Introduction

In Unit 19, we began our inspection of the human body and the many biological systems that make it work. With Unit 20, we will finish that inspection by looking at the *nervous* system, the *endocrine* system, the *reproductive* system, and the *immune* system. We will also consider the many different types of disease that disrupt or slow down a particular body system or perhaps bring all of the interacting systems to a grinding halt. Once again, it's important to keep in mind how each system overlaps and contributes to the others.

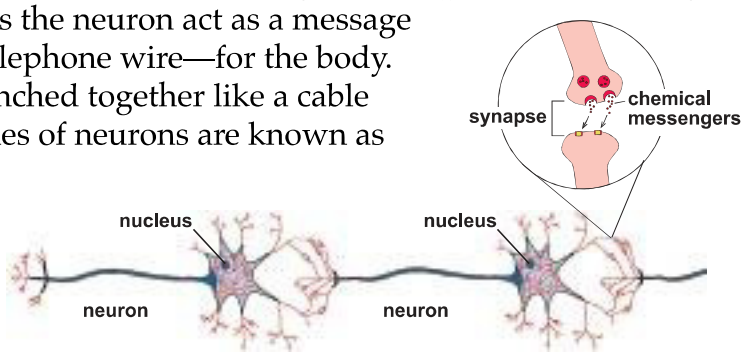
The Nervous System

The nervous system is involved in every movement of every muscle. Nerves are a part of voluntary movements, such as seeing a luscious brownie and reaching for it. They also cause the motion of involuntary muscles, such as the heart's beating or the intestines' pulsing.

The cells that make up the nervous system are called **neurons**. *Neurons* are like parts of an electrical wiring system that carry messages from the sense organs—for example, the eyes, ears, or nose—to the "master control center," the brain. The brain analyzes all of the information it receives and determines what action the body should take. Thus the nervous system can bring about anything from a tiny quiver to a great thought.

Neuron Structure

Like any other cell in the body, the neuron has a nucleus and organelles. Yet the neuron is special in that it has a long, thin shape with branching ends. This shape helps the neuron act as a message pathway—a sort of telephone wire—for the body. Neurons are often bunched together like a cable of wires. These bunches of neurons are known as *nerves*. The spaces between nerve cells are called *synapses*. Messages "jump" these gaps through a chemical process.



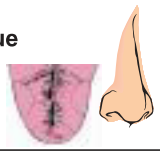
Neurons act as message pathways.

Messages travel along neurons as tiny surges of electricity. Electrically charged atoms of sodium and potassium, called **ions**, are concentrated on opposite sides of the cell membrane of the long neuron fiber. As an electrical impulse moves along the neuron, the cell membrane suddenly allows these *ions* to change sides—sodium ions rush inside the fiber and potassium ions rush out. Thus the nerve impulse moves down the fiber like a wave. It is a wave of chemicals that produce electricity. After the impulse passes a given spot, the concentration of ions returns to its pre-impulse condition. All of this happens in less than one millisecond (one-thousandth of a second)!

The Sense Organs

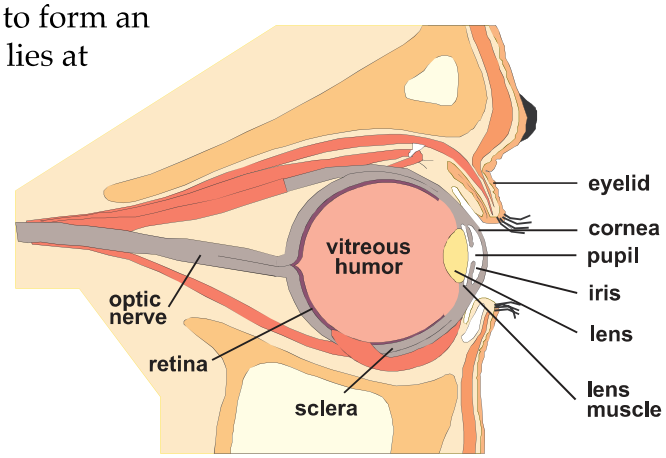
When we think of senses, we usually think of the big five: sight, hearing, smell, taste, and touch. Sense organs take in information from the world around us through neurons and send it to the brain to be processed. The brain then sends back a message along a separate nerve pathway to tell the sense organs what to do next.

