What Is This Module About?

Can you imagine how your life would be if you did not have the ability to move, think and feel? Human beings are blessed with the capacity to think, feel and move. The human body is capable of doing a lot of wonderful things. We are able to tell when we are hungry or tired. We are able to move our bodies whenever we need to do so. We are also capable of thinking and remembering things.

We are able to do all these things because we have an organ system that processes and sends signals to the different parts of our bodies. This is the **nervous system.** It is a system that makes us think, act, react, move and decide. The nervous system does not stop working even when we are asleep.

In this module, you will learn about the nervous system. You will discover the parts and functions of the nervous system. You will also know more about the diseases that can affect the nervous system and how to best take care of it.

This module on the nervous system is divided into four lessons. These are:

Lesson 1 — *Functions of the Nervous System*

Lesson 2 — *The Parts of the Nervous System*

Lesson 3 — *Injuries and Diseases That Can Affect the Nervous System*

Lesson 4 — *Taking Care of the Nervous System*

What Will You Learn From This Module?

After studying this module, you should be able to:

- describe the functions of the nervous system;
- identify the parts of the nervous system;
- demonstrate some voluntary and involuntary actions;
- explain how the nervous system works;
- name some injuries and illnesses that can affect the nervous system;
- identify recent advances in technology that help defective parts of the nervous system to function normally; and
- cite ways of taking care of the nervous system.

Let's See What You Already Know

Before you proceed to study this module find out first how much you already know about the topic. Answer the questions below by writing your answers on the lines provided.

1. Name the four major functions of the nervous system.

   a. _____
   b. _____
   c. _____
   d. _____

2. State the two major divisions of the nervous system.

   a. _____
   b. _____

3. Describe how the nervous system works.

   _____
   _____

4. Name three diseases that can affect the nervous system.

   a. _____
   b. _____
   c. _____

5. Give three ways of taking care of your nervous system.

   a. _____
   b. _____
   c. _____

Well, how was it? Do you think you fared well? Compare your answers with those in the *Answer Key* on page 46 to find out.

If all your answers are correct, very good! This shows that you already know much about the topics in this module. You may still study the module to review what you already know. Who knows, you might learn a few more new things as well.

If you got a low score, don't feel bad. This means that this module is for you. It will help you to understand some important concepts that you can apply in your daily life. If you study this module carefully, you will learn the answers to all the items in the test and a lot more! Are you ready?

You may now go to the next page to begin Lesson 1.

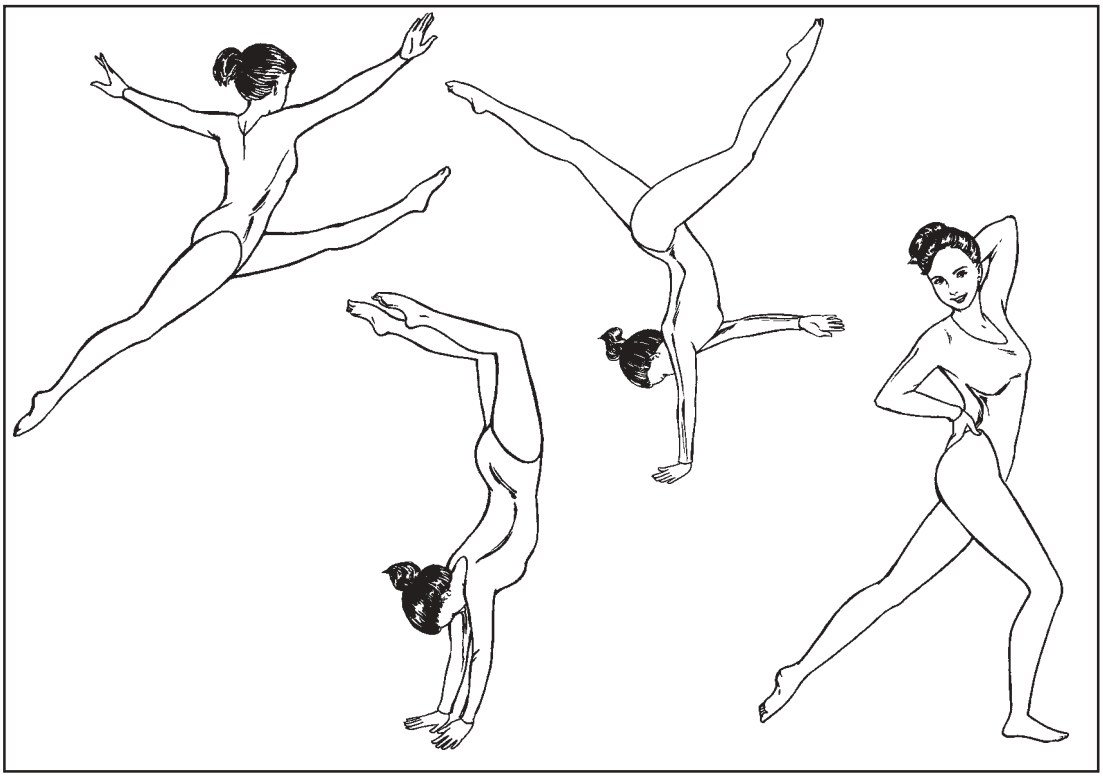
Functions of the Nervous System

The human body is a wonderful machine. It is made up of parts that work together in an orderly way to perform similar functions. A group of body organs working together to perform a function is called an **organ system.** For example, the **nervous system** is a highly developed group of structures that make us think, remember, move and learn new things.

In this lesson, you will study the functions of the nervous system. It is important to find out what these functions are for you to understand the nervous system better.

Let's Study and Analyze

Look at the picture below. What does it show? Do you see how well coordinated her muscles are? What do you think is on the girl's mind as she makes all the difficult moves?



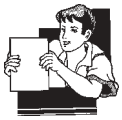
Let's Think About This

What do you think is the role played by the nervous system in enabling the girl in the picture to move?

_____

_____

_____

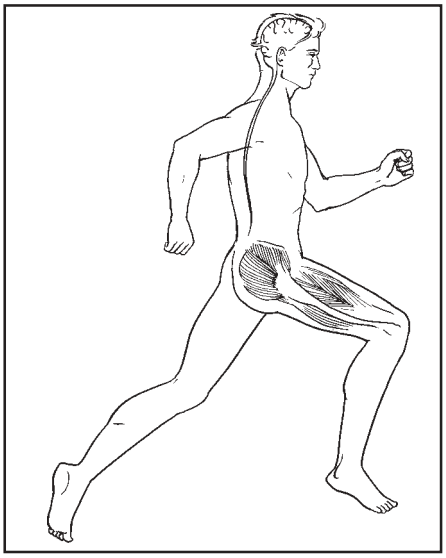


Let's Learn

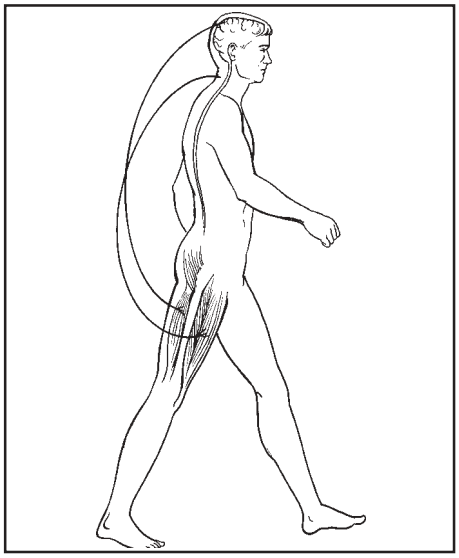
The nervous system is the main control and message center of the body. It is composed of parts that have the ability to transmit impulses. These impulses are electrical signals that travel across your body. These signals bring information and commands that keep your body healthy and functioning well. Imagine you have an organ system that makes everything in your body work!

The nervous system has four important functions. Among these are the following:

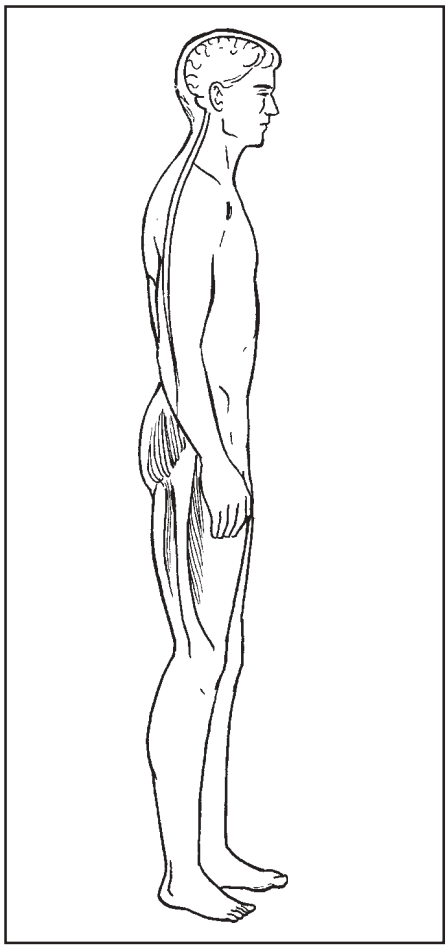
1. *The nervous system makes your body move*. Electrical impulses from the nervous system make muscles contract. *This is called the somatic or voluntary motor function of the nervous system.*



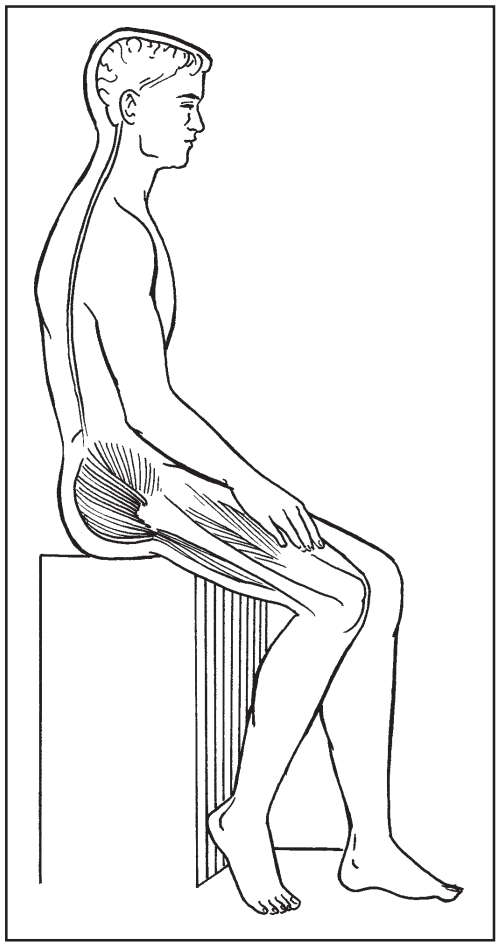
When you run, your nervous system commands your leg muscles to contract and move.



Your nervous system also helps you choose the speed at which to run. It transmits impulses to the muscles precisely to adjust your speed.



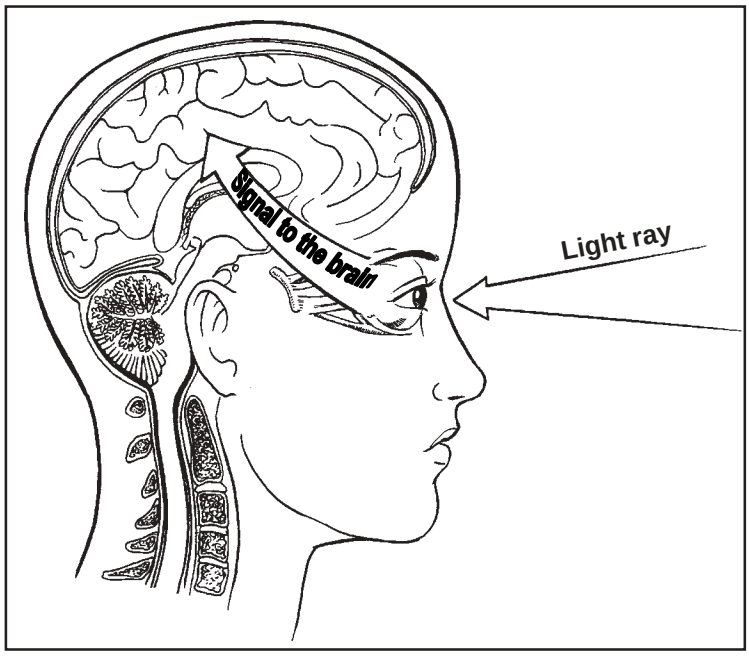
When you decide to stop, your brain sends signals to your muscles to stop contracting.



The nervous system keeps you in a comfortable position while resting.

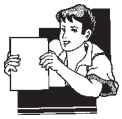
2. *The nervous system picks up stimuli. This is the sensory function of the nervous system*. **Stimuli** are signals from the environment or within your body that you respond to. Sense organs like the eyes pick up stimuli from the environment and the brain gives meaning and reacts to these information.

   All objects reflect light. When you look at an object, your eye gets stimulated by the light reflected by the object. The stimulus is translated into a signal that your eyes send to your brain. Your brain then transmits signals through your nerves that tell how you should respond to the information sent by your eyes.



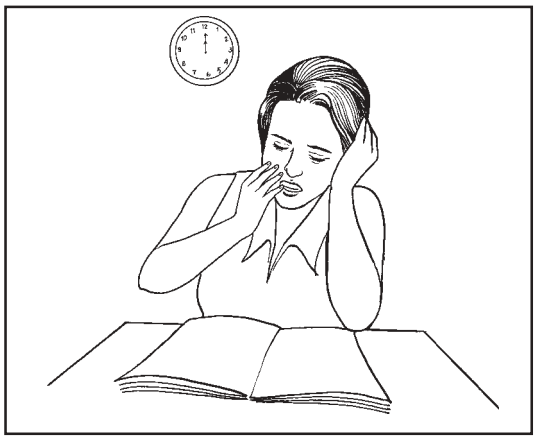
Let's Try This

Imagine how your nervous system functions as it commands various parts of your body to do a particular activity. What movements can you make? List all of these on a separate sheet of paper.



Let's Learn

Light entering your eye comes from the environment. It is called an **external stimulus.** Sometimes the stimulus comes from within your body. This is called an **internal stimulus.**



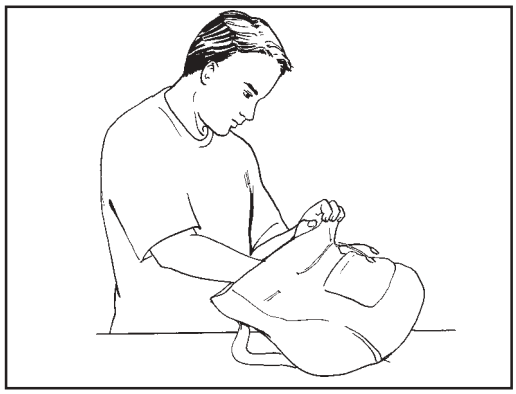
For example, it's already midnight and you are still reading a book. Your body senses that it needs to rest. You begin to feel tired and sleepy. This is an internal stimulus.

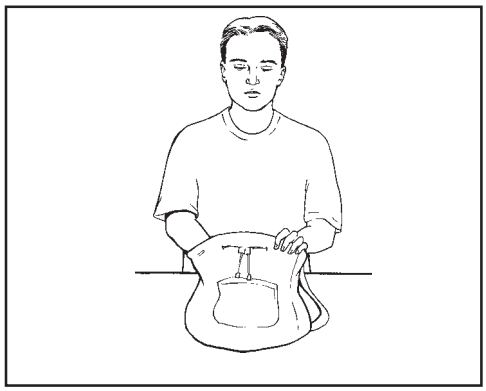
Your nervous system will tell your body to go to bed and rest in response to the internal stimulus.

