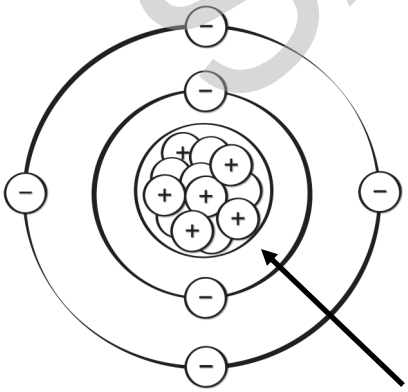


The answer lies within the matter itself. Deep within all matter are atoms. Atoms cannot be seen with just your eyes. If you look at the width of just a single human hair, it is more than one million times thicker than a single atom.

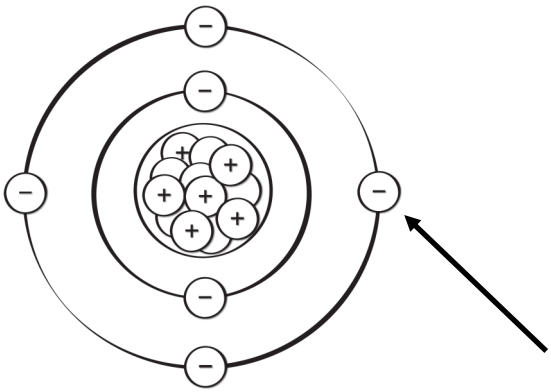
As hard as it is to imagine, atoms are made of even smaller parts called subatomic particles. The three main subatomic particles are protons, neutrons, and electrons. Protons and neutrons are made of quarks. Other types of subatomic particles include leptons (which include neutrinos and other smaller particles) and fundamental bosons (which include photons, gluons, and others).

The **nucleus of an atom** is made of protons and neutrons. **Protons** have a positive charge, but **neutrons** have no charge. They are neutral.

Electrons are smaller than the protons and neutrons. They revolve, or circle around, the nucleus. Electrons have a negative charge, so they are attracted to the positive charge of the protons. This attraction keeps them spinning around the nucleus.

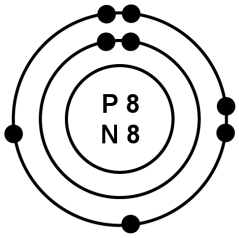


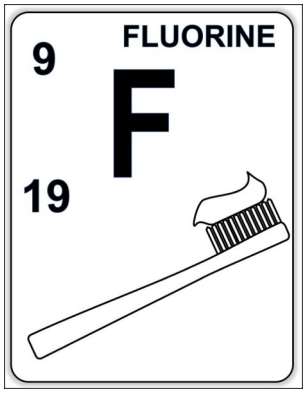
Nucleus (protons and neutrons)

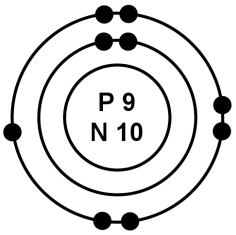


Electrons

The eighth element on the periodic table is oxygen, and I think we all know that oxygen is critical to almost every living thing. People need it to breathe. Plants need it to produce energy. Most fuels need oxygen to burn. Oxygen masks are used by medical professionals to help someone who is struggling to breathe. Oxygen has 8 protons, 8 neutrons, and a mass number of 16.

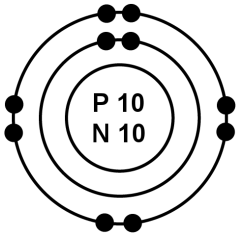


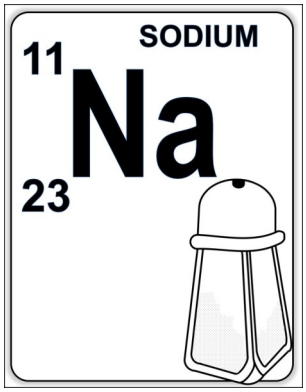


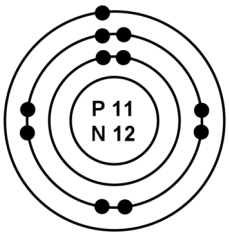


Fluorine is the ninth element on the periodic table. Fluoride, a fluorine ion, is used in toothpaste and even drinking water because it can help reduce the risk of tooth decay. It has 9 protons and 10 neutrons, and its mass number is 19.

The tenth element on the periodic table is neon. If you've ever seen a neon sign advertising a sale or an event, you've seen neon gas at work. When combined with electricity, the gas gives off a distinctive light. Neon light is also able to shine through fog much better than most other kinds of light, so it is commonly used in beacons for airplanes. Neon has 10 protons and 10 neutrons. Its mass number is 20.