The Human Senses

Sense	Sense Organs	Function
sight	**eyes** 	pick up patterns of light; lens forms image on *retina*; impulses from *optic nerve* go to the brain; the brain interprets and decodes the image
hearing	**ears** 	the outer ear directs sound waves through ear canal; sound waves vibrate through the middle and inner ear systems; information travels via the *auditory nerve* to the brain where it is interpreted and decoded
smell	**nose and nasal cavities** 	chemicals in the form of a gas are detected by *neurons*; neurons line the top of the nasal chamber; the *olfactory nerve* carries the message of smell to the brain where it is interpreted as smoke, perfume, or some other odor
taste	**tongue and nose** 	small bumps on the surface of the tongue called *taste buds* cause sense of taste; special nerve cells detect chemicals and send signals to the brain; taste buds sense only sour, sweet, salty, and bitter; our nose and the smell of food helps to determine our food preferences.
touch	**skin** 	five types of nerve cells detect pain, pressure, touch, heat, and cold; signals sent to the brain for decoding; most nerve cells found in the *dermis* (thick inner layer); only nerve cells which detect pain found in the dermis and *epidermis* (thin outer layer)

The Eyes

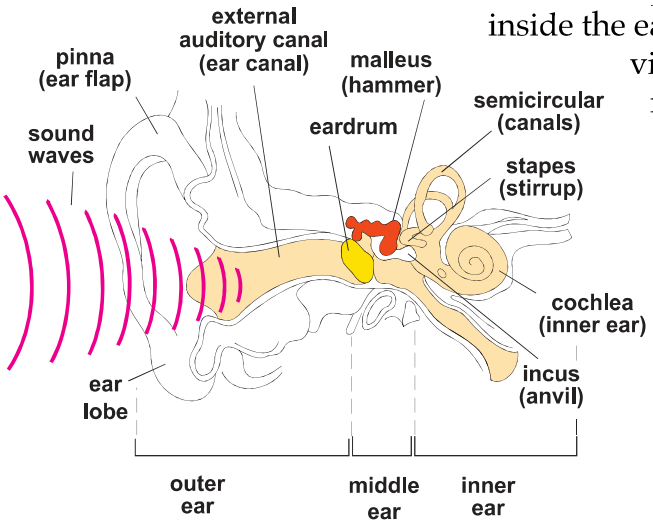
The eye allows us to see by picking up patterns of light, which pass through the lens of the eye to form an image on the **retina**, which lies at the back of the eye. The neurons of the *retina* send impulses to the **optic nerve** according to how much light they take in. From there, the nerve impulses go to the brain, which interprets the signals from the *optic nerve* and, finally, shows us what we perceive as a vision of the outside world.



The eye allows us to see by picking up patterns of light, which pass through the lens of the eye to form an image on the retina.

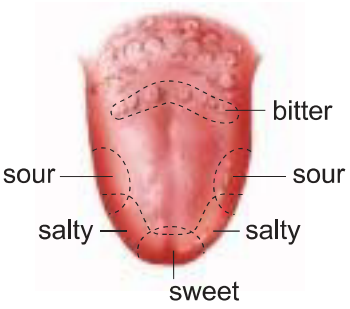
The Ears

The ears perceive sound as air molecules that are set in motion. We call these vibrating air molecules *sound waves*. Sound waves hit the whole body, thus people can sometimes "feel" sounds even if their ears don't work. In healthy working ears, the outer ear structure channels the sound wave down the ear canal to the eardrum. The eardrum picks up the vibration and passes it on to tiny bones inside the ear. These bones pass the vibration on to another membrane that causes fluid inside the spiral-shaped **cochlea** to move. Neurons inside the *cochlea* react as fluid moves past them. The **auditory nerve** gathers this information and sends it to the brain, which interprets the specific patterns of the vibrations as specific sounds. The inner ear also contains tiny hairs that detect gravity and help us keep our balance.



The ears perceive sound as sound waves: air molecules that are set in motion.

The Tongue

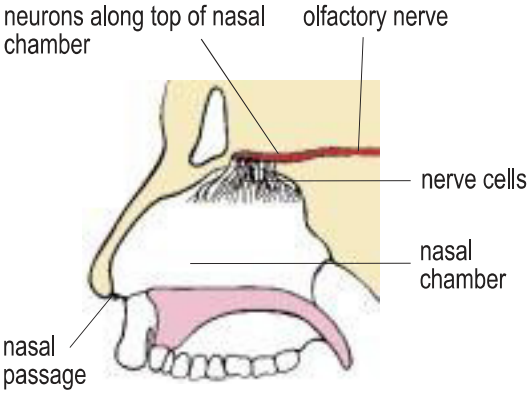


The tongue senses four general flavors.

