

The Nervous System

HASPI Medical Anatomy & Physiology 11a
Lab Activity

Background

The Nervous System

The nervous system is an incredibly complex network of tissues that are capable of carrying information throughout the human body. The two primary cells of the nervous system are neurons, that actually carry and store information, and glial cells that support the neurons. The nervous system is broken up into a few systems depending on the function and location.

Central Nervous System

The central nervous system, or CNS, is made up of the brain and spinal cord. The retina of the eye is also considered part of the central nervous system. The brain is the control center of the body and is housed within the protective hard skull. Layers of tissues called meninges and cerebrospinal fluid also protect the CNS. The spinal cord extends from the brainstem through the vertebral column. There are 31 segments to the spinal cord, and a pair of spinal nerves extends from each segment into the body.

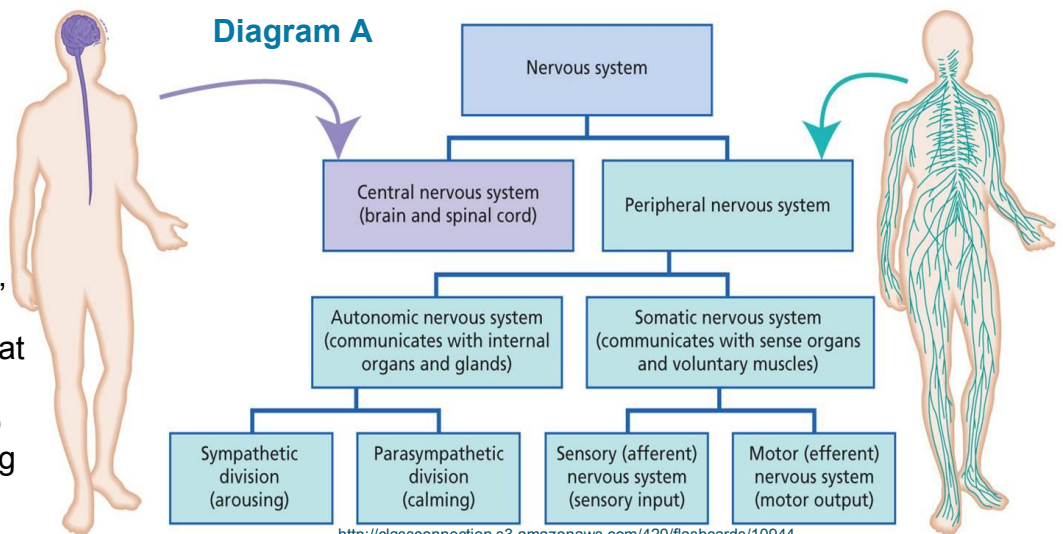
Peripheral Nervous System

There are 43 pairs of nerves that connect the central nervous system to the rest of the body, and they make up the peripheral nervous system or PNS. The PNS is made up of sensory neurons that are capable of receiving stimuli, and motor neurons that are capable of responding to stimuli. For example, sensory neurons in the eye are capable of receiving light stimuli and motor neurons are attached to muscles that can create movement.

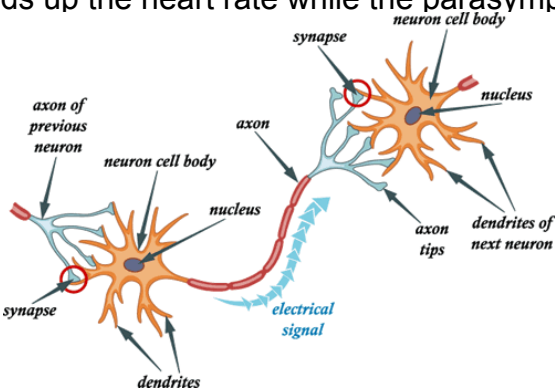
The PNS is broken down into the somatic and autonomic nervous systems, and the autonomic is further broken down into the sympathetic and parasympathetic nervous systems. Diagram A summarizes the relationship between these systems. The somatic NS is the voluntary system that can be controlled consciously, such as movement of muscles. The autonomic NS is the involuntary system and controls unconscious impulses such as the heartbeat. The sympathetic and parasympathetic systems work opposite of one another. For example, the sympathetic system speeds up the heart rate while the parasympathetic system slows down the heart rate.

