

## Lesson Outline for ALEX

### General Lesson Information

Title: The Nervous System

Overview/Annotation- *A short summary or description of the lesson including activities and science concepts.*

In this lesson, students will learn about the function of the nervous system. Students will learn that the nervous system is split up into the central and peripheral nervous systems and understand the function of each. Instructors will indicate how these systems are integrated and how neurons function to send information throughout the nervous system in order for our bodies to function.

Setting or format (outdoors, in groups, lab, etc.):  
Regular classroom

Intended group size (if groups are used):  
Activity 1: Whole class and individual work  
Activity 2: Class will be broken into pairs  
Activity 3: Whole class and individual work

Intended grade level(s):  
7<sup>th</sup> Grade

Approximate Time of Lesson (*Ideally break down into 20-50 minute periods*):  
2-day lesson. Activities 1 and 2 will be completed on the first day and activity 3 will be completed on the second day. Each days' activities should be completed in 50 minutes.

### Researcher Biography

Name & Professional Title:

The NERD Lab

Dr. Laura Morett, Cailee Nelson, Jacob Feiler, Sarah Hughes Berheim

Affiliation:

The University of Alabama

Contact Information (Email, Twitter, Personal Website, etc.):

<http://nerdlab.ua.edu>

[lmorett@ua.edu](mailto:lmorett@ua.edu)

[cmnelson4@crimson.ua.edu](mailto:cmnelson4@crimson.ua.edu)

[jfeiler@crimson.ua.edu](mailto:jfeiler@crimson.ua.edu)

[shughesberheim@crimson.ua.edu](mailto:shughesberheim@crimson.ua.edu)

Brief Description of Research Interests:

Interested in neuroscience and what the brain can tell us about how students in both general and special education learn content in order to enhance our educational system

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### **Associated Standards and Objectives**

Content Standards- *List Alabama Course of Study Standards that connect to lesson*  
Construct models and representations of organ systems (e.g., circulatory, digestive, respiratory, muscular, skeletal, nervous) to demonstrate how multiple interacting organs and systems work together to accomplish specific functions.

Primary Learning Objectives- *Sentences beginning with "Students will be able to..." that describe what students will do in the lesson that relates to how students will be assessed.*

- Students will be able to
    - o Identify the parts of the central and peripheral nervous system
    - o Understand how the nervous system integrates and coordinates bodily activity
- Describe the structure of the nervous system from the single cell level (neuron) to the multi-cell level (brain)

Additional Learning Objectives- *Any learning outcomes that are not directly related to the content standards but may relate to other local or national standards*

### **Preparation Information**

Total Duration- *How many minutes will the lesson last?*  
Two 50-minutes sessions

Materials and Resources- *List of materials teacher will need to gather or prepare for lesson*

Activity 1

- Worksheet (attached)
- Writing utensil for each student
- Dry-erase board/chalkboard and marker/chalk for instructor

Activity 2

- Butcher paper
- Scissors
- Tape
- Different colored markers
- Explore your nervous system PDF (Attachment 2A)

Activity 3

- Candy
  - o Gum-drop buttons, licorice, NERDs, gummy worms, peachie-O's, licorice ropes
- Toothpicks

Technology Resources Needed- *What technology will teacher and students need for the lesson?*

Computer and projector to show YouTube video

Background and Preparation- *Description of information (science content, use of materials, etc.) teacher and/or students will need to know prior to this lesson; list steps for any preparation prior to the lesson*

For teachers, consider refreshing knowledge on the nervous system. For example, it might be useful to know the difference between the central nervous system, peripheral nervous system, autonomic nervous system and somatic nervous system. Also, consider reexamining neurons, their functions and how they are integrated within the nervous system.

Remind students that the nervous system is one of our bodily systems. All bodily systems are made of cells, the nervous system is made up of specific cells called neurons.

Maybe provide a website link or PDF of a short chapter that can be reviewed by teachers, if wanted.