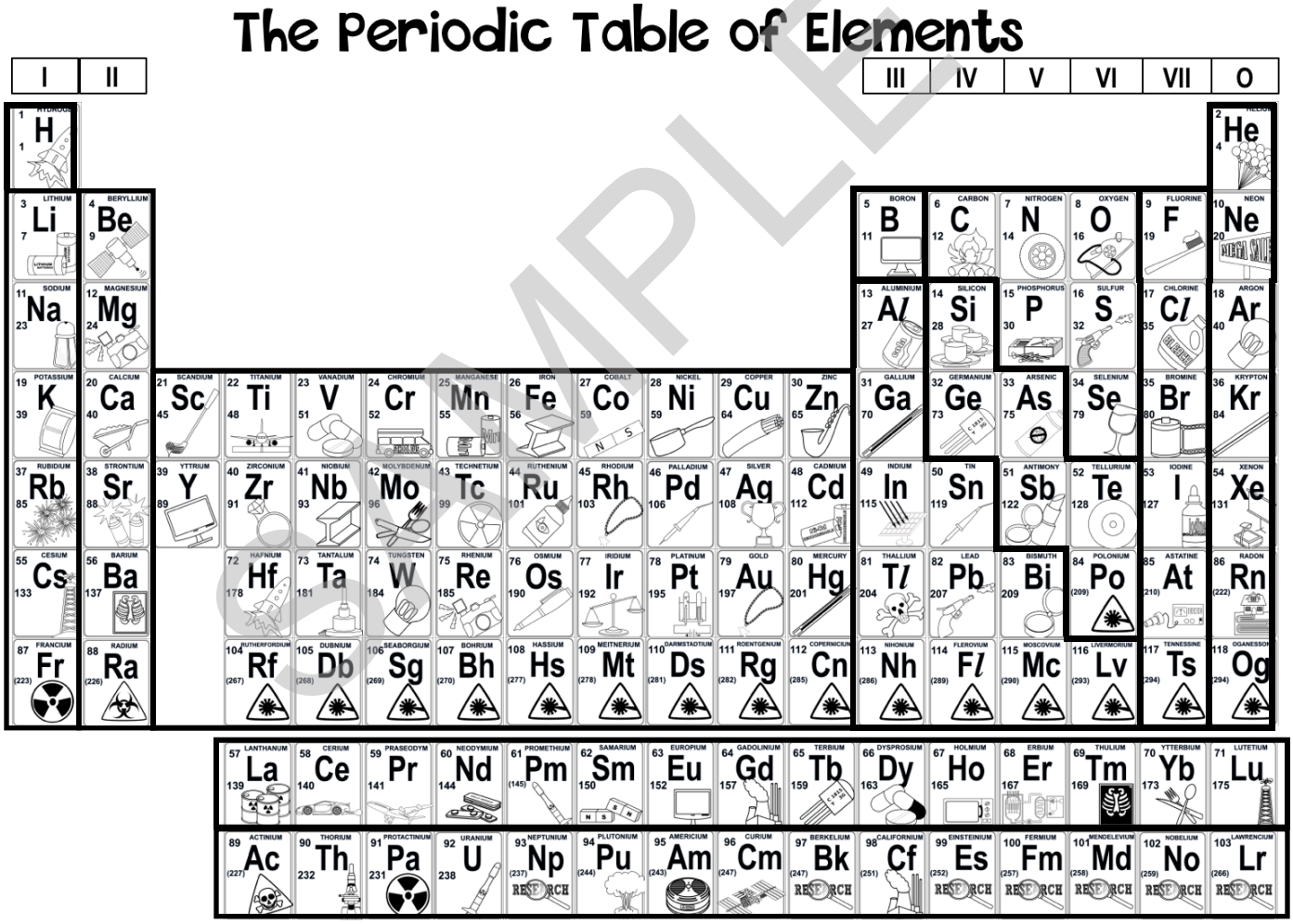




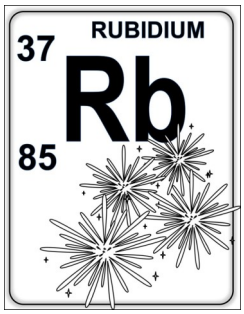
Sodium is the eleventh element on the periodic table. It's probably most famous for being part of table salt. Sodium is actually the sixth most common chemical element in the Earth's crust, but it is never found as a separate element. It's always combined with other elements. It has 11 protons and 12 neutrons, and its mass number is 23.

Sodium through argon have three shells; potassium through krypton have four shells. Rubidium through xenon have five shells; cesium through radon and lanthanum through lutetium, which are two separate rows, have six shells. Francium through oganesson and actinium through lawrencium, which are also two separate rows, have seven shells.

