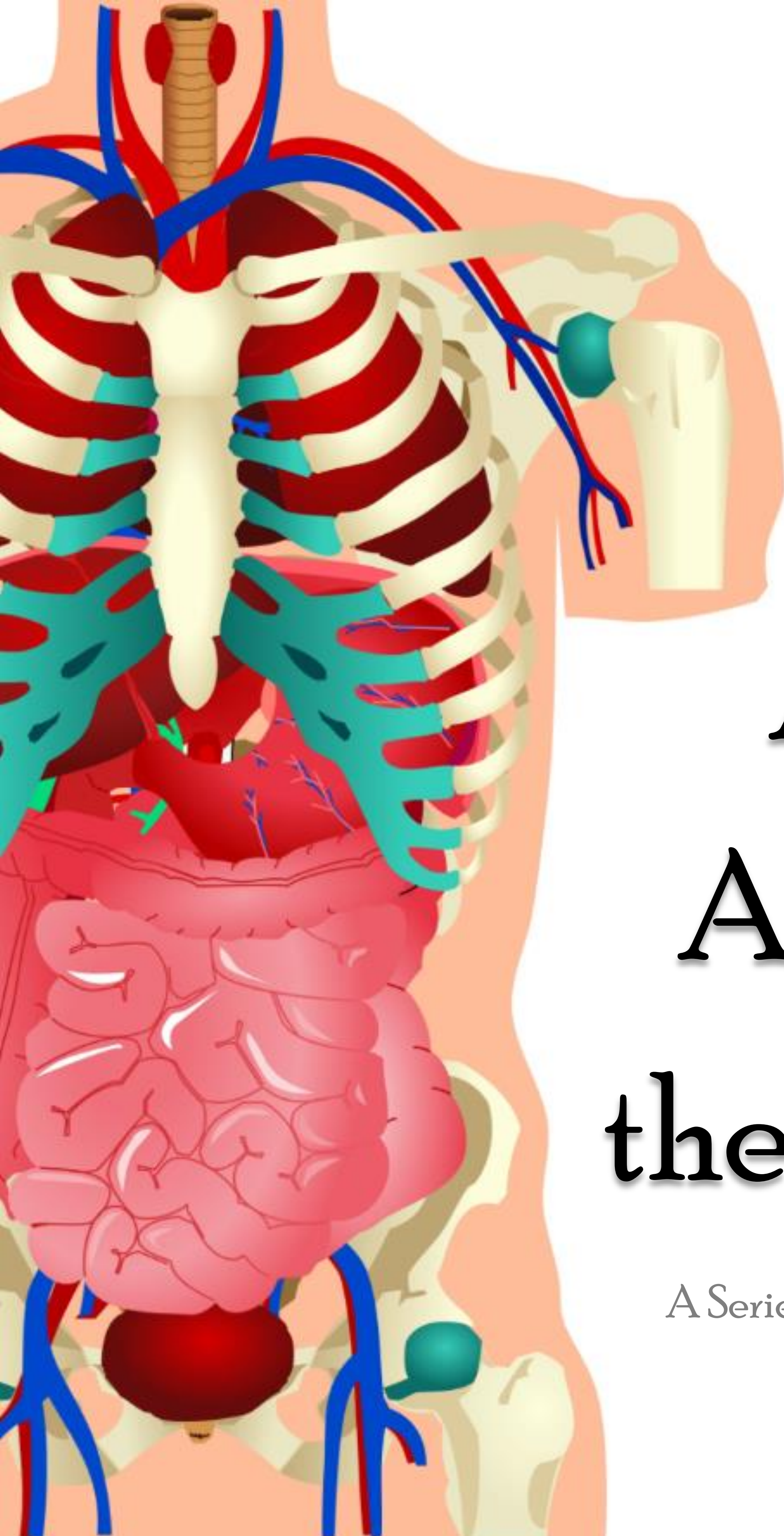
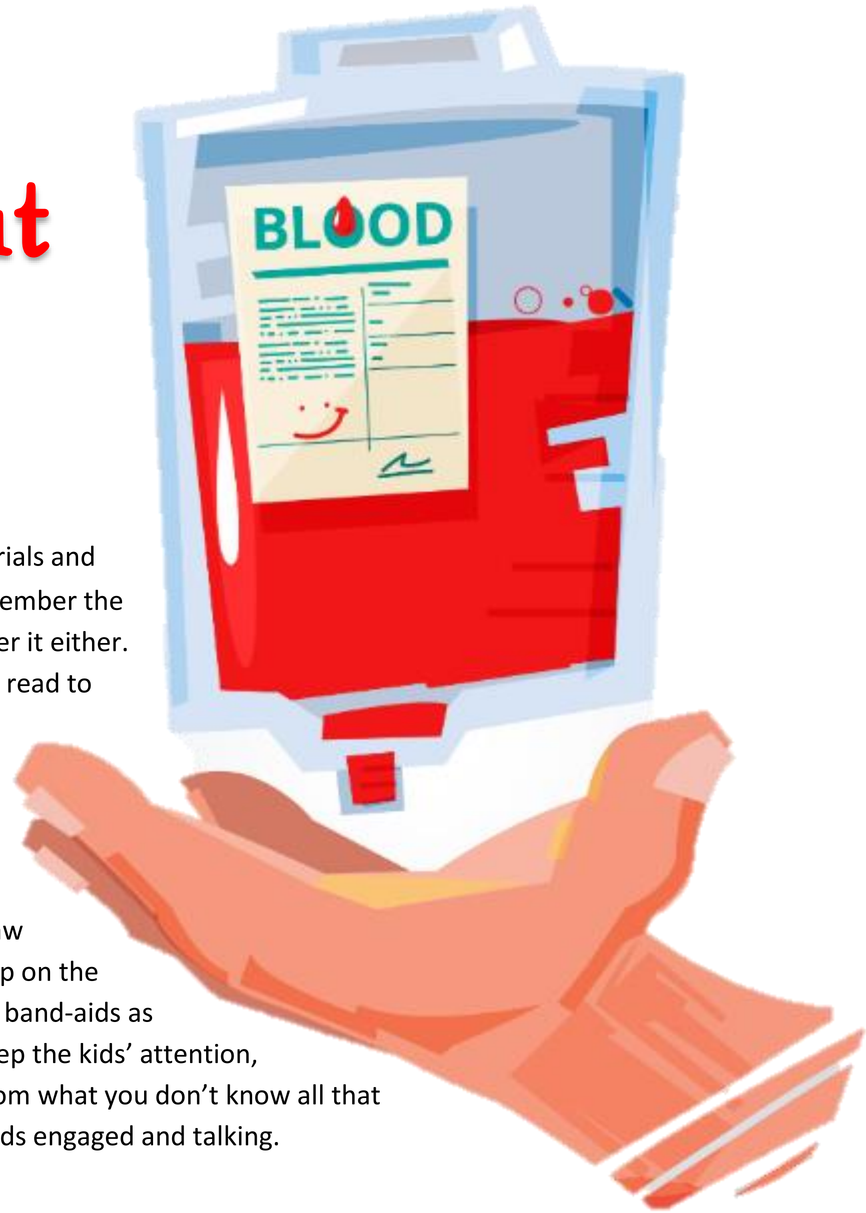


All About the Body

A Series of Lesson Units

Index

All About Blood



Note: Read through the following materials and see what you remember. If you can't remember the information, the students won't remember it either. Make it applicable for the students, <u>don't</u> read to them, don't feel rushed, make it a discussion and do a demonstration. How can you help them remember? How can you make it fun? When you introduce a new word, give a definition/explanation right away and draw pictures, act it out, and <u>write</u> the words up on the board and/or show the pictures. Give fun band-aids as rewards for participation. You want to keep the kids' attention, get them involved, and don't shy away from what you don't know all that well. Get to know it and you'll keep the kids engaged and talking.

Major Parts of the Blood

As part of our study of the human body we are learning about the parts of our blood. The following materials will be a key part of your demonstration and discussion as you discuss the various parts of blood and the information.

Materials:

- A gallon of red liquid—represents how much blood we have in our bodies
- A large empty jar
- a jar of yellow water or corn syrup--plasma
- a jar with cheerios or Red Hots candies—red blood cells
- a jar with small white marshmallows-white blood cells

- a shaker of salt
- a small container of multi-colored sprinkles-nutrients and hormones
- a bottle of red food coloring--hemoglobin
- rice-platelets
- netting from a bag of fruit, ex. Oranges (represents the platelets and how they bind together when you get a cut)
- Small cotton balls
- A dog's chew bone—shows the students where bone marrow is located
- Small snack or sandwich bags -represents your blood vessels
- a spoon
- Optional: fancy band-aids

What is Blood?

The following Information about blood was compiled from [*KidsHealth.org*](KidsHealth.org)

**Go into detail about the underlined words, remember, this is new vocabulary and when we introduce new vocabulary we want to give a definition, explanation, illustration immediately. Draw it, act it out, show a picture.*

You know what blood is — it's that red stuff that comes out if you get a paper cut. The average person has about 1 to 1½ gallons (4-6 liters) of it. *(*Physically show the students a gallon or half gallon of red liquid)* But what is blood, really, and where does it come from?

How Does the Body Make Blood?

It's not made in a kitchen (though it might be spilled there if you get a cut!), but blood has <u>ingredients</u>, just like a <u>recipe</u>. To make blood, your body needs to mix:

red blood cells, which carry oxygen throughout the body *(show the students the Red Hots)*

white blood cells, which fight infections *(show the students the marshmallows and ask them what an infection is, have any of the kids ever had an infection? What happened?)*

platelets, which are cells that help you stop bleeding if you get a cut *(show the students the rice)*

plasma, a yellow liquid that carries *nutrients, *hormones, and proteins (really important things that your body needs) throughout the body *(show the students the jar of yellow liquid and your container of sprinkles)*

*Nutrients are chemicals from the food you eat that give your body energy and other things your body's cells need to do their work and keep you healthy.

*Hormones are like little note carriers. They carry messages throughout your body, telling it what to do and when. An example of a hormone is growth hormone. It gets your bones and muscles to grow.

Big, Bossy Stem Cells

In the bone marrow, there are hematopoietic (say: hee-muh-toh-poh-ee-tik) stem cells. These cells are like the mother of all blood cells. If the body needs some more red blood cells, it tells the stem cells to make red blood cells. If the body needs some more white blood cells, it makes the stem cells produce white blood cells. And if the body needs some more platelets, it makes the stem cells produce - you guessed it - platelets.

Your body makes these things. Bone marrow *(*show the students a bone, ex a dog's chew bone, and let the kids examine it)*— that stuff inside your bones — makes the red blood cells**,** the white blood cells, and the platelets. New blood cells leave the marrow through blood vessels (*Explain: tubes that go through your whole body and carry blood)* going through your bones. Plasma is mostly water, which is absorbed by the intestines from the things you drink and eat.

Your intestines bring the water to the blood vessels and the water enters your blood stream and makes up part of your plasma.

Put all these ingredients together and you have blood — an essential part of the circulatory system. Thanks to your heart (which pumps blood) and your blood vessels (which carry it), blood travels throughout your body from your head to your toes in a circle that keeps going around and around, which is what's called your circulatory system.

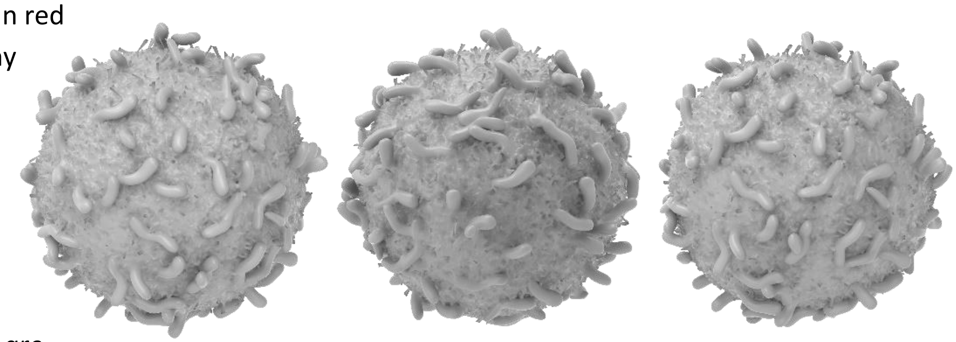
Let's find out more about each ingredient.

Red Blood Cells

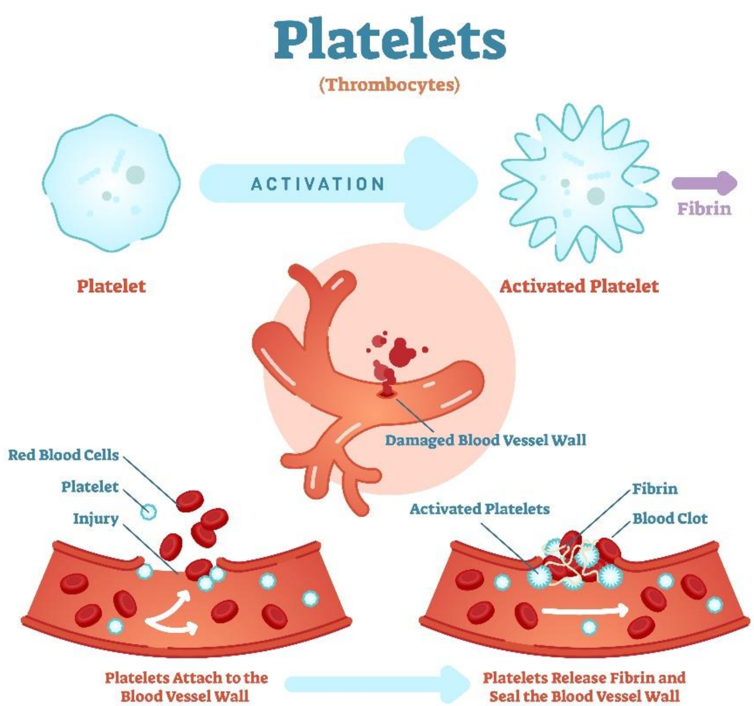
Red blood cells look like flattened basketballs. Most of the cells in the blood are red blood cells. They carry around an important chemical called hemoglobin (say: **hee**-muh-glow-bin) that gives blood its bright red color.

Blood and breathing work together. *(Ask the students how they think that your blood gets its oxygen and why you need oxygen.)* The hemoglobin in blood brings oxygen to all your cells. How? As the blood travels through your lungs the hemoglobin in the red blood cell picks up the oxygen, turns the cell bright red, and then it takes it to all parts of your body which take away the oxygen from the blood cell, which turns dark and has to go back through your heart to your lungs and get more oxygen. *(Draw a simple diagram on the board.)* Without oxygen, your body couldn't keep working and stay alive. *(Have a student volunteer add the Red Hots to an empty jar and another student add red food dye into your jar to represent the hemoglobin.)*

White Blood Cells



White blood cells are bigger than red blood cells. There aren't as many in your blood when you are healthy but if you get sick, your body makes some more to protect you. A single drop of blood can contain anywhere from 7,000 to 25,000. *(Ask students which one means they are healthy. 7,000 or 25,000? Give a fancy band-aid to the one who gave the correct answer.)* When someone gets sick their doctor can do a test of how many white blood cells they have in their body. If the number of white blood cells is very high, that means they are very sick. *(Ask students if they think your jar of blood is from a healthy person or a sick person. If they say healthy ask them if you should add a lot of white blood cells or just a few? If they say sick, ask the same thing. Have a student volunteer add in the marshmallows to represent your white blood cells according to the class' directions.)*



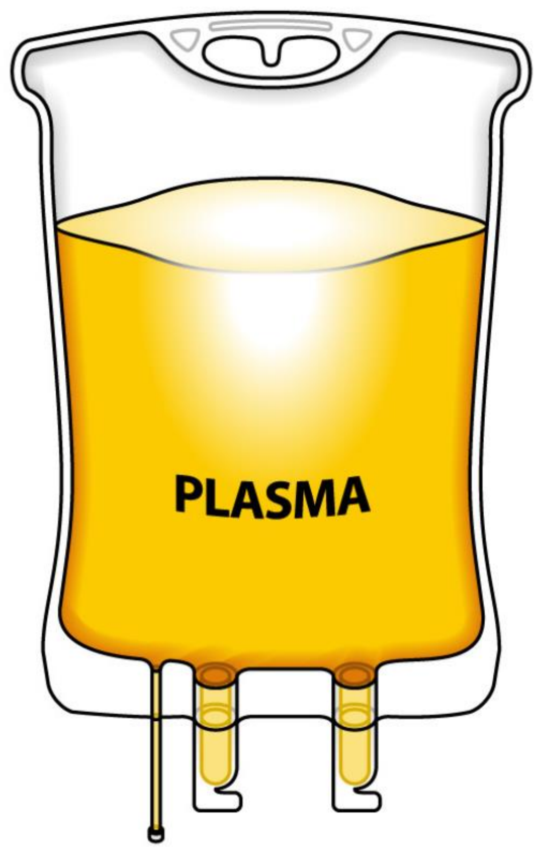
Platelets

Platelets (thrombocytes) are tiny round cells that help to make sure you don't bleed too much once you get a cut or scrape. Platelets are sticky little guys that help prevent bleeding and make blood clots/ scabs when you get a cut *(Have* *students look on their bodies for scabs/blood clots. How long have they had it? How did they get it? Who has had the biggest scab? Give a funky band-aid to the winner).* Let me tell you how this works, platelets are normally round and smooth, but after they are used to produce clots, they turn spiky and jagged around the edges. *(Draw this on the board! Or have a student volunteer draw what you describe. And then ask the students why this would help them not bleed, why would rough edges help? Why would smooth edges not work as well?)*

After you get a cut, the platelets throw themselves over the cut. *(Continue with your drawing)*. From there, they spin a web called fibrin which locks them together and forms a scab. (Draw the fibrin/web across your illustrated cut.) *You can also demonstrate this with your netting bag from the fruit. Have students toss some small cotton balls at the netting. Can they get through? This is how your scab works as well.*

The clot keeps your blood inside the blood vessel and germs out while the cut in the blood vessel heals up. *(Show the blood vessels in your hand to show them an example of a blood vessel. Ask them if they ever pull off their scabs. If they did, what happened? Why did they bleed?)* Without platelets, you'd need more than a bandage to catch the blood when you scrape your knee! *(Ask students if your jar of blood has gotten hurt. Does it need a lot of platelets or just a few? Have a student volunteer put in your rice platelets.)I*

Plasma

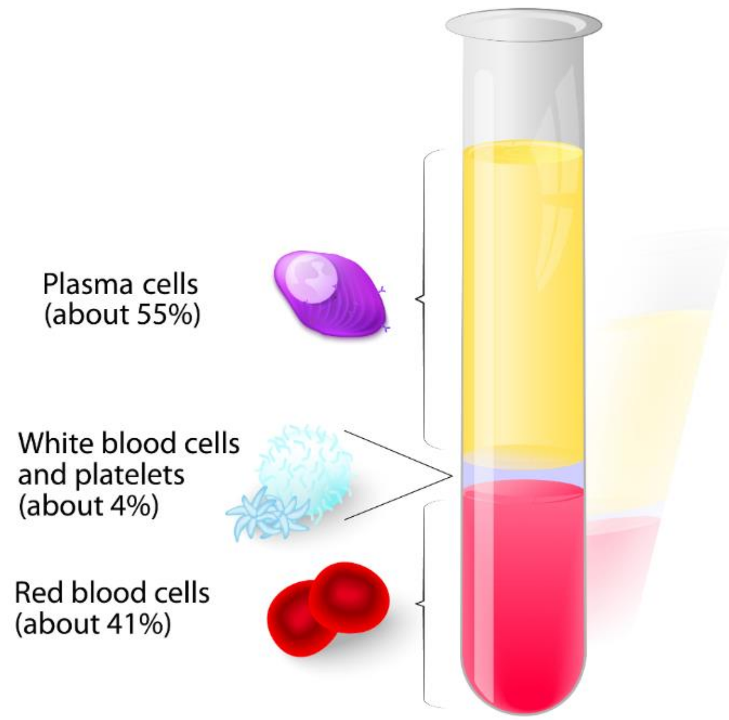


Plasma is a yellow liquid that is mostly water. (Plasma is about 54% of our blood The rest is 45% red blood cells, 1% white blood cells, and 1% platelets.) *(Draw a pie chart or a diagram like the one on the next page, on the board of how much of their blood each part is, or during your demonstration. Talk about how one drop of blood contains a half a drop of plasma, 5 MILLION Red Blood Cells, 10 Thousand White Blood Cells and 250 Thousand Platelets. Write the numbers on the board next to your pie chart and ask them which one the largest amount is.)*

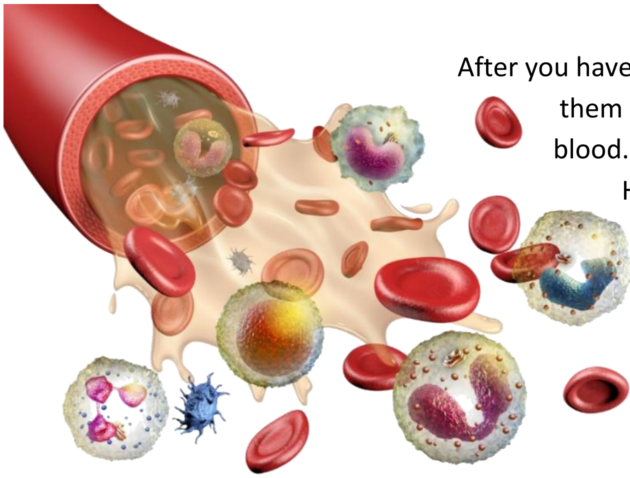
Besides water, plasma also contains dissolved <u>salts</u> and <u>minerals.</u> *(describe what these are, ex. For example Calcium is a mineral. Where do we get calcium from? Milk. What does calcium help? Our bones, teeth, etc.)* Plasma also carries important <u>nutrients</u>, <u>hormones</u>, and <u>proteins</u> through your body. **Remind them of the definitions you discussed earlier. Ex. like we talked* *about: What are nutrients? Nutrients are chemicals from the food you eat that give your body energy and other things your body's cells need to do their work and keep you healthy. What are hormones? Hormones carry messages throughout your body, telling it what to do and when. An example of a hormone is growth hormone. It gets your bones and muscles to grow.*

Germ-fighting white blood cells also ride in the plasma, like a river, and find germs. Without plasma, the blood cells wouldn't be able to move. Plasma also carries away cell waste —(*Explain. Cell waste is like the cell's garbage, it is chemicals that the cell doesn't want anymore.*)

***If you don't get to them making the blood the first day, that is fine, don't feel rushed, just tell them that they will make their own blood the next day. The most important thing is they remember the information and are engaged and interested.



Build Some Blood!



After you have discussed the parts of blood with the students ask them what parts they would need to build their own blood. (Vessels, Plasma, White Blood Cells, Platelets, Hormones, Nutrients, Hemoglobin, and Red Blood Cells) Show them your materials and ask them what they could use to represent each part. Have students help you and work together to build their own bag of blood.

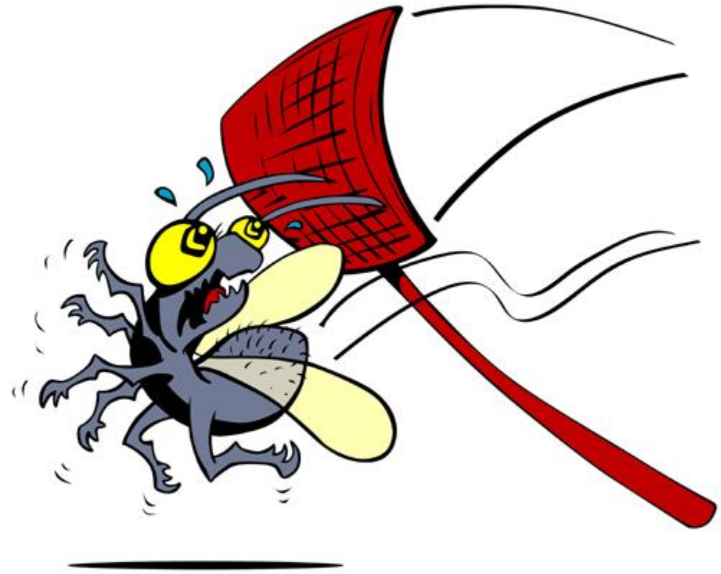
Materials needed:

Blood vessels = Plastic zipseal baggie
Plasma = corn syrup/oil
White blood cells = marshmallows
Platelets = rice
Red Blood Cells = red hots
Hemoglobin = Red Food Dye
Hormones & Nutrients = sprinkles
As you/after you discuss what makes up blood have students put all of the ingredients into the ziplock baggie and squish around to mix. What do they see? *Be sure to remind the kids that what you are looking at is representational and that a true blood cell is thousands of times smaller in your body.* Discuss the following.

Amazing facts about Blood:

- Our plasma is 54% of our blood, 45% red blood cells, 1% white blood cells, and 1% platelets.
- One drop of blood contains a half a drop of plasma, 5 MILLION Red Blood Cells, 10 Thousand White Blood Cells and 250 Thousand Platelets.
- Red Blood Cells are produced at a rate of 4-5 billion every hour. Red Blood Cells live for 120 days in the blood stream, but only 42 days outside of the body. *(Ask them what that means. When people donate blood it doesn't last forever and so people have to keep donating blood.)* When the blood cells outside the body, ex. donated blood, die they are thrown away by a doctor, in your body they are removed from by an organ called the spleen.
- During its short life a red blood cell travels about 15km (9 miles) every day.

Matamoscas!



(Kill the Flies)

A fun and quick way to review facts and vocabulary from the lesson.

Materials:

- Two Fly Swatters
- A white board or poster board
- Pens
- Review materials

1. The Teacher will have all the students divided into two teams.
2. Have all of the vocabulary words from the lesson written up on the board. (For younger students you may want to only put a few words at a time.)
3. Choose one student from each team to come up to the front of the room and stand in front of the board with their fly swatters.
4. Give a simple definition of one of the vocabulary words that is written on the board.
5. The two students then race to swat the correct word that was defined. The student who swats it first gets a point for their team.
6. The students go back to their group and select another teammate to take their place at the board with the fly swatter.

Ideas of Lesson Vocabulary to use *(especially focus on the new vocabulary (underlined words are a good place to start) and vary according to the level and ability of your students*):

- **Plasma**
- **White Blood Cells**
- **Red Blood Cells**
- **Platelets**
- **Blood**
- Ingredient
- Hormone
- Nutrient
- Mineral
- Drop(let)
- Oxygen
- Carry
- Dented
- Sticky
- Web
- Heart
- Lungs
- Germs
- Blood Vessels
- Scab
- Gallon
- Fibrin
- Hemoglobin
- Red
- Blue
- Circulatory System
- Sick
- Healthy
- Protect

White Blood Cell Warriors: Threats? Neutralized!

Remember when we talked about white blood cells and how they find germs? White blood cells (WBCs, also called leukocytes) are a key part of the body's system for defending itself against infection (this system is called the immune system). The white blood cells are always on the lookout for invaders trying to take over your body. They can move in and out of the bloodstream to reach affected tissues.

What's amazing is that a single drop of blood can contain anywhere from *(ask students if they remember how many per drop)* 7,000 to 25,000 white blood cells at a time. *(Ask them if they remember how we said when you're sick you get a lot more white blood cells? Who would be sick? The person with 7,000 or 25,000?)*

Blood contains far fewer white blood cells than red blood cells, although the body can increase production to fight infection. There are several types of white blood cells, and their life spans vary from a few days to months. New cells are constantly being formed in the bone marrow.

If an invader like a germ or virus fights back your body will make even more of these special cells! When a germ does appear, the white blood cells have a variety of ways by which they can attack. There are actually several special kinds of white blood cells.

Have a multi-colored bag of marshmallows with at least three different colors to represent the 3 different kinds of white blood cells. Explain that they are all white blood cells but that each one has a different job, and so you are giving them a different color. Have green M&M's or other candies to represent germs.)

Have an empty snack baggie and hold it up. Explain that you have been cut (open your baggie), and are now able to be invaded by germs, place three "germs" into your bag

Granulocytes (Janitor Cells—Gran, the Janitor cleans up the mess)

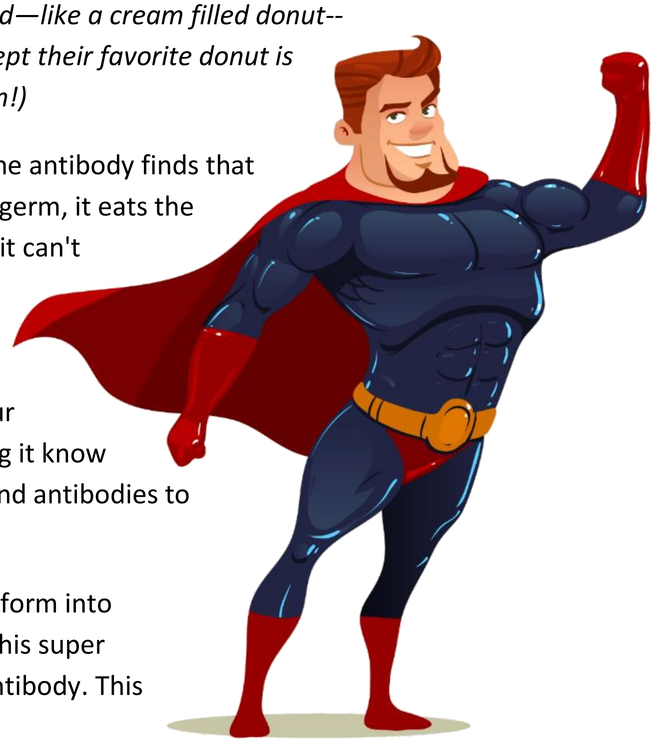
You know how your skin gets a little red and swollen around a cut or scrape? That means the granulocytes (janitor cells) are doing their jobs. *(Show one color of marshmallow-ex. green—and place it in your baggie)* They help make your tissues swell up *(ask students have they ever had their skin turn red and swell up when they got a cut? Did it hurt? Puff up your baggie so that it gets large, like swollen skin and close it)* so that more blood will come to where you have been hurt and help heal it with more white blood cells. *(Add more green marshmallows*) They have a lot to do with how your body cleans things up and helps wounds heal after you get hurt.

Granulocytes also help prevent infection by surrounding, and destroying, things that aren't supposed to be in your body, like germs.

Lymphocytes (Look-Out Cells/Spy Cells—Cyte and Remember Pho-ever)

There are two types of lymphocytes (spy or 'cop' cells), B cells and T cells. *(Show two similarly colored marshmallows)* B cells help make special proteins called antibodies *(explain--antibodies recognize stuff that shouldn't be in your body, like bacteria or a virus you get from a sick friend.)*

Antibodies are very specific and can recognize only a certain type of germ. *(Sample explanation: It's as though they all have a special kind of food that is their favorite and they only want to eat that one kind of food—like a cream filled donut--except their favorite donut is a germ!)*



Once the antibody finds that kind of germ, it eats the germ so it can't hurt you! Then it sends out a signal to your body, letting it know that there are invaders and to send the other white blood cells and antibodies to help and eat the germs.

The really cool part is that even after you are better, B cells transform into memory cells, like a superhero going from his regular identity to his super identity! These super cells remember how to make the special antibody. This makes it so that if the same germ infects you again, it can eat the germ even faster! T cells also battle germs that invade the body, but instead of making antibodies, they work by making special chemicals that help fight the infection. *(Add the two marshmallows into your bag)*

Monocytes (Warrior Ninja Cells--Mono y Mono)

(*Show a final color of marshmallow)*

Monocytes are always hungry. Monocytes are white blood cells that fight infection by surrounding, swallowing, and destroying bacteria and viruses. *(Add your final marshmallow and take out all your germs, explaining that they have all been destroyed and your cut is healed thanks to the white blood cell warriors!)*

White Blood Cells vs. The Germs!

(An Immune System adaptation of "Red Light, Green Light")

One player serves as the White Blood Cell, keeping his or her back to the other players and holding two white streamers in his hands.

All other players stand behind a set line and they are Germs trying to invade. When the White Blood Cell calls "Red Blood Cell," other players race toward the White Blood Cell to try and tag him and “destroy” him.

When the White Blood Cell calls "White Blood Cell” other players must freeze instantly.

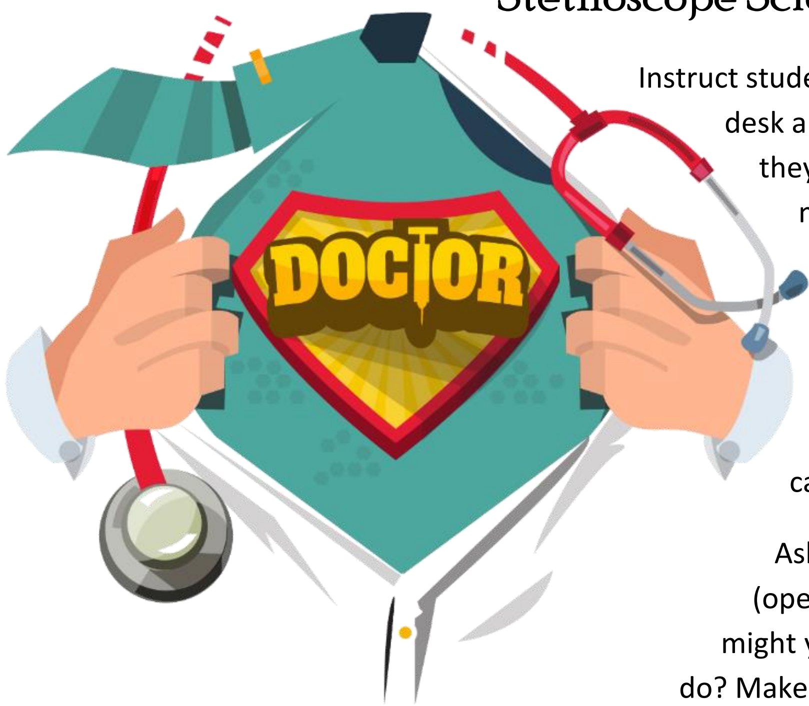
As soon as the White Blood Cell calls ""White Blood Cell,” he or she spins around to look out the other players with the streamers in his/her hands.

Anyone who is tagged by/in reach of the White Blood Cell’s tentacles must return to the start line as a defeated Germ.

The White Blood Cell looks away from the other players again and calls "White Blood Cell" or "Red Blood Cell."

The first Germ to tag the White Blood Cell becomes the next White Blood Cell.

Stethoscope Science

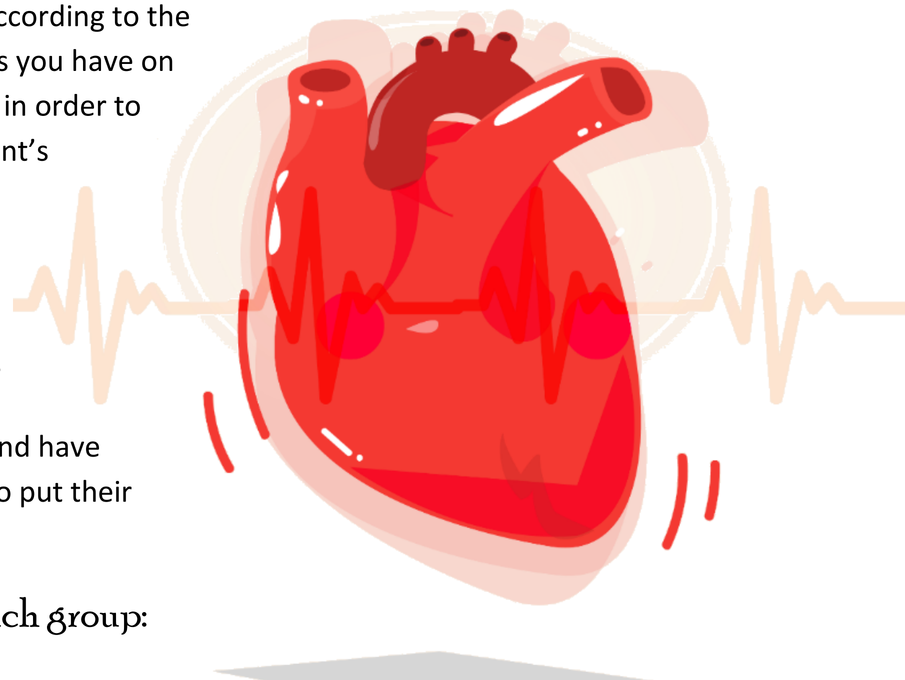


Instruct students to lay their hand (palm side up) on their desk and have students count how many times they can open and close their hand for one minute. Their hands should start getting tired after about 45 seconds. The students might start to wonder what they are doing... be sure they record how many times they opened and closed their hand. Remind them, “Don't stop! Let's see if we can keep going a little longer.”

Ask students what is their hand doing? (opening and closing). What part of the body might your hand represent? What does your heart do? Makes your blood move. Doctors use a special instrument when they listen to your blood move. It is called a stethoscope.

Now we want to find out what a doctor hears with his stethoscope.

Divide students into teams (size them according to the amount of stethoscope building supplies you have on hand) and discuss what you might need in order to hear someone’s heart beat. Write student’s suggestions up on the board. What materials do students suggest? What does a modern doctor’s stethoscope look like? What parts does it have? How could you make your own version?



Give each team the following supplies and have them work together to figure out how to put their stethoscope together

Items you’ll need available for each group:

- 2 foot length of plastic tubing
- 1 larger funnel

- 1 smaller funnel
- small watch(es)
- 1 balloon per team
- A pair of scissors
- 1 rubber band
- Optional: Garden hose as an alternative tubing
- Optional: Cardboard tubes as an alternative tubing
- Optional: Duct or electrical tape, if using or including garden hose or cardboard tubes

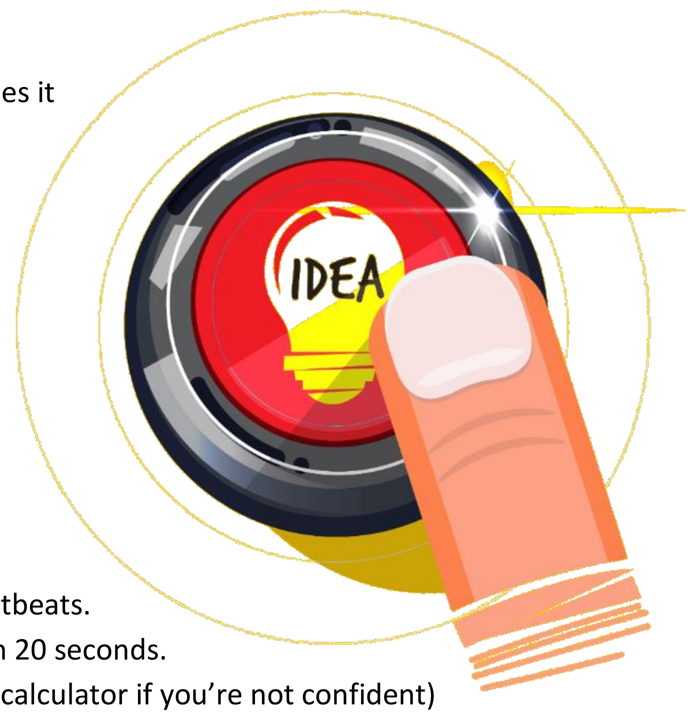
Note: Fit the funnel into one of the ends of the plastic tubing. If you are buying these items together, it is a good idea to make sure they snug tightly together.

After they have completed their stethoscope have students place a funnel against their teammate's chest and listen. Do they hear their friend's heartbeat? Which size helps them hear better, does it make a difference if the larger or smaller funnel is placed against their friend's heart?

Now place the small watch on the table and have students try to hear the ticking. Then have a volunteer put the funnel next to the watch and the other smaller funnel to their ear.

What Happened?

Can you make the sound louder? Try this option: does it make a difference? If students haven't previously figured out this option have them stretch the balloon by blowing it up and then letting the air out. Cut off the top third of the balloon with scissors. Stretch the top third of the balloon tightly over the open end of one the funnels. If necessary, use a rubber band to hold it in place. Does this change the sound quality at all?



Test it Out!

1.Have each partnership measure each other's heartbeats.
Use the timer to count how many beats they hear in 20 seconds.
Have students multiply this number by three (use a calculator if you're not confident) to find out how fast their/their partner's heart beats in one minute. Then multiply that number by 60 for beats per hour, and their hour answer by 24 for beats per day. How many times is your heart squeezing every day?

2. Turn off the lights and after one to two minutes have students test their partner's heartbeats. Did they change? Faster or slower? Why do they think they got the results they did? If they were slower what might be the reason why? (more relaxed?) If they were faster what might be the reason why? (Scared of the dark?)

3. Have one partner run in place for one minute, then listen again. Have the students write down what they hear and calculate the new beats per minute. Have the partners switch.

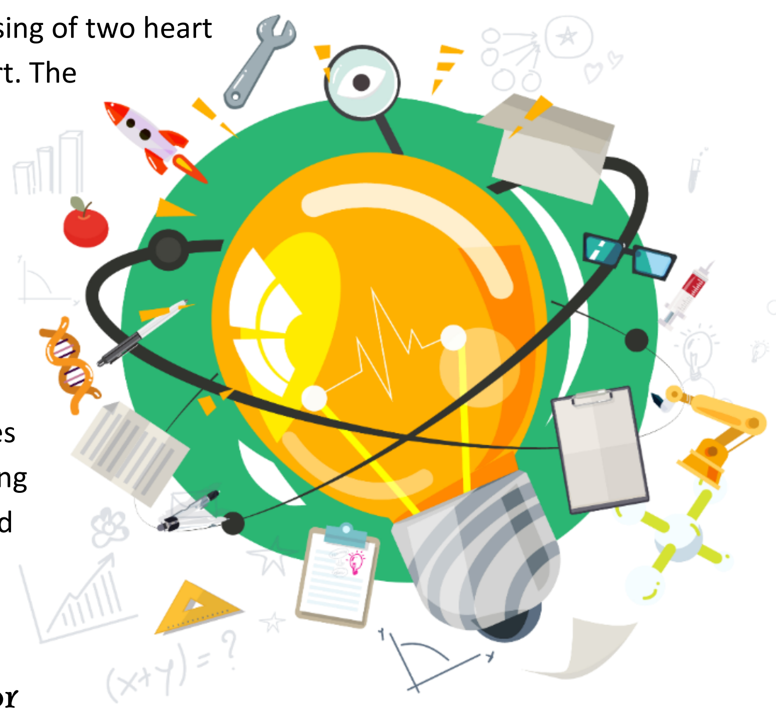
4. Have students come up with more tests such as running around for 5 minutes and then checking how fast your heart is beating.

What's happening?

A stethoscope collects sound waves, or vibrations, that might scatter, never reaching your ears. The tube guides those waves to your ear so that you can hear them.

Did you know that when a doctor listens to your heartbeat with a stethoscope, they are actually listening for two sounds? The first sound is a longer, lower pitched sound. The second is a shorter, higher pitched sound.

The lower pitched sound is made by the closing of two heart valves when blood is flowing out of the heart. The higher pitched sound is made by two other valves when blood is flowing into the heart. When a person exercises or participates in any kind of physical activity, the heart beats faster in order to pump more blood and oxygen to the muscles that are being used. The closing of the heart valves makes a sound which causes the stretched balloon to vibrate. The vibrating balloon makes the air in the tube vibrate and the tube then carries these sound vibrations to your ear.



Websites Related to the Body for Kids:

The Virtual Body (a bilingual site) includes interesting information about the brain, the digestive system, the heart, and the skeleton in a highly interactive format. At this site, every page provides a new adventure. Students can learn the names and functions of each part of the brain, build a human skeleton from a friendly pile of bones, organize the digestive organs, or take a narrated tour of the human heart. You'll have a hard time dragging yourself or your students (upper elementary grades and above) away from this colorful and imaginative site but be sure to wait for each page to fully load before choosing an activity. Otherwise you'll miss half the fun. (Requires Shockwave.) http://www.medtropolis.com/VBody.asp

Slightly older students will enjoy a visit to BodyQuest, a fun-filled and informative exploration of the human body intended for students age 11 and above. There they can tour the human body for an overview of the major body systems, stopping frequently along the way to delve more deeply into each system's individual parts. Students will discover how each body system works and find out how each body part contributes to the functioning of the whole body. They can search for specific information, perform experiments, take a quiz, post or answer questions on a bulletin board, and chat with other BodyQuest users. The site features engaging graphics, highly readable text, and lively music. Learning has never been so easy or so much fun! http://library.thinkquest.org/10348/

Pump it Up!

It's a good idea to begin a discussion and lesson by discovering what your students already know, so start out your lesson with the following activity.

Cardiovascular Kid

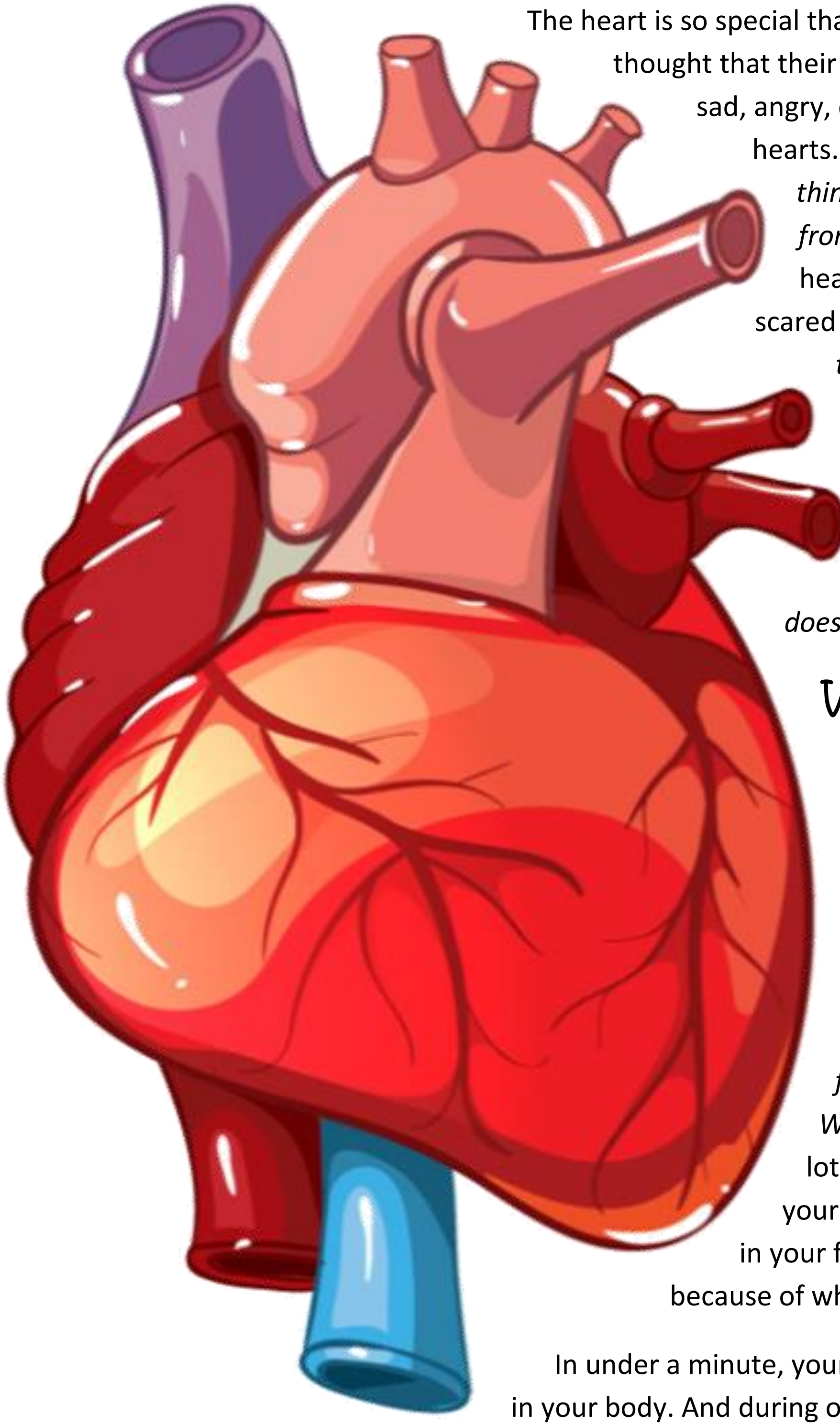
It's a bird, it's a plane....no it's Cardiovascular Kid! Get a large piece of butcher paper - large enough for a student to lie down on. Divide your students into two or more teams. In each team have a student lie down on this paper and have another student outline his or her body. Now have the two teams hang up the outline in front of the room. Working together the teams must race to fill-in their outline with parts of the cardiovascular system and the pictures of the organs supplied below. The students must find the correct label for each of the structures that are drawn or added onto their picture and add it to their Cardiac Kid.

Materials:

- Butcher paper (roll of white paper)
- Markers/crayons (to outline and color the picture)
- Pens and pencils (to label the structures)
- Several sets of pictures and labels of internal organs cut out and put in separate sets (one for each team).
- Red and Blue Yarn

After students complete their pictures and are returned to their seats ask them what is missing on both pictures (if the students haven't added in their veins and arteries) and write down their suggestions. They may suggest things such as hair, skin, clothing, etc. Tell them that it is something inside your body that connects to everything and keeps it all fed with oxygen and nutrients and that they carry your blood. What are they?

The heart sends blood around your body. The movement of the blood through the heart and around the body is called **circulation** (say: sur-kyoo-**lay**-shun), and your heart is really good at it. *(Ask students what the blood does for your cells and what they can remember about blood from the previous lesson. Blood gives oxygen to the cells and takes away the waste/garbage.)*



The heart is so special that a long time ago, people even thought that their emotions (when you feel happy, sad, angry, etc) and thoughts came from their hearts. *(Ask students why people would think their feelings and thoughts came from their heart.)* Maybe because the heart beats faster when a person is scared or excited. *(Ask students where their emotions really come from.)* Now we know that emotions come from the brain, and the brain tells the heart to speed up or slow down if you are happy or sad. *(Ask students what the heart does.)*

Working That Muscle

Your heart is really a muscle, which is a kind of tissue in your body that can tighten and loosen so that other body parts move. It's located a little to the left of the middle of your chest, and it's about the size of your fist. *(Have students make a fist to see how large their hearts are. Who has the largest heart?)* There are lots of muscles all over your body — in your arms, in your legs, in your back, and in your face, but the heart muscle is special because of what it does.

In under a minute, your heart can send blood to every cell in your body. And during one day, about 100,000 heart beats move 2,000 gallons. *Show students a gallon of red liquid and tell them that your heart moves enough blood, that if it was a faucet it would fill up an above-ground swimming pool)* of oxygen-rich blood many times through about 60,000 miles of branching blood vessels that link together the cells of our organs and body parts. *(Have older students figure out how many miles per hour your blood is traveling. 60,000 divided by 24 is miles per hour. How many gallons per minute?)*

That's a lot of work for a muscle the size of your fist that weighs less than your tennis shoe.

Pass out a piece of scrap paper or small stress ball, if available, to each student. The student will crumple the paper into a ball and hold it in his hand. The teacher will instruct the students to squeeze the paper ball each time a number is said. Watch the clock and count to 90 in one minute. Ask the students if this was hard or easy to do. Did their hands get tired?

So how can your heart do all that work? Your heart is like a pump, which is something that is used to move liquids (including air) from one place to another. *(Ask students for examples of pumps. Examples of pumps include bike pumps, balloon pumps, plungers, squirt guns, turkey basters, eye droppers, squirt bottles (cleaning products, ex. Window cleaner), and gas pumps)*

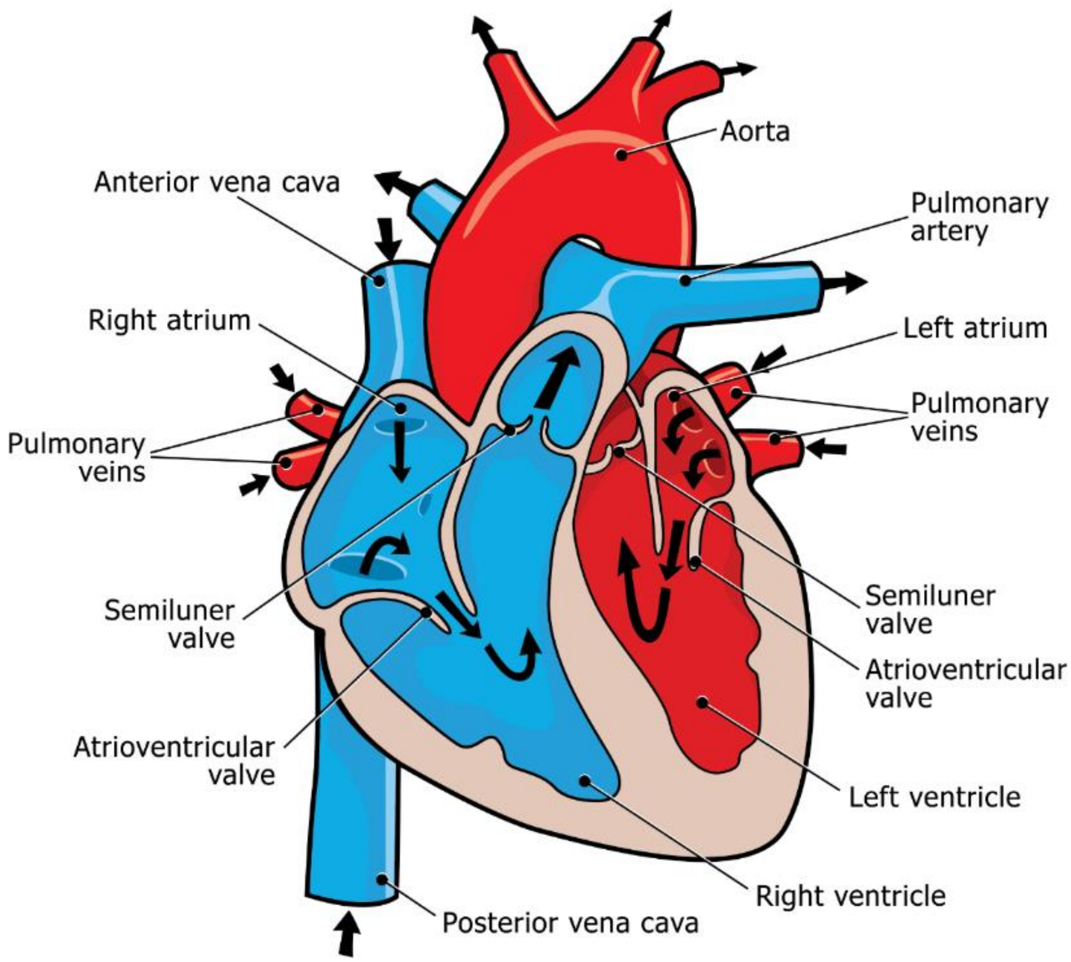
Your heart actually has two pumps in one, one on the right and one on the left. The right side of your heart gets the blood that has come back from the body and moves it to the lungs. The left side of the heart does the exact opposite: It receives blood from the lungs and moves it (and the new oxygen) out to the rest of your body.

Before each beat, your heart fills with blood. Then its muscle contracts to squirt the blood along. When the heart contracts, it squeezes — *(Have students flex their arms and feel their muscles, what happened? The muscle went tight. Have them relax their arm and feel it. What happened? It went soft.)*

You have to think about squeezing your arm, but you don't have to tell your heart to squeeze, if it stopped, you would stop living.

Heart Parts

The heart is made up of four different blood-filled areas, two for each pump, and each of these areas is called a chamber, an open space, like a room. *(Show/create a diagram of the heart)* There are two chambers on each side of the heart. One chamber is on the top and one chamber is on the bottom. The two chambers on top are called the **atria** (say: **ay**-tree-uh). If you're talking only about one, we call it an **atrium**. The atria are the chambers that fill with the blood that comes back to the heart from the body and lungs. *(Add the lungs to your diagram and show where the blood flows in and out of the heart to each lung)* The heart has a left atrium and a right atrium.



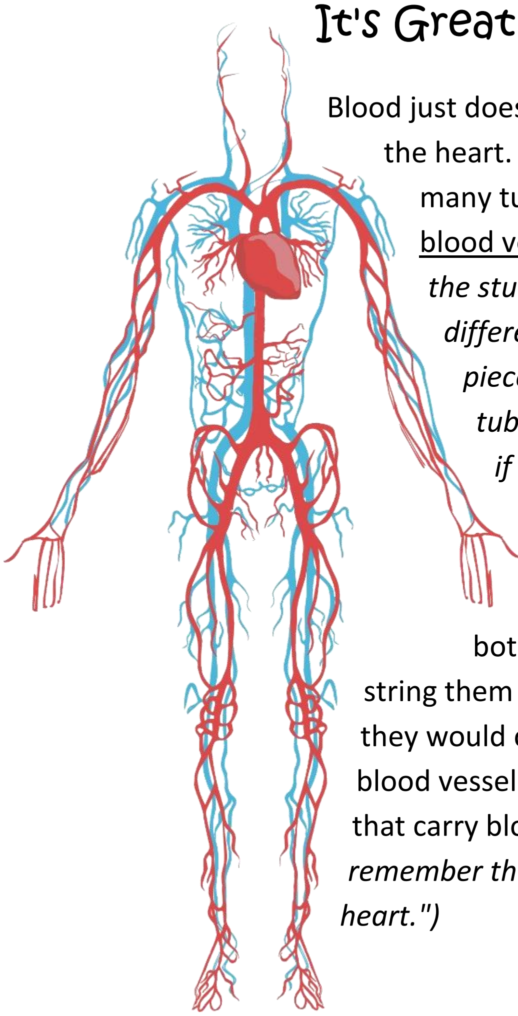
The two chambers on the bottom are called the **ventricles** (say: **ven**-trih-kulz). *(Show these on the diagram)* The heart has a left ventricle and a right ventricle. Their job is to squirt/squeeze out the blood to the body and lungs. In the middle of your heart is a thick wall of muscle called the **septum** (say: **sep**-tum). The septum's job is to keep the left side and the right side of the heart separated. *(Tell students that an easy way to remember the name of the septum is to think of the word separate and how they sound like each other.)*

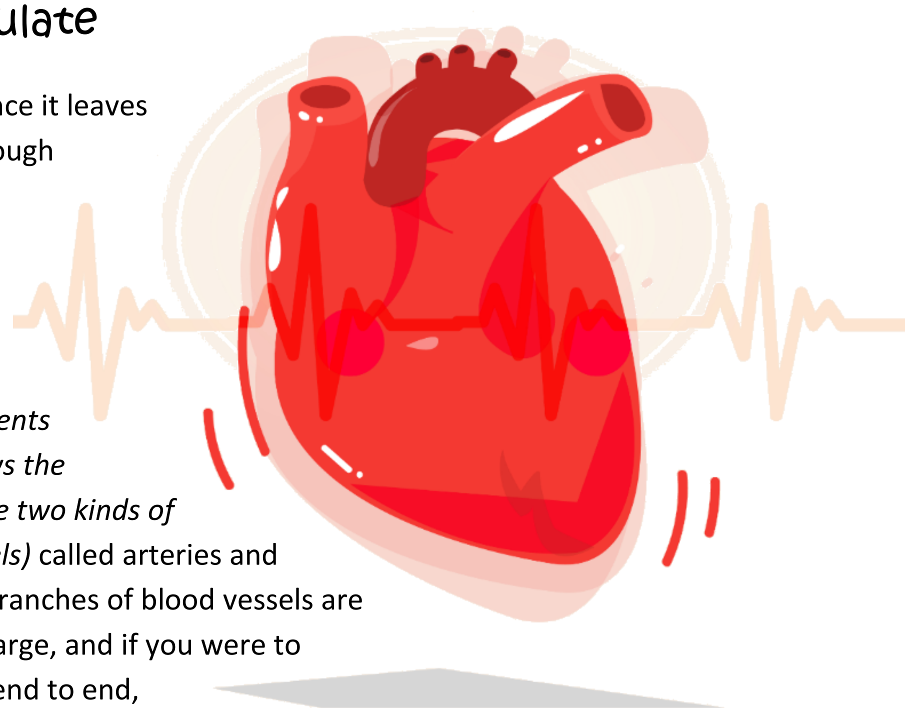
The atria and ventricles work as a team — the atria fill with blood, then move it into the ventricles. The ventricles then squeeze, pumping blood out of the heart. While the ventricles are squeezing, the atria refill and get ready for the next squeeze. So when the blood gets pumped, how does it know which way to go?

Your blood relies on four special valves inside the heart. *(Have students find these on the diagram—what do they look like?)* A valve lets something in and keeps it there by closing — think of walking through a door. The door shuts behind you and keeps you from going backward. *(Ask students if they can think of any other things that act like valves. Tell them they use two valves every time they wash their hands. What would that be? List their answers on the board. Ex. faucets, garden hose nozzles, and soap dispensers.)* Another valve would be on a sink. The valve lets the water flow out, but not back in, and it lets it flow out when you turn the handle. When you don't want water anymore what do you do? You close the valve.

These valves all work to keep the blood flowing forward. They open up to let the blood move ahead, then they close quickly to keep the blood from flowing backward.

It's Great to Circulate



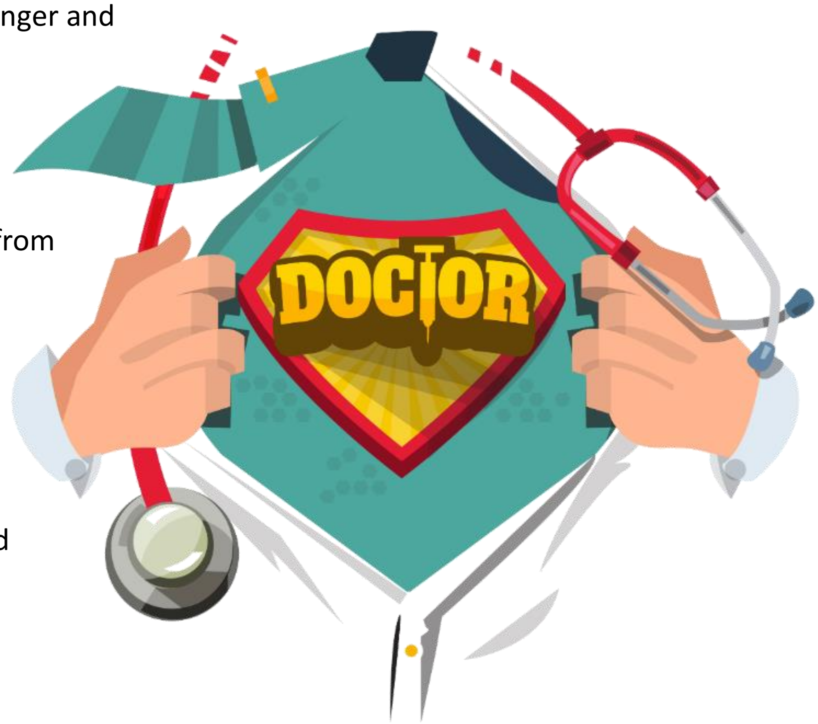


Blood just doesn't sit still once it leaves the heart. It moves through many tubes called blood vessels *(Show the students different sized pieces of clear tubing. Ask students if anyone knows the names of the two kinds of blood vessels)* called arteries and veins. The branches of blood vessels are both small and large, and if you were to string them all together end to end, they would circle the world 2.5 times. The blood vessels that carry blood *away* from the heart are called arteries. The ones that carry blood *back to* the heart are called veins. *(Tell students that they can remember the function of arteries by recalling that "A" stands for "**Away** from the heart.")*

Each side of your heart has specific job. *(Have students raise their left hands)* The left side of your heart sends that oxygen full blood that just came from the lungs out to the body. *(Have students raise their right hands)* When it comes back, the blood enters the right side of the heart. The right <u>ventricle</u> pumps the blood to the lungs to get more oxygen. In the lungs, carbon dioxide is taken out of the blood and sent out of the body when we exhale *(breath out. Have the students take a breath in. Ask them what they just brought into/inhaled into their bodies. Have them breathe out. What did they just exhale/breathe out?)*. When we inhale we get a fresh breath of oxygen that can enter the blood to start the process again. And remember, it all happens in about a minute!