[https://en.wikipedia.org/wiki/Nervous\\_system](https://en.wikipedia.org/wiki/Nervous_system)

## **Procedures and Activities**

*Step-by-step description of lesson that would allow another teacher to successfully complete the lesson (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)*

*Engagement* (sparking interest, introducing phenomenon, engage students' everyday experiences)

See individual activities for engagement ideas.

*Main activity* (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)

Three main activities will be completed, one for each of the learning objectives.

### **Activity 1**

#### **Objective/Goals**

1. List the basic components of the central nervous system and peripheral nervous system.
2. Compare the central nervous system and peripheral nervous system to a highway system in a large city.

#### **Materials**

- Worksheet
- Writing utensils

#### **Activity Type**

- Group work

### **Teacher Preparation**

Arrange the classroom so that there are tables for groups to sit at together. Be mindful that each group should consist of no more than four students. It is also important that students remember what an analogy is, as an analogy is being used to connect new information (the nervous system) with existing knowledge (the interstate highway system).

### **Brief Overview**

Scaffolding the concept of the nervous system by relating it to a simple analogy will enable students to conceptualize that, just like how roads take cars to and from a central interstate, so too does the peripheral nervous system take information to and from the central nervous system (brain and spinal cord). Students will complete the worksheet in small groups to encourage collaborative learning, which prompts students to discuss their ideas and thought processes with others.

### **Teacher Instructions**

- Distribute the worksheet for Activity 1 to each student, and ask students to read the instructions, and answer the questions labelled “PART 1.” It is intentional that minimal guidance is given to students at this point.
- After about 3-5 minutes, gather the students’ attention, and review the answers they came up with for each question. You may want to highlight some of the common answers by writing them on the board for everyone to see.
- Next, ask students to come up with answers to the next set of questions in “PART 2,” just as they did before. These questions may be a little harder for students to answer because they are based on the nervous system, which students may just now be learning about. Encourage students to guess on any question they are unsure of.
- After another 3-5 minutes, bring the students back together, and review the answers. Ask students from each group what they came up with for each question, and review the actual answers as follows. You may want to write on the board for clarity. Use the time to teach students about the various components of the nervous system, as needed.
  - o **What is the purpose of the nervous system? What is/are its function(s)?**  
**What parts of the human body are part of the nervous system?**
    - Purpose of the nervous system: Transmit and process sensory information and coordinate bodily functions.
    - Central nervous system (CNS) is made up of the brain and spinal cord, and these function as the control center for the body.
    - They receive data and feedback from the sensory organs and process the information, and then send commands back out.
    - Information travels from the brain to the spinal cord (central nervous system) and then to the rest of the body (via the peripheral nervous system, PNS).
    - Information also comes from the environment (think temperature, textures, pain, etc.) and goes through the nerves in your body (like your fingers and arms) and back to the spinal cord and up to the brain.
  - o **What happens if the nervous system gets damaged because of an injury?**
    - It does not work as well. Think about someone who is paralyzed in a limb (like a leg). The person cannot move their leg because the nerves connecting to that leg are damaged. This can be damage to the

peripheral nervous system and/or the central nervous system. Damage to the brain and spinal cord will cause much more widespread damage than damage to parts of the peripheral nervous system.

- o **How to signals go from the outside world to the nervous system (think about how you know when you feel something hot or how you can feel the smooth texture of a warm blanket)? How do these sensations get to our brains?**
  - When you touch something, you feel the texture, the shape, the temperature, etc. This information travels from the fingers, to the hand, to your arm, to your shoulder, and into your spinal cord. From the spinal cord, it goes up to your brain. Your brain processes the signal, and that is why you feel it (and know it is a sensation).
- Now, ask students to complete “PART 3” of the worksheet. In this activity, they will label a diagram of roads and an interstate and compare that to the nervous system.
- While students do this, prompt them to discuss what elements of an interstate represent the CNS and what elements represent the PNS. Ask students why they specifically made these selections, being careful to call on students from each group.
- It is important that students use the terminology (CNS, PNS, nerve signals) when answering the questions. Students should make it clear which part of the interstate highway system refers to each part of the nervous system.

