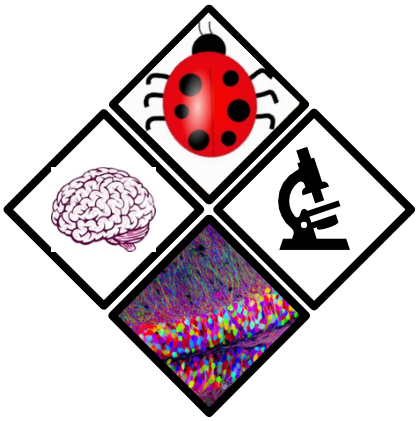
Junior Scientist's



LABORATORY NOTEBOOK

Name:_____

PROJECT BRIDGE

connecting science and community

Contents

PROJECT BRIDGE

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Introduction

Welcome, scientists!

Here, you will find a collection of science and art activities. These activities are designed to teach scientific concepts in a way that is fun, engaging, and accessible. This packet is the brainchild of the Science Outside the Lines and Baltimore Brainfest subcommittees of Johns Hopkins Project Bridge, and the **Psychological and Brain Sciences Equity Committee**. **Project Bridge** is a graduate student led organization that seeks to foster public interest in science and bridge the gap between scientists and their communities. **Science Outside the Lines** does this by combining art and science in order to teach students that these two areas – while seemingly quite different – actually go hand-in-hand! The **Baltimore Brainfest** is normally a one-day event full of brain-related activities for all ages. In lieu of our normal in-person programming due to COVID-19, we have partnered to create this packet that encompasses the goals of our two programs. Here, you will learn about neuroscience, vaccines, food, and much more as you create beautiful artwork and try out cool brain tricks. We hope you enjoy it!

You should be able to complete most activities in this packet on your own (difficulty level: easy), although you may need help from an adult at times (difficulty level medium to advanced). Many activities require no equipment or supplies aside from something to write and color with. For activities that require extra supplies, they are listed at the top of the page. We have also tried to align our content with the Next Generation Science Standards (https://www.nextgenscience.org) used by Maryland public schools. Where applicable, the science standard(s) that align with each activity are listed in the table of contents.

We would love to see photos of your work! You can share them with us using the link below (feel free to submit photos for more than one activity). Have fun!

Show us your work!

https://bit.ly/39

Learn more about Project Bridge!

projbridge.org

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Time: 30 minutes

Difficulty: Medium

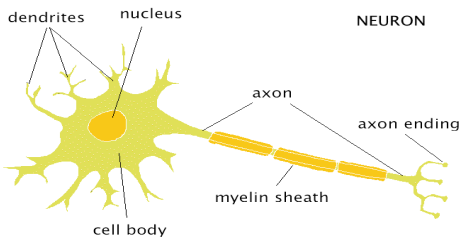
BUILD-A-NEURON

What is your brain made out of? (Write your answers below.)

Neurons! You have billions of tiny brain cells, called neurons, in your brain and they send messages to each other to control your actions, thoughts, emotions…pretty much everything!

So, what does a neuron look like? It has:

- A cell body (the neuron's main hub)
- Dendrites (receives messages from other neurons)
- And an axon (sends messages to other neurons)



Draw your version of a neuron below based on the description above.

*Some neurons have sheaths of fatty insulation called **myelin** around the axons. This makes the messages traveling down the axon go much faster. Messages travel through a neuron's axons and dendrites as small pulses of electricity called **action potentials**, and pass between different neurons in the form of chemicals called **neurotransmitters** that neurons send to each other.*

Time to make our own neurons (instructions on next page)!

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BUILD-A-NEURON

Here's what you need:

- 1 puff ball
- Several pipe cleaners (all different colors)
- Beads

Instructions:

1. Wind a bit of one pipe cleaner around the puff ball, then bend the pipe cleaner to make an axon.
2. Cut another pipe cleaner into equally-sized pieces.
3. To make dendrites, take each piece of pipe cleaner and attach it to the pipe cleaner wound around the puff ball.

Optional:

1. Give your neuron some neurotransmitters by grabbing a few beads and placing them near the end of your neuron's axon.
2. Give your neuron a myelin sheath by winding another pipe cleaner around your neuron's axon.

What is different about the three different parts of the neuron?

How do your neurons communicate?

If your neurons can't communicate, what do you think happens?

True or false:

A newborn baby has more neurons than an adult.

True! At birth, a baby (~100 billion neurons) has twice as many as an adult.

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Time: 15 minutes

Difficulty: Easy

THE NOSE KNOWS

Think about the last time you had a cold. Did you notice it was difficult to taste food? Why is that? Write your best guess below!

Our senses of taste and smell are connected! The scent of food moves from our mouths into our **sinuses** – the inside of the nose, where scent is detected – as we chew. This is an important component of flavor.

When you have a stuffy nose from a cold, your sinuses swell and block your sense of smell, which affects your sense of taste!

Let's test how much of an effect scent has on flavor. Here's what you'll need:

- A bag of Skittles (don't eat them yet!)

Follow the following steps:

1. Close your eyes and pinch your nose
2. Have a skittle

Can you guess what flavor it is?

3. Open your eyes, keeping your nose pinched.
4. Try another skittle.
5. Now release your nose.
6. Try a third skittle.

Write down your best guess for the flavors of the second and third skittles below.

THE NOSE KNOWS

What happened when you released your nose? Were you able to correctly guess the flavor of the skittle?

Was it more difficult to guess the flavor of the skittle with your nose pinched or released?

Why do you think it is easier to taste after your nose was released?

When we breathe in the smell of a food, chemicals from the food are pulled into our noses. Those chemicals activate neurons in our sinuses, which tell our brains what it is we're smelling. When we chew food, those same chemicals mix with our breath.

When we breathe out through our nose as we eat, small and taste come together, making FLAVOR!

When we pinch our noses, we impair our sense of smell, making it difficult to taste the sweet flavor of the skittle when your nose was pinched!

Try this same activity with your parent, sibling, or friend and write down when they guess the flavor correctly!

Trivia:

How many scents can you detect?

Humans can detect more than 10,000 scents!

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Time: 35 minutes

Difficulty: Advanced

FAKE HAND MAGIC

Our brains use many senses together to understand the world.

When touch and sight work together, they can trick a sense called **proprioception** – the sense that keeps track of the parts of your body – into mistaking a fake hand for your own.

Get a partner and a fake hand (like a toy, a drawing model, or an inflated glove) to see it happen!

Here's what you need:

- 1 fake hand
- 1 cardboard screen
- A partner

Instructions:

1. Set up your piece of cardboard on a flat surface (ex: table) -- this will be where you do your experiment!
2. Have your partner place their hands on either side of the screen, making sure one hand is blocked from their view.
3. Place the fake hand on the side of the screen that your partner can see.
4. Gently brush or tap each finger of both the fake hand *and* the out-of-sight real hand – make sure to brush the fingers of the fake and the real hand at the *same* time.
5. Ask your partner if it's beginning to seem as if the brushes they feel are coming from the fake hand, rather than their real one.
6. Once your partner starts to feel the fake hand, surprise them by softly hitting that hand **(*not* the real one!)** with your fist – and ask your partner, did they expect it to hurt when you did that?

If they did, that's because their brain was tricked into adopting the fake hand as their own!

Why do you think your partner was tricked? Pick which step above caused your partner's brain to think the fake hand was real!

Now your turn.

FAKE HAND MAGIC

Why did this happen?

Your partner *saw* the same touches on the fake hand as they *felt* in their real hand, and that made it feel as if the touches they felt came from the hand they could see.

Because of that, their perception of their body changed, making them react as if the fake hand was a part of them – but only for a little while!

How does this activity show you how different senses can interact with each other? (ex: hint! Think about vision and touch)

How are other ways your brain is tricked? Can you think of any examples?

Question:

If someone loses a limb, is it possible for them to feel like the missing limb is still there?

Yes.

This is called phantom limb. It happens when someone feels sensation in a limb that no longer exists.

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Time: 30 minutes

Difficulty: Easy

NUTRITION

How many food groups do you think there are?

There are 6 major food groups!

Fruits, vegetables, grains, proteins, dairy and oils.

What food groups can you find in your fridge? List the foods you find, and use the descriptions below to decide what food is from which group!

Fruits include any whole, canned, frozen, or dried fruit, as well as 100% fruit juice (examples: strawberries, bananas, mangoes).

Vegetables include any fresh, frozen, dried, or canned vegetable (examples: green beans, peppers, mushrooms).