Every where an artery takes blood, there's a vein to take the blood back to the heart. *(Show students the included diagram of the veins and arteries. Note: Veins are blue, arteries are red in the diagram.)* They work together side by side. So how can you tell what those blood vessels you see in your hands are? There's a simple test.

1. Have students roll up their sleeves so they can see the veins on the under side of the forearm.
2. Place your forefinger on one of the veins evident, then push the thumb along the vein toward the shoulder. Leave the finger in place and observe if the blood flows back into the vein. Now remove the finger and observe what happens.
3. Place the finger on one of the veins (preferably the same vein) and push the thumb along the vein toward the hand. Leave the finger in place and observe if the blood flows back into the vein. Now remove the finger and observe what happens.
4. Based on these observations, is it an artery, or a vein? (If it's an artery, then the blood is going to your hand, if it's a vein, the blood is going from your hand, to your heart.)



Listen to the Lub-Dub

When you go for a checkup, your doctor uses a stethoscope to listen carefully to your heart. A healthy heart makes a lub-dub sound with each beat. This sound comes from the valves shutting on the blood inside the heart.

The first sound (the lub) happens when the top two valves close. The next sound (the dub) happens when the bottom two valves close after the blood has been squeezed out of the heart. Next time you go to the doctor, ask if you can listen to the lub-dub, too.

Pretty Cool — It's My Pulse!

Even though your heart is inside you, you don't have to open yourself up to know that it's working. *(Ask students what tells them their heart is working.)* It's your pulse. You can find your pulse by lightly pressing on the skin anywhere there's a large artery running just beneath your skin. *(Ask students where they can find their pulse at.)* Two good places to find it are on the side of your neck and the inside of your wrist, just below the thumb.

Detecting Your Pulse

This activity helps students construct a simple tool to visually detect their pulse. Note: It is always best to test it out yourself before you instruct the students, so you will know the best technique.

Materials:

- Rounded toothpicks
- modeling clay
- stopwatch or visible clock with a hand that shows seconds

Have students try and find their pulse. Tell them that they'll know they've found their pulse when they can feel a small beat under their skin. Each beat is caused by the contraction (squeezing) of your heart. *Have students find and count for 20 seconds and write their number down. Then have them multiply that number by 3. That's how many times their heart beats every minute. When you are resting, you will probably feel between 70 and 100 beats per minute.* Ask the students what other ways there might be of taking someone's pulse. Are there any tools that you can use?

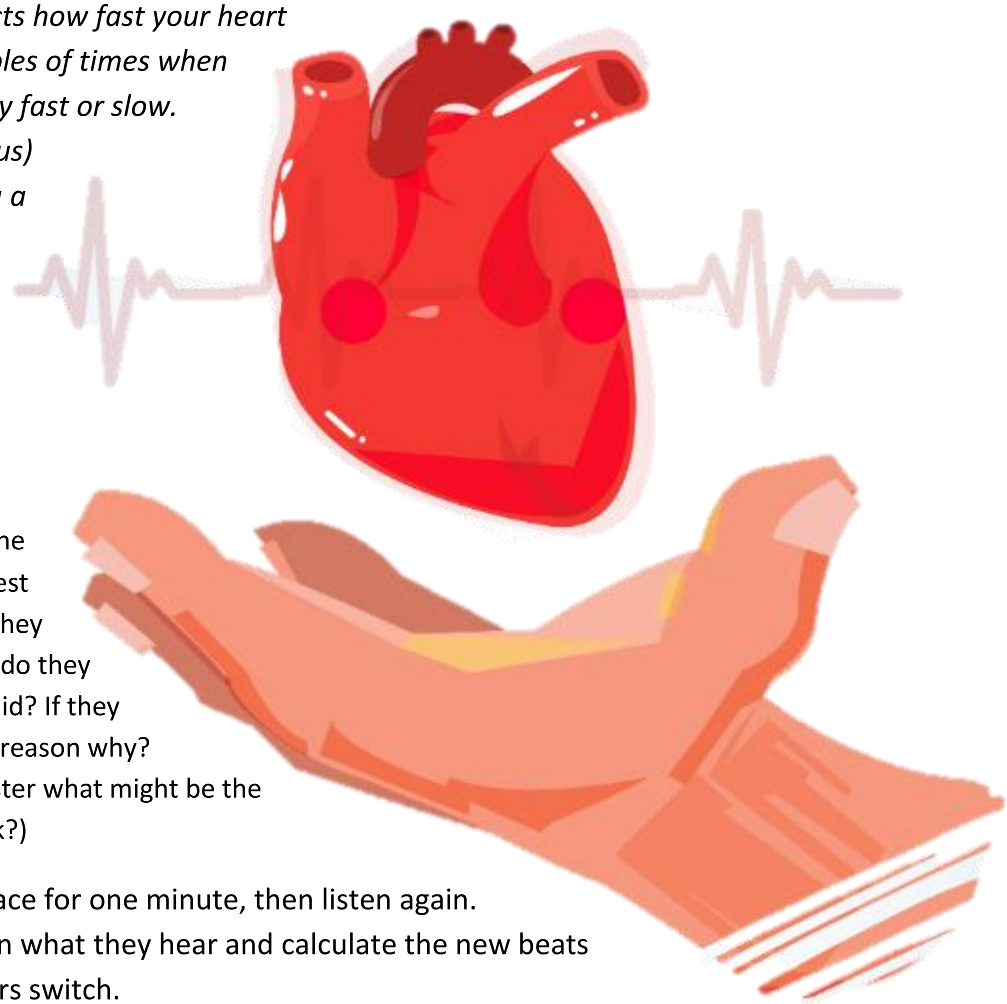
Tell the students you are going to give them some materials to work with and you are going to work together to create a tool that will help them take their pulse.

Give each student a toothpick and a piece of clay. Have students stick the toothpick into a "dime sized" lump of clay. Have students rest the "counter" on the inside of their wrist just below the base of the thumb.

Have students observe the toothpick as it moves. Have students work in pairs to time the counts in 20 seconds. Use this information to determine how many beats per minute. Did they get the same answer as when they measured with their fingers? Which method was more accurate?

Who has the fastest pulse in the group? Who has the slowest?

Ask students if anything affects how fast your heart beats. Have them give examples of times when their heart has beat extremely fast or slow.
(Fast—scared, excited, nervous)
(Slow—sleeping, tired, during a surgery)



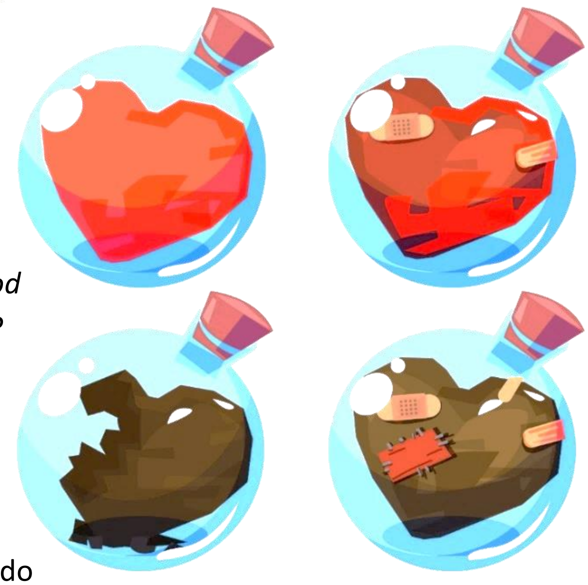
Test it Out! — Do the following pulse experiments

1.Turn off the lights and after one to two minutes have students test their partner's heartbeats. Did they change? Faster or slower? Why do they think they got the results they did? If they were slower what might be the reason why? (more relaxed?) If they were faster what might be the reason why? (Scared of the dark?)

3. Have one partner run in place for one minute, then listen again. Have the students write down what they hear and calculate the new beats per minute. Have the partners switch.

4. Help students come up with more tests such as seeing if holding their breath, going out into cold weather, laughing, or eating hot sauce will raise their pulse rate.

Keep Your Heart Happy



Your heart started pumping blood before you were born and will keep pumping throughout your whole life. Most kids are born with a healthy heart and it's important to keep yours in good shape. *(Ask students what some of the things are they can do to keep their hearts healthy and in good shape. What are some of the things that can hurt your heart? Write them in two columns up on the board.)* Here are some things that you can do to help keep your heart happy:

- Remember that your heart is a muscle. If you want it to be strong, you need to exercise it. *(Ask students for suggestions on how to exercise their hearts.)* How do you do it? By being active in a way that gets you huffing and puffing, like jumping rope, dancing, or playing basketball. Try to be active every day for at least 30 minutes! An hour would be even better for your heart!

- Eat a variety of healthy foods and avoid foods that have a lot of fat and sugar in them. Reading the labels on foods can help you figure out if your favorite snacks contain these unhealthy ingredients
- Try to eat a lot of fruits and vegetables each day.
- Avoid sugary sodas and fruit drinks. *(Ask students what other parts of your body can be hurt by a lot of sugar. Ex. teeth)*
- Don't smoke or use tobacco. It can damage the heart and blood vessels.

Charge Up Your Cardiac Kid!

Materials:

- Red Yarn
- Blue Yarn
- Stick Glue and/or Tape

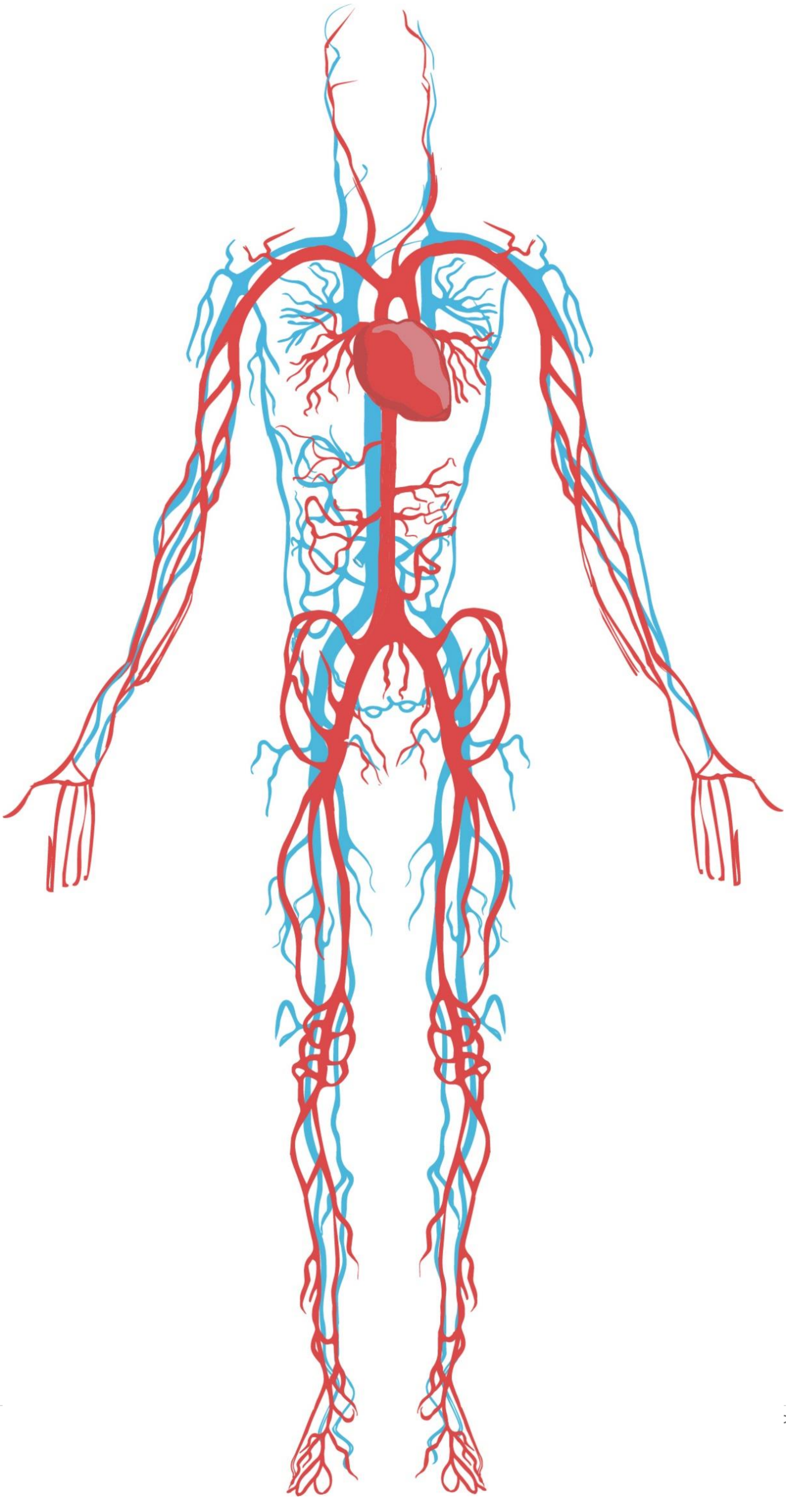
Have students get back into their teams. Give each team a ball of red yarn and a ball of blue yarn.

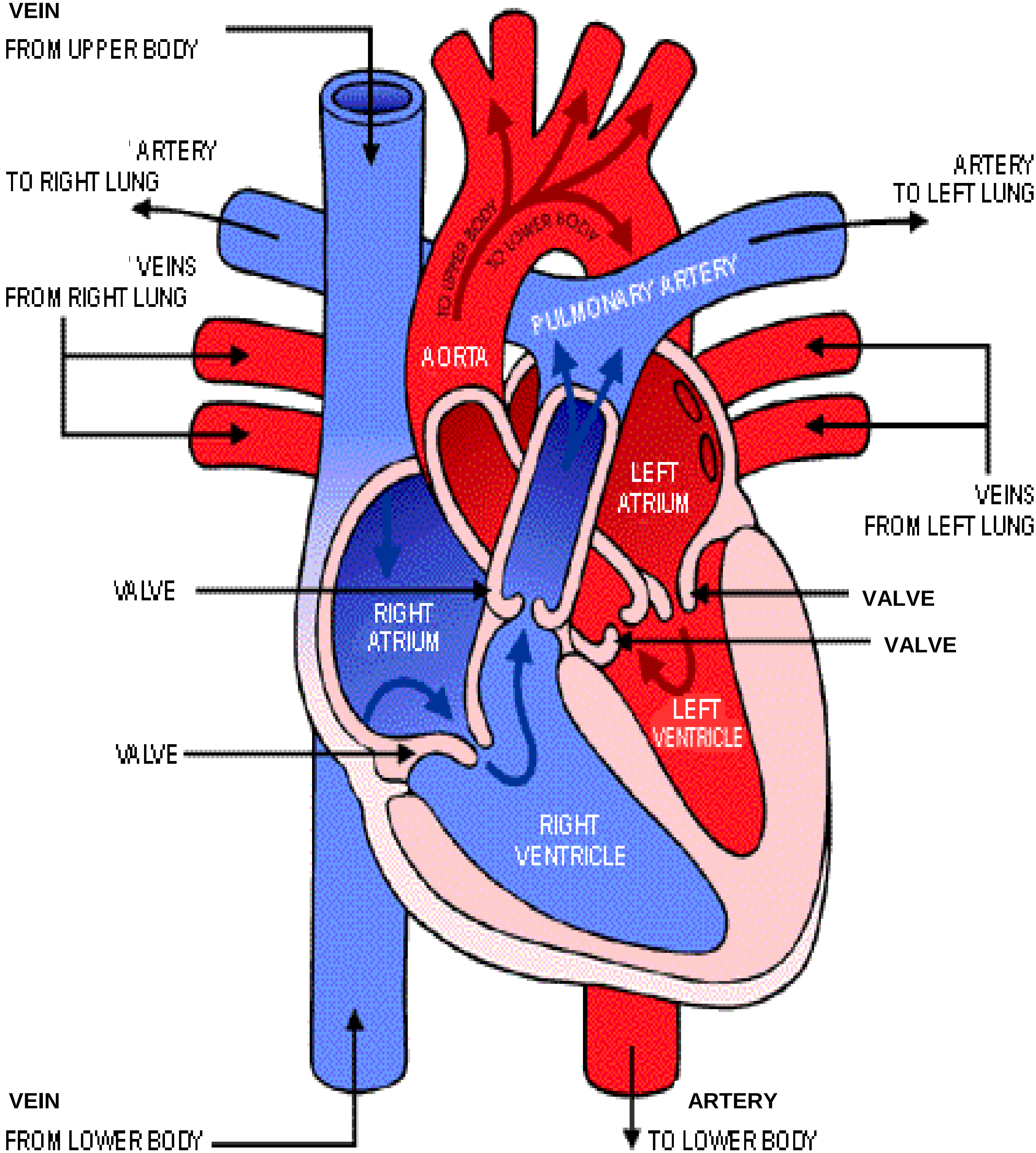
Tell them that in order to power up their Cardiac Kid, he needs to have his circulatory system put in place.

Give each team a diagram of the circulatory system and tell them that at least one vein and one artery must go to each part of the body that is labeled on their pictures. (Including hands, feet, etc.)

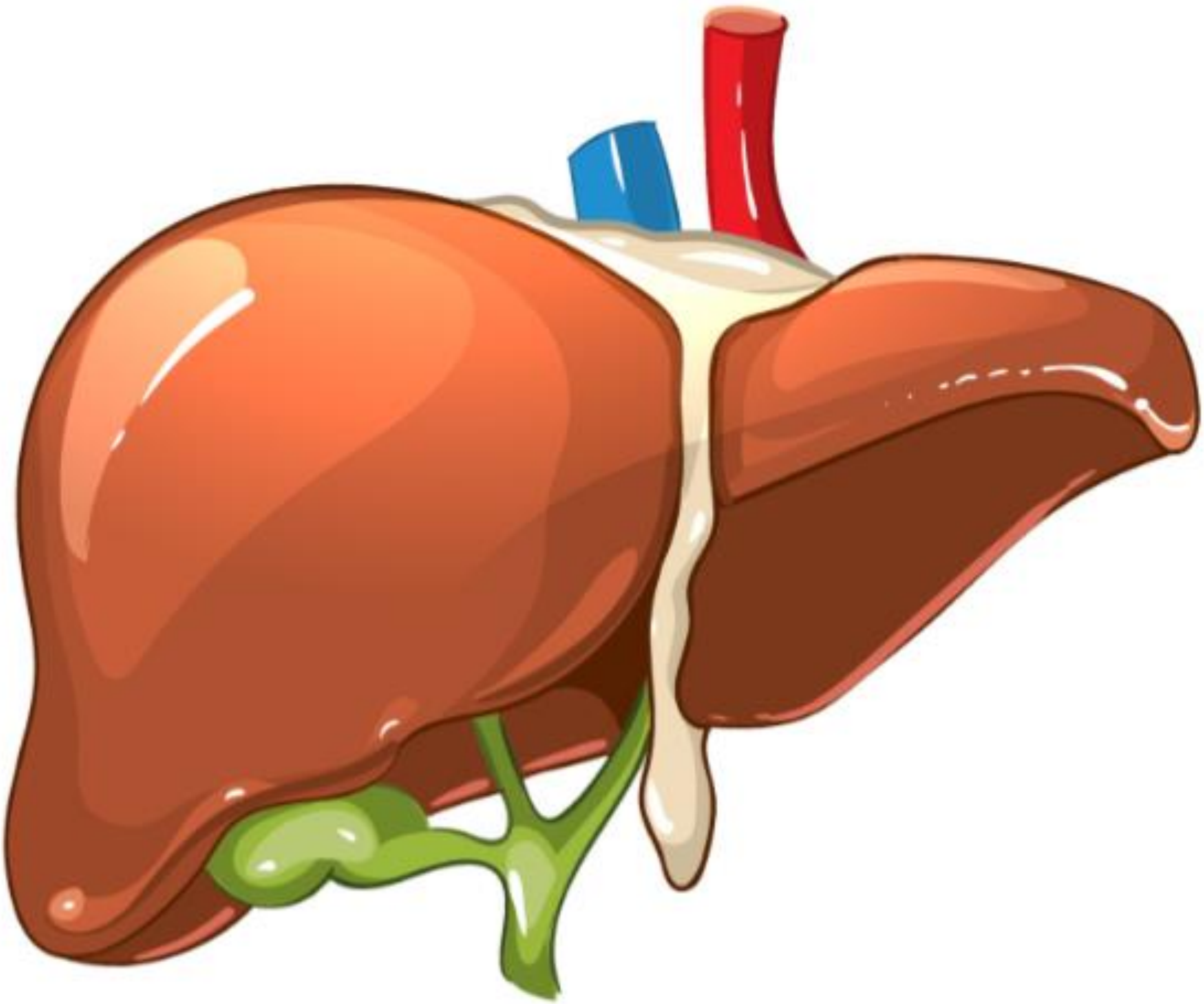
They must glue or tape their veins and arteries into place.

The first team to correctly complete and power up their Cardiac Kid wins!

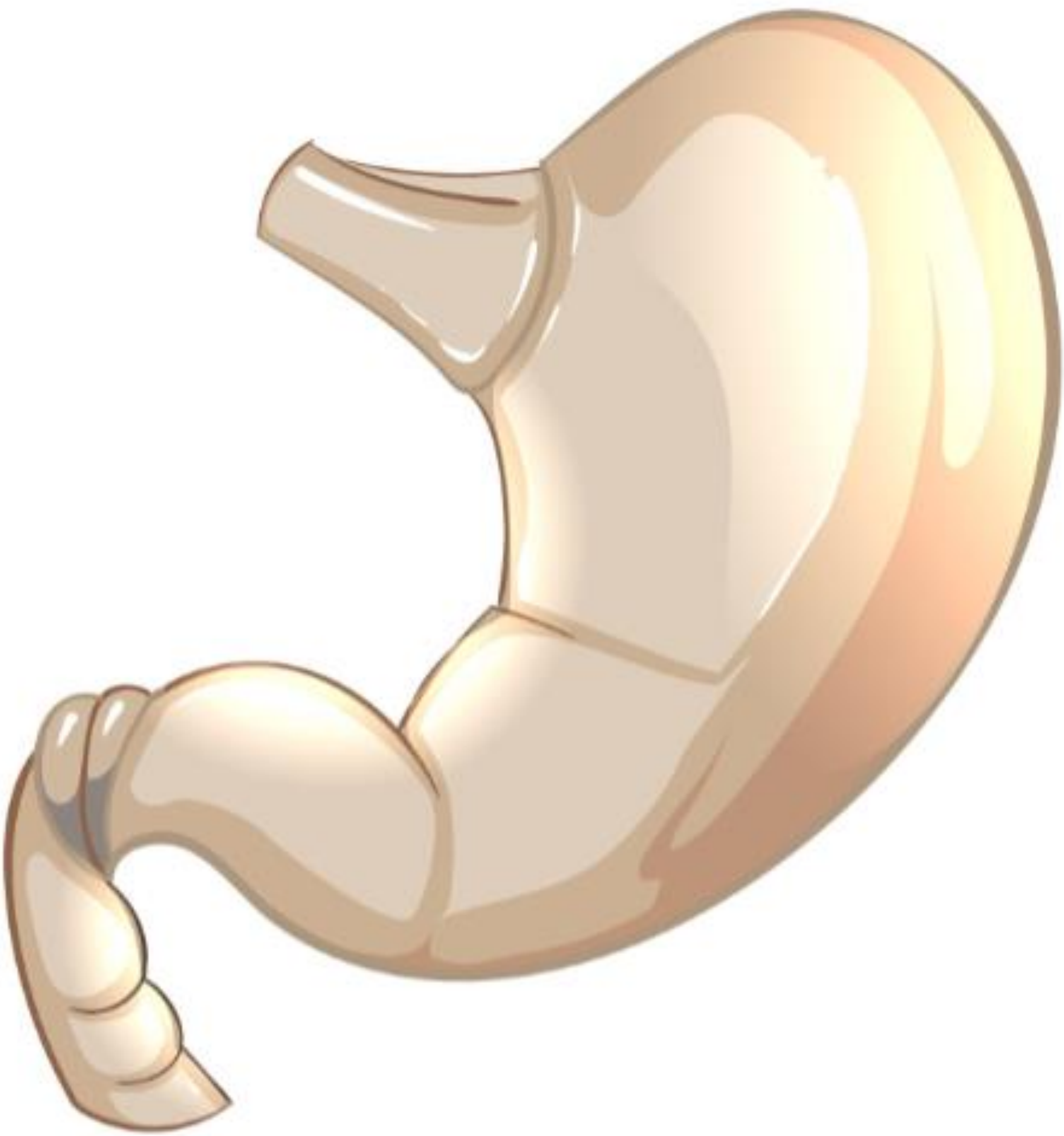



VEIN
FROM UPPER BODY
ARTERY
TO RIGHT LUNG
VEINS
FROM RIGHT LUNG
TO UPPER BODY
TO LOWER BODY
PULMONARY ARTERY
AORTA
ARTERY
TO LEFT LUNG
LEFT
ATRIUM
VEINS
FROM LEFT LUNG
VALVE
RIGHT
ATRIUM
VALVE
VALVE
LEFT
VENTRICLE
VALVE
RIGHT
VENTRICLE
VEIN
FROM LOWER BODY
ARTERY
TO LOWER BODY

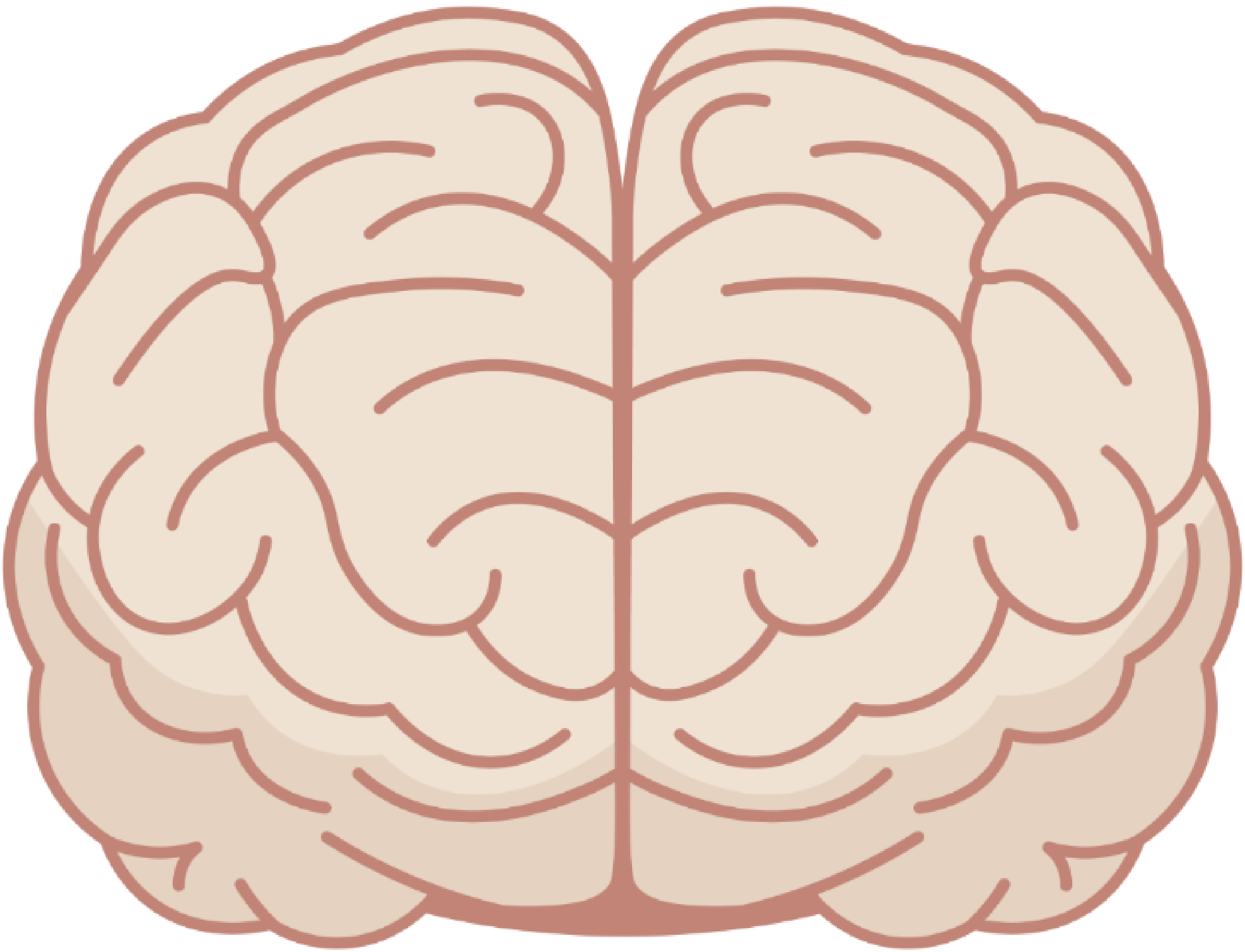
Eyes, Mouth, Nose, Ears



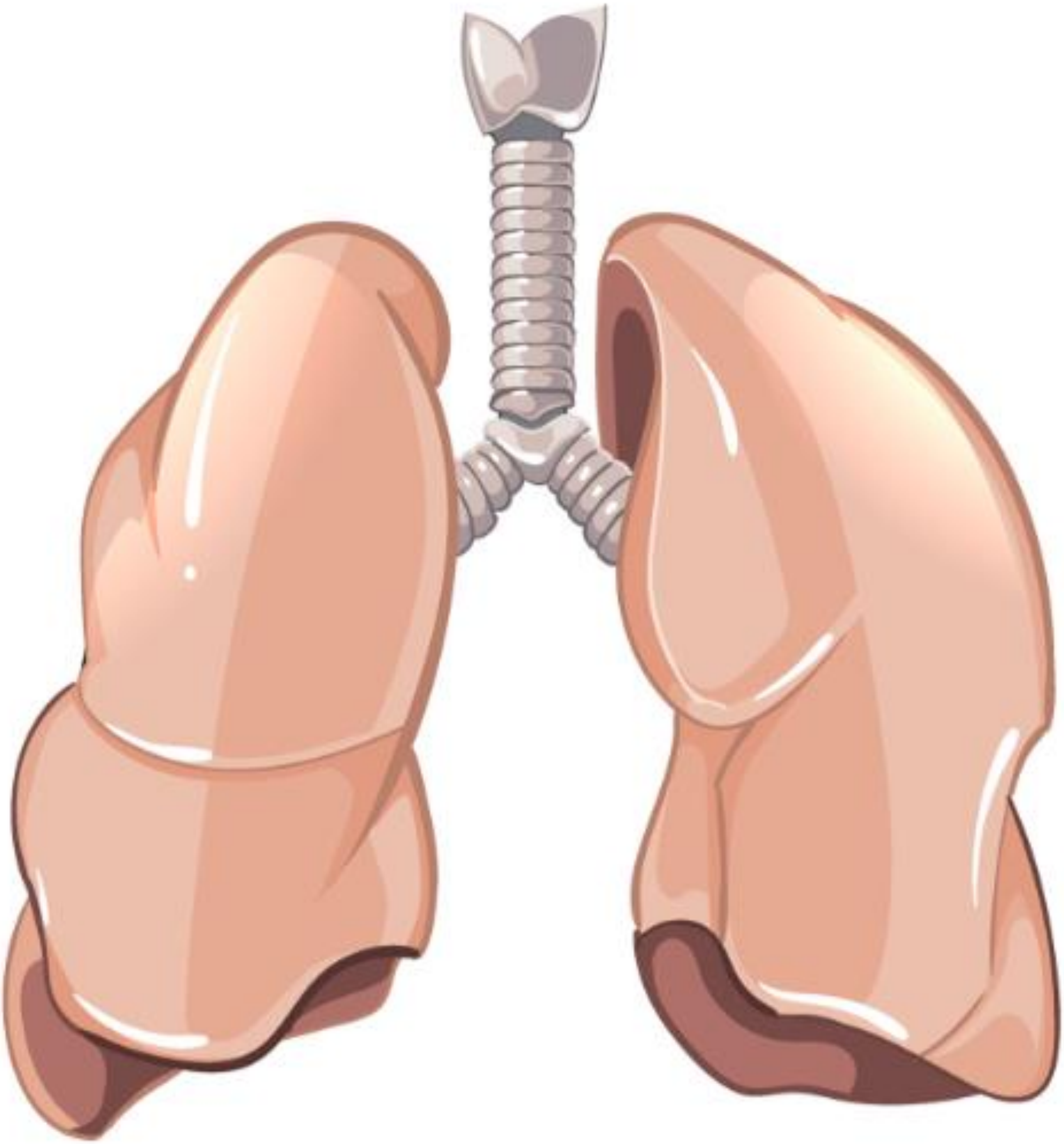
LIVER



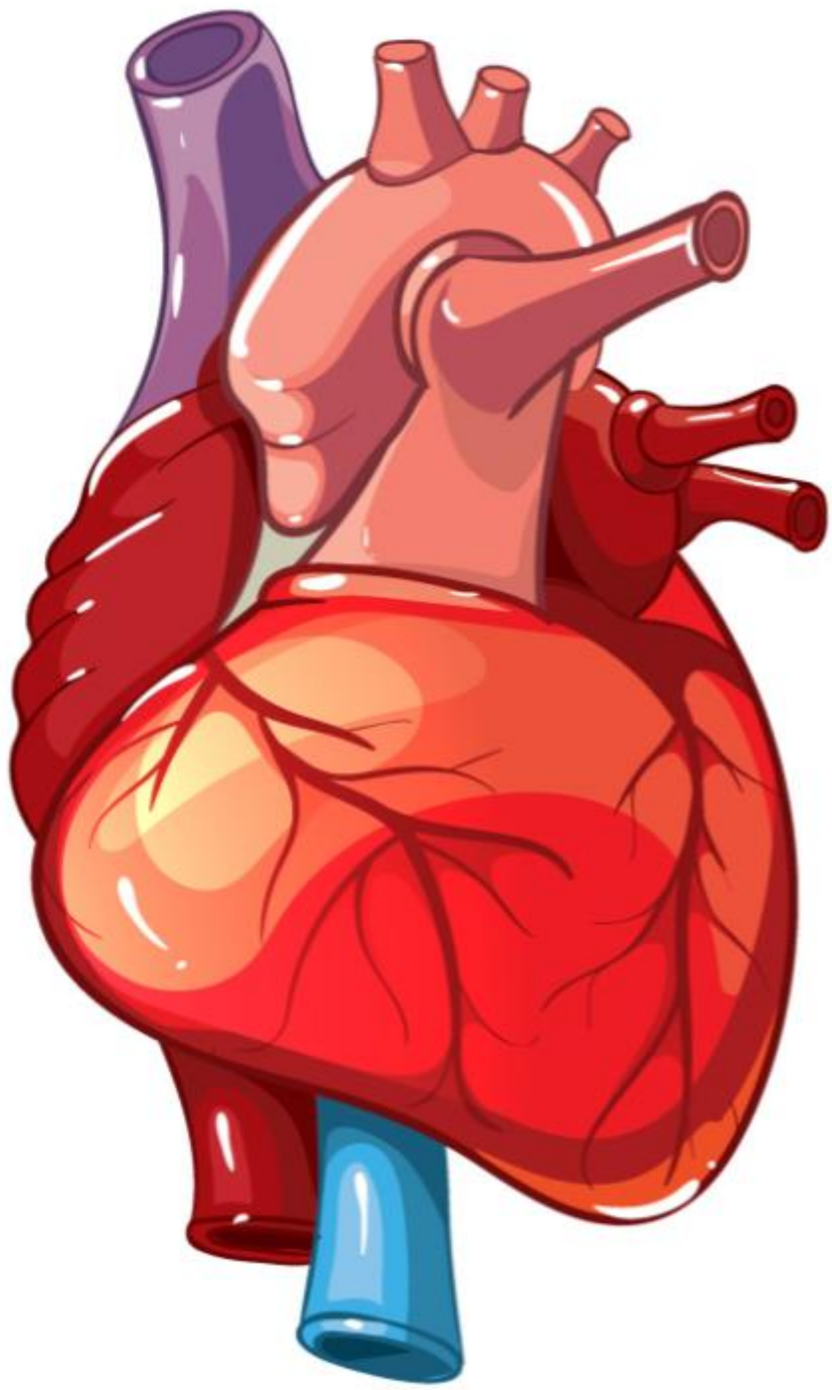
STOMACH



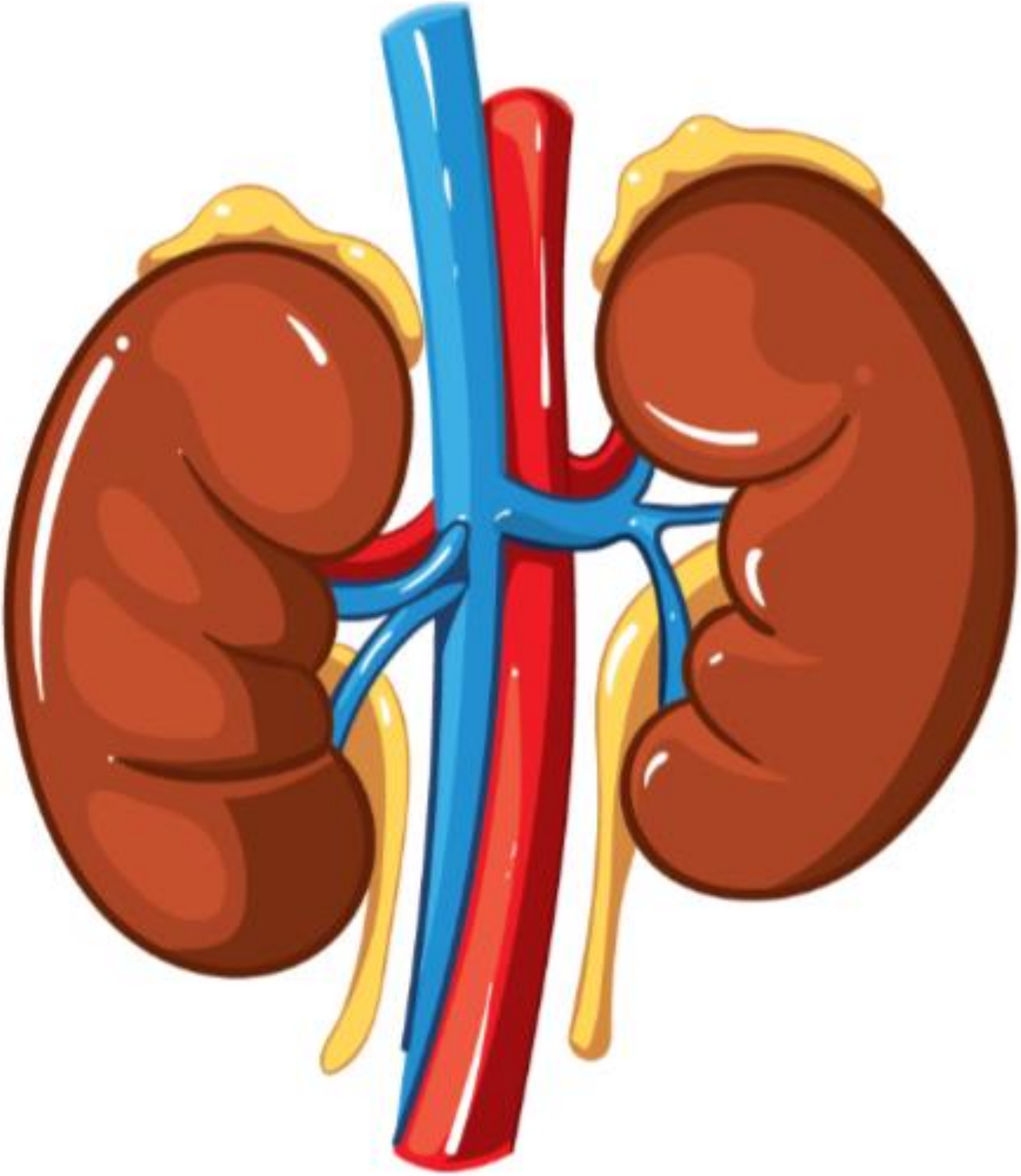
BRAIN



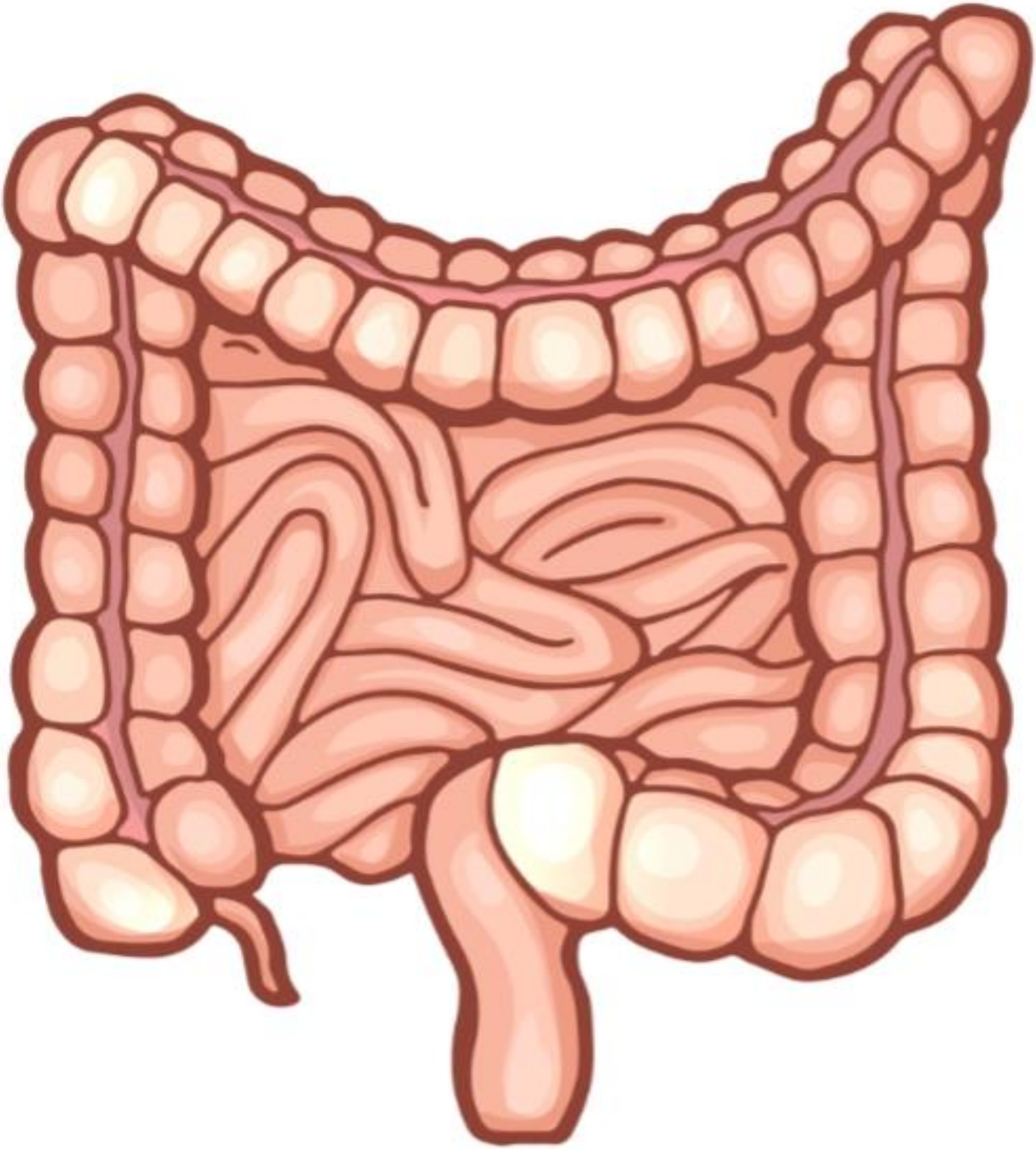
LUNGS



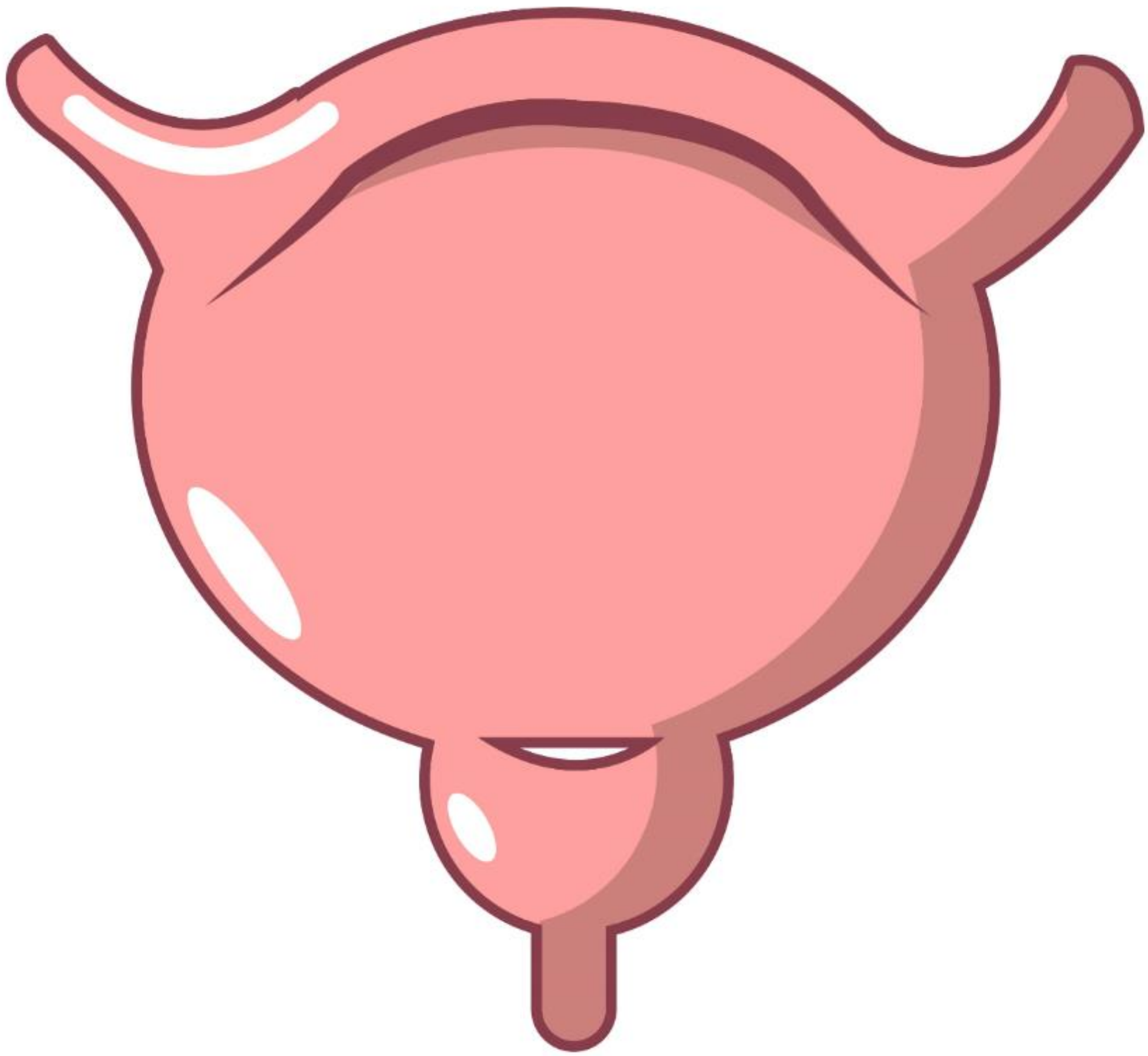
HEART



KIDNEY



SMALL & LARGE INTESTINES



BLADDER

PAGING DR. NAN O. BOT!

ROBOTS TO THE RESCUE?

The idea of armies of microscopic robots patrolling our bodies, cleaning and maintaining them has been a theme in futuristic science fiction for decades. The future is closer than you may think. These days nanobots in medicine are no longer just the realm of science fiction stories or movies like *Inner Space*, it's happening now.

Nanomachines may be tiny – 50,000 of them would fit across the diameter of a human hair – but they have the potential to pack a mighty punch in the fight against cancer and other diseases.

Different scientists are using different approaches in the fight against cancer. The powerful drugs (chemotherapy) that we use to kill cancer unfortunately also kill some healthy cells and cause nasty side effects and can cause permanent damage to our bodies. Of course, the good (saving lives) still outweighs the bad, so we continue to use powerful drugs to kill cancer. But with the latest technology, we can do better.

Cancer survival rates could be hugely improved if scientists are successful in developing microscopic medical weapons that obliterate cancerous cells. Some do this by delivering medicine directly where it is needed. Delivering medicine directly where it's needed not only minimizes side effects but also makes the drugs more effective. That's why researchers are designing tiny robots to precisely carry drugs to cancerous cells while leaving nearby healthy cells alone.

A Targeted Approach

Other researchers are taking a different approach. A team of researchers from Montreal developed an alternative: natural nanobots are almost as good as artificial intelligent nanobots. They used nanotechnology to load bacteria with cancer-fighting drugs and guide them to the cancerous cells. Although the bacteria are quite effective, they can't be customized and controlled as well as a man-made robot.[1]

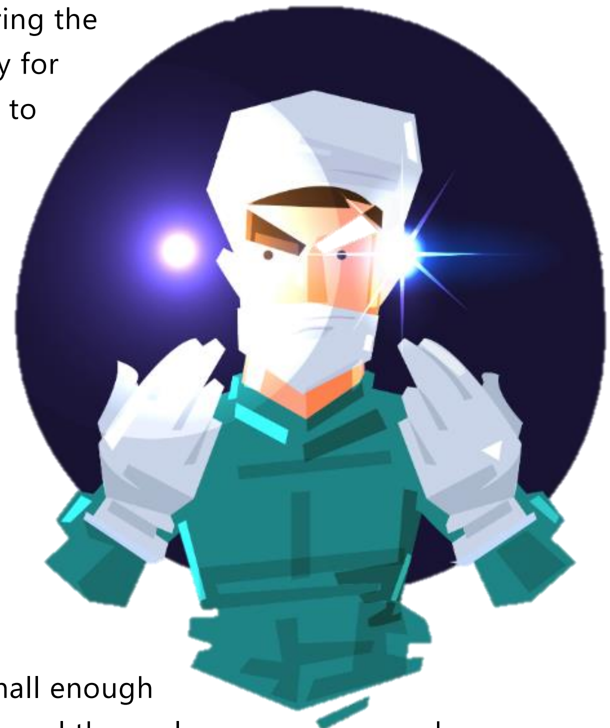
Researchers at Durham University in the UK have used nanobots to drill into cancer cells, killing them in just 60 seconds.[2]

Another clinical trial, done in mice had amazing results. Using a technique called DNA origami scientists from ASU and China programmed tiny robots to carry a blood-clotting enzyme to the blood vessels in tumors. These little biological weapons were able to deliver a dose of lifeblood-blocking, clot-inducing medicine to mice with human breast cancer tumors. Once they reached the surface of the blood vessels they sent the thrombin to the heart of the tumor. Within 24 hours they saw tissue damage on the tumor. Within three days they saw damage on all vessels in the tumor! But perhaps the most significant part of the tech is its precision, at least in the mouse models: The programmed DNA bots avoided causing any clotting or harm to healthy cells, the nanobots passed right by them.[3] That is an extremely important part of the experiment because thrombin can be really dangerous if delivered to the wrong spot in the body. For example, a patient might have a stroke if it was delivered to the brain.[4]

INNER ENGINEERING

[1] Kelly McSweeney *Robotics* Retrieved from: https://www.zdnet.com/article/tiny-robots-attack-cancer/
[2] Sarah Knapton *The Telegraph* Retrieved from: https://www.telegraph.co.uk/science/2017/08/30/nanomachines-drill-cancer-cells-killing-just-60-seconds-developed/
[3] Sy Mukherjee *Fortune* Retrieved from: http://fortune.com/2018/02/13/dna-nanobots-cancer-tumors/
[4] Kristin Houser *Futurism* Retrieved from: https://futurism.com/nanobots-kill-tumors-blood-supply/

Cancer detection and eradication is one thing but tiny nanobots are big players in the future of medicine for other reasons. Scientists are exploring the use of nanobots for a number of healthcare uses, not only for fighting cancer, but also to unblock blood vessels in hard to reach areas, taking biopsies or measuring the level of certain chemicals in otherwise inaccessible areas of the body and going where a surgeon's hands can't reach.



Engineering the Future

A number of hurdles must be overcome, before surgical nanorobots will reach clinical trials. Getting the minuscule robots to travel to a precise site in the body and stay there long enough to carry out a procedure is a big challenge, given the speed and frequency of blood flow in the human body.

To deliver drugs to cancerous cells, nanobots must: be small enough to penetrate a tumor through blood vessels, be able to propel themselves and navigate while avoiding obstacles, have a mechanism for detecting oxygen levels (which indicate active cancer cells), be biocompatible, able to carry drugs, and have on onboard power source. Oh, and on top of all that, they have to be cheap to produce, since they are so tiny that it would take hundreds of millions of robots to deliver the right dosage of drugs. It's a long wish list that even the world's best scientists will struggle to complete. [5]

Welcome to the Team, Lab Rats!

They need your help! You've been invited to join an elite team of biomedical engineers who are striving to solve tomorrow's problems today by thinking up creative or clever solutions to complex medical problems.

Because biomedical engineers often act as a liaison between other types of engineers and

[5] Kelly McSweeney *Robotics* Retrieved from: https://www.zdnet.com/article/tiny-robots-attack-cancer/

physicians, they need good communication skills. They also should enjoy working independently, as well as in groups.

The Head Researcher (aka, the instructor) has handed down a few challenges to get you started as lab assistant. Be bold! Be brilliant! Your crazy idea might be the next great breakthrough!

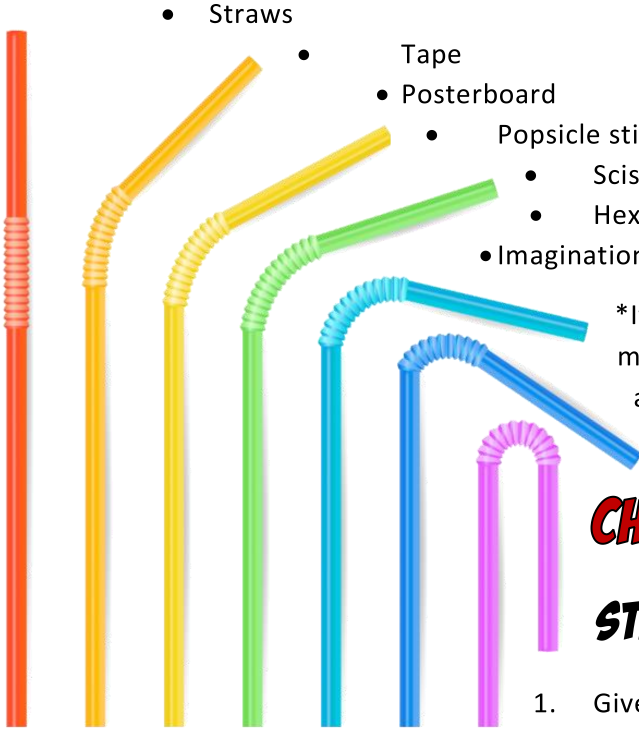
YOUR A-MAZE-ING BODY!

In this activity we'll use play materials you already have like Lego bricks, Magna-Tiles®, and even old wrapping paper and paper towel tubes or straws to create mazes and obstacles for the Hexbug Nano.

This activity is an absolute hit with kids and promotes all kinds of learning: planning, problem solving, engineering and building, creativity and more!

Materials:

- Building toys and materials e.g., blocks, LEGO, Magna-Tiles, Marble run elements, Hexbug building elements, etc.
- Cardboard tubes
- Straws
- Tape
- Posterboard
- Popsicle sticks
- Scissors
- Hexbug Nanos*
- Imagination



*If you've never heard of Hexbugs, they are basically micro robots that are super fun to play with and provide all kinds of learning experiences. You can buy them as singles or in sets of five.

CHALLENGE IDEAS:

STRAW MAZE

1. Give each team one sheet of poster board.

2. Demonstrate how to attach straws to the poster board using tape. Bendy straws work especially well because they can be angled. Show the kids how to cut the straws to whatever lengths they need.
3. Invite teams to create mazes and/or obstacles for their Hexbugs using the provided materials. (Option: Also provide markers for the kids to use to add any details or illustrations to their human body/poster board, such as evil viruses, etc.)[6]

Block Mazes

- Invite your students to create mazes and structures for their Hexbugs nanobots using whatever building toys and materials you have, e.g., blocks, LEGO, Magna-Tiles, Marble run elements, Hexbug habitat building elements, cardboard tubes, etc., and meet the following goals for the research team

Sample Goal Levels:

Level One: Can students build a maze that their hexbug can successfully travel from one end to the other in order to 'apply its medicine' to the target?

Level Two: Can students build a/expand on/modify their maze and make sure that that their hexbug can successfully travel from one end to the other in order to successfully 'apply its medicine' without getting stuck a single time? If it gets stuck 'tissue' could be damaged by the medicine being delivered to the wrong spot!

Level Three: Can students build a maze that demonstrates a special skill that their hexbug nanobot has?

[6] Chelsey *BuggyandBuddy* Retrieved from: https://buggyandbuddy.com/stem-challenge-for-kids-build-a-hexbug-maze-using-straws/

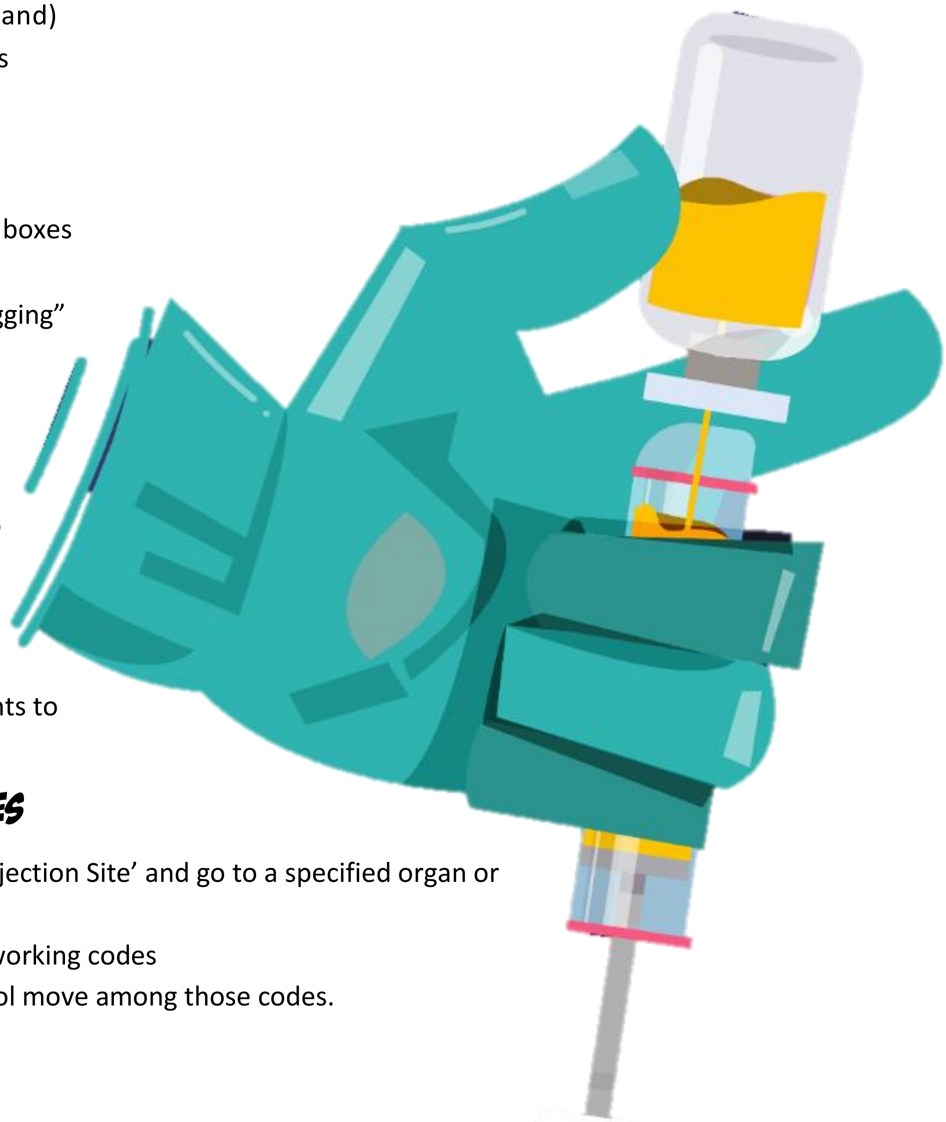
CURING CARDIO KID WITH DR. OZOBOT!

COLOR CODED CURES!

Ozobot reads lines and color combinations on a page, following them almost like a road or a path. Certain color combinations make the Ozobot do tricks, speed up, slow down, among other things. You can see all of the different color codes the Ozobot knows HERE. It also works as a great reference guide.

Materials:

- Ozocode handouts
- Markers (regular or Ozobot brand)
- Optional: Ozobot code stickers
- Paper
- Ozobots: Bit or Evo
- Cardio Kids
- Thin cardboard, ex. From tissue boxes
- Markers
- Strips of white paper for “debugging” or “gauze”
- Scissors
- Clear tape
- Glue stick (be very careful NOT to put the Ozobot on the Cardio Kid if the glue is not dry!)



The Head Researcher (aka, you, the instructor) has set out some challenges for the students/Lab Assistants to accomplish.

LEVEL ONE: CODING COLORFUL CURES

1. The Ozobot needs to start at ‘Injection Site’ and go to a specified organ or ‘tumor’ on your Cardio Kid.
2. There should be at least three working codes
3. There should be at least one cool move among those codes.