### **Activity 2:**

Learning Objective: Understand how the nervous system integrates and coordinates bodily activity

*All handouts and links referenced can be found in the attachments section under Activity 2*

### **Drawing Your Nervous System**

1. Engagement: Ask students the following questions and write some of their responses on a whiteboard, projector, or any screen that is visible and can be visible for the rest of the lesson:
  - a. *Why do you think your body can feel certain things?*
  - b. *What does your body do on its own and what do you have to control?*
  - c. *How do your lungs remember to breathe when you are asleep or your nose tell you dinner is ready?*
2. Have students get into pairs and hand out the materials and “Explore Your Nervous System” handout needed for the project.
3. Explain why our bodies can feel certain things:
  - a. *Our bodies can feel certain things because of our nervous system or the network of nerve cells and fibers which transmits nerve impulses between parts of the body.*
4. Ask students to look at their “Explore Your Nervous System” handout and say:
  - a. *The nervous system in our bodies can be divided into two main systems: the central nervous system (CNS) and the peripheral nervous system (PNS). In the handout, you can see that the central nervous system is made up of our brains and spinal cords. On the other hand, the peripheral nervous system is made up of a large network of nerves that are linked to the brain and spinal cord and*

*are used to transmit information to and from our body and brain. In fact, your peripheral nervous system can be further divided into two separate systems known as the autonomic and somatic nervous system. The autonomic nervous system is responsible for involuntary control over organs. So, it works to help your lungs remember to breathe. The somatic nervous system is responsible for voluntary control over your body. So, it helps you complete intentional activities like raising your arm, catching a ball or even walking.*

5. Show students the YouTube video for more information on what the CNS and PNS are and do.
6. Once the video is over, instruct the students to draw their own nervous system.
  - a. Have students roll out butcher paper and have one of the pair lie down on the butcher paper.
  - b. Have the student who is not lying down cut the butcher paper.
    - i. Ensure that the student is laying with their back down with their arms and legs somewhat spread out.
    - ii. They should cut the paper as a rectangle and large enough to fit the body of the student who is lying down.
  - c. With the student still lying down, have the other student trace the body of the student lying down in black marker.
  - d. Repeat steps A-C so that the other student also has a sheet of butcher paper with their own body traced.
  - e. Then, have the students work together to draw the different parts of the nervous system onto their body tracing.
    - i. Students should use the “Explore Your Nervous System” handout for reference.
  - f. Once they have drawn the different parts, have the students label each of the parts and list what it helps their body do.
  - g. Once both partners are finished, have the students hang up their papers around the classroom for reference.

### **Activity 3:**

Learning Objective: Describe the structure of the nervous system from the single-cell level (neuron) to the multi-cell level (brain)

*All pictures referenced can be found in the attachments section for Activity 3*

### **Remind Students of Day 1 by asking questions:**

#### **Make a Model Neuron**

1. Show students a picture of the neuron (Picture3a) and explain how these cells (~ 86 billion) make up the nervous system
2. Explain what neurons do: Neurons carry information between the brain and throughout the nervous system by using electrical impulses. Neurons are responsible for what we think, say, feel, and do.
3. Explain the structure of the neuron while students make a model neuron:
  - a. Have students start by making the cell body and the nucleus using peachie-O's.