Grains include any food that is made from wheat, rice, oats, cornmeal, or barley (examples: bread, pasta, rice, tortillas).

> Within the grains group, there are **whole grains,** which include the entire grain kernel, and **refined grains,** for which have part of the grain kernel removed. Whole grains are usually healthier than refined grains.

Proteins include any food that is made from meat, poultry, seafood, beans, eggs, soy, nuts, or seeds (examples: chicken, shrimp, black beans).

Dairy includes any food that is made from milk, including cheese, yogurt, and of course milk itself. Dairy is an important source of the mineral calcium, which you need for healthy teeth and bones!

And finally, there is the **oils** group, which includes any fat that is a liquid at room temperature. Some examples of oils include olive oil, canola oil, and vegetable oil.

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NUTRITION

Which food groups do you think are most important for a healthy diet?

Which food groups do you think are most important for playing and exercising?

The USDA recommends eating lots of fruits, vegetables, and whole grains, a moderate amount of proteins and dairy, and just a little bit of oils.

Think of your favorite meals. What food group(s) do they fall into?

1. Example: Cheeseburger – protein (burger patty), dairy (cheese), grains (bun)
2.
3.
4.

Now do the same with your least favorite meals!

1.
2.
3.

Trivia:

Is a tomato a fruit or a vegetable?

They are a fruit! Surprised?

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Time: 20 minutes

Difficulty: Easy

FOOD PROCESSING

Food processing is any method that turns raw, fresh foods into products that we eat. Some examples of food processing include washing, cutting or chopping, cooking, preserving, and freezing. Most foods that we eat are processed in some way.

Even fresh fruits and vegetables are typically cleaned before we eat them! However, some foods are more processed than others. A donut, for example, has undergone many more processing steps than a piece of fresh fruit.

Generally speaking, foods that come in packages – such as chips, cookies, and frozen foods – are more processed than foods that don't come in packages. Both minimally processed and highly processed foods can be part of a healthy diet, but it's good to focus on minimally processed foods (especially fruits and vegetables) when they are available.

What processed foods can you find at home? Look in your pantry or cupboards, and write down which foods have been processed and how.

Why do you think food needs to be processed?

What are your favorite processed foods? Unprocessed?

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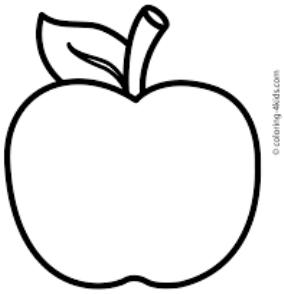
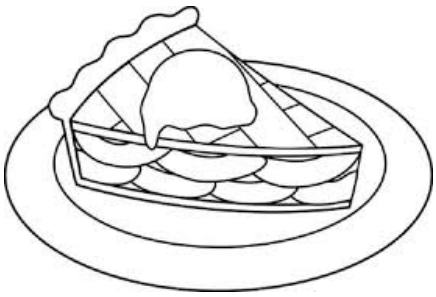
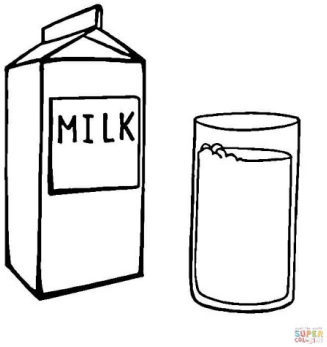
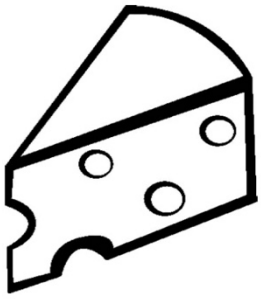
FOOD PROCESSING

Activity - Food Pairs:

The foods in the left column are less processed foods. The foods in the right column are more processed foods, made from the foods on the left. Color in the examples given, then draw two food pairs of your own!

Less Processed	More Processed
Apple 	Apple pie 
Milk 	Cheese 

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Time: 25 minutes

Difficulty: Easy

BRAIN FREEZE!

What happens to your body when you are outside on a cold day? How about on a really hot day?

You sweat and you shiver! Why doesn't your body react this way on nice, warm days?

Your body likes to keep its temperature just right, so it uses shivering and sweating to heat you up or cool you down to keep you somewhere in the middle. If it's a nice day, you don't need to change your body's temperature, because it's already perfect!

But what if something is too hot or too cold for your body to handle? In this case, your body tells you to stay away from that thing by making it feel painful. Pain is actually a handy tool to keep your body safe from objects that could cause serious damage. This is why you might jump out of a really cold shower or spit out really hot food. What's another example of something cold that causes pain? (Write a few examples below)

That's right! A BRAIN FREEZE! Let's learn more about brain freeze and find ways to cure it.

BRAIN FREEZE!

Here's what you'll need:

- Something really cold (ice cream, ice cubes, etc.)
- Something warm (a glass of warm water or your thumb)

Instructions:

1. Put the cold object into your mouth. (If it's ice cream, enjoy!)
2. When your mouth gets really cold and you start have a headache, quick! Press your thumb to the top of your mouth (or swish around the warm water)!

What happened when you warmed up your mouth once you had brain freeze? Did your headache go away? Why do you think that is? (Write your ideas below.)

Putting something cold in your mouth lowers the temperature far below what your body thinks is "just right." The brain freeze headache comes from the blood vessels in the roof of your mouth that carry blood to your brain. When these vessels get really cold, blood flow to your brain gets interrupted, which can be damaging if it doesn't return quickly enough.

Your headache is your body telling you "Quick! Get away from the cold and protect the blood vessels!" This is why warming up your mouth cures brain freeze. It returns your temperature to where it's supposed to be and keeps your brain healthy and strong!

So why does your body react poorly to extremely hot or extremely cold temperatures?

Trivia:

Is it possible to burn yourself by something cold?

Yes! Your skin is equally sensitive to any extreme temperature.

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Time: 45 minutes

Difficulty: Advanced

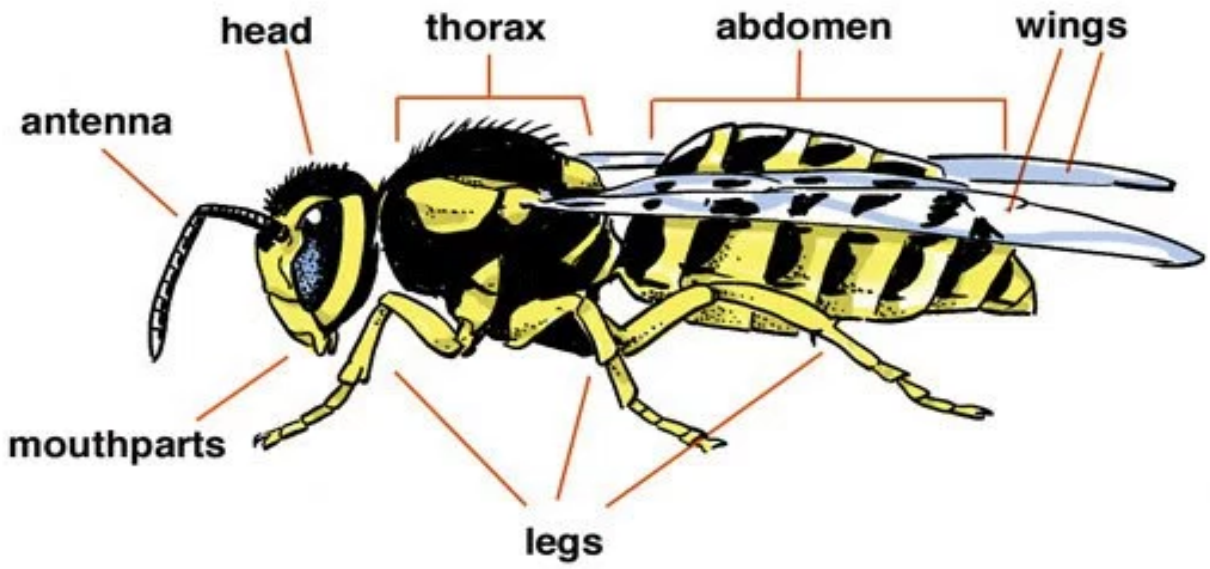
BUG BIODIVERSITY

In this activity you'll learn some of the physical attributes of insects and bugs, and the difference between insects, bugs, and spiders

What do you think of when you see the word 'bug'? Try to write down as many types of bugs you can think of as you can.