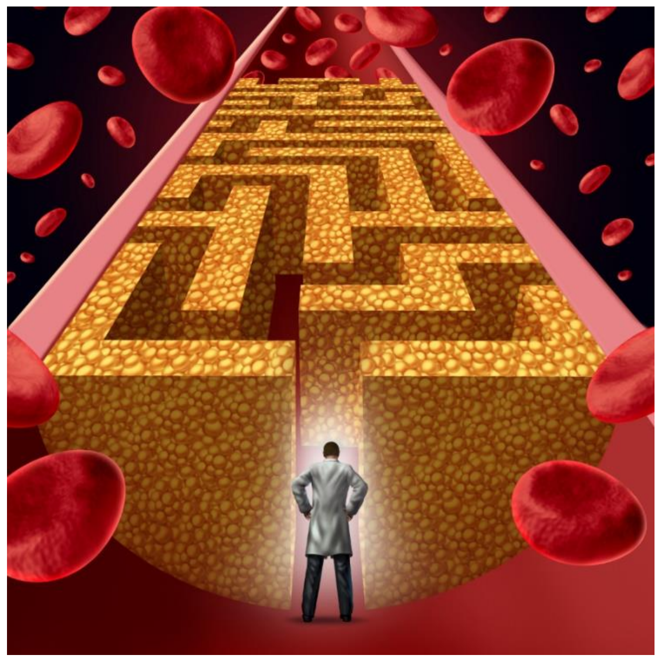
LEVEL TWO: HUMAN TRIALS

At this stage Lab Assistants are ready to incorporate more engineering design thinking. We will still keep all the challenges from the first level, but you'll add in more challenges:

4. The bot must spin to deliver its medicine once it reaches its destination.
5. Build an arterial bypass a.k.a. a bridge or ramp the Ozobot can travel over on your Cardio Kid's circulatory system, preferably near the heart. (Note: the Ozobot is not very powerful so the incline must be very smooth and low. Watch to see if students deduce that if Ozobot has enough momentum, it can navigate the bridge better. They might add a "turbo boost" code just before the ramp.)
6. Create a tunnel tall and wide enough for the Ozobot to pass through somewhere on the body.

Level Three: Going with the Flow

7. Challenge students to create a route that has the bot follow the circulatory system flow in the correct order and direction from the injection site, to the heart, through the body, and/or around the circulatory system.
8. Have the bot 'apply medicine' at multiple spots in the body along the route.



Tip: Demonstrate that to edit codes students can use pieces of white paper to stick over any errors or areas they want to debug or improve. If you use sentence strips in writing, you could compare these to them and perhaps call them "debugging strips" or "gauze strips".

Note: After mastering color coding, kids and teens can advance with Ozobot apps and OzoBlockly, Ozobot's block-based programming language. The Ozobot website has tons of OzoBlockly games and STEM activities for Bit.

Them Bones, They're a Rattlin'

Primary Learning Objectives:

Students will:

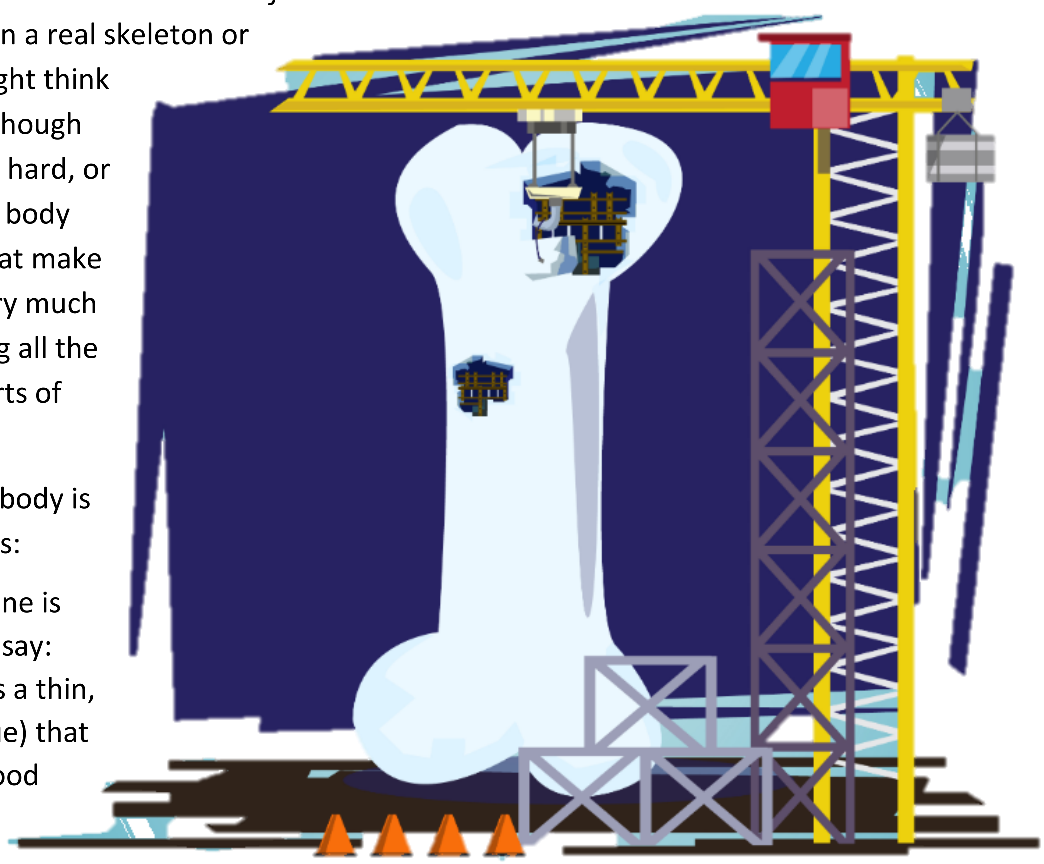
- Recognize that bones are living, growing, and changing body parts.
- Know that all 206 bones have very important jobs and all together they are called the skeletal system.
- Determine that bones are made up of layers and will name and describe each layer and its function and produce a model of the layers of bone structure.
- Recognize the function of the skeletal system is to support the body against the force of gravity, protect soft body parts, produce red blood cells, and to provide sites for muscle attachment to enable body movement.
- Demonstrate their ability to correctly identify bones by name through songs and movement

Every single person has a skeleton made up of many bones, 206 of them in fact if you are an adult. All of these bones have very important jobs and all together they are called our skeletal system. The function of the skeletal system is to support the body against the force of gravity, protect soft body parts, produce red blood cells, store calcium, and phosphorus salts, and to provide sites for muscle attachment to enable body movement. The skull protects the brain and forms the shape of our face. The spinal cord, a pathway for messages between the brain and the body, is protected by the backbone, or spinal column. The ribs form a cage that shelters the heart, lungs, liver, and spleen, and the pelvis helps protect the bladder, and intestines. And while doing all of this, although they're very light, bones are strong enough to support our entire weight.

So, how do they do all of that? Let's find out by taking a look at all of our amazing bones.

What Are Bones Made Of?

(Ask students what they think bones are made of. List their ideas on the board.) If you've ever seen a real skeleton or fossil in a museum, you might think that all bones are dead. Although bones in museums are dry, hard, or crumbly, the bones in your body are different. The bones that make up your skeleton are all very much alive, growing and changing all the time, just like the other parts of your body.



Almost every bone in your body is made of the same materials:

- The outer surface of bone is called the **periosteum** (say: pare-ee-**os**-tee-um). It's a thin, dense membrane (tissue) that contains nerves and blood vessels that nourish the bone.
- The next layer is made up of **compact** bone. This part is smooth and very hard. It's the part you see when you look at a skeleton in a museum. It looks like ivory and is extremely strong. Holes and channels run through it, carrying blood vessels and nerves from the periosteum to its inner parts.
- Within the compact bone are many layers of **cancellous** (say: **kan**-sell-us) bone, which looks a bit like a sponge. Cancellous bone is not quite as hard as compact bone, but it is still very strong. It is made up of a mesh-like network of tiny pieces of bone called **trabeculae** (pronounced: truh-**beh**-kyoo-lee). The spaces in this network are filled with red marrow, found mainly at the ends of bones, and yellow marrow, which is mostly fat.
- In many bones, the cancellous bone protects the innermost part of the bone, the **bone marrow** (say: **mair**-oh). Bone marrow is sort of like a thick jelly, and its job is to make blood cells

- Bones are held together with other bones by long straps called **ligaments** (pronounced: **lih**-guh-mentz), kind of like rubber bands. **Cartilage** (pronounced: **kar**-tul-ij), a flexible, rubbery substance in our joints, supports bones and protects them from rubbing against each other

Take a Little Bite of Bone!

To help students fully grasp the layers of bone have them make edible "bone biopsies." Explain that doctors take biopsies to check how healthy tissues are inside of us. For example, they take samples of marrow to see if people have healthy bones and if the marrow is making enough blood. We are going to make a wedge of bone and see how tasty each layer can be!

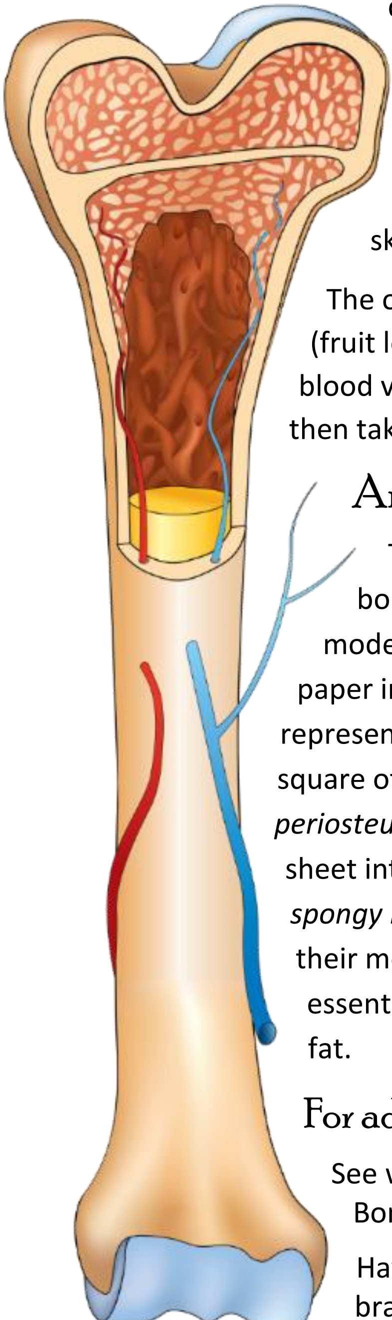
Materials:

- Clear Plastic Cups
- Pudding or yogurt
- Marshmallows or freeze-dried apples
- Sugar Cookies
- Fruit Leather
- Spoons

At the bottom of our biopsy we have bone marrow (chocolate pudding or yogurt)

Bone Marrow**:** Say: **bone mair**-oh Remember, bone marrow is a thick, spongy kind of jelly inside your bones. Bone marrow makes all kinds of blood cells: red blood cells that carry oxygen, white blood cells that fight infections, and platelets that help blood clot.

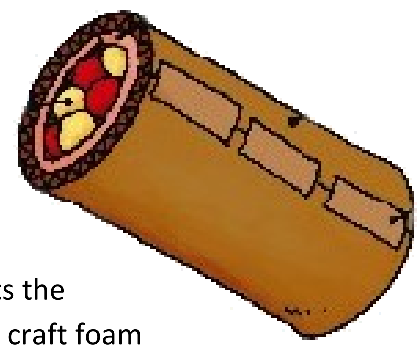
Next, we find our many layers of **cancellous** (say: **kan**-sell-us) bone, (marshmallows or freeze-dried apples) which looks a bit like a sponge. Remember, cancellous bone is not as hard as compact bone is, but it is still very strong.



The next layer is made up of **compact** bone (sugar cookie). This part is . . . smooth and very hard. Instead of being sponge-like, all of this part is compacted, or pushed together. It's the part you see when you look at a skeleton.

The outer surface of our bone sample, the top layer, is called the **periosteum** (fruit leather). It's a thin, dense membrane (tissue) that contains nerves, and blood vessels that bring oxygen and nutrients to the bone. Review the layers, and then take a bite of bone!

Another way to Build a Bone:



To help children understand what the inside of a bone looks like have them make these simple bone models. Have students shape a 2" square of corrugated paper into a tube and tape the ends together. This tube represents *compact bone*. Then have students roll a 2 inch square of printer paper around the bone tube. This represents the *periosteum*. They then roll a 2" square of rubber shelf liner or craft foam sheet into a scroll and insert it into the bone tube. This represents *cancellous* or *spongy bone*, a bone's lightweight inner layer. Finally, students fill the center of their models with red and yellow pompoms. Explain that the *red marrow* produces essential red and white blood cells for the body and that *yellow marrow* stores fat.

For additional basic bone introductions:

See what general bones students know while making either version of Mr. Bone-Jangles.

Have younger students make the simpler Ben and Jerry's version using paper brads and older students can make the full-size version and have the students identify which bone is what as Mr. Bone-Jangles dances to 'Dem Dry Bones' as sung by Louis Armstrong.

Example of how to sing it: at http://www.brownielocks.com/dembones.html Source: Hallmark Halloween.

Lyrics:

The toe bone connected to the heel bone.

The heel bone connected to the foot bone.

The foot bone connected to the ankle bone.

It's easy to connect those dry bones!

The ankle bone connected to the leg bone.

The leg bone connected to the knee bone.

The knee bone connected to the thigh bone.

It's easy to connect those dry bones!

The finger bone connected to the hand bone.

The hand bone connected to the wrist bone.

The wrist bone connected to the arm bone.

It's easy to connect those dry bones!

[Ha! Ha! Ha! Ha! Ha! Oh, yeah! Oh, those bones!]

The arm bone connected to the shoulder bone.

The shoulder bone connected to the collar bone.

The collar bone connected to the neck bone.

It's easy to connect those dry bones!

Well, the neck bone connected to the jawbone.

The jawbone connected to the nose bone.

The nose bone connected to the head bone.

It's easy to connect those dry bones!

[Ha! Ha! Ha! Ha! Ha! Ha! Ha!]

Additional verses can be constructed and sung to help students remember the layers of bones or the scientific names:

Well, the outside of the bone is periosteum.

Periosteum is layered on top of compact bone.

Compact bone layered over cancellous bone.

All to protect that bone marrow!

The phalanges connected to the tarsals

Tarsals connected to the tibia.

Tibia connected to the fibula.

It's easy to connect those dry bones!

Well, fibula's connected to the patella.

Patella is connected to the femur.

Femur is connected to the pelvis.

It's easy to connect those dry bones!

The coccyx is connected to the sacrum.

Sacrum is connected to the vertebrae.

Vertebrae connected to the ribcage.

It's easy to connect those dry bones!

Ribcage is connected to the sternum

Sternum is connected to the clavicle

Clavicle is connected to the scapula

It's easy to connect those dry bones!

Phalanges are connected to the metacarpals

Metacarpals connected to the carpals

Carpals are connected to the ulna

It's easy to connect those dry bones!

Ulna is connected to the radius

Radius is connected to the humerus

And humerus goes back to the scapula

It's easy to connect those dry bones!

Scapula goes back to the vertebrae

Vertebrae connected to the mandible

Mandible's connected to the cranium

It's easy to connect those dry bones!

Cranium has the zygomatic bone

Zygomatic's next to maxillary bone

Maxillary's connected to the sphenoid bone

It's easy to connect those dry bones!

Sphenoid bone connected to the temporal bone

Temporal bone connected to the occipital bone

Occipital bone connected to the parietal bone

It's easy to connect those dry bones!

Parietal bone connected to the frontal bone

Frontal bone connected to zygomatic bone

These are the bones of the cranium

It's easy to connect those dry bones!

Additional Songs:

You can sample the tunes at the following websites:

- The Bones Song (http://www.songsforteaching.com/scienceinsong/206bones.htm)
- Bones (http://www.songsforteaching.com/jennyfixmanedutunes/bones.htm)
- Identifying Bones in the Body. Right Here! (http://www.songsforteaching.com/humanbodyanatomyphysiology/identifyingbones.htm)

"My Cranium" songs

Sung to the tune of the Macarena. It works best if you have the tune playing while you sing it. Students can dance and point to every bone as its name is sung.

My Cranium—short version

Tarsals-Fibula-Tibia-Patella

Femur-Pelvis-Ribs-Sternum

Carpals-Ulna-Radius-Humerus

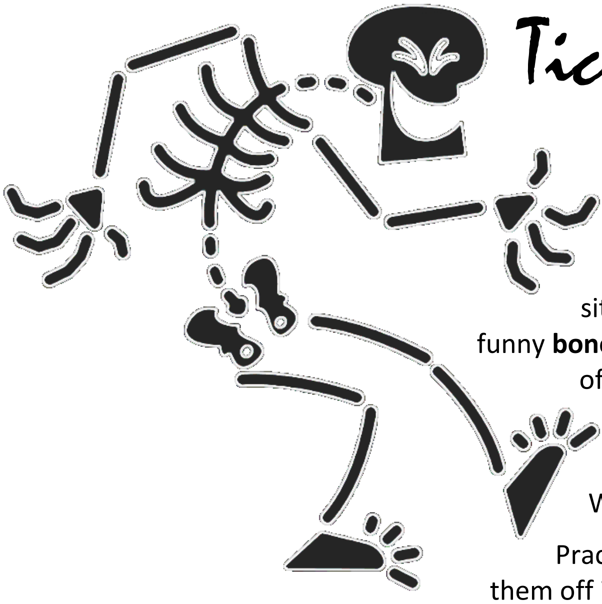
Hey, my Cranium!

My Cranium—longer version

Cranium, mandible,
clavicle and sternum
These are my bones and I'm a gonna learn 'em
Scapula, vertebrae, ribs all around me
Hey, my cranium

Humerus, radius, ulna and carpals
Metacarpals, flanges, this is my pelvis
Elvis used to sing and move around his pelvis
Hey, my cranium.

Coccyx, femur, patella, tibia
Fibula, tarsals,
metatarsals, flanges
Yes, both fingers and toes are flanges
Hey, my cranium.



Tickle My Funny Bone!

Wait! Hold on a minute. Why didn't we mention the funny bone in our song? Where is it? Did it get lost?

In order to find your funny bone, you've got to be open and brave and curious. You've got to be willing to risk it all . . . each time you sit down to write. Wait, write? I thought we were talking about a funny **bone**. We are, but we've got to write to find it. So, here we go. We're off to find our funny bones.

Share poems by Shel Silverstein, Jack Prelutsky, Jeff Moss, Judith Viorst, Bruce Lansky, and other popular poets with your students. What makes them laugh? Why do they think something is funny?

Practice writing funny poems together to give students ideas, then send them off in search of their funny bones. If they start to complain…have them write their favorite complaints down. They'll be writing an "I can't write a poem" poem! This is one poem every one of your students can write.

Why? Because it's so easy and so much fun. All they have to do is to make a list of their favorite excuses/complaints they make every time you ask them to write or great reasons why they "just can't!"

Getting started: Throw them a bone!

As you demonstrate with your own poem, choose a very ordinary excuse for why you can't possibly write a poem right now. For example, you might decide to say that you can't write a poem because you don't have any paper to write on. Next, think of a really outrageous reason why there's no paper available. What if it was because your bookbag had been set on fire? It might start like this:

"I can't write a poem today.
You'll think that I'm a liar,
but all my paper is in flames.
My bookbag is on fire!"

That's a good start. Now the reader of your poem will be wondering how in the world your bookbag was set on fire. In the rest of the poem, you can tell the story of how it happened. Perhaps a fire-breathing dragon wandered into your classroom. Maybe aliens blasted it with a laser. Maybe you accidentally dropped it in a volcano. Your poem could end up being as long or short as you want, depending on how long it takes to tell your outrageous story.

Be sure to end your poem with a line or two that reminds the reader how impossible it is for you to write a poem today. Of course, since you did just write an entire poem, the last line will be very funny because it is no longer true!
It can be fun to use rhymes to make this type of poem. Often, thinking of rhyming words can help to suggest crazy things that might happen next in the poem. But it's also okay to use free verse (a type of poetry without end rhymes) if you want. A free verse poem could start with the words "I can't write a poem because…" and then list all the reasons why it's impossible. End the poem with a line stating that it is obviously impossible to write a poem right now.

Add the right ending and it just might turn into a great poem that will tickle their funny bone, like Bruce Lansky's.

To get them started, give them the title and the lines from the following poem starting from, "Times up?" to "Thanks a lot." Then ask them to come up with some excuses-- the more ridiculous and crazy, the better. Maybe they'll come up with the last line, "Would you like to see another one?" all on their own.

Here's how Bruce Lansky's turned out:

I Can't Write a Poem

Forget it.
You must be kidding.
I'm still half asleep.
My eyes keep closing.
My brain isn't working.
I don't have a pencil.
I don't have any paper.
My desk is wobbly.
I don't know what to write about.
And besides, I don't even know how to write a poem.
I've got a headache. I need to see the nurse.
Time's up? Uh oh!
All I have is this dumb list of excuses.
You like it? Really? No kidding.
Thanks a lot. Would you like to see another one?

-Bruce Lansky [7]

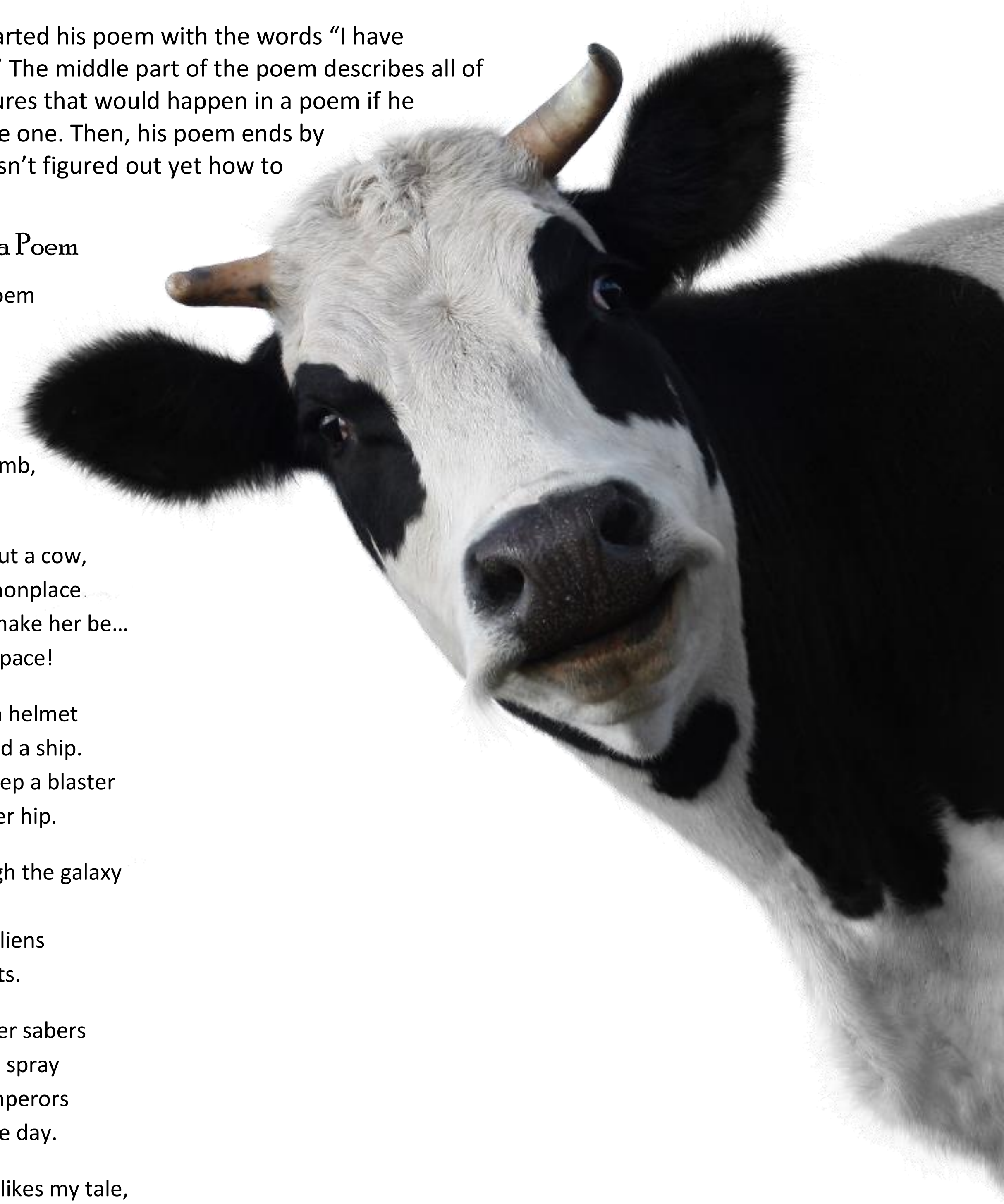
Put a little meat on that bone!

Here is an example of a rhyming poem that Kenn Nesbitt wrote about not knowing how to write a poem. As he says, "It can be fun to use rhymes to make this type of poem. Often, thinking of rhyming words can help to suggest crazy things that might happen next in the poem.

[7] Bruce Lansky "I Can't Write a Poem" Retrieved from: http://www.poetryteachers.com/poetclass/lessons/cantwrite.html

But it's also okay to use free verse (a type of poetry without end rhymes) if you want. A free verse poem could start with the words "I can't write a poem because…" and then list all the reasons why it's impossible. End the poem with a line stating that it is obviously impossible to write a poem right now."

Notice that he started his poem with the words "I have to write a poem." The middle part of the poem describes all of the crazy adventures that would happen in a poem if he were able to write one. Then, his poem ends by saying that he hasn't figured out yet how to write the poem.



I Have to Write a Poem

I have to write a poem
but I really don't
know how.
So maybe I'll just
make a rhyme
with something dumb,
like "cow."

Okay, I'll write about a cow,
but that's so commonplace
I think I'll have to make her be…
a cow from outer space!

My cow will need a helmet
and a space suit and a ship.
Of course, she'll keep a blaster
in the holster on her hip.

She'll hurtle through the galaxy
on meteoric flights
to battle monkey aliens
in huge karate fights.

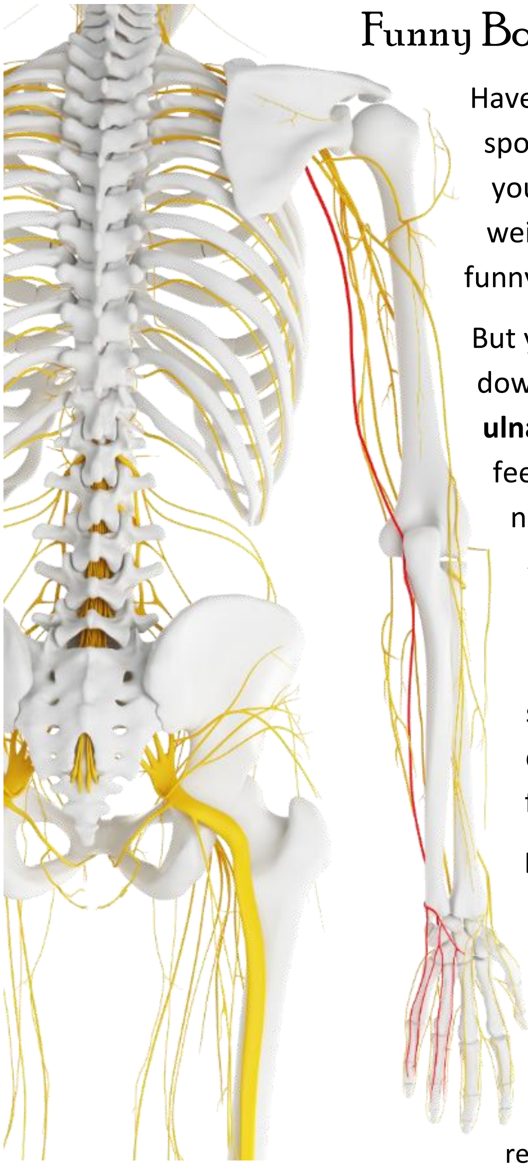
She'll duel with laser sabers
while avoiding lava spray
to vanquish evil emperors
and always save the day.

I hope the teacher likes my tale,
"Amazing Astro Cow."

Yes, that's the poem I will write
as soon as I learn how.

-Kenn Nesbitt[8]

Note to teacher: You don't have to worry about rhythm and perfect rhyme when you judge these poems. The main question is: Are they imaginative? Are they fun to read?



Funny Bone Facts:

Have you ever hit the inside of your elbow in just the right spot and felt a tingling or prickly kind of dull pain? That's your funny bone! It doesn't really hurt as much as it feels weird. The "funny bone" got its nickname because of that funny feeling you get after you hit it.

But your funny bone isn't actually a bone at all. Running down the inside part of your elbow is a nerve called the **ulnar nerve**. The ulnar nerve lets your brain know about feelings in your fourth and fifth fingers. It's also one of the nerves that controls some movement of your hand.

You get that funny feeling when the ulnar nerve is bumped against the **humerus** (say: **hyoo**-muh-rus), the long bone that starts at your elbow and goes up to your shoulder. Tapping your funny bone doesn't do any damage to your elbow, arm, or ulnar nerve. But it sure feels strange!

People sometimes mention the funny bone when they talk about their sense of humor. Maybe you've heard someone say, "that really tickled my funny bone."

Additional ways to review bones:

Skeleton Name Game

(Using the Reproducible) Invite student partners to use the reproducible game board to practice naming and spelling different bones of the body. First hand out copies of the Skeleton Name Game Reproducible(PDF) below. Have student pairs fold the paper in half and hold it between them. Then have students try one of these challenging games.

[8] Kenn Nesbitt "How to Write a Poem About Why You Can't Write a Poem" Retrieved from: http://www.poetry4kids.com/news/how-to-write-an-i-cant-write-a-poem-poem/

Skeleton Jeopardy: Students take turns quizzing each other Jeopardy-style on the names and locations of these major bones, asking "What is the collar bone?" "What is the clavicle?"

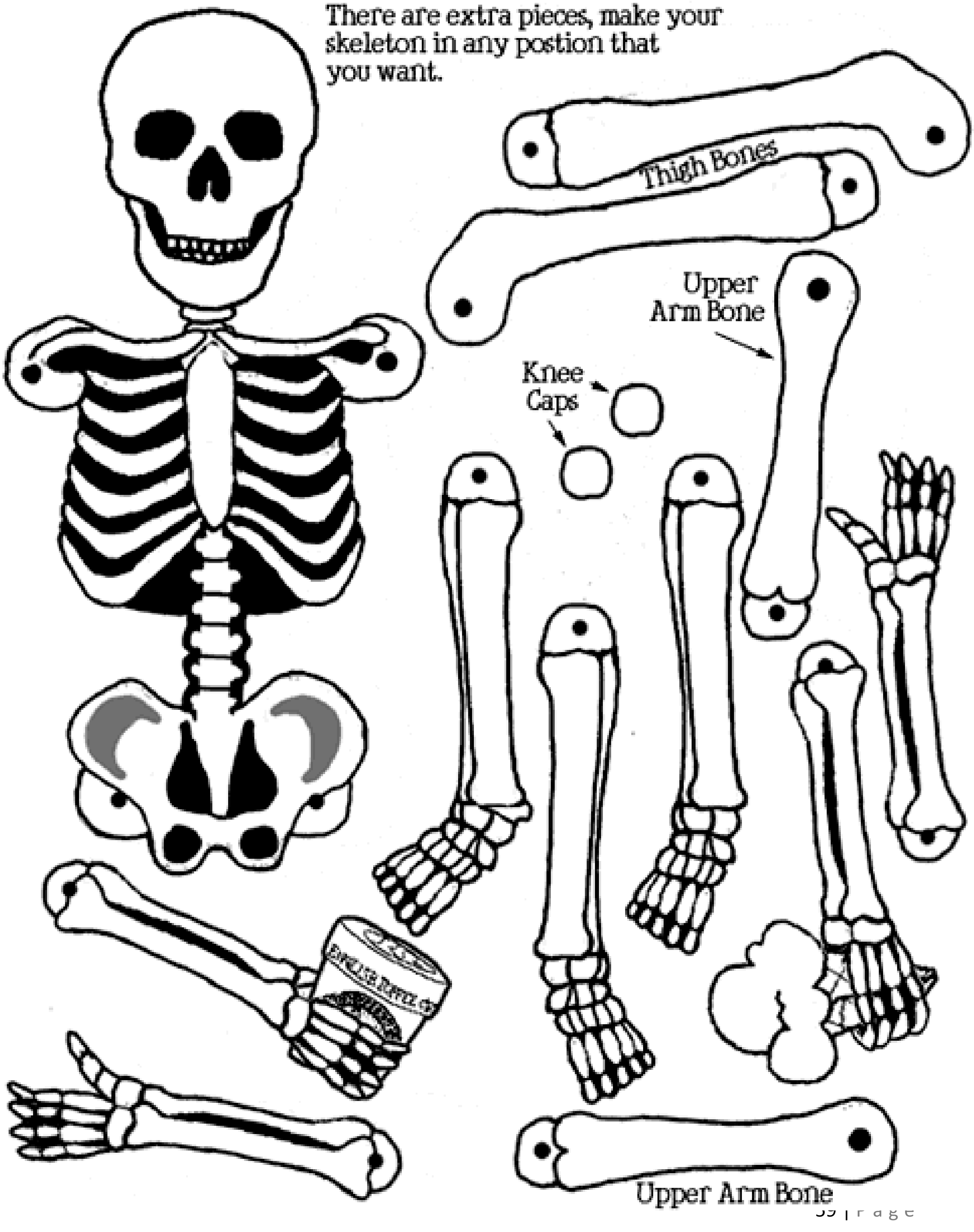
Spell-a-ton: The student facing "Side One" gives bone names to his or her partner, asking, for example, "How do you spell clavicle?"

Skeleton Challenge: One student holds the reproducible and reads the clues on Side Two, while the other answers unaided. [9]

[9] Mackie Rhodes "Super Skeletons" Retrieved from: https://www.scholastic.com/teachers/articles/teaching-content/super-skeletons/

From Ben & Jerry's • http://www.benjerry.com

There are extra pieces, make your skeleton in any postion that you want.

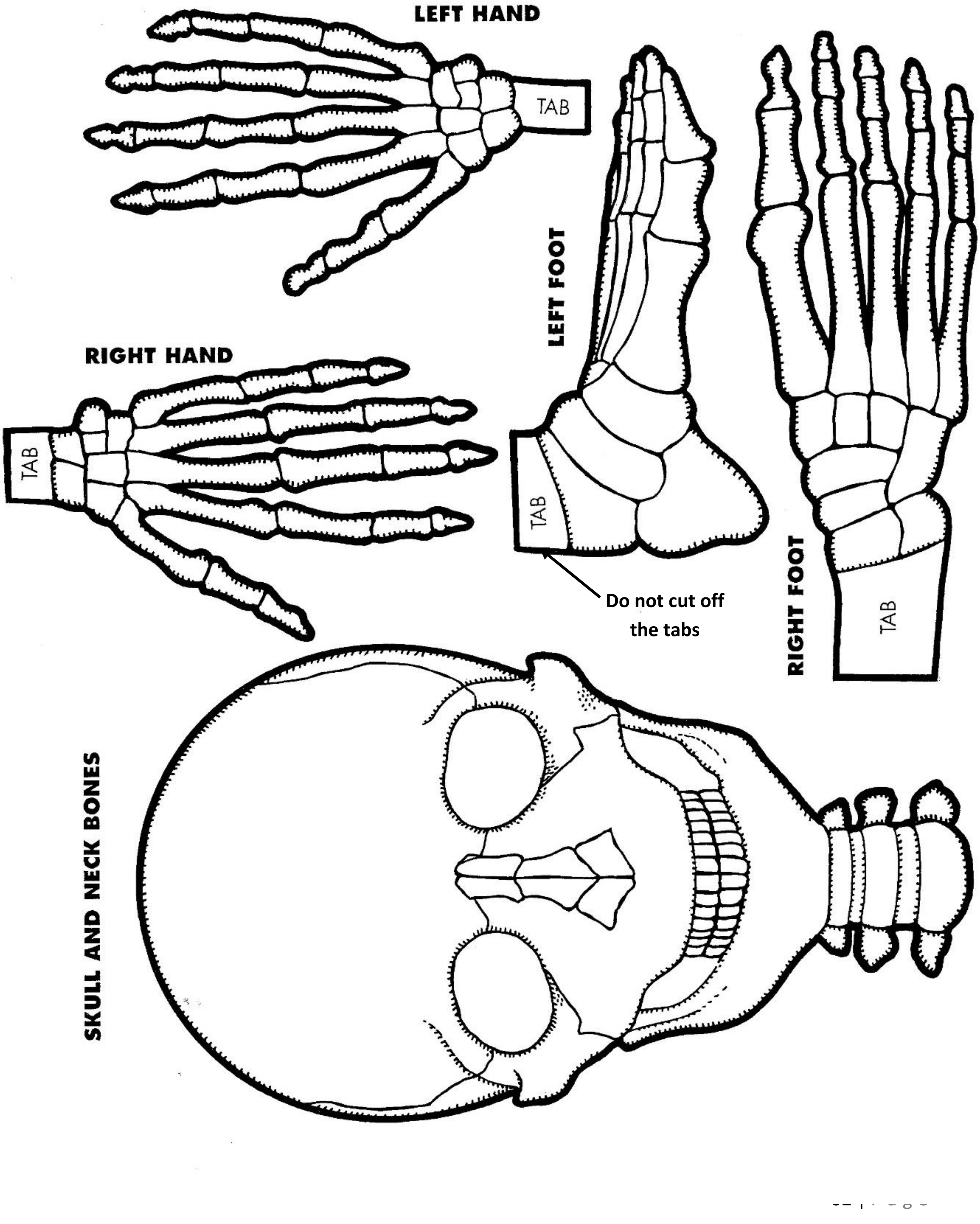


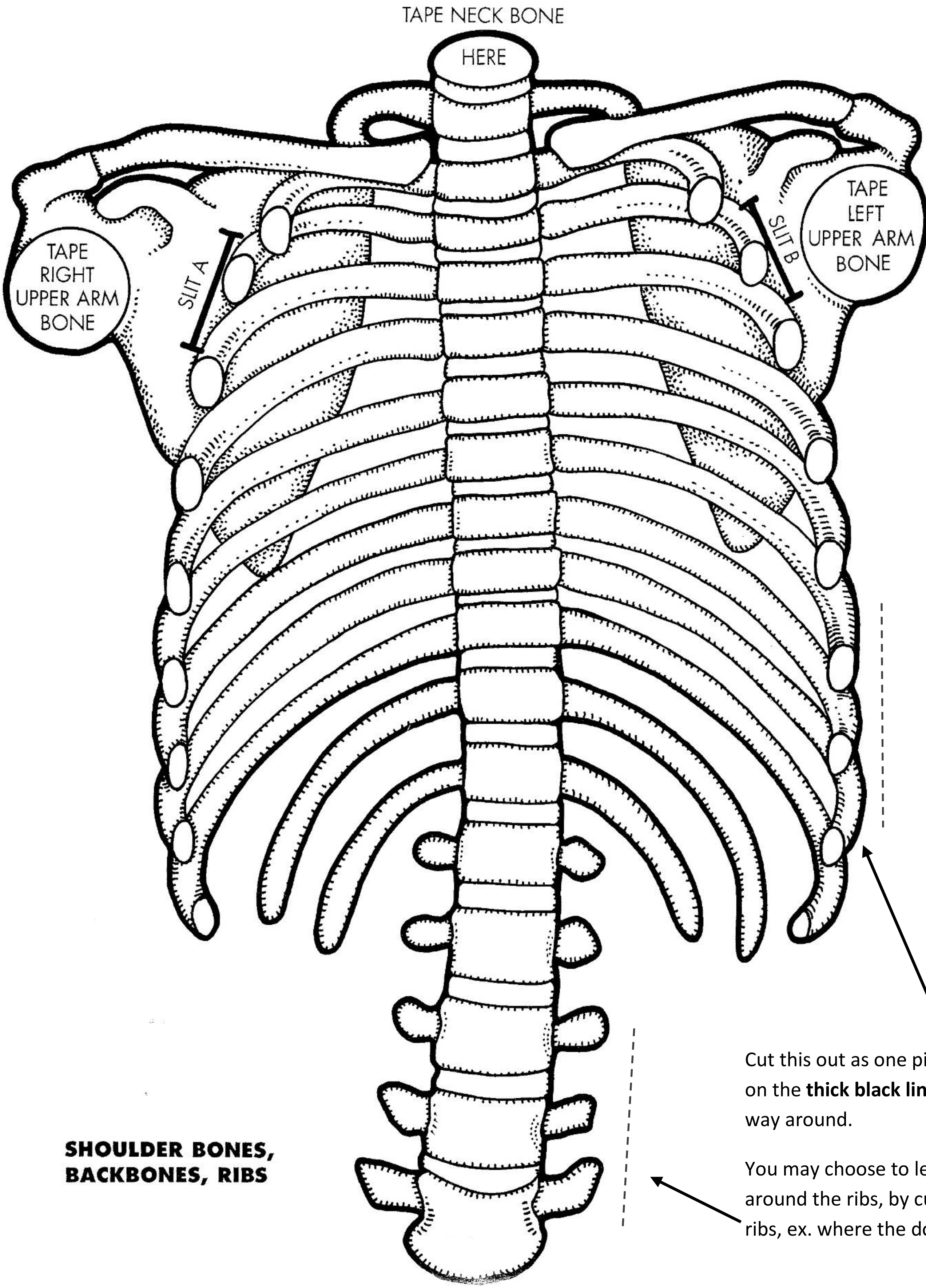
Putting Big Mr. Bone-Jangles Together

Make a set of sheets for each student. You may wish to print them off on cardstock for durability but copy paper will be easier to push brads through and glue. You will want a few spares for the students who ignore instructions and cut off tabs, etc.

1. Remind and review with students that they will only be cutting on the **heavy black lines** not on any of the thinner lines. And emphasize that they will NOT cut off the tabs.
2. Have each student cut out the skull and neck bones as one piece and set aside the hands and feet for later.
3. Have students cut out the spinal cord and rib cage only on the heavy black lines and have them cut it out as one piece, then tape the skull and neck bones on top of backbone.
4. Students will then cut out the pelvic bone and set aside the arm bones for later.
5. Have students glue the lowest bone of the backbone to the pelvis.
6. Next, students will locate the upper and lower left arm bones and cut them out. Then they will glue the elbow tab **behind** the end of the upper arm bone with the black dot that is labeled elbow. When that dries the students will glue the top of the left upper arm bone to the shoulder bone by the ribcage where it indicates to glue/tape it.
7. Then students will repeat the same process to make the right arm.
8. Have students find the pieces for the upper and lower leg bones and cut them out. They will tape the tab that is below the kneecap on the long bone **behind** the end of the bone with the black dot and then tape the top of that bone to the pelvis.
9. Then students will repeat the same process to make the right leg before taping on the kneecaps.
10. Now, it’s time to cut out the left hand and left foot and glue them to the left arm and left leg and then do the same process for the right hand and right foot.
11. Have students cut out their outer ribcage piece and have them work slowly to cut along the outer **heavy black line.** When it’s cut out and ready to go then students will carefully cut it open along the dark cut line down the middle. (Remind students there is no such cut inside of them, they are only cutting it so they can see inside the ribcage.)
12. Students will now find the slit a and slit b marks on their models and carefully cut along each slit line. For younger students the teacher may wish to take a craft knife and slit it for the students.

13. Once the slit is cut students will insert Tab A and Tab b into their slots and tape them down on the back before folding the other two tabs down and taping each to the back of the model. Students can now look inside their own ribcage!

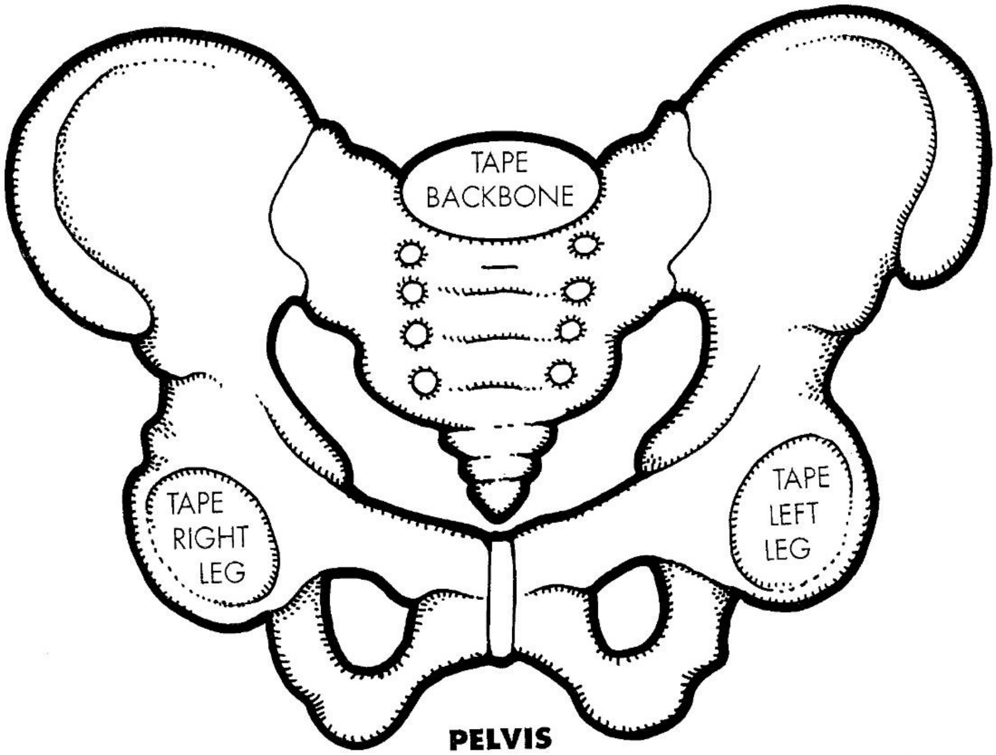

LEFT HAND
TAB
RIGHT HAND
TAB
LEFT FOOT
TAB
RIGHT FOOT
TAB
Do not cut off the tabs
SKULL AND NECK BONES



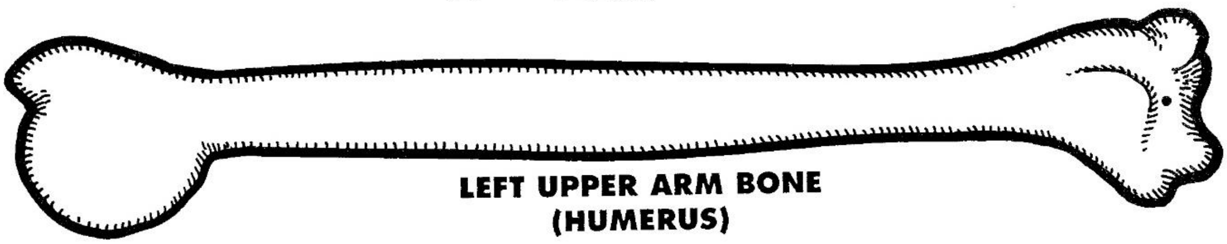
Cut this out as one piece and cut only on the **thick black lines** going all the way around.

You may choose to leave some white around the ribs, by cutting around the ribs, ex. where the dotted lines are.

SHOULDER BONES, BACKBONES, RIBS

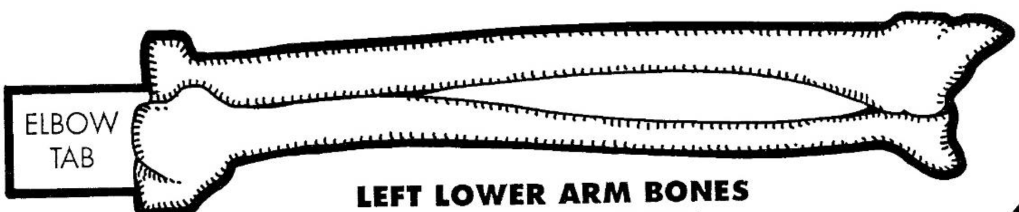


PELVIS

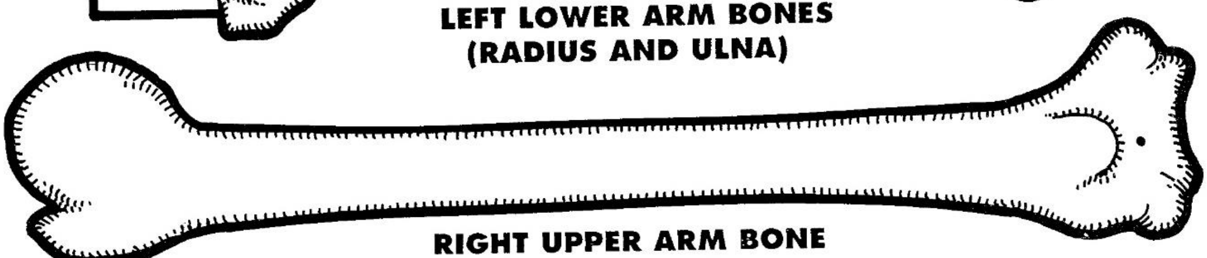


**LEFT UPPER ARM BONE
(HUMERUS)**

Do not cut off the tabs

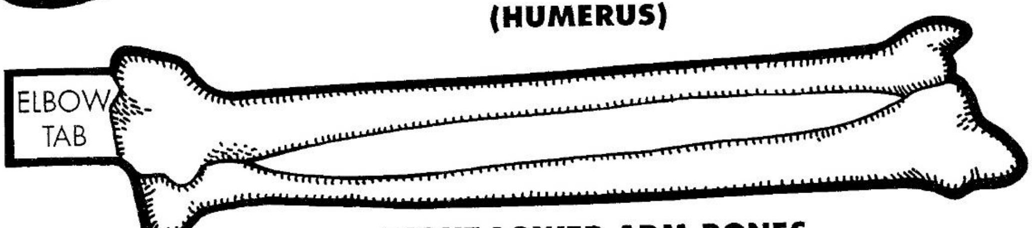


**LEFT LOWER ARM BONES
(RADIUS AND ULNA)**

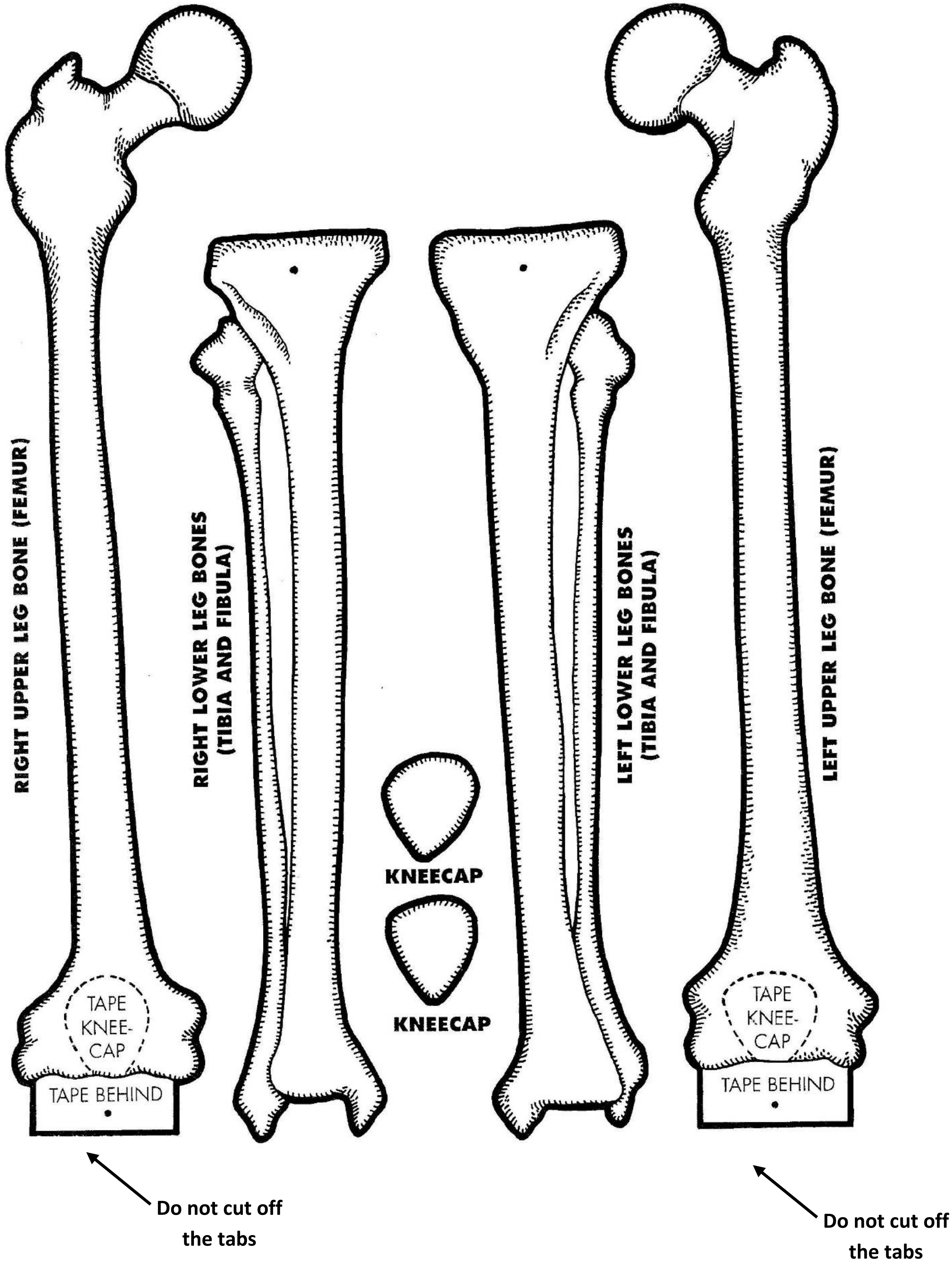


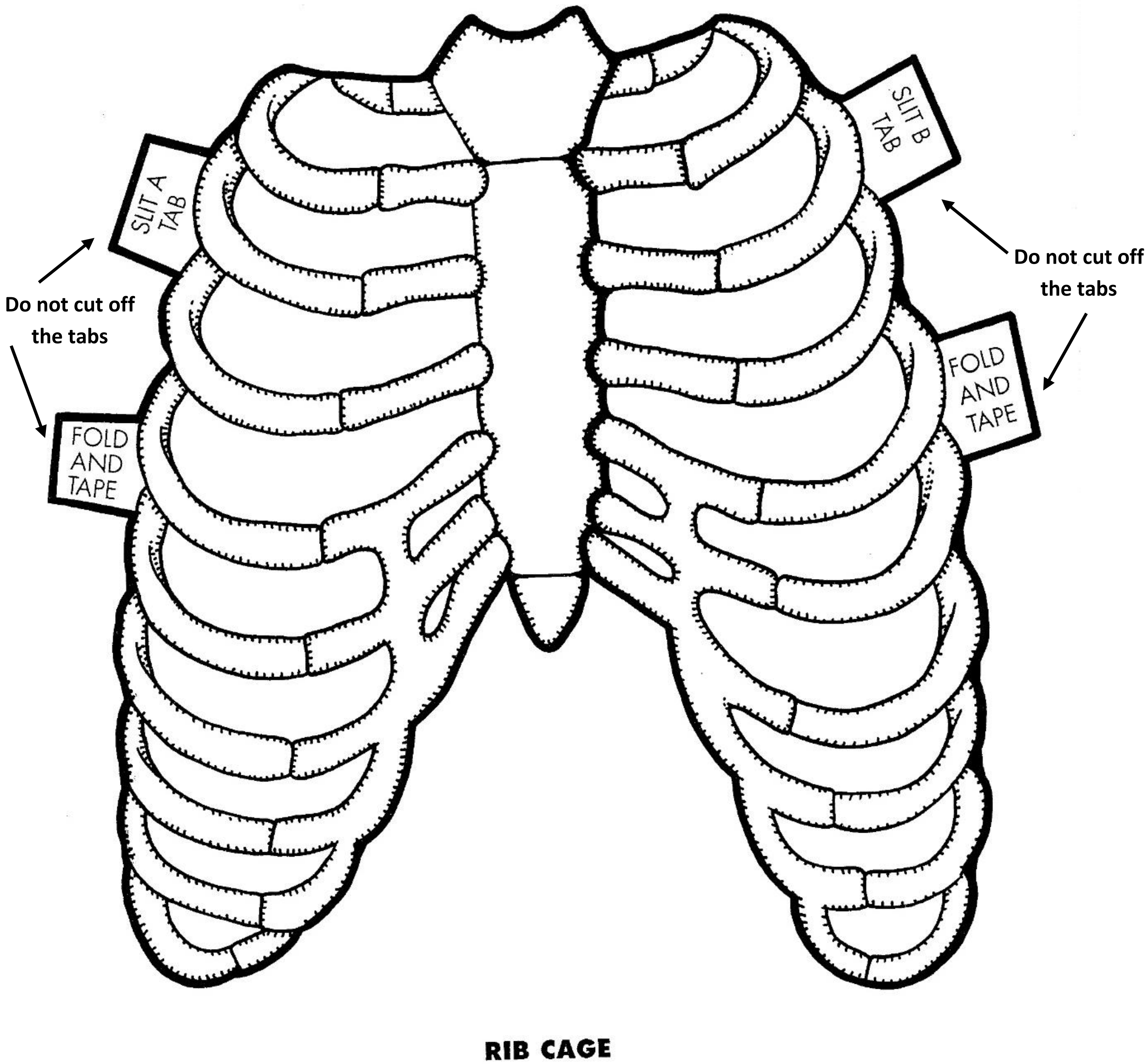
**RIGHT UPPER ARM BONE
(HUMERUS)**

Do not cut off the tabs



**RIGHT LOWER ARM BONES
(RADIUS AND ULNA)**


RIGHT UPPER LEG BONE (FEMUR)
RIGHT LOWER LEG BONES (TIBIA AND FIBULA)
LEFT LOWER LEG BONES (TIBIA AND FIBULA)
LEFT UPPER LEG BONE (FEMUR)
KNEECAP
KNEECAP
TAPE KNEE-CAP
TAPE BEHIND
TAPE KNEE-CAP
TAPE BEHIND
Do not cut off the tabs
Do not cut off the tabs



SLIT A TAB
SLIT B TAB
Do not cut off the tabs
Do not cut off the tabs
FOLD AND TAPE
FOLD AND TAPE

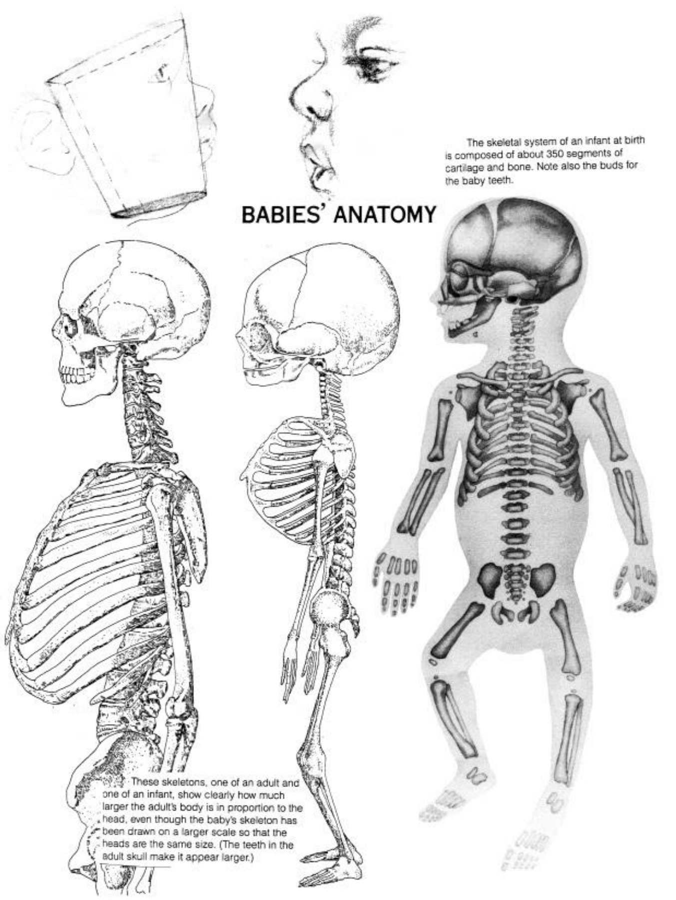
RIB CAGE

How Bones Grow

Primary Learning Objectives:

Students will:

- Recognize that bones are living, growing, and changing body parts.
- Understand the changing role of cartilage in the human skeleton and the terms related to bone growth
- Determine the role of calcium in bone structure
- Explain why some bones are hollow and the role that structure plays in skeletal strength and maneuverability.
- Infer the role and necessity of hollow bones in other animal species skeletal structures



When you were a baby, you had tiny hands, tiny feet, and tiny everything! Slowly, as you grew older, everything became a bit bigger, including your bones.

A baby's body has over 300 bones at birth. These eventually fuse (grow together) to form the 206 bones that adults have. Some of a baby's bones are made entirely of a special material called **cartilage** (say: **kar**-tel-ij). Other bones in a baby are partly made of cartilage. This cartilage is soft and flexible.

Cartilage (En español: Cartílago)

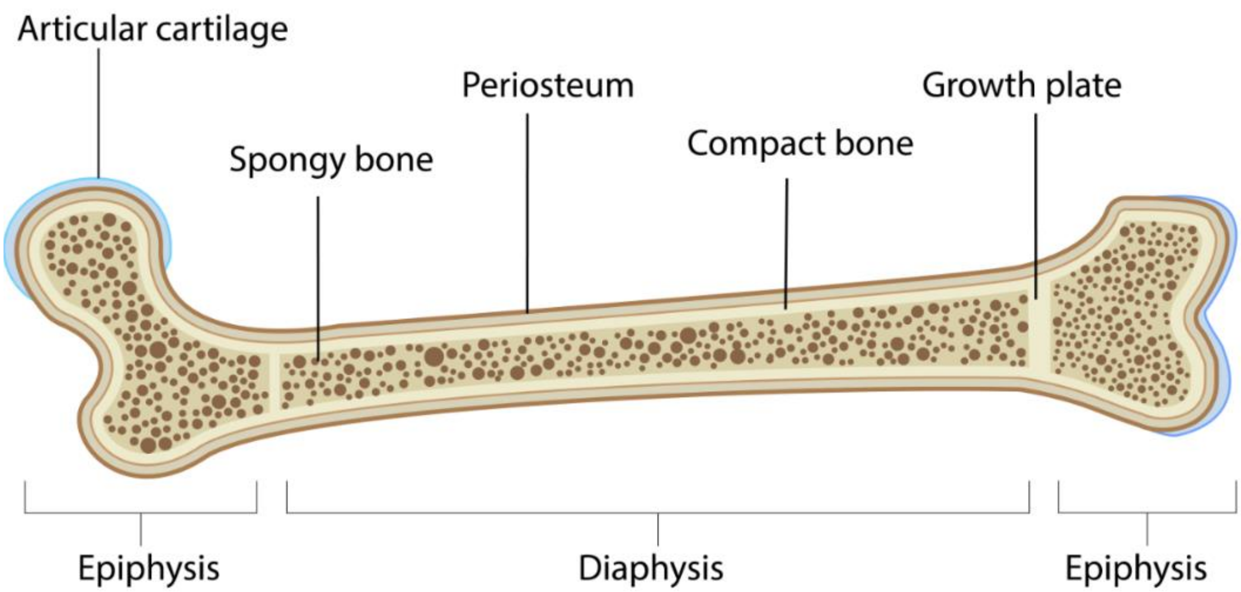
Say: **kar**-tel-ij

Touch the tip of your nose or the top of your ear - that's cartilage. It's bendable, not hard like bone. This flexible material can be found in various parts of your body, including between bones so they don't rub together.