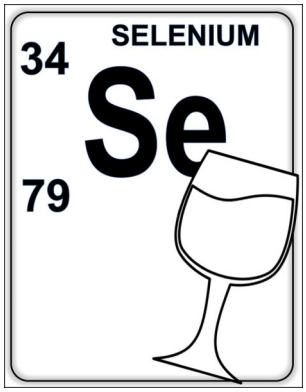
Chemists also break the periodic table down into classes. Each class has certain things in common. We won't look at every element or everything they have in common, but we'll take a look at what makes each class different. For example, most of the metals we will look at are **ductile**, which means they can be drawn into wires, and **malleable**, which means they can be pounded down into thin sheets. It's important to remember that not all scientists agree on what class some of the elements belong in.

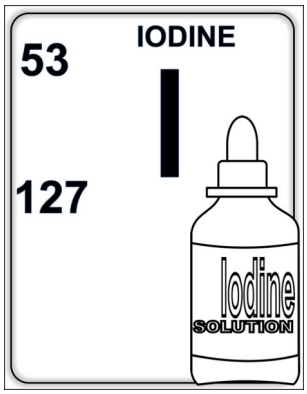


The first class you come to on the left is the **alkali metal** class. It includes lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs), and francium (Fr). They are soft, light metals that react strongly with water. We've already seen some of the uses of lithium, sodium, and potassium. Rubidium is used in fireworks, cesium is being studied as a possible fuel for space vehicles, and francium is radioactive.



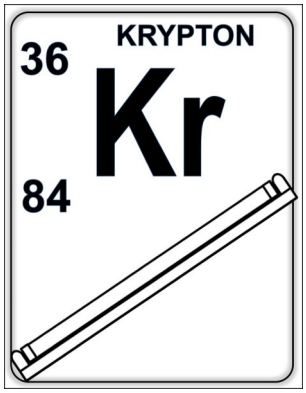
We've already mentioned the next class of elements, **nonmetals**. We know they don't conduct heat or electric current well. They vary in color. Some of them are solids, others are liquids, and others are gasses. They are a little scattered on the periodic table, with hydrogen (H) being the first element in the top left corner and the rest in a block on the right—carbon (C), nitrogen (N), oxygen (O), phosphorus (P), sulfur (S), and selenium (Se). We've already looked at all of these elements except selenium, which is used in manufacturing and in making glass.





Our next class is halogens, which are also nonmentals. They get their name "halogen" from the Greek roots "hal-" and "-gen" which means "to produce salt" or "salt producer." They are in the second column from the right. They include fluorine (F), chlorine (Cl), bromine (Br), iodine (I), and astatine (At). When the element chlorine is combined with sodium, we get sodium chloride, or table salt. Humans use iodine in their bodies to produce thyroxine, which is an important hormone.

The last class of elements is the **noble gases**. They form the first column of the periodic table on the right. They are all gases and do not react easily with other elements. They include helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), and radon (Rn). They are very useful in many ways. Argon is used in light bulbs because it won't eat away or corrode the metal parts of the bulb. Helium doesn't burn, so it is safe to use in blimps. The element krypton is used in many kinds of fluorescent lights.



That is a lot of elements, and there is still much for scientists to learn! Thankfully, we don't have to memorize all 118 elements right now, but let's review the chemical symbols for the first twenty because many of them are going to be good to know as we keep studying chemistry.

Hydrogen	H
Helium	He
Lithium	Li
Beryllium	Be
Boron	B

Carbon	C
Nitrogen	N
Oxygen	O
Fluorine	F
Neon	Ne

Sodium	Na
Magnesium	Mg
Aluminum	Al
Silicon	Si
Phosphorus	P

Sulphur	S
Chlorine	Cl
Argon	Ar
Potassium	K
Calcium	Ca

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.

Nucleus of an atom: _____

Proton: _____

Neutron: _____

Electron: _____

_____

Atomic number: _____

Mass number: _____

Element: _____

Periodic table: _____

Isotope: _____

Ductile: _____

Malleable: _____

Alkali metals: _____

Transition metals: _____

_____

Metalloids: _____

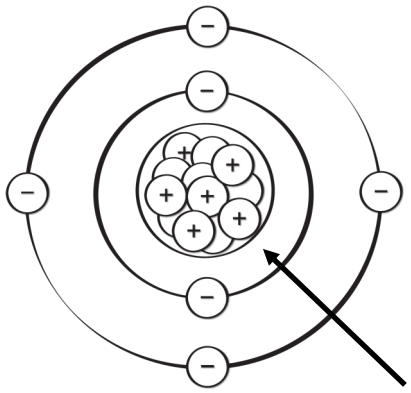
_____

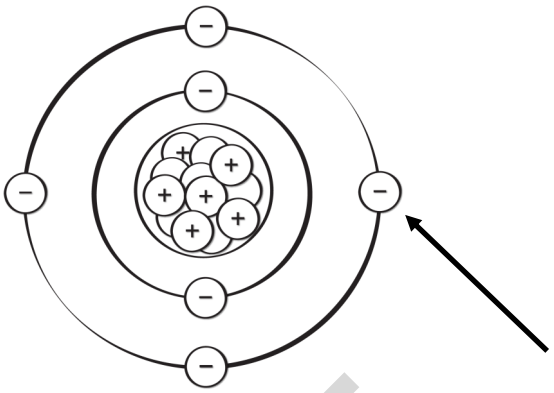
Nonmetals: _____

_____

Review Answer Key

Label the following diagram.

