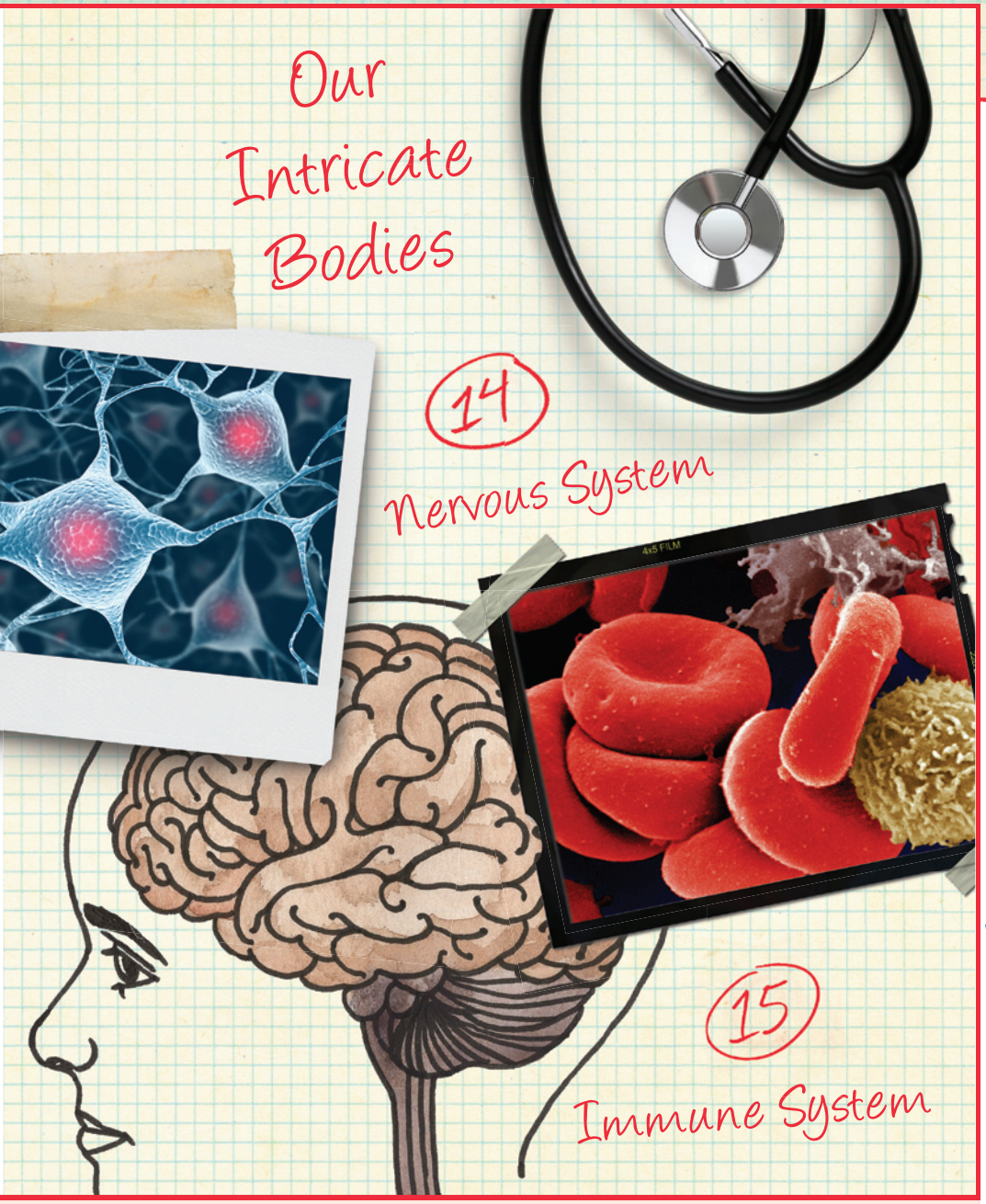
Unit 6 Overview

Lesson	TE pages	ST pages	AM pages	Assessment	Content
Chapter 14: Nervous System					
159	365–67	333–35	225		• Unit and chapter opener • Preview the chapter content
160	368–71	336–39	226		• Structure of the nervous system • The brain • The spinal cord
161	372–75	340–43	227–28	Quiz 14-A	• Peripheral nervous system • Neurons • Somatic nervous system • Autonomic nervous system • Reflexes
162	376–77	344–45	229–30	Rubric	**Activity: Reaction Time** • Exploring variables that affect reaction time
163	378–81	346–49	231	Quiz 14-B	• The five senses
164	382–83	350–51	232	Rubric	**Activity: Touch Tester** • Identifying areas of the body that are sensitive to touch
165	384–87	352–55	233–36		• Memory • Sleep
166	388–91	356–59	237–38	Quiz 14-C	• Endocrine system • Disorders and drug abuse
167	392–93				**Exploration: Effects of Drug Abuse** • Identifying common categories of drugs • Explaining how some types of drugs affect the nervous system
168	394	360	239–40		**Chapter Review** • Apply knowledge to everyday situations
169	394			Test	**Chapter 14 Test**
Chapter 15: Immune System					
170	395	361	241		• Chapter opener • Preview the chapter content
171	396–99	362–65	242		• Diseases • Types of pathogens
172	400–403	366–69	243–44	Quiz 15-A	• How pathogens are spread • Noncommunicable diseases • Epidemiology
173	404–5	370–71		Rubric	**Activity: Of Epidemic Proportions** • Recognizing how quickly pathogens spread • Inferring the source of contamination
174	406–9	372–75	245		• Parts of the immune system • How the immune system works
175	410–13	376–79	246–49	Quiz 15-B	• Immunity • Antibodies and antibiotics • Allergies • Transfusions and transplants • Autoimmune diseases
176	414–15	380–81	250		**Technology: Robotic Surgery** • Comparing robotic surgery with traditional surgery
177	416	382		Rubric	**Activity: Defend and Capture** • Modeling the interaction between the immune system and pathogens
178	417	383		Rubric	**Exploration: Extra, Extra, Read All About It!** • Researching and writing about a medical discovery
179	418	384	251–52		**Chapter Review** • Apply knowledge to everyday situations
180	418			Test	**Chapter 15 Test**



Objectives

- Recognize the interrelationship of science concepts
- Recognize that man's inferences are sometimes inaccurate
- Preview the unit and chapter content

Unit Introduction

In Unit 6 the student will see the marvels of the human body. No study could be a greater reminder of God's wonderful care for us. The nervous system discussed in Chapter 14 and the immune system discussed in Chapter 15 are two of the most complex systems of the body.

The nervous system, endocrine system (also discussed in Chapter 14), and immune system provide most of the control and protection of the other systems of the body.

Look through Unit 6. What kinds of topics do you think you will be studying in this unit? Possible answers: nervous system, endocrine system, diseases, pathogens, immune system

Why do you think these chapters are organized into the same unit? Answers will vary, but elicit that they are both about the human body.

What does the word *intricate* mean? Possible answers: detailed or complex

Why would we call our bodies intricate? Answers will vary, but elicit that God made our bodies with very complex systems that all work together for our benefit.

TEACHER HELPS

Weblinks
The BJU Press website offers additional information and links that you may find helpful throughout the year.

www.bjupress.com/resources

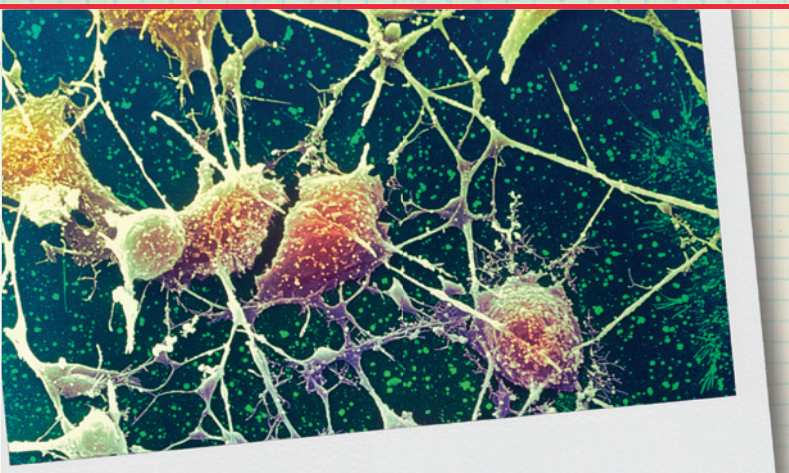
Unit photos
The photos on Student Text page 333 include a stethoscope and microscopic views of neurons and human red and white blood cells.

Project Idea

The project idea presented at the beginning of each unit is designed to incorporate concepts of each chapter as well as information gathered from other resources. You may choose to use the project as a culminating activity at the end of the unit or as an ongoing activity while the chapters are taught.

Unit 6—A Look Inside

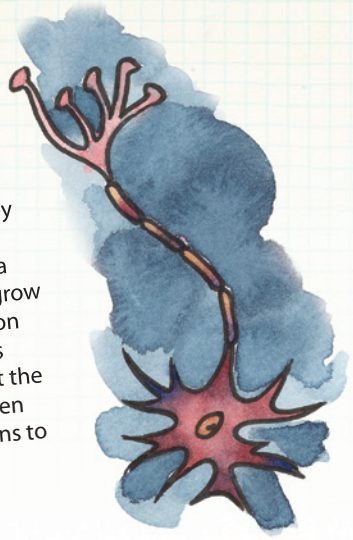
Technology continues to miniaturize. Direct the student to write about a microscopic voyage inside the body. The student should describe the parts of the nervous system, endocrine system, and immune system in a fictionalized context. For example, the nerves could be referred to as power lines, hormones as messengers, macrophages as policemen, and antibodies as ammunition.



14

Nervous System

How would you feel if an employer looked at the bumps and shape of your skull to decide whether you were trustworthy or hard working? This procedure sometimes happened during the 1800s. People who practiced phrenology believed that the bumps and shape of a person's skull identified that person's character, intelligence, and personality. They thought that certain parts of the brain were related to specific functions. Phrenologists believed that if a portion of the brain was used frequently, it would grow larger. This growth supposedly caused the bumps on a person's skull. Today we know that the brain does have certain areas related to specific functions, but the skull does not shrink or swell up based on how often parts of the brain are used. God designed our brains to control all the functions of our bodies.



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TEACHER HELPS

Chapter preview
Other preview and prereading activities may include using a K-W-L chart, a probe, or an anticipation guide.

Chapter photo
The photo is an electron micrograph of nerve cells.

Student Text diagrams
Diagrams from the Student Text are included on the Teacher's Toolkit CD.

BIBLE

Created in God's image
God is the Creator of all. He designed the brain to control all of the functions of the human body. He planned and prepared each detail in a way that will bring honor and glory to Him. [Bible Promises: I. God as Master]

Each one of us is uniquely created in God's image. He gives each individual special talents and abilities. [BAT: 3a Self-concept]

Introduction

Choose a volunteer that will allow another student to feel his head for shapes and bumps. Ask the following question of the student doing the examining:

Did you feel any bumps or unusual shapes on the skull? Answers will vary.

Having bumps on one's skull is normal. Ask this question of the student being examined:

How would you feel if your math grade was based on the size and shape of the part of your skull that was thought to be related to math? Answers will vary.

Some people used to believe this.

Teach for Understanding

Provide time for the student to complete Looking Ahead, Activity Manual page 225. For part B, encourage the student to think of things he would like to learn about the nervous and endocrine systems. He should write his answers in question form, such as, "What does the endocrine system do?"

Provide the answers for part A and allow the student to check his work. After the chapter is finished, you may choose to have him look back at this page and check his understanding of the items he missed.

As time allows, discuss student questions from part B about the nervous and endocrine systems. You may choose to provide trade books or other resources to help answer questions that are beyond the scope of this chapter.

Allow the student to leaf through the chapter, looking at the headings, pictures, captions, charts, etc., and discuss the things he thinks he will be learning about.

Activity Manual

Preview, page 225

The Looking Ahead page is intended to assess the student's prior knowledge before beginning the chapter.

Objectives
- Identify the two main parts of the nervous system
- Explain how the parts of the central nervous system work together
- Describe the four lobes of the cerebrum
- Differentiate among the functions of the three parts of the brain

Materials
- helmet (bike, football, or motorcycle)

Vocabulary
central nervous system
peripheral nervous system
brain
cerebrum
lobes
cerebellum
brain stem
spinal cord

Introduction
Display the helmet.

What is the purpose of a helmet? head protection

Place the helmet on a student.

Let's use the helmet to picture the head. If the head of the student inside the helmet represents the brain, what does the hard outer shell of the helmet represent? the skull

The padding inside the helmet also represents a part of the body that protects the brain inside the skull. Today we will learn about this and other parts of the brain.

Teach for Understanding
Purpose for reading
Which part of the brain helps you identify sounds as speech, music, or noise?

How is your spinal cord different from your spinal column?

Discussion
Which part of your body gathers and interprets information? the nervous system

What are the two main parts of the nervous system? the central nervous system and the peripheral nervous system

Which parts of the body make up the central nervous system? the brain and spinal cord

What is the job of the central nervous system? to make decisions and control the body's actions

Each day people use their senses—seeing, hearing, tasting, smelling, and touching—to observe God's world. But none of the information gathered by the senses would be of any value without a way to understand it. God designed a complicated network to gather and process, or interpret, information. This network is called the nervous system.

Even the most complex computer network cannot compare to the human nervous system. Just imagine all that is happening in your body while you read this paragraph! Your eyes gather information, and your ears hear sounds. Your hands touch the book. And besides all this, your nervous system keeps your heart beating and your lungs breathing without you even having to think about it. Your skin feels the temperature of the room, and your body stays balanced in your seat, all because of your nervous system. But that is only the beginning of the nervous system's responsibilities.

Many parts of the nervous system work together to allow a person to go white-water rafting.

Structure of the Nervous System
The nervous system is divided into two main parts. The **central nervous system** consists of the brain and the spinal cord. This part of the nervous system makes decisions and controls the body's actions. The **peripheral** (puh RIF ur ul) **nervous system** consists of millions of nerve cells that communicate with the central nervous system about what goes on in and around the body.

The Central Nervous System
Brain
The **brain** acts as the command center for the body. Thousands of pieces of data are transmitted to and from the brain every second. The brain organizes and interprets this information and tells the body how to respond. It not only controls actions and speech but also influences emotions. The brain is protected both by the skull and by *cerebrospinal* (sehr uh broh SPY nul) *fluid*. This fluid acts like a cushion and shock absorber for the brain and the spinal cord.