When the skeleton first forms, the whole thing is made of flexible cartilage, but within a few weeks it begins the process of **ossification** (pronounced: ah-suh-fuh-**kay**-shun). Ossification is when the cartilage is replaced by hard deposits of calcium phosphate and stretchy collagen, the two main components of bone. It takes about 20 years for this process to be completed.

The bones of kids and young teens are smaller than those of adults and contain "growing zones" called **growth plates**. These plates consist of columns of multiplying cartilage cells that grow in length, and then change into hard, mineralized bone. These growth plates are easy to spot on an X-ray. Because girls mature at an earlier age than boys, their growth plates change into hard bone at an earlier age.

Bone building continues throughout your life, as your body constantly renews and reshapes the bones' living tissue.

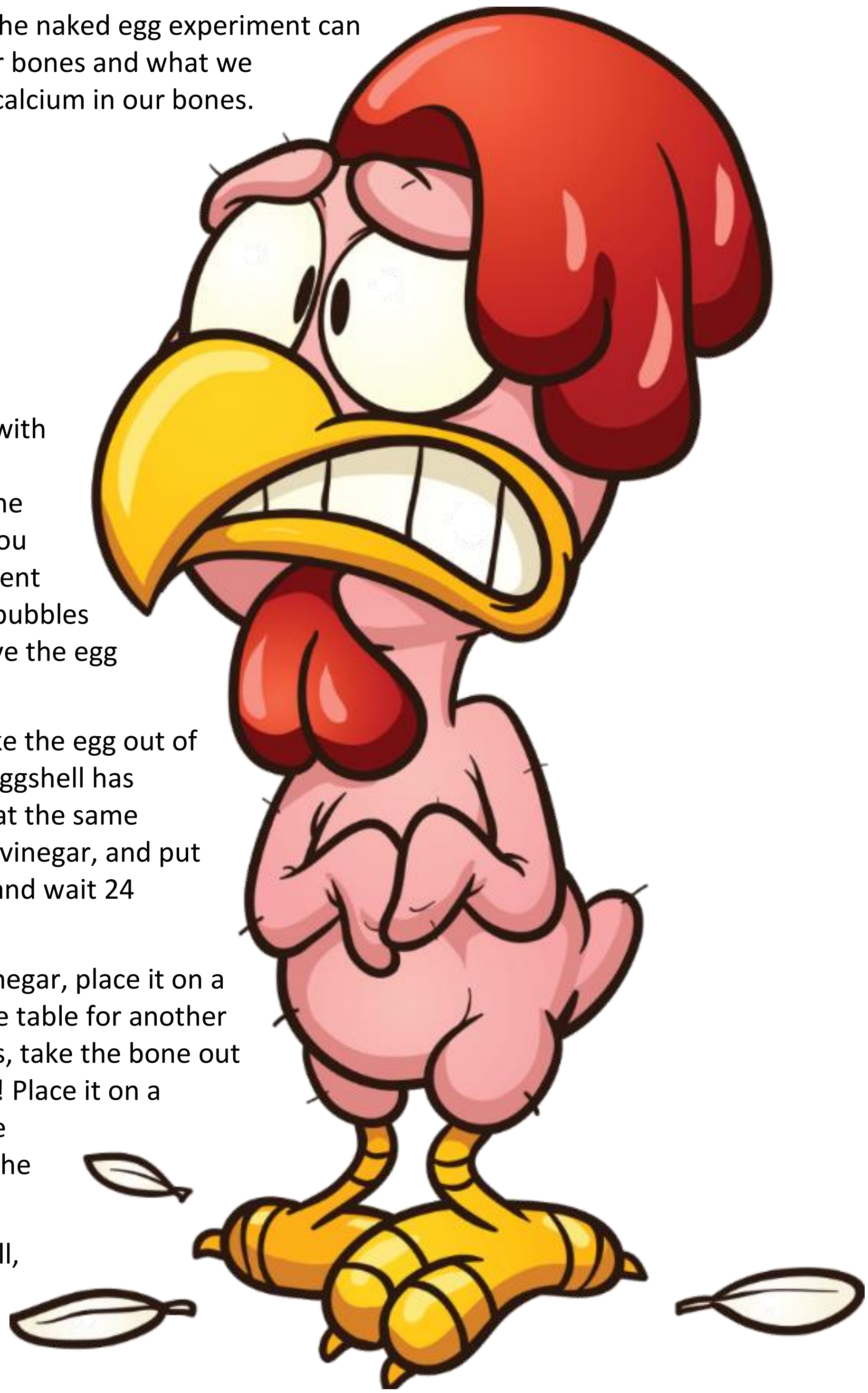


During childhood, as you are growing, the cartilage grows and is slowly replaced by bone, with help from calcium and other minerals like phosphorous. Bones also need vitamin C and vitamin D. *(Ask students where they get their calcium from. Milk and leafy vegetables have calcium, what else has calcium? Students might be surprised by what vegetables have a lot of calcium.)*

A Naked Egg?

Is calcium very strong? Let's see...

A continuation of and variation on the naked egg experiment can show just what calcium does for our bones and what we might like if we didn't have all that calcium in our bones.



Materials:

- Vinegar
- Clear Glass Jars
- Eggs
- Very thin chicken bones

Use a clear glass or jar and fill it up with enough vinegar to cover the egg completely and place the egg into the glass or jar filled with the vinegar. You will see the principal of the experiment starting to happen. Do you see the bubbles rising from the egg? Good, now leave the egg in the vinegar for at least 24 hours.

After the 24 hours have expired, take the egg out of the vinegar. What happened? The eggshell has become completely soft! Now repeat the same experiment, using the same kind of vinegar, and put some chicken bones in the vinegar and wait 24 hours again.

Once you take out the egg of the vinegar, place it on a plate or in a bowl and leave it on the table for another 24 hours. At the end of the 24 hours, take the bone out of the vinegar and make a knot in it! Place it on a plate as well. What happened to the egg that you left on the table after the 24 hours? It became hard again!

Here is how it all works. The eggshell, just like the bone, contains calcium carbonate and that is the substance that makes the eggshell and the bone hard. Vinegar is an acid substance and once you combine or bring these two substances into contact carbon dioxide is released. That was the bubbles you were seeing. This chemical reaction will continue until all the carbon is completely used up. This process takes about 24 hours to complete.

So how do the egg and the bone become hard again? The calcium that remained in the bone and eggshell absorbed the carbon dioxide in the air and this caused the bone and the shell to become hard again!

With the chicken bones hard again, show them off and see if people can clarify the mystery of the knotted bones!

Discuss with the students what would our bones be like if we didn't have any calcium in them? What would we look like? Is calcium important?

Growing Up

By the time you are about 25, the process of cartilage replacement and bone growth will be complete. After it finishes, there can be no more growth — your bones are as big as they will ever be. All of these bones make up a skeleton that is both very strong and very light. *(How is it possible that our skeleton is not heavy? Aren't bones heavy?)*

Our long bones are hollow, and their cross-sectional shape is a circle. Engineers agree that this structure is difficult to bend or twist. *(Why would this be a good thing?)* When we walk, run or lift objects, our bones do flex (bend) a little, but their basic shape helps prevent them from deforming or collapsing. If the central cavity, middle part, of long bones were solid, bones would be much heavier, requiring much larger muscles to hold them in place and create movement. The added weight of extra muscle would make our bodies very heavy and very difficult to move.

Let's see that "Hollow Strength"

Activity Procedure Part 1:

1. Students will roll up a sheet of paper into a cylinder with a diameter of 1 inch. Students will make a total of 4 cylinders/ paper bones.

2. Students will stand the paper bones up on their ends, placing a paper plate on top of the bones.

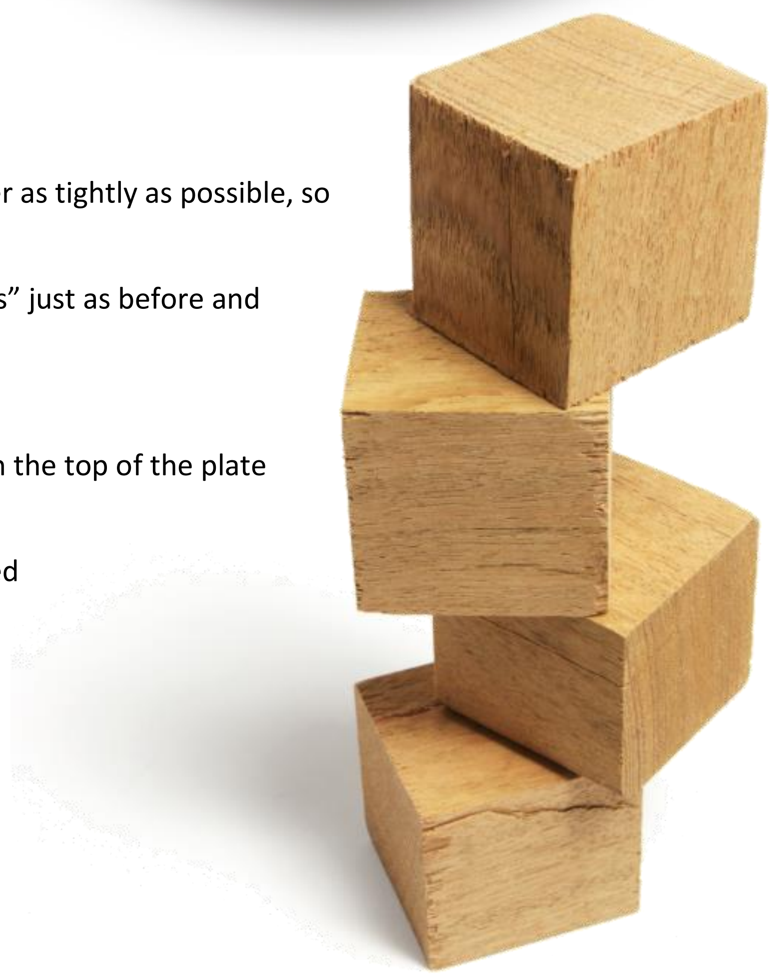
3. The teacher will ask the students to explain what is happening. (The hollow rolls are supporting the plate.)

4. The students will begin to add weights (ex. wooden blocks or pennies) to the plate.

5. The students will count how many blocks the plate can hold before it collapses the bones.

6. The student will chart their results.

Activity Procedure Part 2:



7. Students will roll up 4 more sheets of paper as tightly as possible, so there is little to no hollow section.

8. The students will stand these "paper bones" just as before and place the same paper plate on

top of them.

9. The students will begin to place weights on the top of the plate until it collapses.

10. The students will conclude what happened and chart their results.

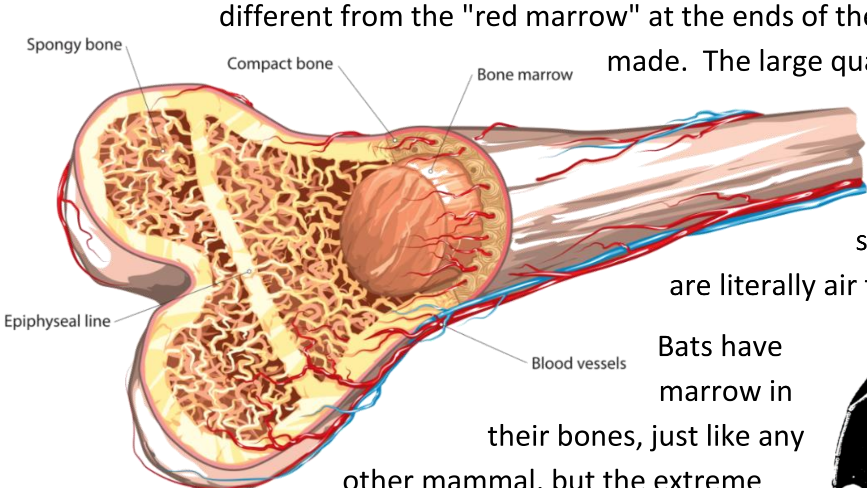
11. The teacher will explain that hollow bones were able to support more weight. Having a hollow center gives the bones a better design and makes them stronger. The large bones in our body are also hollow, which makes them strong, so they can support more weight, but light, so it takes less muscle and less energy to move them.

What other animals have hollow bones? Why?

Birds have hollow bones. Hollow objects are lighter than solid objects and, because of this, birds use less energy in flight and need less food but are still strong enough to stand up to strong winds.

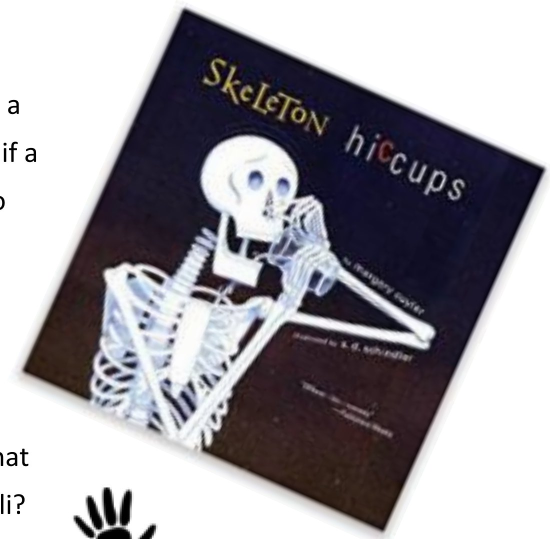
Nearly all bones from all classes of vertebrate except fish are hollow when studied as decomposed or thoroughly cleaned specimens (and some fish bones are, too). In other words, animals had discovered that tubes are structurally much more efficient than solid rods long before engineers did! Bird bones are actually hollow (air filled) in the living animal, presumably for lightness, but air also moves inside of their skeleton and may help them with respiration (breathing.)

Mammal bones, while 'hollow' in that the solid parts of limb bones are tubular, are usually filled with fatty or "white" marrow, which is different from the "red marrow" at the ends of the bones where blood cells are made. The large quantity of fat within large mammal limb bones makes them very difficult to clean thoroughly. Some parts of mammal bones, such as the sinuses in our skulls, are literally air filled, like birds.

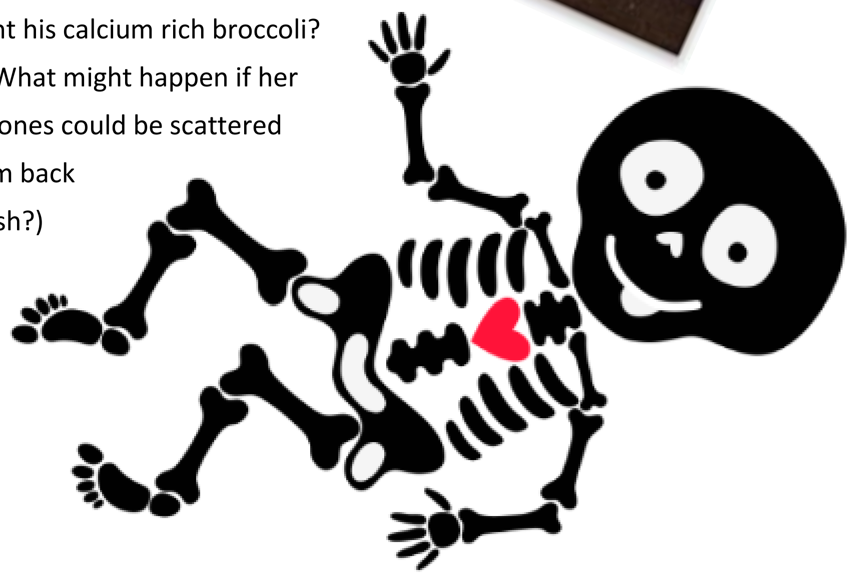


Bats have marrow in their bones, just like any other mammal, but the extreme narrowness of their bones means that the marrow-filled cavities are proportionally smaller than in other mammals, effectively giving them lighter bones than other mammals, an alternative adaptation for flight.

Write that down!

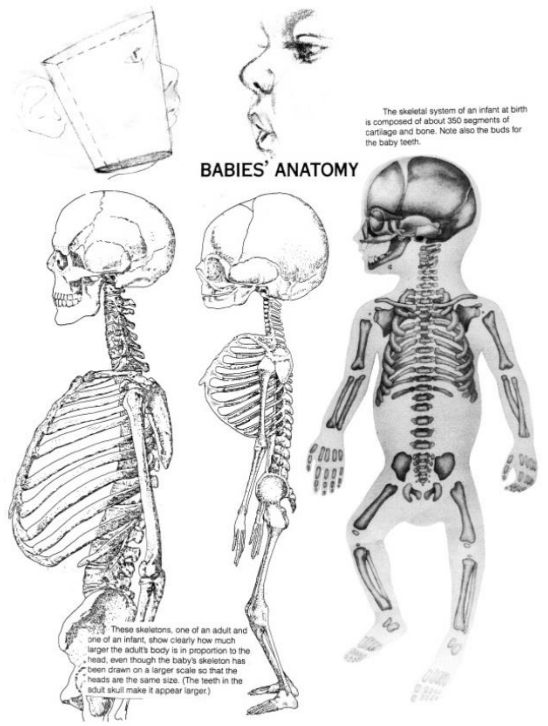


- Have students imagine some problems that might arise from a change in their or an animal's skeleton. What would happen if a bird suddenly had heavy bones? What might the bird have to do? What about if a bear suddenly had hollow bones like a bird?
- Have students imagine some trouble a mother skeleton might have raising her baby. (For some inspiration read *Skeleton Hiccups* by Margarie Cuyler with your students.) What might happen if the baby didn't want his calcium rich broccoli? (He could poke it through his ribs.) What might happen if her baby fell out of his highchair? (His bones could be scattered everywhere! How would she put him back together, especially if he were ticklish?) What tricks might a baby skeleton play? What might the family dog try to do? Play bury the baby?



How Bones Grow

1. A baby's body has over _________ bones when it is born.
2. Babies bones __________ to form the _________ bones that adults have.
3. Our long bones are _______ with _________ in the middle.
4. __________ takes the hard shell off of eggs and makes bones ______.
5. _________ makes blood cells.
6. ____________ makes bones strong.
7. Growing zones are called __________.
8. ____________ is when the cartilage is replaced by bone (it takes over 20 years.)
9. Birds have __________ bones.



10. Bones need ______________, phosphorous, vitamin C and ______________.
11. _______________ is bendable, not hard like bone.

Word Bank

Please fill in the blanks with the missing words. Three words will be used twice.

Ossification	Marrow	300
Hollow	Vitamin D	Calcium
Vinegar	Growth Plates	Flexible
206	Cartilage	

Your Very Supportive Spine

Primary Learning Objectives:

Students will:

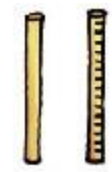
- Recognize that bones are living, growing, and changing body parts.
- Know that the spine protects the spinal cord, gives attachments for muscles and ribs, and allows the body to perform a wide array of movements.
- Be able to describe the shapes and functions of vertebrae and cartilage disks.
- Assemble a model of the spinal column and cord
- Older students will be familiar and be able to locate the cervical, atlas, axis, thoracic, lumbar, sacrum, and coccyx vertebrae on their models.

Your spine is one part of the skeleton that's easy to check out: Reach around to the center of your back and you'll feel its bumps under your fingers.

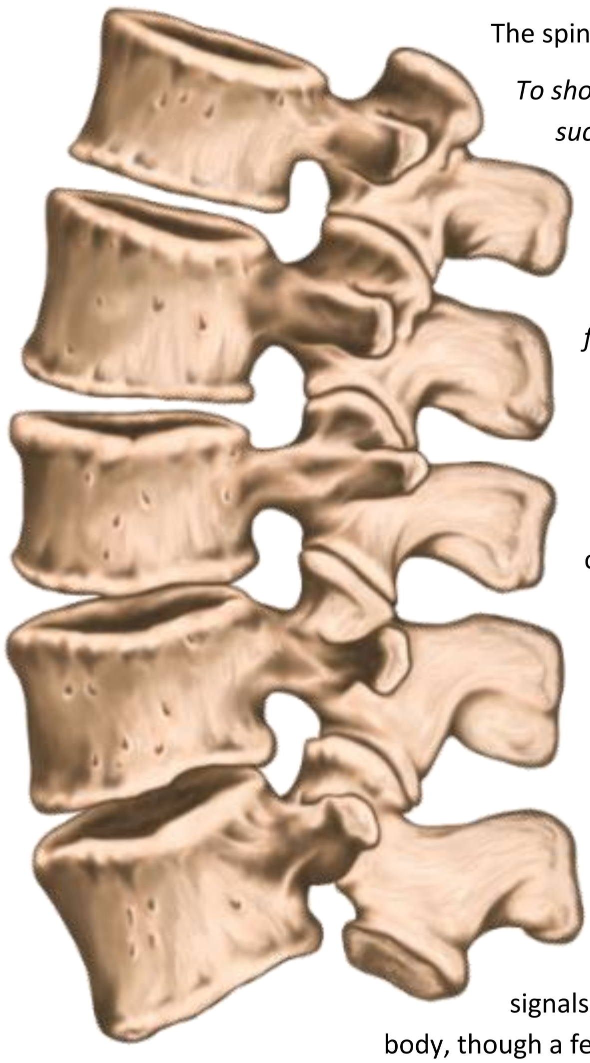
The spine has to carry a heavy load. It has several functions: it serves as a protective surrounding for the delicate nerves of the spinal cord and forms the supporting backbone of the skeleton.

- Supporting the head and give firmness to the skeleton
- Maintaining an upright posture

- Protecting the spinal cord that carries nerves between the brain and every parts of the body
- Giving attachments for muscles and ribs
- Acting like a shock absorber
- Allowing the body to perform a wide array of movements



At any level it is the vertebral column/spine which is principally responsible for holding the weight of the body above and any loads being lifted or carried. When muscles contract to produce movements or stabilize joints, there is often additional stress on the spine. The spine is, however, remarkably flexible.



The spine lets you twist and bend, and it holds your body upright.

To show how the spine's construction allows for flexible movements such as twisting and bending, give students a fat plastic straw to cut in half. Have them cut snips along the length of one of the halves, being sure to leave the straw in one piece. When finished, ask students to bend and twist each straw half. Which straw half can be bent and twisted with more ease and flexibility? [10]

The spine is special because it isn't made of one or even two bones: It's made of 26 bones in all! The Spinal Column is also called the vertebral column. The bones in the spine are called vertebrae (ver-ta-bray) and each one is shaped like a ring. The column starts at the base of the skull and continues to the pelvis. Alternate layers of bone (vertebrae) and cartilage (car-til-ledge, the intervertebral discs) stack vertically one on top of the other in the spinal column.

The vertebrae also protect the spinal cord, a large bundle of nerves that sends information from your brain to the rest of your body. The spinal cord is the main bundle of nerves in the human body. It runs through holes in the bones that make up the backbone.

Most of the nerves in the spinal cord are like a road, they carry signals, like cars, to and from the brain to all the different parts of the body, though a few of the nerves connect one part of the cord with another part.

In order to get a better idea of how these nerves work students will make a model of the spinal cord, nerves, and their protectors.

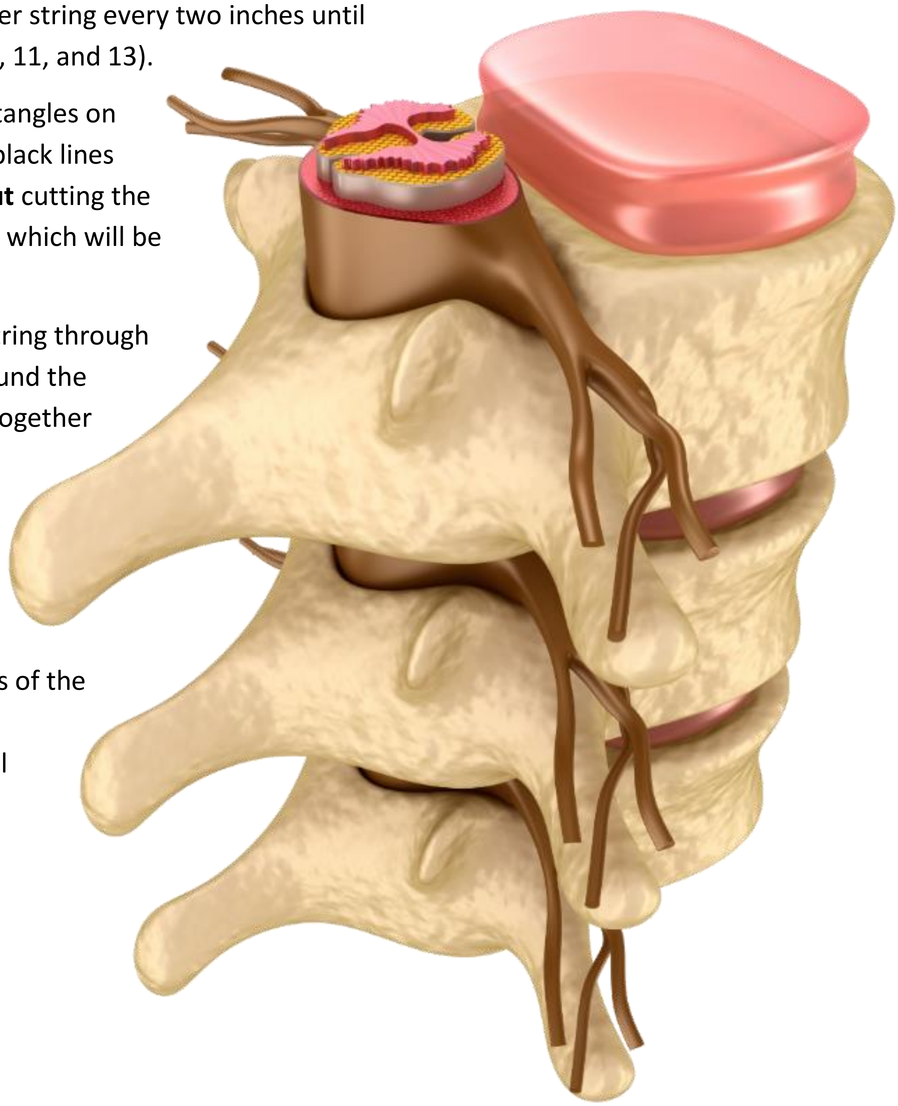
[10] Idea found at http://teacher.scholastic.com/products/instructor/Oct04_bones.htm

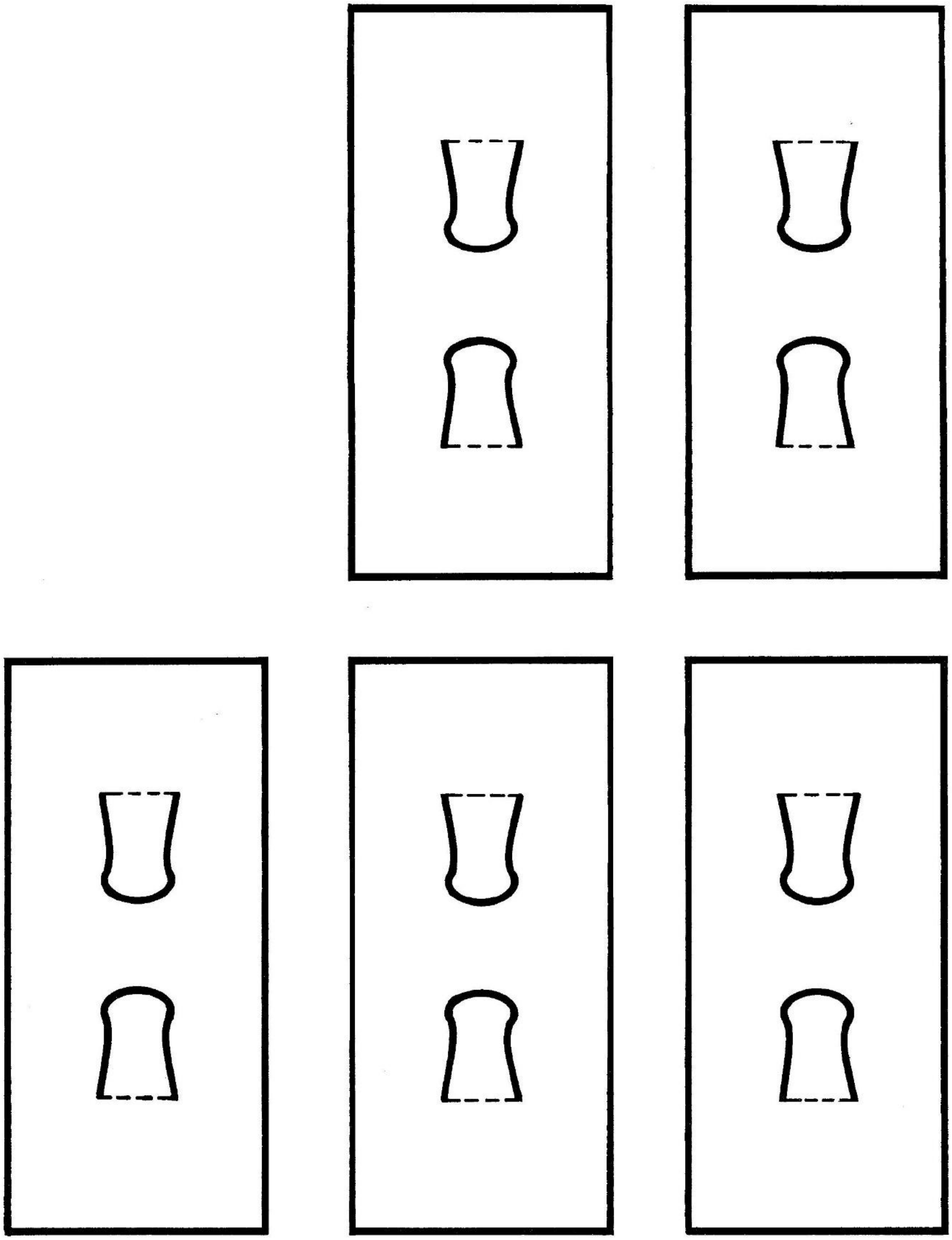
Materials:

- 45 inches of string for each student
- Tape
- Copies of the next page for all of the students.

1. Give each student one piece of string about 15 inches long and five more pieces of string that are about 6 inches long, each.
2. Have the students start two inches from the end of the 15 inch piece (at inch 13) and have them tie one of the short strings around the long string.
3. Then, they will keep going tying another string every two inches until all five are tied on. (At inches 3, 5, 7, 9, 11, and 13).
4. Have the students cut out the five rectangles on the next page and then cut along the black lines on the inside of each rectangle **without** cutting the dotted line, the tabs will become flaps which will be folded back.
5. Students will pull one end of a short string through each tab, then wrap the rectangle around the central long string and tape the ends together to make a tube shape.

   What do students think this represents? The long string represents the spinal cord, the tubes represent the vertebrae that protect the delicate cord, and the ends of the strings coming out of the cylinders represent the spinal nerves going to all the different parts of the body.

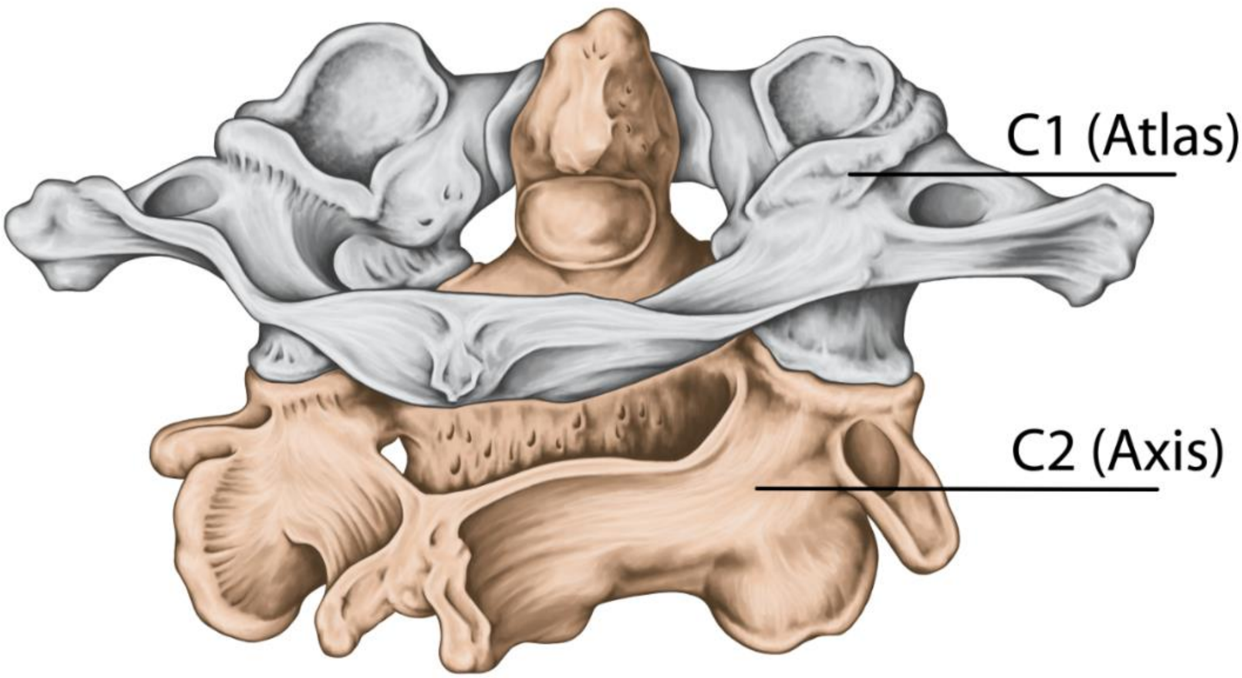




Why do students think that animals who have spinal columns are called vertebrates? What vertebrates can they name? There are five groups (fishes, amphibians, reptiles, birds, and mammals.) In which group do students think that human beings belong? (mammals)

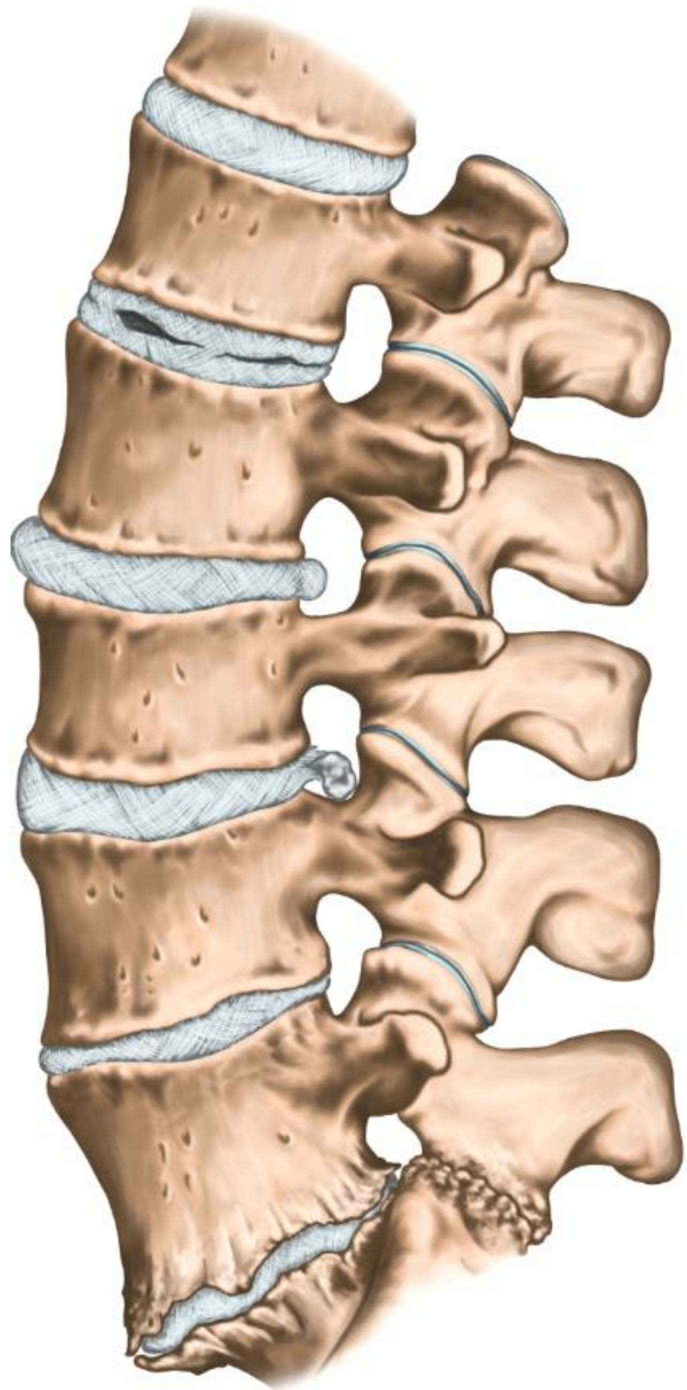
There are different types of vertebrae in the spine and each does a different kind of job:

- The first seven vertebrae at the top are called the **cervical** (say: **sir**-vih-kul) vertebrae. These bones are in the back of your neck, just below your brain, and they support your head and neck. Your head is pretty heavy, so it's lucky to have help from the cervical vertebrae!
- The first two cervical vertebrae are different from all the rest. They are what helps your head move from side to side. They are called the **atlas**, and the **axis**. The atlas is ring shaped. It balances and supports the head. The axis has a tooth-like projection (called the odontoid process, oh-don-toyed) that fits up into the atlas. The combination of these two structures allows the head to turn from side to side. The atlas pivots around the axis.



- Below the cervical vertebrae are the **thoracic** (say: thuh-**ras**-ick) vertebrae, and there are 12 in all. These guys anchor your ribs in place.
- Below the thoracic vertebrae are five **lumbar** (say: **lum**-bar) vertebrae.
- Beneath the lumbar vertebrae is the **sacrum** (say: **say**-krum), which is made up of five more vertebrae that are fused together (stuck) to form one single bone.
- Finally, all the way at the bottom of the spine is the **coccyx** (say: **cok**-siks), which is one bone made of four fused vertebrae.

- The bottom sections of the spine are important when it comes to holding up weight and giving you a good center of gravity. So, when you pick up a heavy backpack, the lumbar vertebrae, sacrum, and coccyx give you the power. When you dance, skip, and even walk, these parts help keep you balanced.



In between each vertebra (the name for just one of the vertebrae) are small **disks** made of cartilage. These disks are a little squishy and keep the vertebrae from rubbing against one another, and they also act as your spine's natural shock absorbers. *(Where else can we find shock absorbers? In cars, in shoes, etc)* When you jump in the air, or twist while slamming a dunk, the disks give your vertebrae the cushioning they need so they don't crack or get hurt. If one of these disks slips out or breaks, it causes a lot of pain!

This illustration shows: Spine disc problems, degenerative lumbar disc disease, degenerative disc disorder, degenerated disk, bulging disk, herniated disk, thinning disk, and disk degeneration with osteophyte formation.

Making a Spine

Materials:

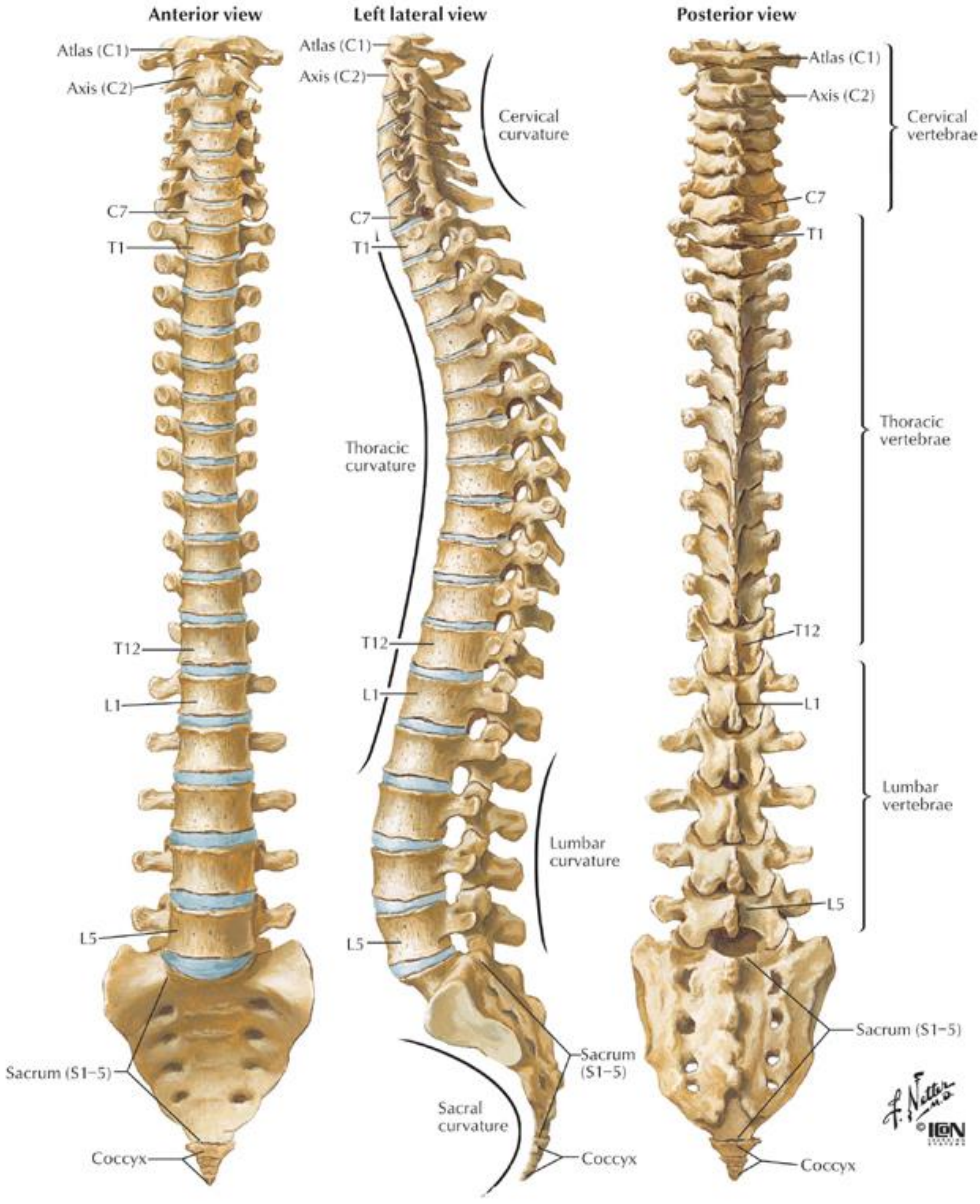
- Diagram of human spine
- White Clay
- Wire hanger or flexible beading wire (medium thickness)
- Wire cutters
- Gray clay
- Colored string
- Paperclips

- Glue
- Slips of paper

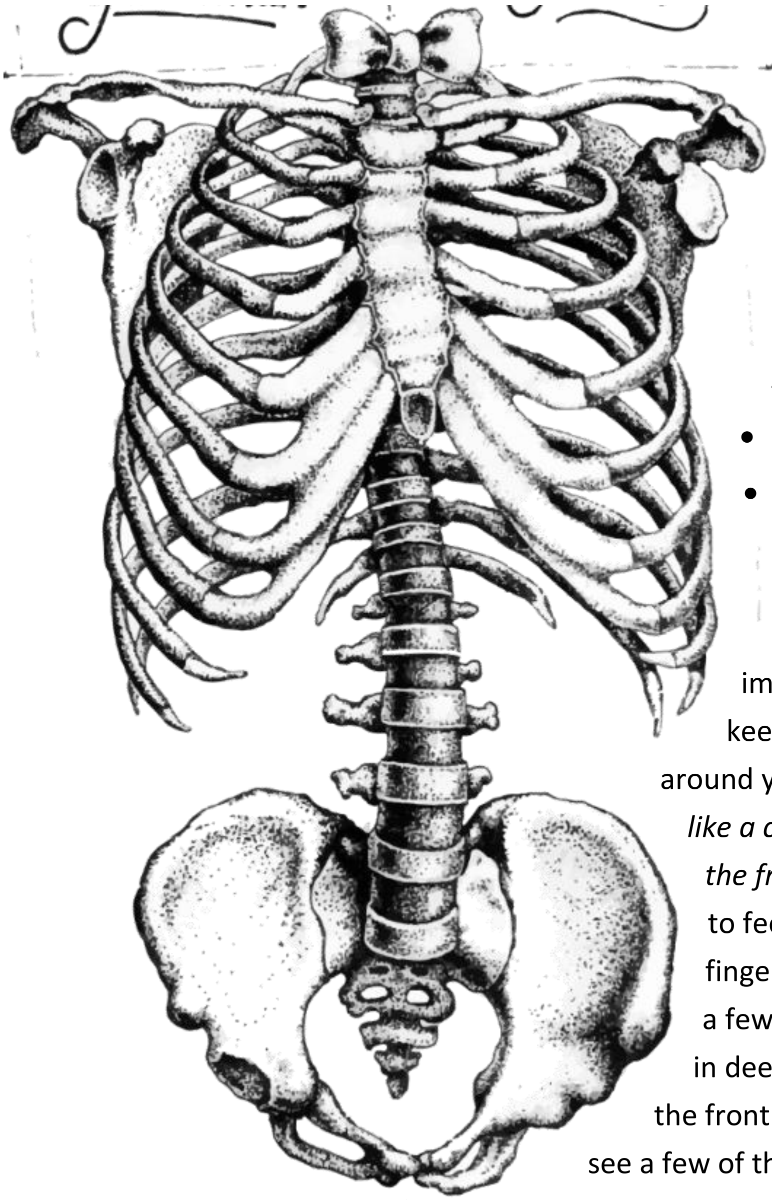
1. Have students make the vertebrae for the spine from the white clay. Mold them by hand into the proper shape and carve a hole through the center for the "nerves." When making vertebrae for the entire model, make them slightly smaller at the top and at the bottom to mimic a real spine. The holes should line up when they are stacked on each other. Make the back part large enough to thread the wire hanger through.
2. Shape the wire hanger into the standard shape of a spine. Shape the extra wire at the bottom into a circle, so the hanger can stand. Thread the vertebrae onto the wire hanger before they dry, leaving space in between each one. Cut any excess wire off with wire cutters.
3. Place the gray clay in the spaces between the white clay. The gray clay represents the connective tissue in between each vertebra. Ensure the hole through the center of the vertebrae is not obstructed. Allow the model to dry thoroughly.
4. Add the nerves. Use colored string, yarn or thread to illustrate the nerves that run through the spinal column. Cut the thread to the correct length, and glue to the top vertebrae in the back.
5. Label the parts of the spinal column. Use the paperclips and attach small slips of paper with the appropriate label. Labels could include the correct name with a separate display to explain the function or interaction of that specific part.

Option: Spinal Cord Bracelets

The human spinal cord has been the inspiration behind the design of many things from watch bands to high heels. Have students get inspired (and help their inspire their memories) by making wearable models/bracelets of the human spine using beading wire or colored cording, beads, and/or buttons.


Anterior view
Atlas (C1)
Axis (C2)
C7
T1
T12
L1
L5
Sacrum (S1–5)
Coccyx
Left lateral view
Atlas (C1)
Axis (C2)
Cervical curvature
C7
T1
Thoracic curvature
T12
L1
Lumbar curvature
L5
Sacrum (S1–5)
Sacral curvature
Coccyx
Posterior view
Atlas (C1)
Axis (C2)
Cervical vertebrae
C7
T1
Thoracic vertebrae
T12
L1
Lumbar vertebrae
L5
Sacrum (S1–5)
Coccyx

An Inner Cage: Ribs



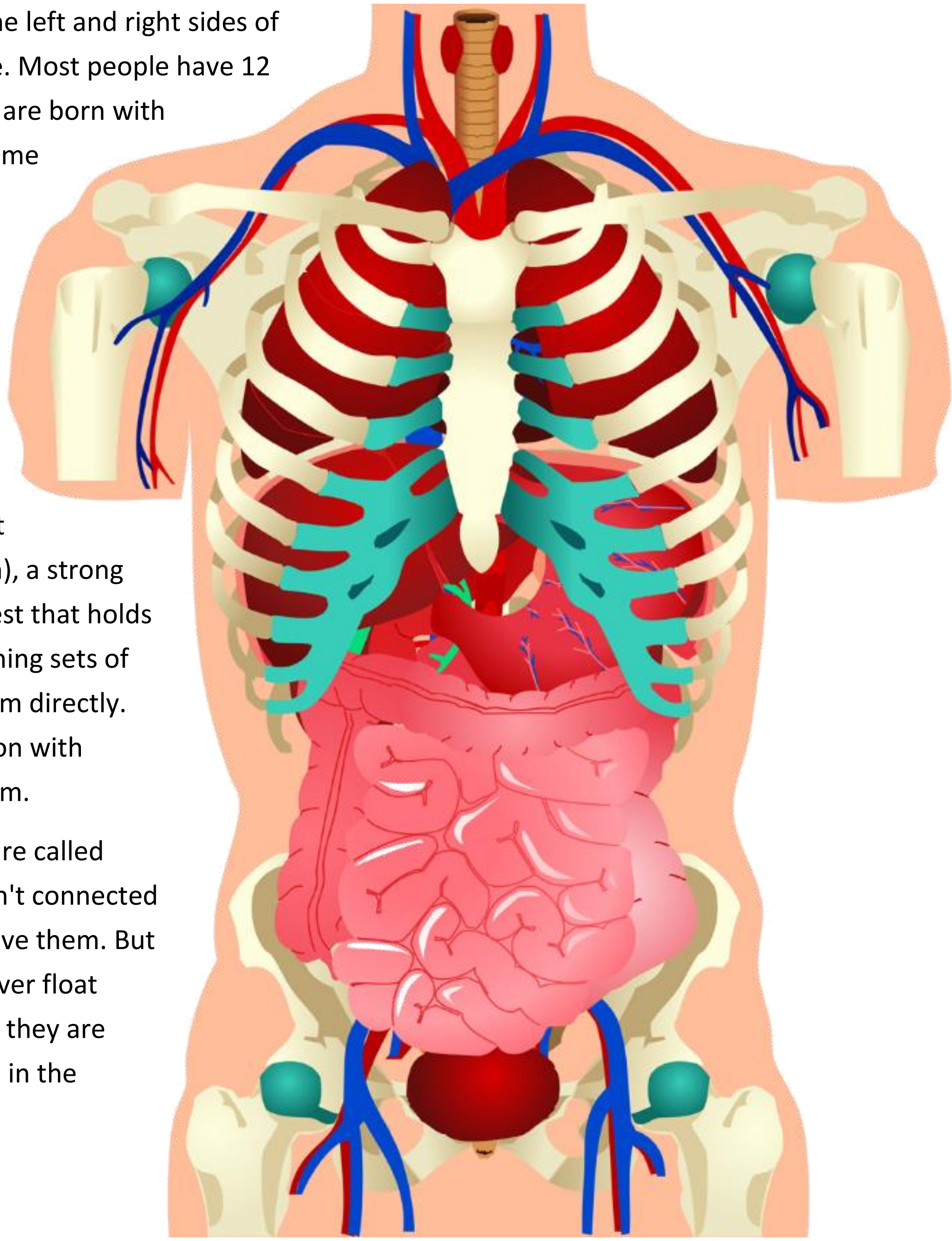
Primary Learning Objectives:

Students will:

- Recognize that bones are living, growing, and changing body parts.
- Know that the ribcage protects the heart, lungs, and liver.
- Describe the importance of the shape of the ribcage.
- Know that ribs come in pairs.
- Understand the role of the sternum, cartilage, and the meaning of the term floating ribs.

Your heart, lungs, and liver are all very important, and luckily you've got ribs to keep them safe. Ribs act like a cage of bones around your chest. *(Ask students why ribs shaped like a cage would work better than ribs just in the front, or just in the back or sides.)* It's easy to feel the bottom of this cage by running your fingers along the sides and front of your body, a few inches below your heart. If you breathe in deeply, you can easily feel your ribs right in the front of your body, too. Some kids can even see a few of their ribs right through their skin.

Your ribs come in pairs, and the left and right sides of each pair are exactly the same. Most people have 12 pairs of ribs, but some people are born with one or more extra ribs, and some people might have one pair less.



All 12 pairs of ribs attach in the back to the spine, where they are held in place by the thoracic vertebrae. The first seven pairs of ribs attach in the front to the **sternum** (say: **stur**-num), a strong bone in the center of your chest that holds those ribs in place. The remaining sets of ribs don't attach to the sternum directly. The next three pairs are held on with cartilage to the ribs above them.

The very last two sets of ribs are called floating ribs because they aren't connected to the sternum or the ribs above them. But don't worry, these ribs can't ever float away. Like the rest of the ribs, they are securely attached to the spine in the back.

YOUR RIBS

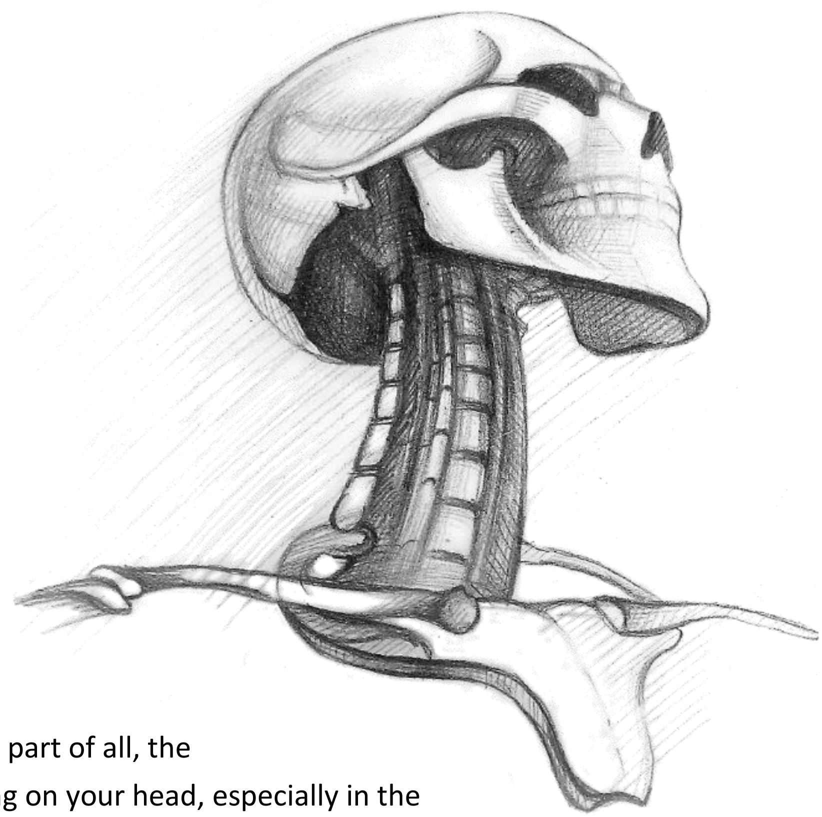
1. Ribs act like a ___________ of bones around your chest.
2. Your ribs come in _________, and the left and right sides are _________ the same.
3. Most people have ________ pairs of ribs.
4. All of the pairs are attached to the ___________.
5. The __________ is a strong _________ in the center of your chest that holds the first seven pairs of ribs in place.
6. The next three pairs are held on with ____________ to the ribs above them.
7. The very last two pairs of ribs are called _____________ ribs.
8. Your ribs keep your __________, ___________, and liver safe.

Word Bank

Fill in the blanks with the correct word.

1. Cartilage
2. Floating
3. Spine
4. Sternum
5. Heart
6. Twelve
7. Exactly
8. Lungs
9. Center
10. Cage
11. Pairs

A Skull's Job



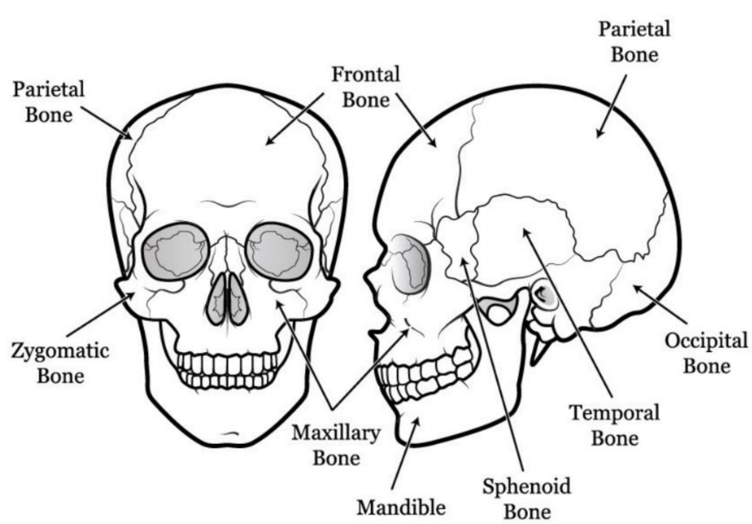
Primary Learning Objectives:

Students will:

- Recognize that bones are living, growing, and changing body parts.
- Know that the skull protects the brain, eyes, and inner ears.
- Describe the changes a skull undergoes within a person's lifetime.
- Put into their own words the term(s) sutures/immovable joints.
- Construct a model, diagram, or artwork, of a skull.
- Participate in comparing and contrasting

Your skull protects the most important part of all, the brain. You can feel your skull by pushing on your head, especially in the back a few inches above your neck. The skull is actually made up of 29 different bones that have grown tightly together.

Some of these bones protect your brain, whereas others make up the structure of your face. If you touch beneath your eyes, you can feel the ridge of the bone that forms the hole where your eye sits.



Want to know something else? Your lower jawbone (mandible) is the only bone in your head you can move. It opens and closes to let you talk and chew food.

Your skull is pretty cool, but it's changed since you were a baby. All babies are born with spaces between the bones in their skulls. This allows the bones to move, close up, and even overlap as the baby goes through the birth canal. As the baby grows, the space between the bones slowly closes up and disappears, and special joints called **sutures** (say: **soo**-churs) or immovable joints connect the bones.

Skulls? Sweet!

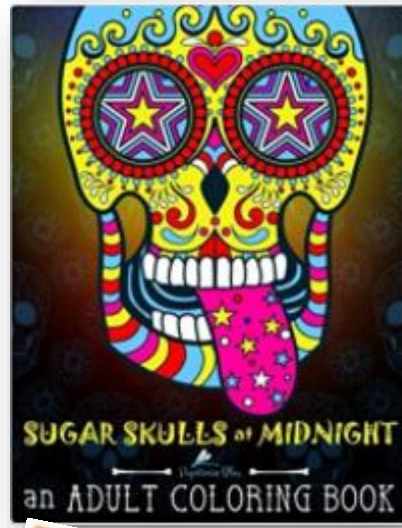
The Sugar Skull is a symbol of Dia de los Muertos, or Day of the Dead, a cultural holiday (not religious, rather like Thanksgiving is a cultural holiday, not a religious one, in the USA) in November that honors th e life of a loved one who has died.

This is a great activity in which to teach symmetry, line and patterns plus explore a bit of South American culture.

Materials:

- Sample sugar skull coloring pages (5+ different designs from 'google searches' or your selected coloring book)
- Colorful markers
- White drawing paper, 12″ x 9″ is a useful size, but not critical
- Black construction paper for mounting, 11″ x 14″
- Optional: Glitter
- Glue

- Optional: Show clips from the movies *Coco* or *The Book of Life*, which are based around the Day of the Dead.



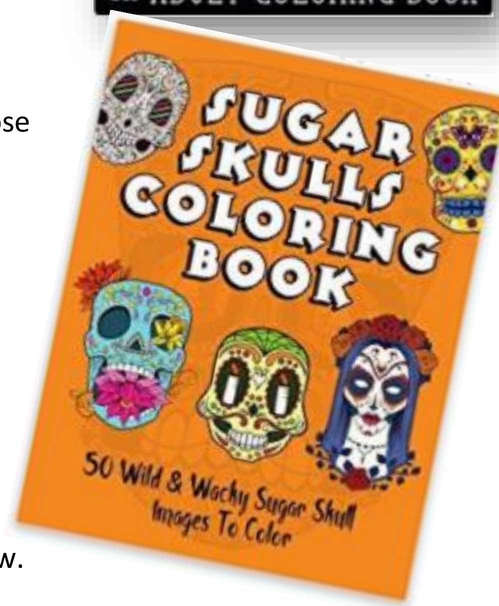
Tip: Get a free Sugar Skull drawing guide from Patty Palmer at Deep Space Sparkle here

Instructions:

Use the sample sugar skull coloring pages as a starter to this line drawing lesson. Copy about 5 different front-view skulls and allow each child to choose their own skull.

Divide each coloring book photo-copy in half vertically, aligning the two sides of the skull and not the paper corners. You want to see half of the skull.

Fold 12" x 9" drawing paper in half vertically and draw the contour line of the skull with a black marker. Draw circles/ovals for eyes, nose shape and teeth.



Fold the paper so that the skull drawing is now on the inside. The paper should look like a book with the front cover blank and the inside should show the skull drawing. When the paper is closed, the skull lines will show through the front paper. Trace over these lines then invert the paper and retrace the lines. Confused? It's easier to do it than explain it! Once you show your students, they will understand right away, so don't over think it.

Tip: It sometimes helps to trace the lines up against a sunny window.

Now that the child has a head complete with eyes, a nose and some teeth, they can mix and match the photocopies and add their own decorations. Many students will have the drawing skills to create a really good skull, but many won't. To help the kids make sharp lines, sit down with the "scribblers" and show how to connect lines and not leave lines hanging.

To finish, students cut their sugar skulls from the white paper and glue them to the 11" x 14" sheet of black paper.

Optional: Have students add glue details and then walk over to the instructor to sprinkle glitter over their paper, in a tub.

A bit of history:

Many cultures honor their dead with dances and celebrations. Día de los Muertos or Day of the Dead, is also known as Fiesta de los Muertos, a yearly two-day celebration that has been held for over 3,500 years. It is a joyous holiday, or festival, which is celebrated in México, Central and South America, and in some areas of the United States, especially, the southwest.

It is more of a cultural holiday than a religious one. It is a wonderful way to celebrate the memories of loved ones who are now gone... through art, cooking, music, building ofrendas, doing activities with children, recounting family stories, fun times and lessons learned... not how the person died, but how they lived. It is a celebration without tears. The first day is reserved for the children. On the second day, the adults are remembered.