Name(s): _____

Period: _____ Date: _____



http://classconnection.s3.amazonaws.com/420/flashcards/1094420/jpg/nervous_system_organization1328056081853.jpg



<https://benchprep.com/blog/wp-content/uploads/2012/12/dendrite-axon.gif>

The Neuron

The neuron is the functional cell of the nervous system. It can send and receive nerve impulses. There are billions of neurons in the body, with more than 100 billion on the surface of the brain alone. Even so, approximately 90% of cells in the brain are supportive glial cells and only 10% are actual neurons. Neurons are made up of a cell body, dendrites, an axon, and axon terminals. When

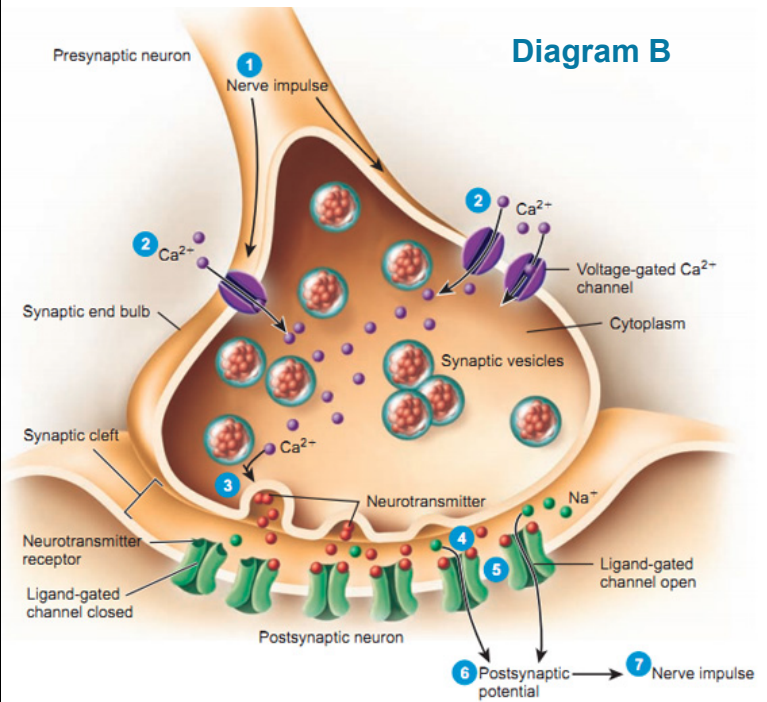
something stimulates a dendrite, the nerve impulse travels through the dendrite, to the cell body down the axon and axon terminals, where the impulse will be passed to the dendrites of the next neuron to perpetuate the impulse. Sensory neurons have a single specialized dendrite to receive stimuli while motor neurons have many dendrites. Axons are covered with a lipid-based myelin sheath created by Schwann cells that is capable of drastically speeding up the nerve impulse.

When you touch a hot pan, sensory neurons at the ends of the fingertips start a chain reaction that is passed through neurons from the fingertip all the way to the brain. The brain is then capable of interpreting this reaction, most likely as “pain” or “hot”, and will immediately send a response back through motor neurons capable of immediately moving the finger away from the hot pan. This is an extremely fast process.

The Synapse & Nerve Impulse

Neurons pass impulses from the axon terminal of one neuron to the dendrite of another neuron at the synapse. The message is actually passed between two neurons through chemicals called neurotransmitters. Different neurotransmitters can relay different messages. For example, serotonin is a neurotransmitter that regulates appetite, sleep, and mood. The following steps outline the process of a nerve impulse at the synapse and correlates with Diagram B.