Let's Try This

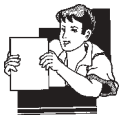
Put some personal belongings, such as a comb, a piece of soap, a ball pen, a piece of paper, etc. inside a bag. Open your bag and get an object. Use your eyes and describe what you are holding. What is its color? What is it made of? You are able to describe the object because of the external stimulus that comes from the light which is sensed by your eyes.

Now close your eyes and get another object from inside your bag. Were you able to get one? Now try to describe that object without opening your eyes. How heavy is it? How does it smell?





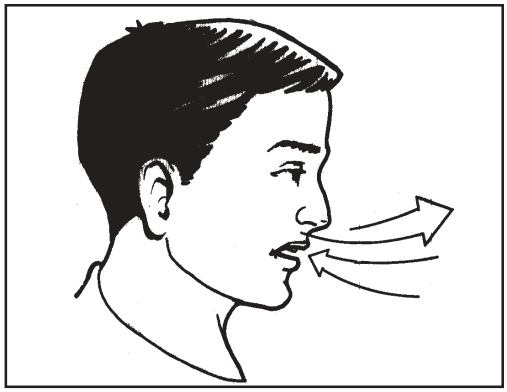
By closing your eyes, you allowed the receptors of your other sense organs like your skin, nose and hands to describe the object. The sense organs sent signals to your brain and the brain sent back signals to determine your response. In a lot of ways, the nervous system is constantly working without us being aware of it.



Let's Learn

The nervous system helps keep the heart beating by constantly transmitting signals to it. It also commands other organs like the lungs to function without your being aware of it. This is the **autonomic or involuntary function** of the human nervous system.

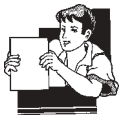
When you are angry, your heart automatically pumps faster because of the signal sent by the nervous system.



You breathe without being aware of it.

Let's Try This

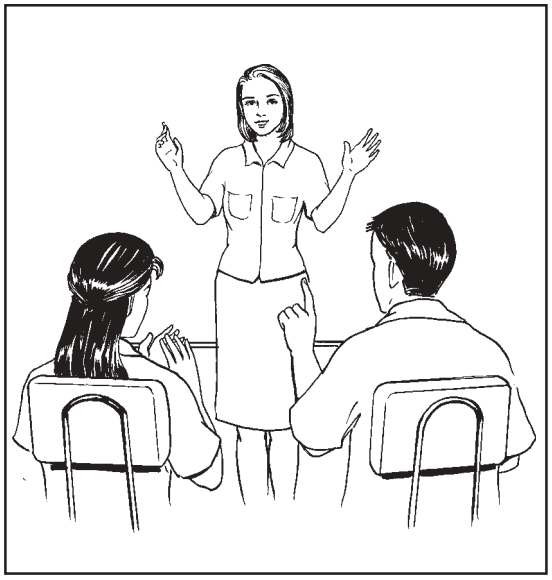
On a separate sheet of paper, make a list of all the involuntary actions of your body that you know of. How important is each of these functions? How many were you able to write down?



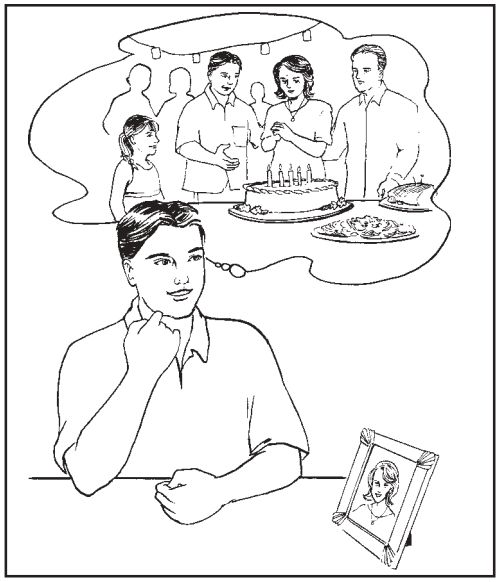
Let's Learn

We use our nervous systems every day for thinking, planning, learning and remembering. These activities reflect the **cognitive function of the nervous system.** This special ability makes us different from animals. The cognitive function of the nervous system enables us to adapt to our environment.

Consider these situations:



Ana was asked to recite a poem in front of her classmates. She was able to remember the lines and intelligently answer her classmates' questions because of her nervous system's cognitive function.



Carlo's mother was about to celebrate her birthday. Carlo wanted to hold a surprise party for her. He relied on the cognitive function of his nervous system in planning the party.

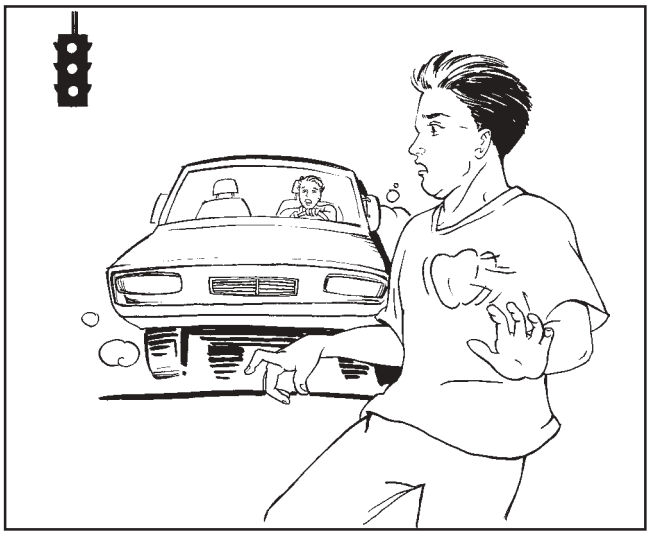
Let's recall the four major functions of the nervous system:

1. The nervous system makes the body move **(somatic or voluntary function)**.
2. The nervous system helps people detect stimuli from their environment **(sensory function)**.
3. The nervous system maintains body functions important for life without our being aware of it. **(autonomic or involuntary function)**.
4. The nervous system helps us think and remember **(cognitive function)**.

These four major functions of the nervous system are not independent of each other. It is important to remember that these functions work together and simultaneously to respond to any situation.

Consider this situation:

Jose is crossing the street when he sees a car approaching very fast **(sensory function)**. His heart starts pounding fast **(autonomic function)**. Seeing the car tells him that danger is coming **(cognitive function)**. His nervous system then directs the rest of his body to move in order for him to avoid the car **(somatic function)**.



The example illustrates how fast the nervous system responds to any situation in a coordinated manner. The nervous system functions to keep your body safe and your mind functioning well.

Let's Think About This

Think of a situation in your life when your nervous system worked to keep you safe from harm. Can you imagine what might have occurred inside your body as your nervous system received from and sent information to various parts of your body?

Let's See What You Have Learned

Column A lists the four major functions of the nervous system. The second column is a list of actions that the nervous system controls. Indicate the major function to which an action belongs by writing the corresponding number in the blank before the letter.

A		B	
1.	Somatic or voluntary function	_____	a. feeling hungry
2.	Sensory function	_____	b. running
3.	Autonomic or involuntary function	_____	c. writing
4.	Cognitive function	_____	d. digestion of food
		_____	e. remembering names
		_____	f. feeling pain
		_____	g. lifting objects
		_____	h. smelling odor
		_____	i. making decisions
		_____	j. breathing

Compare your answers with those found in the *Answer Key* on page 47. If your score is 6 or higher, very good! That means that you are learning. You may review the parts you did not understand. Afterwards, you may proceed to the next lesson.

If your score is 5 or below, you need to study this lesson again. After reviewing proceed to the next lesson.

Let's Remember

The nervous system:

- makes the body move
- enables human beings to react to internal stimuli (signals from within the body)
- interprets and reacts to external stimuli (signals from the environment)
- maintains and regulates the autonomic functions of the body
- gives human beings intelligence and the capacity to think and remember

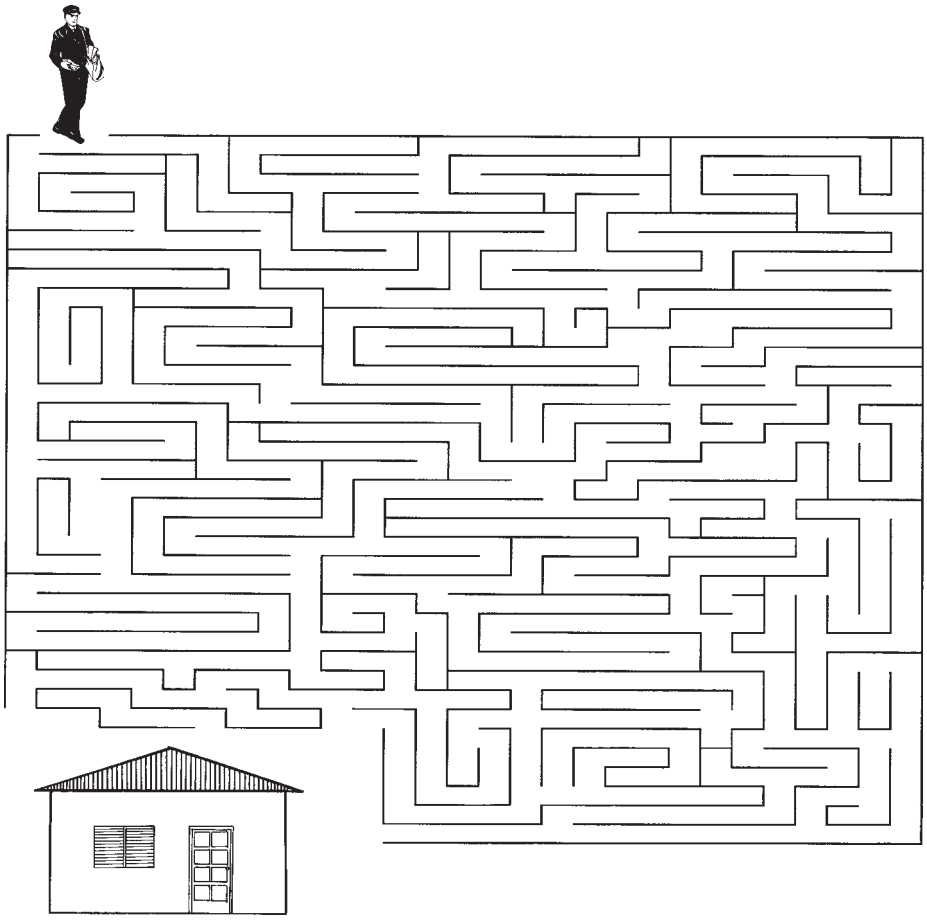
The Parts of the Nervous System

In Lesson 1, you learned about the functions of the nervous system. It is the main control and message center of the human body. Your nervous system helps keep you alive, enables you to react to stimuli, makes you move and helps you acquire knowledge. But do you know how it works?

To understand how the nervous system is able to carry out its functions, you need to learn first its parts. You will learn all these in this lesson.You will also find out how all these parts are organized to create a functioning whole to help you do a lot of things.

Let's Try This

Are you good at maze games? Try the one below. Emil is a postman and he has to deliver a letter to Mrs. Garcia's house. Trace the path Emil has to take in order to reach Mrs. Garcia's House.

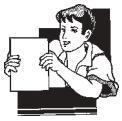


Let's Think About This

Did you enjoy solving the maze? Now think of the similarity of the maze to the nervous system. Can you guess which part of the nervous system each of the following represents?

1. the letter: _____
2. Emil the postman: _____
3. Mrs. Garcia's house: _____

Check your answers against the *Answer Key* on page 48. If you weren't able to guess the answers correctly, that's okay. Just read on to find out about the parts of the nervous system.

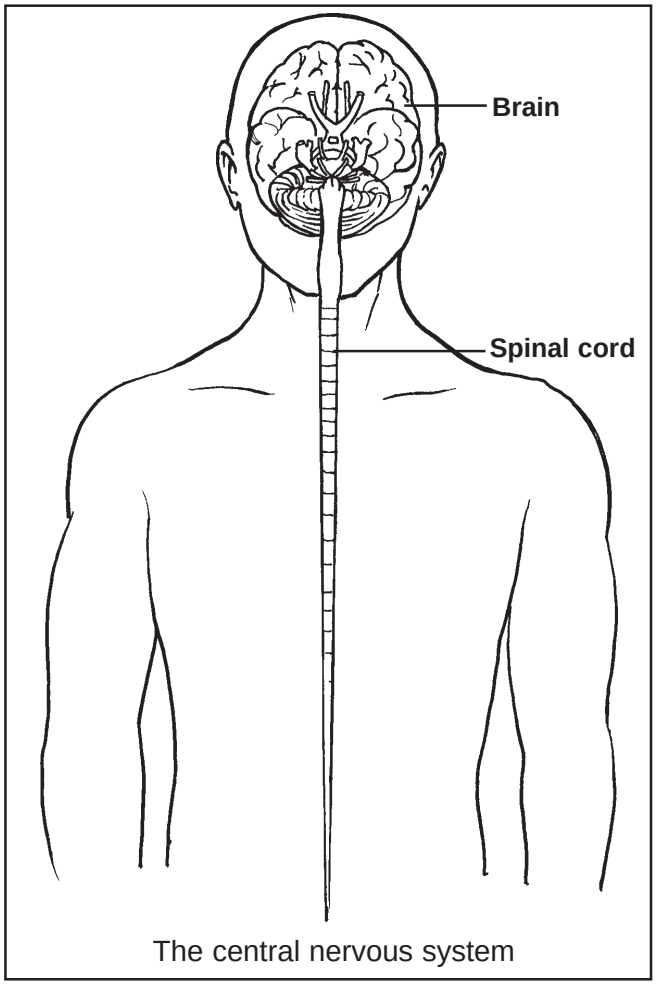


Let's Learn

If your nervous system is able to transmit information throughout the body, then it must be like a busy highway. Imagine a large number of such highways inside your body. Where would the bigger and smaller roads be? Would traffic jams occur?

Fortunately, although the nervous system is much like a busy highway, traffic jams do not occur. This is because of the way the nervous system is organized. Let us now study the parts that make up this system. The nervous system has two major divisions: the **central nervous system** and the **peripheral nervous system.**

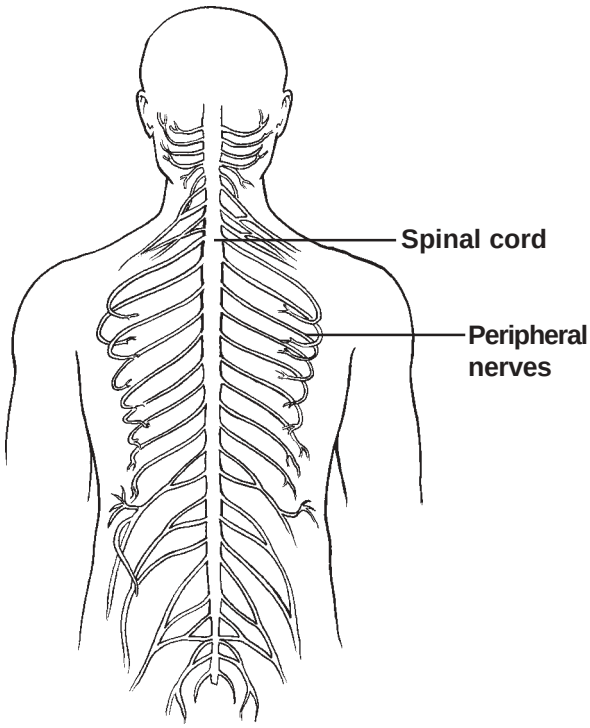
Study the figure below.