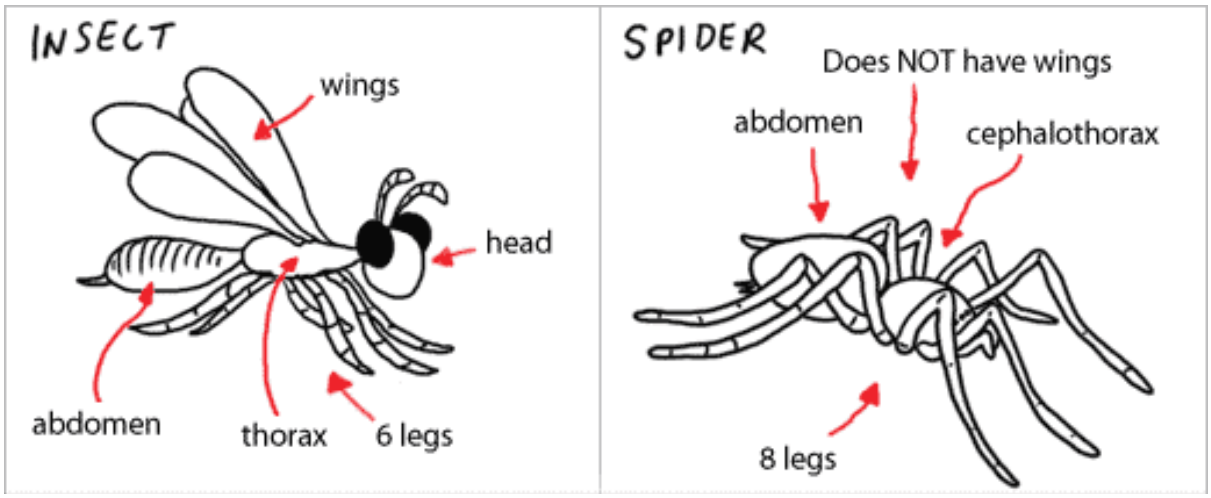
All insects are "bugs", but not all bugs are insects – some are a different type of animal, called **arachnids**. So what makes an insect? Insects have some basic physical features:

- A hard exoskeleton (meaning outer skeleton)
- A 3-part segmented body (the head, the thorax, and the abdomen)
- 6 jointed legs
- Compound eyes (lots of little lenses instead of one)
- 1 pair of antennae
- Wings (in *some* cases, but not all!)



BUG BIODIVERSITY

Do you think spiders are insects? Why or why not?



Spiders are not insects, they are **arachnids**. According to this picture, what do you think are the physical features of the arachnids? (Fill in the numbers)

Arachnids have _____ legs, _____ body segments, and _____ wings.

I found these fruit flies in my kitchen recently! Can you help me identify if they are insects or arachnids? Why do you think so?

BUG BIODIVERSITY

I spotted these red velvet mites recently after the rain! Aren't they striking! Can you help me identify if they are insects or arachnids? Why do you think so?

In addition to the fruit flies, I also found a lot of ants in my kitchen! Can you help me identify if they are insects or arachnids? Why do you think so?

Why do you think insects are super important?

BUG BIODIVERSITY

Some insects have specialized body parts for special purposes: lights to attract mates, horns for fighting, eye stalks for enhanced vision, or stingers for protection. Can you think of any others? (Hint: how do they fly?)

Let's get creative - pick two insects to fuse into a new creature!

Here's what you'll need:

- Scissors and glue
- Cans
- Bottles, paper, boxes, lightbulbs… whatever you can gather around your home!

Instructions:

1. Pick the insects you want to fuse! (Remember: 6 legs, 3 body segments)
2. Draw the body plan, and think of what material to use.
3. Collect the material.
4. Improve on plan.
5. Put together your recycled insect!

Discussion:

1. Are there any special features on your recycled insect? What are the function of those features?

2. What bugs do you see around your home? Where do you usually see them? Are each of them insects or arachnids?

Bug name	Location of sighting	Insect or arachnid

Trivia:

Are there more insects or humans on earth?

For every human, there are 200 million insects. We are outnumbered!

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Time: 45 minutes

Difficulty: Advanced

PLAY DOUGH FUN

You've probably watched your parents bake before and you might even know how to do some baking yourself. Food like pancakes, muffins, and bread all use the **science of mixtures and chemical reactions** to make tasty treats. Today we're going to be making some play dough using the same **chemical reactions** used in baking…and even the same ingredients!

Here's what you'll need (the amounts don't have to be perfect!):

- 2 cups of flour (add more if your dough is too sticky or runny)
- 1 cup of salt
- 1 cup of warm water
- 1 tablespoon of vegetable oil
- Some liquid food coloring

Instructions: mix the flour and salt in a bowl to create a dry mix. Next put a few drops of food coloring into the water, make sure you like the color though because this is the color of your play dough. Next add the oil to the water. What do you notice?

Pour the colored oil-water into the dry mix and stir until all the water is gone. Once all the water is gone, start using your hands to squeeze the mix together until it's easy to take out of the bowl in once piece.

Take the mix out of the bowl 'knead' it by folding it over and smashing it with your hands. After a few minutes of kneading, you've just made your own play dough!

NOW FOR SOME SCIENCE!

You made chemical reactions happen while you mixed this play dough! Let's think about what you did. First you put flour and salt together, what happened? Not much right? That's because no chemical reaction took place. You could still separate the flour and the salt, but it would be really annoying.

Next you added food coloring to the water, and that mixed well right? Well, that's not a chemical reaction either – food coloring is just colored water so you didn't really make a mixture. But when you added oil you saw that it didn't mix. That's because oil is not **soluble** in water – that means they

PLAY DOUGH FUN

don't like to mix with each other! Also, oil is lighter than water so it floats to the top.

All your mixing so far hasn't created a chemical reaction. Once you put the water into the dry mix however, something new happened. The dry mix got all sticky, and the more you kneaded it, the more it stuck together. That's because the water makes chains of molecules in the flour, called proteins, stick together. And the salt helps to hold the water to those chains, making them even more sticky.

Now remember how the oil and water don't mix? Well, the oil here helps trap the water in, so the play dough doesn't get dry as fast – the water has a hard time getting past the oil.

Could you separate out the flour from the water and salt now? What else can you think of that is made using chemical reactions?

What has to happen in order for a chemical reaction to happen?

What other liquids do you think won't mix well with water?

Can you always tell by eye if a chemical reaction has happened?

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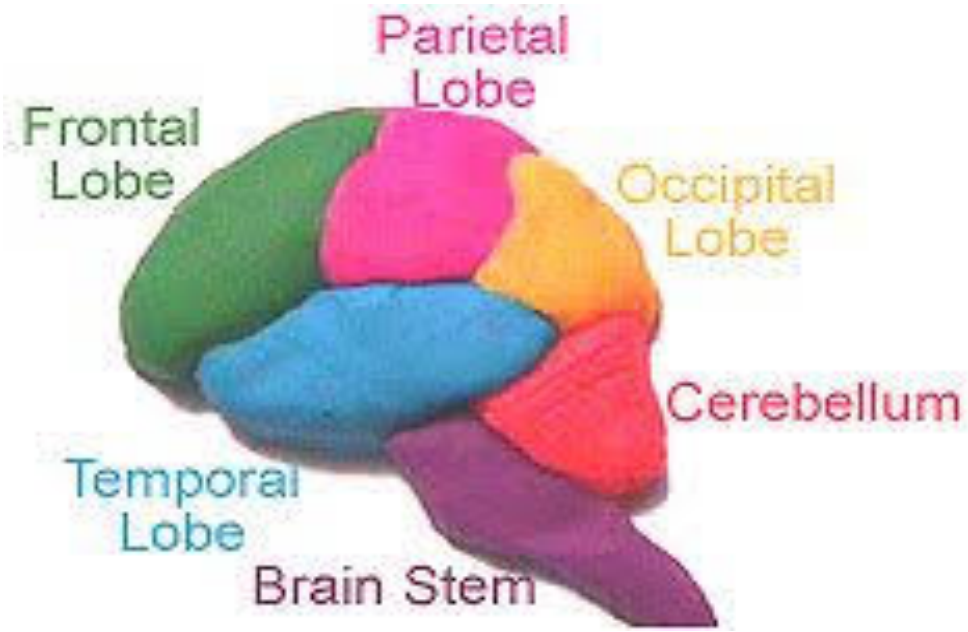
Time: 20 minutes

Difficulty: Easy

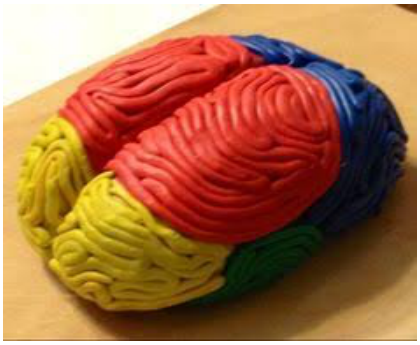
BUILD-A-BRAIN

What is a brain? What does a brain look like? This is what you'll learn in this activity. You'll need modeling clay, Play-Doh, or salt dough, which you can make with the recipe in the previous activity.