Nerve Impulse at the Synapse	
Step 1	The nerve impulse travels down the axon to the synapse
Step 2	The impulse opens channel proteins on the membrane of the synapse that allows calcium (Ca^{2+}) to enter
Step 3	Ca^{2+} prompts synaptic vesicles to release neurotransmitters into the synaptic cleft
Step 4	The neurotransmitter binds to receptors on channel proteins of the NEXT neuron and opens them
Step 5	Na^+ molecules can now travel through the open channel protein into the dendrite of the next neuron
Step 6	Na^+ builds up in the next dendrite and starts an electrical impulse
Step 7	The impulse travels down the dendrite, through the cell body, and through the axon to the next neuron



<http://antranik.org/wp-content/uploads/2012/04/synapse.jpg>

Kendal, E., Schwartz, J., and Jessel, T. 2000. *Nerve Cells and Behavior. Principles of Neural Science*, McGraw-Hill.

Mandal, A. 2012. What is the Nervous System? News Medical, www.news-medical.net.

Materials

- Station 1: Anatomy posters (4)
- Station 2: Betadine, starch/mineral oil, cotton ball
- Station 3: Histology posters (4)
- Station 4: Vision cards, ruler, pipe cleaner, straw, timer
- Station 5: Disease posters (6)
- Station 6: Reaction time stick

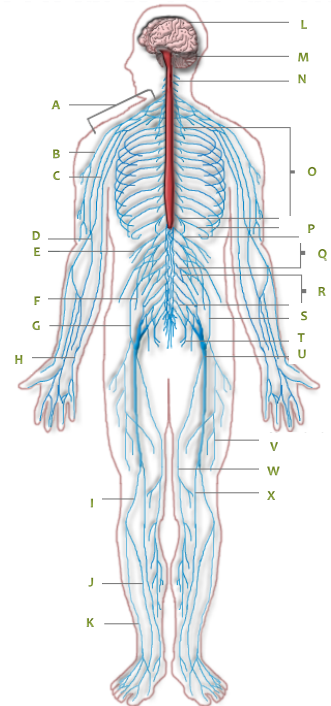
Procedure

This is a station lab activity. There are 6 stations set up around the classroom. Each station will take approximately 10-15 minutes.

Station 1: The Nervous System

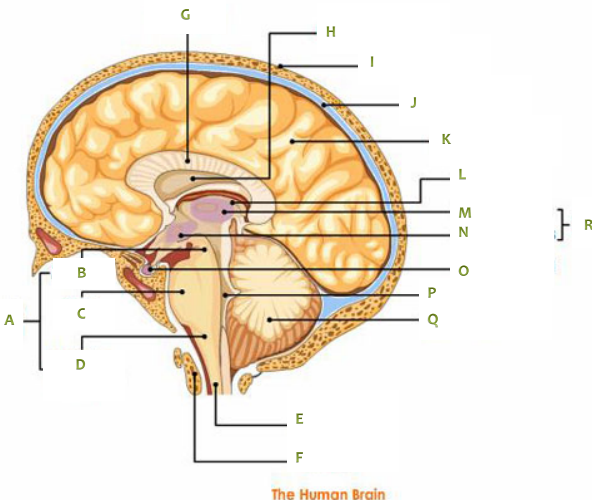
The Nervous System – Using “The Nervous System” chart, identify the labeled A-X in **Table 1** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

Table 1: The Nervous System	
A	M
B	N
C	O
D	P
E	Q
F	R
G	S
H	T
I	U
J	V
K	W
L	X



http://upload.wikimedia.org/wikipedia/commons/b/ba/Nervous_system_diagram.png

The Brain – Using “The Brain” chart, identify the labeled A-R in **Table 2** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