The central nervous system

The central nervous system is made up of the brain and the spinal cord. It is called central because it is located in the middle of the body. The peripheral nervous system is composed of nerve cells or neurons that extend from the spinal cord and reach the different parts of the body. The word **periphery** means on the side. Hence, the parts of the peripheral nervous system are found on the sides of the body.

You can think of the central nervous system as a highway where vehicles carrying important cargo pass through. Before these vehicles can get to their destinations, they need to travel through smaller roads. The smaller roads represent the peripheral nervous system. Without both roads, travelling would be very difficult and important cargoes would never reach their destinations. Likewise, both the central and peripheral nervous systems are important for the entire nervous system to function well.



Nerves make up the nervous system

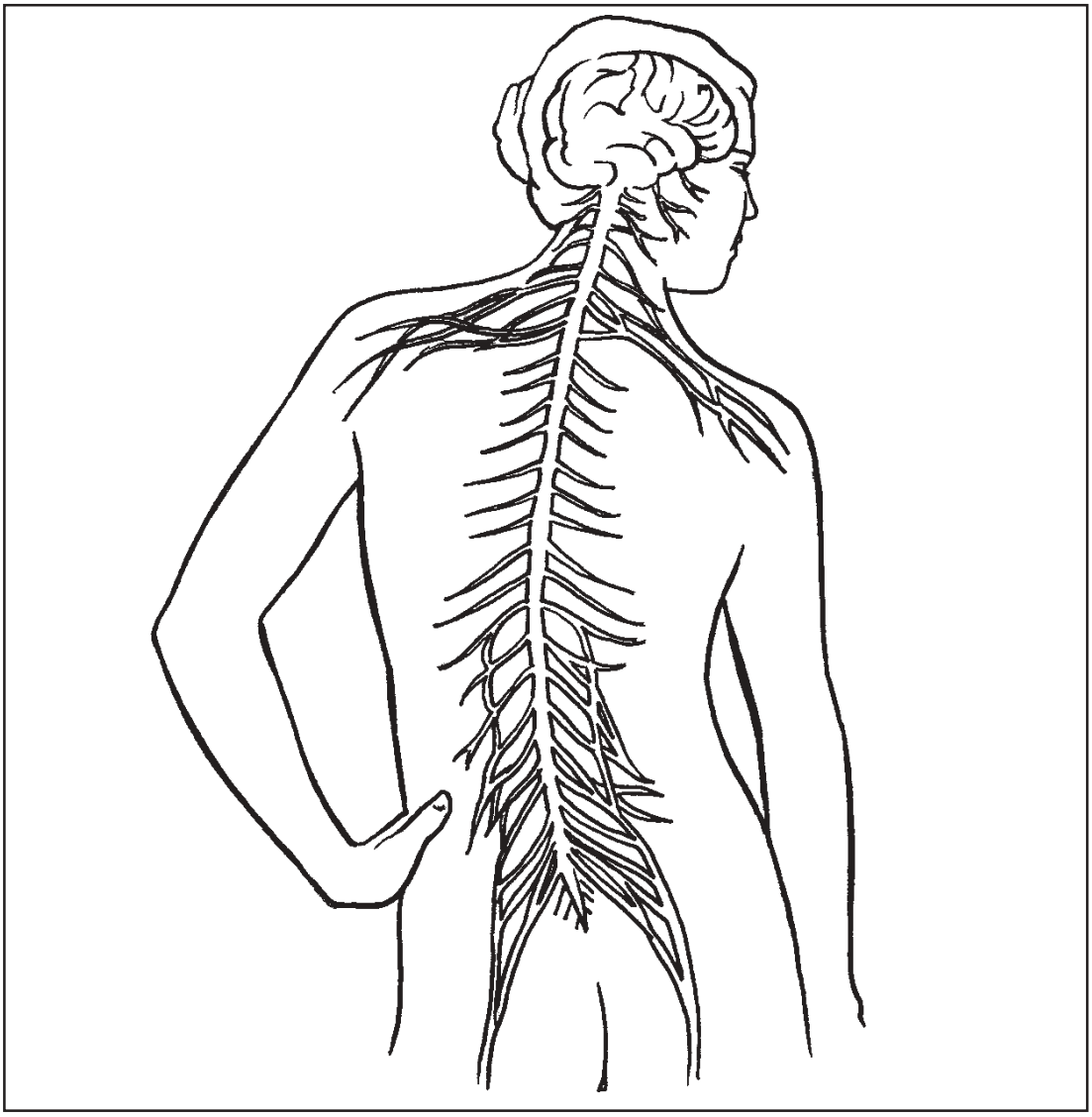
It is important to note that the nervous system is entirely composed of nerve cells or neurons. Neurons are cells that are able to transmit electrical impulses and relay information to and from all parts of the body. The spinal cord and the brain are organs made up of bundles of neurons.

Let's Try This

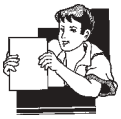
On the next page is a picture of the human nervous system. Shade the central nervous system lightly. Shade the peripheral nervous system black.

After you shaded the central and peripheral parts, imagine an external stimulus acting on one of the hands of the person in the picture. Trace its path as it travels toward the brain. Trace the path that is followed by the signal from the brain in response to that stimulus.

Check your answers comparing the picture with those on this page and on the previous one. Compare your answers with the one found in the *Answer Key* on page 48.



The Nervous System



Let's Learn

The Brain

The brain is the center of the nervous system. It governs most of your body's functions. It is found inside the head and is protected by the skull.

Let's Try This

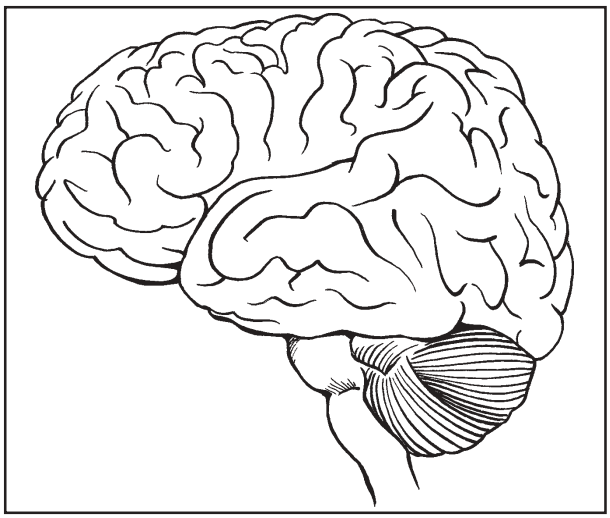
Touch your head. Do you notice how hard your skull is? Tap your head lightly. Notice that your skull does not sound hollow. This is precisely because the brain is found inside it.

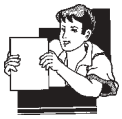
The brain is an organ that can do a lot of things. It is located in the topmost part of the body, a place it rightfully deserves because it is the master controller which governs all our body functions. The brain is the organ which receives, processes and stores information from inside and outside the body. It decides what to do with the received information and sends signals to the body to react, decide or move.

The ability of the brain to receive and send information to the body is just one of the many things it can do. But perhaps the most fascinating characteristic of the brain is its ability to make a person think. The brain is the **seat of human intelligence.** It makes you decide, reason, judge, solve, learn and remember things. Like a very powerful computer, the brain can gather and integrate information which it processes and sends back to the part of the body concerned.

Let's Try This

You now know how great the brain is but do you know what it looks like? Study carefully the picture of a brain below. In the blank spaces provided, write a description of what the brain looks like.





Let's Learn

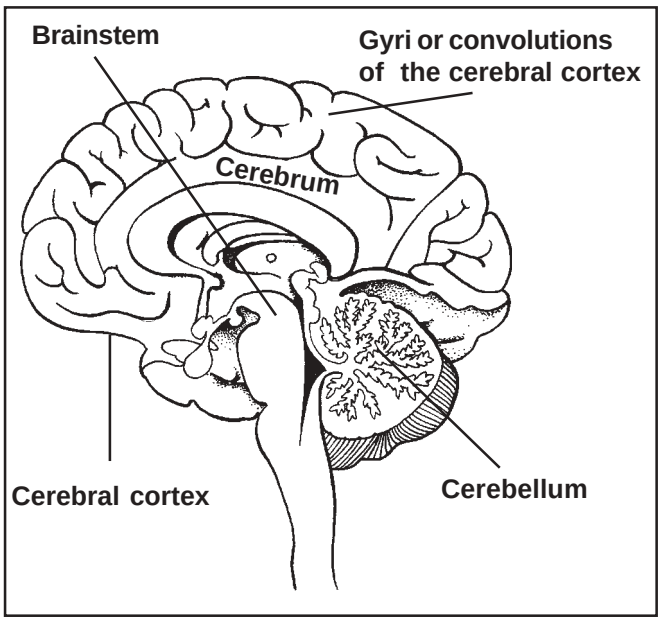
The brain looks like a white cabbage. It is, however, actually composed of nerve cells that are packed closely together to form a ball–like organ. If you wrote that the brain does not look so big, you are correct. The brain of an adult human weighs about 2.5 to 3 pounds only. The small size of the brain makes it even more amazing. The most important part of the nervous system is not so big, but it works!

Did you write down that it has wrinkled folds? If you did, that's very good! These folds are called **gyri** or **convolutions.**

Did you notice that the brain looks like it has a stalk or a handle? If you did, that's very good! That part of the brain is called the **brainstem.**

Are you now ready to know the parts of the brain?

The Cerebrum

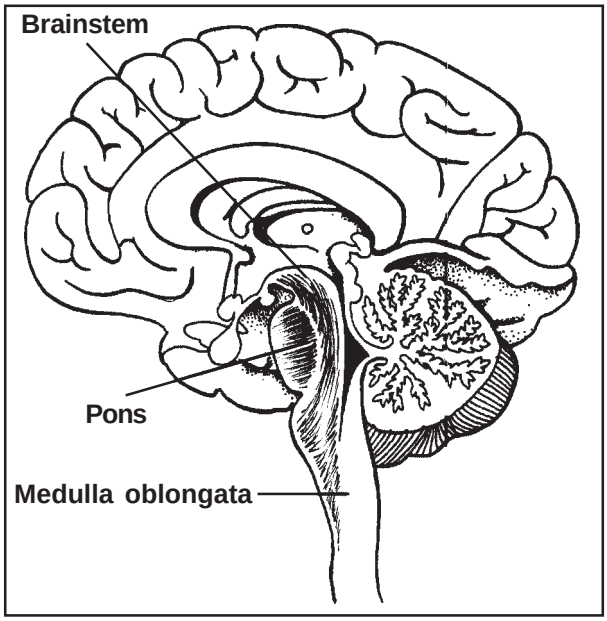


The largest part of the brain is the **cerebrum.** It receives, stores and recalls all the information the body picks up. Cognitive processes such as thinking, memorizing and decision making occur in the outer gray part of the cerebrum, which is called the **cerebral cortex. Cortex** means "covering." The inner white part of the cerebrum relays electrical signals to other parts of the brain.

The Cerebellum

The **cerebellum** is a highly folded mass of nerve tissue located just below the cerebrum. It controls muscle coordination and balance. When you play basketball, the cerebellum helps you in making your moves. Imagine a drunken man walking. He sways in an unbalanced, uncoordinated way. That is how you would be if your cerebellum were not working.

The cerebellum also orders and processes your split second actions and reactions. If your cerebrum orders you to jump, your cerebellum–your "little brain"–brings all of the muscle actions together.

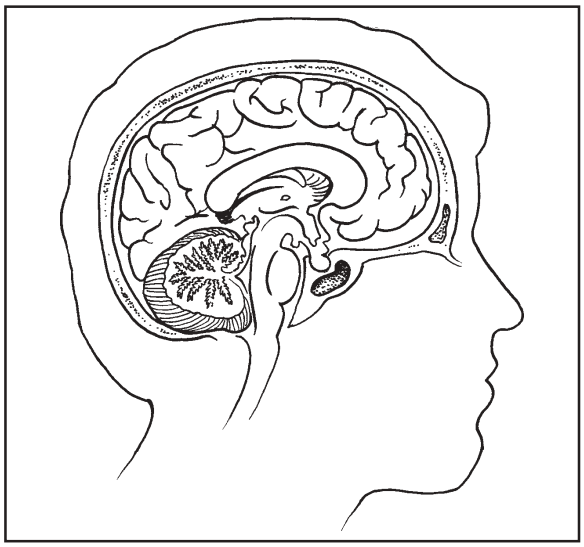


The Brainstem

The **brainstem** is the hind part of the brain. It holds the medulla oblongata and the pons. The **medulla oblongata** or medulla transmits signals between the spinal cord and the brain. It also controls autonomic or involuntary functions such as heartbeat and breathing. The **pons** is partly made up of tracts that connect the spinal cord with higher brain levels. It also contains cell groups that transfer information from the cerebrum to the cerebellum.

Let's Try This

Below is a drawing of the structure of the brain. Label its parts. You may color the brain parts if you like. Check your answer with the *Answer Key* on page 49.



Let's Review

Fill in the blanks with the correct word or group of words.

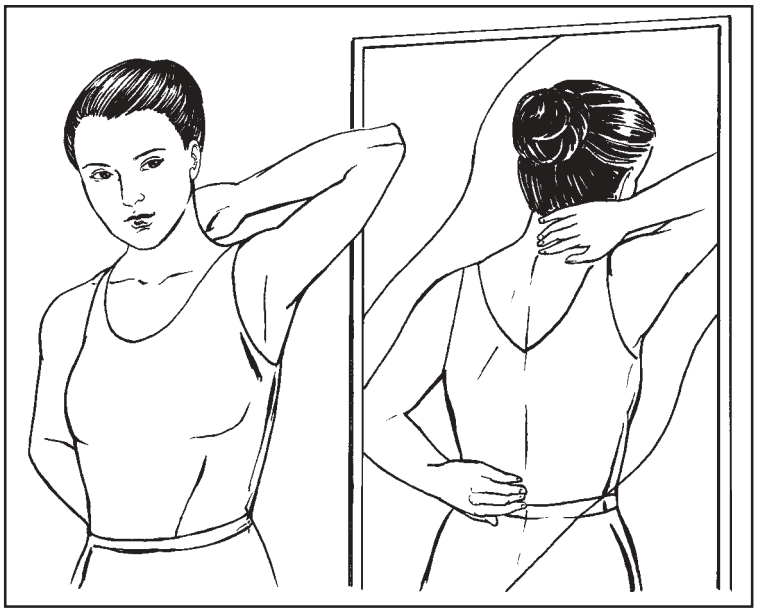
1. There are _____ major divisions of the nervous system.
2. The central nervous system is composed of the _____ and the _____.
3. The nerves that branch off the brain and the spinal cord make up the _____ nervous system.
4. The _____ is the seat of human intelligence.
5. The _____ forms the outermost portion of the cerebrum.
6. The word **cortex** means _____.
7. The wrinkled folds of the brain are called _____ or _____.
8. The _____ control logic, memory, feelings and abilities.
9. The cerebellum controls muscle coordination and _____.
10. Heartbeat is controled by the _____.

Compare your answers with the *Answer Key* on page 49. If your score is 7 and above, well done! You may proceed to the next section. If your score is 6 or below, you need to review the previous section first before proceeding to the next.