How large is your brain? Try to make your brain model approximately the same size as your own! Make fists with both your hands and press your knuckles together: that is about the size of your own brain!

How important is the **Human Brain**? Write down what you think the human brain does below:



Your brain is the command center for your body. All the information your body receives is processed in specialized parts of your brain, which uses that information to make decisions. For example, sight is managed by the **occipital lobe** in the back of the brain, while memory is largely handled in the temporal lobes.

Trivia:

Did you know there are only 4 types of taste cells? How many types of smell cells do you think we have?

We have over four hundred!

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Time: 35 minutes

Difficulty: Medium

CSF IS EGGCELENT!

Our brains are very soft and fragile, and easy to injure if they're not protected properly. So, our brains are protected by both our hard skulls and the fluid inside them. How does this work?

The fluid inside of our skull is called the **cerebrospinal fluid** (or CSF for short). Let's break that word down: *cerebro* refers to the brain, and *spinal* refers to the spine. That's because the CSF surrounds both the brain and the spinal cord. The CSF has three very important roles: it provides nourishment, removes waste, and keeps the brain buoyant and protected from impacts (yes, *buoyant* – your brain is floating in the CSF inside your skull).

What do you do to protect *your* brain? (Hint: have you ridden a bike before?)

In this activity, you'll learn how the fluid inside our skulls protects our brains from being damaged.

Here's what you'll need:

- Water
- 2-3 eggs
- A jar big enough to put an egg in and close

Instructions:

1) Put the egg in the empty jar, close the lid tightly, and shake it hard for about 10 seconds. Write down what happens in the "condition 1" box of the chart on the next page.
2) Fill the jar with water to the brim, put the egg into the jar of water, close the lid tightly, and shake it as hard as the first one for about 10 seconds. Write down what happens in the "condition 2" box.
3) Fill the jar all the way with water, put the egg into the jar of water, close the lid tightly. When the egg is resting against one of the sides, hit the jar with your palm hard. Write down what happens in the "condition 3" box.

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CSF IS EGGCELENT!

	Condition 1	Condition 2	Condition 3
Is there water in the jar?			
Did you shake the jar, or hit it?			
What happened to the egg?			

Discussion:

You should find that the egg doesn't crack in condition 2, but it does crack in both condition 1 and condition 3. Is this surprising?

This happens because the water resists the egg's motion inside the jar, slowing it down before it hits the walls. However, a fast direct hit can overcome the protection of the water, and break the egg anyway.

Just like the water in the jar, the CSF resists the motion of our brains within our skulls, protecting them from hitting the inside of the skull hard enough to cause an injury (called a **concussion**). However, the brain *can* still be injured by strong enough impacts. And even small concussions can cause big changes in how a person feels and behaves, if the person gets a lot of them over time – even if each injury doesn't seem very bad on its own.

That's why it's important to wear a helmet when biking to protect your brain, and to always let an adult know if you or a friend hits their head hard while playing – even if they're not bleeding, or don't feel that bad.

Let's review: What parts of the head protect our brains? Write down what you think.

Trivia:

What color is healthy CSF?

Healthy CSF is clear and colorless. If unhealthy, CSF can turn yellow, orange, or even pink!

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IMMUNOLOGY & VACCINES

Time: 45 minutes

Difficulty: Advanced

Here's something you've been hearing a lot about lately! What do you think a vaccine is for?

Your **immune system** keeps your body safe from microscopic invaders that make you sick. These can include bacteria, viruses, and even small multicellular organisms! The invaders that try to make you sick are called **pathogens**.

Think about the last time you were sick. How did you feel? List 3 things.

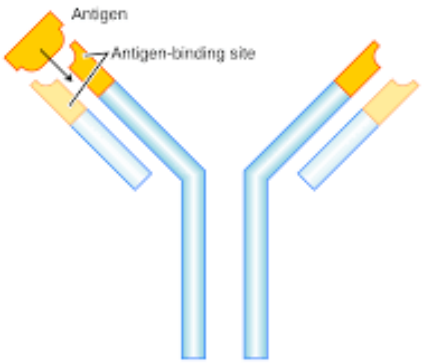
1.

2.

3.

There are two branches of the immune system: the **innate immune system** and the **adaptive immune system.**

When a pathogen tries to enter your body, the innate immune system is the first to try to fight it off. It is a very quick and general response to anything that is not a part of your body. Many of the things that you might feel when you're sick – such as a sore throat – are actually caused by the innate immune system fighting off the pathogen.



Antibody

What does your body do when it tries to fight a pathogen?

IMMUNOLOGY & VACCINES

The **adaptive immune system** takes longer to turn on, and it needs to be activated by the innate immune system. Unlike the innate immune system, the adaptive immune system recognizes and responds to specific pathogens. The pathogen molecules recognized by the adaptive immune system are called **antigens**. There are two main cell types in the adaptive immune system: **T cells** and **B cells**.

T cells kill pathogens directly, by eating them and chewing them up.

B cells kill pathogens by making protein structures called **antibodies**, that recognize and capture a specific antigen.

Antibodies fight pathogens in several ways, including preventing the pathogen from entering more of your cells, and labeling the pathogen for destruction by T cells or by cells from your innate immune system.

Because your adaptive immune system recognizes and responds to specific pathogens, it remembers each pathogen it has seen before and responds more quickly if it sees the same pathogen again. This is called **immunological memory**, and it is very important for keeping us healthy and to help **vaccines** work.

When you receive a vaccine, you are being injected with a small amount of pathogen in a form that CANNOT make you sick. This allows the body to launch an adaptive immune response and produce antibodies. Next time you encounter the pathogen, your adaptive immune system is already prepared and can quickly fight it off! This fast-adaptive immune response not only keeps you healthy, but it also prevents you from spreading the pathogen to other people around you, especially those who cannot safely receive the vaccine. This is why vaccines are so important for keeping our communities healthy!

Can you remember any vaccines you have had to get? (If you can't, ask someone who might know and write a few down!)

Review: Why are antibodies so important? How do they help our bodies fight off pathogens?

IMMUNOLOGY & VACCINES

Let's build an antibody!

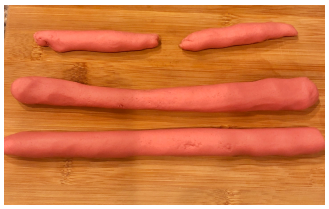
Here's what you'll need:

- PlayDough (from the PlayDough module)
- A butter knife or a cookie cutter (be careful!)

Instructions:

1. Use your PlayDough to form two long, skinny logs (about 6-8 inches long – the exact length does not matter) and two short, skinny logs (about 3-4 inches long).
2. Form a Y-like shape from the long logs, but do not let them touch (see picture below). These are called the heavy chains of your antibody.
3. Now, put the short logs next outside of the top of the Y (see picture below). These are called the light chains of your antibody.
4. Finally, use a butter knife (be careful!) to cut a small triangle out of each side of the top of the Y (see picture). You can also use a cookie cutter to cut out other shapes.
5. The little triangle that you cut out is the antigen, and the spot you cut it from is where it binds the antibody. Do you notice how it fits back perfectly? See what happens when you try to put a round ball of PlayDough here instead – it doesn't fit! This is because antibodies only recognize and interact with their specific antigens.
6. (Optional) Get creative! If you have paint, you can color different parts of your antibody. You can also decorate your antibody with anything you have at home, such as sprinkles, sequins, or toothpicks.

1



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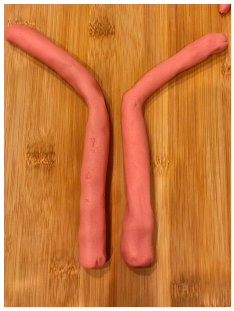

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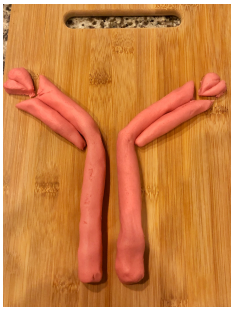

True or False:

Your skin is part of your immune system

True! Your skin is part of your innate immune system. It acts as a barrier to prevent pathogens from entering your body.