- i. *Neurons are composed of a cell body that holds the nucleus. The cell body also holds the other organelles important for cellular function like the mitochondria and golgi body.*
  - b. Have students make the dendrites off of the cell body using gummy worms and toothpicks if needed.
    - i. *Dendrites or dendritic spines receive electrical impulses from other neurons, which is how neurons communicate to create “messages” that tell our body to do something, like raise our hand or swing a baseball bat.*
  - c. Have students create the axon of the neuron that extends from the cell body using licorice.
    - i. *Once an electrical impulse is received by the dendritic spines, the message is carried down the axon to the axon terminal. The axon is important because it helps to move the “message” from the cell body of the nucleus to the axon terminal.*
  - d. Have students create the axon terminal buttons using toothpicks and the gum drop buttons.
    - i. *The axon terminal is at the end of the neuron and it has these “buttons”. The buttons receive a message from the axon terminal and release neurotransmitters to another nucleus’s dendrites to continue sharing the message to more neurons.*
  - e. Have students model neurotransmitters sending a message to another neuron using NERDs.
    - i. *Neurotransmitters are important because there is a tiny bit of space between each neuron in the brain, called a synapse. When neurotransmitters are released from the axon terminal, they carry their message to another neuron.*
  - f. Have students create another cell body with dendrites next to their first neuron, leaving a little bit of room between them for the neurotransmitters.
    - i. *The neurotransmitters attach to another neuron’s dendrites where this process repeats itself. This way messages are shared across neurons and throughout the brain.*
- 4. Have students repeat back to you the process of how electrical impulses are transmitted between neurons in the brain.

### **Gray & White Matter Activities**

#### Gray Matter – Students as Individual Neurons

1. Have students form a line. Tell students each of them will be acting as an individual neuron in a chain of neurons that work to form different tissue types in the brain.
  - a. *Messages can travel via neurons at a speed of 268 mph*
2. Tell students their left hand and fingers are the dendritic spines, their body the cell body, their right arm is the axon, and their right hand is the axon terminal. Each student should have something in their right hand to act as the neurotransmitter.

3. Each person should be about an arms-length away from the next person. When the person at the start of the line says "Go," have them start the signal transmission by placing the "neurotransmitter" into the hand of the person next to them. Have this keep going until you reach the end of the line.
4. As the instructor you should time them to see how long it takes. The transmission is complete when the signal goes all the way to the end of the line. Remember each "neuron" has its own "neurotransmitter."
5. Tell students this is how a message is passed from neuron to neuron in gray matter tissue. This gray matter tissue makes up certain areas of the brain. Show students a picture of the gray matter tissue in the brain (Picture3b).

#### White Matter – Students Make Up One Axon Terminal

6. Next have students get into a line again, standing an arms-length apart. This time they are going to emulate a myelinated axon terminal together.
7. When the student at the front of the line says "Go," they should begin by slapping the hand of the person next to them. Once a person's hand has been slapped, that same person can slap the hand of the next person in line. This should continue all the way down the line until it gets to the last person in the line.
8. The last student in the line should have something in their hand, like a gum drop or whiteboard marker. Once the final student's hand has been hit, the student should throw the thing in their hand up to indicate the message being sent to a new neuron, like how neurotransmission occurs.
9. As the instructor, you should time them to see how long this process takes. The transmission down the axon is complete once the message is conveyed down the axon and the neurotransmitters are released. This process should be completed quicker than the gray matter activity.
10. Have students watch the video via the following link to gain an understanding of where the two types of matter can be found throughout the CNS and what each type is responsible for. FYI the video calls the neuron cell bodies somas.
  - a. <https://www.khanacademy.org/test-prep/mcat/behavior/biological-basis-of-behavior-ner/v/gray-and-white-matter>
  - b. *Ask students questions that relate information from the video to their activity. For example, when the students were acting as individual neurons translating a message, which type of matter were they acting like? Where is this matter found both in the brain and in the spinal cord? What are some of the functions this matter participates in?*
  - c. *What about in the second activity, when the students were acting as an axon tract, what kind of matter were they being? Where is this matter found in both the brain and spinal cord? What are some of the functions this matter participates in?*



*Wrap up and Reflection* (wrap up activity, reflecting on learning, informal assessments of student learning)

The CNS and PNS are both parts of the nervous system, which is one of our body's systems. It is composed of the brain, spinal cord, and nerves. Neurons, the basic cells of the nervous system, make up the brain and spinal cord's gray and white matter. They communicate with one another and coordinate the other systems of the body.

*Final product/Summative evaluation* (e.g. quiz, presentation, essay, etc., may occur during a later class period)

Pre-/post-quiz

Deliverables from each activity

Attachments- *Any materials for the lesson such as video links, worksheets, etc., listed here*

Pre/post quiz

- To be administered before and after the lesson to evaluate learning

Activity 1

- Worksheet

Activity 2

- Handout
- YouTube Link: <https://www.youtube.com/watch?v=44B0ms3XPKU>

Activity 3

- Pictures

## Nervous System Quiz

1. What are the components of the central nervous system?
  - a. Brain and spinal cord
  - b. Nerves
  - c. Neurons
  - d. Cerebrum and cerebellum
2. What is the function of the central nervous system?
  - a. Control thoughts
  - b. Interact with the world
  - c. Serve as a relay between the brain and spinal cord and the rest of the body
  - d. Integrate and coordinate activity of all other bodily systems
3. What are the components of the peripheral nervous system?
  - a. Brain and spinal cord
  - b. Nerves
  - c. Neurons
  - d. Cerebrum and cerebellum
4. What is the function of the peripheral nervous system?
  - a. Control thoughts
  - b. Interact with the world
  - c. Serve as a relay between the brain and spinal cord and the rest of the body
  - d. Integrate and coordinate activity of all other bodily systems
5. What does the autonomic nervous system control?
  - a. Heartbeat
  - b. Throwing a ball
  - c. Kicking
  - d. Speech
6. What are cells that transmit information through the brain and nervous system called?
  - a. Axons
  - b. Dendrites
  - c. Neurons
  - d. Neurotransmitters
7. What is NOT part of a neuron?
  - a. Neurotransmitter
  - b. Axon
  - c. Dendrite
  - d. Cell body

8. What is the gap between neurons called?
  - a. Neurotransmitter
  - b. Axon
  - c. Dendrite
  - d. Synapse
  
9. What do neurotransmitters do?
  - a. Transmit information inside neurons
  - b. Transmit information between neurons
  - c. Transmit blood within the brain
  - d. Transmit neurons within the brain
  
10. Which type of matter in the brain transmits information the fastest?
  - a. Gray matter
  - b. White matter
  - c. Black matter
  - d. Pink matter

## Answers to Nervous System Quiz

1. a
2. d
3. b
4. c
5. a
6. c
7. a
8. d
9. b
10. b

# *Mapping the Nervous System*

## PART 1

**Answer these questions about an interstate highway system.**

1. What is the purpose of an interstate highway system? What is/are its function(s)?
2. What happens when there is traffic on the highway? What about if there is a disruption (think about construction causing a lane to be closed); what happens to the flow of traffic?
3. Think about a trip you have taken in the car or on a bus. When you go from home to school, do you take roads? Or do you take the interstate? What about if you take a trip from home to Birmingham or Atlanta? Do you take roads or the interstate?