Let's Learn

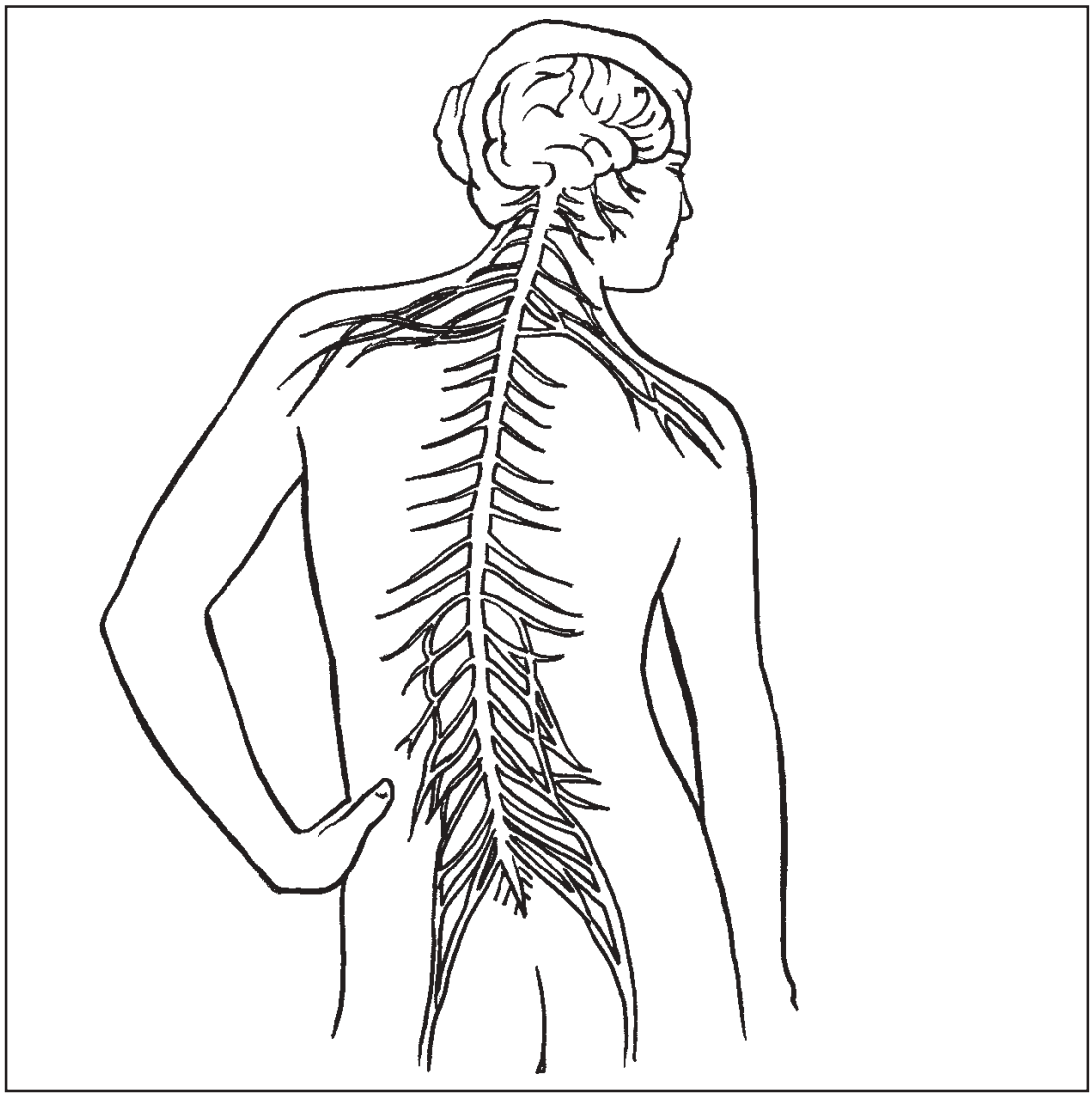
The Spinal Cord

Try this activity. Feel your nape. Then try to reach as far down your back as you can to feel the column of bones. Can you guess the number of bones along this column?



What you touched is your spinal or vertebral column which protects your spinal cord. The **spinal cord** is the downward extension of the brain. The brain has to have a way to receive signals and send commands to the different parts of the body, doesn't it? The spinal cord serves this purpose. It allows impulses to travel to and from the brain. Without the spinal cord, the brain could not receive nor send information. Without the spinal cord, the brain would lose its ability to control the body.

The spinal cord is a very delicate structure. It is only about as thick as your ring finger. It is composed of 31 bundles of nerves, exiting from the 33 connected bones collectively called the column or backbone. The nerve bundles that make up the spinal cord are highly sensitive so they must be protected.



Let's Learn

The Peripheral Nervous System

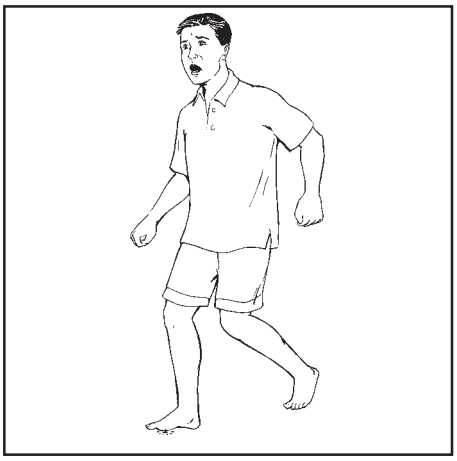
The brain and spinal cord must keep in constant communication with the other parts of the body. How do you think this is achieved? What would be the best way to send signals to and from the central nervous system?

_____

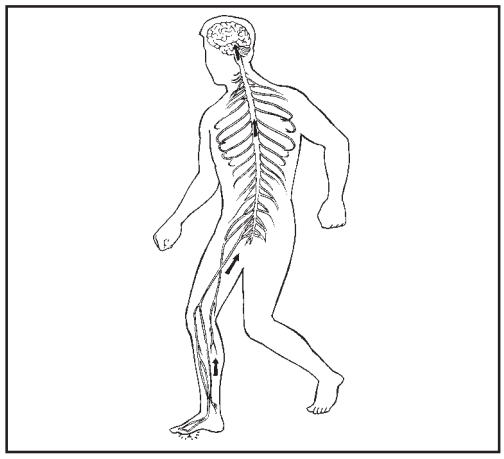
_____

From the spinal cord, bundles of nerve cells branch off and through them the central nervous system sends commands to different parts of the body. Through these nerve cells, pass the sensory signals that bring information from inside and outside the body to be processed in the brain. This system of nerve cells that branch off the brain and the spinal cord comprise the **peripheral nervous system.**

The peripheral nerves allow us to sense and react to our environment. Look at the example below:

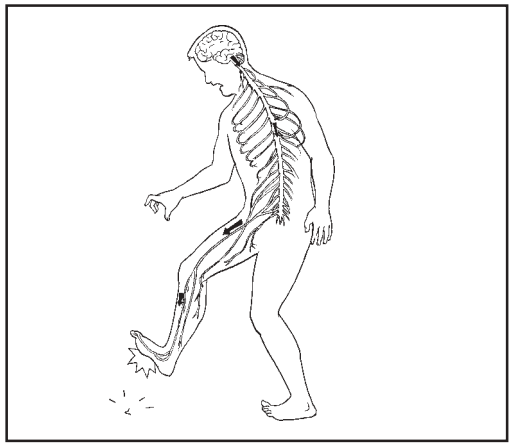


Jose is running barefoot inside his house when he steps on something pointed.



The sensation of pain is immediately detected by receptors in his skin. These receptors send the message to his brain through the spinal cord.

Jose's brain immediately picks up the signal. A decision is made by the brain immediately.



A command to withdraw his foot is sent by his brain. Muscles of his leg contract and the object is avoided.

The brain, through the peripheral nervous system, sends signals to the body to react to certain conditions. An action that is willed or controlled by your thoughts is called a **voluntary action.** Jumping, running and singing are voluntary actions. You run only when you want to run and sing only when you want to sing. You can stop anytime or continue doing something for a long time. There is a conscious effort in doing the activity. These movements are being actively controlled by the brain.

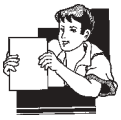
These actions usually happen very fast and are mostly meant to protect the body from harm. An example is a hand being withdrawn immediately from a hot surface. Increased beating of the heart during fearful events is another.

Let's Review

Below is a list of activities that the body can do. Encircle the voluntary activities. Underline the involuntary activities.

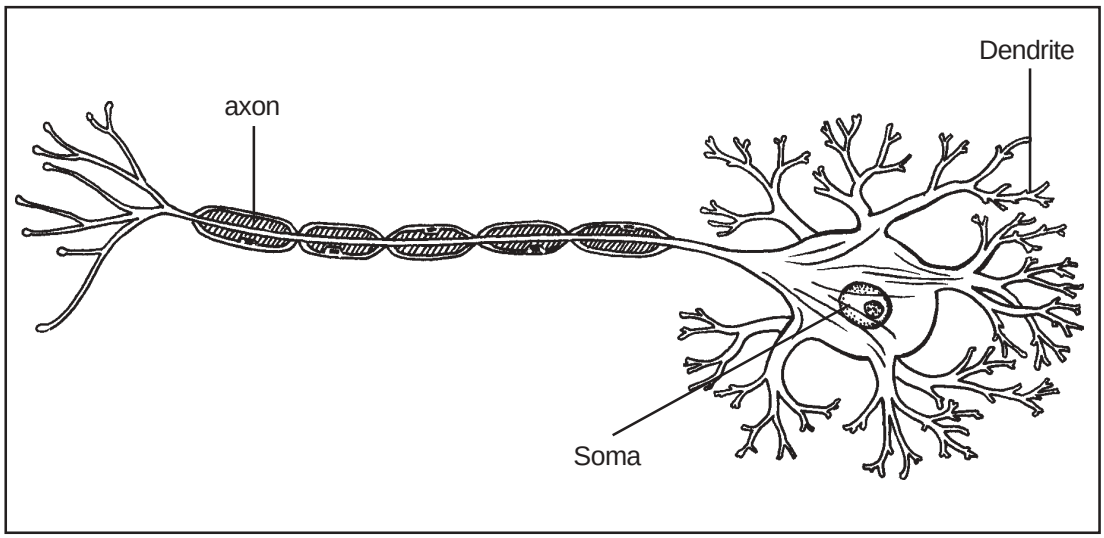
1. running
2. jumping
3. beating of the heart
4. praying
5. breathing
6. singing
7. digesting food
8. talking
9. trembling
10. dancing

Compare your answers with the *Answer Key* on page 49. If you got everything right, that means that you are learning very well. If you missed some items, study the previous section again.



Let's Learn

In the situation presented on page 22, the pain signal from the environment was immediately sent and received and acted on by the central nervous system because of the ability of nerves to conduct electrical impulses. **Nerves** are bundles of fibers (axons) from neurons and which are held together by connective tissue. Look at the diagram of the neuron below.



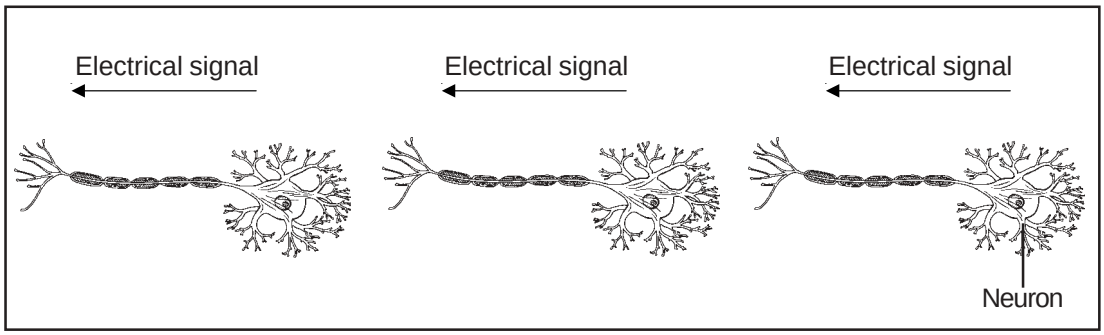
The nerve cell or neuron is the basic unit of the nervous system. Its shape helps it carry out its function. A neuron consists of the following parts:

- The fibers that branch out from the nerve cell are the **dendrites.** These fibers pick up information from the receptors. (Receptors are parts of the body, either nerves or sense organs, that can pick up stimuli from the environment or from within the body).

- The information received by the dendrites is then carried to the **cell body** or **soma** in the form of an electrical signal. The cell body contains the nucleus of the cell as well as other structures that help keep the cell alive.
- The electrical signal continues along the cell body and moves to a single, long fiber called an **axon.** From the axon, the electrical signal is transmitted to another nerve cell. Between the axon of one cell and the dendrite of another is a small gap called **synapse.** When the electrical signal reaches the tip of the axon of one cell, a chemical spills into the synapse. This chemical receives and carries the electrical signal to the dendrite of the next nerve cell.

The relay of an electrical signal from one nerve cell to another takes place at around 100 meters per second.

Can you imagine how the process of transmitting electrical signals takes place? Well, then, think of the process as something like setting off a fire. The flame is the elctrical signal from the receptors and the nerve cells are the pieces of fuel lined up next to each other. Once the flame (the electrical signal) reaches one piece of fuel (a nerve cell), it quickly travels from that fuel to the next (first nerve cell to another), and so on.



Let's Think About This

How fast do you think does electricity travel through nerves? Two meters per second, a million meters per second? Studies on the speed of conduction in the nerve cells show that electricity travels at an average speed of 60 meters per second in a thick myelinated nerve. When a nerve is myelinated, it means that it is covered with a fatty layer called myelin sheath which allows impulses to travel through nerve cells faster. The body length of an average human adult is about 1.2 to 1.8 meters. In one second, a signal traveling through the nerve cells is able to pass from the head to the toes a total of 30 times! That's quite fast, isn't it?

Let's See What You Have Learned

A. Read the following statements. Write **True** in the blank before each correct statement and **False** before each wrong statement.

_____ 1. The spinal cord protects the spinal column.

_____ 2. The spinal cord is made up of nerves.

_____ 3. The spinal cord belongs to the peripheral nervous system.

_____ 4. The spinal cord only sends messages from the brain to the body.

_____ 5. The spinal column is also known as the backbone.

_____ 6. The neuron is the basic unit of the nervous system

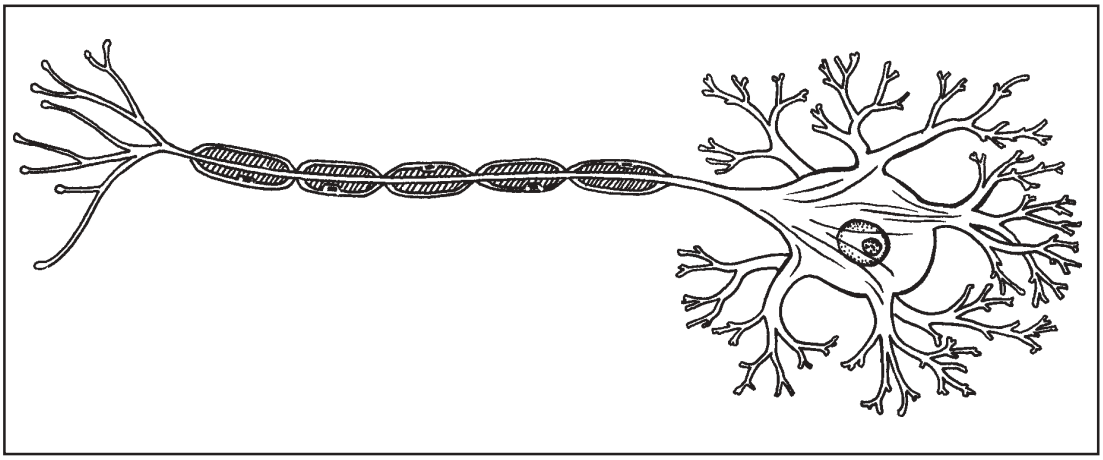
_____ 7. The shape of the neuron helps it carry out its function of transmitting electrical signals.