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Time: 45 minutes

Difficulty: Medium

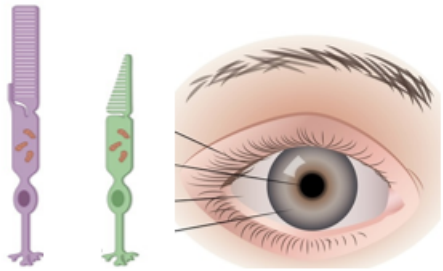
THE SENSES

This activity will show you the different ways you can trick and test your senses.

How many senses do you have? List them out!

We actually have 6 senses: sight, hearing, smell, taste, touch, and balance!

Let's start with our **vision**! List the different ways you can describe the things you see.



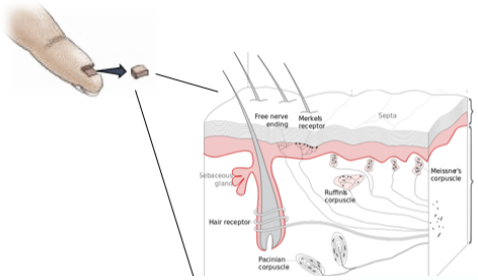
You probably used shape, color, and size, to describe different objects. This is all possible because our eyes use cells called **photoreceptors** to turn light from our environment into electrical signals that our brains can use! Photoreceptors are found in layer of tissue called the retina at the back of your eye. The retina has a small spot where there are no photoreceptors: We call this the **blind spot**! How can we find where it is?

1. Make a thumbs up with both hands with your arms extended all the way in front of you.
2. Close your left eye and focus only on the tip of your left thumb
3. Move your right thumb to the side until it disappears! That's your blind spot! Try with a friend, parent or sibling.

Why are there no photoreceptors in your blind spot? That's because it's the spot where your **optic nerve**, which carries vision information, exits the retina on its way from your eye to your brain!

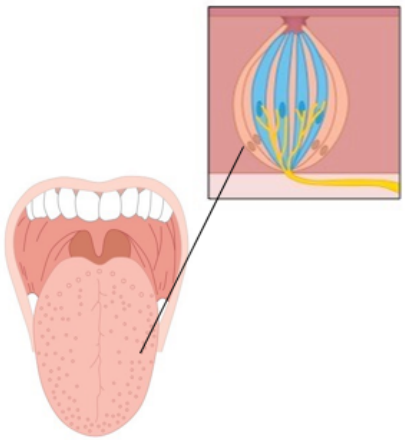
THE SENSES

How do we **TOUCH** things? List the different ways you can describe objects as you touch them (ex: texture, size, etc.)



1. Hold two sharpened pencils in a fist to poke the tip of your finger.
2. Close your eyes, what do you feel?
3. Now use the same pencils and gently poke your arm. Does it feel different?

You should've felt like the two pencils were one when you touched your arm, but not your fingertip. This is because the touch-sensing neurons in the skin of your fingertips are closer together, and better at detecting small distances between touches. Now try this with a friend, parent, or sibling. Write down what they feel.

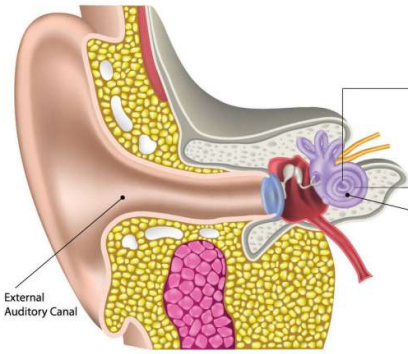


How do we **TASTE**? Write down the different ways you would describe the food you taste.

We have different neurons in our tongues to help us taste sweet, salty, and sour foods! Pick out foods from your kitchen and write down which ones you think would activate sweet neurons versus salty neurons.

THE SENSES

How do we **HEAR?** How do things sound if you are close to them compared to if you are far away? Try to play a song and move far away from the source. Write down when you stop hearing the song.



We have cells in our ears called **hair cells.** Their vibrations turn sound waves into messages the brain can understand. Write down what you think is happening to the cells in your ear when you hear sounds that are loud. How about quiet sounds?

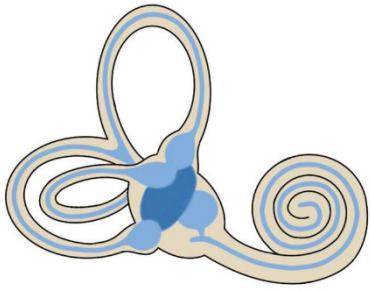
How do we **SMELL**? There are over 400 different types of neurons inside our nose to help us smell different things. Why do you think our sense of smell is so important?

Our sense of smell not only helps us taste, but also makes sure we stay away from foods or things that may have gone bad.

Find a candle or food that you like. Close your eyes and sniff! Write down what kinds of scents you smell.

THE SENSES

How do we **BALANCE**? Our sense of balance is one of the most important, but we always forget about it! Without it, we would have a hard time walking, or even just standing in place without falling over. We owe our sense of balance to the inner ear – the structure you see at the right. The three loops at the left side of it and the round parts at the center are called the **vestibule**. The fluid inside them is moved by the motion of your head, and neurons in the **vestibular system** sense that motion and tell your brain how your head and body are moving through the world.



Let's test it – stand up tall and lift one foot off the ground. How long can you stay balanced? Time yourself! Write down how you can improve your balance.

Discussion:

What is one way each of our senses can help us in our everyday lives?

Write down what each of your senses are doing while you're eating an apple.

Write down what would happen without your sense of smell. What about the other senses?

Trivia:

Humans can see three colors: red, green and blue. How many colors can a mantis shrimp see?

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THE SENSES

Instructions: Match each sense with its body part.