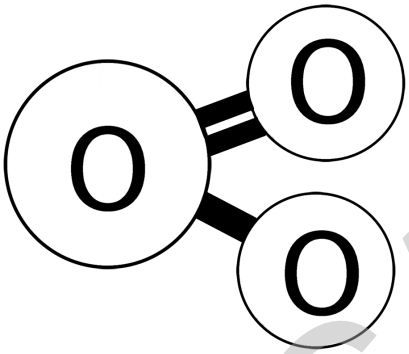




Nucleus (protons and neutrons) _____

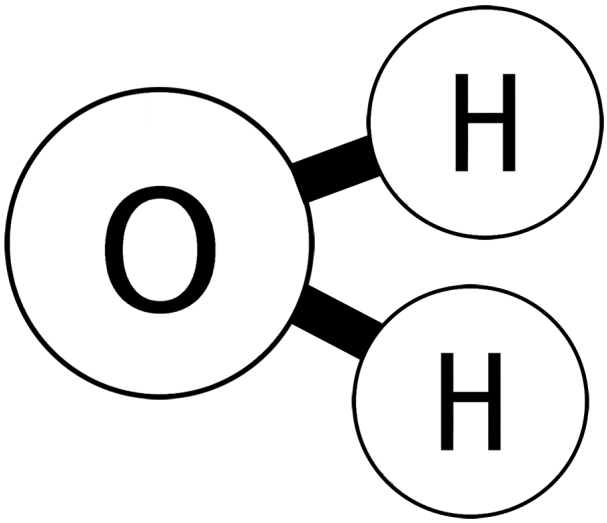
Electrons _____

Write the name of the molecule and the chemical formula.