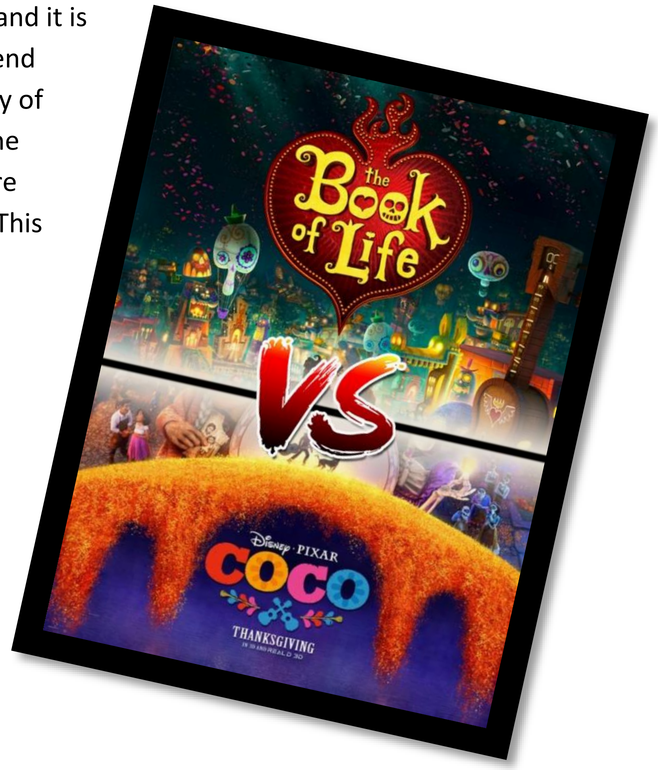
Food plays an important part in the celebration, though the edibles do vary from region to region. Time is taken to prepare the best foods, things like moles, marzipan, tamales, Calabaza en tacha, as well as the pan de muerto and sugar skulls.

This celebration originated with the indigenous native pre-Hispanic peoples of México. These early people believed that the souls of the dead return each year during the summer (That was when the original Day of the Dead ritual was celebrated and it lasted a month) to visit with their living relatives and the day was spent celebrating their family past and present.

The Aztec people held rituals that included the use of skulls. To the Aztec, skulls were used to symbolize both death and rebirth. The skulls and skull art were used to honor the dead and to celebrate. Calacas, costumes of grinning skeletons, are used in the celebration and for special dances. When the calacas dance, they take children by the hand, they are not meant to scare children, but to make them laugh.

When the Spaniards arrived in South America, they tried to eradicate the ritual, but eventually gave up and moved it so it would coincide with their two-day holiday, All Saint's Day.

Day of the Dead continues to be an important celebration and it is often a very expensive holiday for many families. Many spend over two month's income to honor their dead relatives. Day of the Dead is becoming very popular in the U.S. In Mexico, the colorful, much anticipated, Day of the Dead celebrations are generally celebrated in the states from Mexico City south. This includes Michoacan, Mexico, Puebla, Oaxaca, Veracruz, Guerrero, Guanajuato, Chiapas and the Yucatan.



Optional: Show selected clips from the movies *Coco* and *The Book of Life*, which are based around the Day of the Dead. Have students compare and contrast how each film portrays The Day of the Dead. What are the similarities? What are the differences?

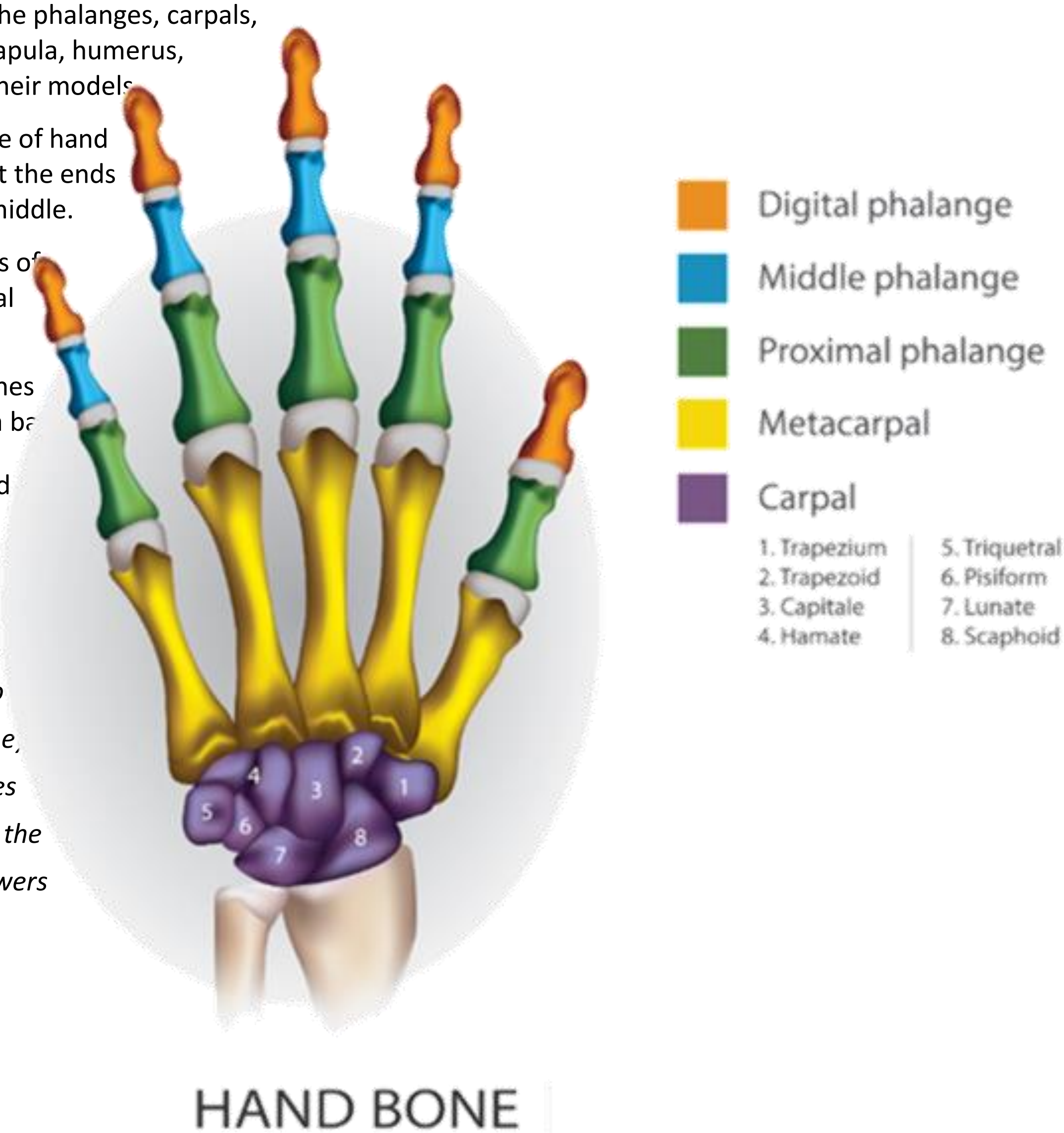
Your Hands

Primary Learning Objectives:

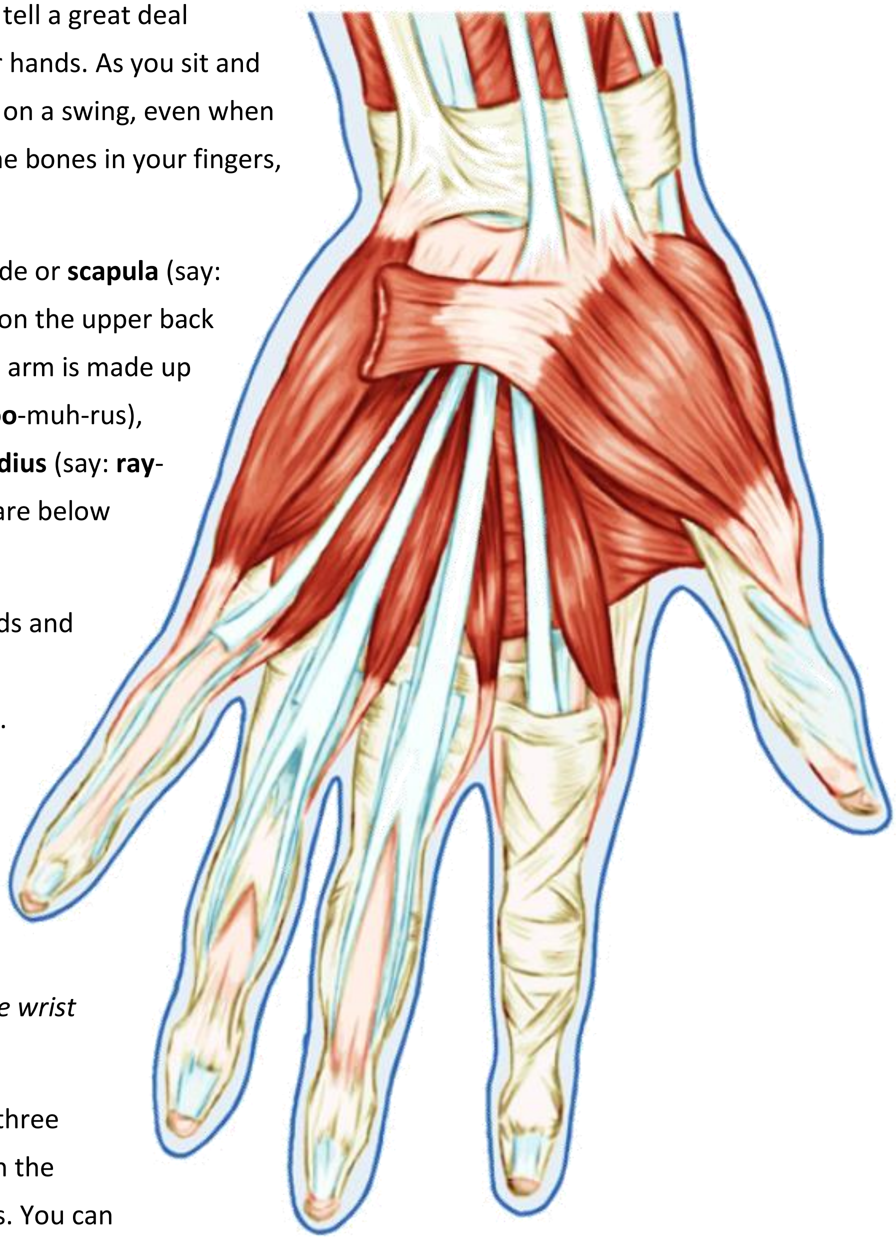
Students will:

- Recognize that bones are living, growing, and changing body parts.
- Identify and locate the phalanges, carpals, and metacarpals, scapula, humerus, radius and ulna on their models
- Describe the purpose of hand bones being wider at the ends and skinnier in the middle.
- Understand the roles of cartilage and synovial fluid in joints.
- Know how many bones they use to pick up a ba

What is the the most used part of the body? The hands! *(Have the student make a short list of activities that they can do with their hands. Then the will make a list of activities that can be done without the use of the hands. All answers will be discussed.)*



The legendary Sherlock Holmes could tell a great deal about a person by looking at his or her hands. As you sit and type at the keyboard, while you swing on a swing, even when you pick up your lunch, you're using the bones in your fingers, hand, wrist, and arm.



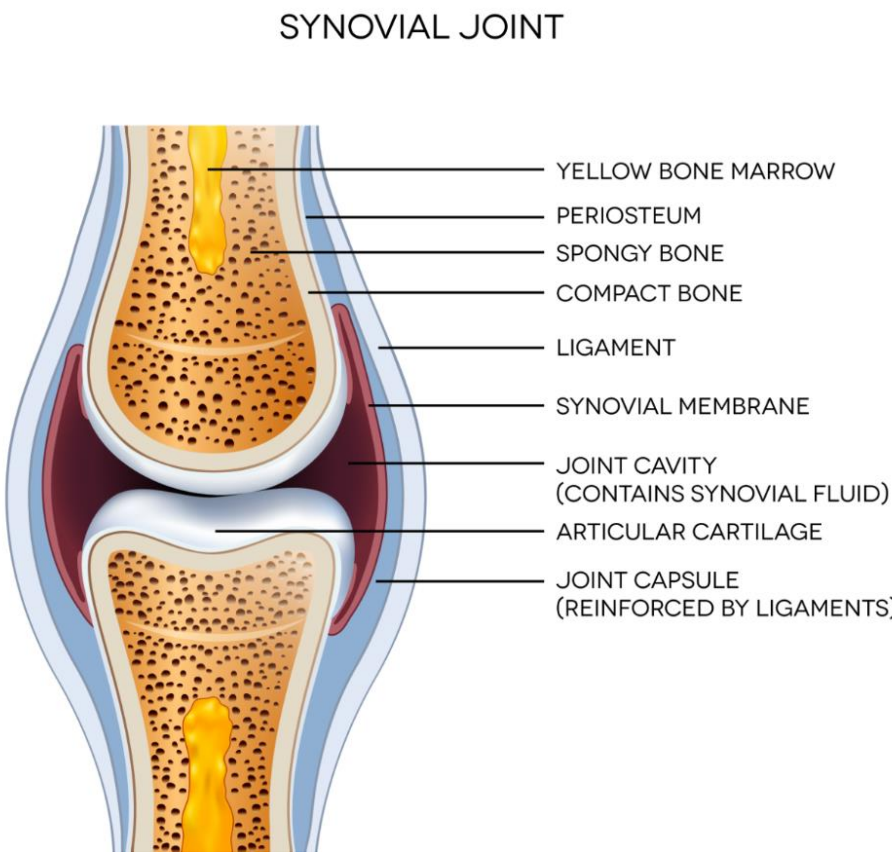
Each arm is attached to a shoulder blade or **scapula** (say: **sca**-pyuh-luh), a large triangular bone on the upper back corner of each side of the ribcage. The arm is made up of three bones: the **humerus** (say: **hyoo**-muh-rus), which is above your elbow, and the **radius** (say: **ray**-dee-us) and **ulna** (say: **ul**-nuh), which are below the elbow.

Each of these bones is wider at the ends and skinnier in the middle, to help give it strength where it meets another bone. At the end of the radius and ulna are eight smaller bones that make up your wrist. Although these bones are small, they can really move! *Have students twist their wrist around or wave and they'll see how the wrist can move.*

Each finger of your hand has a row of three bones, called phalanges, running down the center; each thumb has two phalanges. You can easily feel the phalanges by squeezing the fingers of one hand between the index finger and thumb of your other hand.

Your fingers bend at knuckle joints, where the phalanges are held together by ligaments, muscles, and tendons. Different people can bend each joint different amounts. *Have students compare the range of motion of their fingers with those of their friends.*

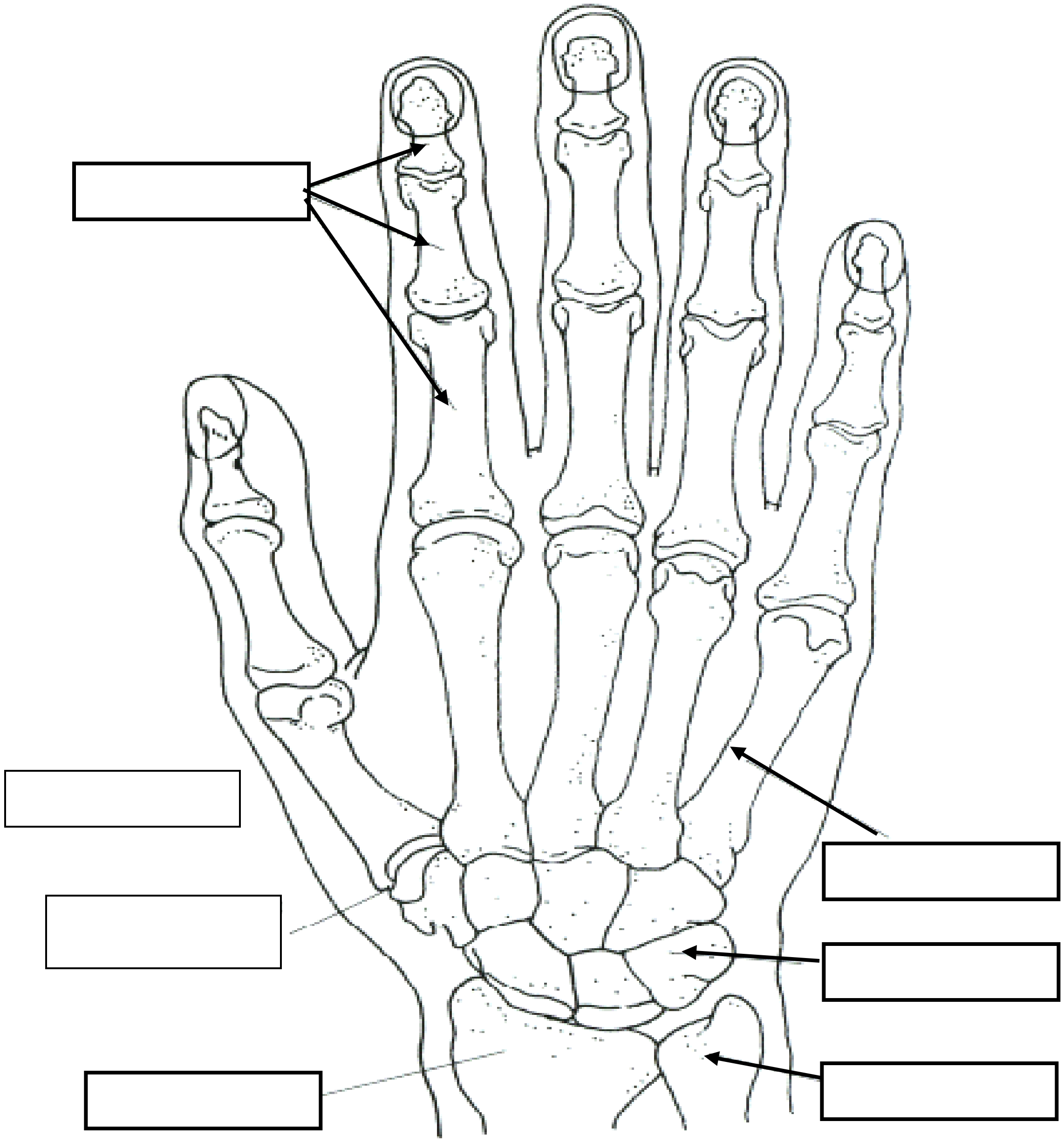
The finger joints are lined with cartilage. Just like cars have fluid for their joints and bikes, and we lubricate hinges when they squeak, we need our hinges lubricated. When cartilage is compressed/squished down by the motion of a finger, a very slippery fluid, called synoutal fluid, oozes out to lubricate the joint and keep it moving well, Synovial fluid reduces the friction to almost nothing, which helps reduce wear and tear on joint surfaces as two adjacent phalanges slide against each other. Hold on to one finger phalange and feel how smoothly your knuckle joint bends.



To demonstrate how slippery fluids can help have students hold out their left hand, extend their pointer finger and quickly slide their right pointer finger down it several times. Then have students put a little olive oil or other slippery fluid on their fingers and do it again. Is there a difference?

The center part of your hand is made up of five separate bones. Each finger on your hand has three bones, except for your thumb, which has two. So between your wrists, hands, and all your fingers, you've got a grand total of 54 bones — all ready to help you grasp things, write your name, pick up the phone, or throw a softball!

Your Hands



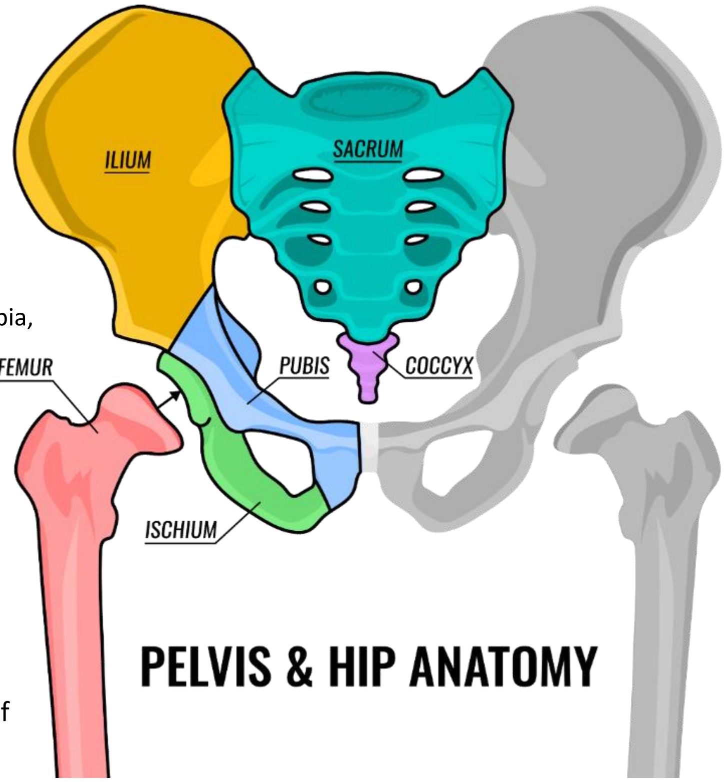
Word Bank

Correctly label the bones using the following words.

1. **Phalanges**
2. **Carpals**
3. **Metacarpals**
4. **Radius**
5. **Ulna**

Then, color the:
Phalanges YELLOW
Metacarpals BLUE
Carpals ORANGE
Radius RED
Ulna GREEN

Your Legs



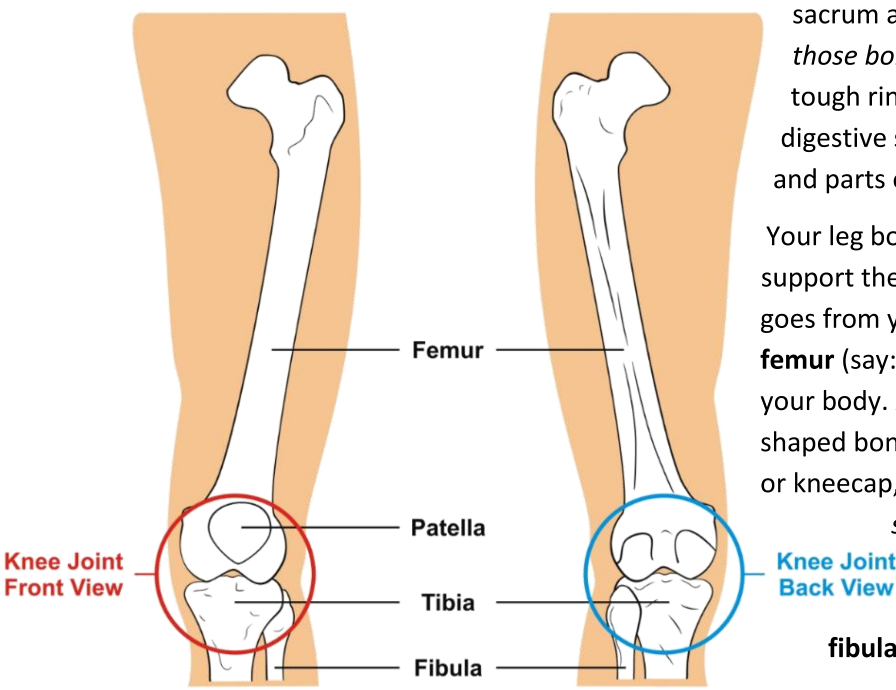
Primary Learning Objectives:

Students will:

- Identify and locate the pelvis, femur, patella, tibia, fibia, and talus on their models
- Understand that all the bones of the foot working together, it would be impossible to balance properly.
- Know that the pelvis protects parts of the digestive system, parts of the urinary system, and parts of the reproductive system.

Sure, your arm, wrist, hand, and finger bones are great for picking up the phone, but how are you supposed to run to answer it? Well, with the bones of the legs and feet!

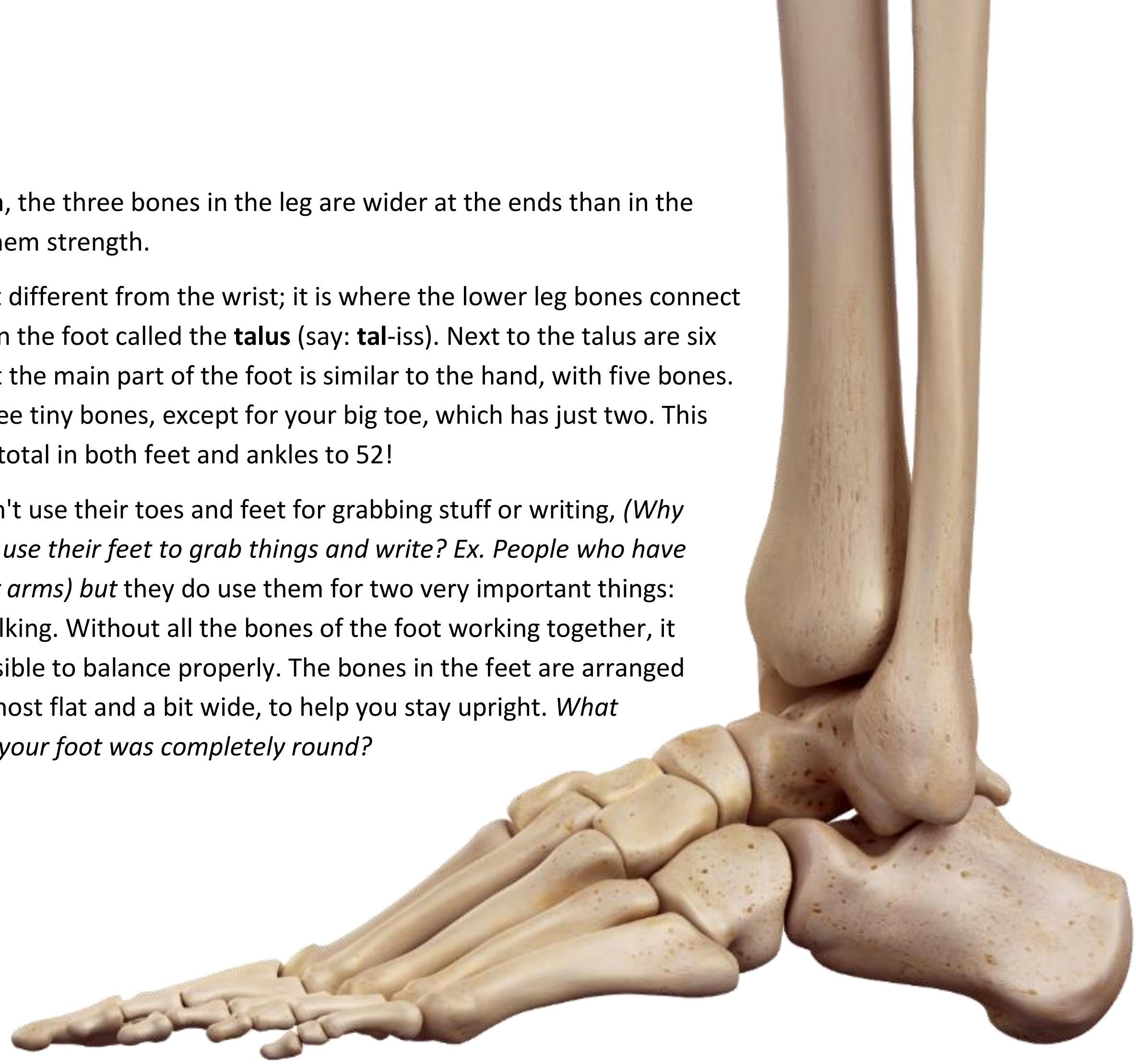
Your legs are attached to a circular group of bones called your **pelvis**. The pelvis is a bowl-shaped structure that supports the spine. It is made up of the two large hip bones in front, and behind are the sacrum and the coccyx *(have students find those bones on their model).* The pelvis acts as a tough ring of protection around parts of the digestive system, parts of the urinary system, and parts of the reproductive system.



Your leg bones are very large and strong to help support the weight of your body. The bone that goes from your pelvis to your knee is called the **femur** (say: **fee**-mur), and it's the longest bone in your body. At the knee, there's a triangular-shaped bone called the **patella** (say: puh-**tel**-luh), or kneecap, that protects the knee joint. *(Have students wiggle their patellas)* Below the knee are two other leg bones: the **tibia** (say: **tih**-bee-uh) and the **fibula** (say: **fih**-byuh-luh). Just like the three bones in the arm, the three bones in the leg are wider at the ends than in the middle to give them strength.

The ankle is a bit different from the wrist; it is where the lower leg bones connect to a large bone in the foot called the **talus** (say: **tal**-iss). Next to the talus are six other bones. But the main part of the foot is similar to the hand, with five bones. Each toe has three tiny bones, except for your big toe, which has just two. This brings the bone total in both feet and ankles to 52!

Most people don't use their toes and feet for grabbing stuff or writing, *(Why not? Who might use their feet to grab things and write? Ex. People who have lost both of their arms) but* they do use them for two very important things: standing and walking. Without all the bones of the foot working together, it would be impossible to balance properly. The bones in the feet are arranged so the foot is almost flat and a bit wide, to help you stay upright. *What might happen if your foot was completely round?*

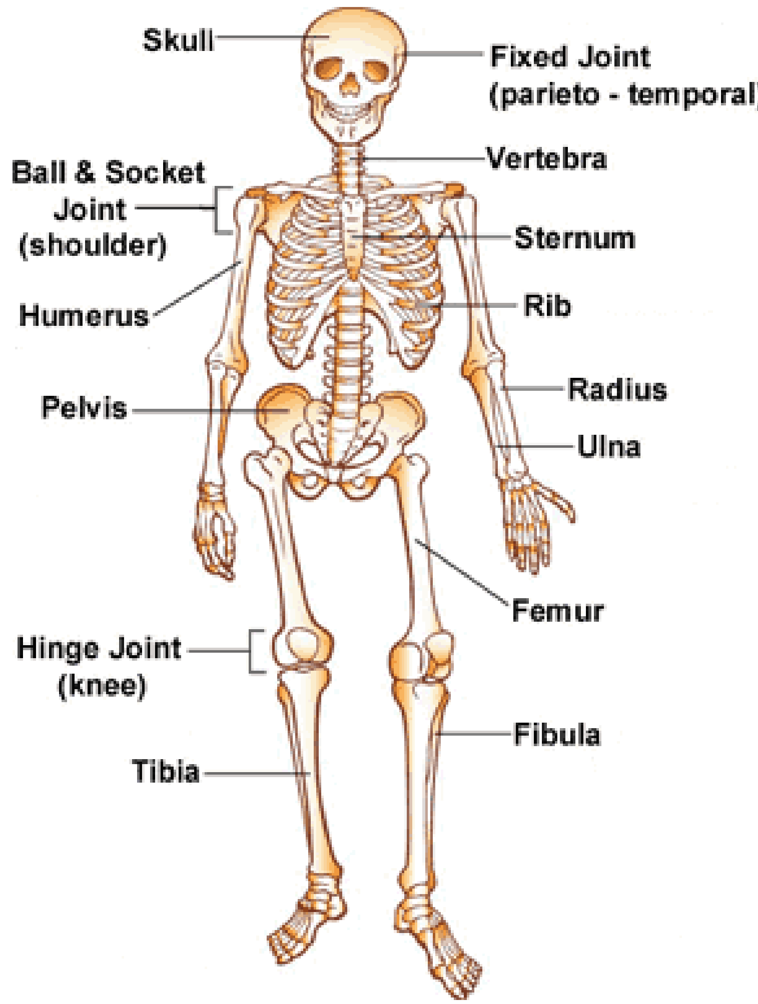


Your Joints

Primary Learning Objectives:

Students will:

- Identify and locate immovable, hinge, partially movable, pivot, and ball and socket joints on their models and on their bodies.
- Be able to construct models of hinge, pivot, and ball and socket joints and arm muscles.
- Understand the roles of muscles, tendons, and ligaments in joint movement.



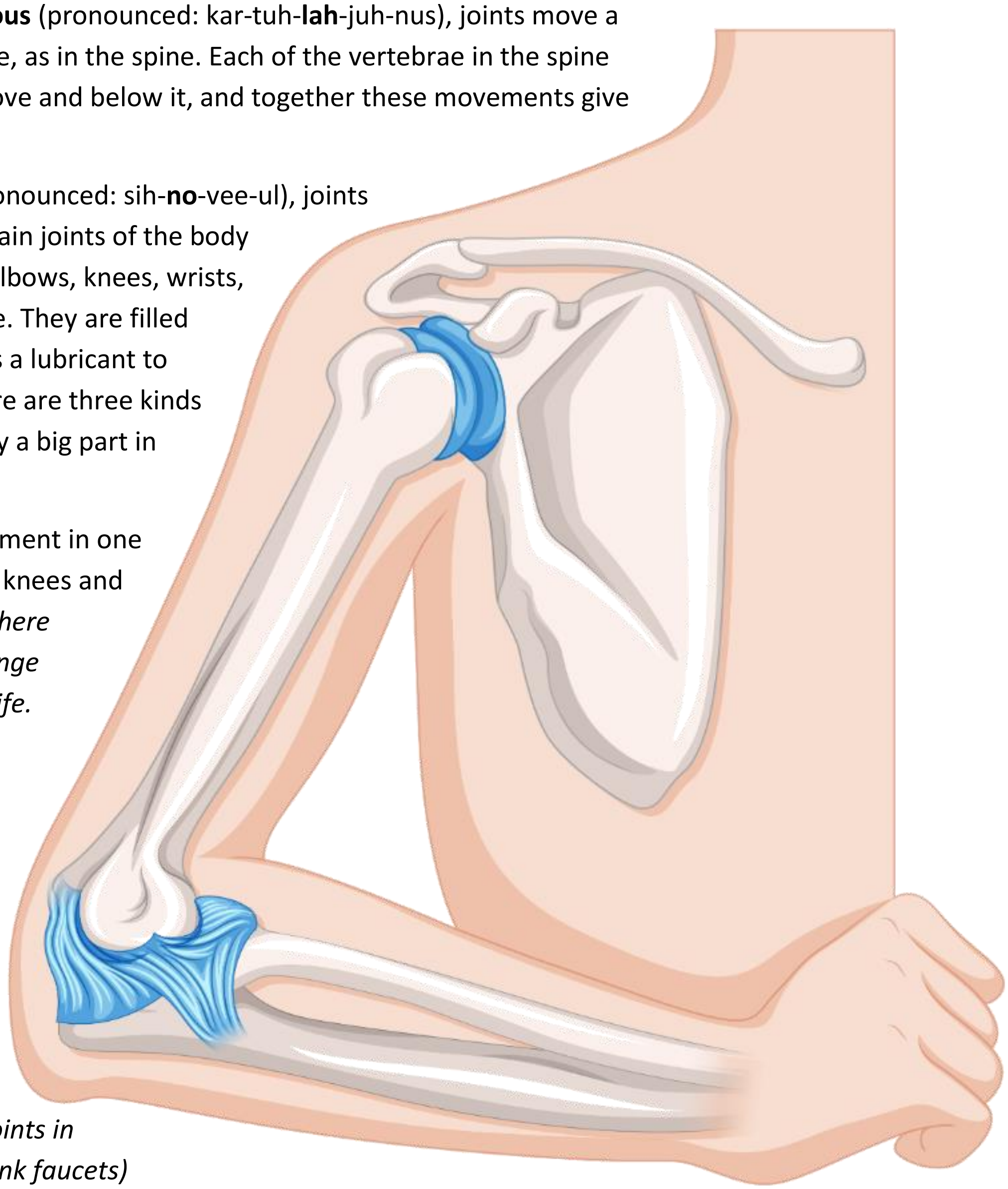
The place where two bones meet is called a joint. Some joints move and others don't. We've learned a little about joints so far. What kinds have we found? And where are they?

What Are the Joints and What Do They Do?

Joints allow our bodies to move in many ways. Some joints open and close like a hinge (such as knees and elbows), whereas others allow for more complicated movement — a shoulder or hip joint, for example, allows for backward, forward, sideways, and rotating movement.

Joints are classified by how they let you move. **Immovable**, or **fibrous**, joints don't move. The dome of the skull, for example, is made of bony plates, which must be immovable to protect the brain. Between the edges of these plates are links, or joints, of fibrous tissue. Fibrous joints also hold the teeth in the jawbone.

Partially movable, or **cartilaginous** (pronounced: kar-tuh-**lah**-juh-nus), joints move a little. They are linked by cartilage, as in the spine. Each of the vertebrae in the spine moves in relation to the one above and below it, and together these movements give the spine its flexibility.



Freely movable, or **synovial** (pronounced: sih-**no**-vee-ul), joints move in many directions. The main joints of the body — found at the hip, shoulders, elbows, knees, wrists, and ankles — are freely movable. They are filled with synovial fluid, which acts as a lubricant to help the joints move easily. There are three kinds of freely movable joints that play a big part in voluntary movement:

> **Hinge** joints allow movement in one direction, as seen in the knees and elbows. *(Ask students where they might have used hinge joints in their everyday life. Ex. doors)*
>
> **Pivot** joints allow a rotating or twisting motion, like that of the head moving from side to side. They work like a ring on a peg. *(Ask students where they might have used pivot joints in their everyday life. Ex. sink faucets)*
>
> **Ball-and-socket** joints allow the greatest freedom of movement. The hips and shoulders have this type of joint, in which the round end of a long bone fits into the hollow of another bone

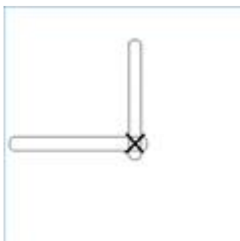
Fixed joints are fixed in place and don't move at all. Your skull has some of these joints (called sutures, remember?), which close up the bones of the skull in a young person's head.

Moving joints are the ones that let you ride your bike, eat cereal, and play a video game — the ones that allow you to twist, bend, and move different parts of your body. Some moving joints, like the ones in your spine, move only a little. Other joints move a lot.

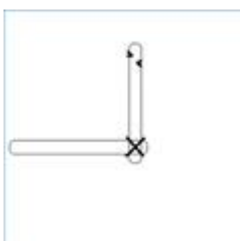
One of the main types of moving joints is called a **hinge joint**. Your elbows and knees each have hinge joints, which let you bend and then straighten your arms and legs. These joints are like the hinges on a door. Just as most doors can only open one way, you can only bend your arms and legs in one direction. You also have many smaller hinge joints in your fingers and toes.

Have students build a hinge joint to get a better idea of how they work.

1. Set two craft sticks on top of one another at a 90-degree angle to form an "L" shape.
2. Wrap the small rubber bands around the two touching ends of the craft sticks in an "X" shape to hold the sticks together in the "L" position. Wrap the rubber bands tightly enough that the craft sticks do not slip out of position, but loose enough to bend together and apart from one another at the non-attached ends like a hinge.



3. Cut two notches in the vertical stick: one just under where the craft stick is rounded at the top on the left side of the vertical stick, and the other slightly lower than the first, on the right side of the vertical stick.



4. Cut two more notches in the horizontal stick. One notch goes on top of the horizontal stick, right next to where it meets the vertical stick and to the left of the vertical stick. The other notch goes on the end of the horizontal stick, to the right of the vertical stick, right in the middle of the curve on the end of the horizontal stick.

5. Wedge the ends of the large rubber bands into the notches on the craft sticks. The rubber bands run from the top of the "L" shape to the bottom on each side of the vertical stick. In other words, the rubber band runs from the top of the vertical stick to the bottom notch, one rubber band on the left of the vertical stick, and one on the right.

6. Using the marker, label the vertical stick "Humerus."

7. Draw a line running down the middle of the length of the horizontal stick with the marker. Label the area above the line "Radius," and label the area below the line "Ulna."

8. Move the sticks back and forth, allowing the rubber band "X" to demonstrate the hinge joint that is found in an elbow

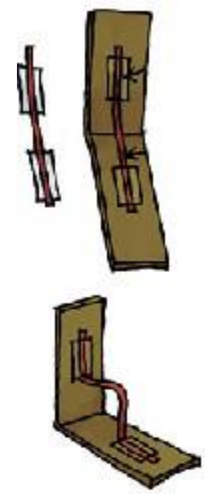
Another important type of moving joint is the **ball and socket joint**. You can find these joints at your shoulders and hips. They are made up of the round end of one bone fitting into a small cup-like area of another bone. Ball and socket joints allow for lots of movement in every direction. Make sure you've got lots of room and try swinging your arms all over the place.

To allow students to see how a ball and socket joint works have each student do the following:

1. Set a three-ounce paper cup in front of them.
2. Roll some clay in your hands into a ball. They will want to use about the same amount of clay as it takes to fill the paper cup.
3. Place the clay ball into the paper cup and press the end of a craft stick into the clay.
4. Rotate the craft stick so the ball moves around inside the cup. This is the same way a ball and socket joint rotates.

Have you ever seen someone put oil on a hinge to make it work easier or stop squeaking? Well, your joints come with their own special fluid called **synovial fluid** (say: **si**-no-vee-ul) that helps them move freely. Bones are held together at the joints by **ligaments** (say: **lih**-guh-mints), which are like very strong rubber bands.

Pull Power



Our movements are powered by muscles, which are connected to our bones by *tendons and ligaments* (tough bands of tissue that reach from one bone to another). To help children understand how muscles move our bones, invite them to follow the steps below to create a model of a human arm.

1. Fold and then unfold an 8" x 1" strip of cardboard to create a cardboard arm.
2. Cut a rubber band in half to represent two "muscles."
3. Tape a rubber-band muscle in a straight line to each side of the cardboard arm.
4. Gently pull one rubber band to make the sections of the arm bend toward each other and contract. This is the action of the *biceps*.
5. Then pull the muscle on the reverse side (the *triceps*) to make the biceps lengthen and relax. The arm will straighten once more. [11]

More to Do: Models of Pivot, Hinge, and Ball and Socket Joints

Materials:

- Copies for each student
- Tape
- Brads
- Scissors

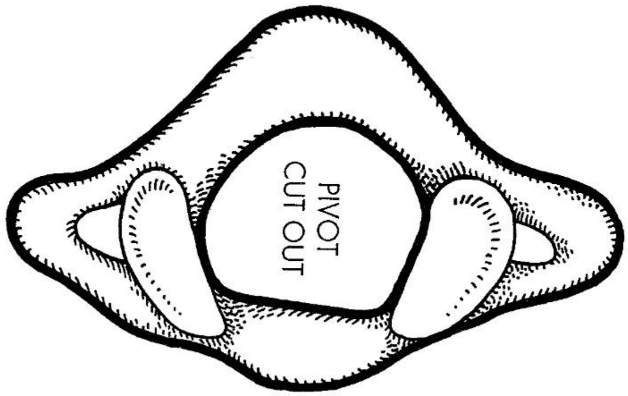
Make each student a set of the following pages, in cardstock. Page one has three pieces that will be cut out and attached to the joints on page two.

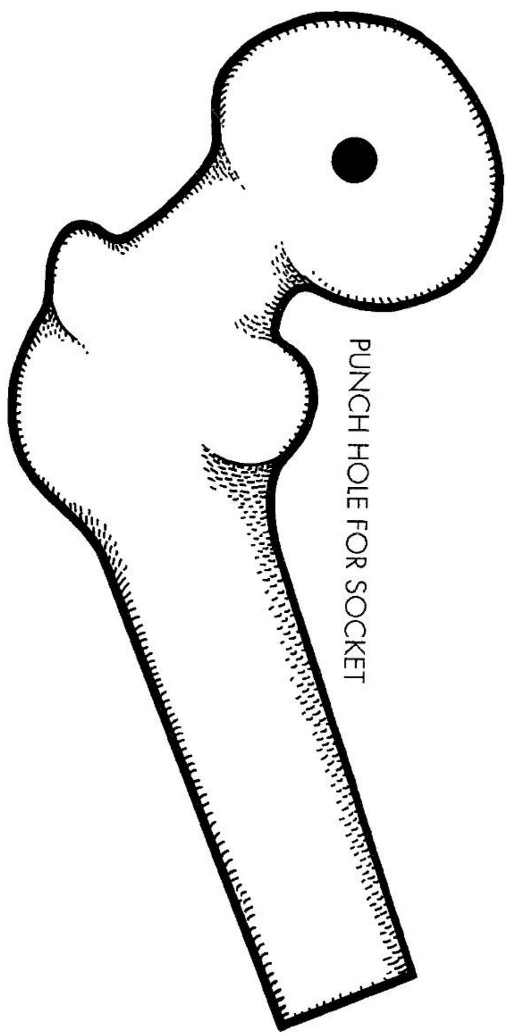
1. Have students start with page one and cut out the bone piece with the hinge tab. Then cut open the slot on page two and insert the hinge tab. Then they will turn sheet two over and tape the tab down.

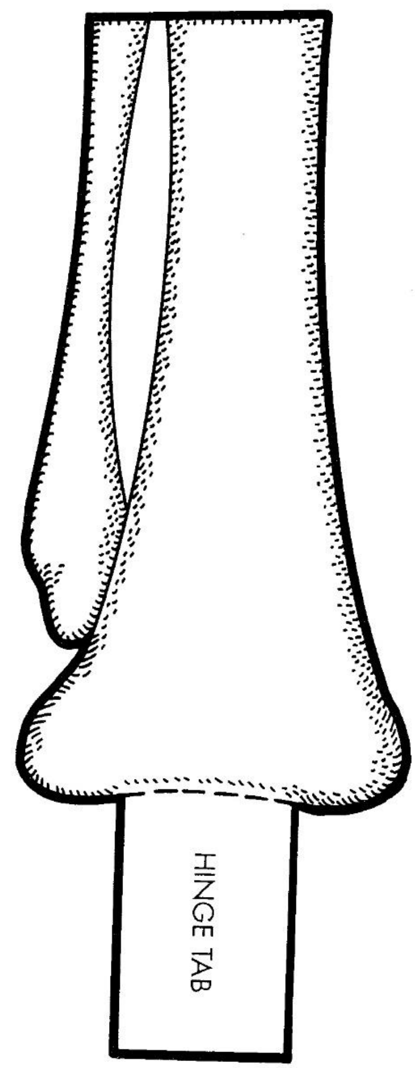
[11] Idea found at http://teacher.scholastic.com/products/instructor/Oct04_bones.htm

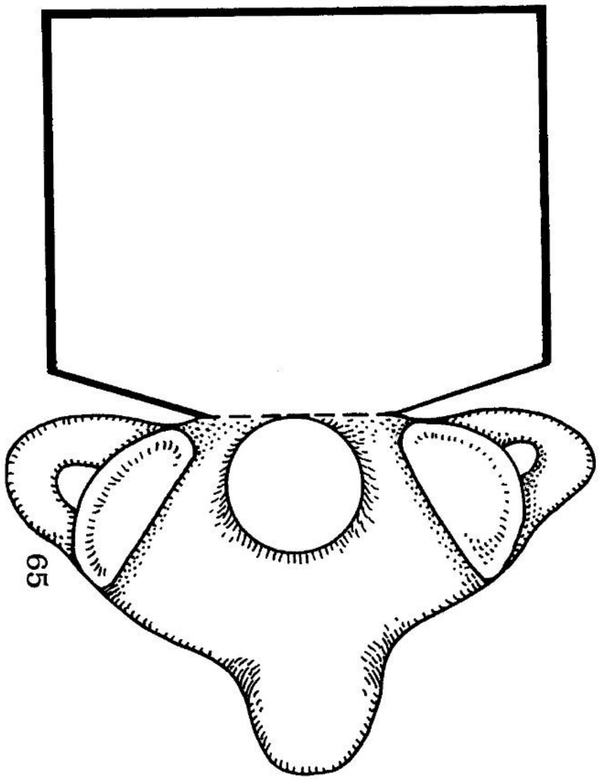
2. Next the students will cut out the ball joint from page one and place the ball over the socket on page two. Have students fasten them together by punching them together with a brad and opening the prongs on the back of the model.
3. Students will then cut out the remaining joint on page one and cut out the middle section. Then students will cut (only!) along the thick black line on the pivot joint, on page 2, leaving the rest intact. Students will then fold up the cut part to make a tube, which will be taped together and then inserted into the center of the cut out pivot joint from page 1.

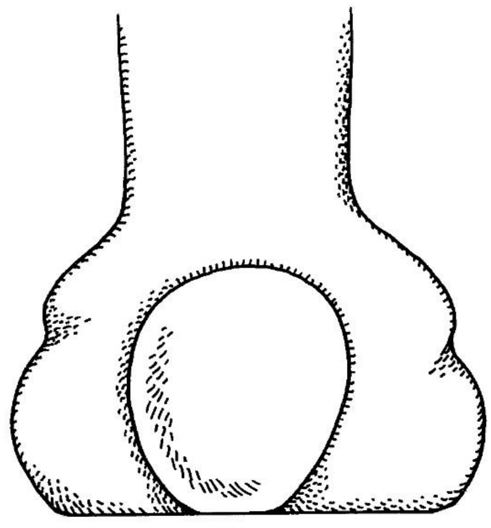
Remind students that bones can't move on their own. *(Ask students what has to move them. Muscles)*

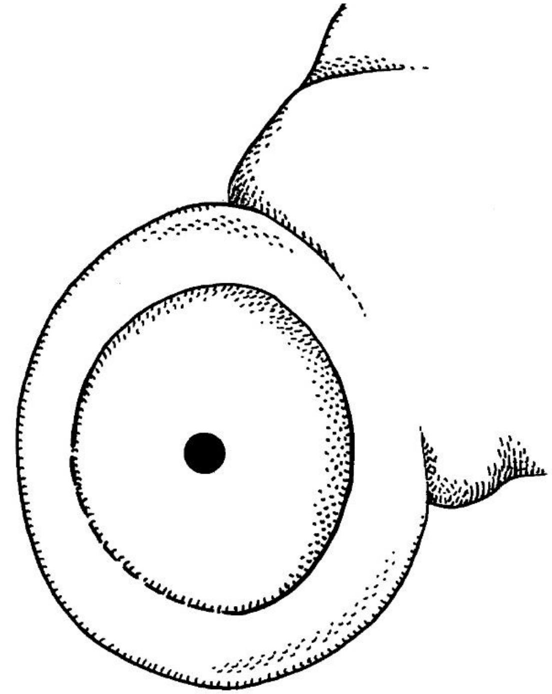

PIVOT
CUT OUT


PUNCH HOLE FOR SOCKET


HINGE TAB

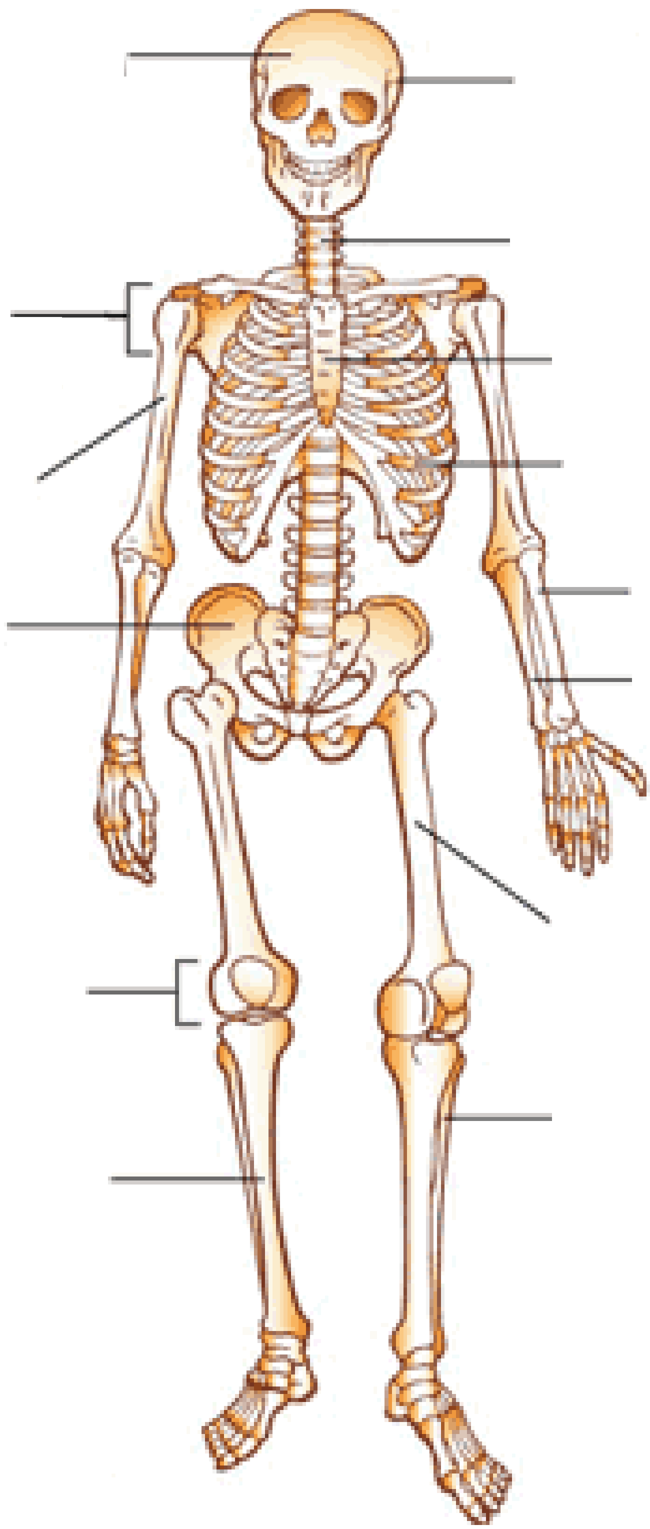

PIVOT JOINT


HINGE JOINT


BALL AND
SOCKET JOINT

Get Mark, Get Set...Go!

Name as many joints and bones as you can within the time limit. Additional bones and joints beyond those marked can also be identified for bonus points. Ha Ha!



Glossary of Bones:

Main Bones of the Human Skeleton System

Cranium-The cranium is a skull bone that covers the brain. The facial bones are not a part of the cranium. The bones that are just above the ear or in front of the ear are called as temporal bones.

Mandible-The mandible is the jaw bone and one of the strongest and the largest bones of the facial skeleton system. You are born with a mandible that is divided into two separate halves. As you grow, the median plane of symphysis of fibrous tissue help joining the mandible into one.

Vertebrae-The vertebrae consists of the various bones of the spinal column. The vertebrae include the cervical vertebrae of the neck, the thoracic vertebrae that is the point of attachment for ribs. It also consists of the lumbar vertebrae that includes the vertebrae of the lower back, the sacrum, that is, the five fused vertebral bones that are joined to the pelvis. The end point of the vertebrae column is the coccyx. It consists of four fused vertebrae that makes the tail bone.

Ribs-The twelve pairs of ribs form a cage like structure, which helps in protecting the chest cavity and the major organs like lungs and heart.

Sternum-The sternum or breast bone is divided into three parts. The manubrium, body of strenum and xiphoid process. Of the twelve pairs of ribs, the first seven pairs are connected to the sternum through the costal cartilages.

Clavicle-The clavicle or the collar bone runs horizontally from the base of the neck to the shoulder. The main function of the of the clavicle is to support the shoulder and provide mobility to the arm. It also helps in partly transferring the weight to the shoulder.

Scapula-The scapula or shoulder blade is a large flattened, triangular shaped bone. It is located in the posterilateral part of the thorax. The shoulder blade is thin, fragile and can be easily broken.

Humerus-The longest and the robust bone of the arm is called the humerus. It is a cylindrical shaft like bone that has a flattened distal end and a rounded articular surface on the proximal end.

Ulna-The ulna is the median bone in the forearm that runs parallel to the radius. On the proximal end, it has a hook-like articular surface. The distill end consists of a rounded head and a styloid process.

Radius-The radius along with ulna make up the bones of the forearm. These bones articulate with the humerus at the proximal end and the wrist bones at the distal end. The radius is the lateral bone of the forearm.

Carpals-The 7 bones of the wrist are called carpals. There are eight small bones that are present at the distal end of the radius and ulna.

Metacarpals-The five metacarpals are bones that make up the palm bones present between the distal row of the carpal bones and the proximal phalanges.

Phalanges-The fourteen bones that make up the fingers and toes are called phalanges. There are three phalanges in each finger and two in the thumb. They are called the distal phalanx, the middle phalanx and the proximal phalanx.

Femur-The longest and the strongest bone in the human skeleton system. The femur or the thigh bone is closest to the body. It is a part of the hip and the knee.

Patella-The patella or the knee cap is the thick triangular bone of the knee. It articulates with the femur and covers the knee joint to protect it.

Tibia-The shinbone or tibia is the larger and stronger of the two bones that make up the bones of the leg below the knee joint. The word 'tibia' in Greek means flute.

Fibula-The calf bone or fibula is the smaller of the two bones that form the lower leg. It is placed laterally to tibia and is the most slender of all the long bones.

Tarsus-The tarsus or heel bone consist of 7 bones that make up the posterior part of the foot, that is present between the tibia, fibula and metatarsals. The tarsus and tibia and fibula joint is commonly known as the ankle joint.

Metatarsus-The five long bones of the foot are called the metatarsus. They are located between the tarsal bones and the phalanges of the toes.

Phalanges of the Foot-There are two phalanges in the great toe and three in the other toes.

Skeletal System: system of bones and cartilage that helps to support and protect the vody

Vertebra: bone that makes up the backbone

Cartilage: tough, flexible connective tissue

Joint: place where two or more bones meet

Ligament: tissue that connects bone to bone

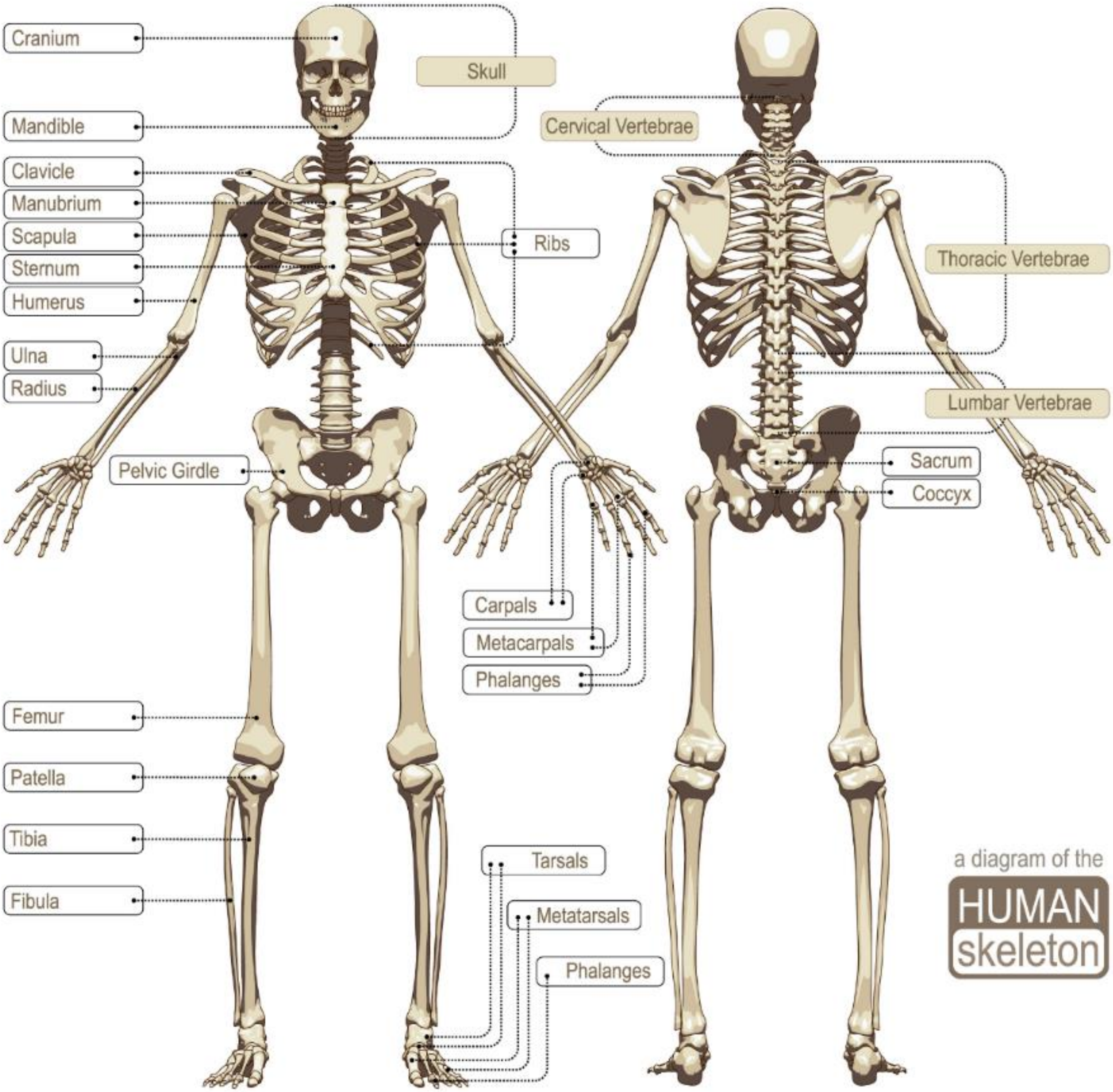
Periosteum: thin membrane that covers a bone

Compact Bone: hardest part of bones

Spongy Bone: part of a bone with many small pores or spaces

Fracture: crack or break in a bone

Bone Marrow: where new blood cells are made


Cranium
Skull
Mandible
Cervical Vertebrae
Clavicle
Manubrium
Scapula
Ribs
Sternum
Thoracic Vertebrae
Humerus
Ulna
Radius
Lumbar Vertebrae
Pelvic Girdle
Sacrum
Coccyx
Carpals
Metacarpals
Phalanges
Femur
Patella
Tibia
Tarsals
Fibula
Metatarsals
Phalanges
a diagram of the
HUMAN
skeleton

WHAT'S ON YOUR MIND?

Lesson Preparation: Brain Building

Make an easy clay for your students to use to make models of their brains using one of the following recipes: Note: You may wish to make colors that match the brain diagrams included in the lesson.

Oatmeal Play Dough

1 cup flour

1 cup water

2 cups oatmeal

Mix everything together in a large bowl. Then knead for a few minutes. This play dough has a nice lumpy texture. (Great for modeling brains!)

No Fuss Play Dough

1 cup cold water
1 cup salt
2 teaspoons vegetable oil
2 cups flour
2 tablespoons cornstarch
Food coloring

In a large bowl, mix together water, salt, oil and a few drops of food coloring. Mix flour and cornstarch and add 1/2 cup at a time, stirring constantly (you may need a little more or a little less than 2 cups flour so make sure you stir in until it is the right consistency). Knead for a few minutes with flour on your hands.

Or: if you have a little more time

Cooked Play Dough

3 cups flour
1 cup salt
6 teaspoons cream of tartar

3 cups water
3 tablespoons vegetable oil
Food coloring

Mix flour, salt, and cream of tartar in a large saucepan. Blend water and oil together in a bowl. Add to the saucepan and cook over medium heat, stirring constantly until it thickens. Add several drops of food coloring until you get the right color. Cook for about five minutes. Take the play dough out of the saucepan and put it on a cutting board or counter and knead for a few minutes. Add flour if it's too sticky.