_____ 8. The neuron has only a soma and an axon.

_____ 9. Dendrites send messages.

_____ 10. Nerves are composed of bundles of neurons.

B. Label the 3 major parts of a neuron.



Compare your answers with the *Answer Key* found on page 50. If your score is 12 or above, congratulations! You have learned about the spinal cord and the neuron well. You may already proceed to the next lesson. If your score is 6 or below, you may need to review the previous lesson before proceeding.

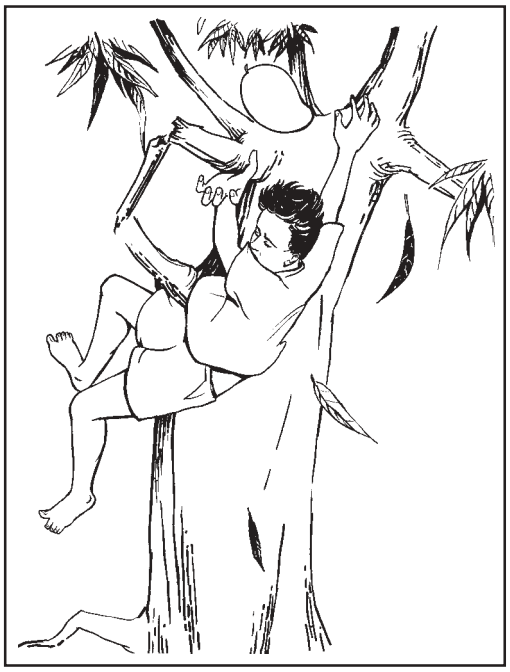
Let's Remember

- The nervous system has two main divisions–the central nervous system and the peripheral nervous system.
- The central nervous system is composed of the brain and spinal cord.
- The brain is the seat of human intelligence. Its main parts are the:
  - Cerebrum–the largest part of the brain; its outer gray part, the cerebral cortex, controls the cognitive processes.
  - Cerebellum–considered the "little brain"; controls muscle coordination and balance.
  - Brainstem–contains the medulla oblongata, which controls autonomic functions, and the pons, which transfers information from the cerebrum to the cerebellum.
- The spinal cord is the downward extension of the brain. It transmits signals from various parts of the body to the brain.
- The peripheral nervous system is composed of all the nerve cells that branch off from the brain and the spinal cord.
- The nerve cell or neuron is the basic unit of the nervous system. It has three main parts: the dendrites, cell body or soma and axon.

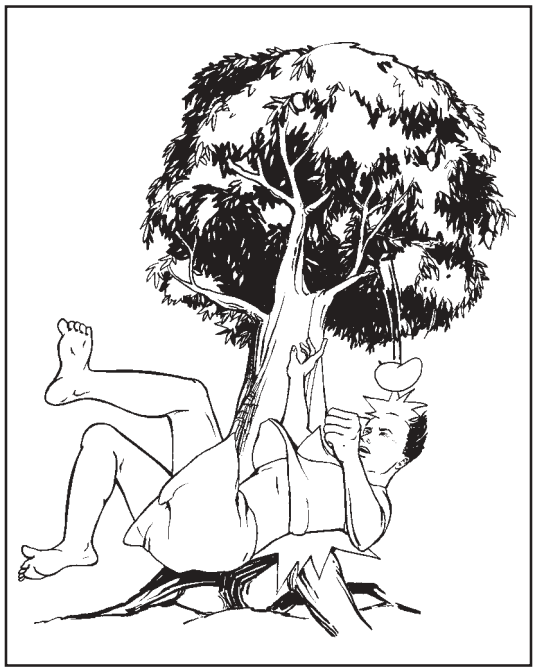
Injuries and Diseases That Can Affect the Nervous System

By now, you have already learned about the functions and parts of the nervous system. You have discovered how important the nervous system is. What if something wrong happens? What if you suddenly developed an injury to your spinal cord? How would it affect your life?

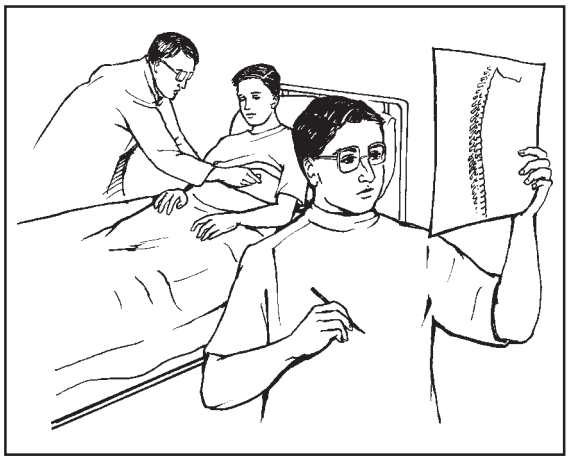
Let's Read



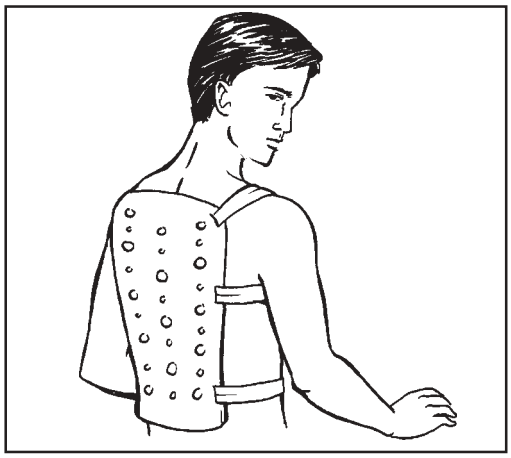
Carlo was climbing a mango tree when he slipped and fell.



He hit his back on a large tree root. Immediately after the accident, he was unable to move.



Carlo was brought to a hospital. The doctors found out that one of his vertebrae was fractured or broken.



He was unable to move for days and had to wear a body brace. He wished that he had been more careful in climbing the tree.

Carlo was lucky that he only sustained minor injuries to his spine. He was able to recover quickly from the accident. Nevertheless, for a long time he had to wear a body brace to allow his fractured vertebra to heal.

Now, consider Ana's case:

Ana was riding a motorcycle without a helmet. She fell off the motorcycle and hit her head on the concrete ground. Ana was immediately brought to a hospital. Doctors told her parents that because she was not wearing any helmet, she sustained a skull fracture. Because of this, her brain was badly damaged. Ana was comatose or unconscious for several weeks.

Let's Think About This

Answer the following questions:

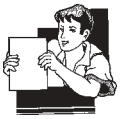
1. What caused Carlo's and Ana's accidents?

   _____
   _____

2. Why is it important to protect the vertebrae and the skull?

   _____
   _____

Compare your answers with the *Answer Key* on page 50.



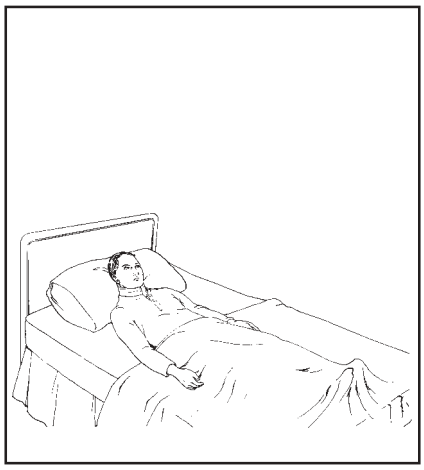
Let's Learn

In the two situations given, Carlo and Ana both suffered from bone fractures. A fracture occurs when a bone is broken. Unfortunately for Carlo and Ana, their fractured bones happen to serve as protective covers for the central nervous system. The vertebrae protect the spinal cord while the skull protects the brain.

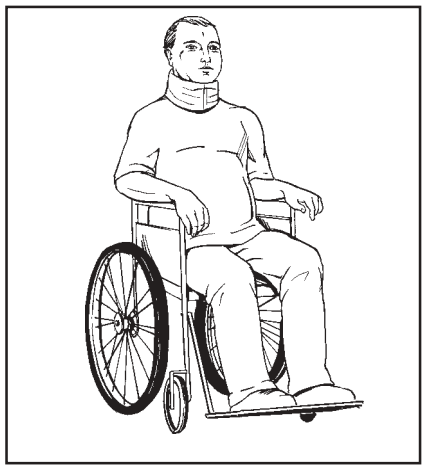
If the fracture is severe, it could also damage the organ the fractured bone protects. This is what happened in Ana's case. Because her brain was damaged by the fracture, she remained unconscious for a long time.

The parts of the nervous system are very delicate. If any of these parts sustain injury, the rest of the body will most likely be affected. Many activities, especially in sports, can be quite dangerous to the nervous system if proper care is not observed.

Risky activities such as diving in shallow water, jumping from a tall tree and high -speed racing could injure the spinal cord. Injury to the spinal cord could lead to **paraplegia,** or inability to move the legs, or **quadriplegia,** inability to move both arms and legs.



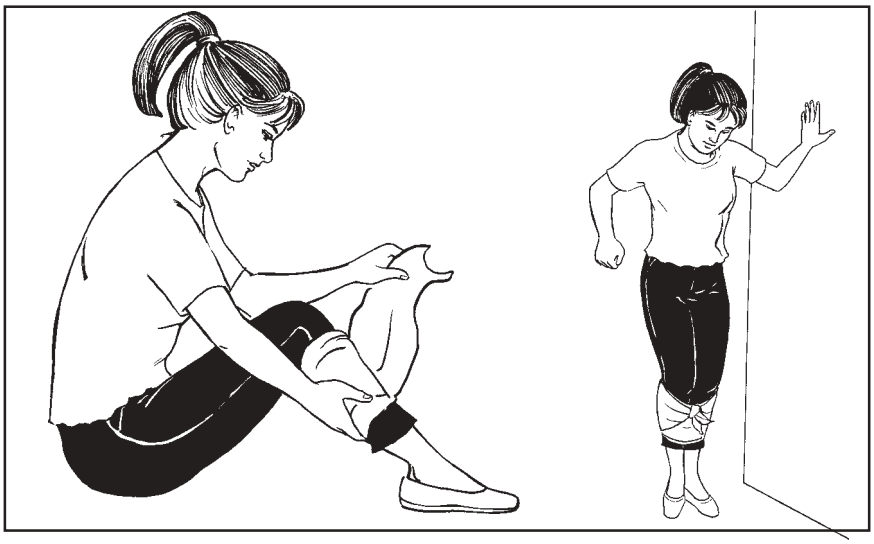
Quadriplegia



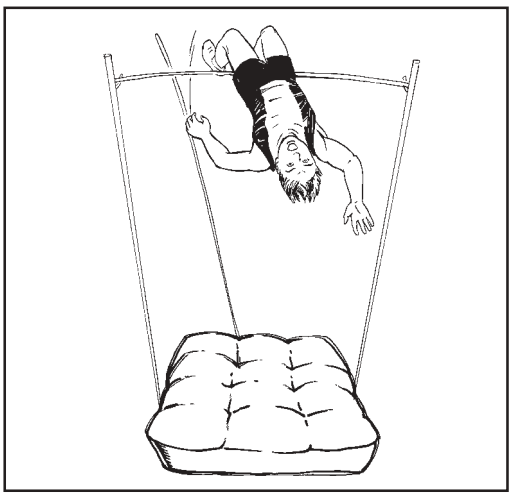
Paraplegia

Let's Try This

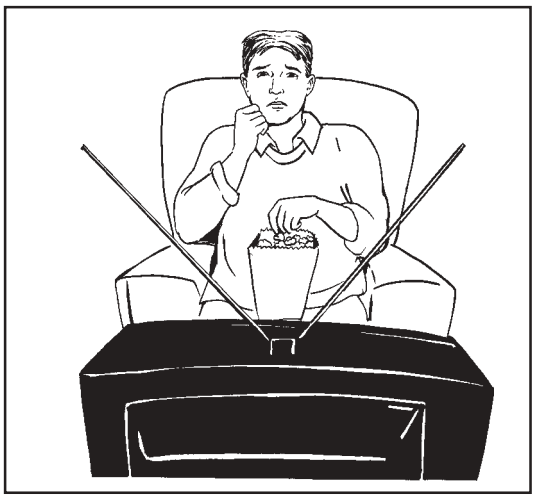
To understand how it is to be a paraplegic, wrap a piece of cloth around both of your legs. Make sure that the cloth is wrapped tightly enough that you are not able to move your legs but not too tightly to cause pain. Try to do the usual things you do inside the house like eating, watching television and going to the bathroom. What did you learn from this activity?



Other accidents can also injure the nervous system.



Athletes sometimes twist their backs. The discs between the vertebrae are tissues that serve as "shock absorber," bearing any strain on the back. When a disc is dislocated, it bulges and causes pressure on the spinal nerves.



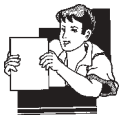
A slipped disc is very painful. The pain is so severe that people who suffer from this injury are not able to move well for months.

Fortunately a slipped disc is curable. The patient is made to wear body braces and undergo physical therapy to reposition the disc.

Let's Think About This

Imagine that you are playing basketball when you suddenly feel something very painful in your back, as if something snapped. The pain is so severe that for a time you are unable to move.

What things do you think you could do in spite of a painful back? What things do you think you would not be able to do?



Let's Learn

Disorders That Can Affect the Nervous System

1. ***Stroke***

> Paulo Cruz is a 75-year-old retired teacher. He was brought to a hospital two years ago because of a stroke. He stayed in the hospital for about a month. When he finally got home, his family noticed that there are now changes in the way he moves and thinks. The right side of his body seems to be weaker than the left. He walks with a limp because of this. Mr. Cruz also forgets about things and gets tired easily.

A **stroke** occurs when a blood vessel supplying oxygen and nutrients to the brain becomes clogged (embolism) or bursts (hemorrhage). When this happens, part of the brain doesn't get the blood flow it needs. Deprived of oxygen, nerve cells in the affected area of the brain cannot function and die within minutes. This area of dead cells is called a **brain infarct.** When brain cells die, the part of the body controlled by these cells cannot function as well. The effects of stroke are often permanent because dead brain cells cannot be replaced.

2. ***Meningitis***

> John is 7 years old. He was brought to a hospital because he was complaining of high fever, headache and stiff neck. His doctors said that he has meningitis.

Meningitis is an infection of the fluid of a person's spinal cord and the fluid that surrounds the brain. It is usually caused by viruses or bacteria. These viruses and bacteria are usually introduced through the bloodstream from infections in other parts of the body. Bacterial meningitis is more severe than viral meningitis. It can result in brain damage, hearing loss or learning disability.

3. ***Multiple Sclerosis***

Diana was 26 years old when she started to notice that she was unable to remember a lot of things. She also found it more difficult to dance because she couldn't control her movements. Her forgetfulness and weakness worsened. By age 28, she was completely paralyzed.

