### Chapter 20 Nervous and Endocrine Systems

#### Section Organizer

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| **20-1 The Nervous System** | 1. Describe the basic structure of a neuron and how an impulse moves.  
2. Compare the central and peripheral nervous systems.  
3. Explain how drugs affect the body. | **Physics Integration:** p. 549  
**Using Math:** p. 550  
**Skill Builder:** Concept Mapping, p. 552  
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**Activity 20-1:** Reaction Time, p. 553 | National  
State/Local | Activity Worksheets, pp. 109–110  
Laboratory Manual, pp. 117–120  
Multicultural Connections, pp. 39–40 | English and Spanish audiocassettes are available for use with each chapter. |
| **20-2 The Senses** | 4. List the sensory receptors in each sense organ.  
5. Explain what type of stimulus each sense organ responds to and how.  
6. Explain the need for healthy senses. | **MiniLab:** Observing Balance Control, p. 555  
**Using Math:** p. 556  
**MiniLab:** Comparing Sense of Smell, p. 558  
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Home Involvement, p. 28  
Laboratory Manual, pp. 121–124  
Enrichment, p. 56  
Study Guide, p. 78 | |
| **20-3 The Endocrine System** | 7. Explain the function of hormones.  
8. Name three endocrine glands and explain the effects of their hormones.  
9. Explain how a feedback system works. | **Problem Solving:** Interpreting Blood Sugar Levels, p. 563  
**Skill Builder:** Comparing and Contrasting, p. 564  
**Science Journal:** p. 564  
**How It Works:** A Hearing Aid, p. 565 | National  
State/Local | Critical Thinking/Problem Solving, p. 20  
Enrichment, p. 57  
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**Activity Materials**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
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| Explore | p. 545 metric ruler  
pp. 560–561  
3 x 5 index cards, toothpicks, glue or tape, metric ruler |
| Activities | p. 553 metric ruler |
| Mini Labs | p. 555 paper, masking tape  
p. 555 different types of food, colognes, or household products, cotton balls |

Need Materials? Contact Science Kit at 1-800-828-7777 or at www.sciencekit.com on the Internet. For alternate materials, see the activity on the listed page.

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### Key to Teaching Strategies

The following designations will help you decide which activities are appropriate for your students.

- Level 1 activities should be appropriate for students with learning difficulties.
- Level 2 activities should be within the ability range of all students.
- Level 3 activities are designed for above-average students.

**ELL** ELL activities should be within the ability range of English Language Learners.

**COOP LEARN** Cooperative Learning activities are designed for small group work.

- These strategies represent student products that can be placed into a best-work portfolio.

multiple Learning Styles logos, as described on page 63T, are used throughout to indicate strategies that address different learning styles.

### Assessment Resources

<table>
<thead>
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<th>Object</th>
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</tr>
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| Chapter Review | pp. 39–40  
Assessment, pp. 77–80 |
| Performance Assessment in the Science Classroom (PASC) | |
| MindJogger Videoquiz | |
| Alternate Assessment in the Science Classroom | |
| Performance Assessment | p. 20  
Chapter Review Software  
Computer Test Bank |
Nervous and Endocrine Systems

Transparencies

Section Focus Transparencies

Science Integration Transparencies

Teaching Transparencies

Meeting Different Ability Levels

Study Guide for Content Mastery

Reinforcement

Enrichment Worksheets

Assessment

Performance Assessment

Chapter Review

Hands-on Activities

Activity Worksheets

Lab Manual

Accessibility

Spanish Resources

Extending Content

Critical Thinking/Problem Solving

Multicultural Connections
Receptor Cells (Section 20-1)

Specialized receptor cells respond to specific stimuli from various parts of the body. The stimulus produces a self-propagating wave of negative charges that are transmitted to the central nervous system via peripheral nerves. The nerve impulse travels at a rate of approximately 120 m/s. The brain and spinal cord of the central nervous system interpret the stimuli information.

Appropriate responses are sent via nerves to various body parts, which react to the stimulus. The response is a coordinated, integrated action that maintains homeostasis within the body.

Sensory Receptors (Section 20-2)

Sensory receptors of the body respond to environmental changes. Voluntary movement of head, limbs, and body is caused by nerve impulses arising in the motor area of the brain and carried by nerves to connect with skeletal muscles. The reaction involves both excitation of nerve cells stimulating the muscles involved and inhibition of the cells that stimulate opposing muscles.

Movements also may occur in direct response to outside stimuli and are called reflexes. These classes of receptors constantly send impulses into the central nervous system. Some receptors are sensitive to pain, temperature, touch, and pressure. Others react to changes in the internal environment, and a third type responds to variations in movement, position, and tension. These impulses end in special areas of the brain, as do those of special receptors concerned with sight, hearing, smell, and taste.

Olfactory receptors, primarily in the nose, respond to gas molecules that become dissolved in the watery fluids of the nasal passages. Taste buds located on small projections called papillae of the tongue, the soft palate, and the walls of the pharynx are sensitive to substances dissolved in liquids. Specialized taste cells within the taste buds function as receptors. Auditory sensory organs are present in the ears. Vibrations in the air with frequencies between about 16,000 and 20,000 cycles per second can be detected as a sound by the ear. Hair-like projections of the organ of Corti within the internal ear respond to the vibrations and transmit nerve impulses to the brain.

A complex arrangement of light-sensitive cells within the retina of the eye reacts to light energy with wavelengths between 380 and 760 millimicrons. The brain interprets the impulses from the optic nerve.

The body’s sense of motion and equilibrium structures are located within the inner ear. Sensory hair cells respond to movements of liquids and of the tiny bits of calcium carbonate called otoliths in the labyrinth canals.

The Pituitary Gland (Section 20-3)

The secrets of the pituitary gland are a good example of endocrine function. Its hormones produce a variety of actions and reactions. The pituitary gland has three parts: the anterior lobe, the intermediate lobe, which is generally thought to be nonfunctional, and the posterior lobe.

The anterior lobe is considered the master gland of the endocrine system. It produces six hormones that cause stimulation of the growth of body cells, production of milk after birth, regulation of thyroid gland secretions, stimulation of egg and sperm production, and regulation of egg release. The posterior lobe of the pituitary gland has a role in regulation of water secretion by the kidney, the contraction of the muscles of the uterus in the birth process, and the contraction of milk-producing glands in female breasts.

Disturbances of Endocrine Function (Section 20-3)

Disturbances in function of endocrine production may be classified as either hyperfunction, which refers to excess activity, or hypofunction, which means insufficient activity. Hyperfunction of the anterior pituitary gland with overproduction of the growth hormone may result in gigantism. When excess adrenal-stimulating hormone is produced by an overactive anterior pituitary gland, a group of symptoms known as Cushing’s disease occurs. Symptoms of Cushing’s disease include hypertension, weakness, plethora, bruising, and an unusual type of obesity. Deficiency in anterior pituitary activity that takes place early in life leads to dwarfism, sexual underdevelopment, weakness, and occasionally severe gauinness.

Hormone-Producing Bacteria (Section 20-3)

Researchers have developed techniques for using genetically altered bacteria to produce insulin for diabetic patients. This procedure is known as genetic engineering. This allows insulin to now be produced in quantity.

For current events or science in the news, access the Glencoe Science Web Site at www.glencoe.com/sec/science/ca

To order the following products for use with this chapter, call National Geographic Society at 1-800-368-2728:

- The Incredible Human Machine (The Human Body Series)
- Videos
- Teacher’s Corner

Teaching Guide

“Teacher to Teacher”

“...begins to understand the nervous system. The ‘interneuron’ student reads the message and decides whether the response is muscular or glandular.”

Rebeca L. Buckingham

Lisbon Central School

Lisbon, NY

Teaching Guide

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Lisbon, NY
CHAPTER 20 THE NERVOUS AND ENDOCRINE SYSTEMS

Chapter Preview

Section 20-1 The Nervous System
Section 20-2 The Senses
Section 20-3 The Endocrine System

Skills Preview

Skill Builders
- Map Concepts
- Make and Use a Table
- Compare and Contrast
- Design an Experiment

Mini Labs
- Interpret Data

Explore Activity

Who’s in front of you? What note do we start on? Where’s the conductor? Am I marching in rhythm? There’s a lot to be aware of when you’re part of a marching band. You must be sensitive to your surroundings and aware when changes take place. All organisms must be able to detect what is happening around them. Sights or sounds can warn of danger. Odors can help find food. Sensations of hot and cold can protect from fire or extreme temperatures. In this chapter, you will learn how your body’s nervous system interprets all of the sensations it receives to produce a picture of its surroundings. In the following activity, find out whether your eyes can interpret objects correctly.

Observe Objects
1. Look at the figure at the right of the page.
2. Estimate the difference in heights between pole A and pole C.
3. Use a metric ruler to measure the heights of poles A, B, and C.

Explore Activity

Making a Model, p. 549; Multiple Learning Styles, p. 546

Assessment Planner

Portfolio
Refer to p. 567 for suggested items that students might select for their portfolios.

Performance Assessment
See p. 567 for additional Performance Assessment options.

Content Assessment
- Section Assessment, pp. 552, 559, 564
- Chapter Assessment, pp. 568-569
- Proficiency Prep, pp. 552, 559, 564

Content Assessment

Explore Activity

Visual-Spatial
Use the Explore Activity to introduce students to one aspect of the nervous system—vision. Inform students that they will be learning more about the nervous and endocrine systems as they read the chapter.

Preparation
Collect some additional illustrations of optical illusions, such as inkblot tests, to extend the learning of this activity.

Materials
- metric ruler

Teaching Strategies
Have students devise their own optical illusions in the form of inkblots.

Assessment in the Science Classroom, p. 73.

Students should observe that the heights are the same but appear to be different. They should also include a reference as to whether their estimates were correct.

Performance Have students collect other optical illusions and work in small groups to find how the eyes can be tricked. Have them present their findings on a poster. Use Performance Assessment in the Science Classroom, p. 73.

Multiple Learning Styles

Auditory-Musical
- Out of Time, p. 566

Kinesthetic
- Quick Demo, p. 548
- Making a Model, p. 549

Logical-Mathematical
- Activity, pp. 573, 555; Assessment, pp. 559, 564; Preview, p. 566

Visual-Spatial
- Explore Activity, p. 545; Activity, pp. 547, 563; Visual Learning, p. 547

Linguistic
- Science Journal, pp. 547, 558

Interpersonal
- Discussion, pp. 550, 551; Enrichment, p. 550; Tying to Previous Knowledge, p. 554; Activity pp. 560-561; Review, p. 566

Intrapersonal
- Enrichment, p. 548

Content Assessment

L2

ELL

Explore Activity to introduce students to one aspect of the nervous system—vision. Inform students that they will be learning more about the nervous and endocrine systems as they read the chapter.

Preparation
Collect some additional illustrations of optical illusions, such as inkblot tests, to extend the learning of this activity.

Materials
- metric ruler

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Have students devise their own optical illusions in the form of inkblots.

Assessment Have students collect other optical illusions and work in small groups to find how the eyes can be tricked. Have them present their findings on a poster. Use Performance Assessment in the Science Classroom, p. 73.
The Nervous System

The Nervous System at Work

After doing the dishes and finishing your homework, you settle down in your favorite chair and pick up that mystery novel you've been trying to finish. Only three pages to go... Who did it? Why did she do it? Then, "CRASH!" You scream and throw your book in the air. What made that unearthly noise? You turn around to find that your dog's wagging tail just swept the lamp off the table beside you. Suddenly, you're aware that your heart is racing and your hands are shaking. But, then, after a few minutes, your breathing returns to normal and your heartbeat is back to its regular rate. What's going on?

Response to Stimuli

The scene described above is an example of how your body responds to changes in its environment and adjusts itself. Your body makes these adjustments with the help of your nervous system. Any change inside or outside your body that brings about a response is called a stimulus. Each day, you're bombarded by thousands of stimuli. Noise, light, the smell of food, and the temperature of the air are all stimuli from outside your body. A growing stomach is an example of an internal stimulus.

How can your body handle all these stimuli? Your body has internal control systems that maintain steady conditions, no matter what's going on outside the body. This is called homeostasis. Breathing rate, heartbeat rate, and digestion are just a few of the activities that are constantly checked and regulated. Your nervous system and the endocrine system, a chemical control system described later in this chapter, are the main ways your body maintains homeostasis.

Neurons

The working unit of the nervous system is the nerve cell, or neuron (NOO rahn). The single neuron in Figure 20-4 is made up of a cell body and branches called dendrites and axons. Dendrites receive messages and send them to the cell body. An axon (AK sahn) carries messages away from the cell body. Any message carried by a neuron is called an impulse. Notice that the end of the axon branches. This allows the impulses to move to many other muscles, neurons, or glands.

Types of Neurons

Your skin and other sense organs are equipped with structures called receptors that respond to various stimuli. Three types of neurons—sensory neurons, motor neurons, and interneurons—then become involved with transporting impulses about the stimuli. As illustrated in Figure 20-2, sensory neurons (B) receive information and send impulses to the brain or spinal cord. Once the impulses reach your brain or spinal cord, interneurons relay the impulses from the sensory to motor neurons. You have more interneurons in your body than either of the other two types of neurons. Motor neurons (D) then conduct impulses from the brain or spinal cord to muscles or glands throughout your body.

Nerve Analogy

Have students write a paragraph that explains how a nerve is similar to a wire going from a controlling switch (stimulus) to a lightbulb (response).

Resource Manager

The following Teacher Classroom Resources can be used with Section 20-1:

- Reproducible Masters
- Activity Worksheets, pp. 109-110
- Enrichment, p. 55
- Laboratory Manual, pp. 117-120
- Multicultural Connections, pp. 39-40
- Reinforcement, p. 55
- Study Guide, pp. 77-78
- Transparencies
- Teaching Transparency 35

VISUAL Learning

Figure 20-2 Have students follow the sequence of events that occurs as an impulse is initiated and moves through the body, and a response is generated.

CA Science Content Standards

Page 546: 5a, 5b
Page 547: 5a, 5b
Flex Your Brain

Use the Flex Your Brain activity to have students explore SYNAPSES.

Enrichment

Intrapersonal Have students research and report to the rest of the class on concussions. They should find out how they occur, what happens to the brain, symptoms, and treatment. Preventive measures such as wearing seat belts should also be brought out.

GLENCOE-TECHNOLOGY

Videodisc

The Infinite Voyage: Unseen Worlds

Chapter 7: Brain Tumor Surgery: Made Possible by MRI

2:30

Refer to the Teacher Guide for a Quickwrite to share ideas during or after a learning experience in this chapter.

Quick Demo

Kinesthetic Have students stand side by side. Their arms and fingers should be stretched out at their sides. Starting at one end of the line, have the students pass a metric ruler from one person to person. Students pass a metric ruler from one end of the line, have the students describe how the disk moves from one person to another. Students should not touch. Use circular pieces of foam rubber for the disks between the vertebrae. Have students note how the cord (rope) is protected.

Across the Curriculum

Language Arts Have students look up synapse in the dictionary. Students will find that it comes from the Greek roots syn (together) and haptein (unite). Ask students to think about how the roots of the word reflect its meaning.

Multiple Learning Styles

Kinesthetic Have students make a model of the vertebral column and spinal cord by stringing 31 thread spools on a rope. Use circular pieces of foam rubber for the disks between the vertebrae. Have students note how the cord (rope) is protected.

Using Science Words

Have students compare the use of the word cortex as used by botanists and physiologists.

The Brain

The brain is made up of approximately 100 billion neurons. You can see in Figure 20-5 that the brain is divided into three major parts: cerebrum, cerebellum, and stem brain. The largest part of the brain, the cerebrum (suh REE brum), is divided into two large sections called hemispheres. Here, impulses from the senses are interpreted, memory is stored, and the work of voluntary muscles is controlled. The outer layer of the cerebrum, the cortex, is marked by many ridges and grooves. The diagram also shows some of the functions that sections of the cortex control.

A second part of the brain, the cerebellum (ser uh BEL um), is behind and under the cerebrum. It coordinates voluntary muscle movements and maintains balance and muscle tone. The brain stem (stem) extends from the cerebrum and connects the brain to the spinal cord. It is made up of the midbrain, thepons, and the medulla. The brain stem controls your heartbeat, breathing, and blood pressure by coordinating involuntary muscle movements of these functions.

The Spinal Cord

Your spinal cord is an extension of the brain stem. It is made up of bundles of neurons that carry impulses from all parts of your body to the brain and from the brain to all parts of your body. The spinal cord, illustrated in Figure 20-4, is about as big around as an adult thumb and it is about 43 cm long.

Guided Reading Strategy

Quickwrites This strategy, sometimes called freewrites, lets students use spontaneous writing to discover what they already know. Have students write a list of ideas about a topic, then share these ideas with the class. Next, have students write their ideas freely in a paragraph without worrying about punctuation, spelling, and grammar. Have students use a Quickwrite to share ideas during or after a learning experience in this chapter.
The Peripheral Nervous System

Your brain and spinal cord are connected to the rest of your body by the peripheral nervous system. The PNS is made up of 12 pairs of cranial nerves from your brain and 31 pairs of spinal nerves from your spinal cord. These nerves link your central nervous system with all parts of your body. Spinal nerves are made up of bundles of sensory and motor neurons. For this reason, a single spinal nerve may have impulses going to and from the brain at the same time.

The peripheral nervous system has two divisions. The somatic system consists of the cranial and spinal nerves that go from the central nervous system to your skeletal muscles. The second division, the autonomic nervous system, controls your heartbeat, breathing, digestion, and gland functions. When your salivary glands release saliva, your autonomic system is at work. Use Figure 20-6 to help you remember these two divisions.

Reflexes

Have you ever moved quickly from something hot or sharp? Then you've experienced a reflex. A reflex is an involuntary and automatic response to a stimulus. Usually, you can't control reflexes because they occur before you know what has happened. A reflex involves a simple nerve pathway called a reflex arc. Figure 20-7 shows a reflex arc. As you reach for the pizza, some hot cheese falls on your finger. Sensory receptors in your finger respond to the hot cheese, and an impulse is sent to the spinal cord. The impulse passes to an interneuron in the spinal cord that immediately relays the impulse to motor neurons. Motor neurons transmit the impulse to muscles in your arm. Instantly, without thinking, you pull your arm back in response to the burning food. This is a withdrawal reflex. A reflex allows the body to respond without having to think about what action to take. Reflex responses are controlled in your spinal cord, not in your brain. Your brain acts after the reflex to help you figure out what to do to make the pain stop.

Remember in Figure 20-2 how the girl was frightened after the lamp was broken? What would have happened if her breathing and heartbeat rate didn't calm down within a few minutes? Your body system can't be kept in a state of continual excitement. The organs of your nervous system control and coordinate responses to maintain homeostasis within your body.

Visualizing A Reflex Arc

Figure 20-7 Your response in a reflex is controlled in your spinal cord, not in your brain.

Sensory neuron

Interneuron

Motor neuron

Motor neurons

Muscle contractions

Spinal cord

Receptor in skin

Direction of impulse

Somatic system

Autonomic system

Heartbeat rate

Breathing, digestive, salivary glands

Skeletal muscles

Peripheral Nervous System (cranial and spinal nerves)

Your brain and spinal cord are connected to the rest of your body by the peripheral nervous system. The PNS is made up of 12 pairs of cranial nerves from your brain and 31 pairs of spinal nerves from your spinal cord. These nerves link your central nervous system with all parts of your body. Spinal nerves are made up of bundles of sensory and motor neurons. For this reason, a single spinal nerve may have impulses going to and from the brain at the same time.

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Chapter 20 The Nervous and Endocrine Systems

Using Scientific Methods

Activity 20.1

Purpose
Logical-Mathematical Students will observe reaction time.

Process Skills
observing, communicating, using numbers, recognizing and using spatial relationships, measuring in SI, interpreting data

Time
30 minutes

Materials
metric ruler

Teaching Strategies
Students should keep their eyes on the ruler as the partner releases it.

Answers to Questions
1. the ruler falling
2. catching the ruler
3. which hand is used
4. observers will vary
5. To find the average, students should add all reaction times and divide by the number of trials.
6. Answers will vary. Generally, the writing hand reacts faster.
7. With practice, stimulus response time will probably improve.

Problem Solving

In this activity, students observe and measure reaction times. The purpose of this activity is to help students understand how practice affects reaction time.

Materials

- Metric ruler

Activity

To find the average reaction time, you must calculate the mean of the reaction times. To do this, you must add all reaction times and divide by the number of trials.

Conclude and Apply

1. Identify the stimulus in this activity.
2. Identify the response in this activity.
3. Identify a variable in this activity.
4. Use the table on this page to find your reaction time.
5. What was your average reaction time for your right hand? For your left hand?
6. Compare the response of your writing hand and your other hand for this activity.
7. Draw a conclusion about how practice relates to stimulus-response time.

Sample data for left-handed person

<table>
<thead>
<tr>
<th>Reaction Time</th>
<th>Where the Ruler Was Caught</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

Sample data for right-handed person

<table>
<thead>
<tr>
<th>Reaction Time</th>
<th>Where the Ruler Was Caught</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Assessment

Performance To further assess students' abilities to measure and improve reaction time, have them formulate and test a hypothesis about how long it would take the nonwriting hand to be trained to respond as the writing hand responds. Use Performance Assessment in the Science Classroom, p. 21

CA Science Content Standards

Page 552: 5a, 5b, 7a, 7c
Page 553: 5a, 5b, 7a, 7c

Reaction Time

Your body responds quickly to some kinds of stimuli, and reflexes allow you to react quickly without even thinking. Sometimes you can improve how quickly you react. Complete this activity to see if you can improve your reaction time.

What You’ll Investigate

How can reaction time be improved?

Goals
• Observe reflexes.
• Identify stimuli and responses.

Procedure

1. Make a data table in your Science Journal to record where the ruler is caught during this activity. Possible column heads are Trial, Right Hand, and Left Hand.
2. Have a partner hold the ruler at the top end.
3. Hold the thumb and forefinger of your right hand apart at the bottom of the ruler. Do not touch the ruler.
4. Your partner must let go of the ruler without warning you.
5. Try to catch the ruler by bringing your thumb and forefinger together quickly.
6. Repeat this activity several times and record where the ruler was caught in a data table.
7. Repeat this activity with your left hand. Record your results.

Using Computers

Flowcharts should show an impulse moving from receptor to sensory neuron to interneuron in the spinal cord to motor neuron to muscle in foot.

Drugs and the Nervous System

Many drugs, such as alcohol and caffeine, have a direct effect on your nervous system. When swallowed, alcohol passes directly through the walls of the stomach and small intestine into the circulatory system. Alcohol is classified as a depressant drug. A depressant slows down the activities of the central nervous system. Judgment, reasoning, memory, and concentration are impaired. Muscle functions also are affected. Heavy use of alcohol destroys brain and liver cells.

Caffeine is a stimulant, a drug that speeds up the activity of the central nervous system. Too much caffeine can increase heartbeat rate and cause restlessness, tremors, and insomnia. It also can stimulate the kidneys to produce more urine. Caffeine can cause physical dependence. When people stop taking caffeine, they can have headaches and nausea. Caffeine is found in coffee, tea, cocoa, and many soft drinks, as seen in Figure 20-8.

Think again about a scare from the loud noise. The organs of your nervous system control and coordinate events chain concept map of the different kinds of neurons that form the nervous system. Neurons communicate through the release of chemicals called neurotransmitters. Each neuron sends signals to other neurons, muscles, or glands through the brain or spinal cord. The central nervous system is made up of the brain and spinal cord. The peripheral nervous system consists of what two types of nerves? cranial, spinal

2. What are nerve cells that relay impulses from sensory to motor neurons? interneurons

3. The peripheral nervous system consists of what two types of nerves? cranial, spinal

4. What connects the brain to the spinal cord? the brain stem

Section Assessment

1. See Figure 20-1.
2. The central nervous system is made up of the brain and spinal cord. The peripheral nervous system is made up of cranial and spinal nerves.
3. Sensory neurons receive information and send impulses to the spinal cord or brain. Motor neurons conduct impulses from the brain or spinal cord to muscles or glands throughout the body.
4. Think Critically Coca contains caffeine, which is a stimulant that can cause sleeplessness.

Using Scientific Methods

Word Processing Create a flowchart showing the reflex pathway of a nerve impulse when you step on a sharp object. Label the parts involved in each step of the process. If you need help, refer to page 678.

Section Assessment

1. Draw and label the parts of a neuron.
2. Compare the central and peripheral nervous systems.
3. Compare sensory and motor neurons.
4. Think Critically: During a cold winter evening, you have several cups of hot cocoa. How can caffeine be a stimulant and cause sleeplessness?
5. What is the function of the dendrite? to receive the messages and send them to the cell body
6. What are nerve cells that relay impulses from sensory to motor neurons? interneurons
7. The peripheral nervous system consists of what two types of nerves? cranial, spinal

Using Computers

Figure 20-8 Cocoa contains caffeine, which is a stimulant that can cause sleeplessness.

Section Assessment

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Using Computers

Figure 20-8 Cocoa contains caffeine, which is a stimulant that can cause sleeplessness.
In Touch with Your Environment

Science fiction stories about space often describe energy force fields around spaceships. When some form of energy tries to enter the spaceship, the ship is put on alert. Your body has an alert system as well, in the form of sense organs. Your senses enable you to see, hear, smell, taste, touch, and feel whatever comes into your personal territory. The energy that stimulates your sense organs may be in the form of light rays, heat, sound waves, chemicals, or pressure.

Sense organs are adapted for capturing and transmitting these different forms of energy.

Hearing

Sound energy is hearing as light energy is vision. As illustrated in Figure 20-4, when an object vibrates, it causes the air around it to vibrate, thus producing energy in the form of sound waves. When sound waves reach your ears, they stimulate nerve cells deep in your ear. Impulses are sent to the brain. The brain responds, and you hear a sound.

Figure 20-10 shows that your ear is divided into three sections: the outer, middle, and inner ear. Your outer ear traps sound waves and funnels them down the ear canal to the middle ear. The sound waves cause the eardrum to vibrate much like the membrane on a drum. These vibrations then move through three little bones called the hammer, anvil, and stirrup. The stirrup bone rests against a second membrane on an opening to the inner ear.

The Inner Ear

The cochlea (KOH klee uh) is a fluid-filled structure shaped like a snail’s shell, in the inner ear. When the stirrup vibrates, fluids in the cochlea also begin to vibrate. These vibrations stimulate nerve endings in the cochlea, and impulses are sent to the brain by the auditory nerve. Depending on how the nerve endings are stimulated, you hear a different type of sound. High-pitched sounds make the endings move differently than lower, deeper sounds.

Balance also is controlled in the inner ear. Special structures and fluids in the inner ear constantly adjust to the position of your head. This stimulates impulses to the brain, which interprets the impulses and helps you make the necessary adjustments to maintain your balance.

Try at Home MiniLab

Observing Balance Control

 Procedure

1. Place two narrow strips of paper on the wall to form two parallel vertical lines. Have a student stand between them, as still and straight as possible without leaning on the wall, for three minutes.
2. Observe how well balance is maintained.
3. Have the student close his or her eyes and repeat standing between the lines for three minutes.

Analysis

1. When was balance more difficult to maintain? Why?
2. What other factors might cause a person to lose the sense of balance?

Caption Answer

Figure 20-10 Spinning makes the fluids in the inner ear send impulses to the brain that conflict with the actual position of the head. Dizziness results.

Assessment

Performance

To further assess students’ understanding of balance, have them repeat the activity with feet apart or arms extended sideways. Use Performance Assessment in the Science Classroom, p. 25.

CA Science Content Standards

Page 554: 5a, 5b, 5g Page 555: 5a, 5b, 7c

Try at Home MiniLab

For additional help doing this activity at home, see the corresponding page in the Home Involvement booklet.
Vision

Think about the different kinds of objects you look at every day. It’s amazing that, at one glance, you can see the words on this page, the color illustrations, and your classroom sitting next to you.

Light travels in a straight line unless something bends or refracts it. Your eyes are equipped with structures that bend light. As light enters the eye, its waves are first bent by the cornea and then a lens, as illustrated in Figure 20-11. The lens directs the light rays onto the retina. A sharp image is formed on the retina, and the brain interprets the signal as being clear. However, if the eye is too long from front to back, light from distant objects is focused in front of the retina. A blurred image is formed. This condition is called nearsightedness because near objects are seen clearly. To correct nearsightedness, eyeglasses with concave lenses are used. Convex lenses focus these images sharply on the retina. If the eye is too short from front to back, light from nearby objects is focused behind the retina. Again, the image appears blurred. Convex lenses correct this condition known as farsightedness. Figure 20-13 shows how lenses are used to correct these vision problems.

Correcting Vision

In an eye with normal vision, light rays are focused by the cornea and lens onto the retina. A sharp image is formed on the retina, and the brain interprets the signal as being clear.

Across the Curriculum

Reading Find out how Helen Keller was able to learn to communicate even though she was deprived of sight and hearing at an early age.

Answer to Reading Check nearsightedness is caused by an eyeball that is too long from front to back, causing distant objects to focus in front of the retina.

3 Assess

Check for Understanding Using an Analogy

Open up a camera and view the internal components to compare them to the human eye.

Extension

For students who have mastered this section, use the Reinforcement and Enrichment masters.

GLENCOE TECHNOLOGY

Videodisc

Glencoe Science Voyages Interactive Videodisc—Life Side 2: Lesson 6: Eying Evolution

CA Science Content Standards

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Page 557: 5a, 5b, 5g, 6c, 6d
**MiniLab**

**Comparing Sense of Smell**

**Purpose**
Kinesthetic Students will observe the difference in the sense of smell between males and females.

**Materials**
small amounts of various spices, flavor extracts, and other odorous substances; cotton balls

**Teaching Strategies**
Senses on the Job
Ask students to clip advertisements in the help wanted section of the newspaper about jobs that require keenness of certain senses such as hearing, vision, balance and coordination, or smell.

They should put these ads, along with brief descriptions of how and why specific senses would be involved, in their Science Journals.

**Procedure**
1. **Design an experiment to test your classmates’ abilities to recognize the odors of different foods, colognes, or household products.**
2. **Record their responses in a data table according to the gender of the individuals tested.**

**Analysis**
1. **Compare the numbers of correctly identified odors for both males and females.**
2. **What can you conclude about the differences between males and females in their ability to recognize odors?**

**Assessment**
Have students conduct a test of identifying the odor of various substances, cotton balls for more than one sniff test. Do not use the cotton balls if any of them might have allergies to the substances; cotton balls may irritate the skin.

**Touch, Pressure, Pain, and Temperature**

How important is it to be able to feel pain inside your body? Several kinds of sensory receptors in your internal organs, as well as throughout your skin, respond to touch, pressure, pain, and temperature, as illustrated in Figure 20-15. These receptors pick up changes in touch, pressure, and temperature and transmit impulses to the brain or spinal cord. The body responds to protect itself or maintain homeostasis. Your fingertips have many different types of receptors for touch. As a result, you can tell whether an object is rough or smooth, hot or cold, light or heavy. Your lips are sensitive to heat and prevent you from drinking something so hot that it would burn you. Pressure-sensitive cells in the skin give warning of danger to a body part and enable you to move to avoid injury. Your senses are adaptations that help you enjoy or avoid things around you. You constantly react to your environment because of information received by your senses.

**Section Assessment**
1. **What type of stimulus do your ears respond to?**
2. **What are the three small bones in the middle ear?**
3. **What are the sensitive nerve cells in your nasal passages called?**
4. **Where are the major sense receptors for taste found?**

**Senses on the Job**
Ask students to clip advertisements in the help wanted section of the newspaper about jobs that require keenness of certain senses such as hearing, vision, balance and coordination, or smell.

They should put these ads, along with brief descriptions of how and why specific senses would be involved, in their Science Journals.

**Assessment**
Use this quiz to check students’ recall of section content.

1. What is the function of the lens in the eye to focus light rays onto the retina?
2. What are the three small bones in the middle ear?
3. What are the sensitive nerve cells in your nasal passages called?
4. Where are the major sense receptors for taste found?

**Performance**
Assess students’ abilities to make and use tables by having them write a statement comparing the different types of energy that stimulate the senses. Use Performance Assessment in the Science Classroom, p. 97.

**Proficiency Prep**
Use this checklist to help students review content.

1. sound waves
2. eyes: rods and cones; nose: olfactory cells
3. The body responds to protect itself or maintain homeostasis.
4. Think Critically: The brain could continue to function when injured, allowing you to carry out activities for survival.

**Section Assessment**
1. sound waves
2. eyes: rods and cones; nose: olfactory cells
3. The body responds to protect itself or maintain homeostasis.
4. Think Critically: The brain could continue to function when injured, allowing you to carry out activities for survival.
Activity 20.2

Investigating Skin Sensitivity

Your body responds to touch, pressure, and temperature. Not all parts of your body are equally sensitive to stimuli. Some areas are more sensitive than others. For example, your lips are sensitive to heat. This protects you from burning your mouth. Now think about touch. How sensitive is the skin on various parts of your body to touch? Which areas can distinguish the smallest amount of distance between stimuli?

Possible Materials
- Index card
- Tape or glue
- Metric ruler
- Toothpicks
- Card with toothpicks 1 mm apart
- 10 mm apart
- Eyes closed
- Card with toothpicks 1 mm apart
- 10 mm apart
- Eyes closed
- 1 mm apart

Possible Hypotheses
Possible hypotheses could in- clude: The more sensitive areas of the body are the fingertips, palms, and cheeks. Less sensitive are the back of the head, forearm, and back of the neck.

Form a Hypothesis
Based on your experiences, state a hypothesis about which of the following five areas of the body you believe to be most sensitive—fingertip, forearm, back of the neck, palm, and back of the hand. Rank the areas from 5 (the most sensitive) to 1 (the least sensitive).

Goals
• Observe the sensitivity to touch on specific areas of the body.
• Design an experiment that tests the effects of a variable, such as the closeness of contact points, to determine which body areas can distinguish the closest stimuli.

Safety Precautions
Do not apply heavy pressure when using the toothpicks.

Test Your Hypothesis

Plan
1. As a group, agree upon and write out the hypothesis statement.
2. As a group, list the steps you need to take to test your hypothesis: Be specific, describing exactly what you will do at each step. Consider the following factors as you list the steps: How will you know that sight is not a factor? How will you use the card shown on the right to determine sensitivity to touch? How will you determine and record that one or both points of touch are felt? List your materials.

Do
1. Make sure your teacher approves your plan and your data table before you proceed.
2. Carry out the experiment as planned.

Analyze Your Data
1. Compare your results with those of other groups.
2. Identify which part of the body tested can distinguish between the closest stimuli.

Draw Conclusions
1. Based on the results of your investigation, what can you infer about the distribution of touch receptors on the skin?
2. What other parts of your body would you predict to be less sensitive? Explain your predictions.

Expected Outcome
The more sensitive areas of the skin to touch are the fingertips, palms, and cheeks. Less sensitive are the back of the head, forearm, and back of the neck.

Error Analysis
Students compare their re- sults and their hypotheses and ex- plain any differences that occurred.

Inclusion Strategies
Physically Challenged Any student who may not be able to manipulate the testing device may be in charge of formulating the hypothesis and the design of the experiment.

Using Scientific Methods

Performance
To further assess students’ understanding of skin sensitivity, repeat this activity on the lower part of the leg and on the foot. Use Performance Assessment in the Science Classroom, p. 17.
The Endocrine System

Functions of the Endocrine System

“The tallest man in the world!” and “the shortest woman on Earth!” used to be common attractions in circuses. These people became attractions because of their extraordinary and unusual height. In most cases, their sizes were the result of a malfunction in their endocrine systems.

The endocrine system is the second control system of your body. Whereas impulses are control mechanisms of your nervous system, chemicals are the control mechanisms of your endocrine system. Endocrine chemicals called hormones are produced in several tissues called glands throughout your body. As the hormones are produced, they move directly into your bloodstream. Hormones affect specific tissues called target tissues. Target tissues are frequently located in another part of the body at a distance from the gland that affects them. Thus, the endocrine system doesn’t react as quickly as the nervous system. Table 20-1 shows the position of eight endocrine glands and what they regulate.

Table 20-1

<table>
<thead>
<tr>
<th>Gland</th>
<th>Regulates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pituitary</td>
<td>Endocrine glands, which produce hormones;</td>
</tr>
<tr>
<td></td>
<td>make production; growths</td>
</tr>
<tr>
<td>Thyroid</td>
<td>Hormone; carbohydrate use</td>
</tr>
<tr>
<td>Parathyroids</td>
<td>Hormone; calcium</td>
</tr>
<tr>
<td>Adrenal</td>
<td>Hormone; blood sugar; salt and water balance;</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Hormone; blood sugar</td>
</tr>
<tr>
<td>ovaries</td>
<td>Hormone; egg production; sex organ development;</td>
</tr>
<tr>
<td>testes</td>
<td>Hormone; sperm production; sex organ development;</td>
</tr>
</tbody>
</table>

The Pancreas—Playing Two Roles

The pancreas produces a digestive hormone. This enzyme is released into the small intestine through tubelike vessels called ducts. The pancreas is also part of your endocrine system because other groups of cells in the pancreas secrete hormones. One of these hormones, insulin, enables cells to take in glucose. Recall that glucose is the main source of energy for respiration in cells. Normally, insulin enables glucose to pass from the bloodstream through cell membranes. Persons who can’t make insulin are diabetic because insulin isn’t there to enable glucose to get into cells.

A Negative-Feedback System

To control the amount of hormone an endocrine gland produces, the endocrine system sends chemical information back and forth to itself. This is a negative-feedback system. It works much the way a thermostat works. When the temperature in a room drops below a certain level, a thermostat signals the furnace to turn on. Once the furnace has raised the temperature to the level set on the thermostat, the furnace shuts off. It will stay off until the thermostat signals again. In your body, once a target tissue responds to its hormone, the endocrine system sends chemical information back and forth to itself. This is a negative-feedback system.

A Negative-Feedback System

The Pancreas plays a dual role. It produces a digestive enzyme and a hormone. The hormone, insulin, enables cells to take in glucose. If a person has diabetes, they do not produce enough insulin.

## Interpreting Blood Sugar Levels

Diabetes results when the pancreas does not produce enough insulin. Insulin is a hormone that enables cells to take in glucose. Glucose is a sugar needed for energy. Extra glucose is not stored, so the glucose is carried in the blood unless insulin enables the cells to take it in. Patients with diabetes have high amounts of sugar in the blood. Normal levels of sugar in the morning are between 60 and 100 milligrams per deciliter (mg/dL). Eating a meal increases glucose in the blood.

The graph shows the sugar in the blood from morning to afternoon. Notice the difference in blood sugars between a diabetic and a nondiabetic person.

Think Critically: Approximately how much difference is there in blood sugar levels between the two persons first thing in the morning? What might account for the increased level in blood sugar after the fourth hour?

Diabetes is a disease of the endocrine system. It results when the pancreas does not produce enough insulin. Insulin is a hormone that enables cells to take in glucose. Glucose is a sugar needed for energy. Extra glucose is not stored, so the glucose is carried in the blood unless insulin enables the cells to take it in. Patients with diabetes have high amounts of sugar in the blood. Normal levels of sugar in the morning are between 60 and 100 milligrams per deciliter (mg/dL). Eating a meal increases glucose in the blood.

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Think Critically: Approximately how much difference is there in blood sugar levels between the two persons first thing in the morning? What might account for the increased level in blood sugar after the fourth hour?
Proficiency Prep

Use this quiz to check students’ recall of section content.

1. What type of glands do not have ducts? endocrine
2. What is one of the hormones produced by the pancreas? insulin
3. What signals a gland to start secreting its hormone again? when the level of hormone in the bloodstream drops

Skill Builder

Comparing and Contrasting In what ways are the nervous system and endocrine system alike? If you need help, refer to Comparing and Contrasting in the Skill Handbook on page 684.

Science Journal

Entries may include that diabetics are people who can’t make insulin. This prevents glucose from entering cells. Diabetes can be controlled, however.

Hormone, the tissue sends a chemical signal back to the gland. This signal causes the gland to stop or slow down production of the hormone. When the level of the hormone in the bloodstream drops below a certain level, the endocrine gland is signaled to begin secreting the hormone again. In this way, the concentration of the hormone in the bloodstream is kept at the needed level. Figure 20-16 illustrates how a negative-feedback system works. Endocrine glands produce hormones directly into the bloodstream and affect target tissues. The level of the hormone is controlled by a negative-feedback system. In this way, many chemicals in the blood and body functions are controlled.

Section Assessment

1. What is the function of hormones?
2. What is a negative-feedback system?
3. Choose one hormone and explain how it works.
4. Think Critically: Glucose passes from the bloodstream through cell membranes and into the cells. Glucose is required for respiration within cells. How would lack of insulin affect this process?
5. Skill Builder

Career Connection

Audiologists need to complete a two-year postgraduate training course before they can work. They need to have an undergraduate degree such as a Bachelor of Arts or Science before they can apply for the course.

Teaching Strategies

Have students design their own speaking tubes that will amplify their voices. Compare the different voices when the tube is coiled and when it is straightened. Students can make the speaking tube by using a cardboard paper-towel holder, tape, and a funnel. Tape the funnel to one end of the tube. Discuss how the amplification of the tube is like the amplification of a hearing aid.

Purpose

Students are introduced to a hearing aid and the different parts that make it work.

Career

Audiologists evaluate and treat people with hearing loss. He or she conducts tests to determine speech-hearing problems. Many audiologists have a master’s degree in audiology (hearing) or speech, language, and pathology (study of diseases). Pretend that you are an audiologist. Create an advertisement about services you can provide and hearing aids that you recommend for people with hearing problems.

Hearing Aid

A hearing aid is a small, electronic instrument (left) that makes sounds louder and easier to understand. A hearing aid fits around the outside of the ear or inside the ear canal. Some hearing aids are so small that they are hardly noticeable.

PARTS OF A HEARING AID

1. The tiny microphone built into the hearing aid picks up sounds. It changes sound waves into electrical signals.
2. The amplifier makes the electrical signals stronger. A hearing aid user can control the degree to which sounds are amplified, or made stronger.
3. The receiver changes the amplified electrical signals back into sound signals and sends them to the eardrum.
4. The battery is the power source that makes the hearing aid work. Like batteries in portable tapes or CD players, batteries in a hearing aid must be changed when they lose power.

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Section 20-1 BODY REGULATION
Your body is constantly receiving a variety of stimuli from inside and outside the body. The nervous and endocrine systems respond to these stimuli to maintain homeostasis. What are some body functions that are constantly being checked and regulated?

Section 20-2 THE SENSES
Your senses respond to energy. The eyes respond to light, and the ears respond to sound waves. The olfactory cells of the nose and the taste buds of the tongue are stimulated by chemicals. What senses are involved as you pick up and eat a freshly baked chocolate chip cookie?

Section 20-3 THE ENDOCRINE SYSTEM
Endocrine glands secrete hormones directly into your bloodstream. Hormones affect specific tissues throughout the body and regulate their activities. A feedback system regulates the hormone levels in your blood. How can a gland that is near your head control the rate of chemical activities throughout your entire body?

Cultural Diversity
Arrow-Poison Frogs
Skin glands of arrow-poison frogs secrete a powerful venom that results in muscular paralysis. An amount as small as 0.00001 g can kill a human. Have students try to find out how the native peoples of Central and South America extract the venom and how they use it to hunt.
Developing Skills

If you need help, refer to the Skill Handbook.

21. Classifying: Classify the types of neurons as to their location and direction of impulse.

22. Comparing and Contrasting: Compare and contrast the structures and functions of the cerebrum, cerebellum, and brain stem. Include in your discussion the following functions: balance, involuntary muscle movements, muscle tone, memory, voluntary muscle action, thinking, and senses.

23. Concept Mapping: Prepare a concept map showing the correct sequence of the structures through which light passes in the eye.

24. Interpreting Scientific Illustrations: Using the following diagram of the synapse, explain how an impulse moves from one neuron to another.

Thinking Critically

16. Accept all reasonable responses; so messages do not get mixed; so that

17. Reflexes are automatic acts that occur without our thinking about them. Therefore, they happen quickly and can shield our bodies from danger such as sharp or hot objects.

18. The doctor might check to

19. Examples include diastasis, dwarfism, or diabetes.

20. The skin on your face has more neurons or more closely arranged neurons than the skin on your back. The sense of touch is more pronounced on the face. You could check this out with a series of tests using something lightweight, such as a feather or paintbrush hair to test sensitivity of the face and neck.

21. Sensory neurons are located in the sense organs and spinal cord and carry impulses to the brain. Interneurons are located in the central nervous system and carry impulses from the central nervous system to motor neurons. Motor neurons are in muscles and glands and carry impulses from brain to muscles and glands.

Thinking Critically

25. Observing and Inferring: If an impulse traveled down one neuron, but failed to move on to the next neuron, what might you infer about the first neuron?

26. Predicting: Refer to the Try at Home MiniLab in Section 20-2 and predict ways to improve your balance. Test your prediction.

Assessment Resources

Glencoe Technology

Chapter Review Software
Computer Test Bank
Mindjogger Videoquiz

The Test Practice Workbook provides students with practice in the format, concepts, and critical-thinking skills tested in standardized exams.

Test Practice

Test-Taking Tip

What does the test expect of me? Find out what concepts, objectives, or standards are being tested before the test. Keep those concepts in mind as you answer the questions.

Test Practice

Use these questions to test your Science Proficiency.

1. What happens to an endocrine gland when the blood level of its hormone is increased?

2. The gland continuously producing hormones until the hormone level in the blood falls below a certain point.

3. All endocrine glands stop producing hormones until all hormone levels in the blood are balanced.

4. Which statement below is the correct

5. Test-Taking Tip

Which gland controls voluntary muscle movements, muscle tone, memory, voluntary muscle action, thinking, and senses.

6. Developingskills

The Test-Taking Tip was written by The Princeton Review, the nation’s leader in test preparation.

1. A

2. D

22. cerebrum—memory, senses, thinking, cerebellum—voluntary muscle action, balance, muscle tone; brain stem—coordinating involuntary muscle movements, controlling heartbeat, breathing, and blood pressure.

23. Concept map should include the following steps: cornea—light—retina—optic nerve—brain.

24. A nerve—transmitting chemical is released from the axon of one neuron, diffuses across the synapse, and starts an impulse in the next neuron.

25. It may be lacking the

26. Ways to improve balance could include practicing, exercising, and taking dance lessons.

Bonus Question

How is your endocrine system like the thermostat in a house? According to the level of hormone in the blood, target tissue sends a chemical message back to the gland to stop or start hormone secretion. Likewise, the thermostat in a car signals the heating or air conditioning unit to start or stop according to the temperature in the house.