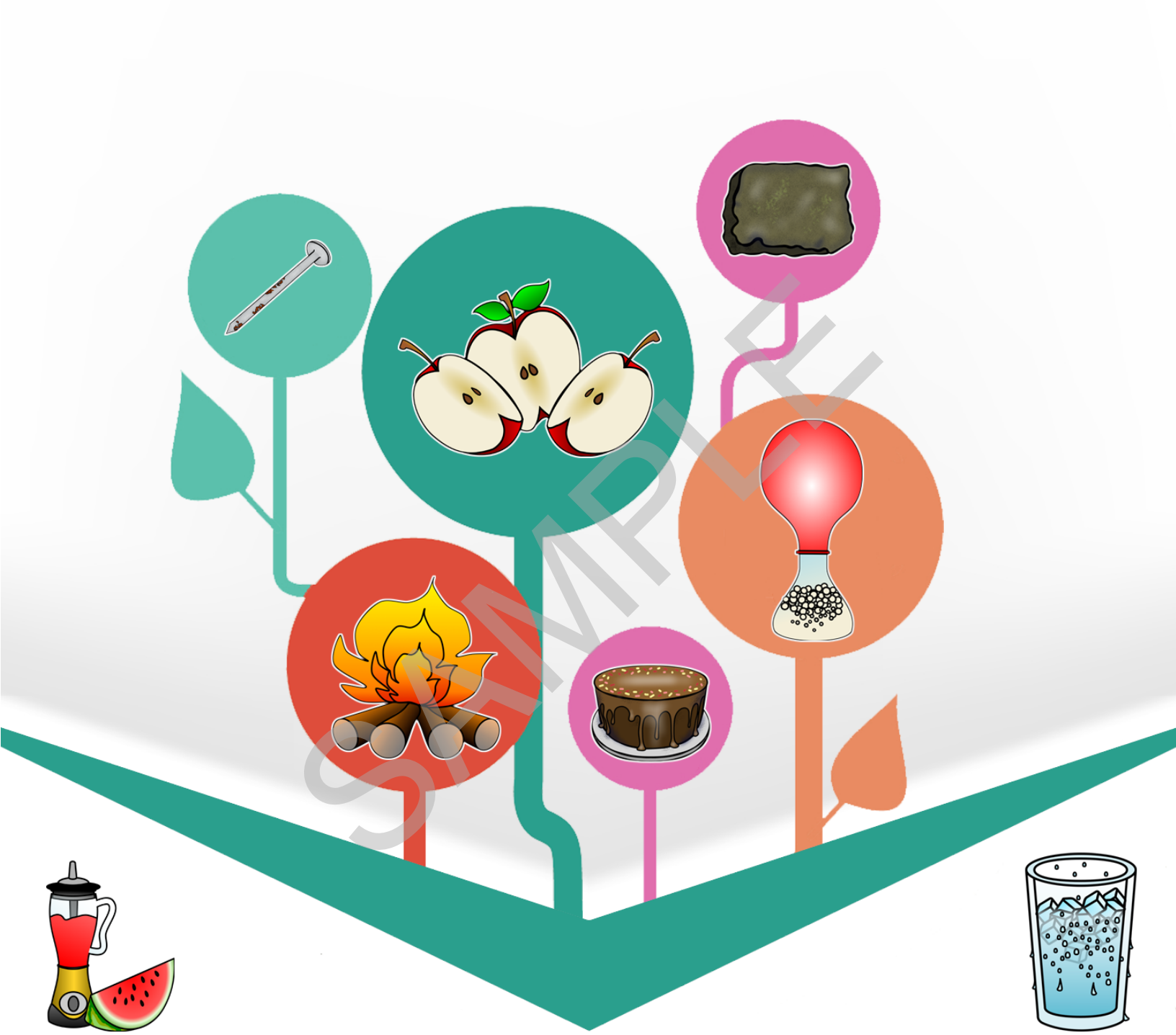
Ozone _____ O_3 _____

Label the atoms of the following molecule and write the chemical formula in the blank on the right.



Water H_2O _____

Physical Science
Level 5

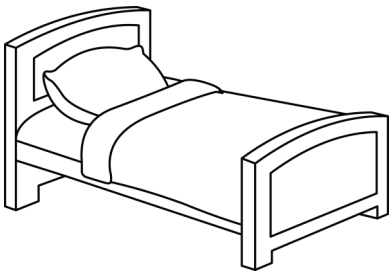


Physical & Chemical Changes

By Bonnie Rose Hudson

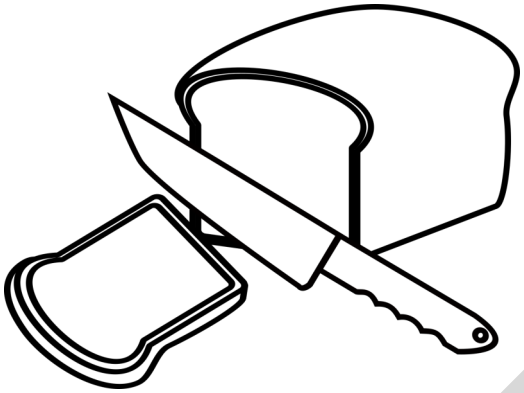
Write Bonnie Rose

Physical and Chemical Changes



You know that everything you can see and touch is made of matter. Matter is made of molecules, and those molecules are made of even smaller atoms. Even though it's all made of atoms, matter has many different shapes and forms. The wood in your walls is different than the stuffing in your mattress (which is a good thing!). Water from your faucet is different than cotton candy.

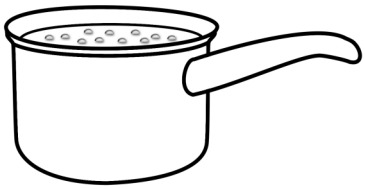
Matter can also change. Steam and ice are both water, but they are not the same. A piece of wood can burn up in a fire. Let's look at some of the ways matter can change and then learn a little about ways it cannot change.



There are two basic ways matter can change. There can be a physical change or a chemical change. Physical changes happen all the time. Have you cut a piece of bread from a loaf? The bread is in a different shape now. It's in two pieces. But both the piece of bread you cut and the loaf are still bread. The substance of the bread hasn't changed, just the form.

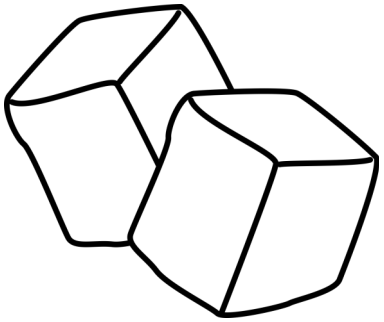
What if you cut a piece of watermelon, chopped it up, and put it in the blender so you could make it into pulp for a smoothie? Is the pulp still watermelon? Of course it is. It's just watermelon in a different form.

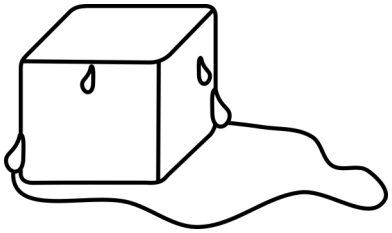
A **physical change** is a change in form or shape. When a physical change happens, you are left with the same substance you started out with. It might just look different.



What about water when it changes to steam or ice? You know that there are three basic states of matter—solid, liquid, and gas. When you heat water, you can cause it to reach the **boiling point**, which is the point where a liquid turns into a gas. Different types of matter boil at different temperatures. For example, water boils at 212 °F (100 °C), but iron boils at 5,432 °F (3,000 °C).