seeing

hearing

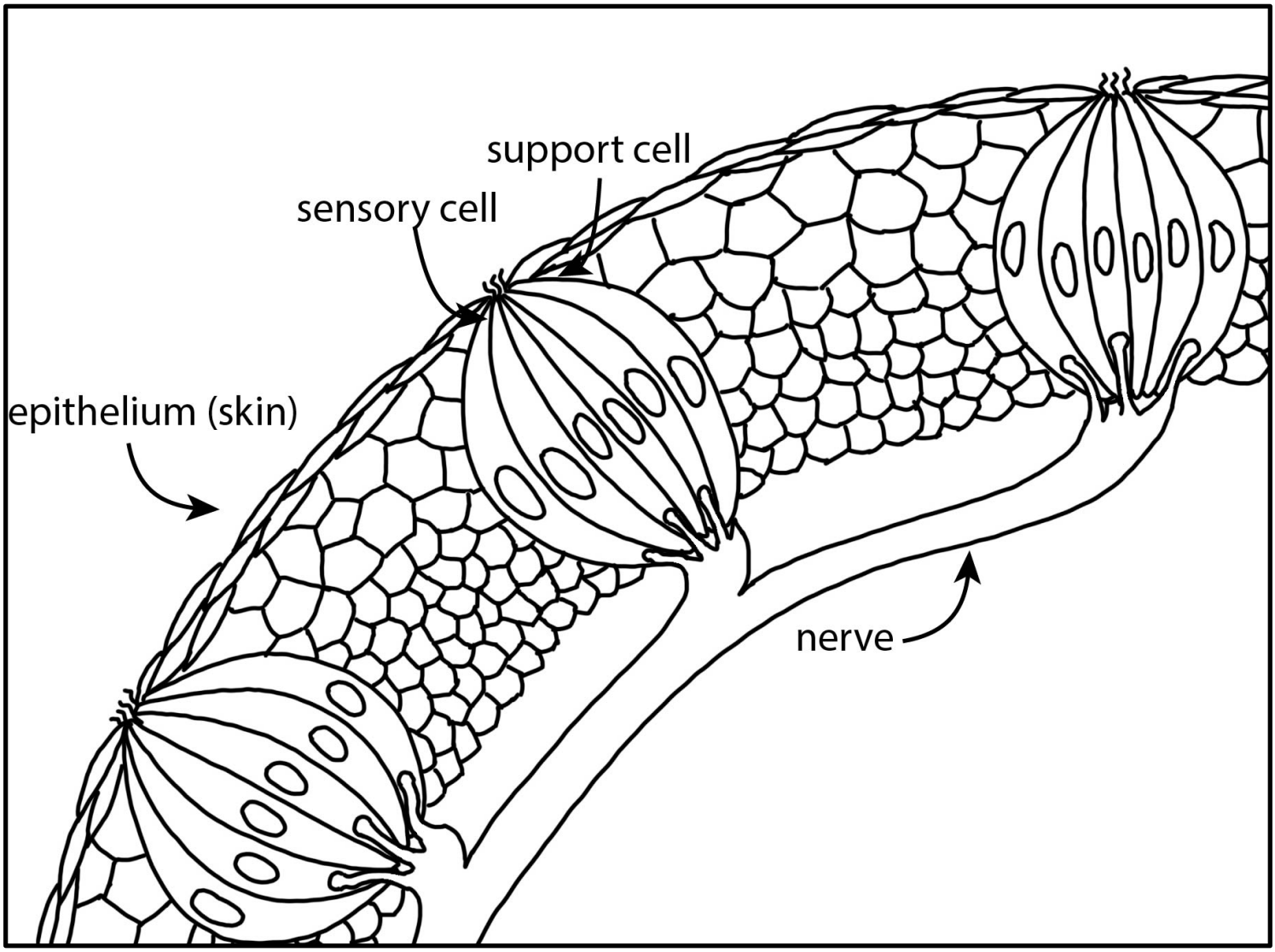
smelling

tasting

touching

THE SENSES

Color in the following cells and guess which ones are important for which sense!

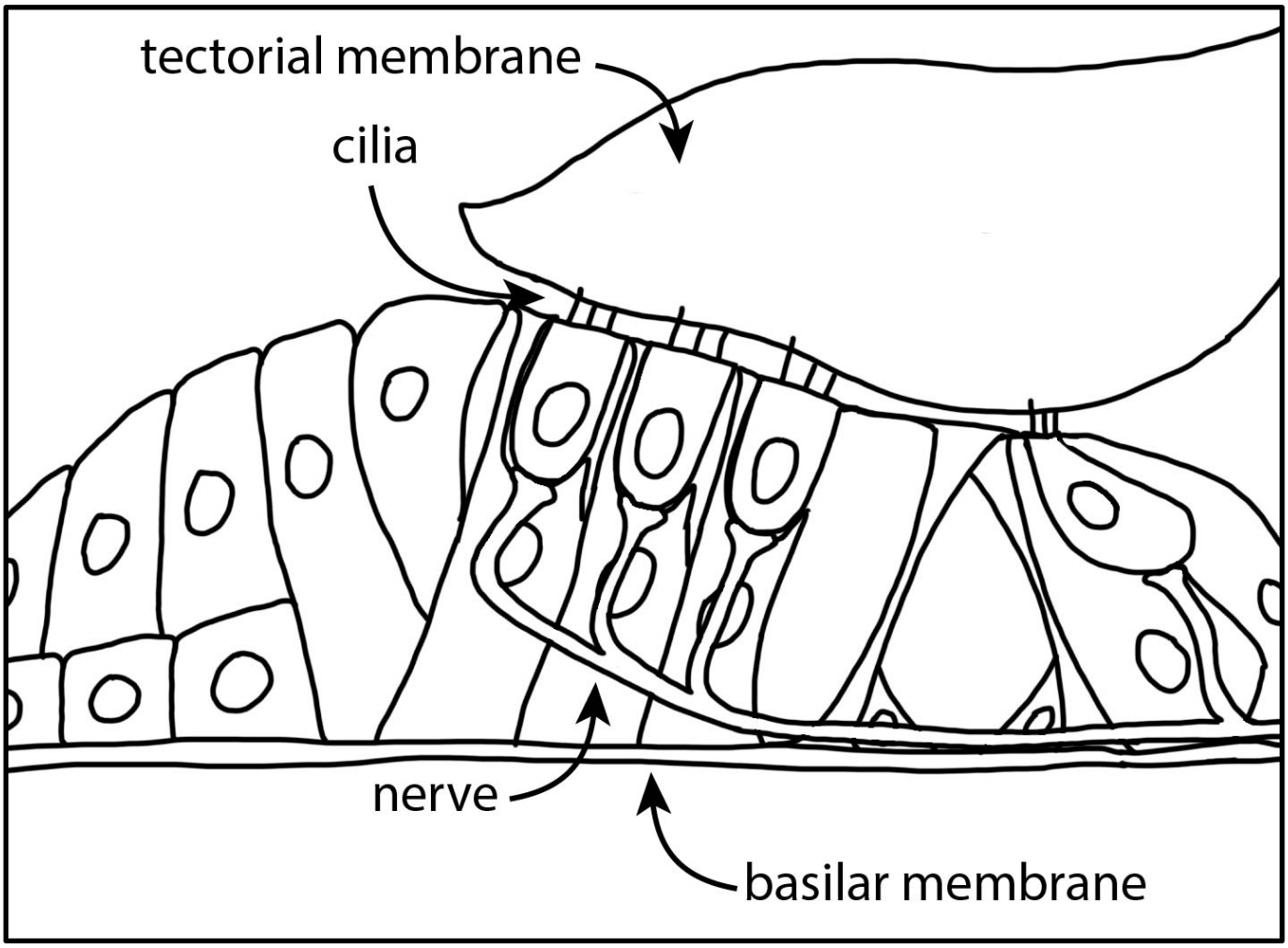


Hint: These cells are found in tiny onion-shaped buds. The ones most crucial for this sense send out tiny hairs - called **cilia** - from their tips, and tell neurons about the chemicals their cilia capture.

Answer: These are taste buds, found in your tongue!

THE SENSES

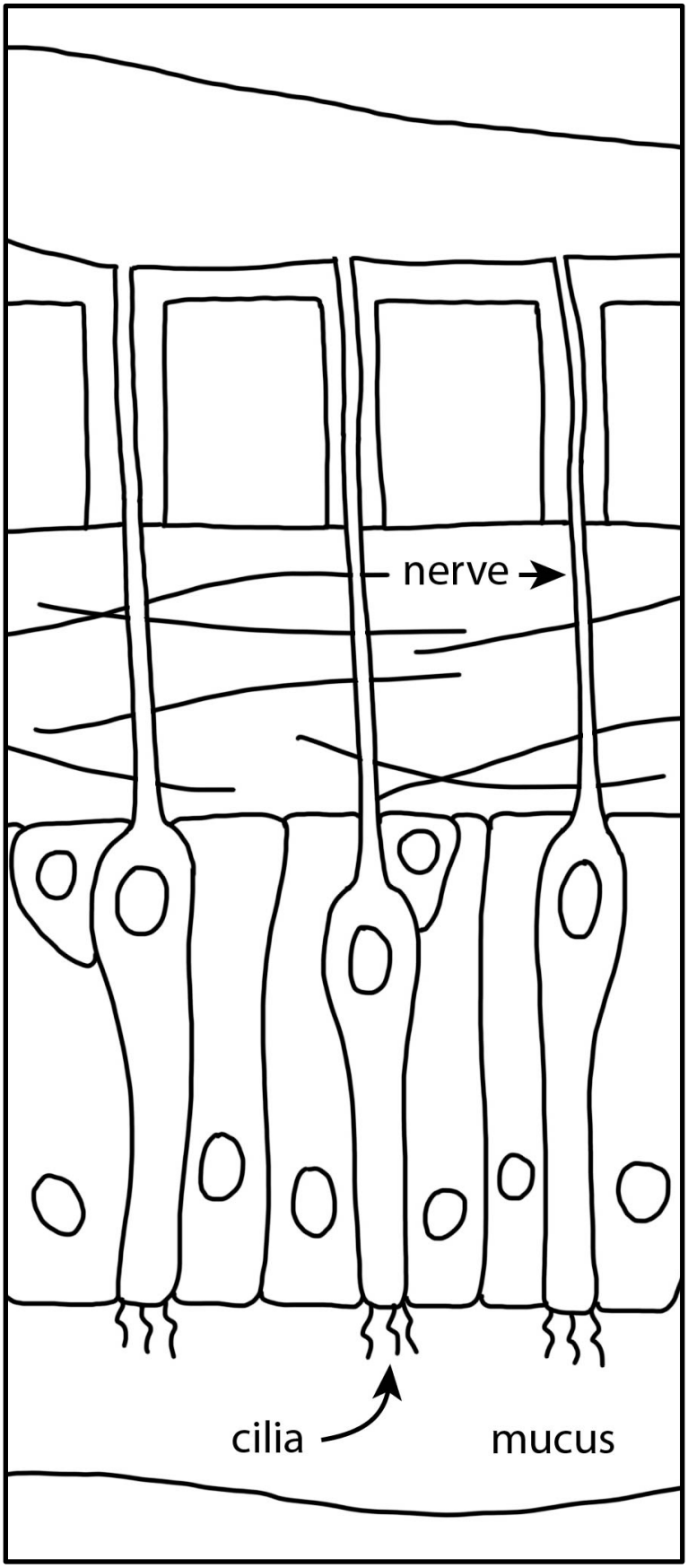
Hint: The “hairs” (more cilia!) on certain cells in this structure – called the **Organ of Corti** – bend against the **tectorial membrane** when the **basilar membrane** vibrates with passing sound waves.