This play dough should last around three months if you keep it sealed in an airtight container or plastic zip lock bag. It's very smooth and fun to play with when it's still warm.

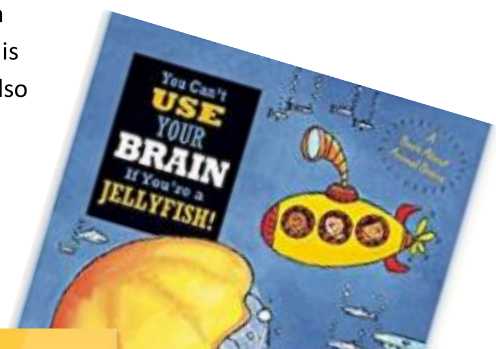
Bag of Brains

Here is a recipe for the construction of a model brain for students to squish and hold

Materials:

- 1.5 cups (360 ml) instant potato flakes
- 2.5 cup (600 ml) hot water
- 2 cups (480 ml) clean sand
- 1 gallon zip lock bag

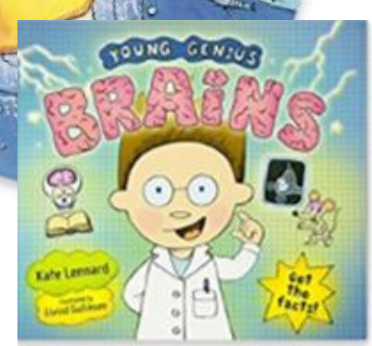
Combine all of the ingredients in the zip lock bag and mix thoroughly. It should weigh about 3 lbs. (1.35 kg.) and have the consistency of a real brain. The resulting mixture is about the size, weight, and color of an adult human brain. (A cauliflower cut in half also is a possible model for the parts of a human brain)



Brainy Books

Check out some of these fun resources for activating prior knowledge!

You Can't Use Your Brain if You're a Jellyfish by Fred Ehrlich, M.D. is about all kinds of brains — insect, bird, dog, cat, monkey, and human — but not about jellyfish brains, because they don't have brains! *Young Genius: Brains* Young Genius is a bright little boy who escorts children through the pages of this amusing and instructive color-illustrated book. Kids will discover answers to many interesting questions about their brains. For example: How can you look at your brain without taking it out of your head? Where do headaches come from? What is imagination? …



Your Fantastic Elastic Brain This fun and engaging introduction to the anatomy and functions of the brain will empower each young reader to S-T-R-E-T-C-H and grow their Fantastic, Elastic Brain!

WHAT'S ON YOUR MIND?

Tips: When you introduce a new vocabulary word, have the students echo the word. Say "echo" and have them repeat the new vocabulary word. Words last longer in our memories when we say them ourselves.

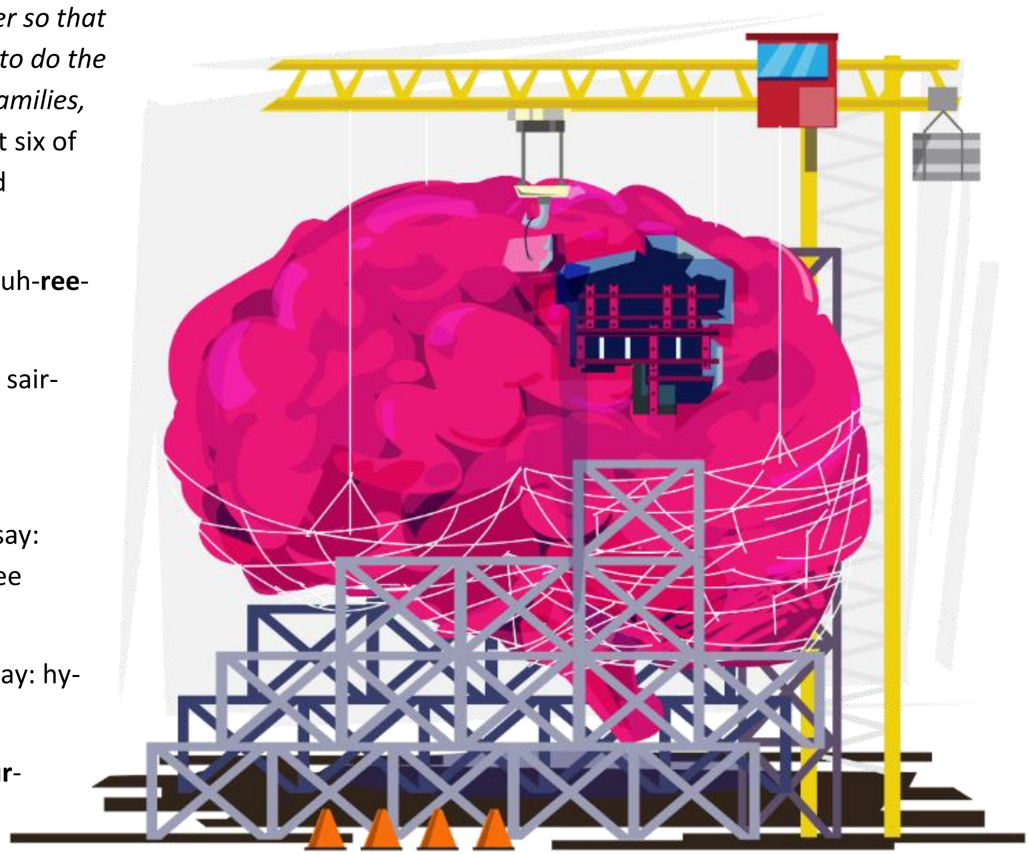
Ask students questions such as the following: How do you remember the way to your friend's house? Why do your eyes blink without you ever thinking about it? Where do dreams come from?

Your brain is in charge of these things and a lot more. In fact, your brain controls just about everything you do, even when you're asleep. Quick—name five ways in which you use your brain every day. Did they include eating breakfast? Or blinking and breathing? How about reading? Not bad for something that looks like a big, wrinkly, gray sponge, or a cauliflower!

Ask the students what they think the brain looks like. Is it just one big lump of stuff or does it have parts? Show the students your bag of brains and/or the cauliflower cut in half. Ask them if it looks like a brain. How are they the same? How are they different? Tell them that they are both ways you can model the brain!

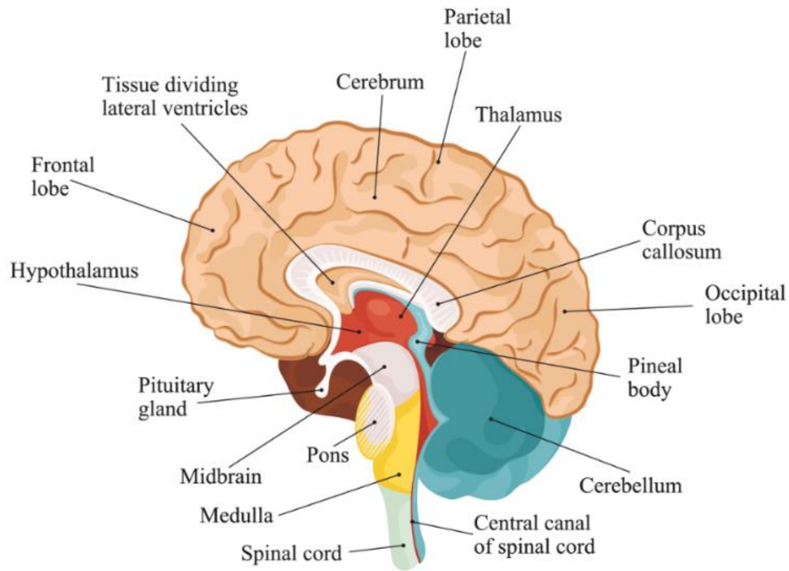
Your brain has many different parts that work together. *Ask students what other kinds of things have a lot of parts that work together so that everyone doesn't have to try to do the same job. Ex. Sports teams, families, etc.* We're going to talk about six of the most important parts and everything they help us do.

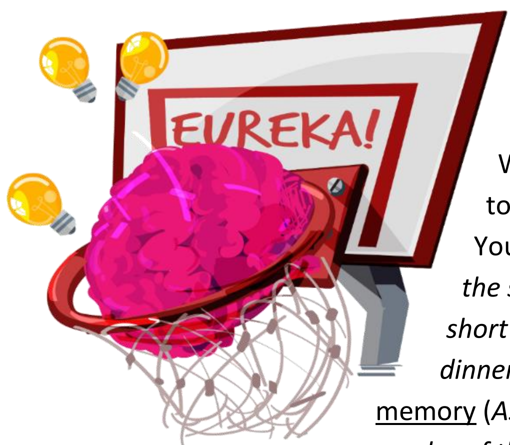
1. cerebrum (say: suh-**ree**-brum)
2. cerebellum (say: sair-uh-**bell**-um)
3. brain stem
4. pituitary gland (say: puh-**too**-uh-ter-ee gland)
5. hypothalamus (say: hy-po-**thal**-uh-mus)
6. neurons (say: **nur**-onz)



The Biggest Part: The Cerebrum

The biggest part of the brain is the cerebrum. *(Point out the cerebrum area on a diagram you draw up on the board and your cauliflower half)* The cerebrum makes up 85% of the brain's weight, and it's easy to see why. The cerebrum is the thinking part of the brain and it controls your voluntary muscles — the ones that move when you want them to. So, you can't dance — or kick a soccer ball — without your cerebrum.





When you're thinking hard, you're using your cerebrum. You need it to solve math problems, figure out a video game, or draw a picture. Your memory lives in the cerebrum — both short-term memory (*Ask the students for some examples of things that they remember for the short term, ex. what you ate for dinner last night*) and long-term memory (*Ask the students for some examples of things that they remember for the long term, ex. their mom, the name of that roller-coaster you rode on two summers ago*). The cerebrum also helps you reason, like when you figure out that you'd better do your homework now because your mom is taking you to a movie later.

The cerebrum has two halves, with one on either side of the head. Some scientists think that the right half helps you think about abstract things like music, colors, and shapes. The left half is said to be more analytical, helping you with math, logic, and speech. Scientists do know for sure that the right half of the cerebrum controls the left side of your body, and the left half controls the right side.

(Model making a cerebrum for the students out of your pink clay. Then, pass out clay and depending on your amount of materials either have students work together or alone to have students model half of their cerebrum, like your example and/or the included diagram)

The Cerebellum's Balancing Act

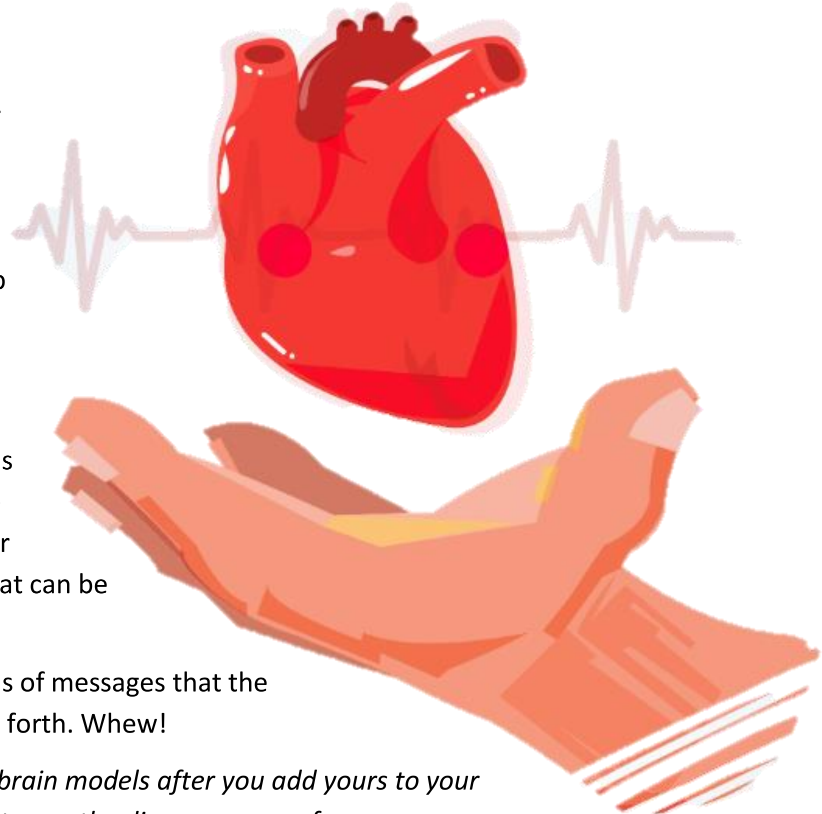
Next up is the cerebellum.

Ask students what the cerebellum does. Show where it is on the diagram. Tell them you are going to give students a hint to what it does. Have students stand beside their desks on one foot for as long as they can. What might be helping them keep their balance?

The cerebellum is at the back of the brain, below the cerebrum. It's a lot smaller than the cerebrum at only 1/8 of its size. But it's a very important part of the brain. It controls balance, movement, and coordination (how your muscles work together). Because of your cerebellum, you can stand up, keep your balance, and move around. Think about a skateboarder riding his board, a yogi, a surfer, a tight rope walker, or a gymnast on a balance beam. What does he or she need most to stay balanced? The best board? The coolest shoes? Glue? Nope — he or she needs their cerebellum! *(Model making a cerebellum for the students out of your clay. Have students add in the cerebellum to their brain models.)*

Brain Stem: Small. But mighty (important)!

Another brain part that's small but extremely important is the brain stem. The brain stem sits beneath the cerebrum and in front of the cerebellum. It connects the rest of the brain to the spinal cord, which runs down your neck and back. The brain stem is in charge of all the functions your body needs to stay alive, like breathing air, digesting food, and circulating blood.



Part of the brain stem's job is to control your involuntary muscles — the ones that work automatically, without you even having to have a single thought about it. You don't have to remember to tell your heart to pump or your lungs to inhale! Luckily, your brain keeps it on the automatic to-do list!

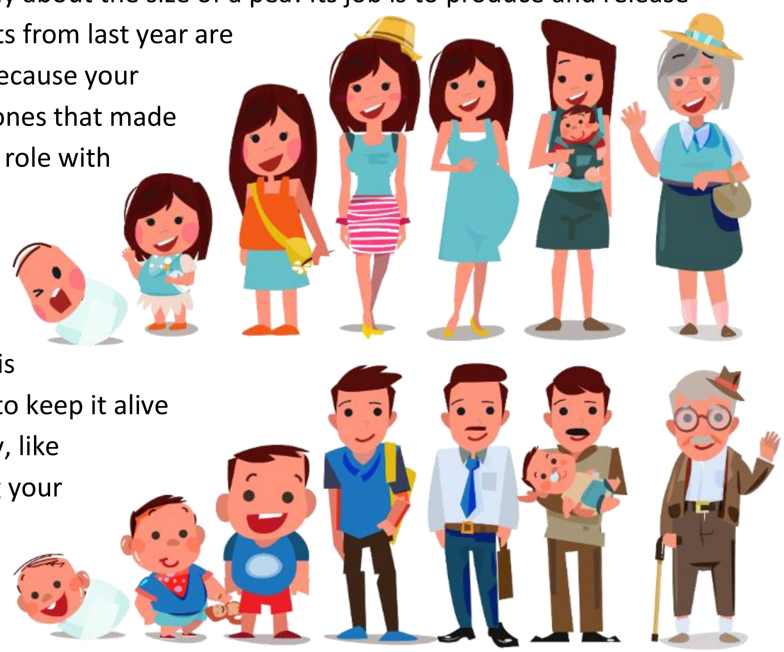
There are involuntary muscles in the heart and stomach, and it's the brain stem that tells your heart to pump more blood when you're biking or your stomach to start digesting your lunch. It also helps you blink, even though that can be both voluntary or involuntary!

The brain stem also sorts through the millions of messages that the brain and the rest of the body send back and forth. Whew!

Have students add in the brain stem to their brain models after you add yours to your model, showing them each step. Allow them to use the diagram as a reference.

Pituitary Gland Controls Growth

The pituitary gland is very small — only about the size of a pea! Its job is to produce and release hormones into your body. If your pants from last year are showing your ankles these days, it's because your pituitary gland released special hormones that made you grow. This little gland also plays a role with lots of other hormones, like ones that control the amount of sugars and water in your body. And it helps keep your metabolism (say: muh-**ta**-buh-lih-zum) going. Your metabolism is everything that goes on in your body to keep it alive and growing and supplied with energy, like breathing, digesting food, and moving your blood around.

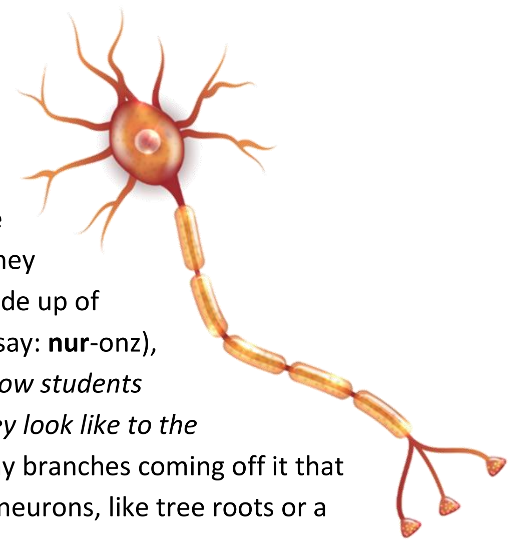


Have students add in the pituitary gland to their brain models after you add yours to your model, showing them each step. Allow them to use the diagram as a reference.

Hypothalamus Controls Temperature

The hypothalamus is like your brain's inner thermostat (that little box on the wall that controls the heat in your house) or thermometer. The hypothalamus knows what temperature your body should be (about 98.6° Fahrenheit or 37° Celsius). If your body is too hot, the hypothalamus tells it to sweat. If you're too cold, the hypothalamus gets you shivering. Both shivering and sweating are attempts to get your body's temperature back where it needs to be. *Have students add in the hypothalamus to their brain models after you add yours to your model, showing them each step. Allow them to use the diagram as a reference.*

Neurons!



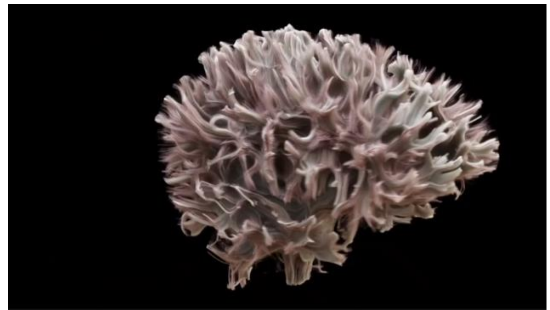
But you might wonder about these nerves, which you can't see without a microscope. What are they anyway? The nervous system is made up of millions and millions of neurons (say: **nur**-onz), which are microscopic cells. *(Show students pictures of neurons, what do they look like to the students?)* Each neuron has tiny branches coming off it that let it connect to many other neurons, like tree roots or a tree.

When you were born, your brain came with all the neurons it will ever have, but many of them were not connected to each other. When you learn things, the messages travel from one neuron to another, over and over. Eventually, the brain starts to create connections between the neurons, so things become easier and you can do them better and better. We can think about it like building a road, at first it's rough gravel and bumpy to drive on, but then it gets smoother and smoother as you pave it. Eventually it's a superspeed highway!

In the first few years of life, more than 1 million new neural connections are formed every second. Neural connections are formed through the interaction of genes and a baby's environment and experiences. These are the connections that build brain architecture – the foundation upon which all later learning, behavior, and health depend.[12]

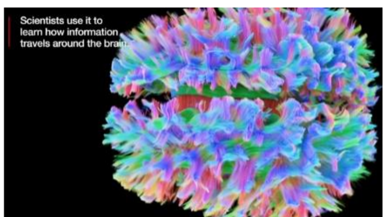
[12] Center on the Developing Child (2009). *Five Numbers to Remember About Early Childhood Development* (Brief). Retrieved from www.developingchild.harvard.edu.

Beautiful Brains!


The wiring of the human brain

The world's most detailed scan of the brain's internal wiring has been produced by scientists at Cardiff University. The MRI machine reveals the fibers which carry all the brain's thought processes.

The scan shows fibers in the brain's white matter called axons. These are the brain's wiring, which carry billions of electrical signals. Not only does the scan show the direction of the messaging, but also the density of the brain's wiring. The extraordinary images produced in Cardiff are the result of a special MRI scanner - one of only three in the world.



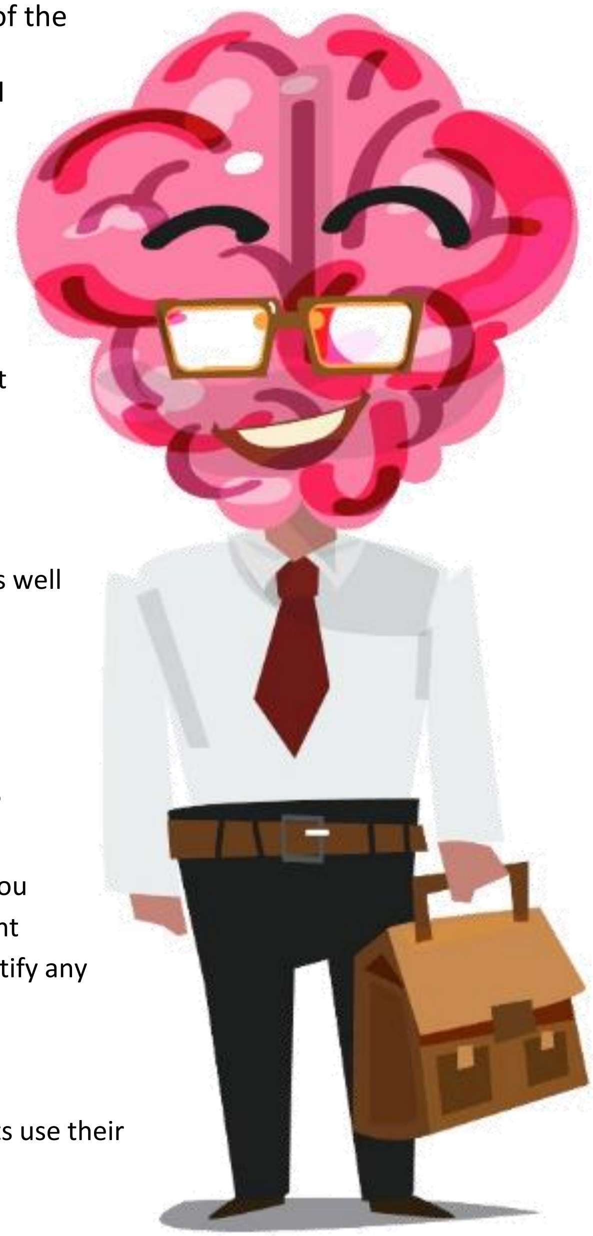
The wiring of the human brain

The scanner itself is not especially powerful, but its ability to vary its magnetic field rapidly with position means the scientists can map the wires - the axons - so thinly it would take 50 of them to match the thickness of a human hair.

[Take a look at the video!]()

It's been done in Cardiff, Nottingham, Cambridge and Stockport, as well as London England and London Ontario. [13]

Brainiac! Can You Name that Brain?

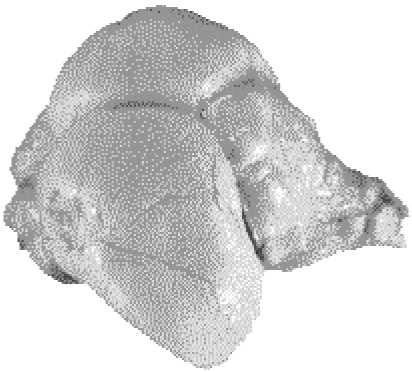


What do other brains look like? Here are some photos of brains of animals. Which looks most like human brains? How do they differ? Make sure students know what these animals are. Show them the included pictures of the animals and see if they can find any that you have the brain pictures of. Ask them which animals they think might have smaller brains, which ones are larger etc. See if they can identify any of the parts of the brain of the animals by guessing.

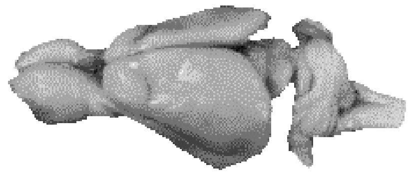
Extension: Concentrate!

Play a game of Concentration with the included cards. Can students use their amazing brains and memories to find the matching pairs?

[13] **Fergus Walsh. 2017. "What the brain's wiring looks like". Retrieved from: http://www.bbc.com/news/health-40488545**

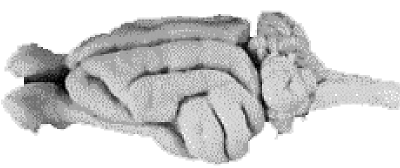


Mole

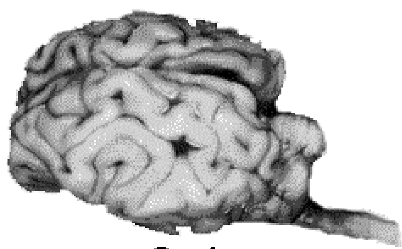


Opossum

Fruit Bat

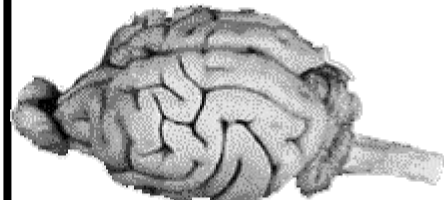


Anteater

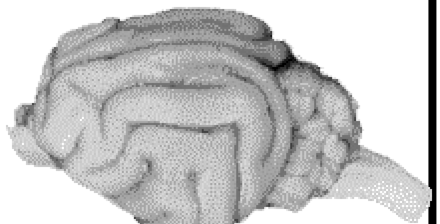


Goat

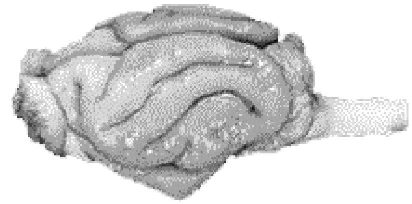
Camel



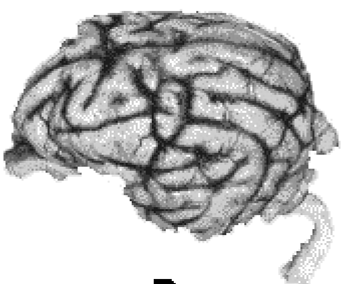
Raccoon



Cat

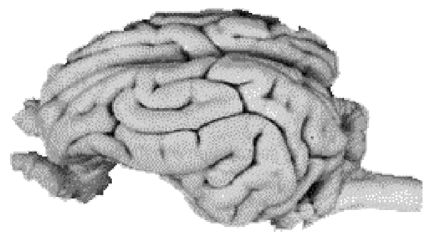


Skunk

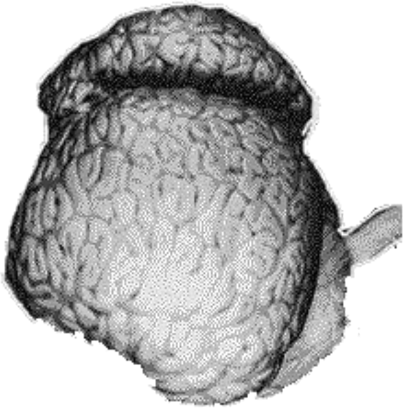


Dog

Deer

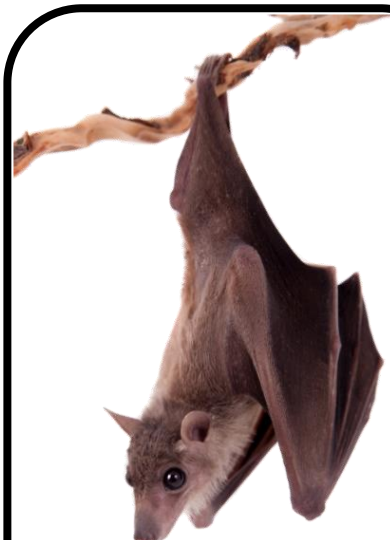


Pig



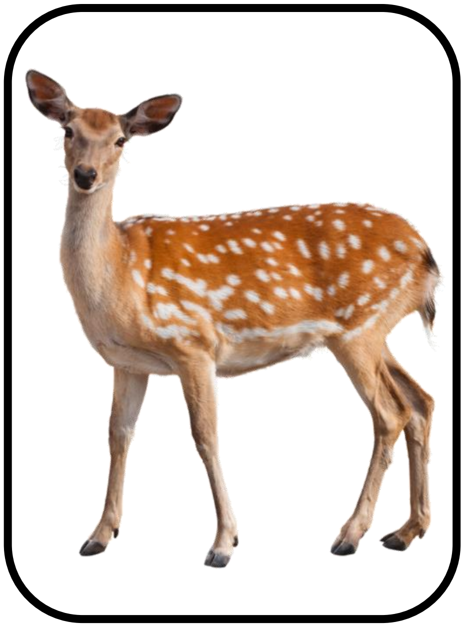
Dolphin

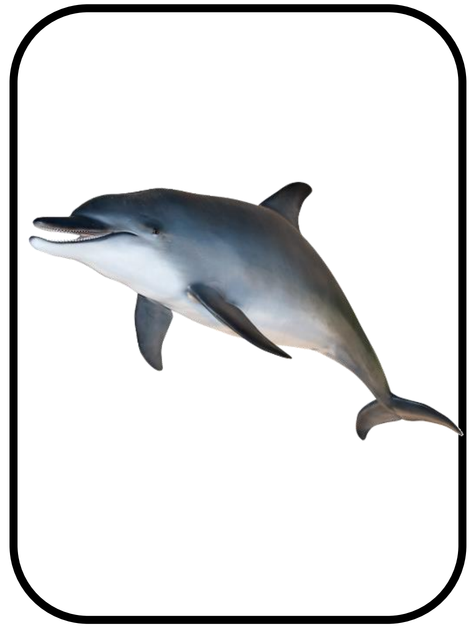
Human









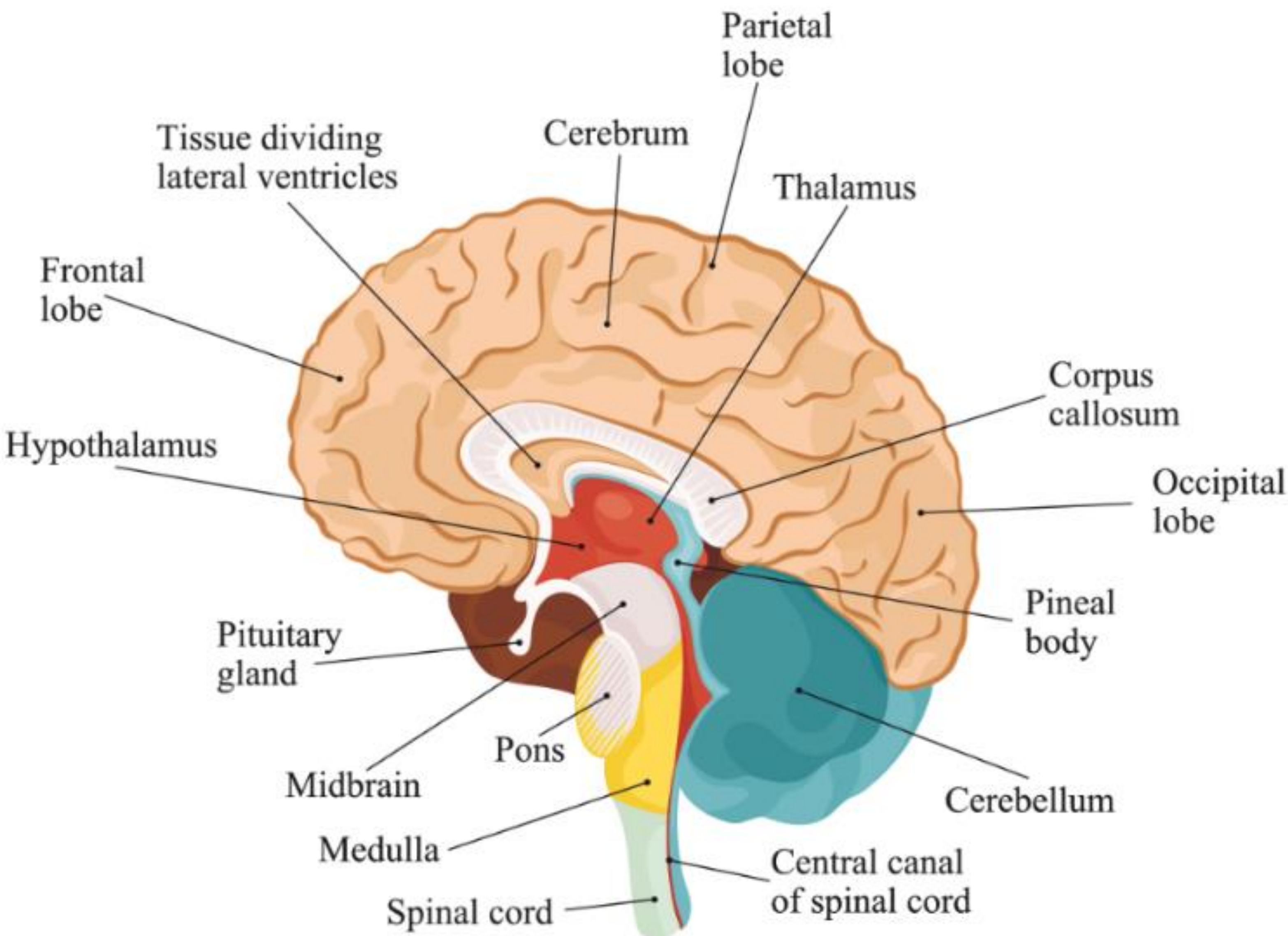
Interesting Animal & Brain Facts

- Some animals' brains function very much like human brains and knowing how an animal's brain operates can sometimes help scientists better understand how our brains work.
- A silkworm has eleven brains but uses fewer than half of them (five), as far as we know.
- Starfish do not have brains.
- A rhinoceros's brain is smaller than its nose. The rhino's brain processes smells that tell the animal a lot about the objects it sniffs.
- An ostrich's eye is bigger than its brain.
- Blue whales have bigger brains than any other animal. The blue whale is the world's largest mammal.
- What is the smartest insect? Honeybees may be the smartest. Bees often plan ahead when looking for food so they can find it easily when it is needed. Worker bees have many jobs including building the hive; collecting pollen, nectar, and water; and taking care of the young.
- What are the smartest non-human animals? Chimpanzees are generally considered the most intelligent animals next to humans. Even at a young age, chimps learn how to use simple tools such as twigs, which they use to dig insects out of logs or mounds of dirt. They even know about medicine!

  By watching their mothers, young chimpanzees in the wild learn which berries and plants to eat when they feel sick. In captivity, chimps can also be taught to count and use sign language to communicate.
- Can animals plan ahead? Scientists say beavers and groundhogs have an image of their future homes in mind before they start to burrow in the ground or build a lodge. Using this mental blueprint, they plan where to put their homes and make sure their houses fit their needs.

Source: Monkeyshines on Health & Science, Mar2004 Your Brain, p36, 1p

HUMAN BRAIN


Parietal lobe
Tissue dividing lateral ventricles
Cerebrum
Thalamus
Frontal lobe
Corpus callosum
Hypothalamus
Occipital lobe
Pineal body
Pituitary gland
Pons
Midbrain
Cerebellum
Medulla
Central canal of spinal cord
Spinal cord

Eye didn't know that!

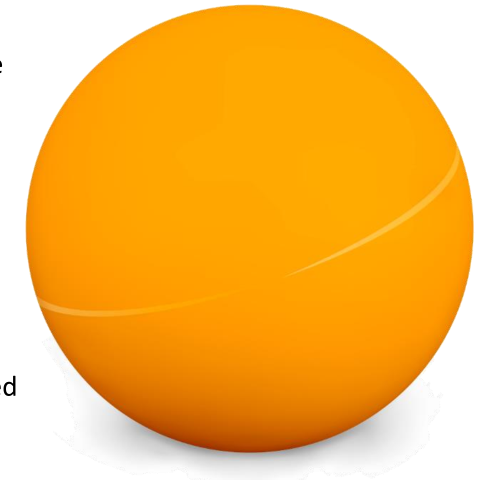
Ask students, which part of their body do they depend on most to help them move through and around things? If they guessed their eyes, they're right!

Your eyes are at work from the moment you wake up to the moment you close them to go to sleep. They take in tons of information about the world around you — shapes, colors, movements, and more. Then they send the information to your brain, using your nerves, so the brain knows what's going on outside of your body. Although the eyes are small compared with most of the body's other organs and parts, their structure is incredibly complex. The eyes work together to perceive depth, how near and far things are from us, which helps us know how big or small objects are, and how far away from us they are, which helps us move around them. Not only do the two eyes work together, they also work with your brain, muscles, and nerves to produce visual images and send messages. Our eyes constantly adapt to all the changes around us — for example, they are able to adjust so that we can easily move around in a nearly dark room or bright sunlight. You can see that the eye's pretty amazing but to understand how your eyes work, you need to know about the parts that make up the eyes.

The Parts of the Eye

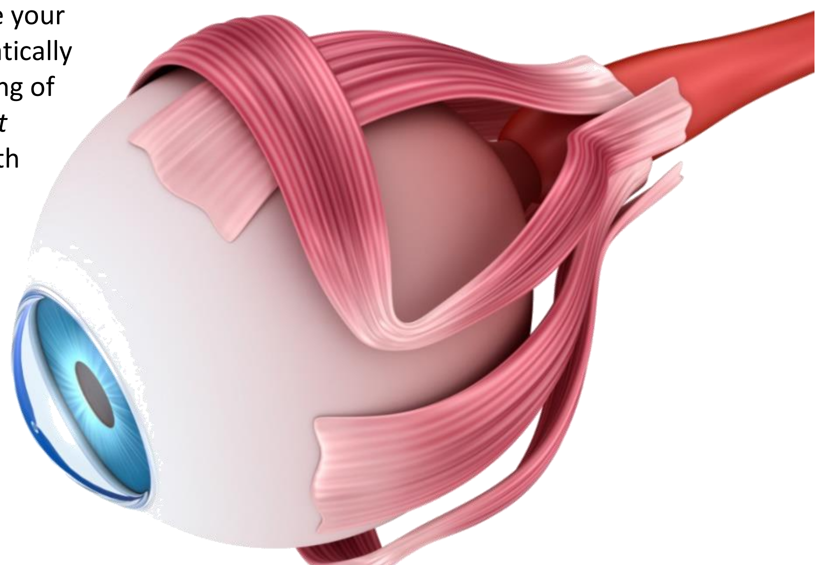
Have students look into a mirror. What do they see? Their eyes of course! Most of your eye is held inside the bony protection of your skull, but there's a lot you can see on the outside, too. But you can't see all of them, since a person's eyeball is made up of layers, kind of like the layers on an onion. Have students look at each other's eyes. What parts can they see? (Eyelids, pupil, iris, sclera, veins, eyelashes)

Big as a Ping Pong Ball



When you look at someone's face you are only seeing part of their eyes. The eye is about as big as a ping-pong ball *(Show the students a ping pong ball)* and sits in a little hollow area (called the eye socket) in the skull where it is surrounded by bone. *(Give each child a ping pong ball and have them tuck the ping pong ball into a piece of clay that will hold it and cover 2/3 of the ball.)* The visible part of the eye is protected by the eyelids and the eyelashes, which keep dirt, dust, and even harmful bright light out of the eye. *(Have students create an eyelid with a smaller strip of clay and blend it in.)* The eyelid protects the front part of the eye. The lid helps keep the eye clean and moist by opening and shutting several times a minute. This is called blinking, and it's both a voluntary and involuntary action, meaning you can blink whenever you want to, but it also happens without you even thinking about it. *(Have students have a contest of how long they can go without blinking. What happens as they try to control their eyelids? What if you snap your fingers near their face? Shine a flashlight in their eyes? Who made it the longest? How did it feel when they finally blinked?)*

The eyelid also has great reflexes, which are automatic body responses, that protect the eye. *(Ask the students when their eyelids automatically close to protect their eyes. When a ball flies at them? What other times? Flash a flashlight into their eyes, do they blink? Could they stop themselves?)* When you step into bright light, or have a flashlight shone in your eyes, for example, the eyelids squeeze together tightly to protect your eyes until they can adjust to the light. And if you flutter your fingers close (but not too close!) to your friend's eyes, you'll be sure to see your friend's eyes blink. Your friend's eyelids shut automatically to protect the eye from possible danger. And speaking of fluttering, don't forget eyelashes. *(Ask students what they think eyelashes do for your eyes.)* They work with the eyelids to keep dirt and other unwanted stuff out of your eyes.



For you to see, the eye has to move. Six muscles surround the eyeball in the skull. These muscles act like the strings on a puppet, moving the eye in different directions. The muscles of each eye normally move together at the same time, making your two eyes to look at the same thing. That's why you have to think to wink! *(Can the students wink? Have them try it. Is it harder than they thought?)*

The outside white part of the eyeball is called the **sclera** (say: **sklair**-uh). The sclera is made of a tough material and has the important job of covering most of the eyeball. Think of the sclera as your eyeball's outer coat. *Have students look very closely at the white of the eye in their mirror*, and they'll see lines that look like tiny pink threads. These are blood vessels, the tiny tubes that deliver blood, to the sclera.

The **cornea** (say: **kor**-nee-uh), a transparent dome, sits in front of the colored part of the eye. *(Have students close their eyes and press gently on their eyelid. They'll be able to feel the slight bulge of the cornea in the middle of their eye.)* It's a tough, clear window that protects your iris and pupil. The cornea helps the eye focus as light makes its way through. It is a very important part of the eye, but you can hardly see it because it's made of clear tissue. Like clear glass, the cornea gives your eye a clear window to view the world through.

Iris is the Colorful Part

Behind the cornea is the iris. The **iris** (say: **eye**-riss) is the colorful part of the eye. When we say a person has blue eyes, we really mean the person has blue irises!

> **DID YOU KNOW?**
> The color of the iris comes from a pigment called melanin (pronounced: meh-luh-nun), the same substance that gives skin and hair their color. The more melanin there is and the closer it is to the surface of the tissue, the darker the iris. People with brown eyes have more melanin in their irises than those with blue eyes.

All irises have the same dark pigment, but darker colored eyes have more of it than lighter-colored eyes. unique, as are the patterns on your iris (the colored part of your eye). Whether your iris is blue, brown, gray, green, or hazel, it's filled with streaks and spots of various colors. Even identical twins, who sometimes share identical fingerprints, have different irises.

The iris is made of a circular muscle that opens and closes, this allows the iris to control how much light goes through a hole in the middle of the muscle *(ask students what the hole might be called, can they find it?)*

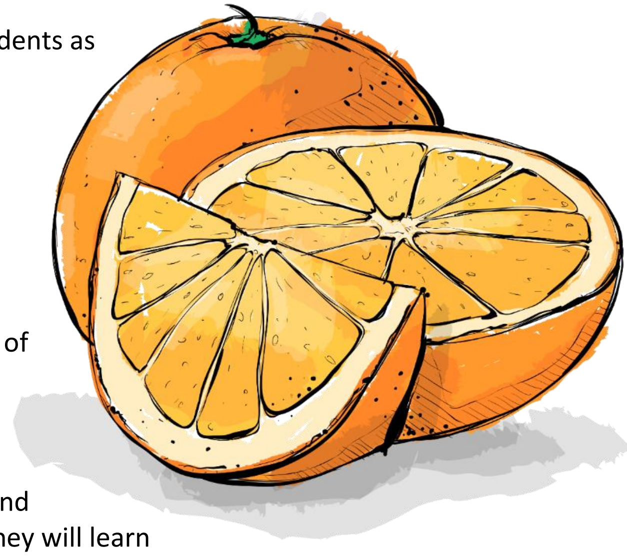
The **pupil** (say: **pyoo**-pul) is the black circle in the center of the iris. Did you know it's simply a hole or opening in the iris? When the muscle contracts (squeezes), it makes your pupil smaller, when it relaxes your pupil gets bigger. This squeezing and relaxing lets different amounts of light enter the eye. Pupils respond quickly to any change in lighting. In just one-fifth of a second, they can go from their smallest size to their largest. At its smallest, the pupil is just over one-thousandth of a square inch. At its largest, the pupil is up to fifty times that size.

To have students see how this works, divide them in pairs. Either have one partner completely cover their eyes for 30 seconds and then uncover them while their partner watches. Did they see any changes? Or have students use a small flashlight to see how their friend's eyes respond to changes in brightness. The pupils will get smaller when the light shines near them and they'll open wider when the light is gone. Have students come up with another experiment to test their iris/pupil reactions.

There is a space between the cornea and the iris. This space is filled with a special clear watery liquid that feeds the cornea and keeps it healthy, as well as helping the cornea stay rounded, so it can focus light correctly. This liquid is called the **aqueous** (pronounced: **a**-kwee-us) **humor**. The cornea and aqueous humor form an outer lens *(what other lenses can the students think of? Magnifying glass? Glasses?)* that **refracts** (bends) the rays of light on their way into the eye so that it all meets at the same spot within the eye.

– Have students finish turning their ping pong balls fully into eyeballs by first using a bright blue, brown, or green marker to draw a filled-in circle over about ¼ of each ball to form irises. Next, students can use a black marker to draw a black circle in the middle of each iris to form pupils. Finally, have students use a bright red marker to draw thin veins over the remaining white part of each ball to give the appearance of a blood-shot eye. Option: Add in thin pieces of black (sliced) coffee stirrers or some other material for eyelashes.

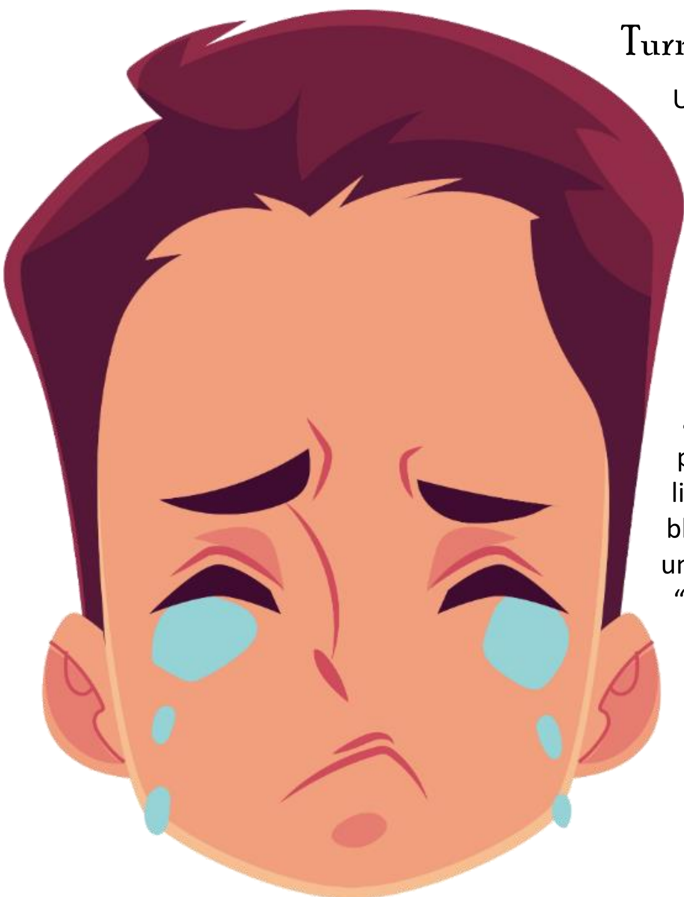
What's in there?



Do the following fun eye model and writing activity with the students as a review and preparation for the lesson on the inner eye.

Peel an orange, keeping the orange whole, don't section it off. Stick your finger into the open groove at the end of the orange. Your finger will allow enough space for you to insert a pimento stuffed olive. Voila! Your eye. *(Ask students what parts each thing represents.)* The orange is the sclera. The green of the olive is the iris, and the red represents the pupil. Point out that we see the sclera as pure white, while inside, there is a network of movement occurring, hence, the orange with its veins and grooves remind us of how the inside would appear if we could see it.

Have students write their ideas down of what is inside the eye and how the inside of the eye works. Tell them that the next week they will learn what is inside their eyeballs and how it all works.



Turning a Blind Eye

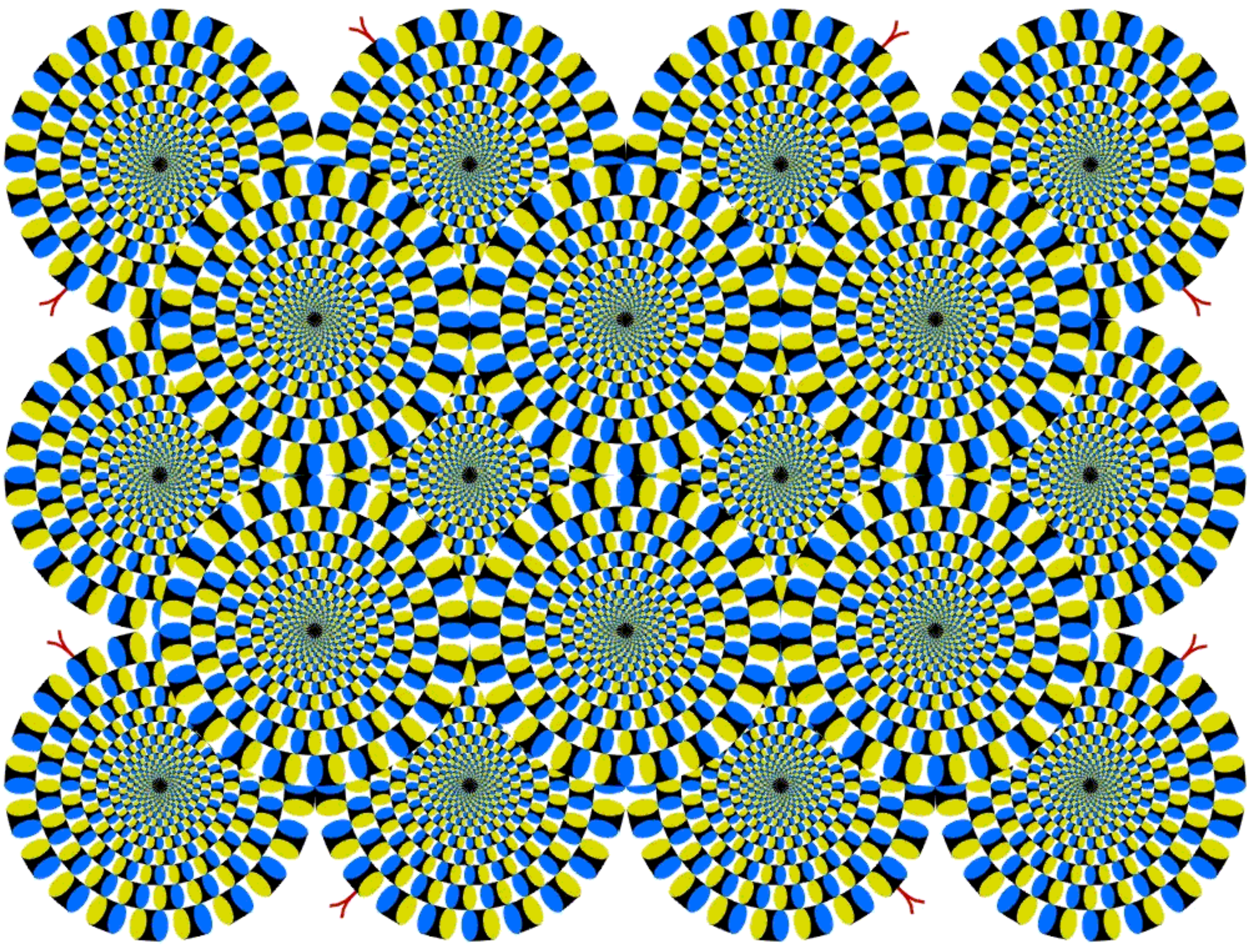
Using spoons and extra ping pong "eyeballs," have a Blind Eye Relay Race. To begin, divide the children into even teams and then into partnerships. (The racer and their "Eyes") Line the pairs up, one pair behind another, at a starting line. Create a goal line several feet away using masking tape or string. Hand two spoons and two eyeballs to the blindfolded partner on each team, and then have them run to the goal line and back with the help of their "Eyes." When a child returns to the starting line, he or she should pass off the spoons and eyeballs to the next player in line, return to the end of the line, and switch roles, the blind partner becomes the "Eyes" etc. Play continues until one team finishes the race, every child having been "blind" and the "Eyes". (Note: If a player drops his or her team's eyeballs, their "Eyes" must guide them to find them pick them back up before they can continue. Also, if you have an uneven number of children, one child may need to run the relay twice.)

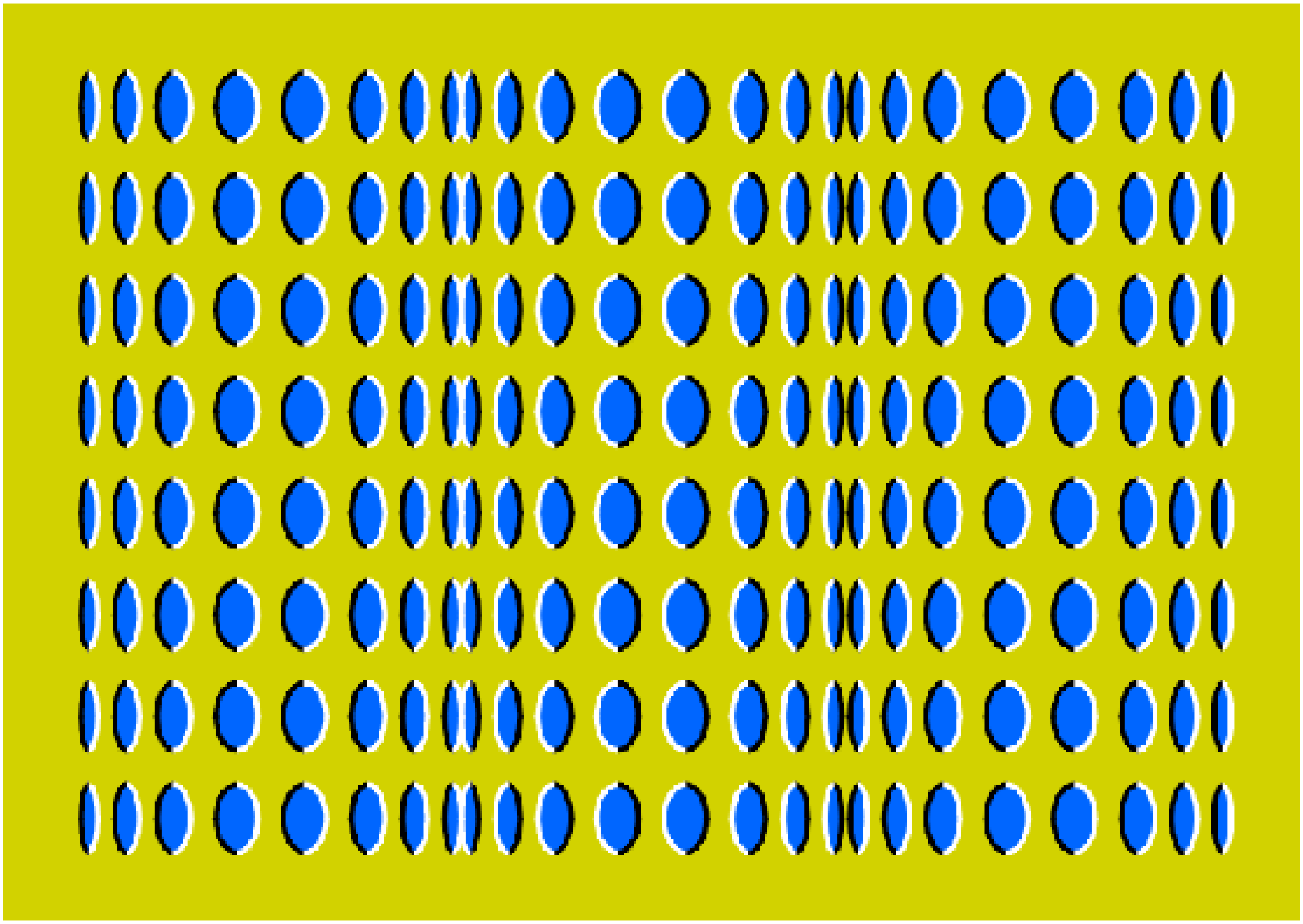
What are "illusions"?

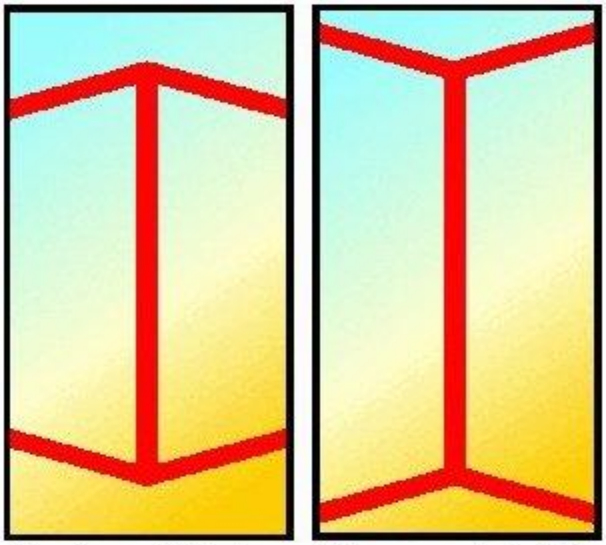
Illusions trick us into perceiving something differently than it actually exists, so what we see does not correspond to physical reality. Hence, the word *illusion* comes from the Latin verb *illudere* meaning, "to mock." In addition, some illusions show us one thing in a picture, while someone else sees something entirely different in the same picture.

Our eyes use tricks to take the image they see and make it into a 3-dimensional map of reality. But our eyes themselves can be tricked in the process.

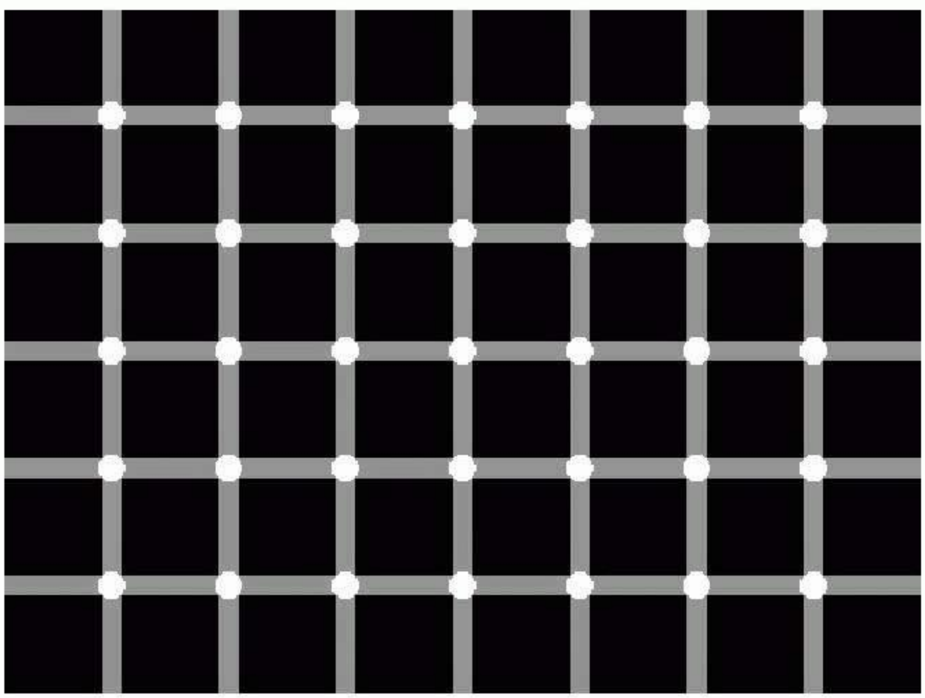
For example: Some students might think that the following pictures are moving. Your eyes are making them move. To test this, stare at one spot in each picture for a few seconds and everything will stop moving; OR look at the black center of each circle in the first picture, and it will stop moving; but when you move your eyes to the next black center, the previous one will move after you take your eyes away from it.







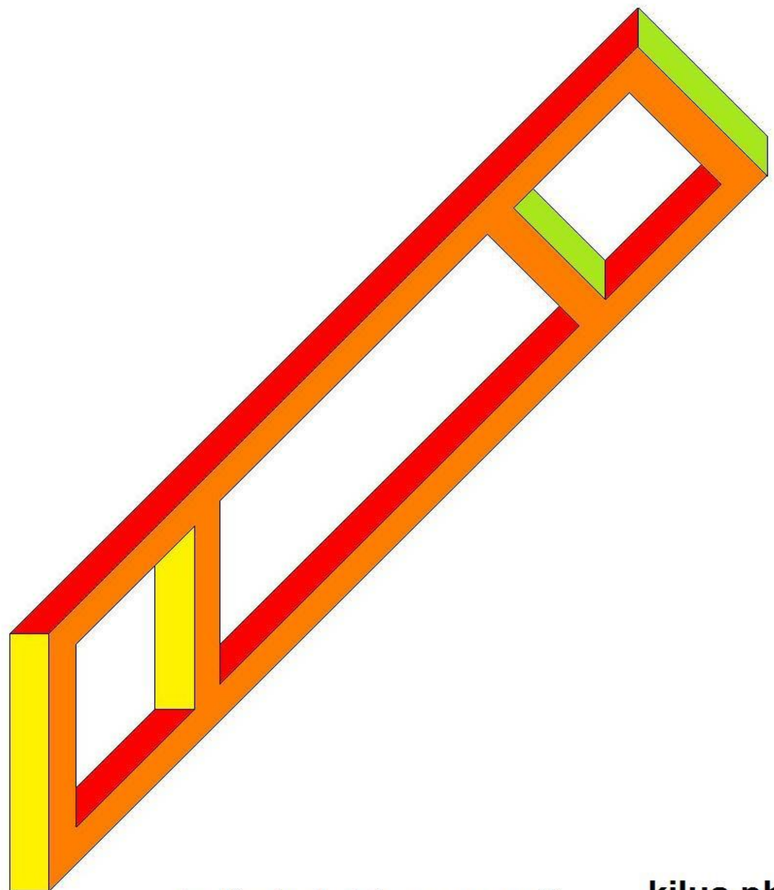
Are the middle bars of the same height?
Yes they are!