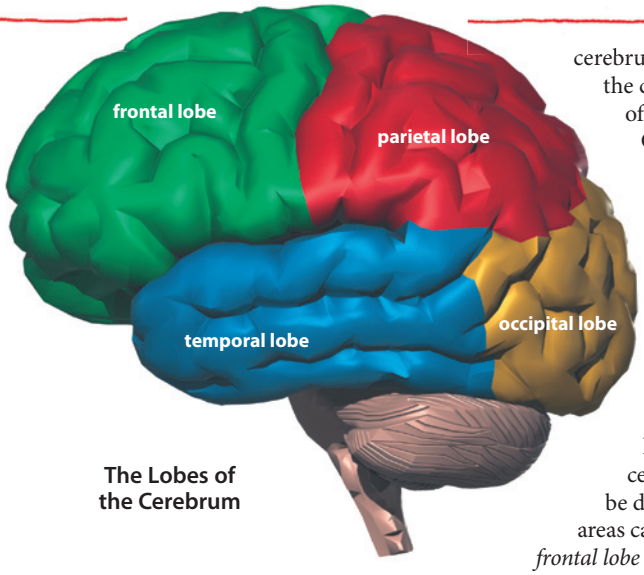
You might expect something as hard working as your brain to be quite large. Actually, the brain weighs only about 1.4 kg (3 lb)! It is shaped

SCIENCE BACKGROUND

Lobes of the brain
The cerebrum actually includes a fifth lobe, the *insula*. The insula is involved with the automatic functions of the brain stem, the sense of smell, and other functions such as taste and digestion. It is located within the Sylvian fissure that separates the temporal lobes from the frontal and parietal lobes. It is usually not visible in drawings of the brain. Sometimes it is called the Island of Reil because it was first described by Johann Christian Reil in 1809. *Insula* is the Latin name for "island."

Cerebrospinal fluid
Cerebrospinal fluid is made in the choroid plexus, blood vessels that line certain areas in the brain. This fluid is a clear, water-like liquid made from substances in the blood. It includes glucose (sugar), protein, and white blood cells. The fluid is continuously made, circulated, and reabsorbed.

Headaches may occur whenever the level of cerebrospinal fluid is low, such as after a doctor has taken a sample of the fluid to test for disease. Too much cerebrospinal fluid can also cause headaches, hydrocephalus, and other problems.



The Lobes of the Cerebrum

like a large, wrinkly walnut. The brain has three distinct parts: the cerebrum (SEHR uh brum), the cerebellum (sehr uh BELL um), and the brain stem. Each part has different functions, but all three parts work together to allow you to live and interact with your environment.

The largest part of the brain is the **cerebrum**, which means "brain." The cerebrum takes up most of the space inside the skull. It can be divided into two halves, the left hemisphere and the right hemisphere. The left hemisphere controls the right side of the body, and the right hemisphere controls the left side of the body. These two halves of the cerebrum are connected in the center by a bundle of nerve fibers.

Certain abilities and talents seem to be controlled by one side or the other, but in many cases of severe brain injury to one side, the other is able to take over.

Each hemisphere of the cerebrum can also be divided into distinct areas called **lobes**. The *frontal lobe* controls conscious movement and makes a person alert to what is going on around him. It is the center of reasoning and decision making and also influences personality. The *parietal* (puh RY uh tul) *lobe* interprets pain, touch, and temperature, as well as some tastes and pressure on the skin. Another part, the *temporal* (TEM pur ul) *lobe*, deals with hearing, speech, and memory. This lobe helps classify sounds as speech, music, or noise. The *occipital* (ahk SIP uh tul) *lobe* stores information about what a person sees. This lobe receives messages from the eyes and interprets those messages. God designed each part of the cerebrum to help people understand and appreciate the world that He created.

DIRECT A DEMONSTRATION

Demonstrate how cerebrospinal fluid protects the brain

Materials: 2 raw eggs, 2 plastic jars with screw-on lids, water

Place one egg inside a jar and close the lid tightly. The egg represents the brain, and the jar represents the skull. Direct the student to shake the jar vigorously.

What happened to the "brain" while it was shaken? It became broken and damaged.

Fill the other jar with water. Place the second egg in the water. Tightly close the jar.

What do you predict will happen when the jar is shaken? Answers will vary.

Direct the student to shake the jar vigorously.

What kept the "brain" from breaking? the water

What part of our body does the water represent? the cerebrospinal fluid

Discussion

Which part of the central nervous system organizes and interprets information? the brain

What protects the brain from injury? the skull and cerebrospinal fluid

About how big is your brain? 1.4 kilograms, or 3 pounds

What does the brain look like? a large, wrinkled walnut

What are the three parts of the brain? cerebrum, cerebellum, and brain stem

What are two different ways that the cerebrum can be divided? hemispheres and lobes

When a person has a stroke, a part of the brain is damaged because of lack of oxygen. Often there is weakness on one side of the body. If a person's right side is affected, which side of the brain was probably damaged? the left

What does the ability of the brain to function even after some severe injuries teach you about God? Possible answer: It shows that God is gracious to man in designing the brain so it can withstand severe injuries and, in some instances, even correct itself.

Discuss how the complexity and interdependence of our body systems testify to God as our Creator.

Discuss *The Lobes of the Cerebrum* diagram.

What are some functions of the frontal lobe? It controls conscious movement, makes a person alert to what is going on around him, is the center of reasoning and decision making, and influences personality.

Which lobe interprets pain, touch, and temperature? the parietal lobe

How is the function of the temporal lobe different from the function of the occipital lobe? The temporal lobe deals with hearing, speech, and memory. The occipital lobe receives messages from the eyes.

Discussion

Discuss the diagram *Parts of the Brain*.

Where is the cerebellum located? underneath the cerebrum

How does its size compare to that of the cerebrum? The cerebellum is much smaller.

What is the purpose of the cerebellum? It receives orders from the frontal lobes and sends messages to muscles throughout the body in order to accomplish tasks.

Which aspects of movement does the cerebellum control? the speed and force at which a person moves

When a person is learning to roller-skate, which part of his brain will tell his muscles what to do? the cerebrum

After a person has learned how to skate, which part of his brain remembers how to do it? the cerebellum

Why might a person with an injured cerebellum have difficulty with eating, talking, or walking? because the cerebellum helps to control balance and muscle coordination

Which part of the brain connects the brain to the spinal cord? the brain stem

Name some actions controlled by part of the brain stem. breathing, heartbeat, blood pressure, swallowing, digestion

Why are these actions called involuntary activities? You do not have to think about them in order for them to happen.

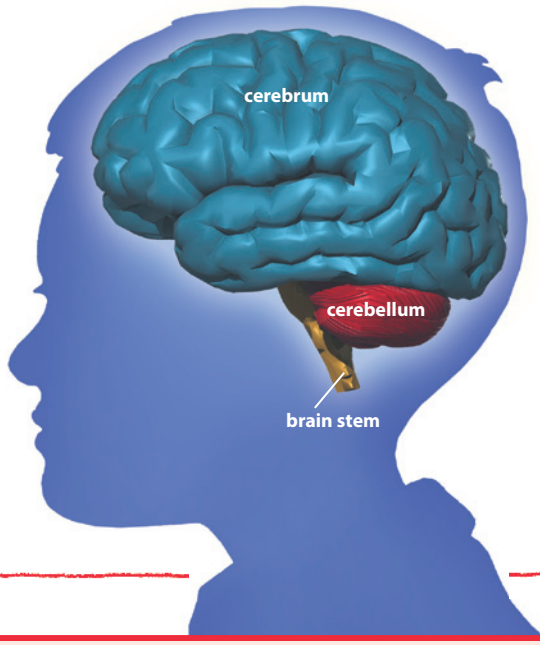
Why do you think God has designed our bodies to do some actions automatically? Elicit that we would never be able to do other things if we had to consciously remember to breathe, swallow, or do other automatic functions.

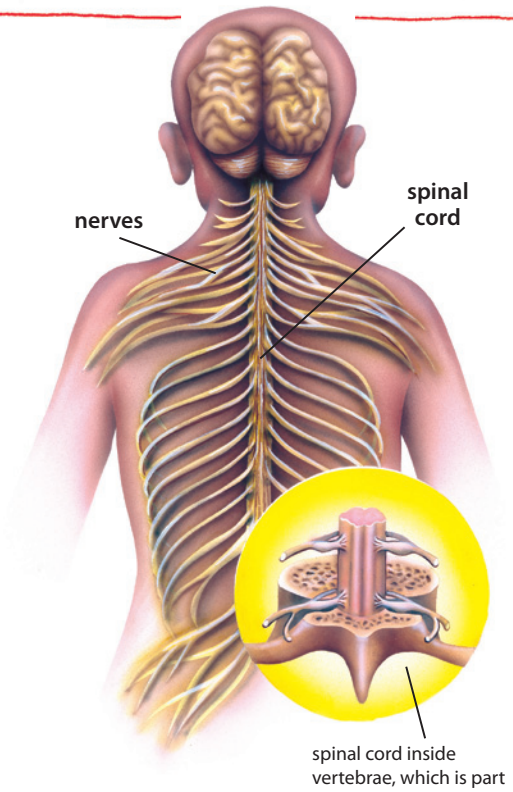
The next part of the brain is the **cerebellum**, which means "little brain." The cerebellum is located underneath the cerebrum and is much smaller. It receives orders from the frontal lobes and sends messages to muscles throughout the body in order to accomplish tasks. The cerebellum does not decide when or where a person should move, but it does control the speed and force with which he moves.

Whenever you learn a new activity, such as bike riding, the cerebrum directs your muscles. Once the activity has been learned, the cerebellum takes over. It remembers how to do that task. The cerebellum also helps to control balance and muscle coordination. If this part of the brain is damaged, a person may have difficulty with motor skills such as eating, talking, or walking.

The final part of the brain is the **brain stem**. The brain stem is located below the cerebrum and in front of the cerebellum. It connects the brain to the spinal cord. Part of the brain stem also controls the functions necessary for life, such as breathing, heartbeat, blood pressure, swallowing, and digestion. These are involuntary activities. You do not have to think about them to make them happen. God has designed our brains to operate some functions automatically. Think of how hard it would be if you had to remember to breathe, make your heart beat, and digest your food all at the same time.

Parts of the Brain





Spinal cord

Can you feel the bumpy bone that goes down the center of your back? That backbone, your *spinal column*, protects your spinal cord. The spinal cord is inside the tunnel made by the *vertebrae*, or bones, in your spinal column. It is surrounded by cerebrospinal fluid and covered by three membranes. These membranes act like filters, protecting the spinal cord from any harmful substances that may be in the blood stream.

God created the **spinal cord** to be the main pathway of information connecting the brain to the rest of the body. The spinal cord is a column of nerve fibers about as thick as one of your fingers. It will be about 43–45 cm (17–18 in.) long when you are an adult. Usually the spinal cord ends at a person's waist.

The spinal cord is divided into thirty-one sections. Each section has pairs of nerves that branch out from between the vertebrae in the spinal column. These nerves continue to branch out and reach all parts of the body. Nerves connect with every spot of skin as well as with each organ and muscle.

The central nervous system is a very important part of the body. Injuries to the brain or spinal column can result in problems such as blindness, paralysis, and loss of speech or movement. Sometimes an injury to the central nervous system can be fatal. That is one reason why it is important to wear the proper protective equipment for sports and other athletic activities.

QUICK CHECK

1. What functions does the central nervous system have?
2. What are the two main parts of the central nervous system?
3. What are the three parts of the brain?

Discussion

Where is your spinal column located? down the center of your back

What is another name for the spinal column? backbone

What does the spinal column protect? the spinal cord

What bones in your spinal column make up the tunnel for your spinal cord? vertebrae

Other than your spinal column, what else protects your spinal cord? cerebrospinal fluid and three membranes

What is your spinal cord? a column of nerve fibers

Emphasize to the student that the spinal cord is the nerve fibers and the spinal column is the bones that protect the spinal cord.

How thick is your spinal cord? about as thick as your finger

How long will your spinal cord be when you are an adult? 43–45 centimeters, or 17–18 inches

Into how many sections is your spinal cord divided? 31

Why do you think the spinal cord is called "the main pathway of information"? The spinal cord is connected to the brain, and nerves branch out of the spinal cord to all parts of the body.

Some people say that the spinal cord looks like a tree. Why do you think they say this? Possible answer: The spinal cord resembles the trunk, with nerves as the branches.

When people talk about the spine, are they referring to the bones or to the nerves? Elicit that usually they are referring to the bones.

What are some things that could result from an injury to the brain or spinal cord? blindness, paralysis, loss of speech or movement, death

Answers

1. The central nervous system makes decisions and controls the body's actions.
2. the brain and the spinal cord
3. cerebrum, cerebellum, and brain stem

Activity Manual

Reinforcement, page 226

SCIENCE BACKGROUND

Meninges

The three membranes, or meninges, that protect the spinal cord also cover and protect the brain. The *pia mater* is the inside layer, closest to the central nervous system. The middle membrane is the *arachnoid mater*, and the outside membrane is called the *dura mater*. Meningitis occurs whenever the membranes become inflamed or infected.

Lesson 161

Student Text pages 340–43
Activity Manual pages 227–28

Objectives
- Identify the parts of a neuron
- Explain how neurons send messages
- Compare the two parts of the peripheral nervous system
- Describe how a reflex occurs

Materials
- stopwatch or watch with a second hand

Vocabulary
neuron
sensory neuron
motor neuron
dendrite
impulse
axon
synapse
reflex

Introduction
What are some different ways that we can send messages to our friends? Possible answers: letters, e-mail, phone calls, instant messaging, text messaging

Why do we send those messages? to stay in contact with our friends; to share experiences

Today we will be studying how the body sends messages to and from the brain.

Why do you think it is important for the brain to stay in contact with the parts of the body? Possible answer: The brain is responsible for controlling the body parts, so it must be in contact with them.

Teach for Understanding
Purpose for reading
Which part of the peripheral nervous system helps your body adjust to its external environment?

What is a reflex?

Discussion
What are neurons? nerve cells

How are neurons similar to other cells in your body? They each have a cell body with a nucleus, chromosomes, and DNA.