Answer: The Organ of Corti is found in your inner ear, and allows you to hear!

THE SENSES

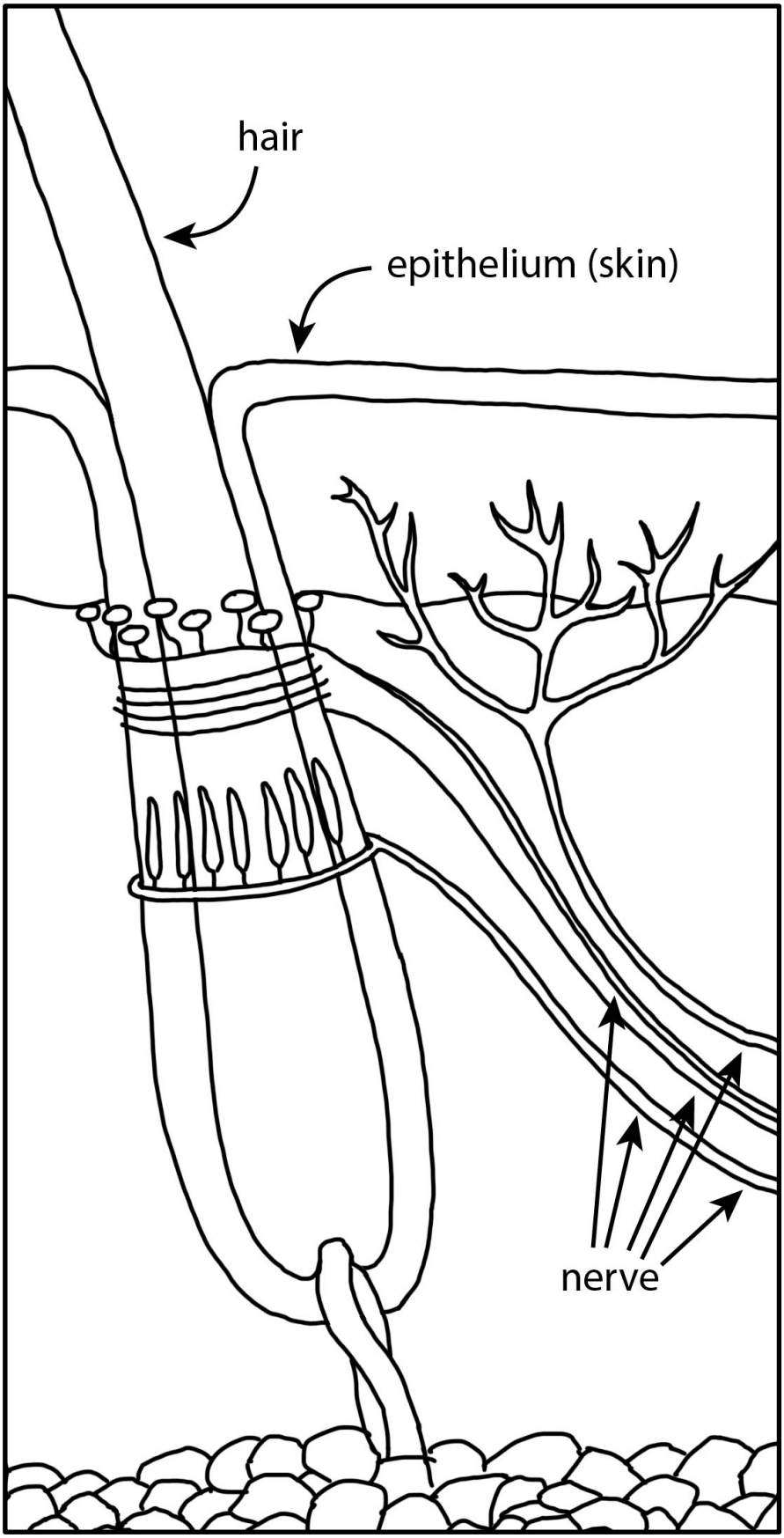
Hint: the sensory cells you see here send their cilia into a layer of **mucus** – or snot.



Answer: These are olfactory sensory neurons in the olfactory epithelium, which is inside your sinuses!

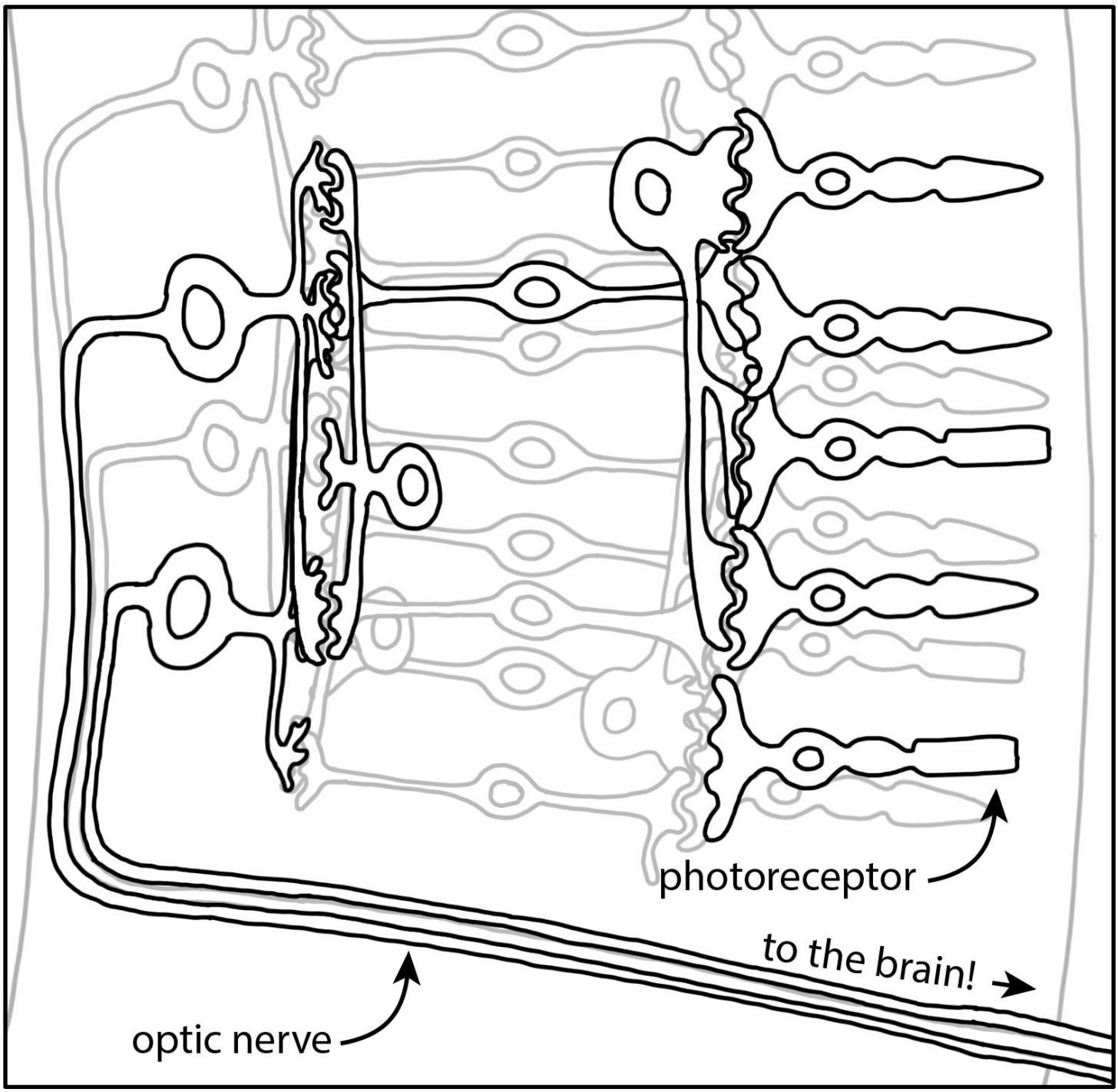
THE SENSES

Hint: The cells responsible for this sense come in many different types, found in many different places in your skin.