Count the black dots! :o)

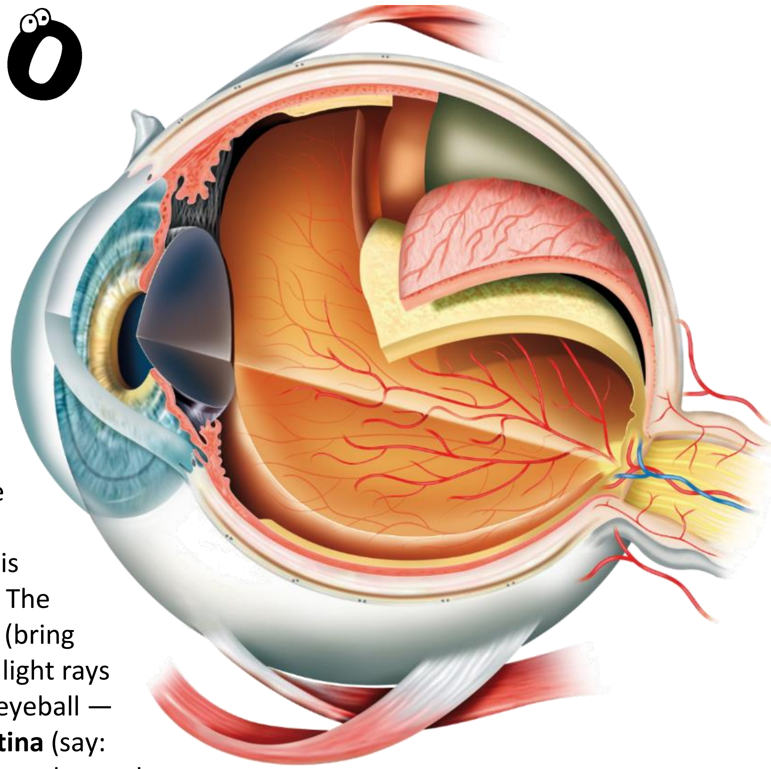
This magnificent painting by American wildlife artist Rusty Rust shows a huge Bengal Tiger standing proudly in a bamboo forest.

You are saying to yourself, "Yeah, so?" Well, Rusty named this piece "*The Hidden Tiger*." Your task is to figure out why. The answer is hidden somewhere in the painting.



is it straight or curve?   kilua pham

LOOK INTO MY EYES

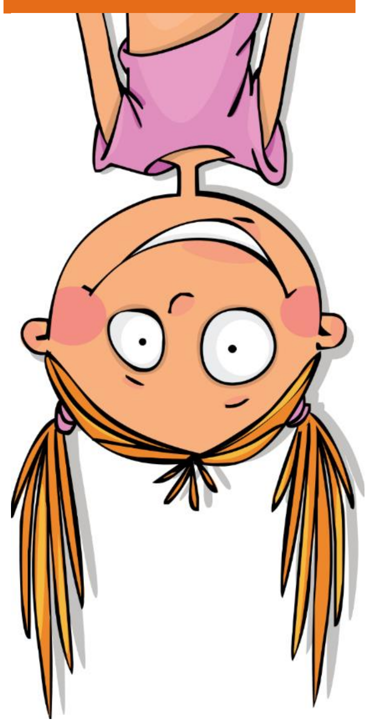


The inner parts of the eye are really cool, but you can't see them by just looking at your eyes in a mirror! Doctors use special microscopes to look at these inner parts of the eye, such as the lens.

So, how do our eyes work?

Did you know?

When light passes through the eye's lens and the image hits the retina, the image is actually upside down! So, the message that the optic nerve brings to the brain is upside down, too. Luckily, your brain knows how to flip the images over so it's right-side up!



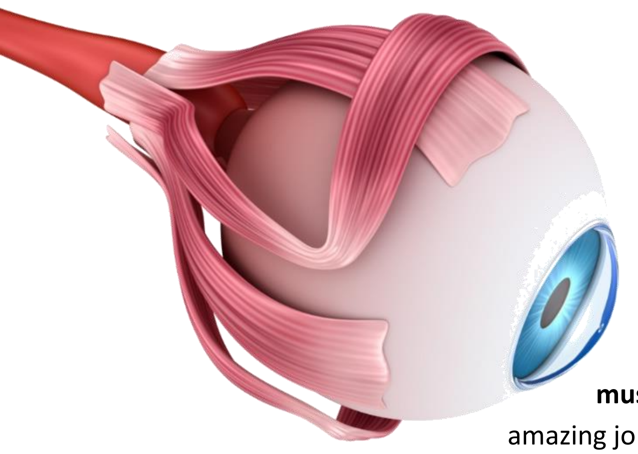
After light enters the pupil, it hits the lens. The lens sits behind the iris and is clear and colorless. The lens' job is to focus (bring together) all of the light rays on the back of the eyeball — a part called the **retina** (say: **ret**-i-nuh). The lens works much like the lens of a movie projector at the movies. Next time you sit in the dark theater, look behind you at the stream of light coming from the projection booth. This light goes through a powerful lens, which is focusing the images onto the screen, so you can see the movie clearly. In the eye's case, however, the film screen is your retina.

Check out the Johnson & Johnson interactive virtual eye model here

A Muscle Makes It Work

The human eye is often described as being very similar to a photographic camera. The iris is compared with the shutter, the pupil to the aperture (or opening), and the retina to the film, and both have lens systems to focus rays of light. Although many similarities exist, a major difference between the two is the mechanism involved in focusing on an object.

In a camera, the focal length of each lens is fixed, and changes in focus are brought about by movement of the lenses (moving them closer and farther away to the

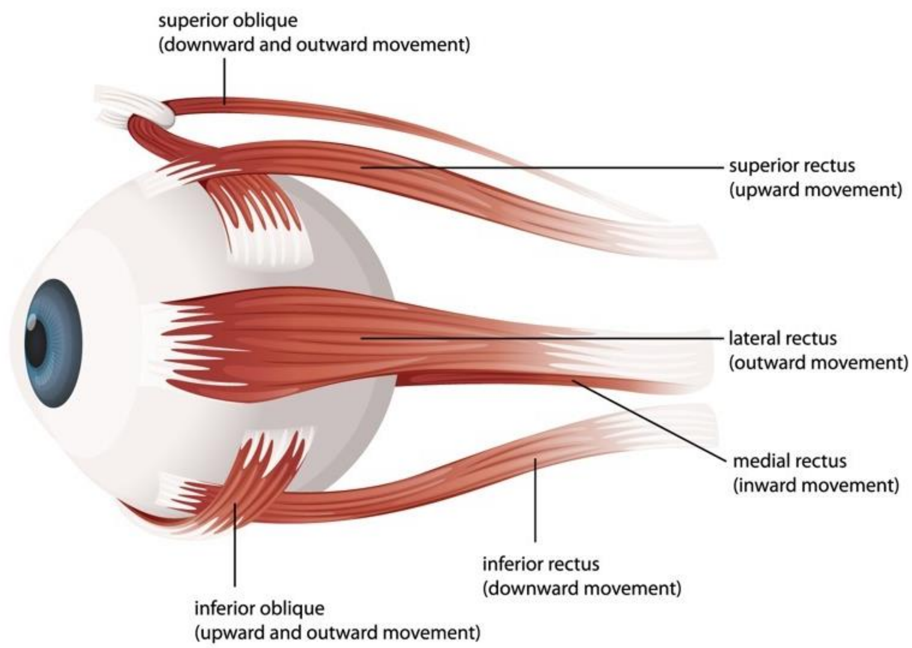


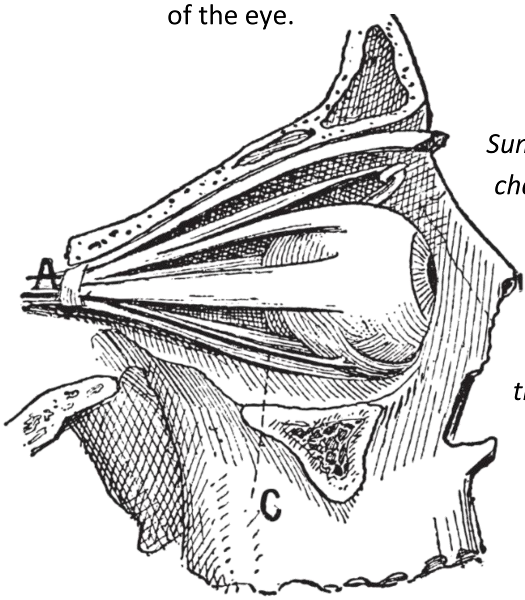
objects). However, in the human eye, changes in focus are brought about by changes in the power of the lens by varying its curvature (how curved).

The lens is <u>suspended</u> (held) in the eye by a bunch of <u>fibers</u>. These fibers are attached to a muscle called the **ciliary** (say: **sil**-ee-air-ee) **muscle**. *(Point it out on the diagram)* The ciliary muscle has the amazing job of changing the shape of the lens. That's right — the lens actually changes shape right inside your eye! *Have students try looking away from and focusing on something way across the room.*

Even though you didn't feel a thing, the shape of your lenses changed. When you look at things up close the lens becomes thicker to focus the correct image onto the retina. When you look at things far away, the lens becomes thinner.

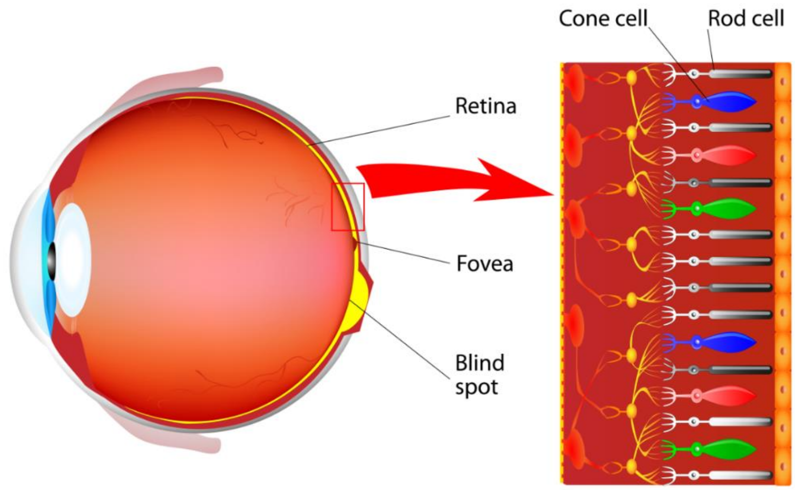
The biggest part of the eye sits behind the lens and is called the **vitreous** (say: **vih**-tree-us) **body**. The vitreous body forms two thirds of the eye's volume and helps the eye keep its round shape. It's filled with a perfectly clear, jelly-like material called the vitreous humor. After light passes through the lens, it shines straight through the vitreous humor to the back of the eye.





Summary: The lens is held up in your eyes by muscle and fibers. This muscle changes the shape of the lens so that you can look at things that are close and changes the lenses' shape again when you need to look at things that are far away. If the lens stayed the same shape you wouldn't be able to see things very well. The middle of your eye is filled with a kind of clear jelly. This jelly helps your eye stay round and lets light go from the lens all the way through to the back of the eye.

Rods and Cones Process Light



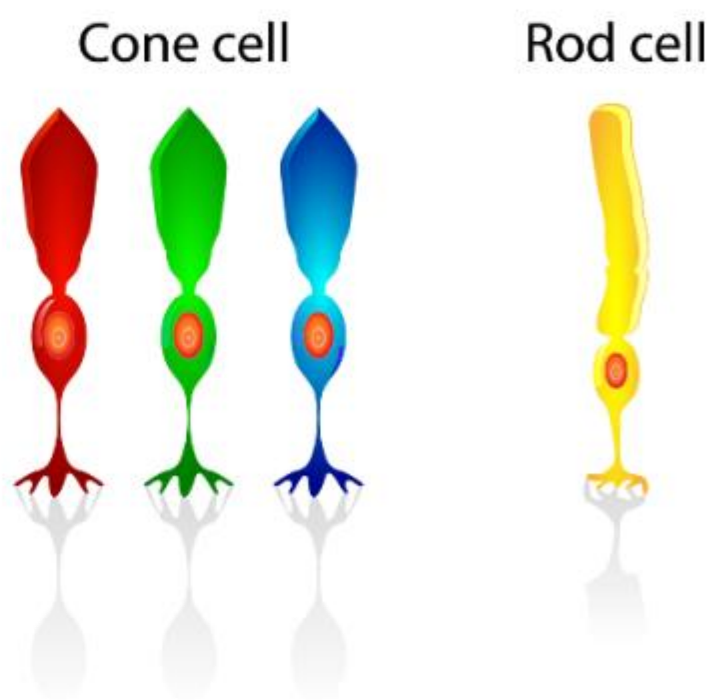
Your retina is in the very back of the eye. It holds millions of cells that are sensitive to light. The retina takes the light the eye receives and changes it into nerve signals so the brain can understand what the eye is seeing.

The retina uses special cells [photoreceptor cells] called **rods** and **cones** to process light. *(show the students the included diagram/poster) Just* how many rods and cones does your retina have? How about 120 million rods and 7 million cones — in each eye!

Rods see in black, white, and shades of gray and tell us the form or shape that something has. Rods can't tell the difference between colors, but they are super-sensitive, allowing us to see when it's very dark.

Cones sense color and they need more light than rods to work well. Cones are most helpful in normal or bright light. The retina has three types of cones. Each cone type is sensitive to one of three different colors — red, green, or blue — to help you see different ranges of color. Together, these cones can sense combinations of light waves that enable our eyes to see millions of colors.

Summary: The back of the eye is called the retina. It has lots of tiny cells that help interpret, or tell the brain, what we are seeing. There are two kinds of these special cells. They are called rods and cones. Rods help us see shapes and shadows, black, white, and gray. Cones help us see colors. It's easy to remember that cones help us see colors because they both start with C!



Helping You See It All

Rods and cones process the light to give you the total picture. You're able to see that your friend has brown skin and is wearing a blue hat while he tosses an orange basketball.

You see the world because light-sensitive cells in your eyes detect patterns of light and darkness and send this information to your brain. Your eyes have two different types of light-sensitive cells: rods and cones. In bright light, your vision depends on the cones; in dimmer light, you use the rods.

After 5 or 10 minutes in the dark, your eyes are relying almost entirely on the rods. Your cones allow you to see color. Your rods only register patterns of light on the retina: they distinguish bright light from dim, but they can't tell one color from another. That's why you can't see colors in dim light.

Summary: Cones need light to work but rods work even when it's almost completely dark. After about 5 or 10 minutes in the dark, you are using mostly rods. That's why you don't see very much color when you go outside at night, or in a dark room, but you can still see shapes and shadows, black, white, and gray.

Testing 1, 2, 3! What do you see?

Test out your retina!

Materials:

• A 3-x-5-inch (8 x 13 cm) card or other stiff paper for each student

• Pen, pencil, or marker

Instructions:

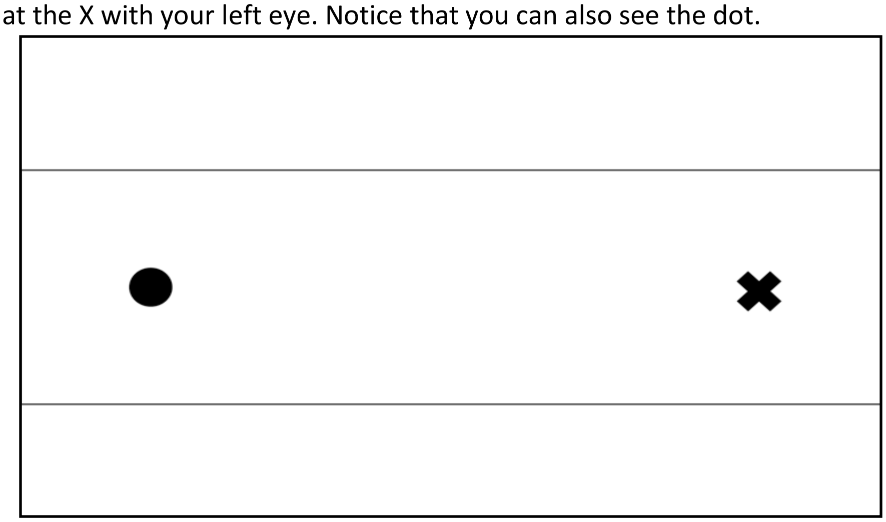
1. Make a dot on the left side of the card and an X on the right side, as shown below (or use the included template page).

2. Hold the card at eye level and arm's length away, making sure the X is on the right side.

3. Close your right eye and look directly at the X with your left eye. Notice that you can also see the dot.

4. Keep focusing on the X as you slowly bring the card toward your face. The dot will disappear, and then reappear, as you bring the card toward your face.

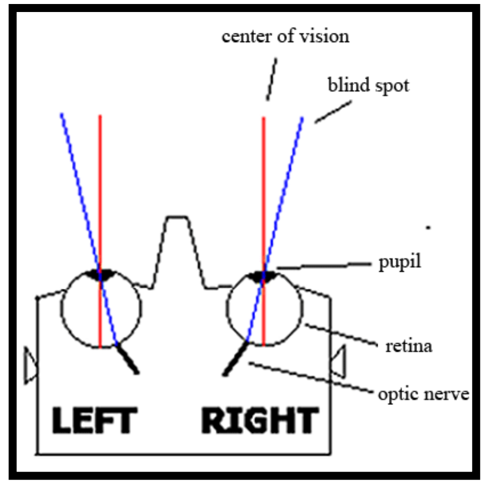
5. Now close your left eye and look directly at the dot with your right eye. This time the X will disappear and reappear as you bring the card slowly towards your face.



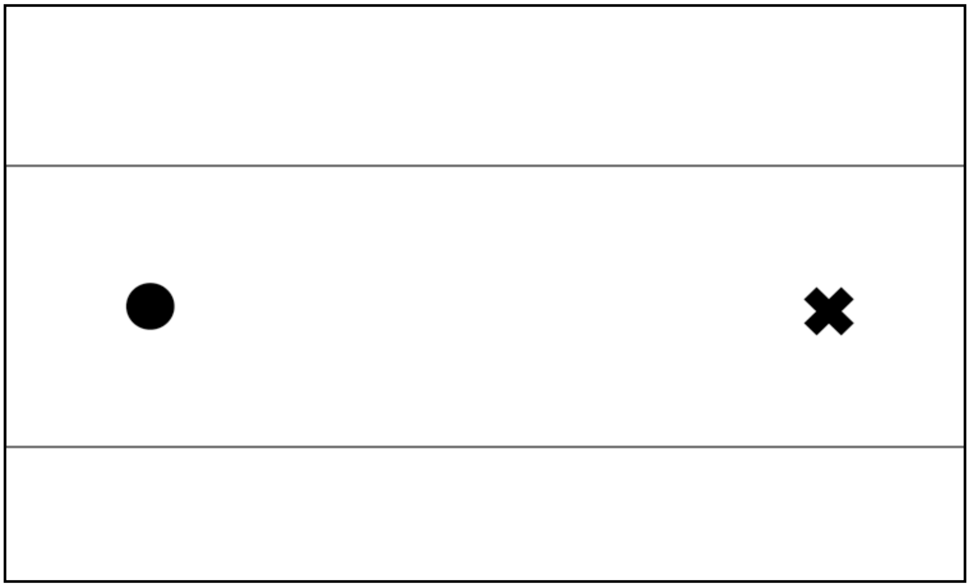
What's Happening?

Remember, at the back of each eye is a light-sensitive lining called the retina. Rods and cones in the retina receive incoming light and then send signals to your brain, allowing you to see. However, there's one small spot on your retina that has no light-sensing cells. That spot—called the blind spot—is where your optic nerve connects your eye to your brain. When you move the card to the exact spot in your vision where the dot or X seem to disappear, you've found the blind spot.

The blue lines on the diagram to the right, from www.doobybrain.com/wp-content/uploads/2008/02 shows where the blind spot is located.

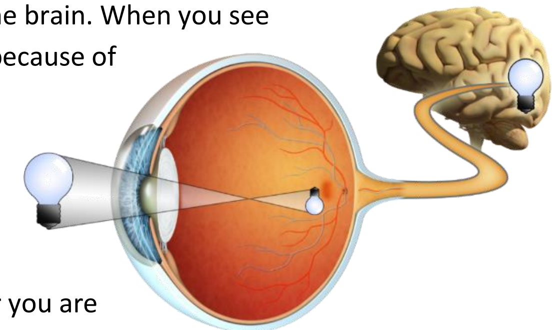


Summary: In the back of your eye, the retina, there is a spot where you don't have any rods or cones. That is where your optic nerve, the nerve that brings messages from your eyes to your brain, is. That spot is called your blind spot. When the dot or x disappears, you can't see it because its in your blind spot.



To the Brain!

Think of the optic nerve as the great messenger in the back of your eye. The rods and cones of the retina translate the colors and shapes you see into millions of nerve messages. Then, the optic nerve carries those messages from the eye to the brain! The optic nerve serves as a high-speed telephone line connecting the eye to the brain. When you see an image, you see it upside down, because of the way your eye is shaped and your eye "telephones" your brain with a report on what you are seeing so the brain flips the image from the eye right side up and translates that report into "frog," "apple," or "bicycle," or whatever you are looking at.



Model It!

To model for the students what a convex lens (a lens that bends out) does to an image, get a magnifying glass. Find a white wall or tape a white piece of paper to a wall that faces a window. Hold the magnifying glass close (3 in; 10 cm) to the white wall or paper. You should see an inverted image of whatever is outside of the window. This is what is projected onto your retina.

Summary: The optic nerve at the back of your eye, behind your retina, carries messages from your eyes to your brain after your retina turns the light from the lens into messages. Your eyes actually see everything upside down because of the way they are shaped, but when the message gets to your brain, your brain flips it over, so you can see right side up.

Line of Sight

Imagine that you're looking at someone's face. *(Ask students: Do you think of your vision as a steady beam that starts at your eyes and ends at their face?)* That's how most people think about vision, but it's not really how vision works. In fact, our eyes are in constant motion. When you're looking at a face, you're really looking at the left eye, then the right, back to the left, down to the mouth, over to the glint of an earring, back to the right eye, and so on.

Did You Know?

A fundamental challenge in face recognition lies in determining which facial characteristics are important in the identification of faces. While most of us might think of eyes as being the most important feature, research has found that eyebrows are more important in face recognition than the eyes!

Can You Spy Your Dominant Eye?

Everyone has a dominant eye. Here's how you can figure out which one of your eyes is dominant.
First, while keeping both eyes open point to an object in the distance and focus on it. Your finger will look blurry. Next, close your left eye. Did your finger move or stay on the object? If your finger stayed on the object, that means your right eye is dominant. If it moved your left eye is dominant.
Another way to tell is to make a triangle with your fingers and focus on an object, ex. A tree. Then, keeping the object in the triangle made by your fingers, pull your hands back towards your eyes. Your hands will automatically go to your dominant eye!

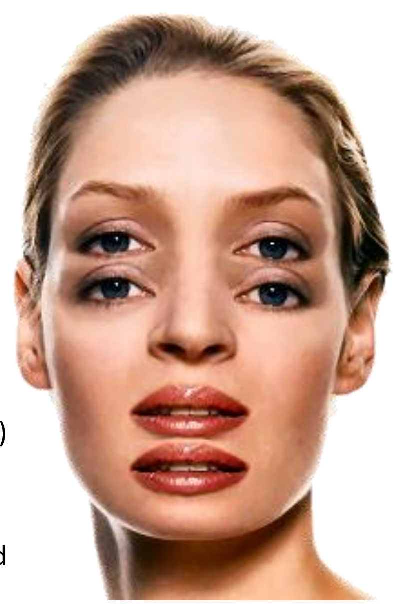
Or maybe you look first at the big bow in the hair, or the shaggy moustache, or the bright red lips. Whatever first draws your attention, your eyes dart back and forth, seeing little bits of the whole picture. It's your brain that puts it all together and tells you that you're seeing a face.

Have students test how long they can keep their eyes looking at the same object. Does it take thought and concentration? Then have them look at another person. What do they notice first?

Summary: When you look at someone's face, you don't just stare straight at them. Your eyes actually move the whole time, going from their eyes, to their nose, to their hair, all around. Your brain takes all those little parts of the picture, puts the whole thing into a big picture, and tells you what you are looking at.

Two by Two

But wait! You have two eyes. That means two different signals, right? But you only see one apple, not two? And we don't have double vision, like it appears when we look at the woman on the right. How does that work?



Test it out!

1. Give each student one sheet of white paper (typing or photocopy paper works well) and have tape on hand.
2. Have students roll the paper into a long tube about an inch (2.5 cm) wide.
3. Use tape to keep the tube from unrolling.
4. Using their right hand, hold the paper tube up to their right eye and look through it. Be sure they keep both eyes open!
5. Tell students to raise their left hand—palm toward them and fingers pointing up—and hold it about two-thirds of the way down the tube, with the little finger of your left hand resting against the tube.
6. They'll notice that they see a hole in their hand! Ask students to give their theories of what happened.

You have two eyes but see only one image of the world. Each eye sees a slightly different image, and your brain combines them to create a complete picture. But what happens if each eye is seeing something very different? In this case, your brain settles the conflict by deciding which parts of each eye's image are the most important and combining them—which puts the hole that one eye sees right in the middle of the hand that the other eye sees.

What else are two eyes good for?

Two eyes give you more depth perception, which is the ability to judge how near or far objects are. In order to put this to the test, have students conduct the following experiment.

Materials: Two pencils per student.

1. Have students hold a pencil lengthwise (on its side) in each hand.
2. Now, have them, with one eye closed, try to touch the erasers together. Did they miss?
3. Now, have them try it with both eyes open. Voila! Two eyes give you better depth perception

How can I clean my eyes? Have No Fear, You Have Tears

The eye has its own special washing system — tears! Tears are really important for your eyes. In outer corner of each eye are the **lacrimal** (say: **lak**-ruh-mul) **glands**, which make tears. *(Show students the eye socket diagram.)* Every time you blink your eye, a tiny bit of tear fluid comes out of your upper eyelid. It helps wash away germs, dust, or other particles that don't belong in your eye. Tears keep the eye moist, help wounds heal, and protect against eye infection.

Tears also keep your eye from drying out. Then the fluid drains out of your eye by going into a canal in the eye lids, into the lacrimal duct (this is also called the tear duct), and tears then exit through a passage that leads into your nose. (This is why our nose runs when we cry.) *(Tell students you can see the opening of your tear duct if you very gently pull down the inside corner of your eye. When they see a tiny little hole, they've found the tear duct.)*

Your eyes sometimes make more tear fluid than normal to protect themselves. This may have happened to you if

Eye Socket

Under the skin around the eye there is a circle of muscles which constrict (tighten), to close the eye lids and bring the eye brow down, to protect the eye ball.

Near the top and outer side of the eye the tear producing gland, (Lacrimal gland), makes tears to wash across the eye. These are drained away down fine canals, (in blue), to drain into the airway of the nose. This is why our nose runs when we cry.

you've been poked in the eye, if you've been in a dusty or smoking area, or if you've been near someone who's cutting onions.

And how about the last time you felt sad, scared, or upset? Your eyes got a message from your brain to make you cry, and the lacrimal glands made many, many tears. When you cry, those holes, your tear ducts, overflow and the tears run down your cheeks.

Summary: Your eyes clean themselves using tears. Every time you blink your eyes let out a little bit of tears to help wash them and keep them nice and wet. The tears leave your eyes through the tear duct, or a tiny tube that goes from the bottom of your eye down to your nose. That's why our nose runs when we cry and sometimes when we cry too much, the tear ducts overflow and tears go down our faces.

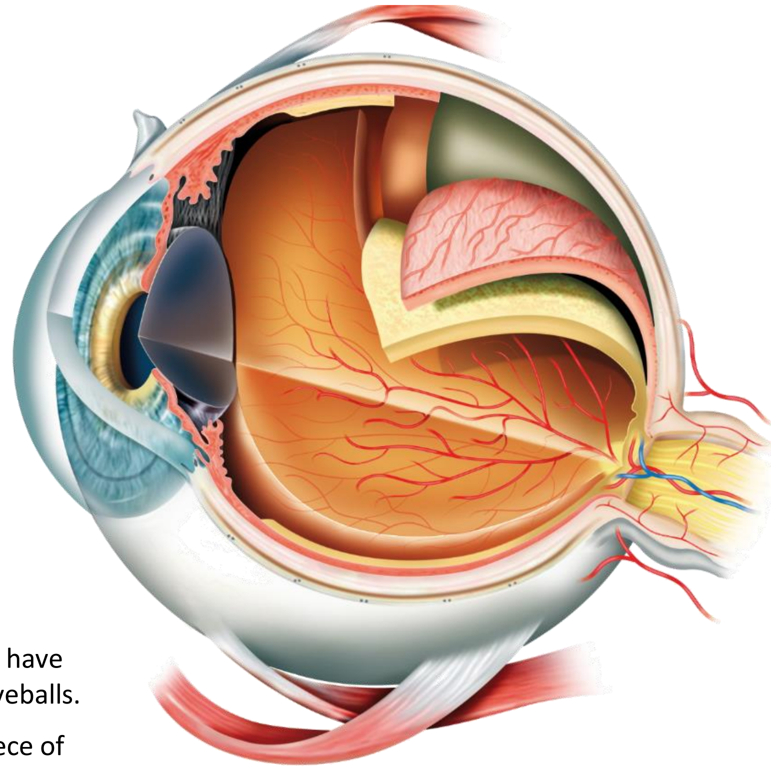
Protect and Serve

Your eyes do some great things for you, so take these steps to protect them:

- Wear goggles in classes where debris or chemicals could go flying, such as wood shop, metal shop, science lab, or art.
- Wear eye protection when playing racquetball, hockey, skiing, or other sports that could injure your eyes.
- Wear sunglasses. Too much light can damage your eyes and cause vision problems, such as cataracts, later in life. If the lens in your eye gets cloudy, it's called a cataract. A cataract prevents light from reaching the retina and makes it difficult to see.

EYE SPY!

Making a model of the human eye



Materials, per model:

- White modeling clay
- Green (or Blue, or Brown), Red, & Yellow modeling clays
- Clear plastic, thin
- Clear Plastic, thick (or a lens from a small magnifying glass)
- Plastic wrap
- Styrofoam ball
- Corn Starch

Have students recount the parts of the eye. Then have students review the parts by making their own eyeballs.

To make the eyeball white layer (Sclera), get a piece of white molding clay and use a roller to make it flat. Make sure that the molding clay does not get very thin. A thin layer will quickly break and you have to repeat everything again.

Put the flat clay on a ball that is already covered with food wrapping or with some starch. The purpose of plastic wrap and starch is to prevent the clay from sticking to the ball.

Using your hands form the clay over the ball. While it is still soft, cut and remove any excess clay hanging from the sides. What you need is just a hemisphere (half of a ball).

Before the clay is fully dry, cut a half circle on one side. This is where the lens and iris will be installed. The diameter of this half circle must be less than the lens that you are going to use.

Note: Any stiff, clear piece of plastic or glass magnifier can be used as the lens. For a 4" ball, you should have a lens with diameter of about 2". Option: A lens can be extracted from a magnifying glass.

Use some pink or red clay to attach the lens to the inside of the eyeball, where you cut a half a circle. These represent the muscles that control the lens. Use a spoon (wet if needed) to push the edges of the lens muscles until they get the same level as inside the eyeball.

Make a small hole at the back of the eye where nerves will exit.

Get a yellow piece of molding clay. Use the roller, or your fingers, to make it flat. Cut a half circle from that and place it inside the eyeball, opposite to the lens. This is retina, a layer of light sensitive nerve cells that eventually exit from the back of the eye. After you place the retina, you may use your wet finger to push down the inner edges, so the retina will gradually disappear as it gets closer to the lens

Use very thin pieces of red clay to draw capillaries inside the eyes. Capillaries distribute nutrients and oxygen to the eyes. Capillaries and nerves exit from the back of the eye. This can be displayed with additional stick or twist of yellow and red molding clay that you may attach to the outside back of the eyeball (behind the hole you already made).

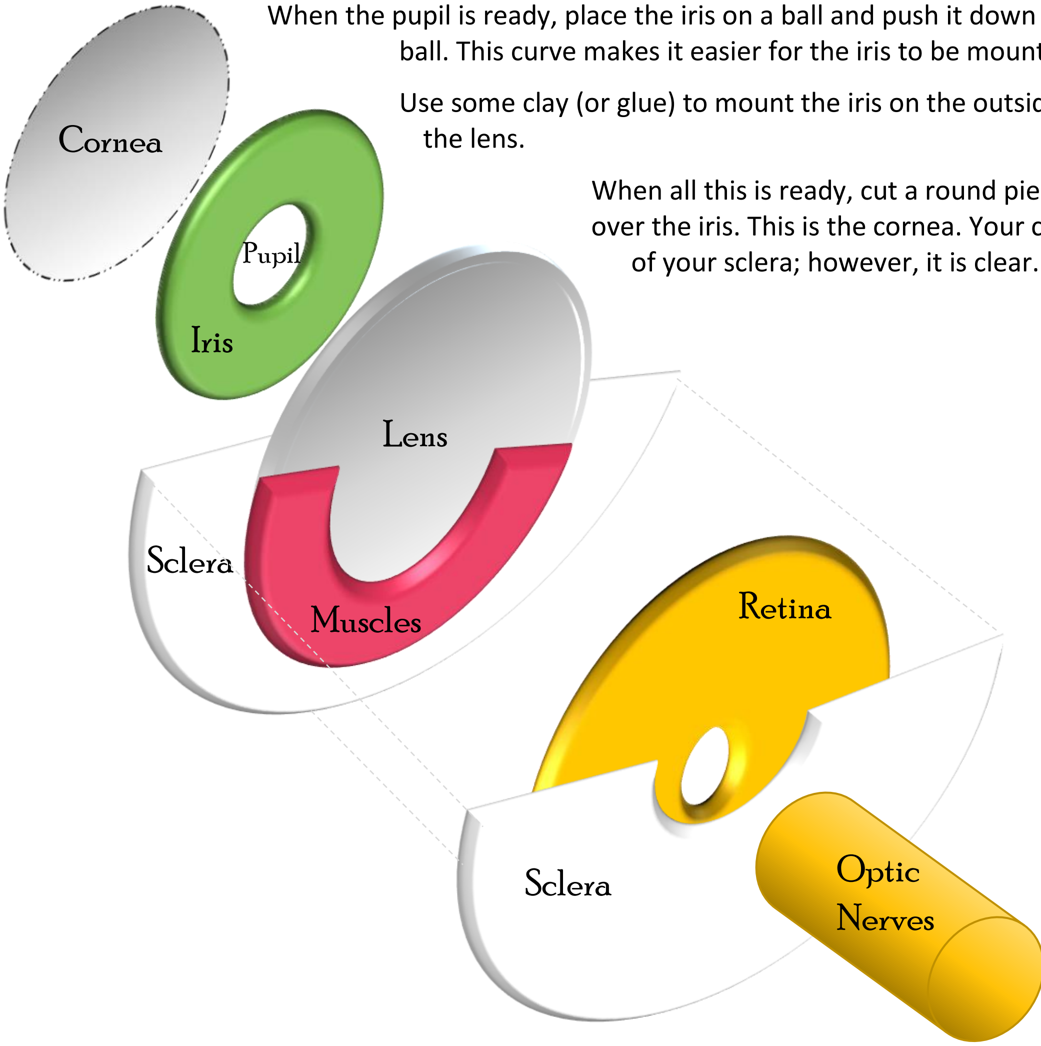
To make an Iris, use the roller to flatten a piece of colored clay. Then use a cup or bottle to cut a circle from that.

Use a smaller pipe or bottle to cut the pupil out of the center of the iris.

When the pupil is ready, place the iris on a ball and push it down so it will take the curve of the ball. This curve makes it easier for the iris to be mounted.

Use some clay (or glue) to mount the iris on the outside of the ball, where it covers the lens.

When all this is ready, cut a round piece of clear plastic and place it over the iris. This is the cornea. Your cornea is actually an extension of your sclera; however, it is clear.



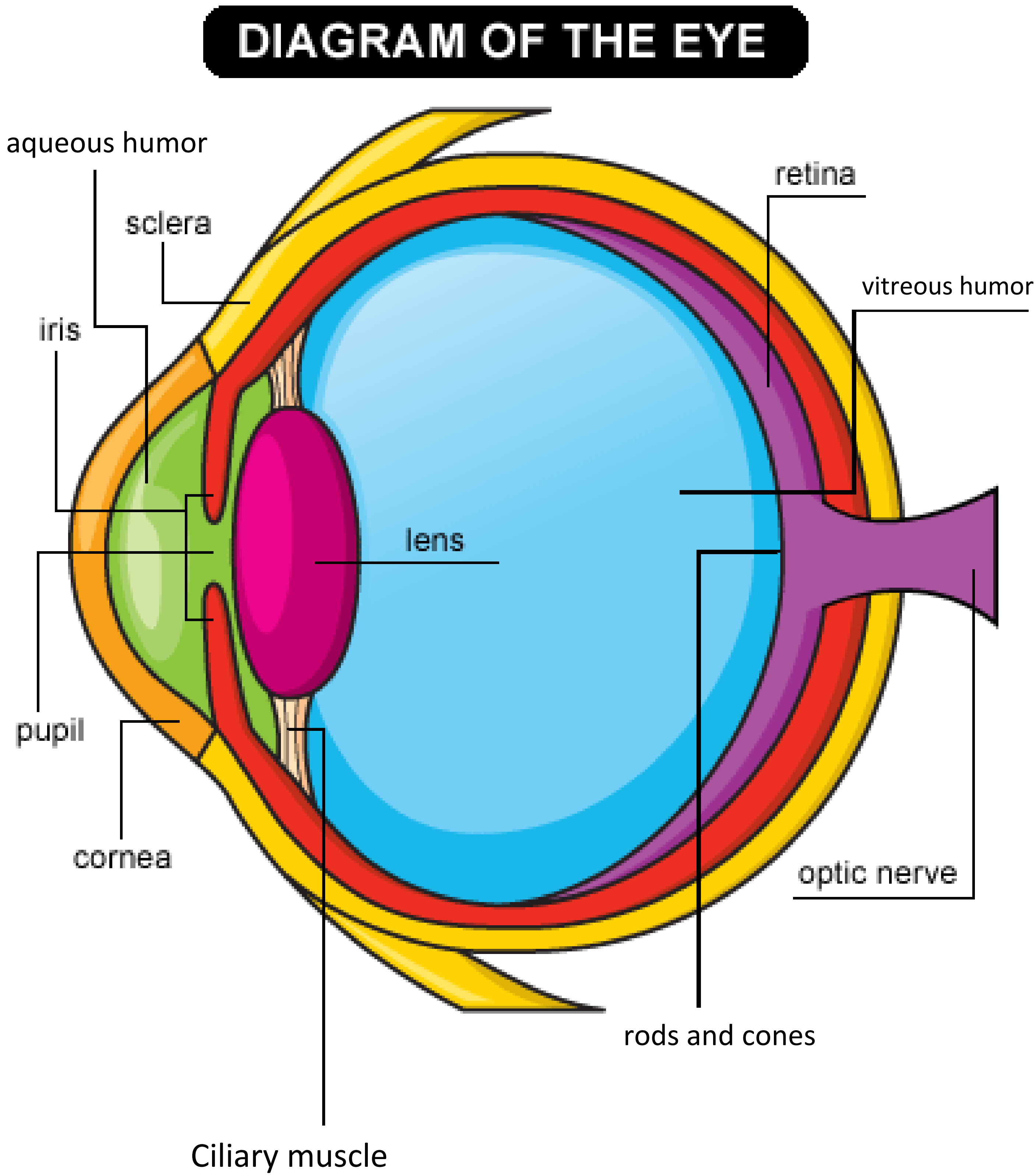


DIAGRAM OF THE EYE
aqueous humor
sclera
iris
pupil
cornea
lens
retina
vitreous humor
optic nerve
rods and cones
Ciliary muscle

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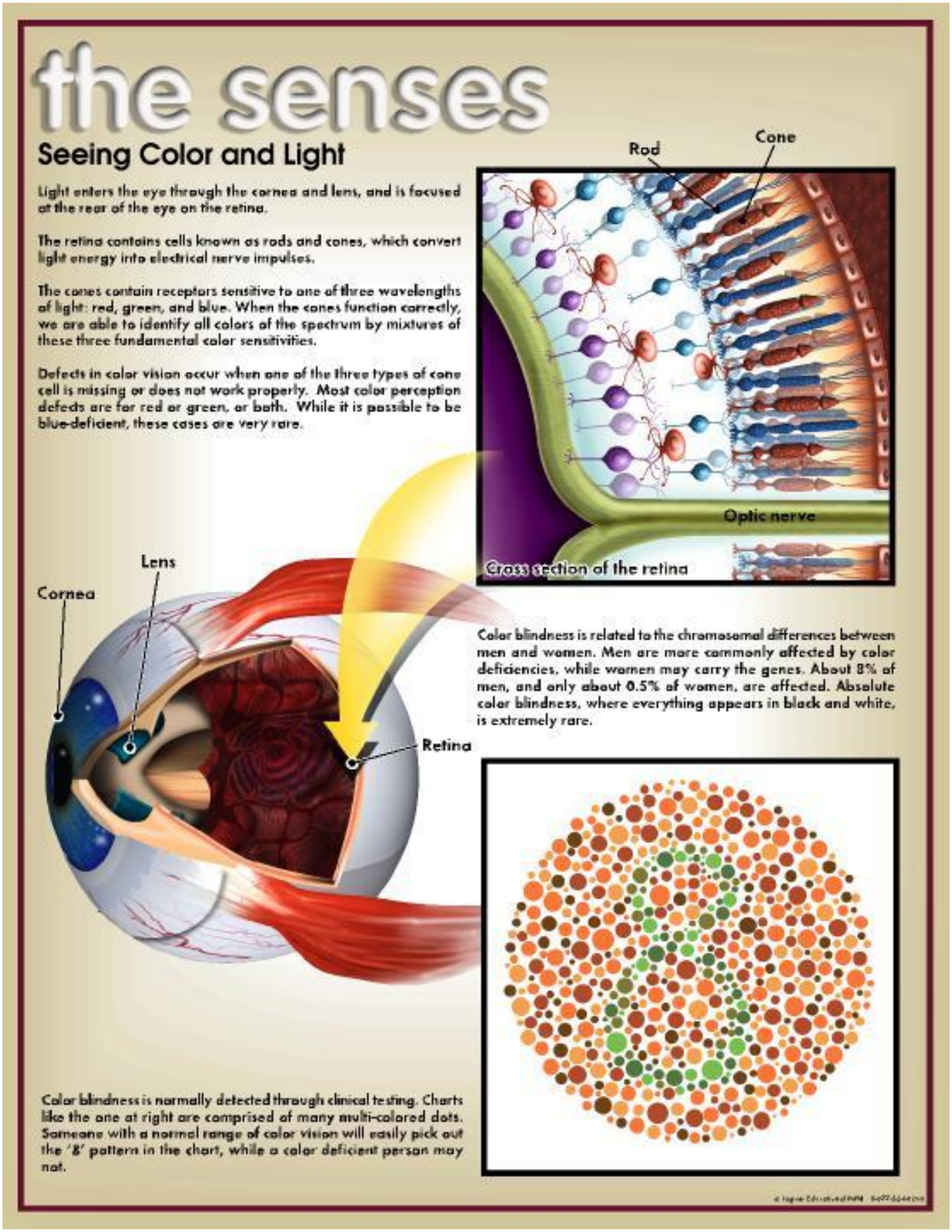


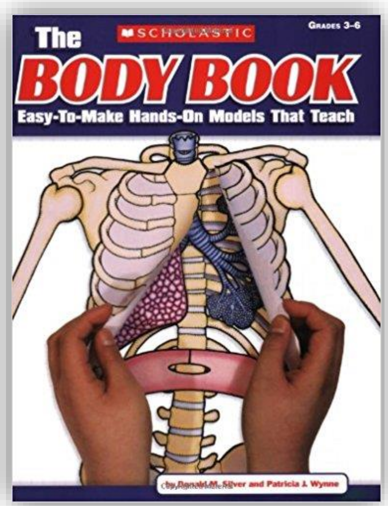
I'M ALL EARS

Primary Objectives:

Students will:

- Identify the parts of the ear
- Know how the parts work together and their individual jobs (ex. The main job of the outer ear is to collect sounds and funnel sounds into your ear canal.)
- Be able to identify each part by and use the scientific terms for the parts of the ear.
- Understand the term idiom, be able to share examples, and know why and how they are used.

Suggested Helpful Resources:

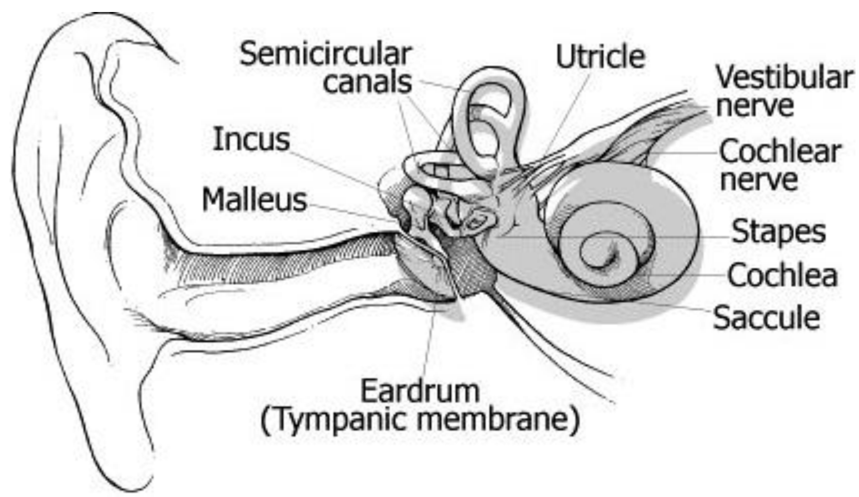


The Body Book: Easy-to-Make Hands-on Models That Teach by by Donald M. Silver and Patricia J. Wynne

Easy-to-make manipulatives help students understand the inner workings of the human body. Reproducible patterns and easy step-by-step instructions help students construct bone and stomach books, a spinal column out of cardboard and string, paper models of the major organs and systems of the human body, and more!

Background & Instruction:

Did you hear something? Maybe the sound you heard was quiet, like the click of a pencil. Or maybe it was loud, like a siren going by. Sounds are everywhere, and you have two cool parts on your body that let you hear them all: your ears!



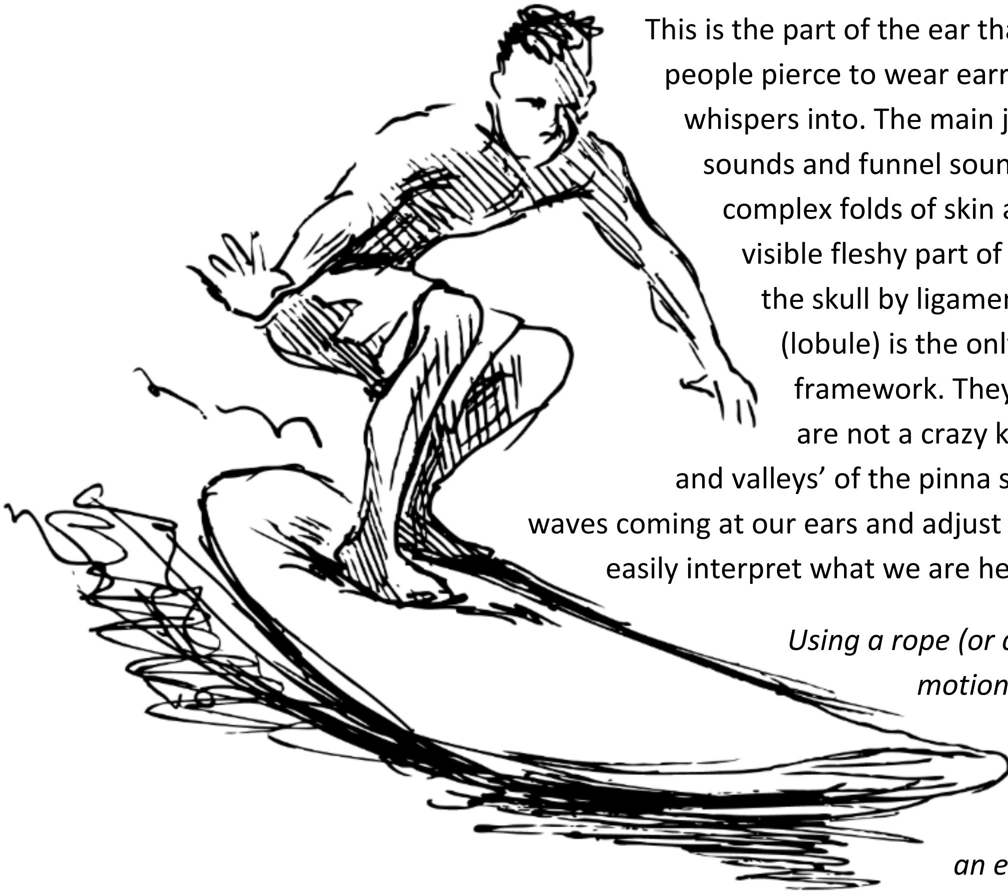
Your ears are in charge of collecting sounds, processing them, and sending sound signals to your brain. And that's not all — your ears also help you keep your balance. So if you bend over to pick up your cat, you won't fall down — or even worse — fall on your cat. Ouch!

The ear is made up of three different sections: the outer ear, the middle ear, and the inner ear. These parts all work together so you can hear and send what you hear to your brain for processing.

Constructing a Model: If you have *The Scholastic Body Book* for Grades 3-6 use pages 32-38. Otherwise students can also make a model out of modeling clay or dough following a diagram.

Option: If you wish have students make an "ear canal" by rolling cardstock into a short tube with spread ends (cut small slices into the ends of the taped tube and spread them flat to enable taping) and attaching it with tape to the outer ear and the opening at the end of the ear canal.

The Outer Ear: Catch the Wave



The outer ear is called the **pinna** or auricle (say: **or**-ih-kul). This is the part of the ear that people can see. It's what people pierce to wear earrings and what your friend whispers into. The main job of the outer ear is to collect sounds and funnel sounds into your ear canal. The complex folds of skin and cartilage of the pinna, the visible fleshy part of the outer ear, are attached to the skull by ligaments and muscles. The earlobe (lobule) is the only part not supported by the framework. They may look like it, but the folds are not a crazy kind of decoration. The 'hills' and valleys' of the pinna slow down the many sound waves coming at our ears and adjust them so our brain can more easily interpret what we are hearing.

Using a rope (or a slinky) demonstrate the motion of sound waves as they enter into the ear. This may be done by having two students volunteer to hold an end of the rope. Have them begin a wave-like motion with the rope.

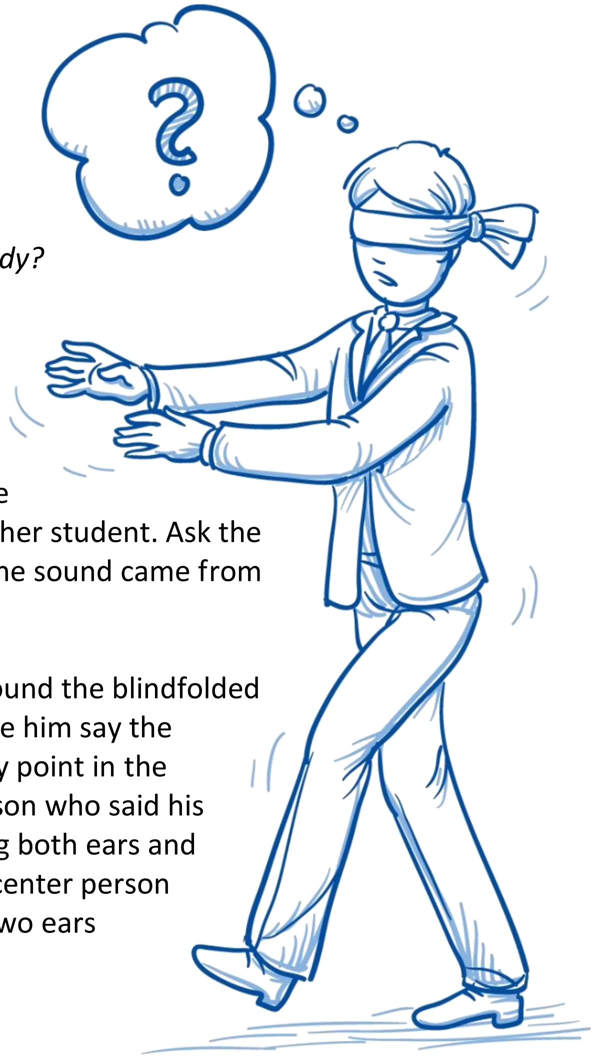
One may also describe the pinna as a kind of audio filter, it keeps too many sounds from coming in all at once and overwhelming our brains. The funnel-like shape gives away another important function, the amplification of sound.

So, our outer ears adjust the sounds for us, focus them, and make them louder? How can we be sure they do all of that?

In order for students to get a better idea of how their outer ear works have the students perform the following experiments:

Two Ears. One Ear. One, Two, You?

Ask students to make predictions: If people in a circle around a blindfolded listener create noises, how accurately can the listener point to each sound source, without turning head or body? With turning head or body?



Ask a student to stand in the middle of the room and close his or her eyes. Point to a seated student and ask that student to clap once. Ask the first student to open his or her eyes and guess who clapped. Now ask the guesser to again close his or her eyes and cover one ear. Repeat the clapping by pointing to or tapping another student. Ask the guesser if it was easier or harder to determine where the sound came from with both ears open or with just one open.

Variation: Have the other people form a large circle around the blindfolded person. Point to one of the people in the circle and have him say the seated person's name. The seated person must then try point in the direction of the voice and identify the name of the person who said his name. Try this experiment with the seated person using both ears and then again with one ear closed. How accurate can the center person identify the caller and where the call came from? Are two ears better than one?

Catching Sounds

Materials Needed:

Each group of four or five students will need:

- a megaphone/ear trumpet (roll and staple poster paper into a conical shape)
- a ticking device (clock or timer).

Strategy:

1. Participants speak to one another--first normally, then with hands cupped around their mouths, and finally through a megaphone. They talk about any differences they notice.

2. Participants listen to one another--first normally, then with hands cupped behind their ears, and finally through an ear trumpet. They talk about differences they notice.

3. Each member of the group counts how many paces away he can hear a ticking device--first with the unaided ear, then with an ear trumpet. The group will compare the distances and draw a conclusion.

Sample Conclusion: Sound waves can be collected and directed into our ear and increase our ability to hear.

What's that Noise?

Jiggling coins, clinking glasses, clapping hands...think you know what these sound like? Test the ability of people to identify several sounds with this game. People should close their eyes or turn away from the "sound maker." Make each sound and see if everyone knows what it is.

Example sounds:

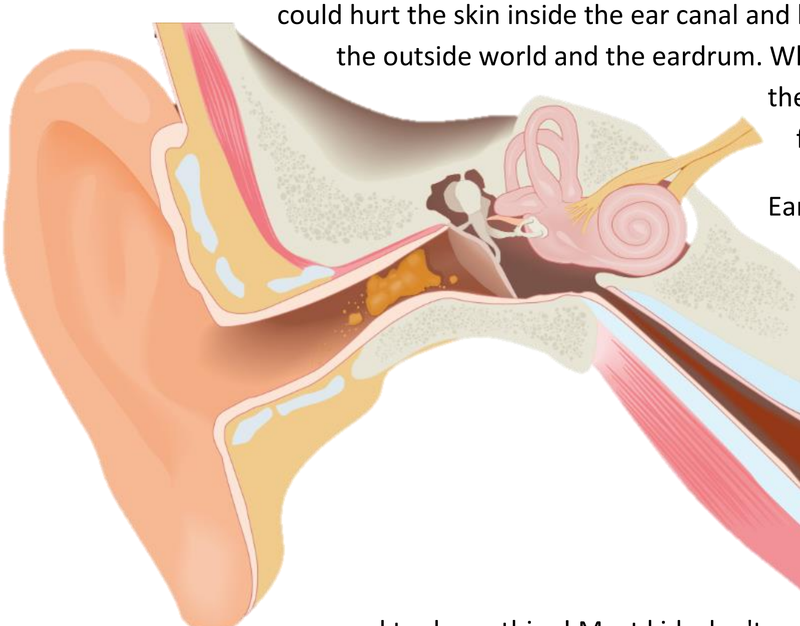
- Shake pennies or other coins
- Clap hands
- Clap chalkboard erasers
- Tap a pencil or pen on a desk
- Close a book
- Crumple up paper or foil
- Stomp on the floor
- Tear some paper
- Close a stapler
- Bounce a ball

What other sounds can you come up with? Are there any that are difficult to identify without sight?

It's sticky. It's shiny. But what is earwax, anyway — and where does it come from?

Earwax is made in the outer ear canal. This is the area between the fleshy part of the ear on the outside of your head (the part you can see) and the middle ear. The skin in the outer ear canal has over 2,000 glands (special structures in your skin that, in this case, only make earwax) in your ear with the special job of only making earwax! The fancy name for this waxy stuff is cerumen (say: suh-**roo**-mun).

So why do we need wax? Earwax has several important jobs. First, it protects and moisturizes the skin of ear canal, preventing dry, itchy ears. Second, it contains special chemicals that fight off infections that could hurt the skin inside the ear canal and kills germs. Finally, it acts as a shield between the outside world and the eardrum. When dust, dirt, and other things enter your ear, the earwax traps them so they can't travel any further.



Earwax isn't just gross. It's gross and useful!

After the wax is produced, it slowly makes its way through the outer ear canal to the opening of the ear. Then it either falls out or is removed when you wash. In most people, the outer ear canal makes earwax all the time, so the canal always has enough wax in it.

If you want to get rid of earwax, here's what you need to do: nothing! Most kids don't need to do anything special to remove earwax. Every time you move your jaw it helps earwax come out, it comes out when you sleep, when you walk, all the time. If you wash your hair regularly, this is enough to keep your ears clean.

You can wipe the outside of your ear with a washcloth but don't use a cotton swab, your finger, or anything else to poke around inside your ear to remove earwax. Your ear canal and eardrum are very delicate, and you may hurt them or cause bleeding by trying to get rid of wax this way. Poking around in your ear may get the very top layer of earwax off, but it just pushes and packs the rest of the wax in farther.

Fun Wax Facts:

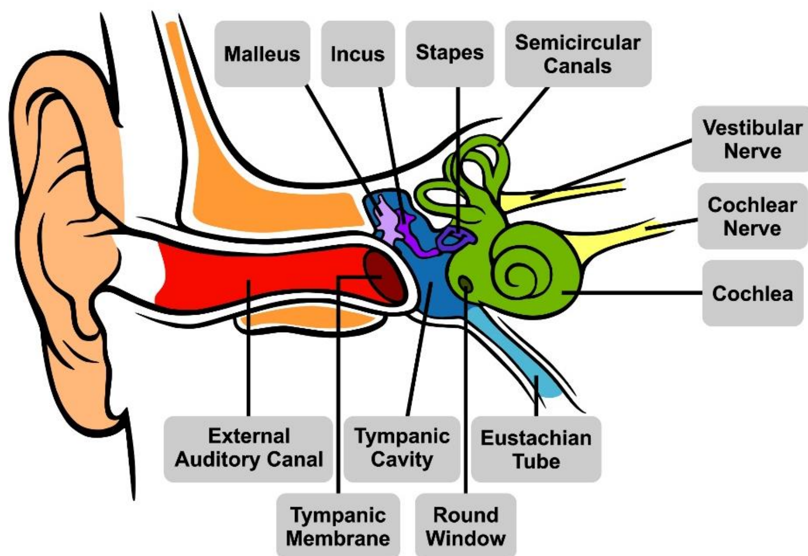
- Many types of whales have a build-up of earwax which increases with time; the size of the deposit is sometimes the only way to determine the age of whales that do not have teeth, whales that have baleen, like blue whales. When cut lengthwise, layers can be seen and counting the growth rings in the ear plug is now the principal method of age determination for baleen whales. In the future scientists hope to use a new type of age measurement that can be done on living whales…using whale dandruff.

- In an episode of the television program *MythBusters*, it was shown that candles can be made of human earwax and those candles can sustain a flame, but they do not burn long or brightly enough to be as practical as paraffin or beeswax candles.

The Middle Ear: Good Vibrations

After sound waves enter the outer ear, they travel through the ear canal and make their way to the middle ear. The middle ear's main job is to take those sound waves and turn them into vibrations that are delivered to the inner ear. To do this, it needs the eardrum, which is a thin piece of skin stretched tight like a drum.

The eardrum separates the outer ear from the middle ear and the **ossicles** (say: **ah**-sih-kulz). What are ossicles? They are the three tiniest, most delicate bones in your body. They include:



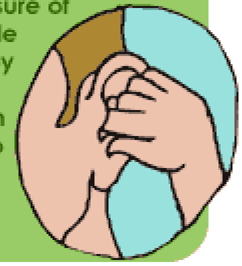
Hammer: the **malleus** (say: **mah**-lee-us), which is attached to the eardrum and means "hammer" in Latin

Anvil: the **incus** (say: **in**-kus), which is attached to the malleus and means "anvil" in Latin

Stirrup: the **stapes** (say: **stay**-peez), the smallest bone in the body, which is attached to the incus and means "stirrup" in Latin

When sound waves reach the eardrum, they cause the eardrum to vibrate. When the eardrum vibrates, it moves the tiny ossicles — from the hammer to the anvil and then to the stirrup. These bones help sound move along on its journey into the inner ear.

Have your ears ever popped when you were riding in a plane or driving up a mountainside? Here's why: Changing altitude (going up or down) affects the pressure of the air (gas) in your ears. Luckily, your middle ear is connected to the back of your nose by a narrow tube called the **eustachian** (say: yoo-**stay**-she-un) tube. The eustachian tube acts like a pressure valve and opens to make sure the air pressure is the same on both sides of your eardrum. When it opens, you feel a pop.



Model Behavior

Demonstrate the behavior of the eardrum.

Materials:

- A funnel
- Clear tubing
- Balloon
- Salt
- Rubber band
- Straws

A balloon should be placed over the large end of the funnel (held taut by using a rubber band). On the small end of the funnel a piece of clear rubber tubing should be attached (straws may be attached to the tubing for hygiene purposes). Grains of salt are then placed on the top of the balloon. Into the rubber tubing, high and low pitched sounds should be made. This demonstrates the vibration of the eardrum by a range of frequencies.

- Do any other sounds make the salt move – yelling, clapping, stomping, loud music, playing a drum?
- Do low or high sounds work better?
- Replace the salt with something else – maybe rice, dry beans, sugar, or paper circles from a hole punch. Is your new item harder or easier to move with sound vibrations? Why do you think?

Variation: It's easy to make a model of the eardrum (also called the "tympanic membrane") and see how sound travels through the air.