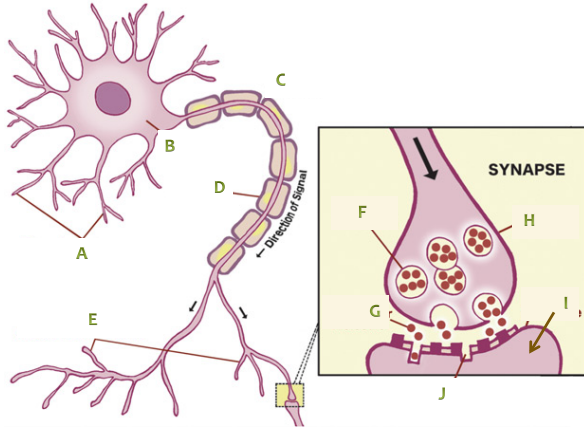


The Human Brain

<http://images.tutorvista.com/content/control-coordination/human-brain.jpeg>

Table 2: The Brain	
A	J
B	K
C	L
D	M
E	N
F	O
G	P
H	Q
I	R

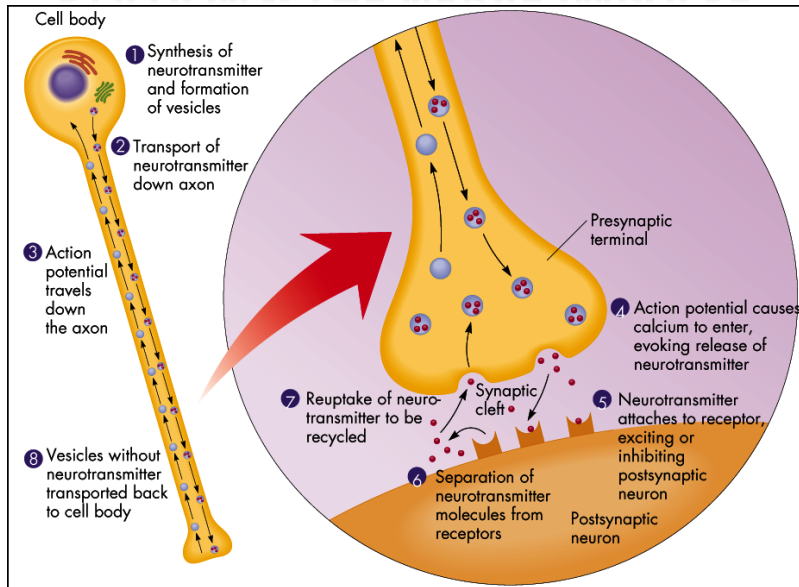
The Neuron – Using “The Neuron” chart, identify the labeled A-J in **Table 3** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.



<http://www.urbanchildinstitute.org/sites/all/files/databooks/2011/ch1:fg2:communication-between-neurons.jpg>

Table 3: The Neuron	
A	F
B	G
C	H
D	I
E	J

The Nerve Impulse – Using “The Nerve Impulse” chart, record the steps 1-8 of a nerve impulse in **Table 4** below. A smaller version of this chart is included here for later review.

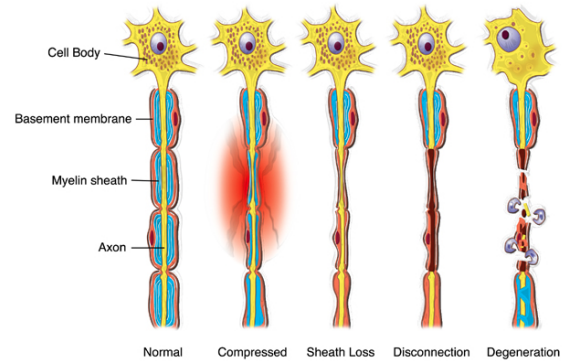


<http://my.fresnounified.org/personallygonza/gonzalez/Neuron/neuron-synapse%20communication.png>

Table 4: The Nerve Impulse	
Step 1	
Step 2	
Step 3	
Step 4	
Step 5	
Step 6	
Step 7	
Step 8	