Multiple sclerosis (MS) is a chronic, progressive disease that occurs when the body's immune system attacks the myelin sheaths that surround the brain and spinal cord. The damaged areas are unable to transmit nerve impulses and the nerves themselves are gradually damaged. MS usually strikes a person between the ages of 20 and 40 years. Its symptoms include visual problems, emotional disturbances, speech disorders, convulsions, bladder disturbances, paralysis and muscular weakness. There is no known cure for this disease.

4. ***Epilepsy***

Buboy was 2 years old when he started having seizures. Without warning, he would just fall to the ground and his body would start convulsing. Afterwards he would lose consciousness and wake up after several minutes. Most of the time, he could not even remember what had just happened. These seizures would happen almost every day until his mother brought him to a hospital. The doctor said that Buboy has epilepsy.

Epilepsy is a chronic disorder of the function of the cerebrum. Sudden bursts of electrical activity cause changes in awareness, tremors, jerking movements and loss of consciousness. Epileptic seizures can now be limited through the intake of some drugs.

5. ***Alzheimer's Disease***

Ronald Reagan is a former president of the Unites States of America. Years after the end of his term, he developed a condition that affected his nervous system. This condition is called Alzheimer's disease.

People with Alzheimer's disease often have lapses of memory. Learning new information is severely hampered as well. Alzheimer's disease is a degenerative disease of nerve cells in the cerebral cortex. It most often occurs among people over 65 years of age. It is characterized by the formation of plaques and malformed nerve cells in the brain. This leads to progressive memory loss and impairment of mental functioning.

6. ***Parkinson's Disease***

> Muhammad Ali was a world-famous boxer. After he retired, he developed constant trembling of his hands. He also experiences tremors in his legs which make him walk and move very slowly. Because of this, he is not able to do a lot of things and always has to be assisted.

Parkinson's disease is a progressive disorder in which the chemicals that facilitate electrical transmission between neurons are defected. Symptoms usually begin in middle to later life. Among these are trembling of the lips and hands, loss of facial expression and rigidity of the muscles. After many years, the patient might no longer be able to move. There's no cure yet for this disease, although there are drugs that can be taken to ease its worst symptoms.

7. ***Mental Retardation***

> When Carla was born, her parents were overjoyed. She was a cute and healthy baby. However, as she grew up, it became obvious that she has problems learning. She also has difficulty interacting with other people and exhibits unusual behavior such as staying in one corner quietly for a very long time. Although she can talk, her words do not make much sense. Because of this, her parents brought her to a doctor who told them that Carla is suffering from mental retardation.

Mental retardation is a condition characterized by below-average intellectual or learning skills as well as a limitation of skills necessary for daily living. Among these skills are the ability to communicate, care for oneself and work. It could be caused by a genetic defect or injuries related to childbirth. The most common cause of mental retardation is trisomy 21 also known as **mongolism** or **Down syndrome.** Down syndrome is a genetic disorder which imparts to its victims a characteristic physical appearance (smaller, abnormally shaped head, flattened nose, protruding tongue and upward slanting eyes).

Let's Try This

Think of a person you know who has an injury or illness that affects his/her nervous system.

1. List down five aspects of his/her body, movement, behavior and thinking that are different from those of people with healthy nervous systems.

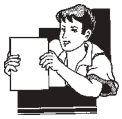
   _____
   _____
   _____
   _____
   _____

2. List down three parts of the nervous system that are possibly affected by the injury or disease.

_____
_____
_____
_____

Check your answers against the *Answer Keys* on page 51. If you got 7 or more correct answers, that means you are learning a lot about injuries and diseases that can affect your nervous system. That's good. If you got a score of 5 or below, review the parts of the section that you missed.

After doing this exercise, think of yourself and how lucky you are that you have a nervous system that functions very well.

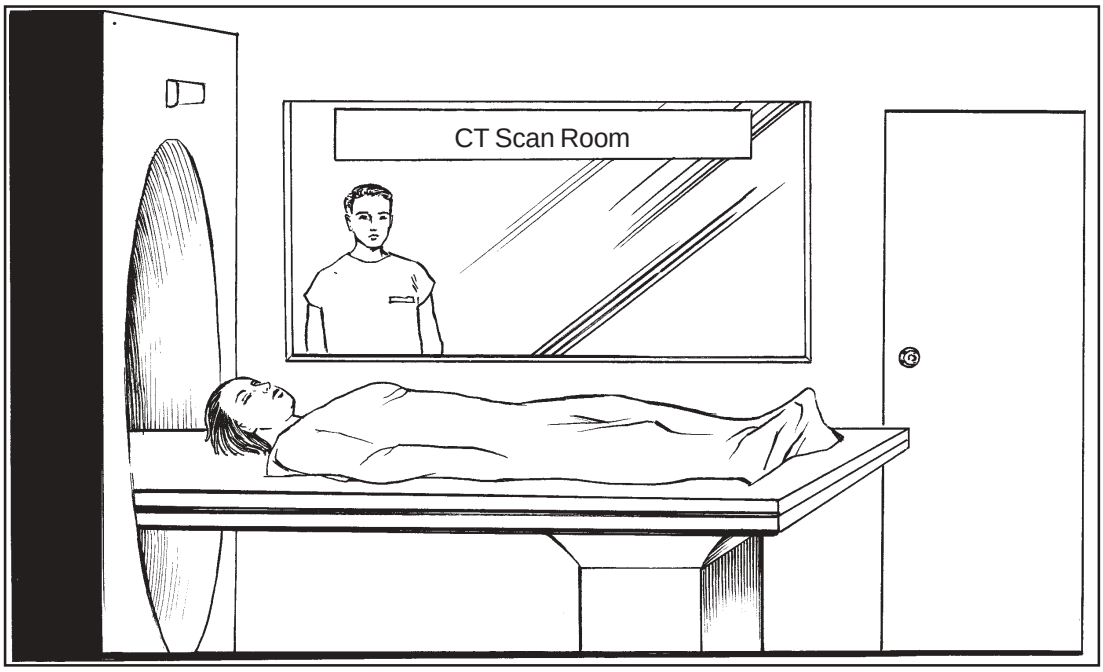


Let's Learn

Because of the many injuries and diseases that can affect the nervous system, new technological advances in neuroscience – the study of the nervous system – have been developed. These advances help scientists and doctors gain more understanding of the nervous system and the diseases that can affect it.

Recent Advances in the Neurosciences

A very important technology developed to understand the structure and workings of the brain is **computerized axial tomography scan,** also known as CAT scan or CT scan. A CT scan is an X–ray technique that allows relatively safe and painless diagnosis in various areas of the body. It gives a better understanding of the brain and other parts of the nervous system by making possible a detailed study of these structures. In a CT scanner, an X–ray tube rotates around a specific area of the body. The tube delivers an appropraite amount of radiation for the tissue being studied. It then takes pictures of the tissue from different angles. A computer program then forms a readable image of the scanned part of the body.

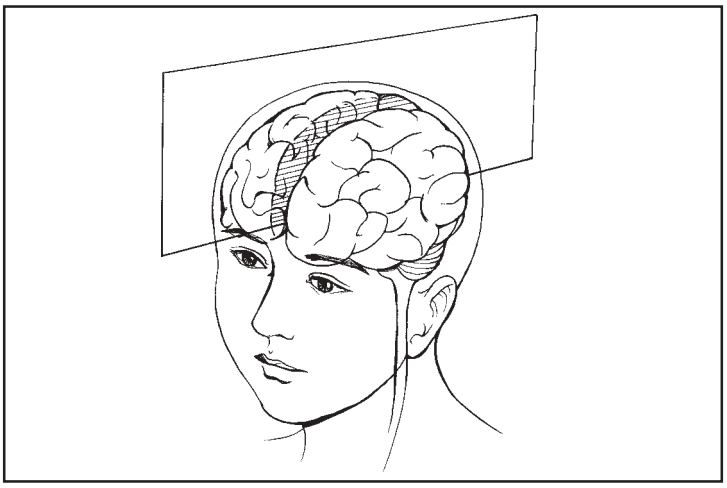


A more sensitive imaging technique is **magnetic resonance imaging (MRI).** This technique uses a strong magnetic field, radio waves and computers to look inside a patient's body. MRIs are most useful in detecting injuries of the spinal cord.

Advances in brain surgery also give more hope to patients affected with brain disease such as tumors. Neurosurgeons or doctors who operate on the nervous system now use lasers for surgery. **Lasers** are highly concentrated beams of light that can cut or burn unwanted tissues in the brain. Robots controlled by the skillful hands of neurosurgeons are also being used to perform surgery on the brain.

Drugs used for the treatment of nervous system disorders such as Alzheimer's disease, Parkinson's disease, meningitis and stroke are being developed, and some of them are currently being used to help a lot of patients towards recovery. Attacks of epilepsy can now be minimized because of drugs like phenytoin and valproic acid.

Surgical cutting of the **corpus callosum,** the structure that connects the two sides of the brain, is now being used to limit the electrical storms of epilepsy coming from one side of the brain to reach the other side.



Surgical procedures on epileptic patients requires cutting off the connection between the left and right sides of the brain.

Truly, human beings are learning more and more about the nervous system because of the development of surgical and diagnostic technology.

Let's Remember

- The nervous system is prone to injuries and diseases that can affect its proper functioning.
- Some injuries that can affect the nervous system are skull and vertebral fractures, slipped discs, and injuries of the spinal cord which could result in quadriplegia or paraplegia.
- Some disorders that can affect the nervous system are stroke, Alzheimer's disease, Parkinson's disease, meningitis, mental retardation, epilepsy and multiple sclerosis.
- Recently developed techniques in diagnosing disorders of the nervous system are the CT scan and MRI. Aside from these, more sophisticated surgical procedures such as those using lasers and robots are now common. New drugs are also being developed to cure the disorders of the nervous system.

Let's See What You Have Learned

Write the correct word in the blank.

1. A _____ is caused by a sudden blockage or bursting of a blood vessel, resulting in a decreased blood supply to the brain.

2. _____ is characterized by progressive loss of memory among the elderly.

3. Parkinson's disease often appears as _____ of the muscles.

4. _____ is an infection of the fluid of a person's brain and spinal cord.

5. _____ is characterized by sudden uncontrollable seizures.

6. Slipped discs are characterized by a sudden shooting _____ in the back.

7. _____ and _____ are technological advances used by neurosurgeons in operating on the brain.

8. Fractures are broken _____.

9. MRI means_____.

10. The structure that connects the two sides of the brain is called the _____.

Compare your answers with those found in the *Answer Key* on page 51.

If your score is 7 and above, congratulations! You may proceed to the next lesson. If you got a lower score, review the items you missed, then proceed to Lesson 4.

Taking Care of the Nervous System

In the previous lesson, you learned about some of the injuries and diseases that can affect the nervous system. You also discovered some recent advancements in diagnostic and treatment procedures that are used to correct the disorders of the nervous system.

In this lesson, you will learn how to take care of your nervous system without which life would not exist. It is easy to take care of the nervous system.

Let's Think About This

How well do you take care of your nervous system? Take the following test to find out.

Answer the questions with either yes or no by putting a check (3) mark on the blank space of the correct answer.

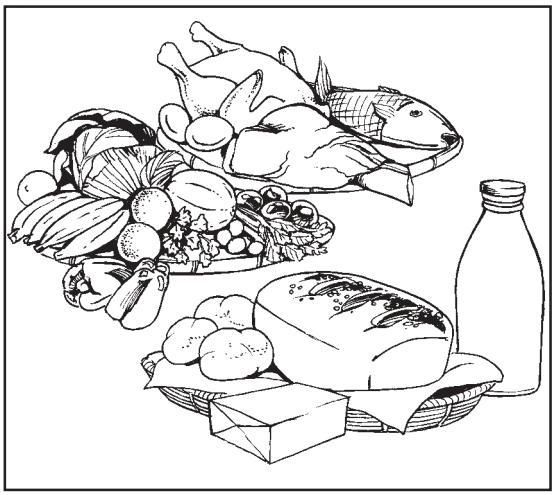
1. Do you wear a seat belt when you are riding in a vehicle? ____ Yes ____ No
2. Do you wear a helmet when you ride a bicycle or motorcycle or when you go skateboarding? ____ Yes ____ No
3. Do you wear protective gear when you engage in sports such as boxing? ____ Yes ____ No
4. When you go swimming, do you make sure that you dive only into the deep end of the pool or that the water in the lake or beach is deep enough? ____ Yes ____ No
5. Do you look both ways before crossing the street? ____ Yes ____ No
6. Do you eat nutritious foods, especially those containing vitamin B? ____ Yes ____ No
7. Do you dispose of chemicals such as pesticides and cleaning solutions properly by placing them in separate containers? ____ Yes ____ No

If you answered yes to all the questions, that means that you are taking care of your nervous system well. Read on to find out more about taking care of your nervous system.

Let's Learn

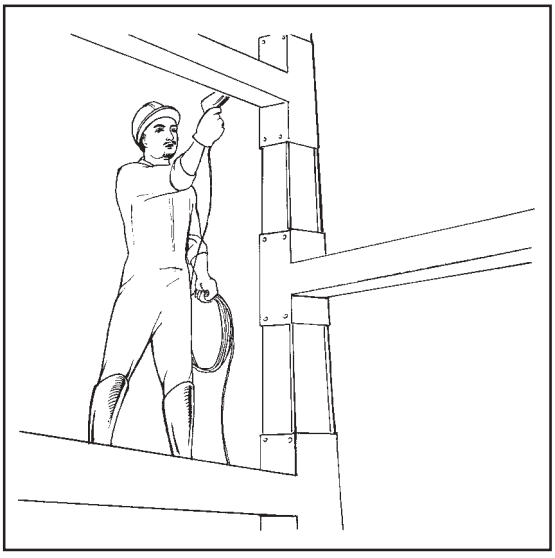
Observe the following practices to make sure that your nervous system remains healthy and functioning well.

Eat nutritious foods.

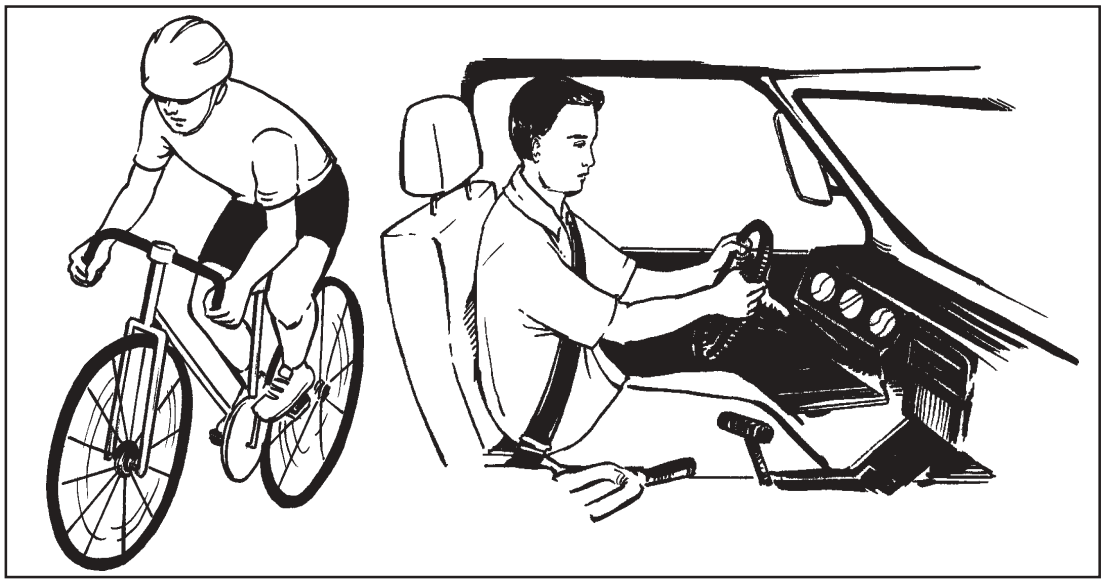


Eat foods rich in proteins, which are building blocks of the brain. Vitamins (especially B complex) and minerals also help in maintaining a healthy nervous system.