Answer: These neurons are responsible for your sense of touch!

THE SENSES



Hint: The cells in one of these layers are light detectors, called **photoreceptors** – and they're actually the farthest from the light!

Answer: These are the cells of the retina, in the back of your eye!

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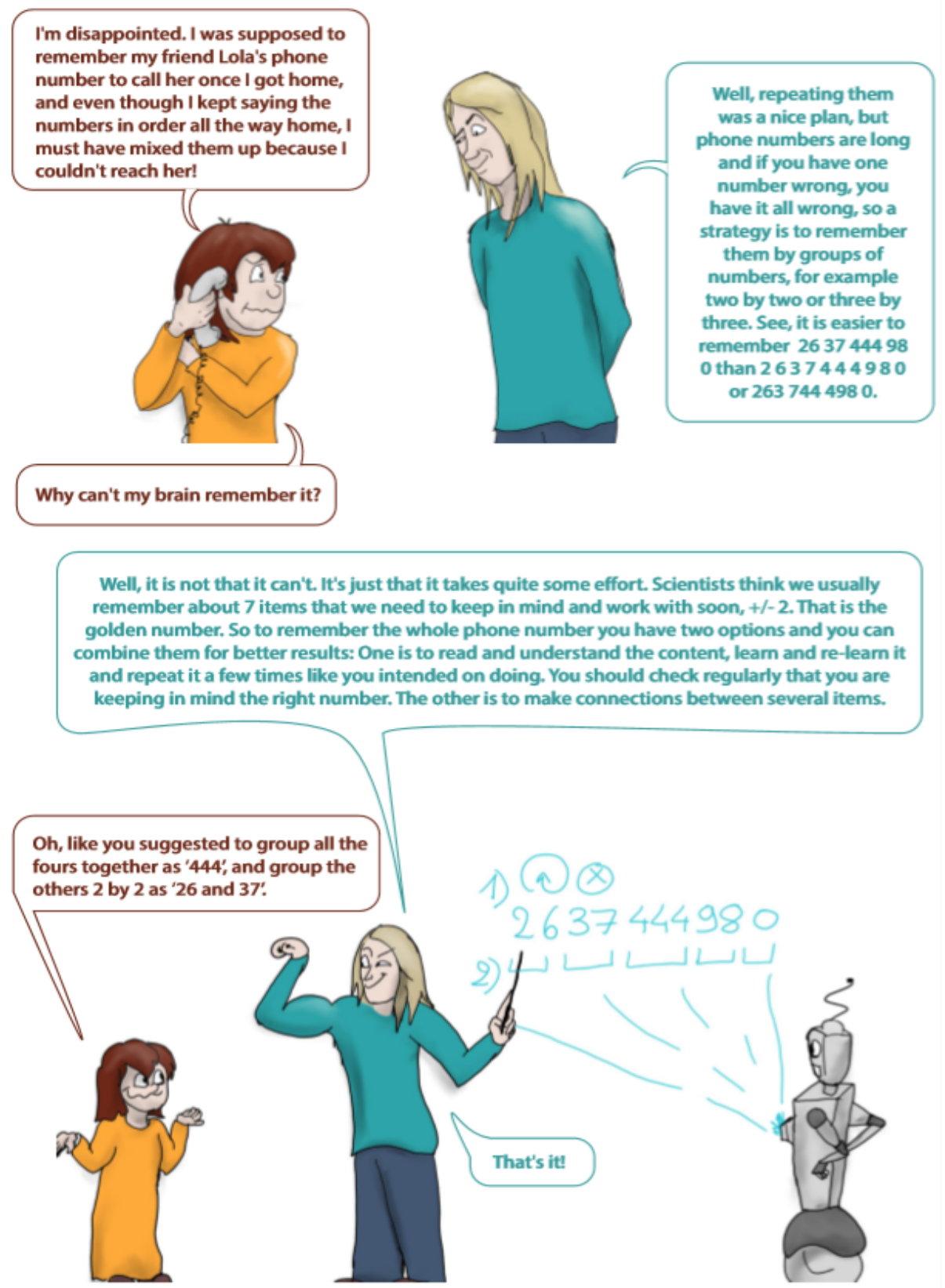
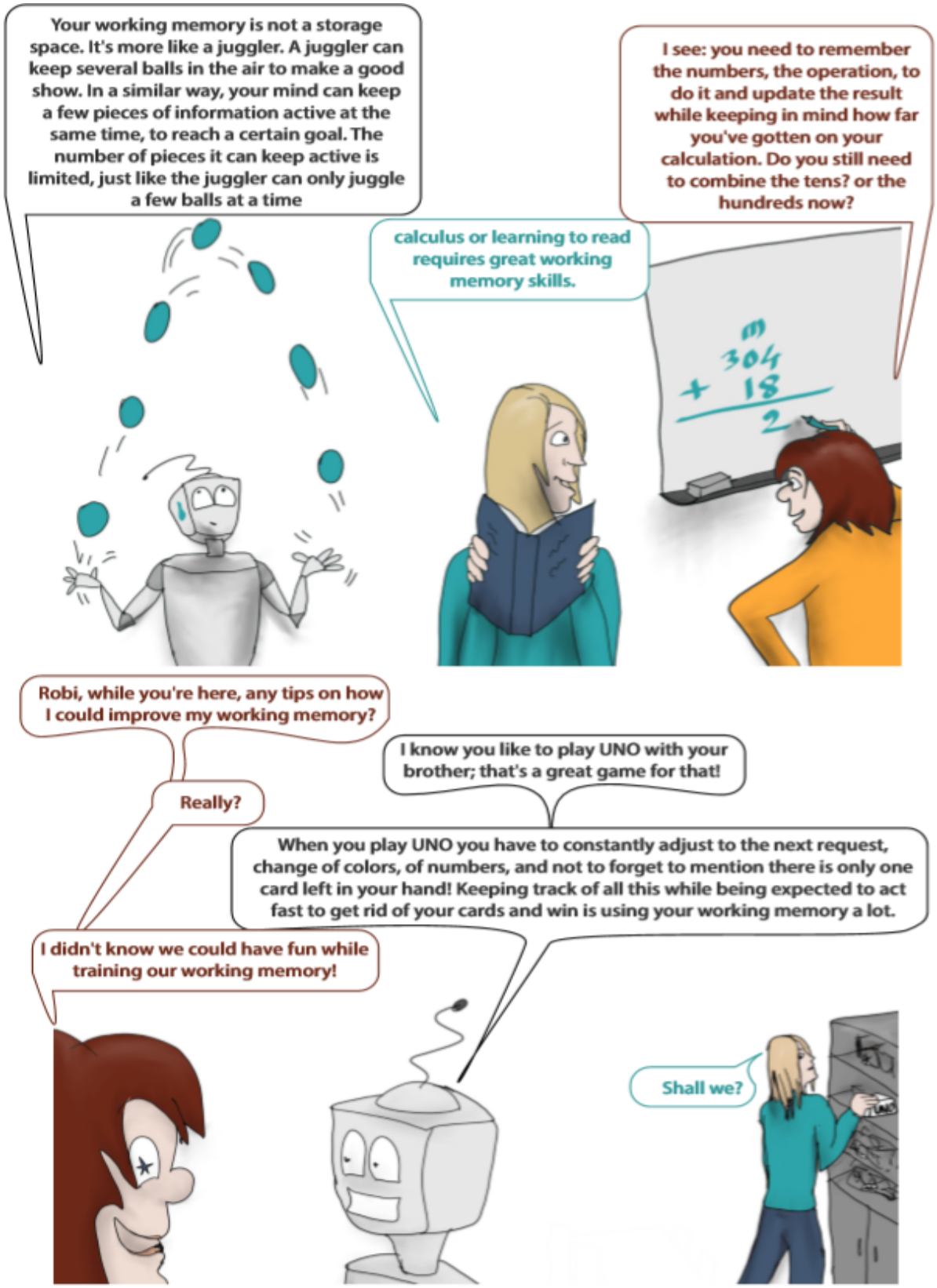
Working memory





Working memory- p.2

Redaction : Clara Sava-Segal, Adeline Lucchesi
Illustration : Roselyne Chauvin