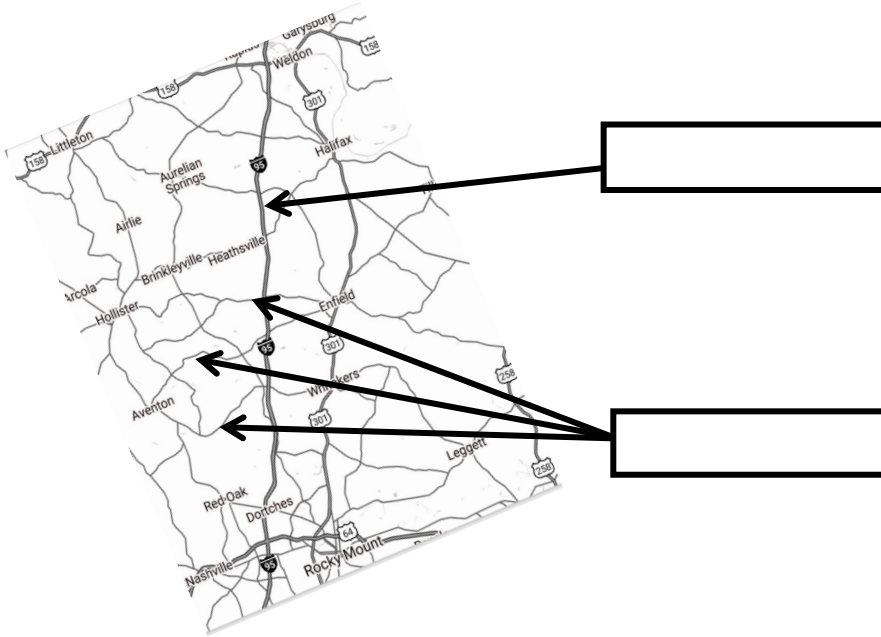
## PART 2

**Now that you understand what a highway system is and what its benefits are, think about the nervous system, and answer these questions:**

1. What is the purpose of the nervous system? What is/are its function(s)? What parts of the human body are part of the nervous system?
2. What happens if the nervous system gets damaged because of an injury?
3. How do signals go from the outside world to the nervous system (think about how you know to move your hand when you feel something hot or how you can feel when you touch something soft)? How do these sensations get to our brains?