Station 2: Nerve Damage

The nervous system is responsible for muscular contractions that produce heat, and therefore sweat. When the nerve to a specific muscle is damaged, it will not send the signal to contract to that portion of muscle, and no sweating will occur in that area. Nerve damage can result from any type of injury in which the actual nerve fibers are disrupted. This could be caused by something as simple as a laceration, or as severe as third-degree burns. Nerve damage is placed into three categories:



http://www.backpain-guide.com/Chapter_Fig_folders/Ch10_Recover_Folder/Ch10_Images/10-2_Nerve_Damage.jpg

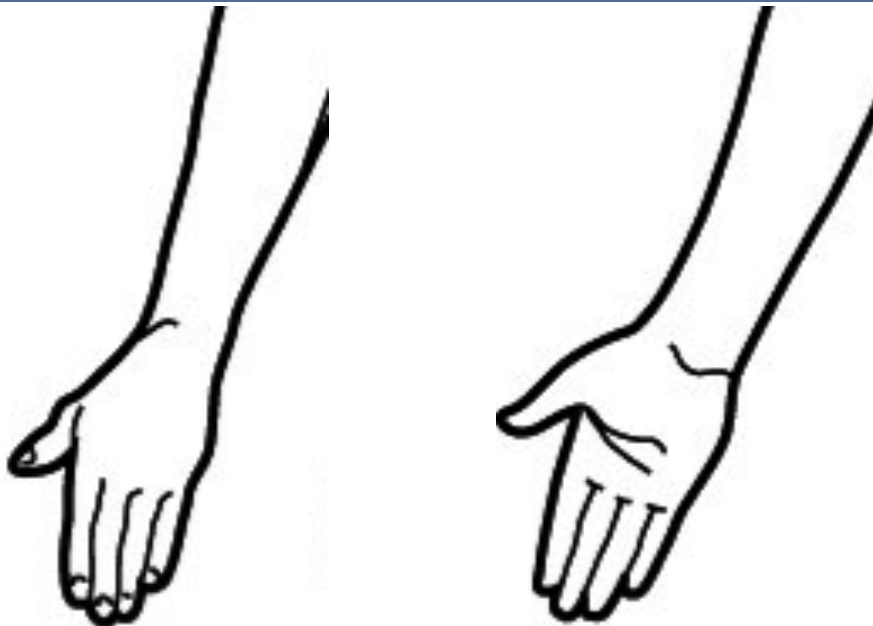
- **Neurotmesis** – The most severe nerve damage resulting in complete loss of function and ability of the nerve to send an impulse. Can result from tearing, stretching, or bruising.
- **Axonotmesis** – Results when the nerve is placed under too much pressure and/or crushed. The axon of the nerve is damaged preventing the nerve from sending impulses, but it is possible for the axon to regenerate. This regeneration can take months to years.
- **Neurapraxia** – The least severe nerve damage that allows for complete recovery within a few months. Can result from constant pressure or lack of blood supply to the nerve.

Directions

✓ when complete

Step 1	Choose one person to be the test subject for this activity. The best subject will have had some injuries to the forearm (deep cut, fracture, etc.), which may display nerve damage.	
Step 2	Using a cotton ball, coat the entire hand, wrist, and forearm with Betadine. Let the Betadine dry completely.	
Step 3	Using a different cotton ball, apply a thin coat of the corn starch/mineral oil solution over the Betadine on the same arm.	
Step 4	Run in place or perform an exercise that will stimulate muscle contraction in the arm until sweating occurs.	
Step 5	Observe the hand and forearm once sweating starts. Areas where sweating has appeared will turn black, and spots will appear from sweat being produced from the pores.	
Step 6	Any areas that remain yellow are areas where sweating has not occurred and may signify nerve damage.	
Step 7	Color in the front and back of the forearm image in Figure C below to show what you observed on the test subject's hand and forearm.	
Step 8	Wash off the forearm with soap and water.	

Figure C



Station 3: Nervous System Histology

The cell and tissue structure of nervous organs is suited for the function they perform. Redraw and label Image B from the posters below. Image A on each chart is for reference!