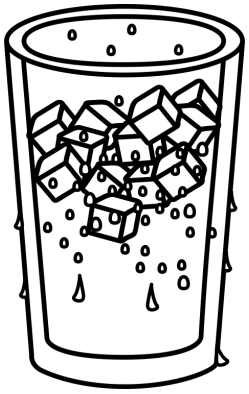
You can also freeze water. The **freezing point** of matter is the point where a liquid changes into a solid. Water turns into a solid at 32 °F (0 °C).





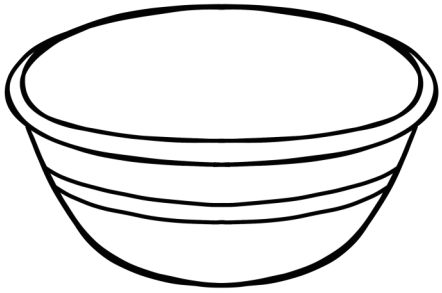
But of course, ice can also melt back into water. The **melting point** is the point where a solid becomes a liquid.

So when water freezes into ice cubes, melts into liquid water, or boils and changes into water vapor, what kind of change is that? These are all physical changes because no matter what state or form it's in, the water is still water. It looks different and acts differently, but it is still water. Nothing about the atoms in its molecules has changed. It's still two atoms of hydrogen and one atom of oxygen in each molecule, so it is still water.



What about when something like ice cubes in a glass cause the outside of the glass to drop in temperature? When the air hits the glass, some of it condenses into water droplets. The **condensation point** is the point where a gas turns into a liquid. Is this still a physical change? The answer is yes because the air is made up partly of water vapor. The air hasn't changed, but part of it has changed form from a gas to a liquid. But the water vapor was in the air all the time.

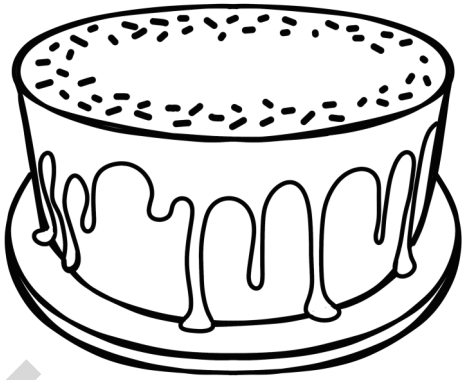
A few solids can change directly from a solid into a gas without changing into a liquid first. This is called **sublimation**. Only a few substances can do this, such as dry ice, iodine, arsenic, and camphor (moth balls).

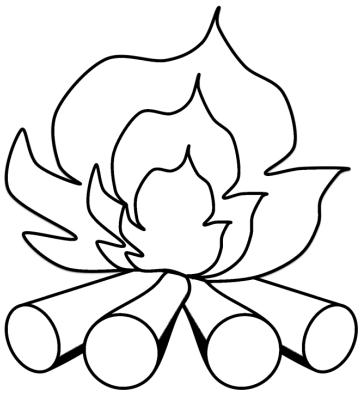


What about when you mix together ingredients for a cake? This one gets tricky. When you have the ingredients together in the bowl, it's just a physical change. But when you bake it, something different takes place. We're going to look at chemical changes next to understand what happens.

Now we know that a physical change is a change in form or shape that leaves you with the same substance. A **chemical change** is a change that happens in the molecules themselves that forms new substances.

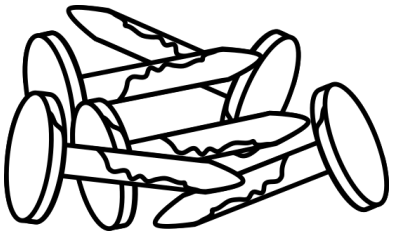
When we bake a cake, a lot of changes happen. Heat changes some of the protein in the eggs, which makes the cake firm. Heat also causes baking powder to produce bubbles of gas, which makes the cake rise. Bubbles are often a sign of a chemical change. Another sign that it's a chemical change is that the ingredients can never be broken back down into the individual ingredients. They are permanently changed, and the molecules themselves are different in a baked cake than they were in the raw ingredients.





When you burn wood, you aren't left with wood anymore. You are left with ashes and smoke. Neither one of those can ever be wood again. As the fire burns, it gives off light and heat energy. Giving off energy is another good sign that something is a chemical change.

Sometimes, even a change in color is a sign of a chemical change. When iron and oxygen combine, a chemical change happens that produces rust. The rust isn't oxygen, and it's not iron. It's reddish-brown and not the color of the original iron. This happens on iron nails often. A chemical change has occurred.



Let's take a closer look at a chemical change in action. We're going to see what happens when we combine baking soda and vinegar. Remember that you should never try any experiment without a parent or teacher who can let you know what is safe to combine. Some combinations can be poisonous or even deadly.

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.

