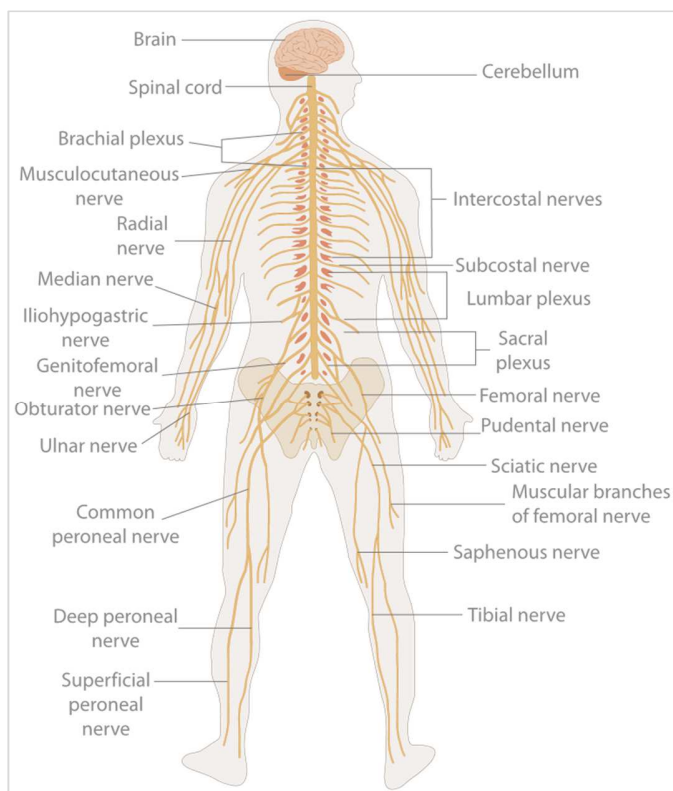


NEUROSCIENCE 101 BACKGROUND READING STUDENT HANDOUT

Name: _____ Date: _____ Period: _____

The Body's Control Center

What are you doing right now? Your eyeballs are moving as you read and make sense of these words. You are breathing and your heart is pumping blood and oxygen throughout your blood vessels. You are sitting upright in your chair, contracting some muscles and relaxing others so that you don't tumble to the floor. Can you hear anything? What kind of mood are you in?



Your nervous system is working twenty-four hours a day, seven days a week to allow you to do these marvelous tasks, from digesting your breakfast to texting a friend.

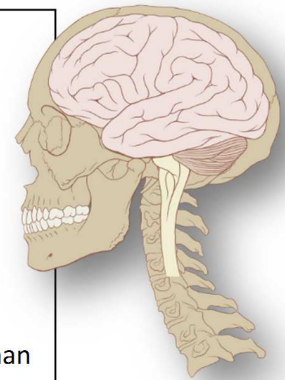
The nervous system is made up of the brain, spinal cord, and the nerves of the body (there's a lot of them!). It is the body's control center: it controls and responds to body functions and directs behavior. The nervous system is responsible for everything from automatic responses (such as heart rate and breathing) to sensing and perceiving (seeing, hearing, smelling, tasting, touching), to emoting, moving, thinking, and talking. The nervous system influences and is influenced by all other body systems, such as the cardiovascular, endocrine, and immune systems. Because specific parts of the brain are specialized to perform certain functions, damage to a

particular area of the brain can disrupt specific activities.

The human nervous system is divided in two parts. The **central nervous system (CNS)** is composed of the brain and the spinal cord. The **peripheral nervous system (PNS)** includes the nerves extending out of and into the brain and spinal cord. The major nerves of the PNS are shown on the diagram above.

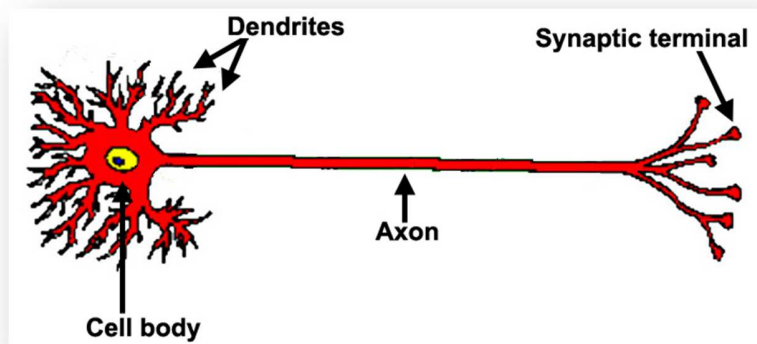
Brainiac-Facts

- The brain is the body's most complex organ.
- The adult human brain weighs approximately 1.4 kg (3 pounds) and contains about 100 billion **neurons** (nerve cells) and trillions of "support cells" called **glia**.
- The spinal cord is about 43 to 45 cm long (17-18 inches) in adult humans and weighs about 35-40 grams (1.2-1.4 ounces).
- The backbone that houses and protects the spinal cord is much longer than the spinal cord—about 70 cm (27 inches) long.



Pass the Message—Catch that Cell Phone!

Neurons (nerve cells) are cells that are specialized for communication. Each neuron communicates with many other neurons to share information.



Neurons send messages electrochemically. This means that neurons communicate using both electrical and chemical signals.