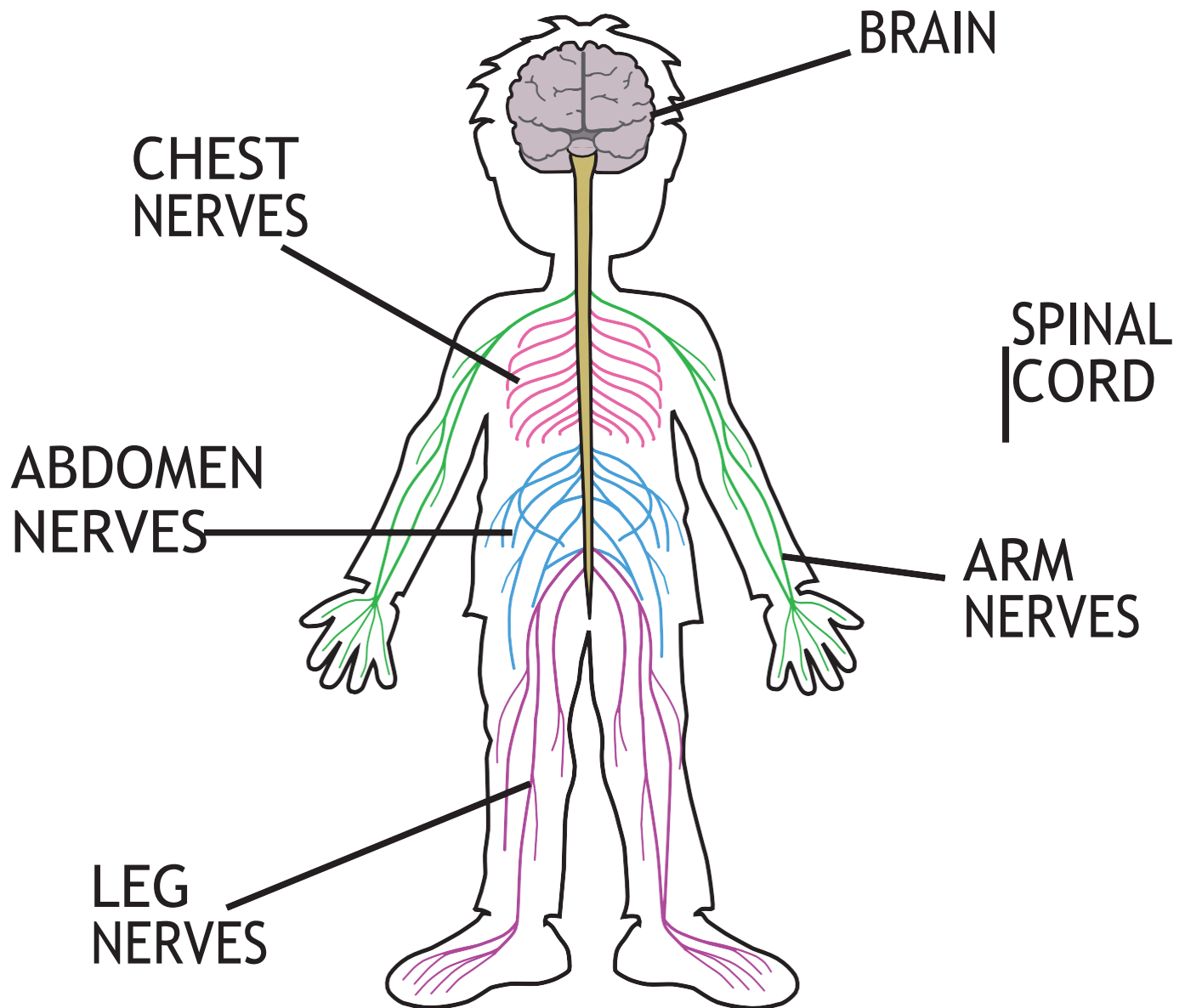
**PART 3**

**Using the analogy that the nervous system is like an interstate highway system, label the boxes below as either central nervous system (CNS) or peripheral nervous system (PNS). Then, answer the question at the end of the worksheet.**



How is the nervous system like an interstate highway system? Write your comparison below, and then discuss the features that are both similar and different with your group.

# Explore Your Nervous System



The brain is the center of your nervous system. It weighs around 3 pounds (1.4 kg), about as much as a cantaloupe.

The Spinal cord is the main highway of the nervous system. It carries signals from the body up to the brain, and from the brain out to the rest of the body.

Sensory Nerves carry messages about pressure, pain, and temperature from the body to the brain.

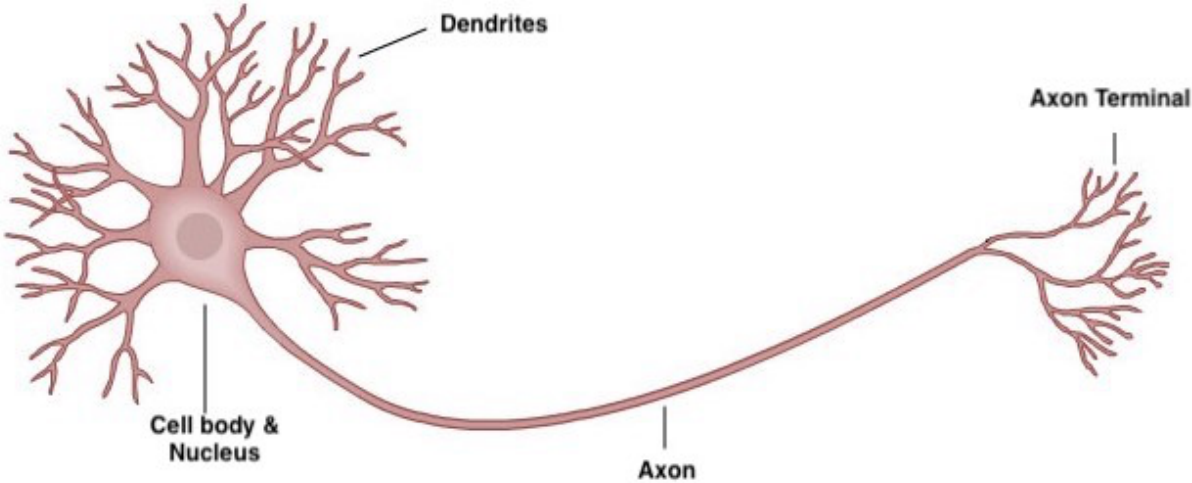
Motor Nerves carry signals from your brain to your muscles and organs, telling them what to do.

[amnh.org/ology/brain](http://amnh.org/ology/brain)

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Picture 3a



Picture 3b