Avoid engaging in risky activities that might cause falls or accidents. Activities such as climbing tall structures may result in accidents that can damage the nervous system.



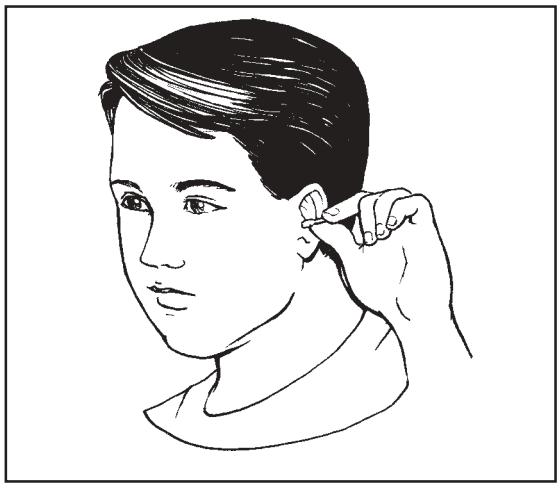
Always follow safety rules whether you are in your workplace or playing a sport. Make sure that you wear protective gear that is appropriate for the activity you're doing.



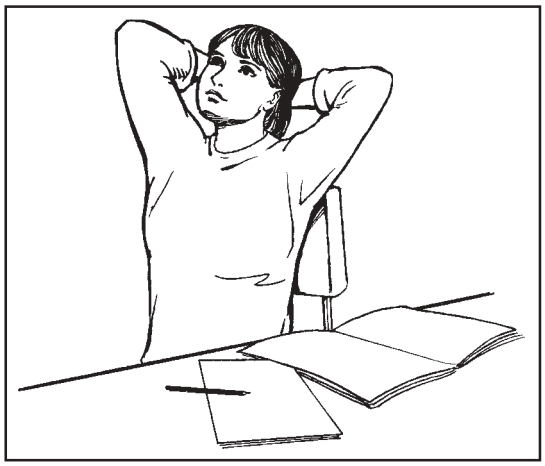
Observe safety when on the road. When you are riding a motorcycle or bicycle, or even when you go skating, don't forget to put on a helmet. Remember that your helmet is your friend and it can protect you from serious head injuries. When inside a vehicle, wear your seatbelt. Many people sustain brain and spinal cord damage in vehicular accidents because they neglect to wear their seat belts.

Dispose of your chemicals properly. Chemicals include insecticides, pesticides and cleaning solutions. Do not just throw these into the drain. Chemicals such as these are capable of poisoning the nervous system, which can lead to serious diseases. Make sure that you put these wastes in containers separate from where you put your other garbage. Label the containers so garbage collectors will know where to put them.

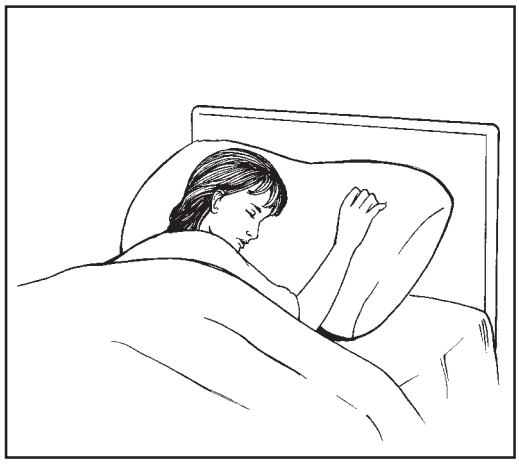
Avoid drugs, including alcohol and cigarettes. They contain substances that can enter and damage the parts of the nervous system.



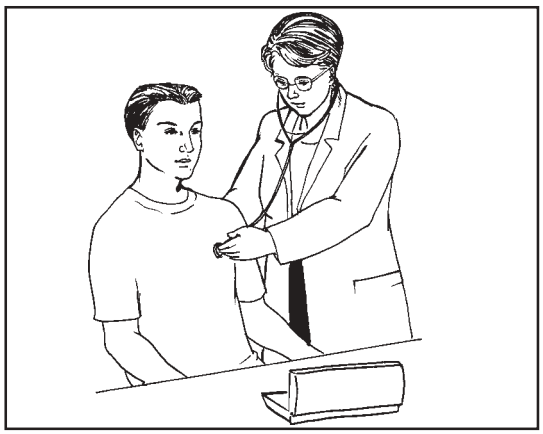
Practice good hygiene, especially of the nose and ears to avoid infections. Remember that these infections can cause meningitis.



Learn to manage stress well. Relax every now and then. Stress adds a burden to the nervous system.



Get a good night's sleep. Sleeps allows the nervous system to repair itself.



Listen to your body. Consult a doctor when you feel something is wrong.

Rest whenever you need to.

Let's Try This

A lot of people figure in vehicular accidents every day. In such accidents, injuries sustained by the brain and spinal cord might be very severe, causing lifetime disorders or even death. Most of the time, these accidents could have been avoided if safety rules were obeyed. Make a poster encouraging people to practice safety on the road. Post it in the NFE Learning Center.

Let's Review

Encircle the number of the phrase that illustrates how to properly take care of the nervous system.

1. taking a bath regularly to avoid infections
2. smoking and drinking
3. getting enough sleep and rest
4. consulting a doctor only when really needed
5. taking illegal drugs such as *shabu* and cocaine
6. wearing a helmet in construction sites
7. avoiding activities that can cause injuries
8. eating only fatty foods
9. relaxing when stressed
10. cleaning ears and nose regularly and properly

Compare your answers with those in the *Answer Key* on page 52.

Let's Remember

- Taking care of the nervous system requires the observation of some very simple habits.
- Prevent injury to the nervous system by avoiding risky activities. If these activities cannot be avoided, use protective gear such as helmets and face guards.
- Avoid drugs, including alcohol and cigarettes, that can affect the nervous system.
- Rest and avoid stress.
- Eat healthy foods especially those rich in vitamin B.
- Consult a doctor if you notice something wrong with your body.

You have now reached the end of the module. Congratulations! Did you enjoy studying this module? Did you learn a lot from it?

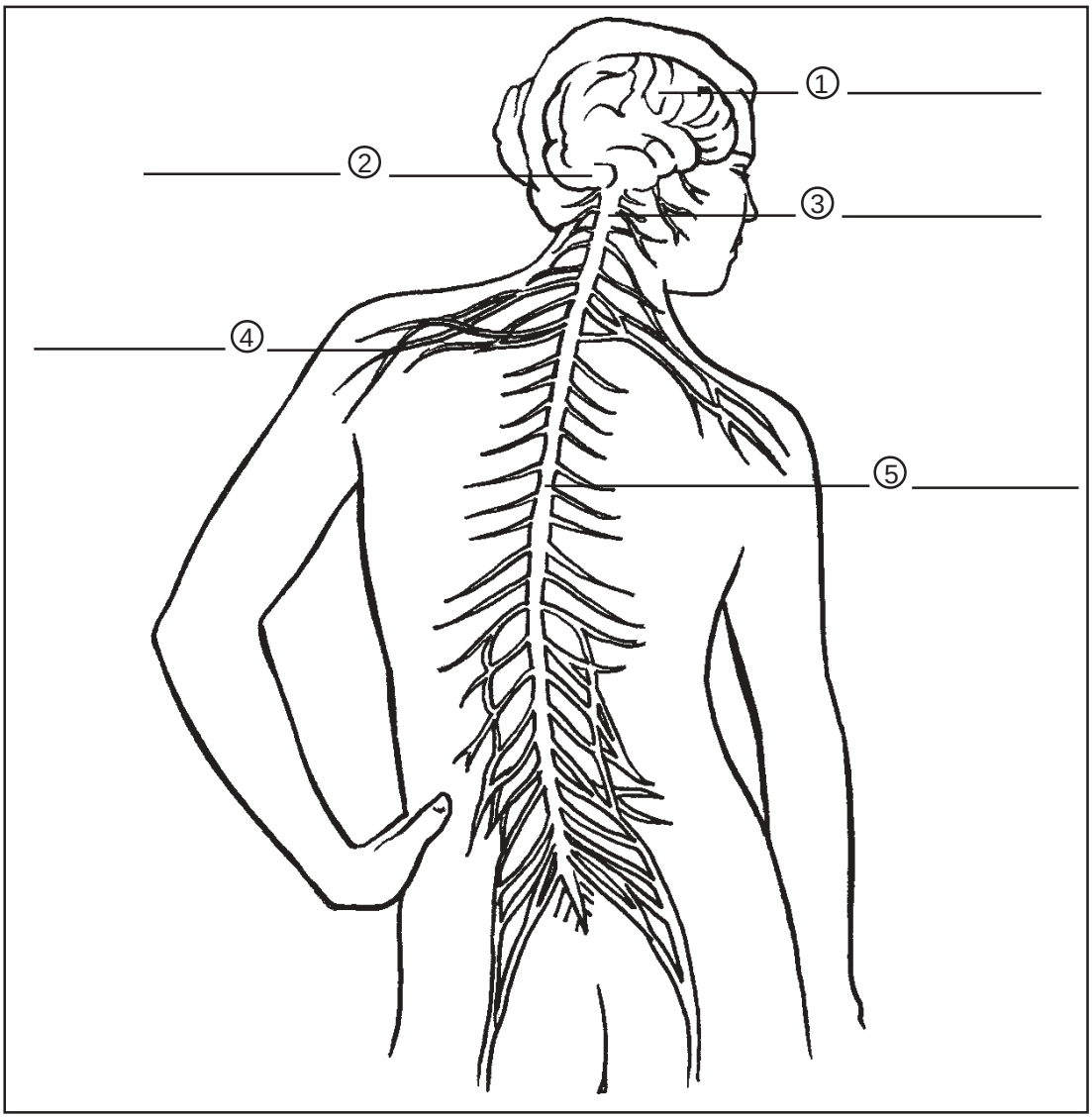
The following is a summary of the module's main points to help you remember them better:

Let's Sum Up

- The nervous system has four major functions: autonomic, motor, cognitive and sensory.
- The nervous system has two main divisions: the central nervous system and the peripheral nervous system. The central nervous system is composed of the brain and spinal cord. The peripheral nervous system is composed of nerve cells that branch off from the brain and spinal cord.
- The brain is the control center of the body. It receives information from different parts of the body, processes these information and sends back signals that tell these parts of the body how to react to a particular stimulus.
- The spinal cord serves as the bridge between the brain and the nerve cells.
- The nerve cell or neuron is the basic unit of the nervous system. It is built in such a way that enables it to transmit electrical impulses.
- The nervous system is prone to various disabling injuries and disorders. The skull and vertebrae, which protect the brain and spinal cord respectively, could suffer from fractures. The discs that protect the vertebrae may also suffer injuries. Among the disorders that can affect the nervous system are stroke, meningitis, epilepsy, multiple sclerosis, Alzheimer's disease, Parkinson's disease and mental retardation.
- Recent developments in neuroscience have led to improvements in diagnostic and treatment techniques for disorders of the nervous system.
- We should always take care of our nervous system by eating nutritious foods, wearing protective gear when necessary, and relaxing whenever we feel stressed.

What Have You Learned?

I. Identify the parts of the nervous system.



II. Fill in the blanks. Choose from among the words inside the box.

brain	epilepsy	cerebellum
external stimulus	spinal cord	vitamin B
neuron	autonomic function	CAT Scan
medulla	peripheral nervous system	

1. The seat of human intelligence is the _____.
2. The _____ is the basic unit of the nervous system.
3. The part of the brain responsible for basic life functions such as breathing and heartbeat is the _____.
4. A signal from outside the body is called _____.
5. The spinal column protects the _____.
6. _____ is manifested by seizures due to electrical bursts in the brain.
7. Increased heart rate during frightening situations is an example of the _____ of the nervous system.
8. _____ is a nutrient important for the proper functioning of the brain.
9. The division of the nervous system which is composed of nerve cells that branch off the brain and the spinal cord is the _____.
10. Motor coordination is governed by the _____.
11. A _____ is an X-ray technique that allows safe and painless diagnosis in various areas of the body.

III. Check the box beside the phrase that illustrates how to properly take care of the nervous system.

1. ☐ avoiding drugs, alcohol and cigarettes
2. ☐ not getting enough rest and sleep
3. ☐ disposing of harmful chemicals
4. ☐ eating only fatty foods

Compare your answers with those found in the *Answer Key* on page 52.

If you got a score of:

0	–	3	You need to study the module again.
4	–	9	You may go back to the parts of the module that you did not understand very well.
10	–	16	Well done! Just review some of the items you missed.
17	–	20	Congratulations! You learned a lot from this module. You are now ready for the next one.

Answer Key

A. Let's See What You Already Know *(page 2)*

1. a. somatic or voluntary function

   b. autonomic or involuntary function

   c. sensory function

   d. cognitive function

2. a. central nervous system

   b. peripheral nervous system

3. (Answers may vary depending on how the learners state the answer. The following is the expected answer, however). The nervous system transmits electrical impulses throughout the body. Signals and information are sent to and from the brain, making possible body functions.

4. a. Parkinson's disease

   b. Meningitis

   c. Alzheimer's disease
   (other possible answers are: epilepsy, multiple sclerosis, stroke)

5. (Answers may vary. The following are sample answers).

   a. Wear protective gear when doing potentially dangerous activities in order to avoid head injuries.

   b. Eat nutritious foods especially those rich in vitamin B, such as grains and fruits.

   c. Get enough rest and sleep.