Physical change: _____

_____

Boiling point: _____

Freezing point: _____

Melting point: _____

Condensation point: _____

Sublimation: _____

_____

Chemical change: _____

_____

Oxidation: _____

Exothermic: _____

_____

Endothermic: _____

_____

Thermodynamics: _____

_____

First law of thermodynamics: _____

_____

Review

Circle the chemical changes shown below. Draw an X over the physical changes.

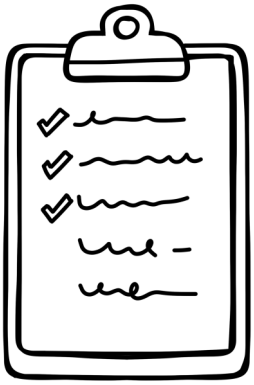
Physical Science
Level 5

Properties & Behavior of Matter

By Bonnie Rose Hudson

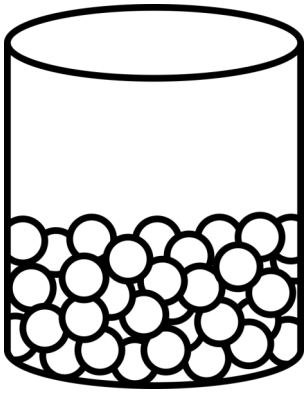
Write Bonnie Rose

Properties and Behavior of Matter

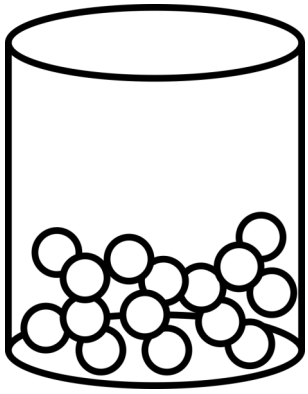


You can probably guess from the title of this unit that we are going to look at both the **properties** of matter and its behavior. But what does that mean? Properties are simply characteristics. We're going to look at ways we can describe matter—whether or not it floats, whether or not it's magnetic, and many other characteristics. We'll also look at how matter behaves in different states and what can make it change from one state to another. Are you ready? Let's get started.

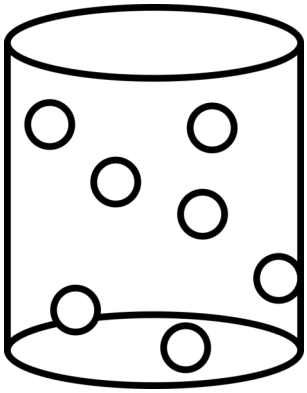
Matter makes up everything we can see or touch. It's made of molecules, which are made of smaller components called atoms. You know there are three main states of matter—solid, liquid, and gas. What makes those three states different?



In a solid, molecules are packed so tightly together that they cannot move around or change shape. They are also not easily compressed. The molecules in a piece of wood, for example, will never suddenly change from one shape into another. If they could, wood wouldn't be very useful for building anything with, would it?

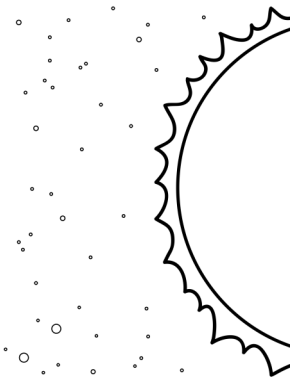


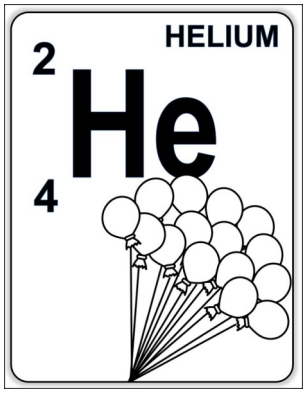
In a liquid, the molecules are still confined to a shape, but the shape is defined by the container the liquid is in. The molecules can slip and slide past each other, so if you pour water out of a large pitcher and into a small bottle, the water changes shape to fill the bottle. But the water can't change how much space it takes. If you have one glass of water and pour it into a pitcher, it will not spread out and fill the pitcher.



In a gas, the molecules are free to move in any direction. A gas fills all available space. If you could pour gas into the pitcher like you poured the water, the gas would expand and fill the pitcher.

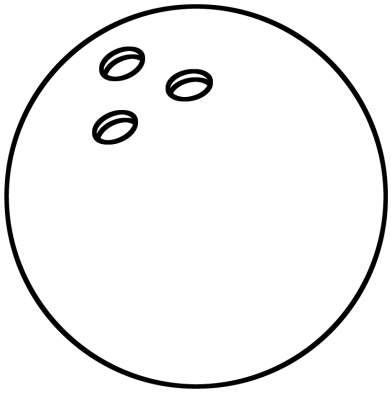
There are several other states of matter, but most are not very common. **Plasma** is a substance where some or all of the atoms have lost at least one electron. It is similar to a gas, and it needs temperatures in the tens of thousands of degrees or higher, or you need electric current, to form plasma. Plasma is found in the sun and stars, lightning discharges, and types of fluorescent and neon signs.