What is unique about neurons when compared to other cells? They can communicate with each other.

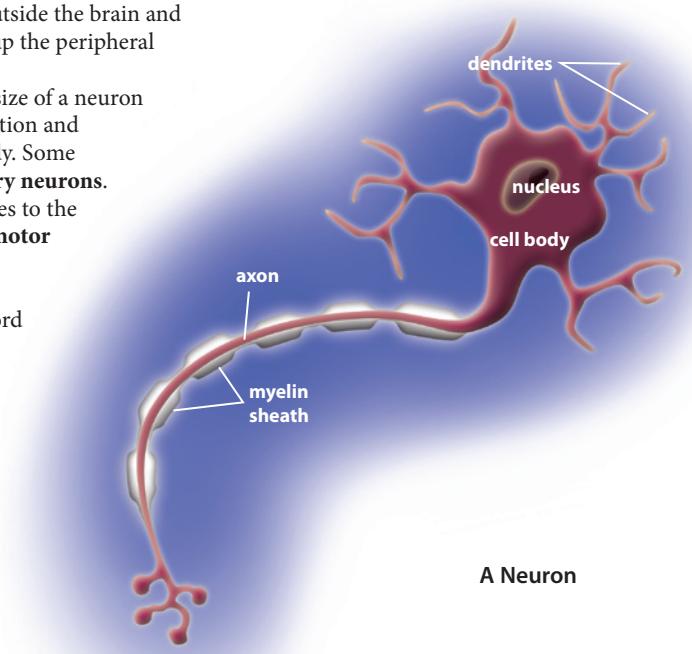
Does the peripheral nervous system include the neurons outside the brain and spinal cord or inside the brain and spinal cord? outside

What determines the shape and size of a neuron? its function and location in the body

The Peripheral Nervous System
Neurons
When you stub your toe, how do you know that it hurts? Thousands of tiny nerve cells send a message up to your brain. The brain interprets the incoming message as pain, and you become aware that your toe is hurting. The nerve cells are called **neurons** (NUR AHNZ). In some ways neurons are similar to the other cells in your body. Each has a cell body with a nucleus, chromosomes, and DNA. But neurons also have the unique ability to communicate with each other. The neurons located outside the brain and spinal cord make up the peripheral nervous system.

The shape and size of a neuron depend on its function and location in the body. Some neurons are **sensory neurons**. They carry messages to the brain. Others are **motor neurons**, sending messages from the brain and spinal cord to the muscles. Neurons can live for a long time, longer than most cells. However, most neurons that die are not replaced.

The **dendrite** (DEN dryt) receives the electrical **impulse**, or message, from another neuron. The dendrite passes that message to the cell body. The cell body passes the message to the **axon** (AK sahn), which sends the impulse on to the next neuron. Although a neuron usually has only one axon, it can have many dendrites. Some nerve cells have as many as 10,000 dendrites! The nerve fibers in your body are actually bundles of axons and dendrites from many neurons. Your body has over ten billion long and microscopically thin nerve cells. Some of the longest neurons have axons more than a meter long.



A Neuron

340

SCIENCE BACKGROUND

Cells
The parts of cells and their functions within cells are discussed in Chapter 4, *Cells and Classification*.

How neurons send messages
The electrical impulse is created by the movement of ions such as sodium and potassium through the neuron's cell membrane.

LANGUAGE

Neurotransmitter
The word *neurotransmitter* is made up of the prefix *neuro*, meaning "nerve," and *transmit*, meaning "to send."

DIRECT AN ACTIVITY

Make a bead neuron

Materials: pony beads, plastic lacing, copy of *Bead Neuron*

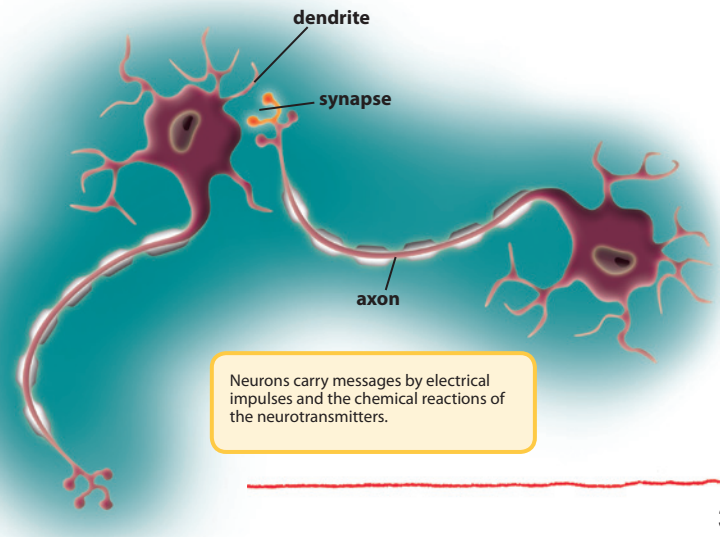
Direct the student to make a bead neuron. Use the bead neuron as a model to review and reinforce the parts of a neuron. The student may find it helpful to color the beads on the instructions the same colors as the beads he is using. You may choose to use a bead neuron instead of the ruler in the Demonstration on TE page 371.

Even though your body contains billions of neurons, the neurons do not touch each other in order to send messages to and from the brain. If you touch a paper clip to your finger, the paper clip presses against the dendrites in your skin. The pressure you feel travels as an electrical impulse through the dendrites, to the cell bodies, and then to the axons.

Between each neuron is a little gap called a **synapse** (SIN aps). As the electrical impulse arrives at the synapse, the electricity causes chemicals called *neurotransmitters* (NUR oh TRANZ mit urz) to be released. These chemicals cross the synapse and carry the message on to the next sensory neuron. The impulse continues from neuron to neuron, sometimes as fast as 120 m (400 ft) per second. This impulse could travel the length of a football field in less than one second.

When the sensation reaches your brain, the brain interprets it and lets your finger know that it is experiencing pressure. By the time you feel the pressure of the paper clip, the message has already traveled to the brain, been interpreted, and traveled back through the motor neurons to tell your finger to move. The amount of electricity involved in sending the nerve message to the brain is about one-tenth of a volt.

God gave some axons a protective covering called a *myelin* (MYE uh lin) *sheath*. This extra insulation helps the neuron send messages faster. Because myelin sheaths are white, areas of the nervous system with myelin sheaths are called white matter. Areas of the central nervous system where the neurons do not have myelin sheaths are sometimes called gray matter.



Neurons carry messages by electrical impulses and the chemical reactions of the neurotransmitters.

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DIRECT A DEMONSTRATION

Demonstrate how impulses travel

Materials: 6 or more students, ruler

Direct the students to stand with their arms outstretched at their sides. There should be a small space between the fingertips of each student, so that the students cannot touch each other. The students represent neurons, and the ruler represents an impulse. Start the impulse by placing one end of the ruler in the hand of the first student.

Which part of the neuron is represented by the hand that receives the ruler (impulse)? dendrite

The student passes the ruler over his head to his other hand.

The impulse moves from the dendrite to which part of the neuron? axon

The student passes the ruler to the next person without touching hands.

What is the name of the gap between the axon of one neuron and the dendrites of the next? synapse

Continue passing the ruler and reviewing how neurons send impulses.

Discussion

How are sensory neurons different from motor neurons? Sensory neurons carry messages to the brain. Motor neurons carry messages from the brain to the muscles.

We know that most cells are replaced when they die. How are neurons different? Most neurons are not replaced when they die.

Why might a person who has had a severe cut on a finger or toe lose feeling in that part of the body? Possible answer: The neurons there might have been injured and not replaced.

Refer to *A Neuron* diagram and the neurons shown on page 341 as each part is discussed.

What are impulses? the electrical messages sent from neuron to neuron

Which part of a neuron receives the impulse? the dendrite

Which part of a neuron sends the impulse to the next neuron? the axon

What are nerve fibers? bundles of axons and dendrites from many neurons

What is a synapse? the little gap between each neuron

How do the neurons send impulses? The impulse is received by the dendrites, sent to the cell body, and then sent to the axon. At the axon, chemicals are released that carry the message across the synapse to the dendrites of the next neuron.

What are neurotransmitters? the chemicals that cross the synapse and carry the impulse on to the next neuron

What protective covering helps neurons send messages faster? the myelin sheath

How is white matter different from gray matter? White matter consists of neurons that have myelin sheaths. Gray matter consists of neurons without myelin sheaths.

Discussion

What are the two parts of the peripheral nervous system? somatic nervous system and autonomic nervous system

Which part helps the body adjust to its external environment? somatic nervous system

Which muscles are controlled by the somatic nervous system? the skeletal muscles

How are the skeletal muscles different from muscles controlled by the autonomic nervous system, such as the heart? Most skeletal muscle movement is voluntary. Other muscles, such as the heart, are involuntary muscles. You cannot control them.

What is the purpose of the autonomic nervous system? It regulates the body's internal environment.

Check a student's heart rate for 30 seconds as he sits still in a chair. Record his heart rate. (It will probably be easiest if he finds his pulse on his neck and then counts the number of heartbeats for the 30 seconds.) Direct the same student to run in place or do jumping jacks for one minute. Check his heart rate again and record the number.

Why are these two numbers different? The first number shows how fast the heart was beating while the student was still and resting. The second number shows how fast the heart was beating after exercise.

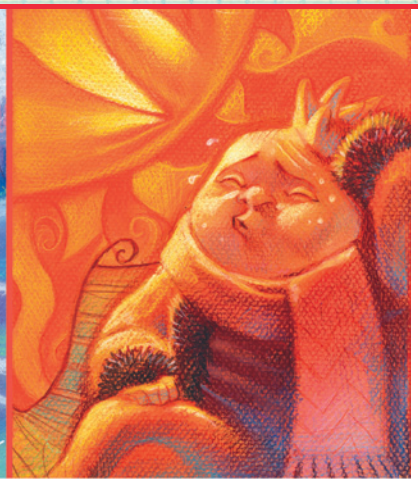
Did the student control his heart rate, or did it change automatically? It changed automatically.

Which part of the peripheral nervous system regulates your heartbeat? autonomic nervous system

What are some other activities controlled by the autonomic nervous system? Possible answers: temperature, blood pressure, breathing, digestion

Which kind of neuron is used by the autonomic nervous system? motor neuron

How often is your autonomic nervous system functioning? continuously



Somatic nervous system

The peripheral nervous system can be separated into two parts. One part, the *somatic* (soh MAT ik) *nervous system*, controls your skeletal muscle movements. The somatic nervous system helps your body adjust to its external environment. The sensory neurons gather information about things in your environment and send that information to your central nervous system. The central nervous system then sends messages to your muscles, making them contract and relax as you move.

Autonomic nervous system

The peripheral nervous system also helps to regulate your internal environment. This part of the peripheral nervous system is sometimes called the *autonomic nervous system* because it controls involuntary activities. Usually you do not have conscious control over these activities.

For example, the autonomic nervous system controls your heart rate. Stress or fear can cause your heart to beat faster. But when you are resting or digesting food, the autonomic nervous system slows your heartbeat. The autonomic nervous system also helps your body maintain a constant temperature. When you are cold, your body starts to shiver. If you get too warm, your body releases perspiration through its pores. All of these reactions happen automatically.

The autonomic nervous system also regulates your blood pressure, breathing, digestion, and many other bodily functions. If you had to think about each one of these activities in order for it to occur, you would probably not be able to do anything else! The autonomic nervous system uses motor neurons to keep your body running smoothly. It works continuously, even when you are sleeping.

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SCIENCE BACKGROUND

Autonomic nervous system
The autonomic nervous system is divided into the sympathetic nervous system and the parasympathetic nervous system. During stressful times, the sympathetic nervous system prepares the body to respond quickly by increasing the heart rate, blood pressure, etc. At times of rest, such as digestion and relaxation, the parasympathetic nervous system decreases the heart rate and blood pressure.

Shivering
When the body is chilled, the sympathetic nervous system causes the body to shiver. This shivering helps warm the body because of the increased muscle activity.

Yawning
Even though a yawn seems quite "contagious" at times, it is not considered to be a reflex. People used to think that yawns occurred when the lungs did not have enough oxygen or when someone was bored. Although yawns may occur at these times, they are not caused by lack of oxygen in the lungs or by boredom. Scientists are not certain what causes yawning, but some believe that a low oxygen level in part of the hypothalamus triggers yawns.

Photic sneezing
Some people tend to sneeze when exposed to a bright light such as sunlight. This genetic reflex is called *photic sneezing*.

Reflexes

Sometimes your body responds to a situation before your brain makes a conscious decision. For example, if you touch a hot stove accidentally, the electrical impulse immediately begins to travel from neuron to neuron until it reaches the spinal cord. Before the impulse passes on to the brain, an automatic message is sent back to your hand, telling your muscles to move your fingers away from the hot stove.

While this is happening, the impulse continues to the brain. Your brain interprets the message, and you realize that you are touching something hot and should move your hand. Since the whole process happens so quickly, you do not notice the time difference. From the time you touch the stove until you move your hand and your brain registers what has happened, less than one-thousandth of a second has passed.

Even though this seems to happen all at once, you actually pull your hand back before your brain tells you that there is pain. This is called a reflex. A **reflex** is an action that happens before the brain has time to think about the action. A reflex is hard—sometimes impossible—to control.

FANTASTIC FACTS

What triggers you to sneeze? This reflex usually happens whenever the lining of the nose becomes irritated by foreign particles, such as dust or pollen. Scientists have found that a person can sneeze about as fast as a baseball pitcher can pitch a fastball. Some sneezes have been as fast as 150 km/h (about 100 mi/h). Sneezes can be quite powerful because they involve not only the nose but also muscles in the chest, abdomen, face, throat, and eyelids. Sneeze droplets can travel as far as 1.5 m (5 ft) before they settle.

QUICK CHECK

1. What is the difference between sensory and motor neurons?
2. What is the purpose of the autonomic nervous system?
3. How are reflexes different from other muscle movements?

Discussion

Why might your body need to respond to a situation before your brain decides on the action? Possible answer: to protect itself from danger

Which part of the central nervous system would send an automatic message telling your hand to move away from a hot stove? the spinal cord

Does this happen before or after the brain recognizes that your hand is touching something hot? before

What do we call an action that happens before the brain can think about it? reflex

Can you tell that your hand moves before you think about the stove's being hot? no **Why?** The body reacts so quickly that the movements and thoughts seem to happen at once.

What are some other reflexes? Possible answers: sneezing, blinking, knee reflexes

Reflexes are an example of how God designed the body with built-in ways to protect itself.

Discuss *Fantastic Facts*.

What causes most sneezes? the lining of the nose being irritated by foreign particles

How fast can a sneeze be? 150 kilometers per hour or 100 miles per hour; about as fast as a pitcher's fastball

Which parts of the body are involved in a sneeze? nose, chest muscles, abdomen, face, throat, and eyelids

Answers

1. Sensory neurons carry messages from the senses to the brain. Motor neurons carry messages from the brain to the muscles.
2. to control involuntary activities
3. The brain controls all muscle movements except reflexes. Reflexes happen automatically before the brain has time to think about the action.

Activity Manual

Review, pages 227–28

These pages review Lessons 160 and 161.

Assessment

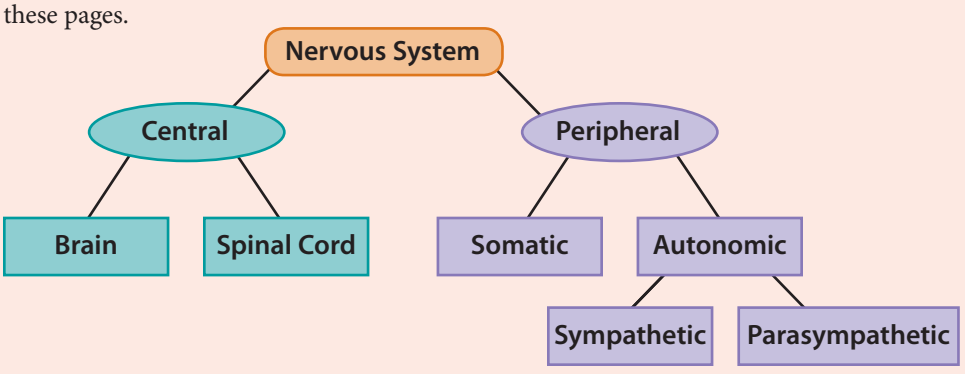
Quiz 14-A

The quiz may be given any time after completion of this lesson.

TEACHER HELPS

Organization of the nervous system

This diagram is provided to be a quick reference for the organization of the nervous system. You may choose to have the student develop a concept web or other graphic organizer during his reading or the discussion of these pages.



Objectives
- Explore variables that affect reaction time

Materials
- See Student Text page

Introduction

Have you ever had a 150 km/h (100 mi/hour) fastball pitched to you?

If you had, were you able to hit it?

Why can some baseball players hit balls this fast, but you cannot? Possible answers: The baseball player is stronger, faster, or has practiced more.

Why do some softball teams use orange balls for practice? Elicit that orange balls are easier to see.

Do you think orange balls help the softball player react more quickly to hitting the ball? Accept any answer.

In today's activity, you will be testing your reaction time and determining ways to improve it.

Teach for Understanding

Purpose for reading
The student should read all the pages before beginning the activity.

Procedure
Provide time for the student to test his reaction time using both strips of poster board. After recording measurements, discuss how changing the color affected the reaction time.

Did you notice a difference in your reaction times when you used the colored strip instead of the white strip of poster board?

Did the colored strip increase or decrease your reaction time?

What are some things other than the color of the strip that might affect your reaction time?

If needed, suggest variable changes such as dropping different long, straight items, closing your eyes, using the other hand, or using a mirror.

Would these variables be more likely to increase or decrease your reaction time?

Allow the student to test additional variables as time allows.

ACTIVITY

Reaction Time

Process Skills
- Predicting
- Measuring
- Inferring
- Identifying and controlling variables
- Recording and interpreting data

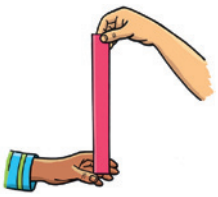
Your body continually reacts to your environment. Most of these reactions, such as your body temperature, are automatic. However, you can change the speed of some reactions. Many factors can affect your body's ability to react quickly. In this activity you will test variables that can either increase or decrease your reaction time.

Problem

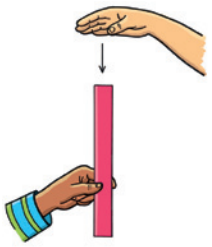
How does changing a variable affect my reaction time?

Procedure

Materials
assorted 3 cm × 30 cm strips of poster board, one white and three of different colors
centimeter ruler
additional items as needed
Activity Manual



1. Have a partner hold the top of the white strip of poster board. Hold your thumb and index finger on either side of the bottom of the strip without touching it.
2. When your partner lets go of the strip, try to catch it between your fingers as quickly as you can. Mark the place on the strip where your thumb and finger caught it. Measure the distance from the bottom of the strip to the mark. Record the measurement in your Activity Manual.
3. Repeat two times. Each time, mark the strip of posterboard with a different color or symbol. Average your measurements.
4. Choose a color of poster board that you think will improve your reaction time. Test your time again three times using the colored strip of poster board. Record and average your measurements.



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BIBLE

Christlike reactions
Reactions are actions that we do quickly with minimal thought. They are generally a result of inherited or practiced traits. Our reactions to others are also a result of our inherited personalities and our practiced traits. A Christian's reactions should evidence the fruits of the Spirit, such as love, joy, peace, patience, gentleness, goodness, meekness, and self-control. As Christlike reactions are practiced, the person is more likely to react properly to others. [BATs: 3c Emotional Control; 4b Purity; 4e Honesty; 5b Giving; 5d Communication; 5e Friendliness]

5. Compare the results of the two tests. Explain how changing the variable of color affected your reaction time.
6. List three other variables that might change your reaction times.
7. Predict whether each change will increase or decrease your reaction time.
8. Test each of your variables and record the results.

Conclusions

- Were your predictions correct?
- Which changes increased your reaction time?

Follow-up

- List everyday activities that benefit from faster reaction times.

SCIENCE PROCESS SKILLS

Identifying and controlling variables

What was the main variable that you changed? the color of the strip

What are some variables that you could not control? Possible answers: individual reaction times; benefit of practice; how the person felt

Could these variables have been controlled? probably not

What are some ways the effects of these uncontrolled variables could be minimized? Possible answers: do the tests over several days and average the results; add more people to the sample group

What other variables were changed in later tests? Answers will vary based on the student's choices.

When you changed variables, were other variables created that you could not control? Answers will vary.

Why is it important for scientists to identify and control as many variables as possible? Possible answer: Uncontrolled variables may give inaccurate results.

Conclusions

Provide time for the student to evaluate the results and answer the questions.

Use the questions in the Science Process Skills to discuss identifying and controlling variables.

Activity Manual

Activity, pages 229–30

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Objectives

- Recognize how the five senses interact with the nervous system
- Interpret diagrams for information
- Identify the nerves associated with hearing, sight, and smell
- Explain how the different senses communicate with the brain

Introduction

What would it be like if you could not use some of your five senses?

How would the lack of senses affect the way that you gather information? Answers will vary.

The lack of which sense would probably most affect a scientist's conclusions? sight **Why?** Most conclusions are drawn from observations that are based on sight.

Today we will be studying the five senses and seeing how they interact with the nervous system to keep us aware of God's world.

Teach for Understanding

Purpose for reading

Which part of the ear changes vibrations into nerve impulses?

In which part of your skin is your sense of touch located?

Discussion

Which body system helps all five senses function? the nervous system

Discuss *The Ear* diagram.

What are sound waves caused by? vibrations

Which part of the ear vibrates as it receives sounds? the eardrum

Which part of the ear changes the vibrations into nerve impulses? the cochlea

Which three small bones transfer vibrations from the eardrum to the cochlea? anvil, hammer, and stirrup

Which nerve transmits nerve impulses from the ear to the brain? the auditory nerve

Which part of your body interprets the sound vibrations received by your ear? the brain

Interactions with the Nervous System

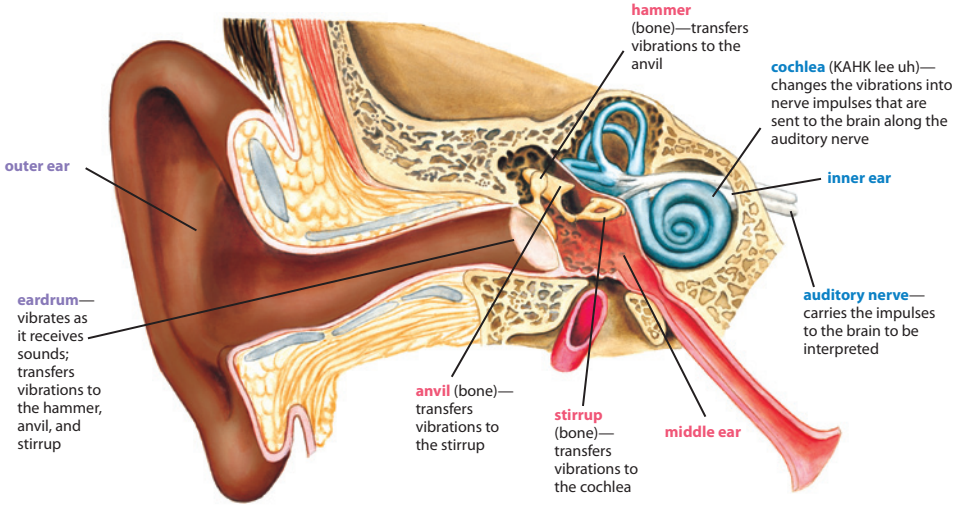
The Five Senses

Our five senses help us to be aware of the world around us. Without these senses we would not be able to understand or appreciate God's creation. But our senses only gather information. The interaction of the senses and the central nervous system allows us to interpret the sensory information, or stimuli, that is gathered. All five senses can function only with the help of the nervous system.

Hearing

Sound waves, caused by vibrations, are funneled into the ear canal by the outer ear. The vibrations continue to move through the middle ear and inner ear, where the cochlea changes them into nerve impulses. Finally, the impulses reach the brain, which interprets them to let you know what sounds you are hearing. Without your brain to interpret the sounds, your ear would still receive sound waves, but the vibrations of your ear would have no meaning to you.

The Ear



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TECHNOLOGY

Cochlear implant

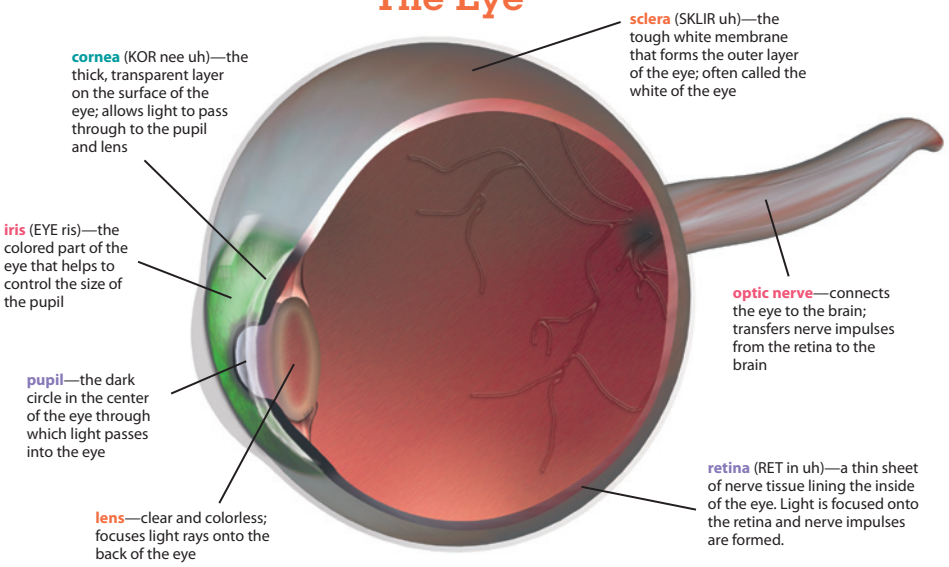
A cochlear implant may help some deaf people convert sound waves into electric currents that stimulate the auditory nerve to send impulses to the brain. The implant functions similarly to the hair cells in the cochlea that normally change sound waves into the electrical impulses. The benefits of a cochlear implant vary from person to person, but these implants have helped many deaf people discern sounds that had been unknown to them previously.

DIRECT AN ACTIVITY

Hearing and locating sounds

Play a game of Marco Polo within an established boundary. The person who is "It" must either have his eyes closed or be blindfolded. As he seeks for the other players, he calls out, "Marco." The other players move around within the boundaries and answer, "Polo." The person who is "It" must listen to the replies and move to tag another player. The player tagged will become the new "It."

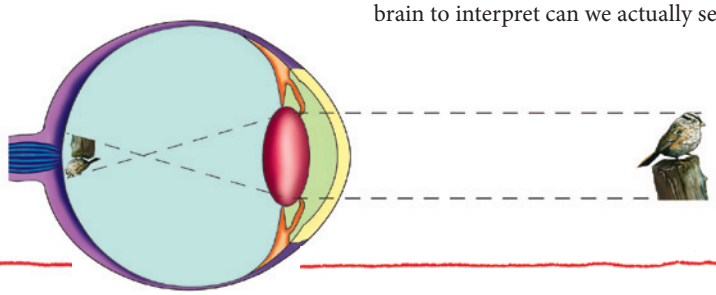
The Eye



Sight

Without light you would not be able to see anything. When light bounces off objects, the parts of the eye work together to allow the brain to see an image. However, images received by the brain are upside down. The brain flips the images over and recognizes what you are seeing.

We speak of the eye as seeing. But the eye only provides the means for the brain to receive sensory information. Only as the sensory receptor neurons in the retina collect information and send it along the optic nerve for the brain to interpret can we actually see.



Discussion

Discuss *The Eye* diagram.

What must bounce off an object in order for you to see that object? light

What is the purpose of the lens of the eye? It focuses light rays onto the back of the eye.

In which part of the eye are nerve impulses formed? the retina

What does an image look like on the retina? The image is upside down.

Which parts of the eye does light go through before the image is formed on the retina? cornea, pupil, lens

Which nerve sends messages from the eye to the brain? the optic nerve

Can your eye see without the brain being involved? no **Why?** The eye only gathers the sensory information and sends it to the brain. The brain interprets the information and identifies what is seen.

As an example of how our bodies are wonderfully put together (Ps. 139:14–16), discuss the way our eyes and brains work together to help us perceive our world. For this to happen, light waves are reflected off of the object we are seeing, pass through the air, and then go through several structures in our eye, which help to bend and focus those light rays. The rays must be focused to a pinpoint area on the inner lining of our eye (retina) where the light energy, through a chemical reaction, is converted to an electrical impulse. This impulse travels through a special nerve to a particular brain region where the electrical signal is compared with previous signals, allowing the viewer to form a mental image and recognize what he is looking at. Think about how fast this is happening to enable something like the reading of a textbook!

DIRECT A DEMONSTRATION

Demonstrate how the eye sees things upside down

Materials: glass fishbowl filled with water, black poster board, white poster board, candle

Make a small pencil hole in the middle of the black poster board. Stand the black poster board against one side of the bowl. Lean the white poster board against the other side of the bowl. Light the candle. Position the candle so that the light is shining through the hole in the black poster board. Darken the room. Adjust the white poster board until an image of the flame appears on it.

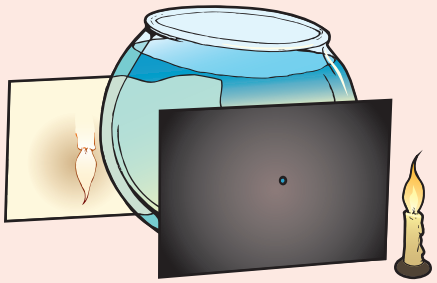
Which part of the eye does the black poster board represent? the pupil

Which part of the model represents the eyeball? the bowl filled with water

Which part of the eye does the white poster board represent? the retina

How does the image appear? upside down

How is this similar to the eye? The curved eyeball causes the light entering the eye to bend, inverting the image as it forms on the retina.



Discussion

Discuss the diagram about taste, smell, and touch as each sense is discussed.

Where are some of your taste buds located? inside bumps on your tongue

What are these bumps called? papillae

Where are the sensory receptors for taste located? inside the taste buds

Which one of your other senses is directly linked to your sense of taste? the sense of smell

Why might a person hold his nose while taking bad-tasting medicine? The sense of smell affects taste. Holding one's nose helps to reduce the taste of the medicine.

What type of cell detects odor particles that have entered the nose? olfactory receptor cells

Which nerve sends impulses from the nose to the brain? the olfactory nerve

How is your sense of touch different from the other four senses? It is the only sense located all over the body.

Which part of your skin contains the nerve receptors for your sense of touch? the inner layer, or the dermis

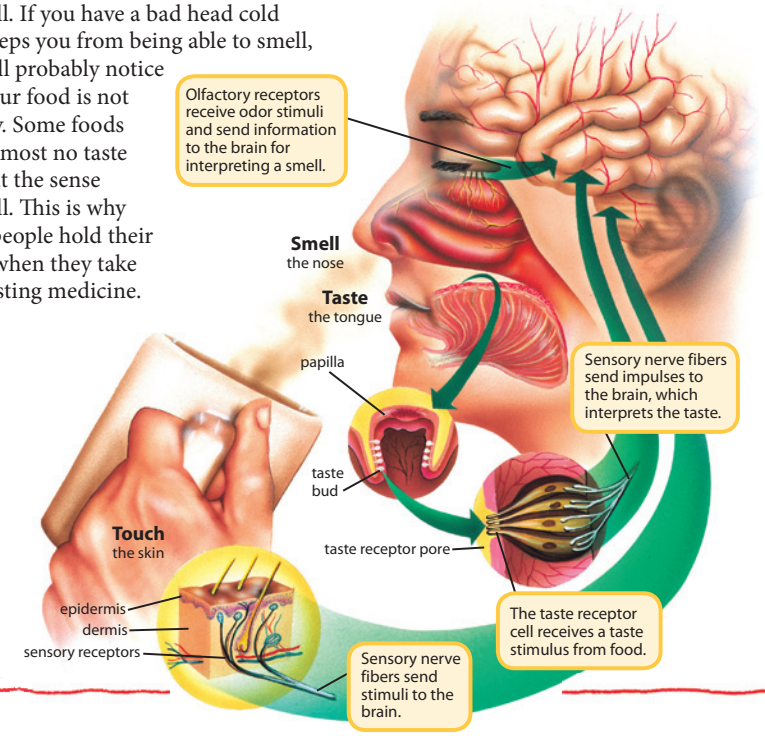
Taste

Taste buds help us recognize different tastes and flavors. If you look inside your mouth, you will see lots of tiny bumps, called papillae (puh PILL ee) all over your tongue. Those bumps are not taste buds. The taste buds are located inside the bumps. Some bumps contain only a few taste buds, but others have more than one hundred taste buds.

Inside the taste buds are sensory receptors. The receptors receive the taste and send it along to the brain to be interpreted. The brain then decides what the taste is. However, your sense of taste is directly affected by your sense of smell. If you have a bad head cold that keeps you from being able to smell, you will probably notice that your food is not as tasty. Some foods have almost no taste without the sense of smell. This is why some people hold their noses when they take bad-tasting medicine.

Smell

The air contains many different odor particles. As you breathe in, air enters into the nasal cavity. Inside the nasal cavity, the odor particles first pass through a thick layer of mucus. Then they float up to the top of the nasal cavity. *Olfactory* (ohl FAK tuh ree) *receptor cells* detect the particles and send impulses to the olfactory nerve. The olfactory nerve sends the impulses to the brain. The brain interprets the message and identifies the smell.



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SCIENCE BACKGROUND

Tasting and smelling

The senses of taste and smell are closely linked and are often referred to as the chemical senses. Adults have about 10,000 taste buds located on the tongue, cheek, palate, and throat. The taste receptors respond to chemicals dissolved in the saliva. Humans have about 10 million olfactory receptors that respond to odor chemicals dissolved in the mucus layer.

Taste buds are usually replaced about every 10–14 days, and olfactory receptors are replaced about every 4–8 weeks. These receptor cells are the only sensory cells that the body replaces regularly. However, the number of taste buds declines as people age.

Scientists have found that people can recognize at least 5,000 different tastes and more than 10,000 different odors. Many memories are often associated with specific smells and tastes.

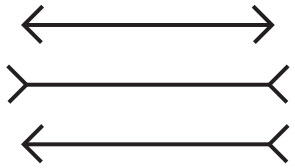
Touch

You use your sense of touch to feel things. Each of the other four senses is located in just one certain place. But the sense of touch is located all over your body. The outer skin, or *epidermis* (ep ih DUR mis), however, is not responsible for your sense of touch. There are no nerve receptors in the epidermis.

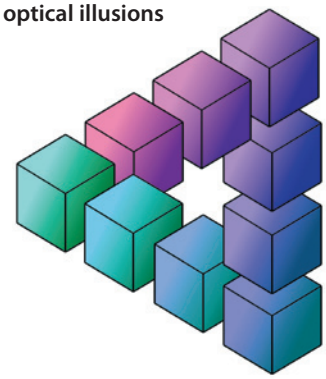
Your sense of touch originates in the *dermis*, or inner layer of skin. The dermis is filled with tiny sensory receptors. Some of these receptors detect movement and pressure. Others recognize temperature changes or detect pain. These sensory receptors send messages to the brain about what you touch. The brain processes the information and sends messages back, letting you know how things feel.

You might have noticed the pressure of your shoes on your feet when you first put them on. In just a short while, though, you do not even feel your shoes on your feet. When your brain constantly receives the same pressure signals from your skin, it becomes used to the pressure. God designed your senses to adapt to the environment around you to keep from being overloaded with stimuli. Have you ever noticed a certain odor, such as air freshener, when you entered a room? After you have been in the room for several minutes the odor is not as noticeable.

Your body has many different types of receptors that send specific messages to the brain. These receptors allow the brain and senses to work together, keeping us aware of the world around us. However, we cannot completely trust our senses. Sometimes the information we gather is inaccurate. For example, optical illusions can confuse our sight perception. Only one source of information—God's Word—is completely accurate and trustworthy.



optical illusions



QUICK CHECK

1. Which nerves are associated with sight and hearing?
2. Which other sense is closely associated with your sense of taste?
3. How is your sense of touch different from your other senses?

DIRECT AN ACTIVITY

Discerning with senses

Materials: 2 different brands of the same food or drink, such as dried fruit, potato chips, fruit juice, or soft drink

Remove or hide the labels so that only the person directing the challenge knows which product is which. Allow the student to predict which brand he will prefer. Record the predictions. Provide time for the student to taste each sample. Record his sample preferences. Reveal which brand is which, and compare the predictions with the results.

Discussion

What types of things are detected by the sensory receptors in your skin? Possible answers: movement, pressure, temperature changes, pain

People often wish that they did not feel the pain of a headache, a broken bone, or other injury. We often take medicine to lessen the amount of pain felt. Can you think of a reason why it is important that we feel pain? Possible answer: If we did not feel any pain, we might injure ourselves more severely. Pain can also make us aware of an infection or other medical condition that needs attention.

Why do you not feel the pressure of your shoes after you have worn them for a while? The sense of touch adapts to the pressure because the brain has become used to the pressure.

Why do our senses adapt to the environment around us? Possible answer: to keep us from being overloaded with stimuli

Is the information received by our senses always accurate? no **Give an example of a time when the information received may not be accurate.** Possible answer: optical illusions

What is the only completely accurate and trustworthy source of information? God's Word **[BAT: 8b Faith in the power of the Word of God]**

Discuss ways that a person can verify the accuracy of the information he gains from his senses such as repeating the experience and comparing results or observing with more than one sense.

Answers

1. The optic nerve is associated with sight. The auditory nerve is associated with hearing.
2. the sense of smell
3. It is the only sense located all over your body.

Activity Manual

Review, page 231

This page reviews Lesson 163.

Assessment

Quiz 14-B

The quiz may be given any time after completion of this lesson.

Objectives
- Predict and identify areas of the body that are the most sensitive to touch

Materials
- See Student Text page
- *Touch Tester* (IA), copy for each group

Introduction
Have you ever felt a fly crawling on your arm?

The sensory receptor cells in your arm registered the touch of the fly and transmitted impulses to your brain about the fly's movement. Sensory receptors are located all over your body, but some areas of your body have more receptors than other areas have. In this activity you will determine which place on your body is the most sensitive to touch.

Teach for Understanding
Purpose for reading
The student should read all the pages before beginning the activity.

Procedure
Reproduce the Touch Tester pattern. Provide time for the student to assemble his Touch Tester.

Remind the student to predict his sensitivity before he begins testing. Each student should test someone else and be tested himself. The answers he records should be his own results.

Explain to students that this activity is measuring two-point discrimination. The most sensitive areas of the body have a greater number of receptors in a given area and thus can detect points that are closer together.

Remind the students to record their results after testing each place.

ACTIVITY

Touch Tester

Process Skills
- Predicting
- Measuring
- Inferring
- Recording data

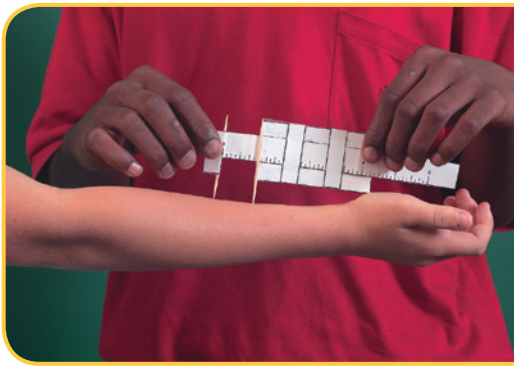
The nerve endings in the skin contain neurons that send messages to the brain about the things we touch. God made some areas of our bodies more sensitive than other areas by giving them more neurons. In this activity you will test and compare the sensitivity of different places on your body.

Problem
Which place on your body—the arm, finger, palm, or neck—is most sensitive to touch?

Procedures
Note: This activity uses English rather than metric measurements.

Materials
Touch Tester
scissors
2 toothpicks
tape
blindfold (optional)
Activity Manual

1. Assemble the Touch Tester that your teacher gives you.
2. Predict the sensitivity of the areas of your body listed in your Activity Manual. Number from 1–4, with 1 being the place on your body you think will be the most sensitive.
3. With your eyes closed or blindfolded, have your partner begin testing the areas of your body listed.
4. To use the Touch Tester, begin with both toothpicks together at the 0 mark. Gently press the toothpicks on the skin. Determine the number of toothpicks that are felt. If only one toothpick is felt, slide the toothpick to the next mark and test the skin again. Continue sliding the toothpick and retesting until both toothpicks are felt.
5. Record the distance between the toothpicks.



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TEACHER HELPS

Assembling the tester
When assembling the Touch Tester, make sure that the placement of the tape does not interfere with the movement of the measurement strip.

Group size
This activity works best when done in groups of two.

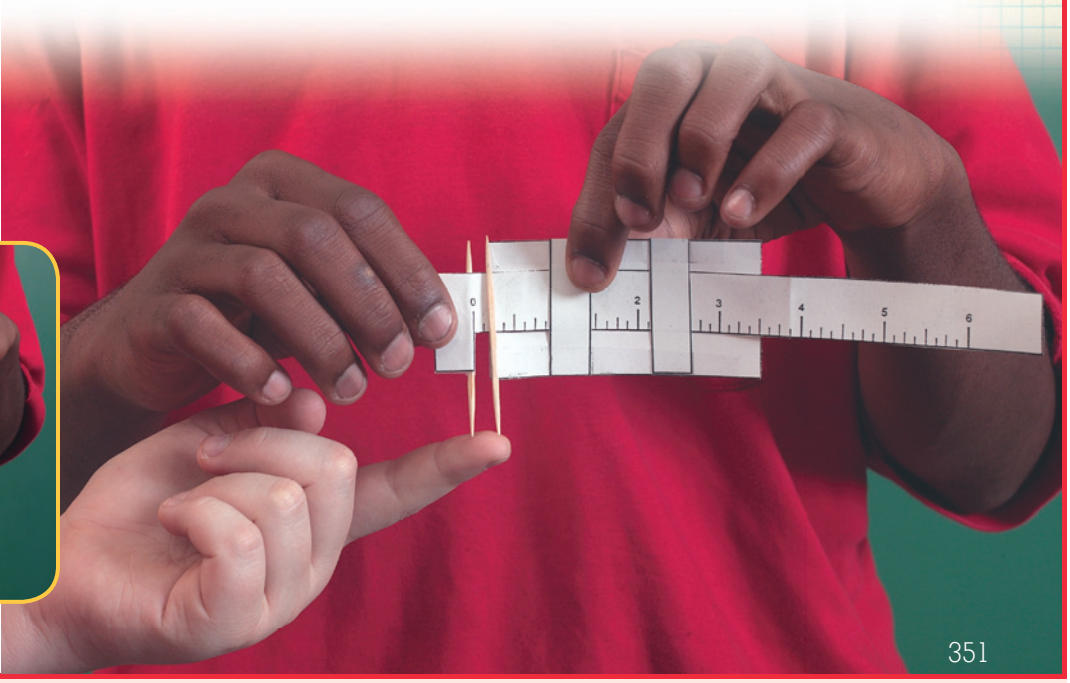
6. Repeat steps 3–5 to test the sensitivity of each place on your body.
7. Number the places again based on your measurements. Write 1 next to the place with the smallest measurement.

Conclusions

- Were your predictions correct?
- Think how you use each part of the body that you tested. Why do you think God made some places on your body more sensitive than other places?

Follow-up

- Research to find how the distance between the toothpicks compares with the number of neurons in each area of skin.
- Test other areas of your body, such as your face, ear, the top of your foot, and the bottom of your foot.



SCIENCE PROCESS SKILLS

Predicting
Predicting is forming an idea of a future event based on previous knowledge.

On what did you base your predictions? Answers will vary, but elicit that the student's predictions were based on previous knowledge of his own body's sensitivities.

After you tested the first place on your body, did you still think your predictions would be accurate? Why? Answers will vary.

Suppose you were asked to predict something for which you have no background knowledge. Would you be making a good or reasonable prediction? no **Why?** It would be a guess since it is not based on observation or knowledge.

What could you do to make your prediction more valid? Possible answers: conduct research; make observations of similar situations

Why do you think scientists research their topics and the research results of other scientists extensively before planning and making their own predictions about their own experiments? Since predicting implies background knowledge, scientists must gain this knowledge before they can anticipate a result.

Conclusions

Provide time for the student to evaluate the results and answer the questions.

Which place did you find to be the most sensitive?

What makes some places on your body more sensitive than other places? There are more neurons in some places than in others.

Why do you think God made some areas of your body more sensitive than others? Answers will vary.

Use the questions in the Science Process Skills to discuss predicting.

Activity Manual

Activity, page 232

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Objectives
- Differentiate between short-term memory and long-term memory
- Identify two categories of long-term memory
- Describe some characteristics of REM sleep and explain why sleep is important to the body

Materials
- prepared list of 10 two-digit numbers

Vocabulary
memory
long-term memory
short-term memory

Introduction
Display the list of numbers and give the student one minute to study the numbers. Remove the list and direct the student to write what he remembers. Check the student's list for accuracy. Direct the student to turn over his list and set it aside.

Teach for Understanding
Purpose for reading
What section of the brain seems to be necessary for developing long-term memories?

What is REM sleep?

Discussion
What is memory? the ability to remember or recall something

Why do you think God told the Israelites to remember what He had done for them? Possible answers: to give glory to Him; to remind them of their need of Him; to give courage when things were difficult **[BATs: 7b Praise; 7e Humility; 8d Courage]**

How do scientists think memories are formed? by neurons communicating with each other

How is short-term memory different from long-term memory? Short-term memory is stored only temporarily. Long-term memory is more permanent.

What are some examples of short-term memories? Possible answers: grocery list, phone number, score of a basketball game

What are some examples of long-term memories? Possible answers: music or sports skills, names of parents and best friends, major accomplishments

Memory

Memory plays a very important role in our daily lives. Suppose you woke up one morning and could not remember your name, how to tie your shoes, or where you put your homework assignment. You would have a difficult time functioning that day. But God has given your brain the ability to store and retrieve information. In fact, God tells us to remember. For example, in Deuteronomy 8:2, God told the Israelites to remember how He brought them out of Egypt and protected them during their forty years of wandering. The ability to remember is called **memory**.

What kinds of things do you remember? You remember sounds, smells, things that you saw, and hopefully, things that you have studied. The entire brain is involved in making and keeping memories. Scientists think that memories are formed by neurons communicating with each other. They identify a memory as a specific pathway from neuron to neuron. The brain continually makes new connections between neurons as you learn and process new information.

Some memories are kept longer than other memories. **Short-term memory** stores information only temporarily. This information might be a phone number, a grocery list, or the number of points scored in a basketball game. Usually when you look up a phone number, your short-term memory remembers the number only for a little while. The more often you see or hear something, though, the longer you will remember it. We need to be careful about what kinds of information we take in through our senses. Things that we see or hear can stay in our memory for a long time.

Long-term memory can store information for months, years, or even for a lifetime. These memories can be a mixture of sensory information as well as facts and experiences. Some scientists think that emotions play a part in transferring information to long-term memory. If something you experienced was unpleasant, you want to remember to avoid it. On the other hand, if the experience was comforting or pleasurable, you usually want to repeat it.

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SCIENCE BACKGROUND

Memories
The brain classifies memories in many different ways, sometimes associating a memory with one of the senses. Certain sounds, smells, or sights can sometimes bring back a specific memory quickly. The more times a memory is reviewed and stored in the brain, the more new neural pathways form, making it easier to access the information again. An infant has many more neurons in his brain than he will have in adulthood. Neurons that are not used or stimulated to form pathways often die or cease functioning.

SCIENCE MISCONCEPTIONS

"Forgotten" memories
When an item stored in long-term memory is forgotten, that memory is not necessarily gone. It may be that the person is not accessing that memory through the same neural pathway that stored the memory.

Scientists do not know exactly how some information in short-term memory transfers into long-term memory. An area inside the temporal lobe, called the *hippocampus* (hip uh KAM pus), seems to be necessary for making new long-term memories. Scientists and doctors have found that if damage occurs to this area of the brain, people can still remember old long-term memories but cannot store any new long-term memories. Their memories of current events or new people and places are held only in short-term memory.

Long-term memories can also be described as *declarative* or *procedural*. Declarative memories involve any knowledge that requires you to recall specific facts. These facts include your friend's birthday, vocabulary words, and definitions. Procedural memories include remembering how to ride a bike, play a violin, and paint a picture.

Scientists are not exactly sure how we learn. But scientists do know that different people learn in different ways and that the ability to learn changes as people grow older. Though some things are easier to learn as children, other information requires more maturity to understand. We know that God never intends for us to stop learning. We should say with David in Psalm 143:10, "Teach me to do thy will; for thou art my God: thy spirit is good; lead me into the land of uprightness."

SCIENCE BACKGROUND

Memory loss

Amnesia is a general term used to describe memory loss. A person may experience amnesia if the brain is injured. Depending on the cause, amnesia may be temporary or permanent. This memory loss could be caused by trauma, diseases, infections, drug and alcohol abuse, or by reduced blood flow to the brain.

Discussion

Which area in the brain seems to be responsible for transferring short-term memories into long-term memory? the hippocampus

What can happen when the hippocampus is damaged? New long-term memories cannot be made. Old long-term memories are remembered, but all new experiences are stored in short-term memory only.

What are two different types of long-term memories? declarative and procedural

How are declarative and procedural memories different? Declarative memories include remembering specific facts. Procedural memories include remembering how to perform certain skills.

Why would remembering how to perform a skill be called a procedural memory? A procedure is a way to do or perform something.

Do all people learn the same way? no

What are some ways people learn or receive information to be remembered? Possible answers: reading, hearing, doing

What happens to the ability to learn as a person gets older? It changes.

Why do you think God may allow learning abilities to change with age? Accept reasonable answers. Elicit that the types of things we need to learn and remember change. Some information requires more experience and maturity to understand.

Do you think God intended for anyone to get old enough that he would no longer need to learn new things? no

The Bible reminds us that a wise man will continue to hear instruction and gain knowledge (Job 32:4–9; Prov. 1:5; 8:33).

Direct the student to again write down the numbers from the list used in the Introduction without reviewing the list or his previous answers. Discuss the results of the tests performed in the Introduction.

Did your results change from the first test to the second test? probably yes

Which type of memory did you use as you took the first test? short-term

Why did you have difficulty remembering the numbers the second time? Most likely the numbers were not part of long-term memory.

What would have helped the numbers become long-term memory? Possible answer: studying them for a longer time

Discussion

What does your nervous system do while you sleep and your body rests? The nervous system keeps the autonomic functions going and appears to do some sensory housekeeping.

What are some things you do to help your parents with housekeeping? Possible answers: put things in their proper places; clean; throw away unusable things

Do you think you use all the sensory information that comes into your body each day? no **Why?** Possible answer: Much of the information is unimportant.

What does *sensory housekeeping* mean? Accept reasonable answers. Elicit that our brains also put information into their proper places and clear out unnecessary information.

What are three different types of sleep stages? light sleep, deep sleep, and REM sleep

Which stage of sleep does a person experience first? light sleep

Does your heart rate increase or decrease as you begin to fall asleep? decrease

Which part of the nervous system regulates your heart rate and breathing as you sleep? the autonomic nervous system

Why is it difficult to wake someone up out of deep sleep? The body is very relaxed.

What are some characteristics of REM sleep? Possible answers: The brain is very active. The eyes move quickly back and forth. Some muscles twitch.

Why is REM sleep important to the body? Possible answers: It helps the brain develop and helps the brain sort through and organize information received throughout the day.

In which stage of sleep do most dreams occur? REM

What characteristics of REM sleep might you observe in a sleeping animal? Possible answers: muscles in ears and paws twitching; eyes moving back and forth under the eyelids

What is an electroencephalograph (EEG)? a machine used to study how the brain works

What does an EEG measure? electrical impulses of neurons in the brain

Why can electrical impulses be used to measure the brain's functions? Neurons communicate with each other through electrical impulses.

Sleep and the Nervous System

When you sleep your body rests, but your nervous system remains very active. Not only does the nervous system maintain the autonomic functions such as your breathing and heartbeat, it appears to do some sensory housekeeping as well.

Scientists have identified several different stages of sleep. Although the brain remains active throughout all the stages of sleep, its level of activity changes. When you first fall asleep, your autonomic nervous system slows down your heart rate and breathing. Your body prepares to rest, and you enter the first stages of light sleep. Later, in deep sleep, your body becomes very relaxed. Waking up out of deep sleep can be quite difficult.

People go back and forth between periods of light sleep and deep sleep throughout the night. Scientists have found that there is also another stage of sleep where the brain is very active. The eyes move back and forth quickly, even though the eyelids are closed. Often a person's muscles begin to twitch, and the brain seems to be as active as if the person were awake. This stage of sleep is called rapid eye movement, or *REM* sleep. REM sleep occurs only after the body has gone through periods of light and deep sleep.

REM sleep is very important to our bodies. Some scientists think that this stage of sleep helps our brains to develop. Infants usually spend about 50 percent of their sleep in REM sleep. Scientists also think that REM sleep may be one of the ways that our brains

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SCIENCE BACKGROUND

Sleep medicines

Some sleep medicines used to treat insomnia or other health problems cause the body to skip REM sleep and spend more time in deep sleep. When the person is no longer using the medicine, the body sometimes tries to catch up on missed REM sleep, thus causing more problems. Each stage of sleep is important for the body's health.

sort through and organize all of the information received throughout the day. Most dreams occur during REM sleep. A person who can remember details about a dream probably woke up during REM sleep.

Scientists use a machine called an *electroencephalograph* (ih lek troh en SEF uh luh GRAF), or EEG, to study how the brain works while people sleep. The EEG measures the electrical impulses produced by the neurons in the brain. By studying sleep patterns, scientists have noticed that both the quality and the quantity of sleep are important for a person's health. Failing to get adequate rest can affect every area of a person's life. Most scientists also believe that getting a good night's sleep improves a person's memory.

Children usually need about nine to ten hours of sleep each night. Adults require a little less—about seven to eight hours each night. While we are sleeping, our bodies rest and can work on other functions, such as repairing cuts and bruises. Sleep also gives children's bodies time to grow.

Our brains filter sounds while we sleep so that familiar noises do not bother us. The brain can also allow the body to rest while it stays alert to certain noises. Just ask any mother how long it takes for her to awake to her child's cry at night. The brain's multiple abilities show evidence of its wonderful Creator.

QUICK CHECK

1. Give an example of a short-term memory.
2. How is declarative memory different from procedural memory? How are the two similar?
3. Why do scientists think that REM sleep is important for the body?

a child connected to an EEG

Discussion

How many hours of sleep do children need? nine to ten

What are some benefits of getting a good night's sleep? Possible answers: health, improved memory; The body works on other functions such as repairing cuts and bruises. Children's bodies grow.

Why might children need more sleep time than adults do? Possible answers: A child's body is growing. Children have more sensory information to "housekeep."

Why does your body need more sleep when you are sick or injured? The body must repair itself. During sleep, many body functions are slowed down and are not attended to, so the body's energy can be more concentrated on healing.

Why can someone who lives near a railroad track sleep soundly as a train passes by, but an overnight guest might be awakened by the sound of the train? The brain filters out familiar noises while we sleep. The person who lives there is used to the sound of the train, but his guest is not.

Emphasize the amazing skills that God designed our brains to do.

Answers

1. Possible answers: phone number, grocery list, basketball score
2. Declarative memory involves the recall of specific facts. Procedural memory involves remembering how to do a certain skill. Both are long-term memories.
3. REM sleep helps the brain develop and may also be one of the ways the brain sorts through and organizes all the information received throughout the day.

Activity Manual

Reinforcement, page 233

Bible Connection, page 234

This page discusses things God tells Christians to remember.

Expansion, pages 235–36

These pages allow the student to practice graph reading skills while gaining information about the sleep times of animals.

Objectives
- Compare characteristics of the nervous system and the endocrine system
- Identify the function of some glands in the endocrine system
- Identify some common nervous system disorders
- Recognize some of the problems resulting from drug abuse

Materials
- padlock with correct key or key to the classroom door
- several keys that will not unlock the padlock or the door

Vocabulary
hormone
endocrine gland
hypothalamus
pituitary gland
epilepsy
multiple sclerosis
Parkinson's disease
Alzheimer's disease

Introduction
Distribute the keys and direct the student to try to unlock the lock.

Did every key work in the lock? no **Why?** Not all the keys were made to fit that lock.

Only the key made for that lock will unlock it. Today we will be learning about some chemical messages used by our bodies. These messages and the cells that they affect are somewhat like locks and keys. The chemical messages can affect or "unlock" only certain cells.

Purpose for reading
What is the hypothalamus?

What are some nervous system disorders?

Discussion
What are two ways that the endocrine system differs from the nervous system? It uses chemical messengers instead of electrical impulses, and it works more slowly than the nervous system.

What are hormones? the chemical messengers used by the endocrine system

Where are hormones produced and released? in endocrine glands

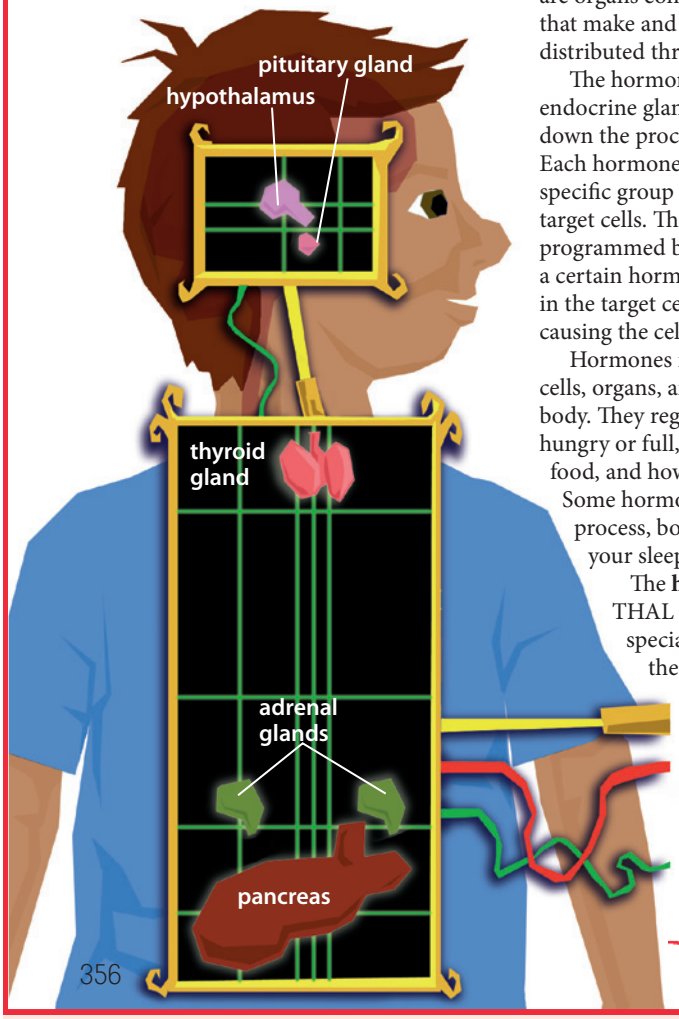
What are two ways that hormones can affect cells? They speed up or slow down certain processes.

Are all the cells in the body affected by each hormone? no **Why?** Each hormone can affect only a certain group of cells called its target cells.

What programs these target cells to receive only a certain hormone? genes

The Endocrine System

The nervous system is directly connected to another system of the body, the endocrine (EN duh krin) system. Together these systems control all the functions of the human body.



The endocrine system works more slowly than the nervous system. Instead of electrical impulses, the endocrine system uses chemical messengers called **hormones**. Most of the body's hormones are produced in the **endocrine glands**. These glands are organs containing special cells that make and release hormones to be distributed throughout the body.

The hormones released by the endocrine glands speed up or slow down the processes of certain cells. Each hormone can affect only a specific group of cells, known as its target cells. These target cells are programmed by genes to receive only a certain hormone. Special receptors in the target cell bind to the hormone, causing the cell to function differently.

Hormones influence almost all the cells, organs, and functions of your body. They regulate whether you feel hungry or full, how your body uses food, and how you handle stress. Some hormones control your growth process, body temperature, and even your sleep.

The **hypothalamus** (hy poh THAL uh mus) is a group of special cells near the base of the brain. Neurons in the hypothalamus help regulate the pituitary (pih TOO ih tehr ee) gland, which is located just underneath it. Even though it is only

SCIENCE BACKGROUND

Hormone production
Many other body organs, including the kidney and stomach, also secrete hormones. The kidney produces a hormone that stimulates red blood cell development in bone marrow. The stomach produces a hormone that increases the amount of hydrochloric acid in the stomach. Another hormone produced by the stomach causes the constriction of stomach muscles.

Pancreas
The pancreas makes some hormones that are used to help digest food. The insulin secreted by the pancreas causes cells to absorb sugar from the blood. If the pancreas does not produce enough insulin, the blood will contain too much sugar, resulting in *hyperglycemia*, also known as diabetes. If the pancreas produces too much insulin, the cells absorb too much sugar, resulting in low amounts of sugar in the blood. This is known as *hypoglycemia*.

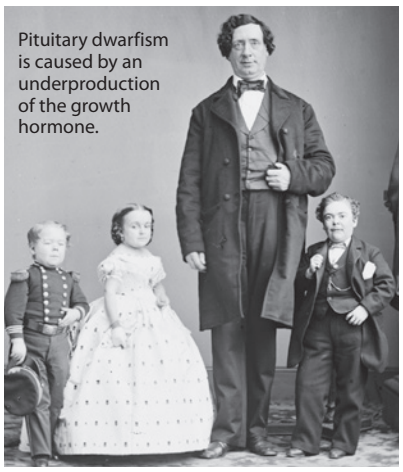
about the size of a pea, the **pituitary gland** is very important for your body. Sometimes called the master gland, the pituitary gland produces hormones that control other glands in the endocrine system. This gland also produces a growth hormone that helps bones grow and develop.

Many times the amount of hormones released also depends on the circumstances in a person's life. Your body has two *adrenal* (uh DREE nul) *glands* located on top of your kidneys. These glands help your body respond to stressful or dangerous situations. They release a substance called adrenaline (uh DREN uh lin), which increases your blood pressure and heart rate during stress. You may have heard of someone who showed great strength and endurance in a dangerous situation. This strength was possible because of the hormones released by the adrenal glands. These hormones also increase a person's heart rate and cause a person to tremble when he is nervous or scared.

The *pancreas* is located near the stomach, and it releases the hormone insulin. Insulin helps control the amount of sugar in the bloodstream. If a person's pancreas does not make enough insulin, a disease called diabetes could develop.

Your *thyroid gland* is located in your neck, just below your voice box. This gland is shaped like a butterfly. It controls how your body uses food to make energy. It also influences your body's growth and development. If the thyroid releases too many hormones,

Gigantism is caused by an overproduction of the growth hormone.


Pituitary dwarfism is caused by an underproduction of the growth hormone.

a person may become nervous or hyperactive or may lose too much weight. When the gland does not release enough hormones, the person often gains weight and feels tired all the time. The pituitary gland and the hypothalamus control these glands and many others.

Discussion

What are some life processes regulated by hormones? Possible answers: hunger; how the body uses food; how the body handles stress; growth; body temperature; sleep; weight

What group of cells near the base of the brain connects the nervous system with the endocrine system? hypothalamus

What does the hypothalamus do? helps regulate the pituitary gland

Why is the pituitary gland sometimes called the master gland? It makes hormones that control the other glands in the endocrine system.

What is another special hormone produced by the pituitary gland? the growth hormone

Which glands help the body respond to dangerous or stressful situations? the adrenal glands

What hormone is released during times of stress? adrenaline

Which hormone does the pancreas produce to regulate the amount of sugar in the bloodstream? insulin

What disease can occur when the pancreas does not produce enough insulin? diabetes

Which gland is shaped like a butterfly? thyroid

What does the thyroid gland control? how the body uses food

Discuss the photos on Student Text page 357.

What causes gigantism? overproduction of the growth hormone

What condition is caused when the body does not produce enough growth hormone? pituitary dwarfism

TEACHER HELPS

People in the photos

In the top photo, the tall man is Robert Wadlow. In the bottom photo, the man on the far right is Tom Thumb. See History for more information about them.

HISTORY

Giants and dwarfs

In the past, people who exhibited dwarfism or gigantism were sometimes part of circus or carnival sideshows. Being on exhibit was often their only means of income.

Charles S. Stratton, known as Tom Thumb, traveled with P. T. Barnum. Tom Thumb was only 33 inches tall. He was a great attraction throughout the United States and Europe in the 1800s.

As an adult, Ella Ewing was 8 feet 4.5 inches tall. She worked as part of several museum displays and traveled with the Barnum & Bailey circus. Ella is thought to have been the tallest woman, but she is not recorded in the *Guinness Book of World Records*.

The tallest person recorded by the *Guinness Book of World Records* is Robert Wadlow (1918–1940) of Alton, Illinois. By age ten, Robert was 6 feet 5 inches tall and wore size 17½ shoes. His growth was caused by an overactive pituitary gland. When he died in 1940, he was 8 feet 11.1 inches tall. He did not work for a circus or carnival.

Disorders and Drugs

Both the nervous system and the endocrine system are extremely important to our bodies' health. God designed our bodies in a wonderful and marvelous way. The Bible says that we are "fearfully and wonderfully made" (Ps. 139:14). However, since the Fall when sin entered the world, people's bodies do not always work in the ways God designed them to function.

Sometimes disorders are called diseases. But you cannot catch these diseases. These disorders occur when the body fails to function as it should. Sometimes doctors can treat the symptoms of a disorder. But often they do not know the causes or the cures for the disorders.

Epilepsy (EP uh lep see), often called seizure disorder, occurs when the neurons in the brain send their electrical impulses too quickly and at an irregular rate. Other conditions besides epilepsy can cause seizures. But a person with epilepsy has repeated seizures, usually of a similar pattern. Doctors can prescribe medicine that helps to control the seizures, but they have not discovered a cure.

A disease called **multiple sclerosis** (skluh RO sis) destroys the myelin coating that covers the axon in some neurons. This causes the neurons to "short-circuit" so that the impulses cannot keep moving along. The symptoms that a person with this disease has depend on the location of the damaged nerves. People with multiple sclerosis may experience muscle weakness, paralysis, or loss of vision.

Parkinson's disease and Alzheimer's disease are two diseases of the nervous system that occur mainly in elderly people. **Parkinson's disease** causes damage to certain brain cells that control movement. This disease can cause a person's head, arms, and hands to tremble. A person who has Parkinson's disease may have trouble keeping his balance and doing simple tasks such as eating.

Alzheimer's (AHLTS hy murz) **disease** also destroys brain cells, but in a different way. This disease affects thinking processes. At first, a person with Alzheimer's disease usually has trouble with short-term memories. Later, the person may lose the ability to learn new information or to reason. A person with this disease may not be able to recognize family members and friends. Many people with this disease also suffer from depression and anxiety.

Scientists and doctors are searching for cures for these and other nervous system diseases. Some nervous system problems may be inherited or may happen because of head or back injuries. For some people, the nervous system does not develop properly before birth. Sometimes drug abuse or unhealthful habits cause or intensify nervous system disorders.

Discussion

Why do our bodies not always work in the ways God designed them to function? Answers will vary, but elicit that sin affects all of God's creation, including our bodies.

What causes a disorder? The body fails to function as it should.

Some disorders are called diseases. What is different between these "diseases" and real diseases such as chickenpox or colds? These "diseases" are not contagious. They are malfunctions, or disorders, of the body. Chickenpox and colds are contagious.

Which nervous system disorder happens when neurons in the brain send their impulses too quickly and at irregular rates? epilepsy

Many different things can cause a person to have a seizure. What is noticeable about the seizures of someone with epilepsy? The seizures are repeated and usually have a regular pattern.

Which part of neurons does the disease multiple sclerosis destroy? the myelin sheath covering the axon

What occurs in places where the myelin sheaths are destroyed? Nerve impulses are stopped and cannot continue to move.

Why might a person with Parkinson's disease have difficulty eating or writing? Parkinson's disease causes damage to brain cells that control movement.

What is the most noticeable symptom of Parkinson's disease? muscle tremors

Other than occurring mostly in older people, what do Parkinson's disease and Alzheimer's disease have in common? Both diseases cause damage to cells in the brain.

How are they different? Parkinson's disease damages cells that control movement, but Alzheimer's disease affects thinking processes.

What are some possible causes of nervous system diseases? Possible answers: heredity; head and back injuries; improper development of the nervous system before birth; drug abuse; unhealthful habits

How do drugs such as cocaine and marijuana affect the body? They change the way neurons in the brain send and receive information.

Why might a person addicted to a drug such as cocaine keep taking more of the drug? The drug changes the way the neurons normally work and causes his body to want more of the drug even though it is harming him.

SCIENCE BACKGROUND

Disease and age

Although Parkinson's disease and Alzheimer's disease occur mainly in older people, there are cases of both diseases occurring in younger people. Alzheimer's disease usually does not begin until after age 65, but it may begin as early as age 40. Parkinson's disease usually does not affect people younger than age 30, but it can develop at any age.

When you think of drug abuse, you probably think first of illegal drugs. Drugs such as cocaine and marijuana are harmful to the body. These types of drugs change the way that neurons in the brain send and receive information. Drugs affect the nervous system in many different ways, and some drugs can be addictive. By altering how the neurons work, some drugs make a person's body want to have more of the drug. The person then continues taking the drug even though it actually harms him and could be fatal.

But not all drug abuse happens with drugs such as cocaine, marijuana, or heroin. Some athletes take additional hormones called steroids to make themselves stronger or more muscular. But the improved performance may come with dangerous side effects, such as seizures and heart attacks. Even legal drugs such as cold and fever medicines can be abused. Any time a person uses a medicine in excess or in a way that it is not meant to be used, he could be creating problems for his body. These problems may show up immediately or may not appear for several years. Christians need to remember that their bodies are temples of God and do not belong to them (1 Cor. 6:19). Everything that a Christian does should be to the honor and glory of God (1 Cor. 10:31).

QUICK CHECK

1. Why are the hypothalamus and pituitary gland important to the interaction of the nervous and endocrine systems?
2. What is a disorder?
3. How can legal drugs sometimes be abused?

Being Spirit filled

Discuss Ephesians 5:17–19. Being Spirit filled means saying yes to what God wants you to do. God should control what we say and do. Relate this passage to the discussion about drug abuse. If a Christian abuses drugs, he is allowing something other than the Holy Spirit to control him.

DIRECT AN ACTIVITY

Ministering to others

Provide an opportunity for students to visit patients in a nursing home or hospital (especially those patients suffering from nervous system disorders). Remind the students that even though they may not know the patients that they visit, a few minutes of cheery conversation and perhaps some gospel songs or hymns can be a good way to witness about Christ. [BAT: 5c Evangelism and missions]

Discussion

Why do some athletes take steroids or other similar drugs? to make themselves stronger or more muscular

Steroids and similar drugs can temporarily improve a person's athletic performance. What are some side effects that may occur after taking drugs like these? seizures, heart attacks

Some steroids are used for medicinal purposes to treat health conditions such as asthma, arthritis, lupus, or eye diseases. Remind the student that the drug use mentioned in this discussion does not refer to drugs used for appropriate medicinal purposes.

Why might some people decide to use drugs? Possible answers: peer pressure; thinking it won't hurt them; curiosity; rebelling against authority; to block out unpleasant thoughts or guilt over wrong actions

Is taking drugs a wise choice? no **Why not?** because God commands us to take care of our bodies, and drug abuse destroys the body [BAT: 3d Body as a temple]

Beside the fact that a Christian's body is the temple of God, why would using drugs be dishonoring to God? because everything we do should glorify God

Drug abuse is not limited to cocaine, heroin, or steroids. Non-prescription medicines and other substances that are not even medicines are sometimes abused by being used in ways that they were not intended to be used.

Answers

1. Neurons in the hypothalamus regulate the pituitary gland, and the pituitary gland produces hormones that control all the other glands in the endocrine system.
2. A disorder is a condition that occurs when the body does not function properly.
3. Legal drugs, such as cold and fever medicines, can be abused any time a person uses them in excess or in ways that they are not meant to be used.

Activity Manual

Reinforcement, page 237

Review, page 238

This page reviews Lessons 165–66.

Assessment

Quiz 14-C

The quiz may be given any time after completion of this lesson.

Lesson 167

Objectives

- Identify some common categories of drugs
- Explain how some types of drugs affect the nervous system
- List some biblical reasons for not abusing drugs

Materials

- *Effects of Drug Abuse* (IA), copy for each student
- *Keeping God's Temple Clean* (IA), copy for each student

This lesson is designed as an interactive discussion alerting the student to the effects and dangers of abusing drugs or other substances. The focus of the lesson should be the truth that the body of a Christian is the temple of God and that as such, the body should be kept pure.

The material discussed is not all-inclusive. You may choose to incorporate your own thoughts and additional Scripture or resources as appropriate for your student.

Introduction

Drugs can be beneficial or deadly. Most drugs are used to treat diseases or control pain. Christian young people may face temptation to experiment with drugs. Peer pressure and lack of knowledge about the seriousness of drug abuse could lead a person to submit to temptation.

Teach for Understanding

Discussion

What does *abuse* mean? Answers will vary, but elicit that abuse can mean to use something in a way other than for its intended purpose.

Use *Effects of Drug Abuse* as you discuss the types of drugs and their effects.

One group of drugs is called stimulants. What would you expect these drugs to do to your body? Elicit that *stimulant* sounds like *stimulate* and that stimulant drugs speed up some body processes.

Read the first line of the chart. Which two drugs in the stimulant category are legal? caffeine and nicotine

What are some common sources of caffeine? Possible answers: soft drinks, tea, coffee, chocolate

How is nicotine usually taken into the body? smoking or chewing tobacco

What are some possible results of stimulant abuse? Possible answers: nausea, seizures, heart attack, high blood pressure, internal bleeding, and death

Effects of Drug Abuse

Name _____

Category	Common drugs	Effects of drug	Possible results of abuse
Stimulants	Cocaine Crack Methamphetamine Caffeine Nicotine	Speeds up the central nervous system Interferes with the sending of nerve messages Increases alertness and energy	Shortness of breath, nausea, and seizures Decreased learning and memory Increased risk of heart attack, high blood pressure, internal bleeding, and nervous system disorders Death
Depressants	Heroin Morphine Alcohol Codeine	Slows down (depresses) the central nervous system May bring a pleasurable feeling Blocks pain message	Shortness of breath, sleepiness, and loss of appetite Increased anxiety Increased blood pressure Decreased memory and physical coordination Decreased decision making and judgment abilities Deterioration of brain, liver, heart, or other organs Death
Hallucinogens	LSD Marijuana PCP Mescaline Psilocybin	Changes the way neurons in the brain send and receive information, resulting in hallucinations	Increased blood pressure Decreased coordination and alertness Decreased memory, concentration, learning, and problem-solving abilities Increased emotions, such as fear and anger Risk of flashback reactions long after use has ended Affects the brain stem and involuntary actions such as sneezing, breathing, and coughing Death
Steroids	Prescription medications Can be found in some dietary supplements, and some herbal remedies that claim to be "all natural"; muscle builders	Affects the hypothalamus and other nerve cells Alters the function of organs and the genetic material of individual cells Disrupts hormones in the endocrine system	Headaches, nausea, seizures, and central nervous system disorders Increased anger and aggression Reduced appetite and growth Decreased learning and memory Weakened immune system Increased risk of heart attack, high blood pressure, tumors, cancer, and liver problems Death
Inhalants	Ordinary products that are inhaled, contrary to their intended purpose	Prevents oxygen from reaching the brain Can cause abnormalities in the brain and nerves Can deteriorate the myelin sheaths on some nerves Inhaled drugs reach the brain faster and can cause greater damage than oral or injected drugs	Seizures Blurred vision Uncontrolled shaking Decreased memory, concentration, learning, and problem-solving abilities Increased risk of blindness, deafness, or liver damage Death

Another group of drugs is called depressants. What would you expect a depressant to do to your body? Elicit that *depress* gives the idea of slowing down. These drugs slow down some body processes.

Read the line of the chart about depressants. How do depressants affect the nervous system? Depressants slow down the central nervous system, sometimes block pain messages, and cause the brain to feel pleasure.

Cough medicine with codeine carries a warning that the user should not operate machinery when taking the medication. Why do you think it would carry this warning? Possible answer: As a depressant, codeine reduces alertness, which may cause accidents.

What other depressant listed is a legal drug that is commonly abused? alcohol

Read the line on the chart about hallucinogens. How do these drugs affect the brain? They change how the brain sends and receives information.

What are some possible results of hallucinogen abuse? Possible answers: decreased coordination, alertness, memory, and concentration; increased blood pressure; flashback reactions; increased risk of cancer

Keeping God's Temple Clean Key

A. Answer the following questions.

Which type of drug changes the way the brain receives information from the senses? _____

Which type of drug slows down the central nervous system? _____

Which type of drug affects the hypothalamus and the endocrine system? _____

Which type of drug speeds up the central nervous system? _____

Which type of drug prevents oxygen from reaching the brain? _____

B. Use your Bible and the word bank to complete the puzzle.

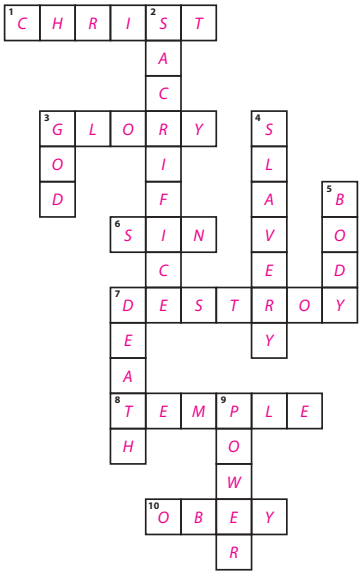
body	destroy	obey	slavery
Christ	glory	power	sin
death	God	sacrifice	temple

Across

1. A Christian's desire should be for ____ to be magnified and exalted in his body (Phil. 1:20).
3. Everything a Christian does should be done to the ____ of God (1 Cor. 10:31).
6. A person commits ____ when he does not do what he knows is right (James 4:17).
7. If someone destroys his body, God will ____ him (1 Cor. 3:17).
8. The body of a Christian is the ____ of God (1 Cor. 3:16).
10. People are slaves of the person or thing that they ____ (Rom. 6:16).

Down

2. A Christian should present his body as a living ____ to God (Rom. 12:1).
3. A Christian is not his own. He belongs to ____ (1 Cor. 6:19).
4. Like false prophets, the temptation to use drugs may promise liberty and freedom; but actually, it results in ____ (2 Pet. 2:19).
5. A Christian should honor and glorify God with his ____ (1 Cor. 6:20).
7. The way that seems right to a person leads to ____ (Prov. 14:12).
9. A Christian should not be under the ____ of anyone or anything other than God (1 Cor. 6:12b).



Discussion

Read the line on the chart about steroids. What parts of the body do these drugs affect? Accept any part of the body. Steroids affect the endocrine system, which produces hormones that affect every part of the body.

Some steroids are used as medicine to treat conditions such as asthma, eye disease, lupus, or rheumatoid arthritis.

Emphasize to the student the importance of reading and following the directions, dosages, and warnings of medicines he takes. Using any medication in a way other than as prescribed can cause harm.

Have you ever been in a closed room that has just been painted? Answers will vary. **Did the smell give you a headache or make you feel sick or dizzy?** Answers will vary.

Read the line on the chart about inhalants. Why do you think inhalants are a particularly bad problem among some young people? Possible answers: Inhalants are easily accessible, and most have no medicinal purpose.

Why do inhalants sometimes cause greater damage than other drugs? Inhaled drugs reach the brain faster.

How do inhalants affect the nervous system? Possible answers: They prevent oxygen from reaching the brain, cause abnormalities in the brain and nerves, and deteriorate myelin sheaths on some nerves.

What are some common side effects of inhalant abuse? Possible answers: seizures, blurred vision, shaking, decreased memory and concentration, increased risk of blindness, deafness, liver damage

Do you think that being a Christian means that a person will never be tempted to abuse drugs? no **Why?** A Christian still has a sinful nature.

What should a Christian do if he or she is tempted to abuse drugs? Possible answers: pray; remember verses about Christians' bodies being God's temple; flee the place of temptation; talk to parents or a trusted adult

Complete *Keeping God's Temple Clean* together and discuss the biblical principles. Use the information to reinforce that a Christian should honor and glorify God in what he does with his body.

SCIENCE BACKGROUND

Illegal drugs

Some drugs that are now considered illegal were once produced and used for medication or as additives in food and beverages. These drugs seemed helpful at first. But as their side effects were observed, doctors and scientists determined that the risks outweighed the benefits of using them, and they were classified as illegal.

Classification

Some drugs fit into more than one category. For example, nicotine is a stimulant. However, if a person is a heavy smoker, larger amounts of nicotine can act like a depressant.

Nicotine

Nicotine is now recognized as a deadly drug. Research estimates that more than 400,000 Americans die each year from nicotine-related diseases.

Caffeine

Caffeine is found in many foods, beverages, and medicines. Although most people do not normally ingest enough caffeine to be fatal to them (10 g), health professionals recommend that adolescents have no more than 100 mg per day and that consuming more than 500 mg may affect an adult's health. The amount a person can tolerate and its effects can depend on the person's health.

Alcohol

Many people die each year from alcohol-related traffic accidents. Even more die from alcohol-related diseases. Alcoholism is an addiction to a powerful drug, but an alcoholic chooses to take each drink.

Objectives
- Recall concepts and terms from Chapter 14
- Apply knowledge to everyday situations

Introduction
Material for the Chapter 14 Test will be taken from Student Text page 360 and Activity Manual pages 227–28, 231, 238, and 239–40. You may review any or all of the material during the lesson. Questions similar to Solve the Problem or the ones in Thinking It Through, Activity Manual pages 239–40, may appear on the test.

You may choose to review Chapter 14 by playing "One, Two, Three" or a game from the Game Bank on the Teacher's Toolkit CD.

Teach for Understanding
Diving Deep into Science
Information on this page reflects the vocabulary and concepts the student should know for the test.

Solve the Problem
In order to solve the problem, the student must apply material he has learned. The student should attempt the problem independently. The answer for this Solve the Problem is based on the material on Student Text page 359. Answers will vary and may be discussed.

Activity Manual
Review, pages 239–40
These pages require written responses to application questions.

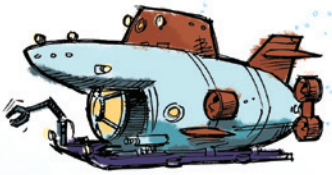
Lesson 169
Objective
- Demonstrate knowledge of concepts taught in Chapter 14

Assessment
Tests, Chapter 14

DIVING DEEP INTO SCIENCE

Words to Know
brain
lobes
spinal cord
neurons
dendrite
impulse
axon
synapse
reflex
memory
hormones
endocrine glands
hypothalamus
pituitary gland
epilepsy
multiple sclerosis
Parkinson's disease
Alzheimer's disease

Key Ideas
Parts of the brain
Relationship between parts of the nervous system
How impulses are transmitted
Differences between sensory neurons and motor neurons
Functions of the somatic nervous system and autonomic nervous system
How the senses interact with the nervous system
Differences between short-term and long-term memory
Importance of sleep
How the endocrine system works
Dangers of drug abuse



Solve the Problem
Yesterday Sara found out that her eighteen-year-old cousin is taking steroids to improve her softball playing. Her cousin says that she needs to take this drug in order to build up her endurance as a softball pitcher. She insists that it is not a dangerous drug like cocaine and that she will not use the drug after softball season. What are some reasons her cousin should not take this drug? What should Sara say? Are there some Bible verses she could share with her cousin?

Steroids interfere with the way that the nerve cells in the brain function. The side effects of steroid use may be noticeable immediately, or they may not appear until after Sara's cousin is an older adult. Sara needs to remind her cousin that Christians should be controlled by the power of God and not by the influence of drugs. Verses Sara may use include 1 Corinthians 3:19–20; 10:31; and Philippians 1:20.

360

Review Game
One, Two, Three

Divide the class into teams of three students. Give each team an object to pass. Each team represents a neuron.

Alternate questions between teams. When a review question is answered correctly by one team, the object is passed to the next person on that team. The team receives a point for each question answered correctly. When the third person answers correctly, the team receives 5 bonus points, and the object returns to the first person. If after two tries a student cannot answer his question, he may pass the object, but the team does not receive points. The student must answer a question correctly before he can pass the object to the next person and receive points. Continue playing until all review questions have been used. The team with the most points wins.

Variation: "Neurons" could be linked together to allow a message to travel from the "arm" to the "brain" and back again.