Brain Tissue

Using colored pens/pencils, draw the histology Image B from the "Brain" chart in the space below. Using Image A as a reference, label your drawing with the granule layer, molecular layer, Purkinje cell bodies, and Purkinje cell dendrites.



Spinal Cord

Using colored pens/pencils, draw the histology Image B from the "Spinal Cord" chart in the space below. Using Image A as a reference, label your drawing with the central canal, dorsal horn, dorsal root, ventral horn, site of ventral root, and ventral fissure.



Peripheral Nerves

Using colored pens/pencils, draw the histology Image B from the "Peripheral Nerve" chart in the space below. Using Image A as a reference, label your drawing with the nerve fascicle, epineurium, and perineurium.



Neuromuscular Junction

Using colored pens/pencils, draw the histology Image B from the "Neuromuscular Junction" chart in the space below. Using Image A as a reference, label your drawing with the skeletal muscle, motor end plate, axon, nerve bundle of axons, and synaptic knob.



Station 4: Visual Acuity

There are four short activities at this station. Follow the directions for each activity below.

A. Where is Your Blind Spot?

✓ when complete

Step 1	Obtain a blind spot card (the card will have a dot and x) and a ruler. The blind spot is the area of vision where the optic nerve attaches to the retina, and there are no receptors for light.	
Step 2	Close your right eye and hold the blind spot card out in front of your left eye at arm's length with the dot to the left and the x to the right.	
Step 3	Focus on the x with your left eye. Very slowly bring the x toward your eye. At a certain distance the dot will disappear from your peripheral vision.	
Step 4	Stop moving the card at the point that the dot disappears and have a partner measure the distance from your eye to the card. Record the distance in cm in Table 5 below.	
Step 5	Repeat Steps 2-4 closing your left eye to find the blind spot on your right side.	

Table 5. Blind Spot	Left Side	Right Side
Distance (cm)		

B. Are You Colorblind?

✓ when complete

Step 1	A common test for colorblindness is the Ishihara Colorblindness Test.	
Step 2	Look at the circles A – F on the Ishihara test sheet.	
Step 3	There is a number in each circle. If you are able to see the number, record the number for each circle in Table 6 below. Those who are colorblind will not be able to see all of the numbers.	

Table 6. Colorblindness	A	B	C	D	E	F
Number						

C. Optical Illusions...What is Real?

✓ when complete

Step 1	There are 5 sheets with a variety of optical illusions.	
Step 2	Each illusion has directions and a question. Write your answers to each question in Table 7 below.	

Table 7. Optical Illusions			
Question	Answer	Question	Answer
A		F	
B		G	
C		H	
D		I	
E		J	

D. How Is Your Depth Perception?

✓ when complete

Step 1	Obtain a pipe cleaner and a straw. Depth perception is the ability to judge whether an object is nearer or farther than another object. Depth perception can be affected by different vision in each eye.	
Step 2	Hold the middle of the straw out at arm's length directly in front of your eyes.	
Step 3	Close your right eye. Have a partner start the timer as soon as you attempt to place the pipe cleaner into the straw with your left hand.	
Step 4	Stop the timer when the pipe cleaner is completely in the straw and record your time for the left eye in Table 8 below.	
Step 5	Repeat steps 3 and 4, closing your left eye and then leaving both eyes open.	

Table 8. Depth Perception	Left Eye	Right Eye	Both Eyes
Time			

Station 5: Nervous Disease

Using the “Nervous Disease” charts, complete the following table. List ONLY THREE Causes or Risk Factors, Symptoms, and Treatment Options for each disease.

Cerebrovascular Accident (Stroke)			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
In what region of the United States do the most deaths from stroke occur?			
Autism			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
By how much did the prevalence of autism increased from 2000 to 2008?			
Alzheimer’s Disease			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
Which U.S. states have the highest prevalence of Alzheimer’s disease?			
Spinal Cord Injury			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What activity causes the most spinal cord injuries?			
Meningitis			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What age group is at highest risk for contracting meningitis?			
Multiple Sclerosis			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
In what country is multiple sclerosis most prevalent?			