The tongue gives us the sense of taste through its tiny **taste buds**. These are little, flask-shaped structures with pores in the top. Food dissolved in saliva enters these pores. Then hairlike nerve endings inside react, sending signals to the brain. Research shows *taste buds* can sense only four general flavors: sour, sweet, salty, and bitter. Much of our appreciation of food stems from its smell.

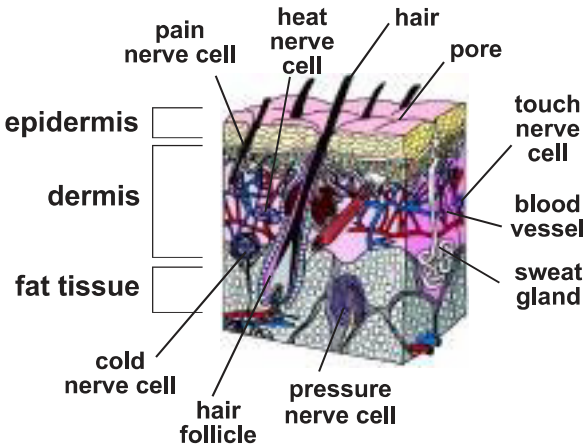
The Nose and Nasal Cavities

Neurons inside the nose and nasal cavities allow us to smell. Smells enter the nose as chemicals floating in the air. Different groups of nasal neurons are sensitive to particular types of chemicals. They send signals that travel through the **olfactory nerve** to the brain where they are interpreted as odors.



Neurons inside the nose and nasal cavities allow us to smell.

The Skin

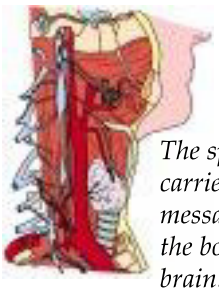


Skin has a sense of touch and can feel pain, pressure, heat, and cold.

Besides the sense of touch, our skin can feel several other conditions: pain, pressure, heat, and cold. Different neurons in the skin are responsible for sensing each of these conditions. According to their job, the neurons are either very close to the skin surface, as with neurons for pain or touch, or deeper in the skin tissue, as with neurons for pressure.

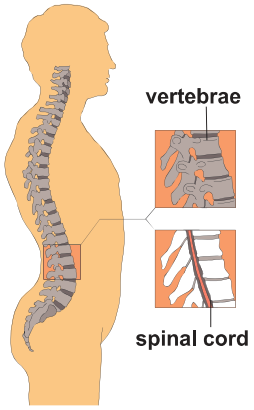
The Spinal Cord

If you think of a nerve—a bundle of neurons—as a telephone cable filled with telephone wires, then you can think of the spinal cord as the mega-cable for the body's nervous system, leading to the main switchboard, the brain. The spinal cord carries sensory messages from the body to the brain, and motor impulses from the brain to the body.



The spinal cord carries sensory messages from the body to the brain.

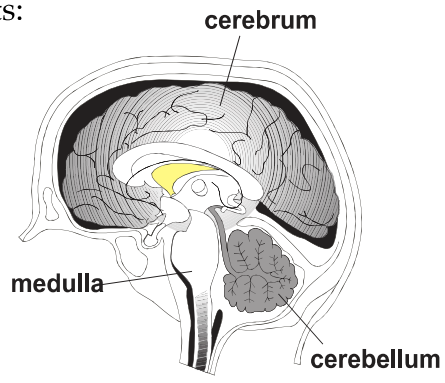
The spinal cord leads directly from the brain and descends about two-thirds of the way down the back. It is protected by the bones of the spinal column called *vertebrae*. The inner part of the spinal cord is made up of "gray matter," the same tissue of densely packed neurons of which the brain is made. The outer part is made of nerve fibers. Many spinal nerves branch off from the spinal cord between the bones of the spine.



The spinal cord is protected by the bones of the spinal column called vertebrae.

The Brain

The brain is divided into three major parts: the **cerebrum**, the **cerebellum**, and the **medulla**. Nerves carry electrical impulses which may have been caused by external or internal factors to the brain. For example, we respond by eating the food that smells good to us. However, pain in our stomach caused by eating spoiled food may cause us to vomit. As we examine how the three parts of the brain function, we will see how the different organs and parts of the body communicate.



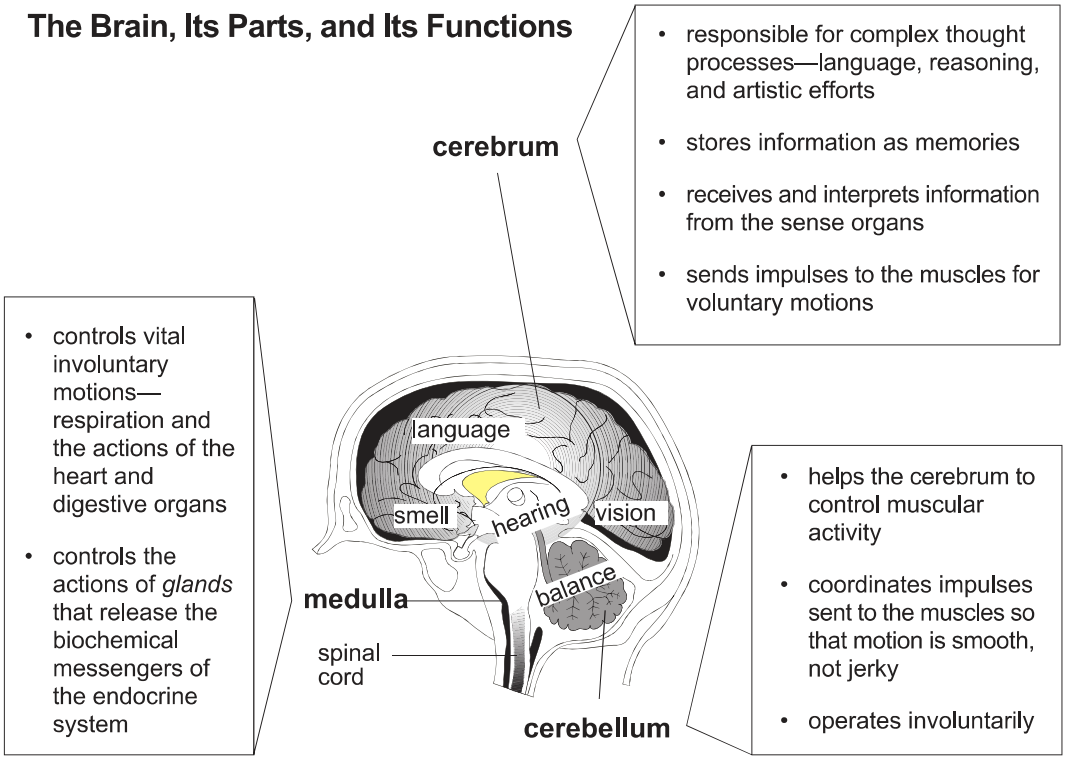
The brain is divided into three major parts.

The upper part of the brain, the *cerebrum*, is the largest part of the brain. It's the cerebrum most people picture when they think of the brain—gray

and ridged with deep wrinkles and furrows. The cerebrum is responsible for *complex thought processes* such as language, reasoning, and artistic efforts. It stores information as memories. It also receives and interprets information from the sense organs and sends impulses to the muscles for voluntary motions. The cerebrum is made up of two halves: the right half controls the left side of the body and the left half controls the right side.

The *cerebellum* helps the cerebrum to control *muscular activity*. It coordinates impulses sent to the muscles so that motion is smooth, not jerky. The operation of the cerebellum is involuntary. The cerebellum lies beneath the cerebrum.

The *medulla* is the bottom part of the brain, lying at the base of the skull and at the top of the spinal cord. The medulla controls *vital involuntary motions*, such as the activities of all internal organs. These activities include respiration and the actions of the heart and digestive organs. The medulla also controls the actions of **glands** that release the biochemical messengers of the endocrine system, which we'll look at next.



Practice

Use the list below to complete the following statements.

auditory nerve	**ions**	**optic nerve**
cochlea	**neurons**	**retina**

1. The cells that make up the nervous system are like parts of an electrical wiring system. They are called _____ .

2. Electrically charged atoms of sodium and potassium, called _____ , are concentrated on opposite sides of the cell membrane of the long neuron fiber.

3. The eye allows us to see by picking up patterns of light, which pass through the lens of the eye to form an image on the _____ , which lies at the back of the eye.

4. The neurons of the retina send impulses to the _____ , and from there, the nerve impulses go to the brain.

5. The eardrum picks up vibrations and passes them on to tiny bones inside the ear, which pass them on to another membrane that causes fluid inside the spiral-shaped _____ to move.

6. The _____ gathers information and sends it to the brain, which interprets the specific patterns of the vibrations as specific sounds.

Practice

Use the list below to write the correct term for each definition on the line provided.

cerebellum	**medulla**
cerebrum	**olfactory nerve**
glands	**taste buds**

_____ 1. the uppermost and largest part of the brain; responsible for complex thought processes

_____ 2. the lowermost part of the brain; maintains the involuntary function of vital organs, such as the heart, the intestines, and endocrine glands

_____ 3. the middle part of the brain; coordinates motor impulses

_____ 4. little, flask-shaped structures in the tongue containing neurons that react to different tastes

_____ 5. the nerve that sends information from the nose to the brain

_____ 6. structures in the endocrine system that produce hormones

Practice

Use the list above each section to complete the statements in that section. **One or more terms will be used more than once.**

brain	**hearing**	**neurons**	**sight**	**taste**
eye	**nerves**	**sensory**	**smell**	**touch**

Nervous System

1. _____ cause the motion of involuntary muscles such as the heart's beating.

2. The cells that make up the nervous system are called _____ .

3. Neurons carry messages from the sense organs to the _____ , the "master control center."

4. Bundles of neurons are called _____ .

5. Our _____ organs take in information from the world around us.

6. The five senses are _____ , _____ , _____ , _____ , and _____ .

7. The retina and optic nerve are part of the _____ .

8. The spiral-shaped cochlea helps us with our sense of _____ .

One or more terms will be used more than once.

cerebellum	**neurons**	**taste buds**
cerebrum	**spinal cord**	**touch**
medulla		

9. The _____ on the tongue give us the sense of taste.

10. The sense of smell comes from _____ inside the nose.

11. Neurons in the skin are responsible for the sense of _____ and other conditions such as pain, pressure, and temperature.

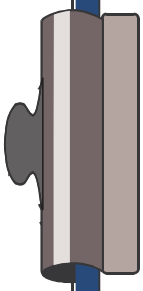
12. The primary "cable" for the body's nervous system is the _____ .

13. The brain is divided into three major parts: _____ , _____ , and _____ .

14. The largest part of the brain is the _____ .

15. The part of the brain that controls muscular activity is the _____ .

Lab Activity: The Human Brain



Facts:

- The human brain is divided into a right and a left side.
  - right side—thought to control creativity
  - left side—thought to control the ability to analyze problems
  - right side—controls the left side of the body
  - left side—controls the right side of the body
- In most people, one side of the brain is dominant.

Investigate:

- You will check to see the following:
  - which hand you use most often in certain activities
  - which foot you use most often in certain activities
  - if you see or draw objects more to the right or the left side
- You will find out if the left side or the right side of your brain is dominant.

Materials:

- paper
- red pencil

1. Place a check mark in the proper column in the table on the next page to show which hand you usually use to do the following tasks. *Note: If you use either hand just as often, then check both columns.*

2. Place a check mark in the proper column in the table to show which foot you usually use to do the following tasks. *Note—if you use either foot just as often, check both columns.*

Finding Your Dominant Side		
Task	**Left**	**Right**
write name		
wave "hello"		
bat		
thumb position with hands clasped		
hold spoon		
catch from falling		
walk down stairs		
walk up stairs		
skipping		
standing		
start to run		
Do numbers 3 - 5, then mark below.		
dog drawing		
circle drawing		
dominant eye		
Totals		

3. Draw, in the space provided on the following page, a simple side view of a dog. Place a check mark in the column of the table that shows the direction your drawing faces **away** from.

dog drawing

4. Draw a circle with your **right** hand in the space provided below. Note the direction in which you made this circle. Now draw a circle with your left hand. Note the direction in which you made this circle. If both circles were drawn clockwise, mark the right column in the table on page 646. If both circles were drawn counterclockwise, mark the left column in the table. If you drew one circle in each direction, check both columns.

left hand

right hand

5. Roll a sheet of paper into a tube. Hold the tube a couple of inches in front of your eyes. Look through the tube at some distant object with both eyes open as shown in the figure below. Then, while looking through the tube at the distant object, close one eye and then the other. The eye that sees the object through the tube is your dominant eye. Place a check mark in the proper column in the table on page 646.

6. Total up the check marks for each column of the table on page 646 and place the total at the bottom of the columns.