A **superfluid** is a liquid that has no viscosity so it moves without resistance. It has only been observed with helium. If you cool helium molecules to extraordinarily low temperatures to the superfluid state, it behaves similarly to a gas in some ways. For example, if you had helium in a superfluid state in a container, it could work its way up the side of the container and "crawl" out of the container. Helium is unique in another way, too. It's the only element that can never be made into a solid at normal atmospheric pressure. All other elements can be turned into a solid if you get it cold enough. But helium cannot be made solid unless it is put under extremely high pressure and low temperature.

Now that we know a little bit more about how matter behaves, let's look at some of its many properties. There are numerous ways you can describe an object. Think of a sneaker, for example. What color is it? How big is it? How much does it weigh? Is it firm or flexible? How does it smell? (That could be scary to find out about a sneaker!) All these things describe the sneaker. There are many properties of matter, such as size, shape, color, and texture, that you can tell just by looking at an object, but there are many other properties that you have to think more about because you can't always see these characteristics.



Mass is one way we describe matter. There are actually two different ways to describe mass. Mass is the amount of matter an object has. But mass is also a way to measure **inertia**. Inertia is also a property of matter. It's the property that explains why objects at rest tend to stay at rest unless they are acted on by an outside force. Matter doesn't just move itself. Something needs to act on it. The more mass something has, the more force is needed to overcome its inertia. Think about a bowling ball and a baseball. It takes a lot less force to move a baseball than it does a bowling ball.

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.

Properties: _____

Plasma: _____

_____

Superfluid: _____

Mass: _____

Inertia: _____

_____

Volume: _____

Density: _____

Buoyancy: _____

_____

Transparent: _____

Translucent: _____

Opaque: _____

Conductor: _____

_____

Ductile: _____

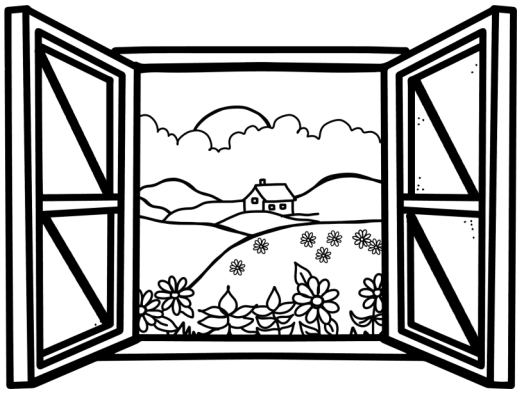
Insulator: _____

Recyclable: _____

Review

Using what you've learned about the properties of matter, look at the following terms. For each type of material, write at least one thing you could use matter with that property to create and why that characteristic makes it a good choice. (Try not to use the object in the picture for your answer.)

Transparency:



_____

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_____

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Conductor:

_____

_____

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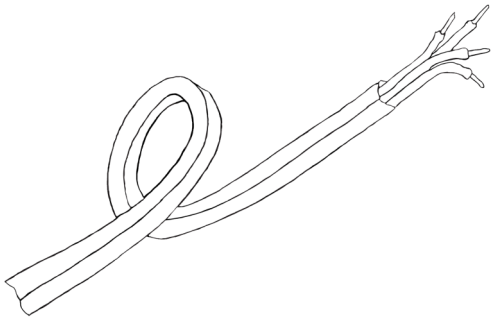
Ductile:



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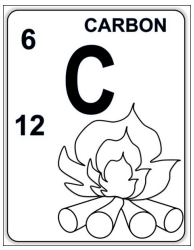
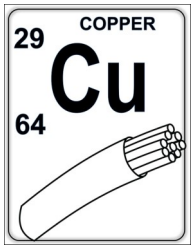
Which of the following elements is a metal? Draw a circle around it.

Oxygen

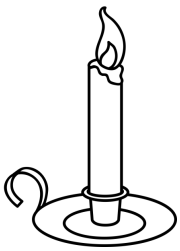


Carbon

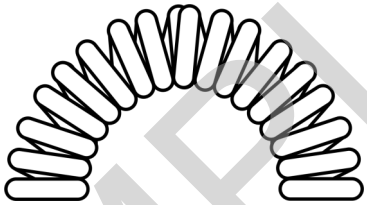


Copper

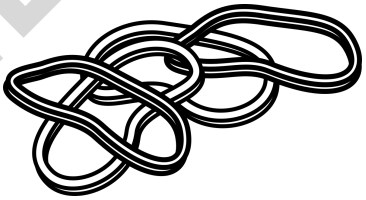
Which of the following materials is not elastic? Draw an X through it.



Wax



Spring



Rubber band

List six properties of matter.

Name the five states of matter discussed in this unit.

_____