Station 6: Reaction Time

Sensory neurons function to take information from the environment to the brain, so the brain can formulate a response. Measuring how quickly your nervous system is able to take in sensory input and respond is called reaction time. Your reaction time can be dependent on several factors including receptor responsiveness, impulse speed, and number of neurons just to name a few. In this activity, you will be measuring your reaction time in response to visual and auditory stimuli.



✓ when complete

Directions

Step 1	Obtain a partner and a reaction time stick.	
Step 2	Sit down and rest the forearm of your dominant arm on a desk with your hand hanging over the edge.	
Step 3	Hold your thumb and forefinger about 1 inch apart and have your partner hold the bottom edge of the reaction time stick (starts at .04 s) between your thumb and forefinger.	
Step 4	Your partner will drop the reaction time stick without warning at any time, and you will pinch your thumb and forefinger together to catch the stick as fast as you are able to react.	
Step 5	Record the time visible just above your thumb and forefinger in Table 9 for "Dominant Hand" Trial 1.	
Step 6	Repeat steps 4 and 5 two more times, and record the times for trials 2 and 3. Average the times for trials 1-3 and record the "Average Reaction Time."	
Step 7	Repeat steps 4-6 using your non-dominant hand and record your results.	
Step 8	Repeat steps 4-6 but now have your partner ask you random questions THAT YOU MUST ANSWER throughout each trial. These may be math equations, biology questions, or even everyday questions. Record your reaction time results for "Distraction."	
Step 9	Repeat steps 4-6 but close your eyes and have your partner say "NOW" as soon as they drop the reaction time stick. Record your results for "Auditory Only."	

Table 9. Reaction Time

	Trial 1	Trial 2	Trial 3	Average Reaction Time
Dominant Hand				
Non-Dominant Hand				
Distraction				
Auditory Only				

Analysis Questions - *on a separate sheet of paper complete the following*

Station 1

1. List ALL of the protection surrounding the brain.
2. Explain how a nerve impulse would move through a neuron.

Station 2

3. Compare and contrast neurotmesis, axonotmesis, and neurapraxia.
4. Give three examples of injuries that could cause nerve damage.
5. Explain how observing whether the skin is sweating or not can indicate nerve damage.
6. Was there any nerve damage present on your test subject? If yes, what may have caused the damage?

Station 3

7. What are Purkinje fibers and in what part of the brain are they found?
8. What exits from the ventral root of the spinal cord?
9. What type of tissue is epineurium and perineurium?
10. How does the neuron at a neuromuscular junction interact with the muscle to which it is attached?

Station 4

11. Explain why there is a blind spot in your vision.
12. Colorblindness is a recessive sex-linked disorder present on the X chromosome. Explain why more men suffer from colorblindness than women.
13. What is depth perception? How was your depth perception affected by closing one eye?

Station 5

14. What were the common causes & risk factors found between the majority of the neurological disorders?
15. What were the common symptoms found between the majority of the neurological disorders?

Station 6

16. How was your reaction time different from your dominant and non-dominant hand? Hypothesize why this happened.
17. How did distractions affect your reaction time?
18. Why was there a difference in your reaction time between watching and listening to catch the reaction time stick?

Review Questions - *on a separate sheet of paper complete the following*

1. What is the function of the nervous system?
2. What are the two primary cells of the nervous system, and what do they do?
3. What protects the brain?
4. What is the difference between sensory and motor neurons?
5. Make a flow chart outlining the different systems of the nervous system.
6. How many neurons are found in the human body?
7. Explain how a nerve impulse travels through a neuron.
8. Explain how your nervous system would get the message to your brain and respond if you slammed your finger in the car door.
9. What is a neurotransmitter? Give an example.
10. Summarize the steps of a nerve impulse at the synapse (use drawings if you would prefer).