Imagine you are talking on your cell phone while walking the family dog in a park. Just as you are crossing a wooden bridge over a creek, your dog spots a squirrel and yanks

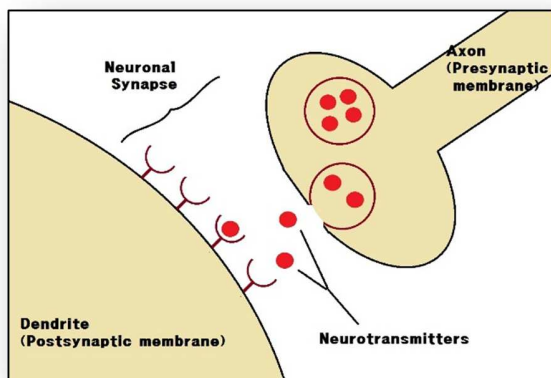
hard on his leash. You are thrown off balance as your phone fumbles out of your hand and flies into the air. You reach out and catch the phone before it falls over the side of the bridge. *Phew!*

What happened within your nervous system to help you catch your phone? A message was sent electrochemically from neuron to neuron, from your fingertips all the way to the brain where it was processed. Since a response was needed (*Grab it! Quick!*), the brain then passed a message back through the neurons to cause muscle impulses and movement. At lightning speed, your brain processed an astounding amount of information and sent a message back through your neurons to your hand. Your quick-acting nervous system saved your phone from a swim in the creek below.

Here's how a message gets relayed from neuron to neuron (remember, this all occurs at an amazingly fast speed): Neurons have specialized cell parts called **dendrites** and **axons**. Dendrites bring electrical signals **to** the cell body. Axons take information **away** from the cell body.

The Synapse

Information from one neuron flows to another neuron across a **synapse**. The synapse is a small gap separating neurons. At the end of the axon, before the synapse is the **synaptic terminal**: a bulge in the axon that stores and releases neurotransmitters. At the dendrite side of the synapse has receptor sites for neurotransmitters.



Special chemicals called **neurotransmitters** send information from one neuron to another. These chemicals are stored and released from the **synaptic terminal** of a neuron. They are released by the first neuron into a space between two neurons called a **synaptic gap**. The neurotransmitter is taken up by the dendrites of the second neuron. If enough neurotransmitters are taken up by the dendrites, the second neuron may fire and pass its own neurotransmitter to another neuron.

When a chemical neurotransmitter is passed from one neuron to another, it can cause an electric signal (or impulse) to be carried along the receiving neuron—and that electrical signal may cause the cell to pass its own chemical neurotransmitters to another neuron.

The electrical signals carried along neurons are called **action potentials**. Within each neuron, it is an "**all-or-none**" impulse:

- Once the action potential starts, it continues without interruption down the length of the axon.
- The size of the action potential stays the same as it travels down the axon.

The message of *Grab it! Quick!* is sent to the brain, processed, and the brain then sends a message back along the neurons causing movement among the muscles in the hand. The cell phone is saved from a plunge in the creek.

Every single one of your thoughts, behaviors, and movements result from combinations of signals passed along your neurons. The action potentials in your muscles cause contractions and movement, allowing you to hold this piece of paper, breathe, move your eyeballs to read these words, listen to music, and stay upright in your chair.

Many drugs and **neurotoxins** can change the ways that neurotransmitters are released and taken up by neurons. The plant extracts you'll work with in the *Sowing the Seeds of Neuroscience* curriculum may do these very same things!



Neuron Trivia

Q: How many neurons are there in the human brain?

- There are at least one hundred billion neurons in the human brain and we use them all.

Q: How big is a neuron?

- Neurons come in many different shapes and sizes. The smallest neurons have **cell bodies** that are only 4 microns wide while the biggest neurons have cell bodies that are 100 microns wide—about the width of a human hair.

Q: How fast does a message travel through the nervous system?

- Messages can travel in neurons at speeds up to 268 miles per hour! That's faster than a high-speed bullet train.

Q: How many other neurons is each neuron connected to?

- Each neuron may be connected to and able to communicate with 1,000 to 10,000 other neurons. That's quite a neural network!

Neuroscience 101: Vocabulary List

Action potential: An electrical signal carried along the axon of a neuron. It is an "all-or-none" impulse that transmits information within the nervous system. The action potential is sometimes called a spike.

Axon: The part of the neuron that takes information **away** from the cell body.

Cell body: Also called the soma; the part of the cell that contains the nucleus.

Central Nervous System (CNS): The brain and spinal cord.

Chemical transmission: Neurons communicate using both electrical and chemical signals. Chemical transmission is when a neurotransmitter is received by a dendrite, increasing or decreasing the likelihood that an action potential will occur in that cell.

Dendrites: Extensions from the neuron cell body that bring information **to** the cell body.

Electrical transmission: Neurons communicate using both electrical and chemical signals. Electrical transmission is the electrical signal that is carried along the receiving neuron after a chemical neurotransmitter is passed from one neuron to another. The response received by the dendrite increases or decreases the chances that the receiving neuron will generate an action potential.

Glia: Non-neural support cells of the nervous system.

Nervous system: An organ system that controls and responds to body functions and directs behavior.

Neuroactive chemicals: Chemicals that interact with or affect the brain or other nervous system cells in animals.

Neuroanatomy: The structure of the nervous system.

Neuron: A nerve cell.

Neurotoxin: Poison that affects the nervous system.

Neurotransmitter: Chemical that transmits information across the synapse to communicate from one neuron to another.

Peripheral Nervous System (PNS): The part of the nervous system containing all of the nerves outside of the brain and spinal cord.

Synapse: Chemical or electrical junctions that allow electrical signals to pass from neurons to other cells. A synapse includes the synaptic terminal, synaptic gap, and dendrite.

Synaptic gap: The area between neurons that allows neurotransmitters to pass between neurons. It is the functional connection between an axon of one neuron and a dendrite of another.

Synaptic terminal: A bulge in the axon that stores and releases neurotransmitters.