B. Lesson 1

Let's Try This (page 8)

(The following are possible answers:)

- heartbeat
- breathing or respiration
- digestion of food
- coughing
- swallowing

Let's See What You Have Learned (page 10)

a. **(2)**

b. **(1)**

c. **(1)**

d. **(3)**

e. **(4)**

f. **(2)**

g. **(1)**

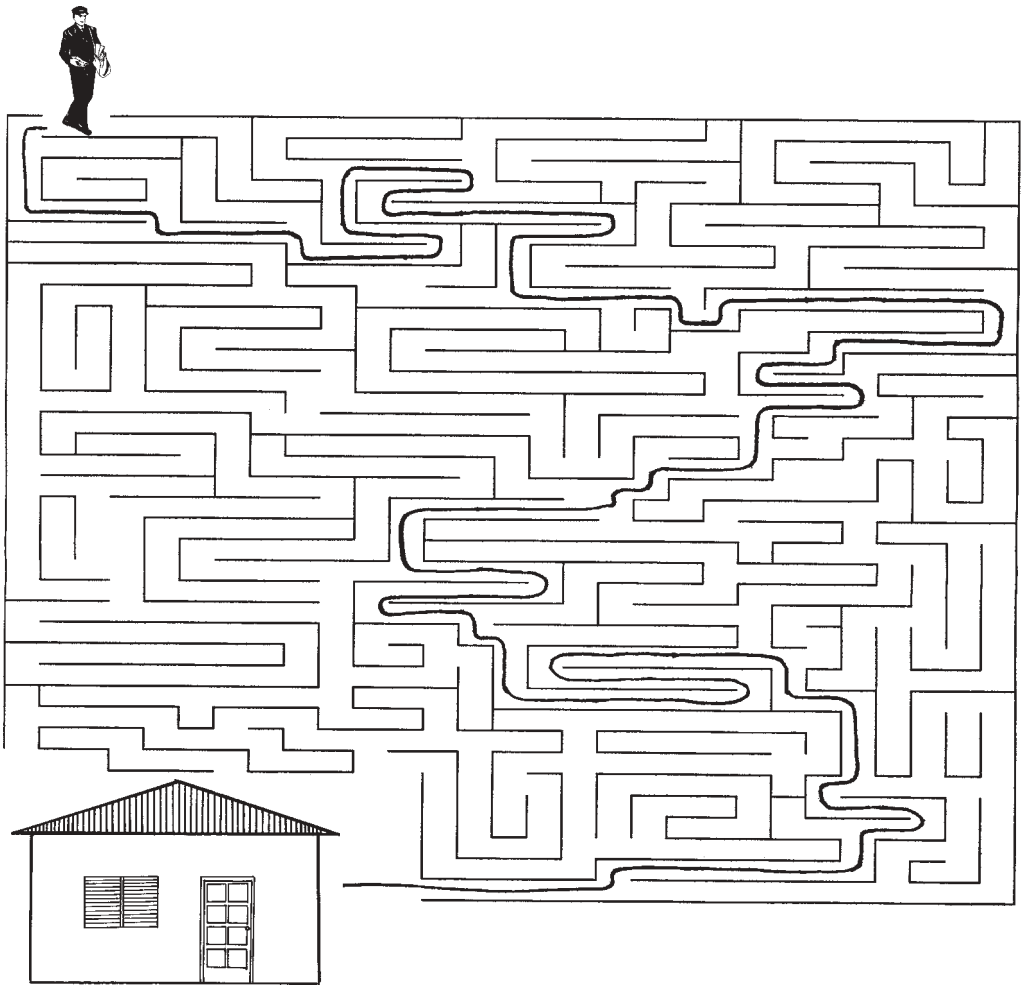
h. **(2)**

i. **(4)**

j. **(3)**

C. Lesson 2

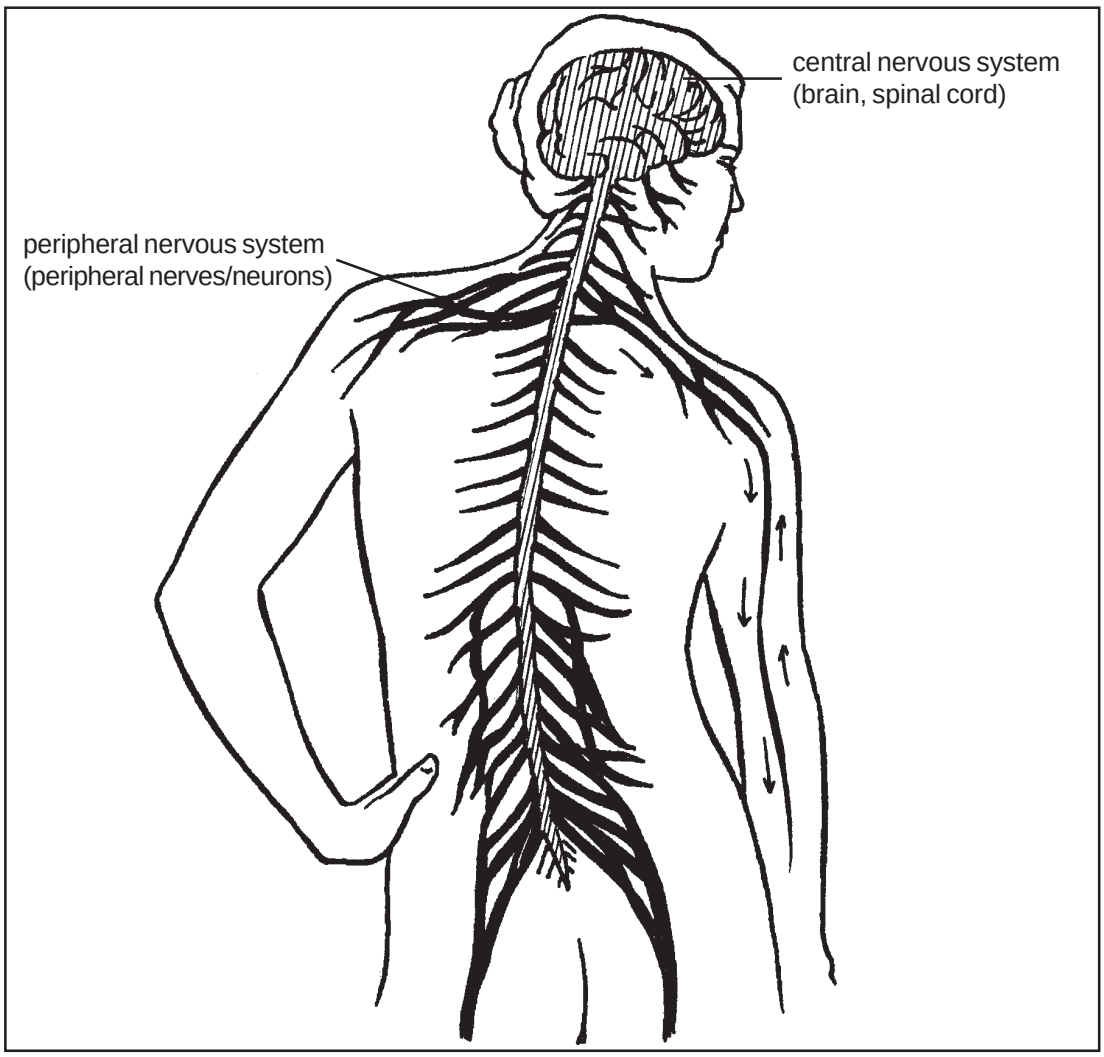
Let's Try This (page 11)



Let's Think About This (page 12)

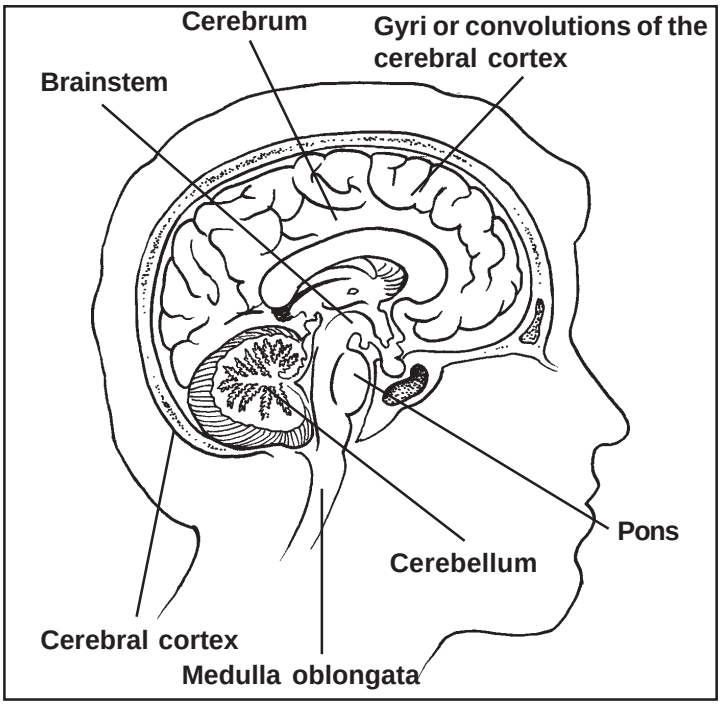
1. The letter represents electrical signals coming from different parts of the body. Similar to letters, the signals are where information is stored.
2. Emil the postman represents the nerve cells or neurons. Similar to the postmen the neurons carry or transmit information from one place to another.
3. Mrs. Garcia's house represents the brain. Similar to the house, the brain is the destination of the information where it will be received and processed.

Let's Try This (page 15)



The external stimulus is detected by the receptors in the skin. These receptors send the message to the brain through the nerves and the spinal cord. When the brain picks up the signal, a decision is made by the brain on how to act in response to that stimulus.

Let's Try This (page 19)



Let's Review (page 19)

1. two
2. brain; spinal cord
3. peripheral
4. brain
5. cerebral cortex
6. covering
7. gyri; convolutions
8. brain
9. balance
10. medulla/medulla oblongata

Let's Review (page 23)

The following should be encircled (voluntary activities): running, jumping, praying, singing, talking, dancing.

The following activities should be underlined (involuntary activities): beating of the heart, breathing, digesting food, trembling (The body trembles automatically).

Let's See What You Have Learned (page 25)

A. 1. False. The spinal column protects the spinal cord and not the other way around.

2. True.

3. False. The spinal cord belongs to the central nervous system.

4. False. It also sends messages from the body to the brain.

5. True.

6. True.

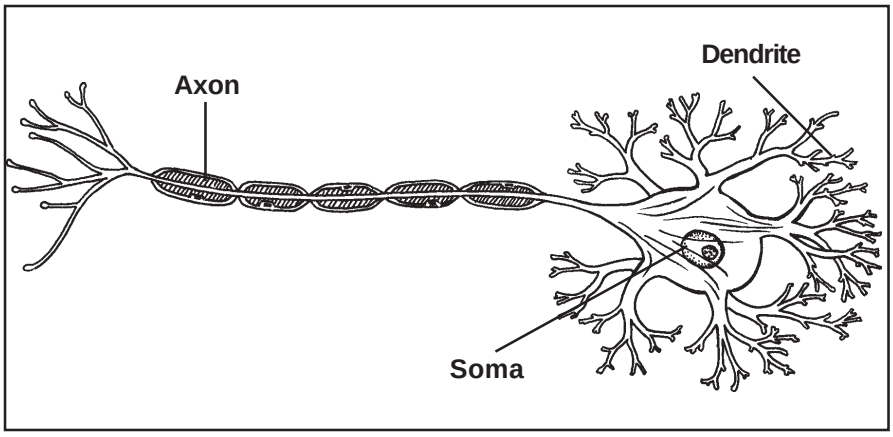
7. True.

8. False. A neuron also has dendrites.

9. False. Dendrites receive messages.

10. True. Nerves are composed of bundles of axons of neurons.

B.



D. Lesson 3

Let's Think About This (page 29)

1. Carelessness caused Carlo's and Ana's accidents. Carlo should have been more careful in climbing the tree. Ana, on the other hand, should have worn a helmet. They failed to protect their nervous systems, hence they suffered injuries.

2. It is important to protect the brain and the spinal cord because these two organs are very delicate. If they are injured, the rest of the body will fail to function well.

Let's Try This (pages 33–34)

1. (The following are possible answers:) A person suffering from a nervous system disorder is different from a person with a healthy nervous system because he/she suffers from:
   - weakness of body parts
   - difficulty in movement
   - memory loss
   - impaired learning
   - behavioral changes
2. Three parts of the nervous system that may be affected by injury or disease:
   - the brain
   - spinal cord
   - peripheral nerves

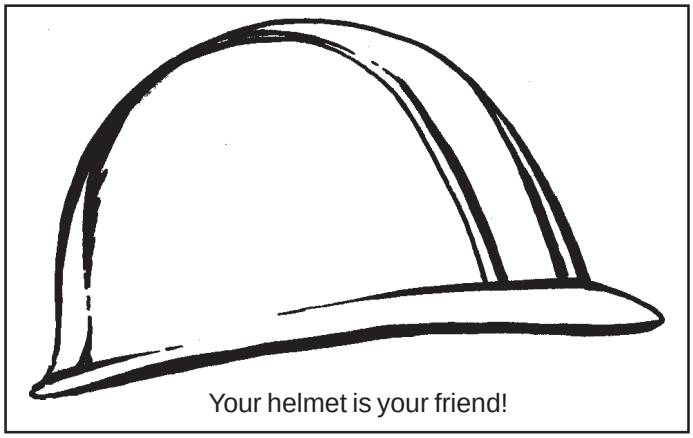
Let's See What You Have Learned (page 37)

1. stroke
2. Alzheimer's disease
3. rigidity
4. Meningitis
5. Epilepsy
6. pain
7. Lasers; robots
8. Bones
9. magnetic resonance imaging
10. corpus callosum

E. Lesson 4

Let's Try This (page 42)

(Posters will vary according to how learners made them. Below is a sample poster).



Let's Review (page 42)

The following numbers should be encircled: 1, 3, 6, 7, 9, 10.

F. What Have You Learned? *(pages 44–50)*

I.
1. cerebrum
2. cerebellum
3. brainstem (medulla oblongata, pons)
4. peripheral nerves
5. spinal cord

II.
1. brain
2. neuron
3. medulla
4. external stimulus
5. spinal cord
6. epilepsy
7. autonomic function
8. vitamin B
9. peripheral nervous system
10. cerebellum
11. CAT scan

III.
1. [3]
2. [ ]
3. [3]
4. [ ]

Glossary

Action potential Electrical impulses that travel through a neuron.

Alzheimer's disease A disease characterized by progressive loss of memory.

Autonomic function Refers to the nervous system's ability to maintain life through the automatic or involuntary control of the internal organs of the body.

Axon The tail of a neuron where electrical impulses pass through.

Brain The seat of human intelligence. It is the main organ of the nervous system found inside the skull.

Brainstem The area between the brain and the spinal cord where the vital functions of life are controlled and where signals pass through.

Cerebellum Also known as the little brain, coordinates the movements of the body.

Cerebral cortex Also known as the cerebrum; the outermost part of the brain concerned with intelligence.

Cognitive function Refers to the nervous system's ability to think, learn, remember and process information.

Dendrite A branch of a neuron.

Epilepsy A disease characterized by uncontrollable movements due to the abnormal firing of neurons in the brain.

External stimuli Signals from the environment.

Fracture A break in a bone usually caused by accidents.

Gyri Singular is gyrus; refers to the convolutions or curving patterns of the brain.

Internal stimuli Signals from within the body.

Medulla oblongata The area in the brainstem that controls heartbeat, breathing and other vital functions of the body.

Meninges Covering of the brain.

Meningitis The inflammation of the covering of the brain due to an infection.

Myelinated A type of neuron that transmits impulses faster due to its fatty covering.

Myelin sheath The fatty covering of an axon that permits the faster travelling of impulses.

Multiple sclerosis A disease characterized by progressive difficulty in thinking and movement.

Nerves Bundles of neurons that transmit electrical impulses throughout the body.

Nervous system The master control system of the human body. The nervous system is made up of a group of structures that transmit and process impulses throughout the body to enable it to live and function well.

Neuron The basic unit of the nervous system; capable of transmitting electrical impulses.

Organ system A group of organs in the body that performs a specific function.

Paraplegia Inability to move the legs due to an injury in the nervous system.

Peripheral nervous system The part of the nervous system that is found outside the skull and the spinal cord; brings signals to the rest of the body.

Periphery Located on the side.

Pons An area found in the brainstem where signals pass between the brain and the spinal cord.

Quadriplegia Inability to move both arms and legs.

Sensory function Refers to the nervous system's ability to sense stimuli from within the body and from the environment.

Slipped disc An painful injury of the nervous system due to the slipping of the discs found between the bones of the spine.

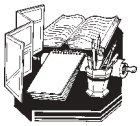
Soma The cell body of a neuron that maintains metabolic functions.

Somatic function Refers to the voluntary or willed movements created by the nervous system.

Spinal cord The organ found inside the spine that transmits signals from the brain to the body and back.

Stimuli Signals from the environment or within the body that elicit a reaction.

Stroke An injury to the nervous system due to the blockage of blood supply to the brain; causes problems with movement and even mental function.



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