Learning Guide to Accompany

The Brain

The Children's Hour radio show podcast
https://www.childrenshour.org/the-brain/

The human brain is a spongy, three-pound organ in your head. It makes up only 2% of your body mass. Yet this single organ controls every aspect of your body, including heart rate, appetite, emotions, learning, and memory. Also, the brain controls the immune system's response to disease and determines, in part, how well people respond to medical treatments. It's the vehicle for our thoughts, memories, and imaginations. Scientists have still not achieved a full understanding of how the brain does all that it does. We use our brains every time we move and think and interact with others. Every time we learn something, we change our brains.

This guide will help you learn some of the basics about the brain, which we talked about on our radio show/podcast. Also, it will link you to many wonderful resources where you can learn more.

About Us

The Children's Hour Inc is a New Mexico-based non-profit organization that produces an award-winning children's radio program that is educational, entertaining, and engaging, and includes kids who participate in its creation. The program is internationally syndicated broadcasting on more than 115 public radio stations worldwide. Program themes focus on civics, STEM, culture, and music education, featuring New Mexico children as co-hosts and lead interviewers. Katie Stone has been the executive producer of *The Children's Hour* for 20 years.

For more information, contact: Katie Stone | (505) 850-3751 | katie@childrenshour.org

Tell us about you!

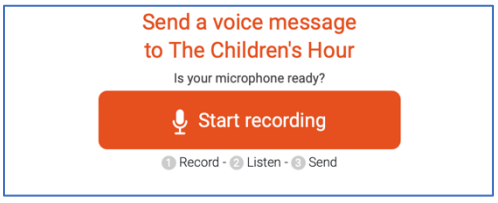
We at the Children's Hour would like to know:

1. How old are you?
2. Was this your first time listening to a radio show or podcast for kids?
3. Was this radio show less fun or more fun compared to other things you do for fun, like playing video games or watching TV?

   ☐ Less fun ☐ More fun
4. Would you listen to a radio show again if you could?
5. Of everything you heard in the radio show, what will you remember most?

If you would like to draw a picture about anything you learned on the radio show, you can do so below, or on a blank page. Scan and email it to us, and we may display it on our online pages.

If you would like to tell the creators of this radio show something in your own voice, you can send a voice message to *The Children's Hour* here: https://www.childrenshour.org. Look for the orange button and click to record.



Video: Meet the Parts of Your Brain!
Watch and listen to this 4-minute animated musical number as the cerebellum, cerebral cortex, hippocampus, amygdala, and brain stem introduce themselves. Learn their locations and functions as they dance across the stage.
https://youtu.be/oPFKwu_quxI

Video: Your Complex Brain
https://www.brainfacts.org/core-concepts/your-complex-brain

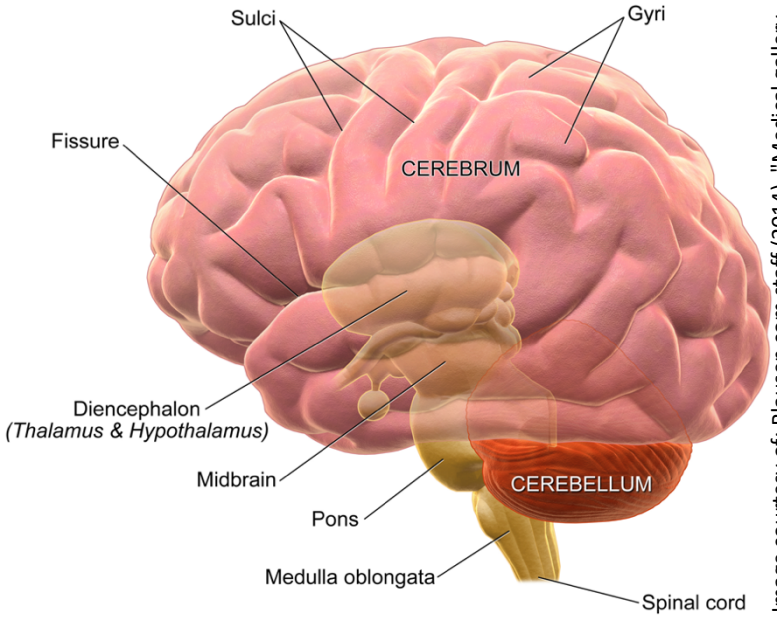


Image courtesy of: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". *WikiJournal of Medicine* 1 (2). DOI:10.15347/wim/2014.010. ISSN2002-4436

Brain Anatomy

Cerebrum

Big and Smart

The cerebrum is the thinking part of the brain, and it controls your **voluntary muscles**. So, when you dance, kick a soccer ball, or press a button, you are using your cerebrum. You also us it when solving math problems, playing a game, and drawing a picture. Your memory lives in the cerebrum — both short-term memory (what you ate for dinner last night) and long-term memory (the name of that roller-coaster you rode on two years 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, one on either side of the head. Scientists think that the right side is where you think about abstract things like music, colors, and shapes. The left side is said to be more analytical, helping you with math, logic, and speech. We know for sure that the **right hemisphere** of the cerebrum controls the left side of the body, and the **left hemisphere** controls the right side of the body.

Cerebral Cortex

Convoluted Lobes

The outside of the cerebrum is called the **cerebral cortex**. Cortex is a Latin word that means "bark," like the bark of a tree. The brain's cortex is convoluted, with ridges and grooves. A ridge in the cortex is called a **gyrus** (plural **gyri**), and a groove is called a **sulcus** (plural **sulci**). The major sulci and gyri mark the divisions of the cerebrum into the **lobes** of the brain.

Video: Learn the Gyri of the Brain in 4 Minutes
https://youtu.be/o4Jblotpras

There are four main lobes:

1) **Frontal lobe** is responsible for initiating and coordinating motor movements; higher cognitive skills, such as problem solving, thinking, planning, and organizing; and for many aspects of personality and emotional makeup. **Broca's area** for the production of language is found in the left frontal gyrus.
2) **Parietal lobe** is vital for sensory perception and integration, including the management of taste, hearing, sight, touch, and smell. It interprets input from other areas of the body.
3) **Occipital lobe** helps process visual information, including recognition of shapes and colors.
4) **Temporal lobe** helps process auditory information and integrate information from the other senses. **Wernicke's area** for the comprehension of language is located in the left temporal gyrus.

The temporal lobe also plays a role in short-term memory through its hippocampal formation, and in learned emotional responses through its amygdala (see below).

Hippocampus

Learning and Memory

Embedded deep within the temporal lobe is an S-shaped structure called the hippocampus. Humans have two hippocampi, one on each side of the brain. You can recall past experiences and imagine the future by using the hippocampus. Also, it plays a major role in learning and spatial navigation. In Alzheimer's disease (and other forms of dementia), the hippocampus is one of the first regions of the brain to suffer damage.

Amygdala

Emotions

Also in the temporal lobe, your brain has a little bunch of cells on each side called the amygdala. The word amygdala is Latin for “almond,” and that's what this area looks like. Scientists believe that the amygdala is responsible for emotion.

Corpus Callosum

The Bridge

The brain tissue that lets the right and left hemispheres talk to one another is the corpus callosum, made up of millions of nerves that carry messages from one side of the brain to the other.

Cerebellum

Balance

Cerebellum means “little brain” in Latin. At the back of the brain below the cerebrum is a smaller part of the brain that controls balance, movement, and coordination (how your muscles work together). Because of your cerebellum, you can stand upright, keep your balance, and move around. Think about a surfer riding the waves on his board. What does she need most to stay balanced? Her cerebellum!

Brain Stem

Breathe, Squeeze, Beat and Blink

The brain stem sits beneath the cerebrum, and it controls your **involuntary muscles** — the ones that work automatically, without you even thinking about it. Therefore, the brain stem is in charge of all the automatic functions your body needs to stay alive, like breathing air, digesting food, and pumping blood. It connects the rest of the brain to the spinal cord, which runs down your neck and back. The brain stem also sorts through the millions of messages that the brain and the rest of the body send back and forth. It’s a big job to work as the brain’s secretary.

If you could hold a brain in your hands, what would it feel like? I would be the size of a _____. It would have the weight of a _____. It would have the texture of _____.

Check out these amazing resources/links:

3D Brain

An interactive tour of the human brain

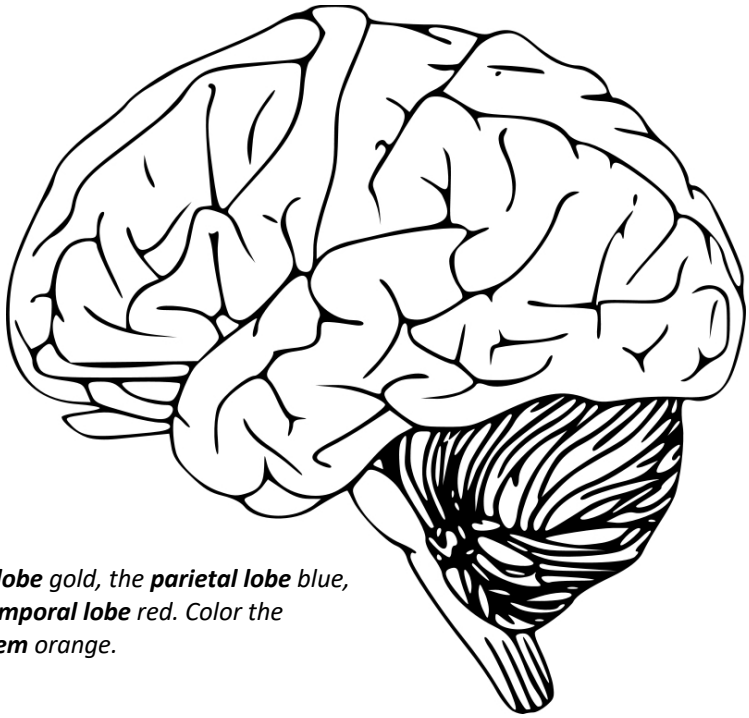
https://www.brainfacts.org/3d-brain#intro=true

Video: Brain Dissections

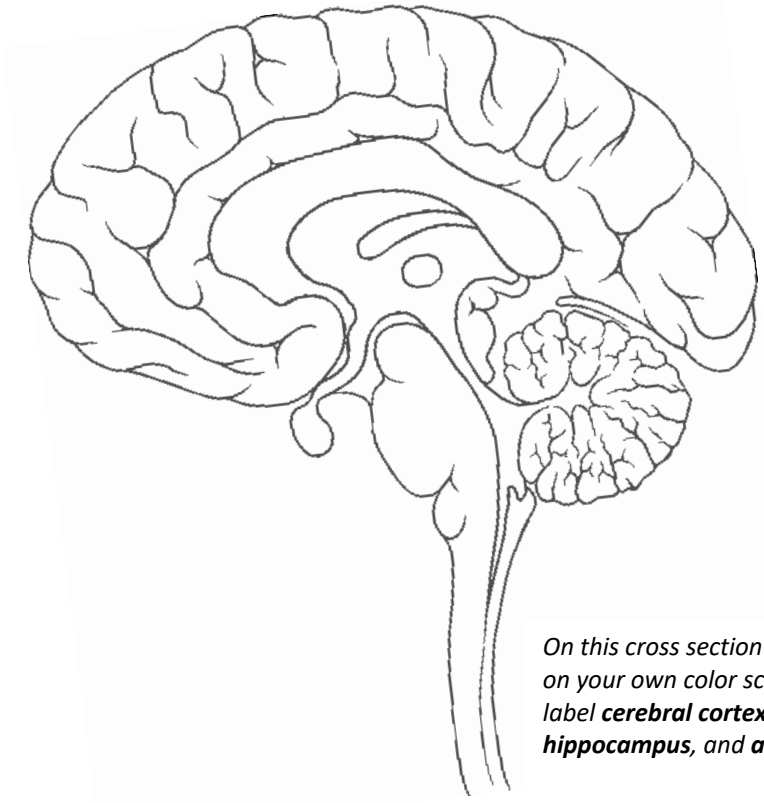
Actual human brains are dissected to show the regions and lobes of the brain.

https://youtu.be/_aCCsRCw78g

Color the brain.



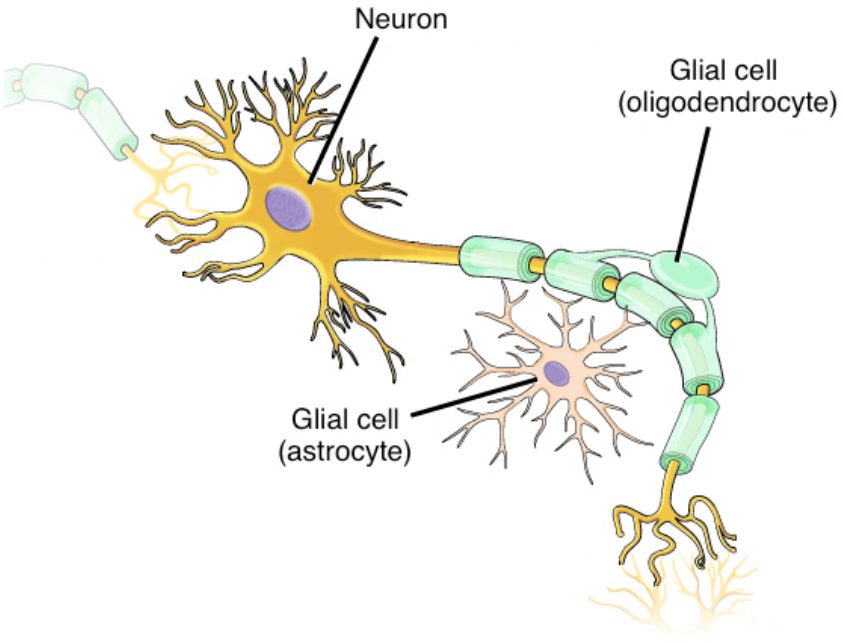
*On the cerebrum, color the **frontal lobe** gold, the **parietal lobe** blue, the **occipital lobe** green, and the **temporal lobe** red. Color the **cerebellum** brown and the **brain stem** orange.*



*On this cross section of the brain, you can decide on your own color scheme. Be sure to color and label **cerebral cortex**, **cerebellum**, **brain stem**, **hippocampus**, and **amygdala**.*

Neurons and Glia

Video: How Neurons Communicate
https://www.brainfacts.org/core-concepts/how-neurons-communicate



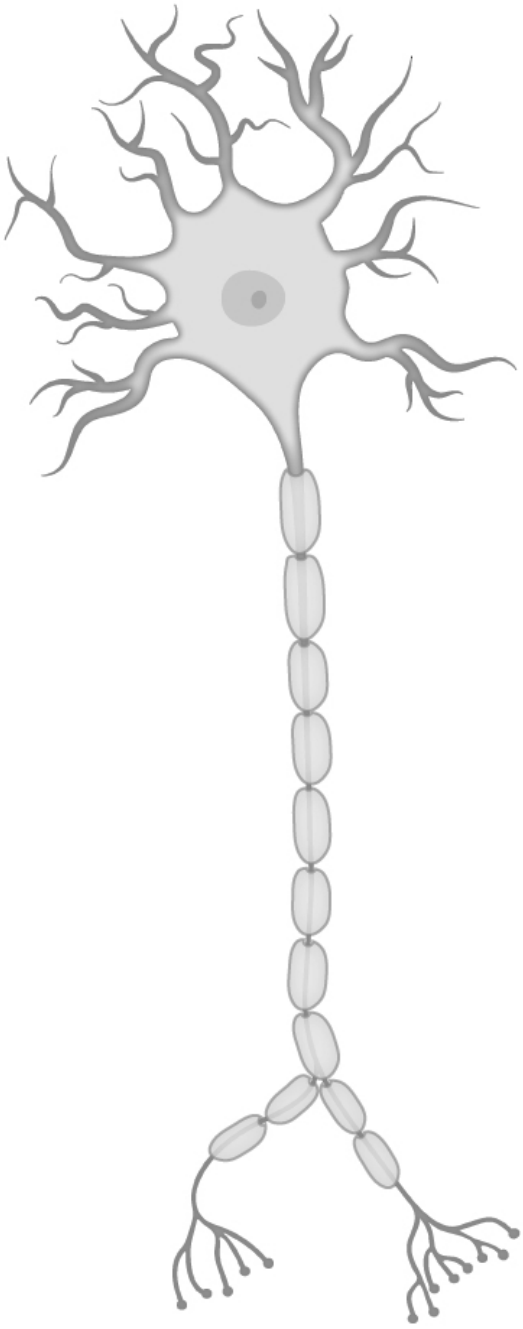
A **neuron** is the basic working unit of the brain. It is a specialized cell designed to transmit signals to other nerve cells, muscle cells, or gland cells. The brain can do what it does because of the interconnected network of neurons. The human brain contains about 86 billion neurons; there are potentially 0.86 quadrillion neural connections. Neurons carry signals from our body parts (the senses) into the brain. Neurons process signals in the brain; there are decision-making networks and motor control networks of neurons in the brain. Neurons also carry signals from the brain out to the muscles.
An electrical signal travels within a neuron, from one end to the other end. A chemical signal travels between neurons. Because the brain signals are electrical, they generate a magnetic field, which can be detected and measured. A single neuron may be connected to as many as 200,000 others, at junctions called synapses. They form an extensive network throughout the body and can transmit signals at speeds of 100 meters per second.

Neurons make up 10% of brain cells. The other 90% of brain cells are **glia** (meaning "glue" in Greek). **Glial cells** are found in the spaces between neurons. Some glial cells (**astrocytes**) maintain the composition of this watery space, helping neurons to function properly. Others (**oligodendrocytes**) wrap an insulating myelin sheath around the neurons. Researchers have known for a while that glial cells transport nutrients to neurons, clean up brain debris, digest parts of dead neurons, and help hold neurons in place. Current research is uncovering important new roles for glia in brain function. Glial cells can become damaged in neurodegenerative conditions such as **stroke**, **spinal cord injury**, **multiple sclerosis**, and **cerebral palsy**. A better understanding of how neurons interact with glial cells may help in finding new treatments for these conditions.

The "nerve" cells that interconnect and carry signals in the brain are called _____.

The cells that are the helper cells of the brain are called _____.

Parts of the Neuron



Cell body
Contains many components typically found in other types of cells. This includes DNA, located in the nucleus, which holds instructions for producing the proteins that determine the shape and function of the cell. Also called the **soma**.

Cell membrane
A film of fatty molecules that encloses the neuron.

Dendrites
Protrusions from the cell body that form branches connecting to other cells. These branches receive signals from the axons of neighboring neurons.

Axon
The long projection that carries signals away from the cell body. Axons can range in length from a fraction of an inch (or centimeter) to three feet (about one meter) or more.

Myelin sheath
Many neurons are insulated by myelin: multiple layers of cell membrane that wrap around the axon. The sheath enables the signal to travel more rapidly along the axon.

Synapse
A connection between two neurons. When a nerve signal travelling along an axon reaches a synapse, it triggers the release of a chemical **neurotransmitter** that diffuses across the gap and binds to proteins on the surface of the receiving neuron. This binding causes an influx of ions, changing the membrane voltage and initiating an electrical signal in the receiving neuron.

Use the following resources/links to better understand neurons:

Visualize Neurons
Use an interactive online tool to assemble a neuron and then build a neural network.
https://www.brainfacts.org/brain-anatomy-and-function/cells-and-circuits/2019/build-a-neuron-011819

Bendy Neuron
Build a multicolored model out of pipe cleaners.
https://nwnoggin.org/wp-content/uploads/2017/02/How-to-make-a-pipe-cleaner-neuron.pdf

3D Printer Neuron
If you have access to a 3D printer, you can print and hold a model neuron!
https://3dprint.nih.gov/discover/3dpx-000529

How to Grow Your Brain

As we learn things, we build and strengthen the connections between neurons. **Pathways** develop. Think back to the first time you rode a bike. Your brain had to think about pedaling, staying balanced, steering with the handlebars, watching the road, and maybe even hitting the brakes — all at once. Hard work, right? But eventually, as you got more practice, the neurons sent messages back and forth until a pathway was created in your brain. Now you can ride your bike without thinking about it because you formed a "bike riding" pathway among your neurons.

Video: How Experience Shapes Your Brain
https://www.brainfacts.org/core-concepts/how-experience-shapes-your-brain

Video: How are Synapses Like Trees?
https://www.brainfacts.org/brain-anatomy-and-function/cells-and-circuits/2020/how-are-synapses-like-trees-an-introduction-to-synaptic-pruning-101920

Did you know that a person who is paralyzed by a **stroke** can recover? A person can regain the ability to walk and talk because the brain forms new connections between intact neurons. This process requires stimulation through physical activity.

The ability of the brain to modify itself and adapt to challenges of the environment is referred to as **plasticity** (or neuroplasticity). Plasticity allows for specific body or brain functionality centered in one part of the brain to move to a different region of the brain, if and when necessary. Three ways the brain can be plastic:

- New neurons can be formed; they do not stop being created (regardless of age).
- Neurons can form new inter-connections.
- Synapse structure can change.

Healthy Brain Habits

Your brain is protected inside your skull and cushioned by some fluid, but it could still be damaged if your head is hit or bumps into something hard. So…

Play safe:

- Wear a helmet if you are riding a bike, scooter, or skateboard.
- Wear a helmet if you play sports where you could be hit or fall (such as baseball or horse-riding).
- Never dive into water unless you know how deep it is.
- Listen to the voice inside you that says: "This is not a good idea!" That's your brain talking.

Nourish your brain:

- Eat healthy food like fish and fresh vegetables and fruits.
- Get plenty of sleep.
- Exercise your brain by learning new things and trying to remember them.
- Stay away from alcohol, drugs, and tobacco, which are harmful to brain development.
- Try yoga and/or meditation which studies show may have a positive effect on brain activity.
- Give your brain the chance to make new pathways by doing challenging activities, such as puzzles, reading, music, creating, conversing, improvising, gaming, or anything else that gives your brain a workout. Make connections!

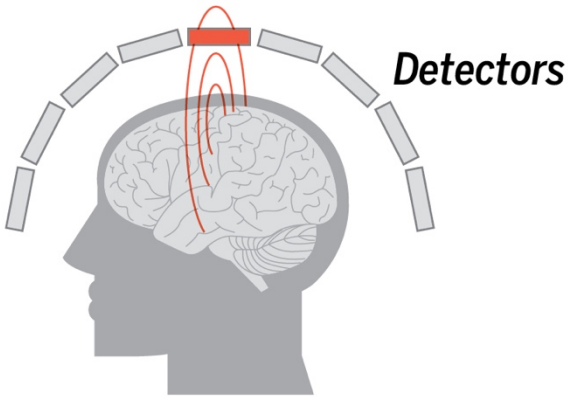
What things do you do to grow and strengthen your brain?

What is a Neuroscientist?

Neuroscientists study the brain and the nervous system. They decipher just how the brain accomplishes all its diverse functions. These scientists look for a deeper understanding of how the brain's billions of cells are born, grow, and connect. They study how these cells organize themselves into effective, functional pathways. Neuroscientists seek answers to some challenging **questions**: How do brain pathways enable us to read and speak? How do we think, remember, despair, or motivate? How can we prevent or heal disorders of the brain?

On the radio show, Katie and the kids crew interviewed Nick Aase and Ingrid Lane, two researchers at the **Mind Research Network (MRN)** at the University of New Mexico in Albuquerque. The MRN is an organization of scientists from around the world who use imaging technology in neuroscience investigations. Ultimately, these neuroscientists seek to find clinical solutions to prevent, diagnose, and treat mental illness and other brain disorders. MRN researchers use two neuroimaging techniques in combination to study the brain:

- **Magnetic resonance imaging (MRI)** is a medical imaging technique to form pictures of the anatomy and the physiological processes of the body. MRI scanners use magnetic fields and radio waves to generate images of the organs (like the brain) inside the body.
- **Magnetoencephalography (MEG)** is a functional neuroimaging technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain, using very sensitive magnetometers. MEG can characterize rapidly changing patterns of neural activity, down to millisecond.



The fMRI shows detailed information about the areas of brain activity while a person is engaged in a particular task, and the MEG shows exactly when certain areas become active. Together, this information can give a more precise understanding of how the brain works.

Would you like to participate in research at The Mind Research Network? With your parent's permission, you can volunteer to have your brain measured as part of a study. Go online to find out more: https://www.mrn.org

Have you ever had your brain measured?

What things have you measured? Why?

If you could be any kind of scientist, what kind would you be? What would you measure?

Meet a Neuroscientist

In an online article, you can learn about how neuroscientist Kimberley McAllister studies the making and breaking of connections in the brain. Here's the link:
https://www.brainfacts.org/brain-anatomy-and-function/cells-and-circuits/2020/making-and-breaking-connections-in-the-brain-111820

More to Explore

Video: I Love You With All of My Brain
This song tells how regions of the brain work together to create the experience of love.
https://www.brainfacts.org/thinking-sensing-and-behaving/emotions-stress-and-anxiety/2020/i-love-you-with-all-of-my-brain-110920

Video: Journey of Sound to the Brain
Learn how sound makes its way to your brain.
https://youtu.be/eQEaiZ2j9oc

Video: Mental ABCs: The Neuroscience of Language
How do we create and produce something as complicated as language? And what happens when our language abilities become impaired?
https://www.brainfacts.org/thinking-sensing-and-behaving/language/2020/mental-abcs-the-neuroscience-of-language-100620

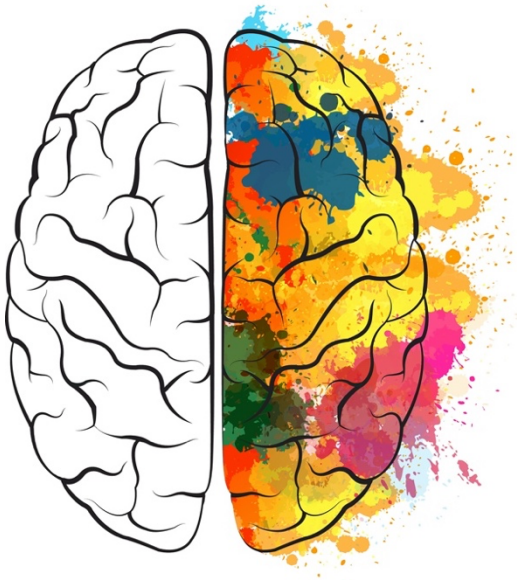
Video: Right Vs. Left Brain Theory
Split-brain theory (the idea that the left-brain is logical, ordered, calculative, and a lover of math and science, while the right brain is creative, free, passionate, and a lover of art and imagination) is not the entire truth.
https://www.brainfacts.org/brain-anatomy-and-function/anatomy/2014/right-vs-left-brain-theory

Nervous System from A-to-Z Coloring Book
http://faculty.washington.edu/chudler/pdf/FromAZ.pdf

What Part of the Brain Deals With Anxiety? What Can Brains Affected by Anxiety Tell us?
https://www.brainfacts.org/diseases-and-disorders/mental-health/2018/what-part-of-the-brain-deals-with-anxiety-what-can-brains-affected-by-anxiety-tell-us-062918

How Smartphones Hijack the Brain
https://www.brainfacts.org/neuroscience-in-society/tech-and-the-brain/2021/how-smartphones-hijack-the-brain-010821

Why the Brain Loves Stories
https://www.brainfacts.org/neuroscience-in-society/the-arts-and-the-brain/2021/why-the-brain-loves-stories-030421



Connect to Curriculum

https://www.nextgenscience.org

Information/Activity	Core Idea	National Standard
p.8 Video: How Experience Shapes Your Brain p.10 Video: Journey of Sound to the Brain	Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.	LS1.D (4-LS1-2)
p.3, 4, 5 Videos Brain Anatomy (reading) 3D Brain (online interactive tour) Color the Brain	In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.	LS1.A (MS-LS1-3)
p.7 Visualize Neurons Bendy Neuron	Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.	LS1.A MS-LS1-2
p.10 Video: Journey of Sound to the Brain	Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.	LS1.D (MS-LS1-8)
p.9 Magnetic resonance imaging (MRI) is a medical imaging technique to form pictures of the anatomy and the physiological processes of the body. MRI scanners use magnetic fields and radio waves to generate images of the organs (like the brain) inside the body. Magnetoencephalography (MEG) is a functional neuroimaging technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain, using very sensitive magnetometers. MEG can characterize rapidly changing patterns of neural activity, down to millisecond.	Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.	PS4.C (HS-PS4-5)
p.6, 7 Neurons and Glia (reading)	Systems of specialized cells within organisms help them perform the essential functions of life.	LS1.A (HS-LS1-1)