Materials:

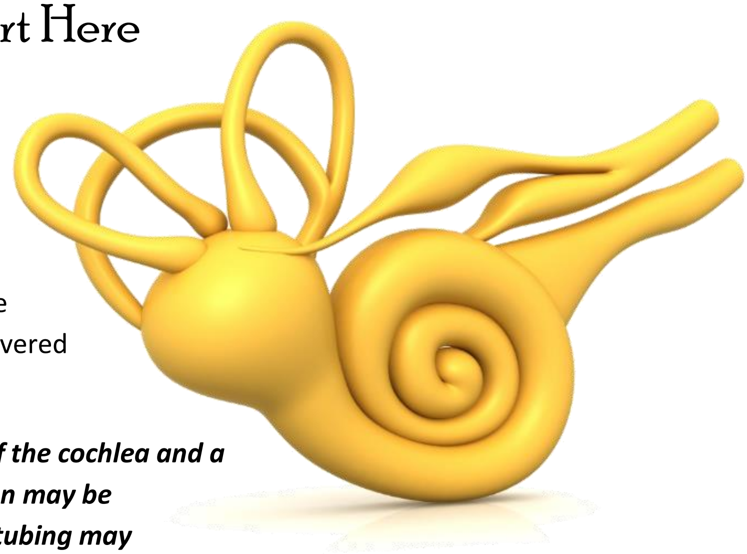
- Plastic wrap
- Container with wide opening
- Uncooked rice (any other small grain will work)
- Tin cookie sheet (or other noise maker)

Just stretch a piece of plastic wrap over a large bowl or pot (any container with a wide opening will work). Make sure the plastic wrap is stretched tightly over the container. The plastic represents the eardrum. Place about 20-30 grains of uncooked rice on the top of the plastic wrap. Now you need a noise maker. A tin cookie sheet or baking tray works well. Hold the cookie sheet close to the plastic wrap. Hit the cookie sheet to create a "big bang" noise and watch the rice grains jump.

The "big bang" produces sound waves (changes in air pressure) that cause the plastic sheet to vibrate which causes the rice grains to move. Sound waves vibrate the eardrum in much the same way.

- Do any other sounds make the rice move – yelling, clapping, stomping, loud music, playing a drum?
- Do low or high sounds work better?
- Replace the rice with something else – maybe dry beans, sugar, or paper circles from a hole punch. Is your new item harder or easier to move with sound vibrations? Why do you think?

The Inner Ear: Nerve Signals Start Here



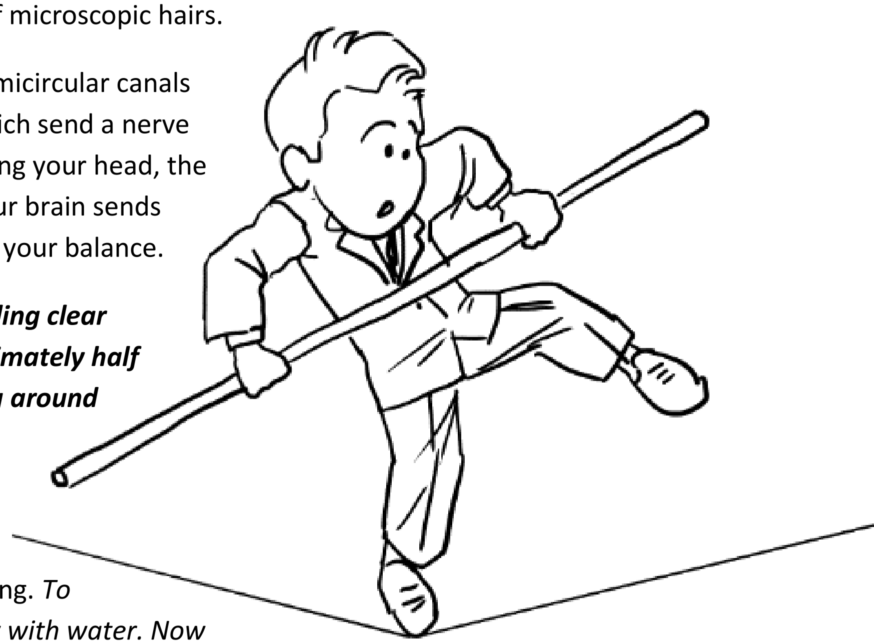
Sound comes into the inner ear as vibrations and enters the **cochlea** (say: **ko**-klee-uh), a small, curled tube in the inner ear that coils around a core of bone. The cochlea is filled with liquid, which is set into motion, like a wave, when the ossicles vibrate. As the fluid moves it ripples from the oval window to the round window, which are also covered with thin skins of tissue, membranes.

A spiral shell may be displayed to show the shape of the cochlea and a hanger molded into a circle and covered with a nylon may be used to demonstrate the oval window. The rubber tubing may then be used again to represent the auditory nerve which leads to the brain.

The cochlea is also lined with tiny cells covered in tiny hairs that are so small you would need a microscope to see them. They may be small, but they're awfully important. When sound reaches the cochlea, the vibrations (sounds) cause the hairs on the cells to move, creating nerve signals that the brain understands as sound. The brain puts it together and hooray! You hear your favorite song on the radio.

Day or Night, Ears Keep You Upright

Ears do more than hear. They keep you balanced, too. In the inner ear there are three small loops above the cochlea called semicircular canals, they kind of look like a three loop pretzel. Like the cochlea, they are also filled with liquid and have thousands of microscopic hairs.



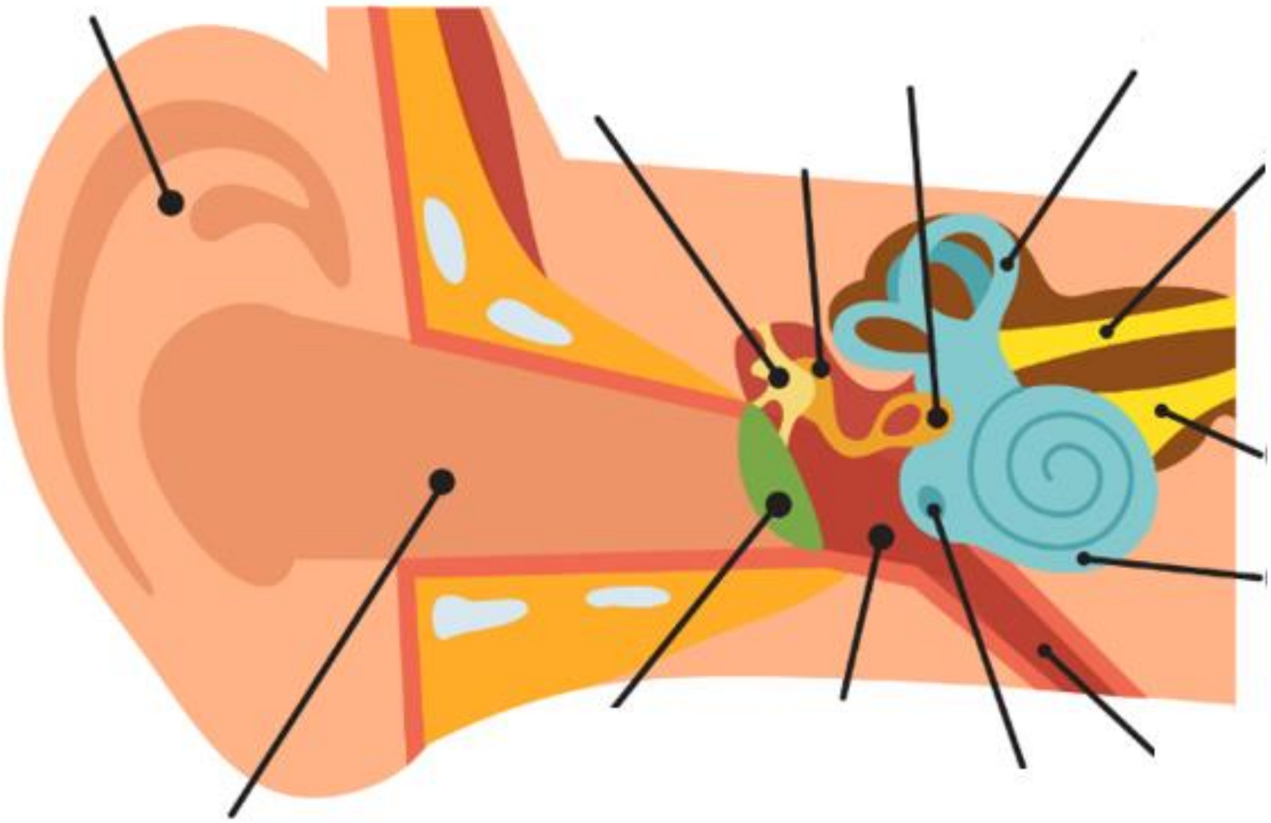
When you move your head, the liquid in the semicircular canals moves, too. The liquid moves the tiny hairs, which send a nerve message to your brain about how you are holding your head, the position of your head. In less than a second, your brain sends messages to the right muscles so that you keep your balance.

The semicircular canals may be shown by molding clear rubber tubing into a circle and filling it approximately half way with colored water. By moving the tubing around the students can be shown the way the semicircular canals are able to balance.

Sometimes the liquid in your semicircular canals keeps moving after you've stopped moving. *To help students understand this, fill a cup halfway with water. Now move the cup around in a circle in front of you and then stop. Did they notice how the water keeps swishing around, even after the cup is still?* That's what happens in your semicircular canals when you spin in circles or go on the Tilt-A-Whirl at the amusement park. *How do students think that affects them?*

When you stop spinning or step off the ride, the fluid in your semicircular canals is still moving. The hairs inside the canals are sensing movement even though you're standing still. That's why you might feel dizzy — your brain is getting two different messages and is confused about the position of your head, is it up, down, or sideways? Once the fluid in the semicircular canals stops moving, your brain gets the right message, you regain your balance, and you aren’t dizzy anymore.

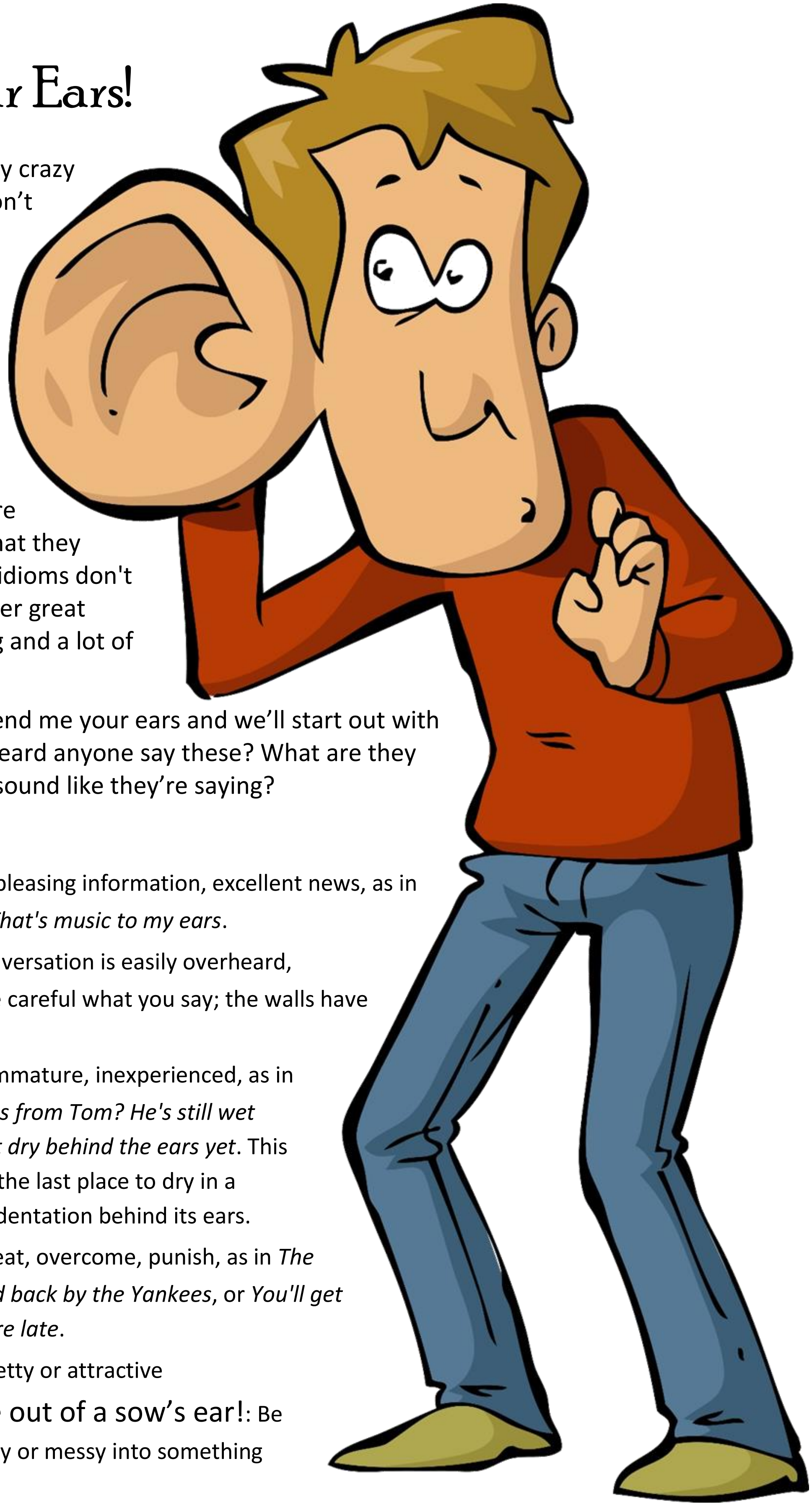
Label the Diagram of the Human Ear



Word Bank:

- Outer ear
- Incus (Anvil)
- Vestibular Nerve
- Stapes (Stirrup)
- Malleus (Hammer)
- Tympanic Membrane (ear drum)
- Round Window
- Cochlear Nerve
- External Auditory Canal
- Semicircular Canals
- Eustachian Tube
- Cochlea
- Tympanic cavity

Lend Me Your Ears!



Sometimes people say some pretty crazy things that I'm pretty sure they don't mean, well they don't them literally, I hope! Like that you should be all ears. Does your teacher really want your whole body to be made out of ears?

Probably not. Your teacher is using an idiom. Idioms are common, everyday expressions with metaphoric meanings. They're using colorful ways to describe what they really want. When taken literally, idioms don't make much sense, but they do offer great opportunities for creative thinking and a lot of laughs.

Since we're learning about ears, lend me your ears and we'll start out with some ear idioms. Have you ever heard anyone say these? What are they really trying to say? What does it sound like they're saying?

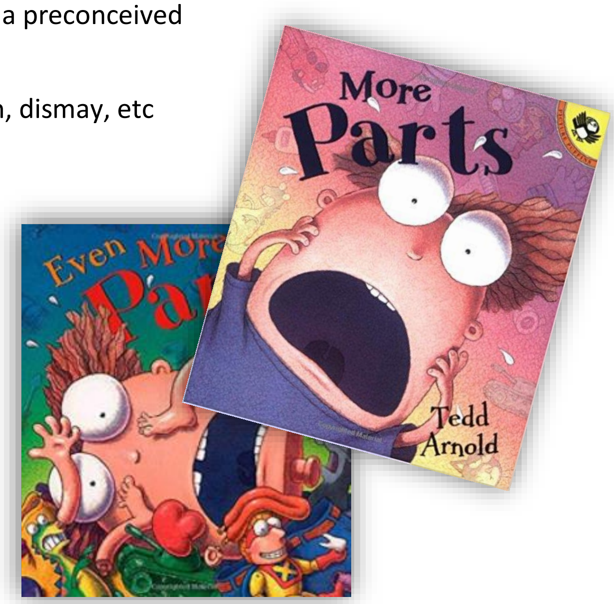
- Music to my ears! Very pleasing information, excellent news, as in *So they're getting married? That's music to my ears*.
- Walls have ears: The conversation is easily overheard, someone is listening, as in Be careful what you say; the walls have ears.
- Wet behind the ears: Immature, inexperienced, as in *How can you take instructions from Tom? He's still wet behind the ears*, or *Jane's not dry behind the ears yet*. This term alludes to the fact that the last place to dry in a newborn colt or calf is the indentation behind its ears.
- Pin your ears back: Defeat, overcome, punish, as in *The Red Sox had their ears pinned back by the Yankees*, or *You'll get your ears pinned back if you're late*.
- Cute as a bug's ear!: Pretty or attractive
- Can't make a silk purse out of a sow's ear!: Be unable to turn something ugly or messy into something

attractive or of value, as in *No matter how expensive his clothes, he still looks sloppy—you can't make a silk purse out of a sow's ear*.

- Flea in his ear: You will give someone an annoying hint or a stinging rebuke, as in If he doesn't bring the right equipment, I'll put a flea in his ear.
- Bug in his ear: Give someone a hint about something, as in *Janet put a bug in her husband's ear about getting the children a dog for Christmas*.
- I'm all ears--to be listening attentively or eagerly
- Bend someone's ear: to talk excessively to someone, talk about a matter at tedious length; monopolize someone's attention. For example, *Aunt Mary is always bending his ear about her financial problems*.
- Fall on deaf ears: what you say is ignored
- Out on his ear: Dismissed, thrown out in disgrace, as in *In this company you get only one chance, and if you fail you're out on your ear*. This term alludes to being physically thrown out head first.
- Give ear or lend ears: to give attention, esp. favorable attention; listen; heed
- Have an ear to the ground *or* Keep an ear to the ground: to pay careful attention to what is going on around them.
- Have the ear of--to be able to influence someone who will listen to them, ex. Tom has the ear of the president.
- In one ear and out the other--heard but without effect, didn't pay attention to what was said
- Play by ear--to play (a musical instrument or piece) without reading music
- Play it by ear--to act as the situation demands, without a preconceived plan; improvise
- Set on its ear--to cause excitement, mayhem, confusion, dismay, etc
- Turn a deaf ear--to be unwilling to listen

Fun Resources for idioms about the human body:

People say the strangest things: Give me a hand. . . . Hold your tongue. . . . Scream your lungs out. . . . In *More Parts* and its wildly popular sequel, *Even More Parts*, by Ted Arnold a young boy takes idioms about the human body literally---to comic effect. Phrases like "give him a hand" and "jump out of his skin" have the boy petrified! But be careful, readers: This clever book just might make you laugh your heads off!



What other idioms have students heard? Do they know any in another language?

Idioms come in every language. For example, there are idioms in English and there are idioms in Spanish that are saying the same thing but using different ideas to get there!

No tiene dos dedos de frente.
Literally means: He doesn't have two fingers of forehead.
The English equivalent is: He's not the sharpest tool in the shed.

Tiene más lana que un borrego.
Literally means: He has more wool than a lamb.
The English equivalent is: He's loaded with cash.

A otro perro con ese hueso.
Literally means: To another dog with that bone.
The English equivalent is: You're pulling my leg.

La carne de burro no es transparente.
Literally means: The flesh of the donkey is not transparent.
The English equivalent is: I can't see through you.

Cada quien tiene su manera de matar pulgas.
Literally means: Each has his way to kill fleas.
The English equivalent is: There's more than one way to skin a cat.

Da un beso a la botella.
Literally means: Give the bottle a kiss.
The English equivalent is: Take a swig.

El hijo de la gato, ratones mata.
Literally means: The son of a cat kills mice.
The English equivalent is: Like father like son.

Antes que te cases mira lo que haces.
Literally means: Before you marry look what you are doing.
The English equivalent is: Look before you leap.

Más vale pájaro en mano que cien volando.
Literally means: A bird in the hand is worth more than 100 flying.
The English equivalent is: A bird in the hand is worth two in the bush.

Mientras que en mi casa estoy, rey soy.
Literally means: While in my house, I am king.

The English equivalent is: A man's home is his castle.

Yo tengo una tía que toca la guitarra.
Literally means: I have an aunt who plays the guitar.
The English equivalent is: What does that have to do with the price of tea in China?

Idiom Times!

Invite individual students or small groups of students to write hilarious and quick newspaper-style stories that play on the literal meaning of idioms.

Here's an example: "Students Buckle Down! Several students were found buckled to their chairs in the library. Teachers are attempting to solve this problem...."

"He Has His Ear! Local police are baffled by a recent crime spree. All the thief seems to have taken are his victim's ears."

Collect articles and combine them into a class newsletter, issue of The Idiom Times, or post the stories on a bulletin board. Students may wish to create illustrations to accompany their articles.

Idiom Pictionary = Ictionary!

Pictionary Words: Idioms

out of the frying pan and into the fire	one leg in the door	why the long face?
in the same boat	up a creek without a paddle	raining cats and dogs
feeling under the weather	green with envy	frog in your throat
head over heels in love	a wolf in sheep's clothing	grab the bull by the horns
out of this world	water under the bridge	put your foot in your mouth
bull in a china closet	have a cow	tie the knot
have two left feet	get cold feet	bouncing off the walls
a fifth wheel	kick the bucket	when in Rome
rise above the blues	scared stiff	one smart cookie
caught red-handed	the squeaky wheel gets the grease	a fly on the wall
jump the gun	throw a fit	take a hike
fraidey cat	carry a tune	eat my words
apple of my eye	hit the road	a blessing in disguise
piece of cake	all bark and no bite	when pigs fly
cost an arm and a leg	hold your horses	the whole nine yards
everything but the kitchen sink	close, but no cigar	back to the drawing board
go out on a limb	wake up on the wrong side of the bed	steal my thunder
once in a blue moon	let the cat out of the bag	hit the sack
let bygones be bygones	grab the bull by the horns	make a mountain out of a molehill
dyed-in-the-wool	can't keep a good dog down	pull the wool over your eyes

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Each student takes one pre-prepared idiom card.

If the idiom is not well-known, the student can check the meaning with the teacher.

Then, he or she draws a quick picture of the literal meaning and invites the group to guess the idiom.

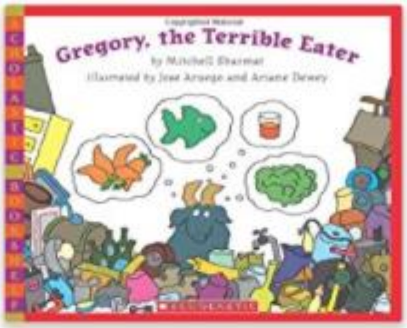
Once they guess correctly, discuss the figurative meaning of the idiom and have them use it in a sentence.

Option: Make it a competition, the team that guesses first, gets the point.

For sample printable lists click here and here.

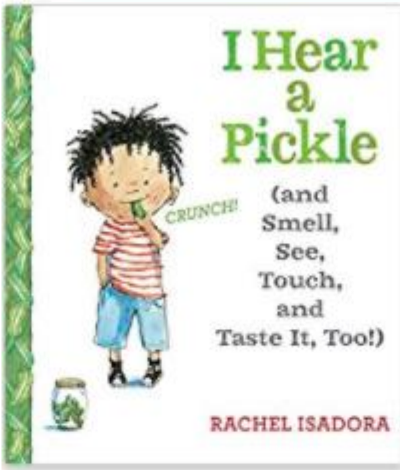
Idiom Bluffs:

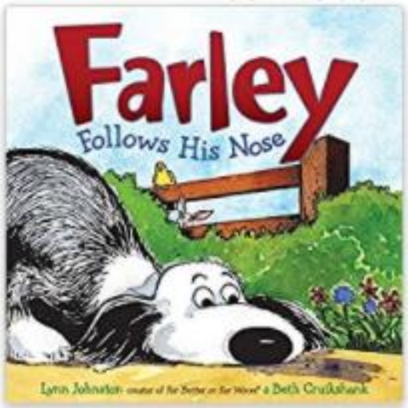
Each group writes the real definition and two false definitions on the back of each idiom card. Later, give the group a chance to read its cards and have the rest of the class guess the true definition.



TASTING WITH YOUR NOSE!

An Exploration of the Most Delicious Scents





Introduce the topic by reading a book such as *I Hear a Pickle* by Rachel Isadora, Gladys *Goes Out to Lunch,* by Derek Anderson*, Farley Follows His Nose* by Lynn Johnston, or *Gregory the Terrible Eater* by Mitchell Sharmat. Discuss the book and why Gregory disliked some foods while loved others.

Want to find out just how bad it would be if the cat actually your tongue? Try eating an ice-cream cone or singing your favorite song without it. You need your tongue to chew, swallow, and sing. And don't forget talking and tasting!

[14]Our sense of taste has led to great geographical discoveries, the founding of nations, and to wars between countries. 500 years ago, the price of the spices coming from southeastern Asia matched that of the price of gold. Taste, and a desire to get rich, is why the Portuguese explorer Vasco Da Gama went around Africa, reached India and returned back to Europe with a lot of spices. America was "discovered" because of our sense of taste, Columbus was looking for a quick and easy pathway towards spice-rich south Asia. 300 years ago, European nations like France, England, Holland, Portugal and Spain

Thay, leth go ob by thongue!
(Say, let go of my tongue!)

[14] Image Credit: ©Linda Silvestri, All Rights Reserved. Sketched Out: Drawing on My Perspective. http://sketchedout.wordpress.com/2008/04/23/cat-got-your-tongue/ 3/24/11

were at war of each other over who could control the sources of spices. All this because of our sense of taste...

As soon as, even before, we are born we already love sweet flavors. This makes sense because sugars are the chemicals we need for energy and growth and babies have a lot of growing to do. We are born disliking bitterness, which is a natural protection against eating something poisonous. Then we learn to recognize sour and salty flavors as growing babies. We can even keep many tastes in our memory and know when food is spoiled (and not to be eaten) if the taste does not match what we remember.

So, what would life be like if we could not taste? Then it wouldn't matter what we ate, every meal and snack would taste the same. Does everything we eat or drink have a taste? Why does your tongue turn black when you eat berries and how does the color go away? After all tongues are not washable, or are they? Actually, they are, the saliva our mouths keep creating and swallowing (10,000 gallons in a lifetime!) does the cleaning and rinsing for us.

They're Your Buddies, They're Your Pals

[15]

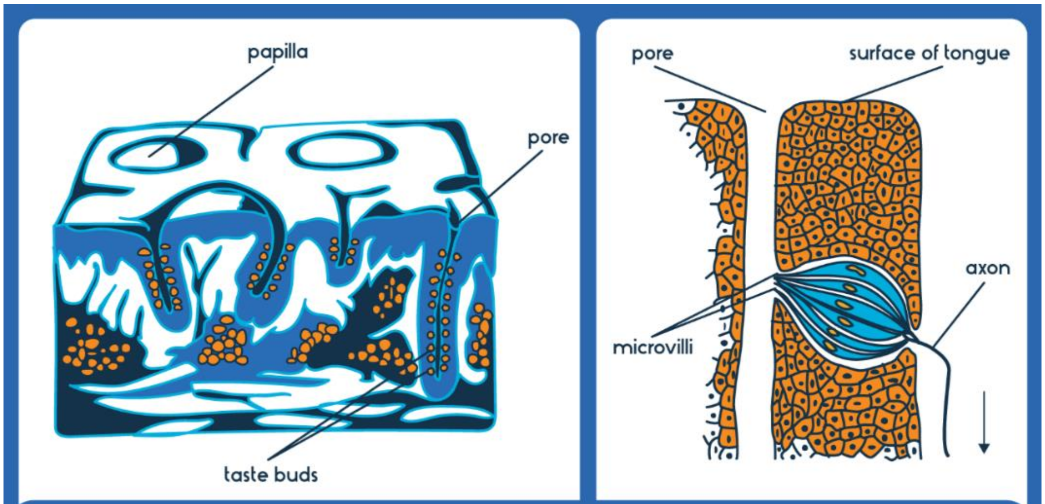
Did you ever wonder why your favorite foods taste so good? Well, you can thank your taste buds for letting you appreciate the saltiness of pretzels and the sweetness of ice cream.

Taste buds are sensory organs that are found on your tongue and allow you to experience tastes that are sweet, salty, sour, and bitter. How exactly do your taste buds work? Well, stick out your tongue and look in the mirror.

[15] Taste Bud Image Credit: http://www.sciencephoto.com/images/download_lo_res.html?id=804780061

Colored scanning electron micrograph (SEM) of a taste bud (center) on a tongue. Numerous bacteria (green/yellow) cover the tongue. Magnification unknown.

See all those bumps? When you see the bumps on your tongue don't think they are the taste buds, these bumps are called papillae (say: puh-pih-lee) and the taste buds are inside each papillae, maybe a few or a few hundred buds in each one. The flavor must be dissolved in your saliva before any taste bud can handle it, then this flavor - let's say it's Mint Chocolate Chip - gathers in tiny, tiny puddles in the bottom of all these taste buds. Taste buds have very sensitive microscopic hairs called microvilli (say: mye-kro-vih-lye). Those tiny hairs send messages to the brain about how something tastes, so you know if it's sweet, sour, bitter, or salty.



Papillæ on the surface of the tongue and taste buds

Everyone's tastes are different. In fact, your tastes will change as you get older. When you were a baby, you had taste buds, not only on your tongue, but on the sides and roof of your mouth. This means you were very sensitive to different foods. As you grew, the taste buds began to disappear from the sides and roof of your mouth, leaving taste buds mostly on your tongue. As you get older, your taste buds will become even less sensitive, so you will be more likely to eat foods that you thought were too strong as a child.

The average person has about 10,000 taste buds and they're replaced every 2 weeks or so. But as a person ages, some of those taste cells don't get replaced. An older person may only have 5,000 working taste buds. That's why certain foods may taste stronger to you than they do to adults. Smoking also can reduce the number of taste buds a person has.

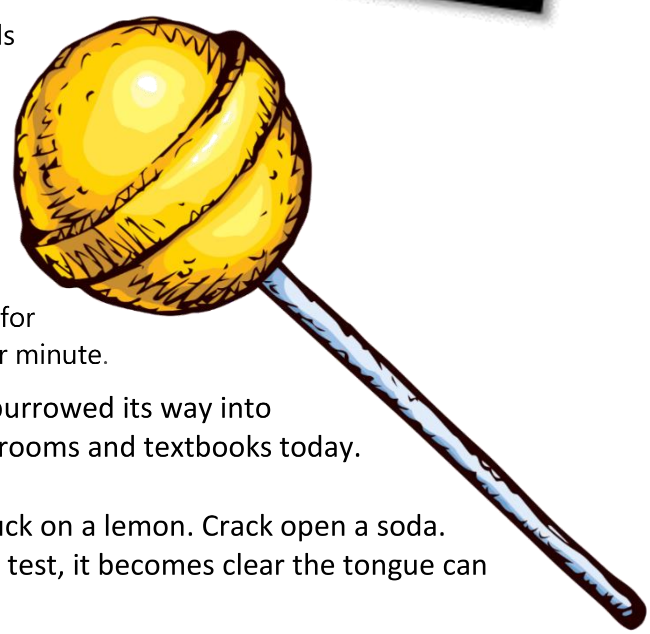
That map will get you lost!

Everybody has seen the tongue map – that little diagram of the tongue with different sections neatly cordoned off for different taste receptors. Sweet in the front, salty and sour on the sides and bitter at the back.

It's possibly the most recognizable symbol in the study of taste, but it's wrong. In fact, it was debunked by chemosensory scientists (the folks who study how organs, like the tongue, respond to chemical stimuli) long ago.

The ability to taste sweet, salty, sour and bitter isn't sectioned off to different parts of the tongue. The receptors that pick up these tastes are actually distributed all over. We've known this for a long time.

In the decades since the tongue map was created, many researchers have refuted it. Indeed, results from a number of experiments indicate that all areas of the mouth containing taste buds – including several parts of the tongue, the soft palate (on the roof of your mouth) and the throat – are sensitive to all taste qualities.



It is true that the tip and edges of the tongue are particularly sensitive to tastes, as these areas contain many tiny sensory organs called taste buds. Different parts of the tongue do have a lower threshold for perceiving certain tastes, but these differences are rather minute.

Despite the scientific evidence, the tongue map has burrowed its way into 'common knowledge' and is still taught in many classrooms and textbooks today.

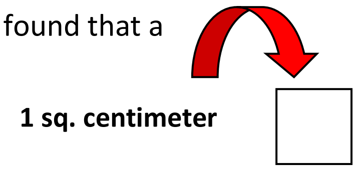
The true test doesn't require a laboratory, though. Suck on a lemon. Crack open a soda. Touch a salted pretzel to the tip of the tongue. In any test, it becomes clear the tongue can perceive these tastes all over.[16]

Sense-sational Facts

- We have almost 10,000 taste buds inside our mouths; even on the roofs of our mouths.

[16] Steven D Munger, *"The tongue map you learned in school is wrong." Retrieved from:* *University of Florida Center for Smell and Taste* http://cst.ufl.edu/that-neat-and-tidy-map-of-tastes-on-the-tongue-you-learned-in-school-is-all-wrong.html

- Insects have the most highly developed sense of taste. They have taste organs on their feet, antennae, and mouthparts.
- Fish have taste buds on their lips and skin, as well as in their mouths and throat, and can taste with their fins and tail as well as their mouth.
- In general, girls have more taste buds than boys.
- Scientists have measured the taste bud density of volunteers. They found that a person who is an "average taster" has about 184 taste buds per square centimeter (see square centimeter) of tongue - now that's a lot of tasting - but some people are "supertasters" with 425 buds per sq.cm. Whereas those called "non-tasters" average just 96 buds per sq.cm. Genetic supertasters react much more intensely than others to sweeteners, bitterness and the creamy sensation of fat in food. Supertasters find the caffeine in coffee more bitter and seem to eat fewer so-called cruciform vegetables such as broccoli and cauliflower - which to them seem very bitter.



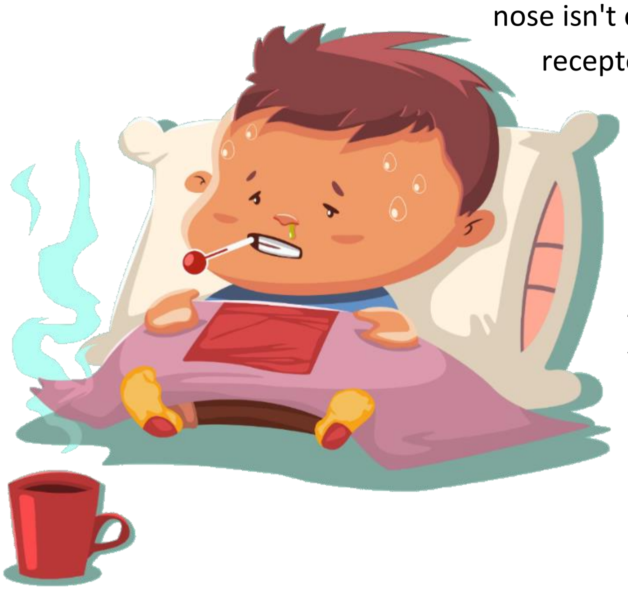
- Taste is the weakest of the five senses.
- Things like medications, smoking, not getting enough of the right vitamins, injury to the head, brain tumors, chemical exposure, and the effects of radiation can cause taste disorders.
- Snakes, some lizards, and cats can smell with their tongues. They have what is called a Jacobson’s organ on the roof of their mouths. When the tongue is brought back in the mouth it is placed on the Jacobson’s organ and interpreted by the brain
- The forked tongue of snakes and some lizards helps them pick up scent molecules to find the direction of a scent.

Tongue's Best Friend?

But before you give taste buds all the credit for your favorite flavors, it's important to thank your nose. It is actually our sense of smell that first identifies the flavor of food...think of the smell of frying bacon, freshly baked bread, warm chocolate chip cookies, or a newly peeled orange. Olfactory (say: ahl-fak-tuh-ree) receptors inside the uppermost part, the top part, of the nose contain special cells that help you smell. These cells send messages to the brain.

Here's how it works: While you're chewing, or when it's cooking, or peeled, the food releases chemicals that immediately travel up into your nose. These chemicals trigger the olfactory receptors inside the nose. They work together with your taste buds to create the true flavor of that yummy slice of pizza by telling the brain all about it!

Last time you had a cold and your nose felt stuffed up, did you notice that foods didn't taste as strong as they usually do? When you have a cold or allergies, and your nose is stuffy, you might notice that your food doesn't seem to have much flavor. That's because the upper part of your nose isn't clear to receive the chemicals that trigger your olfactory receptors.



Have students try holding their nose and eat something, like a bite of apple. They'll notice that their taste buds are able to tell their brain something about what they're eating — that it's sweet, for instance — but they won't be able to pick the exact flavor until they let go of their nose.

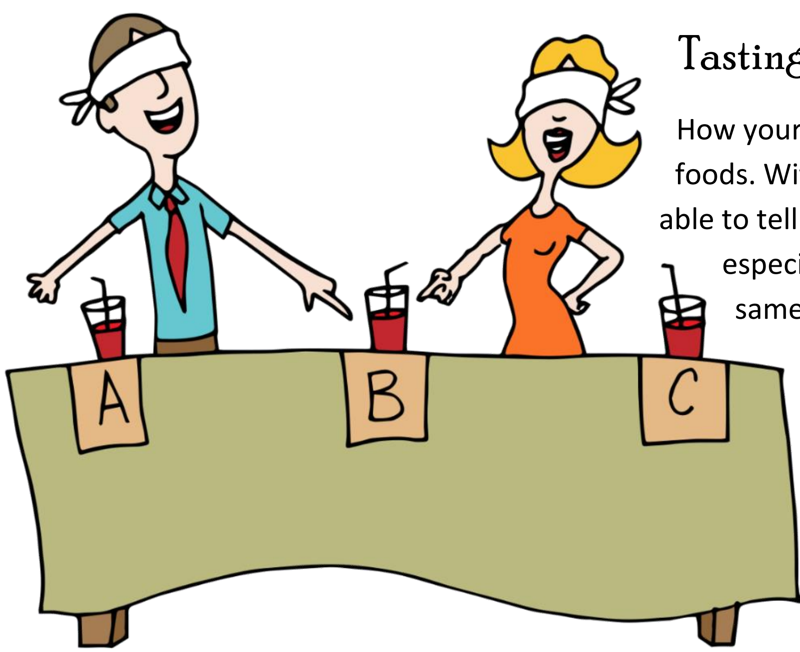
Your nose helps you taste foods by smelling them before they go in your mouth and as you chew and swallow them. Strong smells can even confuse your taste buds.

To demonstrate this, hold an onion slice near a student's nose while they eat a bite of an apple. What do they taste?

Your tongue also gets help from your teeth, lips, and mouth. Your teeth help your tongue grind food as the tongue mixes the food around your mouth. And without your teeth, lips, and the roof of your mouth, your tongue wouldn't be able to form sounds to make words.

Saliva is also a friend of the tongue. A dry tongue can't taste a thing, so saliva helps the tongue by keeping it wet. Saliva moistens food and helps to break it down, which makes it easier for the tongue to push the food back to swallow it.

TASTY EXPERIMENTS



Tasting with Your Nose

How your sense of smell helps you taste foods. Without your nose, you may not be able to tell the difference between foods — especially if the foods all have the same or very similar textures (for instance, ketchup, mustard, honey, barbecue sauce, and sweet and sour; jelly beans with various flavors, gloppy yogurt and pudding, or slices of different fruits and vegetables).

Materials:

- A blindfold
- Foods to taste, *such as different sauces, baby foods flavored jelly beans, different fruit and vegetable slices, or a variety of yogurts and puddings

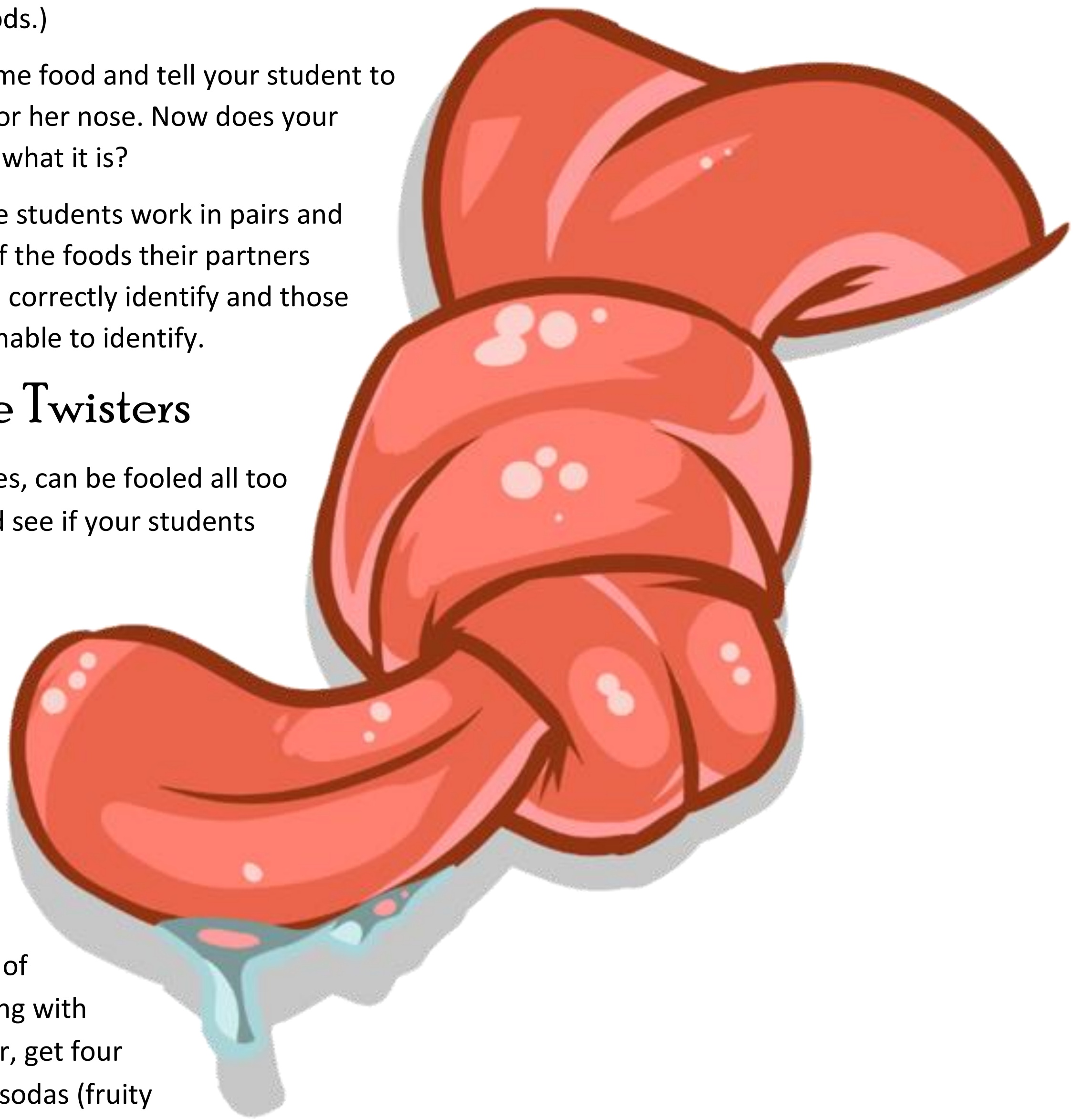
- Spoons, cotton swabs, or tiny popsicle sticks if necessary
- A cup of drinking water for everyone

*Note: Baby foods are good comparison items: they come in a variety of fruit and vegetable flavors and have very similar textures. A test food most kids like is the jelly bean. Buy several flavors of jelly beans and have everyone try to guess the flavor (with and without the use of their nose). The advantage of using the baby foods and jelly beans is that they are have the same texture. Therefore, the blindfolded person will not be able to use touch information to distinguish the different items.

1. Blindfold a student (if they are uncomfortable being blindfolded simply have them close their eyes) and have them pinch his or her nose.
2. Offer your student one flavor of the food at a time.
3. Can he or she identify it? (Your student might want a drink of water between the different foods.)
4. Offer the same food and tell your student to unpinch his or her nose. Now does your friend know what it is?
5. Option: Have students work in pairs and keep track of the foods their partners were able to correctly identify and those they were unable to identify.

Tricky Tongue Twisters

Our brains, and tongues, can be fooled all too easily... try this out and see if your students pass the test.



1) Pour three or four small glasses of different flavored drinks such as cranberry, apple and lime. Keep the concentration of flavor weak, diluting with sparkling water. Or, get four different flavored sodas (fruity

ones such as lemon, grape, cherry, etc.). These sodas should also be different colors.
2) Also get one unflavored, clear soda (such as, club soda or seltzer water). Add a few drops of food coloring to the unflavored, clear soda (orange works well). This will make it LOOK like orange soda, but of course, it will NOT have any taste. Pour the five drinks into different cups for taste testers. Ask people to tell you what each drink tastes like.

2) Most people when asked to identify each flavor will confirm with certainty that the colored water is an orange flavored drink. How many people said your unflavored drink was "Orange"?

Food companies add color to food to influence what it tastes like. People like to see foods in colors that they expect.

Variation:

Materials:

- At least 4 different flavored jelly beans (two of each flavor for each subject)
- Cups or napkins
- Pen (to label cups and napkins)

In this experiment, use jelly beans instead of soda. For each subject you test, you will need pairs of jelly beans. For example, get 2 cherry jelly beans, 2 lime jelly beans, 2 lemon jelly beans and 2 orange jelly beans. Each jelly bean flavor has its own unique color: red for cherry, green for lime, yellow for lemon and orange for orange. Divide the jelly beans into two groups: each group should have one of each flavor.

Label small containers or napkins with the numbers 1 through 4. Place the jelly beans from the first group into a container or on a napkin - one jelly bean into each container or on each napkin. Wrap the jelly beans in the second group in foil or place them in a cup so that your subjects cannot see them. Label these cups with the numbers 1

through 4. Make sure that the flavors of the second group have different numbers than the flavors in the first group.

Now you are ready to start the experiment. If you want, you can tell your subject the names of the flavors that they will be tested. In other words, you can say, "The jelly beans you taste will be either cherry, orange, lime or lemon." Tell your subject to look at the jelly bean in container #1 of the first group and then taste the jelly bean. After they have tasted the jelly bean, tell your subject to write down its flavor. Do the same thing with jelly beans #2-#4.

The next part of the experiment is a bit more difficult. You must keep the color of the jelly beans in group 2 hidden from your subjects. You can blindfold your subjects or have them close their eyes while they taste the jelly beans. Keep track of the flavors that your subjects say each jelly bean tastes like. You can even tell your subjects that the flavors they will taste will be the same as before.

What are the results? Did your students make any mistakes when they could not see the color of the jelly bean? If they did, what was the most common mistake? What would happen if you used an unusual flavor? What would happen if you found a jelly bean with an abnormal color...for example a red-colored lemon-flavor jelly bean?

Spit Test Variation

Purpose: To use the sense of taste to identify flavors that taste bad or good

Materials~

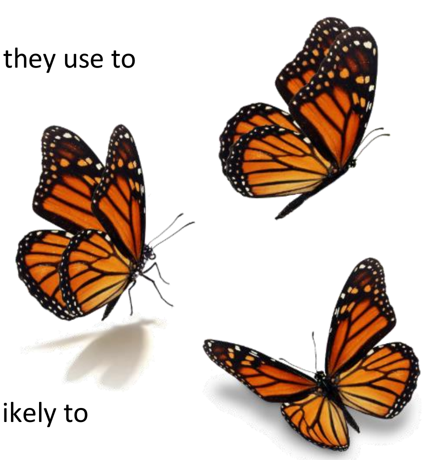
- Gourmet Jelly Beans (recommended because they have the most flavors),
- Bernie Bott's Jelly Beans or BeanBoozled beans (optional, if your students like gross stuff),
- Paper
- Pen/ pencils

Warning: Check for food allergies. Also, if using Bernie Bott's Jelly Beans or BeanBoozled Beans have tissues or a trash can available. Some of the flavors like pepper, vomit, sardine, skunk spray, toothpaste, etc. are strong and the kids will want to spit them out.

Instructions

1. Separate Jelly Beans into flavors. (Keep the jelly bean bag or box; it will help in identifying the flavors).
2. Write the flavors of the jelly beans you want to use on the board.
3. Have the students take out some paper and list one though five.
4. Pass out the Jelly beans and give each student ten jelly beans total; 2 of each flavor of five different flavors.
5. The students will only be eating one of each bean pair. The other bean will be used to identify the flavor afterwards.
6. Have the students describe what the bean looks like.
7. Next tell the students to eat one of the flavors and have them predict what each flavor will be based on their observations for each bean.
8. Continue to let them eat until they have tasted each of the five different flavors
9. Then with your help, have them identify the flavors of the remaining jelly beans. Allow the students to see if their predictions were correct.

Ask the students if their predictions match with the flavor. What methods did they use to determine the flavor of the jelly bean?



Remind students that our tongue has taste buds on it. Those taste buds send signals to the brain which interprets the taste of food. We then decide whether or not that food is good or bad for us to eat.

Animals in wild do the same thing we do when trying new foods; they will try a little bit of it. But if the taste disagrees with the animal, they will spit it out—protecting them from eating bad food. This also works to the benefit of insects that look like a nasty tasting insect. They're less likely to be eaten! E.g., butterflies that look like Monarch butterflies, which taste bitter, are less likely to be eaten by birds.

Taster's Name: ____

Name of the Food	Identified Correctly	Didn't Identify Correctly

Taster's Name: ____

Name of the Food	Identified Correctly	Didn't Identify Correctly

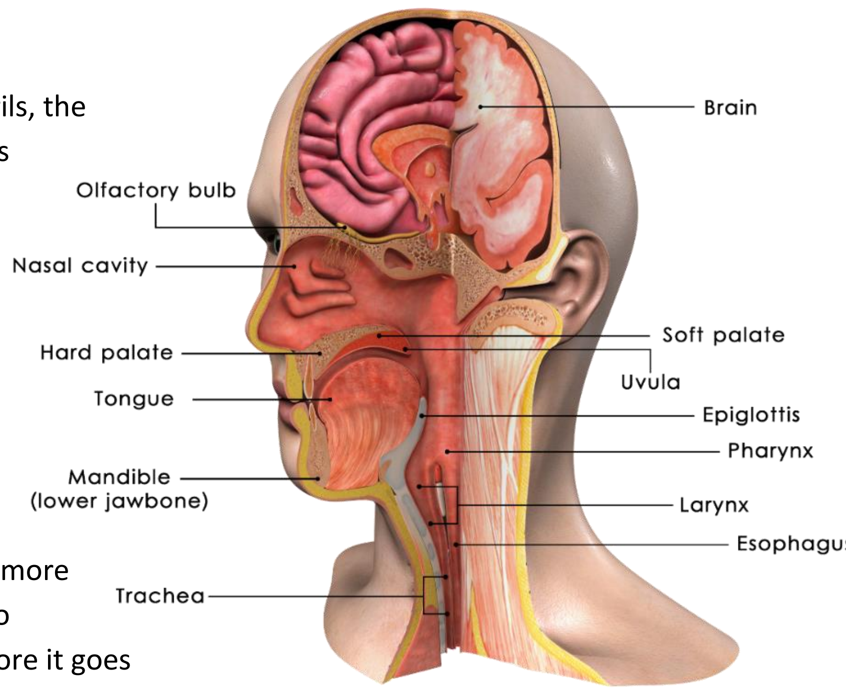
YOUR NOSE KNOWS

A big batch of cookies coming out of the oven. Your gym bag full of dirty clothes. How do you smell these smells and thousands more? It's your nose, of course.

Your nose lets you smell and it's a big part of why you are able to taste things. The nose is also the main gate to the respiratory system, your body's system for breathing. Let's be nosy and find out some more about the nose.

Getting the Air in There

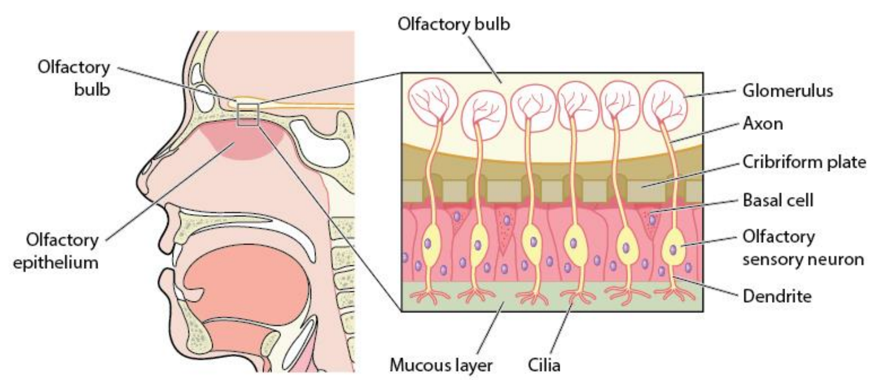
When you inhale air through your nostrils, the air enters the nasal passages and travels into your nasal cavity. The air then passes down the back of your throat into the **trachea** (say: **tray**-kee-uh), or windpipe, on its way to the lungs.



Your nose is also a two-way street. When you exhale the old air from your lungs, the nose is the main way for the air to leave your body. But your nose is more than a passageway for air. The nose also warms, moistens, and filters the air before it goes to the lungs.

Sniff, Sniff, Take a Whiff

The nose allows you to make scents of what's going on in the world around you. Just as your eyes give you information by seeing and your ears help you out by hearing, the nose lets you figure out what's happening by smelling. It does this with help from many parts hidden deep inside your nasal cavity and head.



Up on the roof of the nasal cavity (the space behind your nose) is the **olfactory epithelium** (say: ol-**fak**-tuh-ree eh-puh-**thee**-lee-um). Olfactory is a fancy word that has to do with smelling. The olfactory epithelium contains special receptors that are sensitive to odor molecules that travel through the air.

These receptors are very small — there are at least 10 million of them in your nose! There are hundreds of different odor receptors, each with the ability to sense only certain odor molecules. Research has shown that a single odor can stimulate several different kinds of receptors. The brain interprets the combination of receptors to recognize any one of about 10,000 different smells.

How Signals Get Sent

When the smell receptors are stimulated, signals travel along the olfactory nerve to the olfactory bulb. The olfactory bulb is underneath the front of your brain just above the nasal cavity. Signals are sent from the olfactory bulb to other parts of the brain to be interpreted as a smell you may recognize, like apple pie fresh from the oven. Yum!

Identifying smells is your brain's way of telling you about your environment. Have you ever smelled your toast burning? In an instant, your brain interpreted the smell and a problem, and you knew to check on your toast.

You learned to associate a certain smell with burning and now your brain remembers that smell, so you recognize it. Your sense of smell also can help you keep safe. For example, it can warn you not to eat something that smells rotten or help you detect smoke before you see a fire.

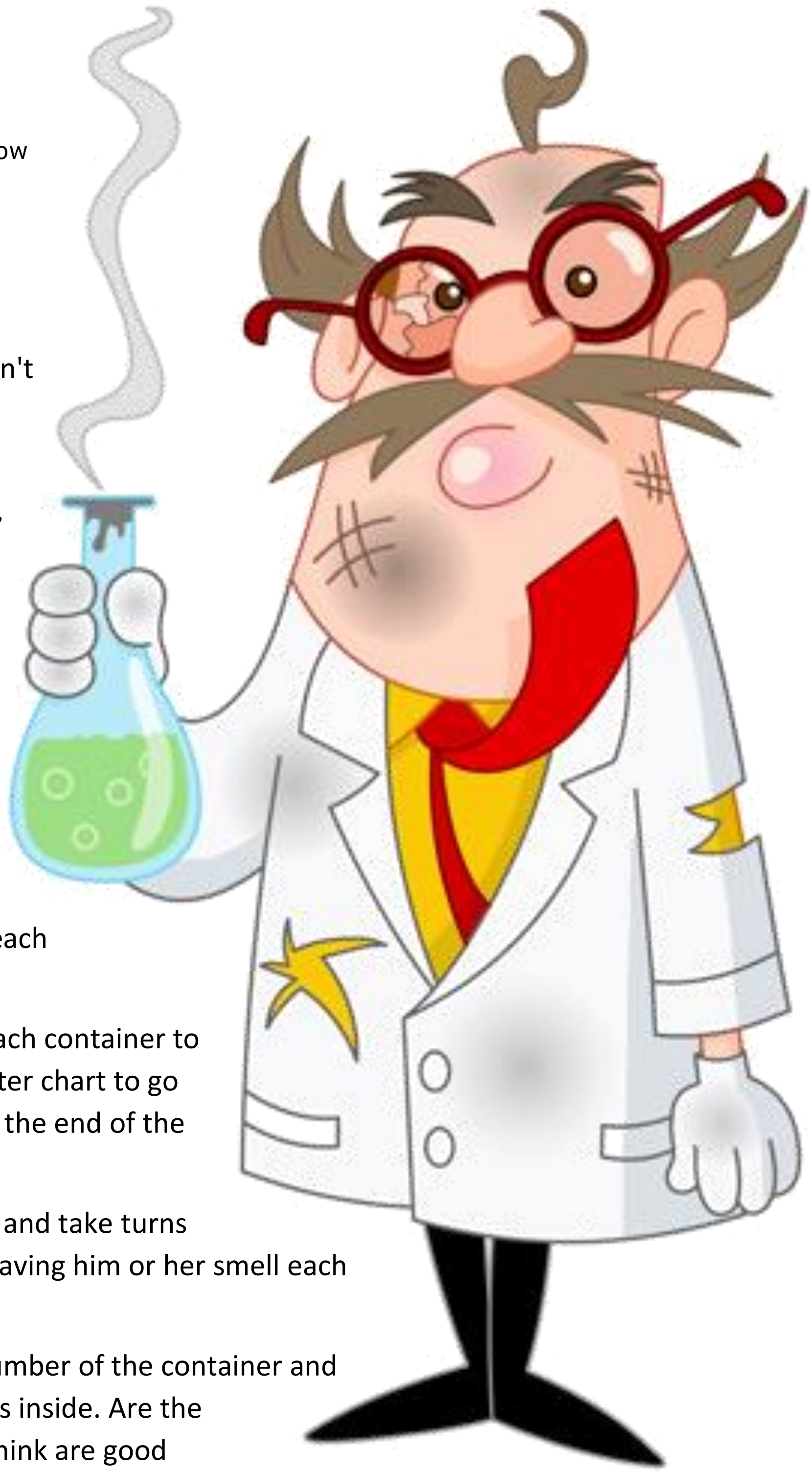
Tastes Great!

Most people just think of the tongue when they think about taste. But you couldn't taste anything without some help from the nose! The ability to smell and taste go together because odors from foods allow us to taste more fully.

Take a bite of food and think about how it tastes. Then pinch your nose and take another bite. Notice the difference? It's just another reason to appreciate your knockout of a nose!

NOSY EXPERIMENTS!

Mystery Smells



You can recognize a lot of different smells. How many? Try this and see.

Materials:

- Blindfolds
- Small, lidded containers that you can't see through
- Smelly stuff, such as lemons, bananas, orange peel, pine needles, a cotton ball soaked in perfume, chocolate, coffee, dirt, vanilla, garlic, onion, mint, vinegar, rose petals, pencil shavings, or ginger

1. Poke small holes in the container lids.
2. Put one "smelly" object in each container.
3. Write a number on the side of each container.
4. Tape a label to the bottom of each container to say what's inside or keep a master chart to go through with the whole class at the end of the experiment.
5. Have students work in partners and take turns blindfolding their partner and having him or her smell each container.
6. Students will write down the number of the container and their friend's guess about what's inside. Are the answers right? Which do they think are good smells? Which do they think are gross? Do the partners agree?

Match-A-Smell

Collect pairs of items that smell and place them in containers that students cannot see through. Poke holes into the top of the containers. Mix up the containers and have students try to match the containers that have the same item. When they have made their decisions, open up the containers and see how they did.

Suggested smells:

lemon | orange peel | cedar wood | perfume-soaked cotton | banana | pine needles | chocolate | coffee | dirt | vanilla | garlic | onion | mint vinegar | moth balls | rose flowers | saw dust | ginger | peppermint | pencil shavings | potato chips

Materials:

- Smells
- Opaque Containers

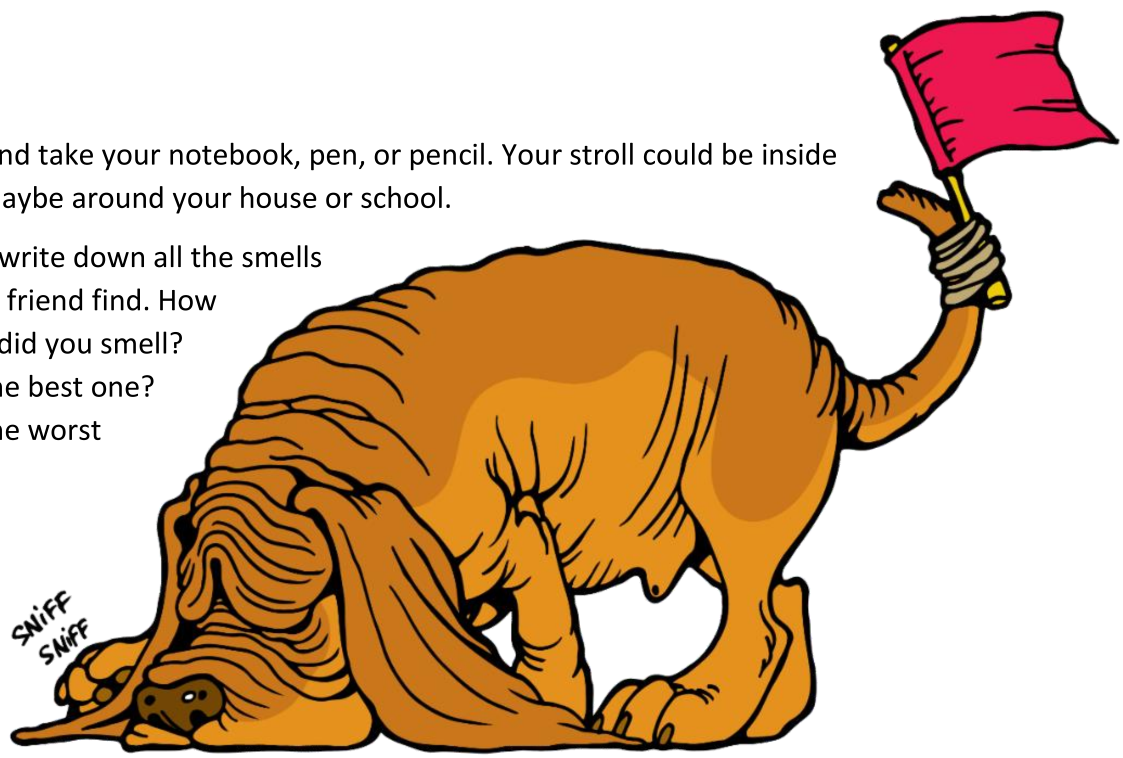
Going on a Smell Hunt!

How many smells can you recognize?

Materials:

- A friend or two
- A notebook
- A pencil or pen

1. Plan a walk and take your notebook, pen, or pencil. Your stroll could be inside or outside, maybe around your house or school.
2. As you walk, write down all the smells you and your friend find. How many smells did you smell? Which was the best one? Which was the worst one?



Smeller's Name: ____

Item #	Food Name Guess	Smelled Good!	Smelled Bad!	Identified Correctly	Didn't Identify Correctly

Smeller's Name: ____

Item #	Food Name Guess	Smelled Good!	Smelled Bad!	Identified Correctly	Didn't Identify Correctly

Lesson Plan

Date(s):

Pages:

Grade level(s):

Skills/Standards I want to incorporate:

- [ ]
- [ ]
- [ ]

Activities I want to do:

How I'm going to tie the standards in:

Materials I already have:

Materials I need to find, buy, or borrow:

Additional Notes & Ideas: