**The Human Body**

**Unit Overview**
Unit 10 describes the systems of the human body and how they interact with one another.

**Chapter 34** describes the integumentary, skeletal, and muscular systems.

**Chapter 35** covers the digestive and endocrine systems.

**Chapter 36** presents the nervous system and the effects of drugs on body systems.

**Chapter 37** describes the respiratory, circulatory, and urinary systems.

**Chapter 38** focuses on human reproduction and development.

**Chapter 39** outlines the structures and processes involved in immunity.

**Introducing the Unit**
Ask students which systems are important for a runner to succeed at a track meet. Which systems are involved in the excitement the runner feels before the race? Which systems are involved when the runner is racing?

**WebQuest**
A WebQuest is an inquiry-based online project in which all information used by students is obtained from the Web. Students evaluate the information to complete the activity. Access the Unit 10 WebQuest at ca.bdol.glencoe.com/webquest

**California Standards**
The following standards are covered in Unit 10:
Investigation and Experimentation: 1a, 1d, 1k, 1m
Biology/Life Sciences: 9a, 9b, 9c, 9d, 9e, 9f, 9g, 9h, 9i, 10a, 10d

**Why It’s Important**
The organ systems of the human body coordinate to fulfill the body’s basic survival needs. These include the uptake and distribution of oxygen, digestion of food, and the elimination of wastes. These systems also allow humans to complete complex behaviors such as writing or riding a bike.

**Understanding the Photo**
The hurdlers in this photo are breathing fast and can feel the burn in their muscles as they compete. Running a race requires the coordination of many different body systems—systems that do not work independently but interact in hundreds of complex ways.

**Activity**
Have students research more information about any of the time line entries or another “first” in medical/science history. Have students present a report on their findings including information about the scientist, the impact of his or her work on scientific thought and society, and if relevant, what type of technology was used.

**History & Biology**
1607 English colonists arrive in present-day Jamestown, Virginia, and establish the first permanent English settlement in America.

1628 William Harvey gives an accurate description of blood circulation.

1752 Experiments show that the gastric juices of the stomach chemically digest food.

**Time Line**
890 1607
English colonists arrive in present-day Jamestown, Virginia, and establish the first permanent English settlement in America.

1628 William Harvey gives an accurate description of blood circulation.

1752 Experiments show that the gastric juices of the stomach chemically digest food.
Unit Projects

**Using the Library**

*Linguistic*  Have student groups prepare a report on how an injury to one system structure—such as torn cartilage or a ruptured spleen—can disrupt the whole system. **LS** **COOP LEARN**

**Interview**

*Interpersonal*  Have student groups interview a nurse or physician about a disease or disorder that affects mainly one body system. Have students present their findings in a report. **L2** **COOP LEARN**

**Modeling**

*Kinesthetic*  Have student groups design and make a model of one body system, such as the nervous or endocrine system. They may use any materials they wish. **L2** **ELL** **COOP LEARN**

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**Advance Materials Planning**

The following materials may need to be ordered a few weeks in advance of the planned activity.

**Chapter 34**
- Additional Lab (p. 896) slides of human skin

**Chapter 35**
- Chapter Launcher (p. 916) iodine solution, amylase solution
- Quick Demo (p. 920) pancreatic enzymes, Benedict’s solution
- Quick Demo (p. 930) human skull or large animal skull
- MiniLab 35.2 (p. 934) thyroid/parathyroid slides
- BioLab (p. 936) iodine solution, amylase solution

**Chapter 36**
- BioLab (p. 964) *Daphnia*

**Chapter 37**
- Quick Demo (p. 985) whole kidney

**Chapter 38**
- Quick Demo (p. 997) and Figure 38.7 (p. 1001) slide of cross section of testes
- Figure 38.7 (p. 1001) slide of cross section of ovaries
- MiniLab 38.1 (p. 1006) slide of human sperm, slide of human egg, and slide of sea star blastula
- Quick Demo (p. 1007) slides of sea star development

**Chapter 39**
- Additional Lab (p. 1032) bacterial culture and antibiotic disks
- MiniLab 39.2 (p. 1035) blood smear slides
### Section Objectives

#### Section 34.1 1 session, 1/2 block
1. **Compare** the structure and functions of the epidermis and dermis.
2. **Identify** the role of the skin in responding to external stimuli.
3. **Outline** the healing process that takes place when the skin is injured.

#### Section 34.2 2 sessions, 1 block
4. **Compare** the different types of movable joints.
5. **Describe** how bone is formed.
6. **Identify** the structure and functions of the skeletal system.

#### Section 34.3 2 sessions, 1 1/2 blocks
7. **Classify** the three types of muscles.
8. **Analyze** the structure of a myofibril.
9. **Interpret** the sliding filament theory.

### National Science Standards

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### State/Local Standards

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<td>Section 34.2</td>
<td>Biology/Life Sciences 10</td>
</tr>
<tr>
<td>Section 34.3</td>
<td>Biology/Life Sciences 9h* Investigation &amp; Experimentation 1d</td>
</tr>
</tbody>
</table>

### Advanced Lab and Demo Planning

#### Student Labs:
- **Student Labs:** MiniLab 34.1, p. 895: non-toxic, washable-ink stamp pad, index card
- **Problem Solving Lab 34.1,** p. 896: microscope slide of human skin, microscope
- **Additional Lab,** p. 896: microscope slide of human skin, microscope

#### Teacher Demonstrations:
- **Quick Demo,** p. 897

#### Student Lab:
- **Problem Solving Lab 34.2,** p. 903

#### Teacher Demonstrations:
- **Quick Demo,** p. 900: X rays
- **Quick Demo,** p. 902: beef bone

#### Student Labs:
- **Problem-Solving Lab 34.3,** p. 906
- **MiniLab 34.2,** p. 907: ruler

#### Teacher Demonstration:
- **Quick Demo,** p. 906: chicken feet

#### Student Lab:
- **Design Your Own BioLab,** p. 910: stopwatch or clock with second hand, graph paper, small weights

### Key to Teaching Strategies

- **L1** Level 1 activities should be appropriate for students with learning difficulties.
- **L2** Level 2 activities should be within the ability range of all students.
- **L3** 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.
## Reproducible Masters and Transparencies

### Unit 10 FAST FILE Resources
- **MiniLab Worksheet**, p. 3
- Reinforcement and Study Guide in English, p. 11
- Reinforcement and Study Guide in Spanish, p. 15
- Concept Mapping, p. 19
- Transparency Worksheets, pp. 21, 25–26
- **Section Focus Transparency 81**
- **Basic Concepts Transparency 61**

### Unit 10 FAST FILE Resources
- Real World BioApplications, pp. 7–8
- Reinforcement and Study Guide in English, pp. 12–13
- Reinforcement and Study Guide in Spanish, pp. 16–17
- Critical Thinking/Problem Solving, p. 20
- Transparency Worksheets, pp. 22, 27–30
- **Laboratory Manual**, pp. 223–226
- **Section Focus Transparency 82**
- **Basic Concepts Transparencies 62, 63**

### Unit 10 FAST FILE Resources
- **MiniLab Worksheet**, p. 4
- **BioLab Worksheet**, pp. 5–6
- Real World BioApplications, pp. 9–10
- Reinforcement and Study Guide in English, p. 14
- Reinforcement and Study Guide in Spanish, p. 18
- Transparency Worksheets, pp. 23, 31–34
- **Probeware Labs**, pp. 25–28
- **Inside Story Poster**
- **Section Focus Transparency 83**
- **Basic Concepts Transparency 64**
- **Reteaching Skills Transparency 49**

### Unit 10 FAST FILE Resources
- Chapter Assessment, pp. 35–40
- Student Recording Sheet, p. 41
- **Reviewing Biology**, pp. 67–68

## Technology

### Interactive Chalkboard CD-ROM: Section 34.1 Presentation
- **TeacherWorks™ CD-ROM**
- Guided Reading Audio Summaries MP3

### Virtual Labs
- Virtual Lab: Bones, the Body’s Support
- **Interactive Chalkboard CD-ROM: Section 34.2 Presentation**
- **TeacherWorks™ CD-ROM**
- Guided Reading Audio Summaries MP3

### Interactive Chalkboard CD-ROM: Section 34.3 Presentation
- **TeacherWorks™ CD-ROM**
- Guided Reading Audio Summaries MP3

### Interactive Chalkboard: Chapter 34 Assessment
- **MindJogger Videoquizzes DVD/VHS**
- **ExamView® Pro Test Bank CD-ROM**
- **TeacherWorks™ CD-ROM**
- Succeeding on National Standards CD-ROM

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*Indicates materials created specifically for California.*
BioDigest

The BioDigest at the end of this unit can be used as a(n):

• preview to introduce important unit concepts.
• overview if time does not permit teaching the entire chapter.
• review of key unit concepts.

Understanding the Photo
During sports activities, the integumentary system plays an important role in cooling the body. The muscular system, using the skeletal system for support, is able to contract and provide movement.

What You’ll Learn

■ You will interpret the structure and functions of the integumentary system.
■ You will identify the functions of the skeletal system.
■ You will classify the different types of muscles in the body.

Why It’s Important

Your skin, skeleton, and muscles work together to protect, support, and move your body. A knowledge of each system helps you understand how your body is able to accomplish such a variety of activities.

Understanding the Photo

The integration of the skeletal and muscular systems provides the support and power these athletes need to perform. The skin plays a role in regulating their body temperatures as they compete.

Demo

Bounce a tennis ball or do some other kind of activity in front of the class. Ask students to explain how the skeletal and muscular systems are helping you perform this activity. As the students list various ways these systems help, write them on the board under two columns: skeletal and muscular. Use arrows to connect any answers that show connections between the systems, such as the muscles using the skeletal system for support and leverage. Ask students to consider the main functions of these two systems. How effectively would one system be able to function without the other? Have students think about examples such as a broken bone, a sprained joint, or a torn muscle.
Structure and Functions of the Integumentary System

Skin, the main organ of the integumentary (in·h TÉ·gun·men·tē) system, is composed of layers of the four types of body tissues: epithelial, connective, muscle, and nervous. Epithelial tissue, found in the outer layer of the skin, functions to cover surfaces of the body. Connective tissue, which consists of both tough and flexible protein fibers, serves as a sort of organic glue, holding your body together. Muscle tissues interact with hairs on the skin to respond to stimuli, such as cold and fright. Nervous tissue helps us detect external stimuli, such as pain or pressure. The skin is a flexible and responsive organ. Skin is composed of two principal layers—the epidermis and dermis. Each layer has a unique structure and performs a different function in the body.

Epidermis: The outer layer of skin

The epidermis is the outermost layer of the skin, and is made up of two parts—an exterior and interior portion. The exterior layer of the epidermis consists of 25 to 30 layers of dead, flattened cells that are continually being shed. Although dead, these cells still serve an important function as they contain a protein called keratin (KER uh tun). Keratin helps protect the living cell layers underneath from exposure to bacteria, heat, and chemicals.
**2 Teach**

**Purpose**
Students gain a further understanding of how structures of the skin perform their functions.

**Teaching Strategies**
- Ask students to identify the primary function of hair. \( L2 \)
- Use the diagram to point out to students where pimples may form. \( \text{in blocked hair follicles} \)

**Visual Learning**
Set up the bulletin board display showing skin problems and challenge students to identify which skin structure is involved in each problem shown. \( L2 \)

**Critical Thinking**
An injury to the top layers of epidermis would not bleed, because blood vessels are only found in the dermis layer.

**Enrichment**
Have students conduct research on artificial skin. Students should report how artificial skin is made and how its structure compares with that of natural skin. \( L5 \)

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**The Skin**

*Figure 34.1*
The skin is an organ because it consists of tissues joined together to perform specific activities. It is the largest organ of the body; the average adult’s skin covers one to two square meters. Critical Thinking: *Would an injury to the top layers of the epidermis result in bleeding? Explain.*

**Melanin**
Differences in skin color are due to the amount of the pigment melanin produced by the cells. Melanin helps protect underlying cells by absorbing ultraviolet light, which can damage cells and lead to the development of skin cancer.

**Oil glands**
Most oil glands are connected to hair follicles. Oil prevents hair from drying out and keeps the skin soft and pliable. It also inhibits the growth of certain bacteria.

**Hair**
Hair’s primary function is to protect the skin from injury and damage from solar rays. It also provides an insulating layer of air just above the surface of the skin.

**Elastin**
The connective tissue of the dermis contains many elastic fibers that allow the skin to return to its original shape after being stretched.

**Sweat glands**
Sweat glands are located deep in the dermis and open up through pores onto the surface of the skin.

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**Using Models**

**Modeling Skin Structure: Kinesthetic**
Have students use a variety of materials to create three-dimensional models of the skin. Use the illustrations found in Figure 34.1 as a guide. Students should include labels that identify each structure in their models as well as its function. \( L2 \) \( ELL \)

**Inclusion Strategies**

**Learning Disabled: Linguistic**
Have students write a story about skin injury and healing from the viewpoint of the skin. Students should include the steps outlined in Figure 34.4 in their stories. \( L1 \)
The interior layer of the epidermis contains living cells that continually divide to replace the dead cells. Some of these cells contain melanin, a pigment that colors the skin and helps protect body cells from damage by solar radiation. As the newly formed cells are pushed toward the skin’s surface, the nuclei degenerate and the cells die. Once they reach the outermost epidermal layer, the cells are shed. This entire process takes about 28 days. Therefore, every four weeks, all cells of the epidermis are replaced by new cells.

Look at your fingertips. The epidermis on the fingers and palms of your hands, and on the toes and soles of your feet, contains ridges and grooves that are formed before birth. These epidermal ridges are important for gripping as they increase friction. As shown in Figure 34.2, footprints, as well as fingerprints, are often used to identify individuals as each person’s pattern is unique. Make a set of your own fingerprints while doing the MiniLab on this page.

Dermis: The inner layer of skin

The second principal layer of the skin is the dermis. The dermis is the inner, thicker portion of the skin. The thickness of the dermis varies in different parts of the body, depending on the function of that part.

The dermis contains structures such as blood vessels, nerves, nerve endings, hair follicles, sweat glands, and oil glands. Why do some people have dark skin while others are pale? Find out by examining Figure 34.1. Beneath the dermis, the skin is attached to underlying tissues by the subcutaneous layer, which consists of fat and connective tissue. These fat deposits also help the body absorb impact, retain heat, and store food.

Figure 34.2
Babies’ footprints are recorded at birth to establish an identification record for them in the future.

MiniLab 34.1
Examine Your Fingerprints
Fingerprints form when the epidermis conforms to the shape of the dermis, which has small projections to increase its surface area.

Procedure
1. Press your thumb lightly on the surface of an ink pad.
2. Roll your thumb from left to right across the corner of an index card, then immediately lift your thumb straight up from the paper.
3. Repeat the steps above for your other four fingers, placing the prints in order across the card.
4. Examine your fingerprints with a magnifying lens, identifying the patterns by comparing them with the diagrams below.
5. Compare your fingerprints with those of your classmates.

Analysis
1. Observe Are the fingerprint patterns on your fingers identical?
2. Compare and Contrast Do any of your fingerprints show the same patterns as those of a classmate?
3. Infer How can a fingerprint be used to identify a person?

Arch Whorl Loop Combination

Expected Results
Each finger has a unique fingerprint and each individual has a unique set of fingerprints.

Assessment
Performance Have students design an experiment to determine if the print patterns of toes are unique to each individual. Use the Performance Task Assessment List for Designing an Experiment in PASC, p. 95.

Acne Treatments: Interpersonal
Ask students to research various acne treatments. Have them record in their journals how these treatments prevent or treat acne.

Purpose
Students will observe, describe, and compare similarities and differences among fingerprint patterns to determine the uniqueness of such patterns.

Process Skills
observe and infer

Teaching Strategies
■ Use non-toxic, washable-ink stamp pads for students to make fingerprints.
■ For consistency when they make comparisons, have each student use the thumb and fingers of their right hand to make fingerprints.
■ Have students begin by placing the left side of the thumb or finger on the card, and roll it completely over to the right side.
■ Have students wash hands with soap and water after completing a set of fingerprints.
Thinking Critically

1. Understanding the Concept of Homeostasis

In this lab, students will observe the structure of human skin. They will analyze the series of events that occur in the body as internal body temperature increases.

Process Skills

- Think critically, recognize cause and effect, concept map, apply concepts, predict, sequence

Teaching Strategies

- Make sure that students are familiar with all the terms used in the lab, including dilate and capillaries.
- Verify that the concept of perspiring as a way of lowering body temperature is understood by students.
- This lab would be suitable for small cooperative groups.

Thinking Critically

1. Identify a function of skin that is associated with homeostasis.

2. Analyze how the skin systems work together to maintain homeostasis in response to a rise in internal temperature.

3. Infer why temperature regulation is important for maintaining homeostasis.

4. Predict what would happen if your body temperature were too low.

Assessment

Knowledge Ask students to explain why a person becomes flushed when he or she has a fever. What evidence do they have that body temperature is controlled automatically and not consciously? Use the Performance Task Assessment List for Formulating a Hypothesis in PASC, p. 93.

Functions of the integumentary system

1. Identify a function of skin that helps maintain homeostasis.

2. Analyze how the skin systems work together to maintain homeostasis in response to a rise in internal temperature.

3. Infer why temperature regulation is important for maintaining homeostasis.

4. Predict what would happen if your body temperature were too low.

Additional Lab

The Structure of Skin

Purpose

In this lab, students will observe the structure of human skin.

Materials

- Microscope slide of human skin, microscope

Procedure

Give students the following directions.

1. Focus the human skin slide on low power. Then switch to high power.

Remind students to handle prepared slides with extreme caution.
sunlight varies, daily intake of vitamin D from dietary sources or supplements may be needed to meet requirements.

Skin also serves as a protective layer to underlying tissues. It shields the body from physical and chemical damage and from invasion by microbes. Cuts or other openings in the skin surface allow bacteria to enter the body, so they must be repaired quickly. Figure 34.4 shows the stages involved in skin repair.

**Figure 34.4**
Healing the dermis after injury occurs in a series of stages.

1. **Blood clot**
   - Blood flows out of the wound until a clot forms.

2. **A scab soon develops**, creating a barrier between bacteria on the skin and underlying tissues.

3. **New skin cells begin repairing the wound from beneath. A scar may form if the wound is large.**

**Physical Science Connection**

**Movement of heat from the skin**
Heat is carried to small blood vessels within the skin by the flow of blood. Heat then moves to the skin surface by conduction. There, heat is transferred to the surroundings primarily by radiation and by the evaporation of sweat. For a person at rest at room temperature, about 60 percent of the heat transferred is by radiation, and about 20 percent is by evaporation.

**Examining Skin**
Ask students to examine and compare the skin that covers various parts of their bodies. In different parts of the body, skin has different thicknesses, varies in moisture, is tight or loose, and is either covered with hair or hairless.

**Physical Science Connection**
Initiate a discussion with students about examples of heat transfer by radiation. Students might have felt heat coming from a hot object that they are not directly in contact with, such as a radiator or an electric space heater. Other examples include the heat emitted from a fire or a light bulb that can be felt at a distance. Remind students that radiant heat travels as electromagnetic waves.

**California Content Standards**

Pages 897–898: Biology/Life Sciences 10, 10a

**Assessment**

**Skill**
Have students draw, label, and color human skin as seen under the microscope. Students should place their drawings in their journals. Use the Performance Task Assessment List for Scientific Drawing in PASC, p. 127.
Skin Injury and Healing

If you’ve ever had a mild scrape, you know that it doesn’t take long for the wound to heal. When the epidermis sustains a mild injury, such as a scrape, the deepest layer of epidermal cells divide to help fill in the gap left by the abrasion. If, however, the injury extends into the dermis, where blood vessels are found, bleeding usually occurs. The skin then goes through a series of stages to heal the damaged tissue. The first reaction of the body is to restore the continuity of the skin, that is, to close the break. Blood flowing from the wound soon clots. The wound is then closed by the formation of a scab, which prevents bacteria from entering the body. Dilated blood vessels then allow infection-fighting white blood cells to migrate to the wound site. Soon after, skin cells beneath the scab begin to multiply and fill in the gap. Eventually, the scab falls off to expose newly formed skin. If a wound is large, high amounts of dense connective tissue fibers used to close the wound may leave a scar.

Have you ever suffered a painful burn? Burns can result from exposure to the sun or contact with chemicals or hot objects. Burns are rated according to their severity.

First-degree burns, such as a mild sunburn, involve the death of epidermal cells and are characterized by redness and mild pain. First-degree burns usually heal in about one week without leaving a scar. Second-degree burns involve damage to skin cells of both the epidermis and the dermis and can result in blistering and scarring. The most severe burns are third-degree burns, which destroy both the epidermis and the dermis. With this type of burn, skin function is lost, and skin grafts may be required to replace lost skin. In some cases, healthy skin can be removed from another area of the patient’s body and transplanted to a burned area.

As people get older, their skin changes. It becomes drier as glands decrease their production of lubricating skin oils—a mixture of fats, cholesterol, proteins, and inorganic salts. As shown in Figure 34.5, wrinkles may appear as the elasticity of the skin decreases. Although these changes are natural, they can be accelerated by prolonged exposure to ultraviolet rays from the sun.

**Extension**

Encourage students to research what special training dermatologists receive in medical school.
Section 34.2

Bones: The Body's Support

The Body's Foundation
Finding Main Ideas On a piece of paper, construct an outline about the skeletal system. Use the red and blue titles in the section as a guideline. As you read the paragraphs that follow the titles, add important information and vocabulary words to your outline.

Example:
I. Skeletal System Structure
   A. Joints
      1. Ball-and-socket joint
      2. Pivot joint

Skeletal System Structure
The adult human skeleton contains about 206 bones. Its two main parts are shown in Figure 34.6 on the next page. The axial skeleton includes the skull and the bones that support it, such as the vertebral column, the ribs, and the sternum. The appendicular (a pen DI kyuh lur) skeleton includes the bones of the arms and legs and structures associated with them, such as the shoulder and hip bones, wrists, ankles, fingers, and toes.

Joints: Where bones meet
Next time you open a door, notice how it is connected to the door frame. A metal joint positioned where the door and frame meet allows the door to move easily back and forth. In vertebrates, joints are found where two or more bones meet. Most joints facilitate the movement of bones in relation to one another. The joints of the skull, on the other hand, are fixed, as the bones of the skull don't move. These immovable joints are actually held together by the intergrowth of bone, or by fibrous cartilage.

Joints are often held together by ligaments. A ligament is a tough band of connective tissue that attaches one bone to another. Joints with large ranges of motion, such as the knee, typically have more ligaments surrounding them. In movable joints, the ends of bones are covered by cartilage.

As a baby develops in the uterus, its bones develop from cartilage. As a child grows, bones increase in both length and thickness.

Unit 10 Fast File Resources
Real World BioApplications, pp. 7–8
Reinforcement and Study Guide in English, pp. 12–13
Reinforcement and Study Guide in Spanish, pp. 16–17
Critical Thinking/Problem Solving, p. 20
Transparency Worksheets, pp. 22, 27–30

Reading Essentials for Biology, Section 34.2
Laboratory Manual, pp. 223–226
Section Focus Transparency 82
Basic Concepts Transparencies 62, 63

Physical Science Connection
Possible answers include the knees, ankles, fingers, and head and neck. Bones serve as the rigid rods, joints are fulcrums, and muscles provide the input forces for the levers. Most levers in the human body are class three, which means that the input force is situated between the fulcrum and the output force.

California Content Standards
Pages 898–899: Biology/Life Sciences 10
This layer of cartilage allows for smooth movement between the bones. In addition, joints such as those of the shoulder and knee have fluid-filled sacs called bursae located on the outside of the joints. The bursae act to decrease friction and keep bones and tendons from rubbing against each other. Tendons, which are thick bands of connective tissue, attach muscles to bones. Figure 34.7 shows the different movable joints in the skeleton.

Forcible twisting of a joint, called a sprain, can result in injury to the bursae, ligaments, or tendons. A sprain most often occurs at joints with large ranges of motion such as the wrist, ankle, and knee.
Concept Development
Have students use a medical dictionary to find out what is meant by the terms slipped disk or herniated disk. Have students find out the causes of these problems and report their findings to the class.

Biology Journal
Marfan’s Syndrome Have advanced students report on Marfan’s syndrome, which affects connective tissue, bones, muscles, and ligaments. It is possible that Abraham Lincoln was mildly afflicted with this syndrome. Have students explain how this syndrome affects normal functioning of the musculoskeletal system.

Word Origin
Have students describe how the word origin of “arthron” helped them understand the meaning of the words arthropods and arthroscopy.

Virtual Lab
Students will discover the types of joints in the human body in Bones, the Body’s Support.

Joint Movement Ask advanced students to gather examples of everyday objects that model the movement of each type of joint. Have them describe on index cards the type of movement each object allows and the type of joint that allows this type of movement in the body. They should prepare a poster or display of their results for presentation to the class. See BioChallenges and Enrichment for additional projects and activities.
Using Science Terms
Discuss the derivation of the word osteoporosis with students. Ask students to find other terms in the chapter that make use of the prefix “osteo-”. Ask them to explain how the prefix relates to the meaning of each term.

Caption Question Answer
Figure 34.8 Osteons receive oxygen from small blood vessels running within the osteon systems. Nerve impulses travel on nerves in the osteon canals.

Formation of Bone
The skeleton of a vertebrate embryo is made of cartilage. By the ninth week of human development, bone begins to replace cartilage. Blood vessels penetrate the membrane covering the cartilage and stimulate its cells to become potential bone cells called osteoblasts (AHSS tee oh blastz). These potential bone cells secrete a protein called collagen in which minerals in the bloodstream begin to be deposited. The deposition of calcium salts and other ions hardens and the newly formed bone cells, now called osteocytes, are trapped. The adult skeleton is almost all bone, with cartilage found only in places where flexibility is
needed—regions such as the nose tip, external ears, discs between vertebrae, and movable joint linings.

**Bone growth**

Your bones grow in both length and diameter. Growth in length occurs at the ends of bones in cartilage plates. Growth in diameter occurs on the outer surface of the bone. The increased production of sex hormones during your teen years causes the osteoblasts to divide more rapidly, resulting in a growth spurt. However, these same hormones will also cause the growth centers at the ends of your bones to degenerate. As these cells die, your growth will slow. After growth stops, bone-forming cells are involved in repair and maintenance of bone. Learn more about how bones age by doing the Problem-Solving Lab on this page.

**Skeletal System Functions**

The primary function of your skeleton is to provide a framework for the tissues of your body. The skeleton also protects your internal organs, including your heart, lungs, and brain.

The arrangement of the human skeleton allows for efficient body movement. Muscles that move the body need firm points of attachment to pull against so they can work effectively. The skeleton provides these attachment points.

Bones also produce blood cells. Red marrow—found in the humerus, femur, sternum, ribs, vertebrae, and pelvis—is the production site for red blood cells, white blood cells, and cell fragments involved in blood clotting. Yellow marrow, found in many other bones, consists of stored fat as shown in Figure 34.9.

### Problem-Solving Lab 34.2

**Make and Use Tables**

**How does bone density differ between the sexes?** Bone has a certain compactness or strength that can be measured in terms of the bone’s mineral density. The higher the density of bone, the stronger it is. The lower the density of bone, the weaker it is.

**Solve the Problem**

Examine the chart’s average values for bone density of males and females at different ages. The data are for the upper femur where it fits into the hip.

<table>
<thead>
<tr>
<th>Age</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
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</table>

**Thinking Critically**

1. **Evaluate** What is the trend for bone density as a person ages?
2. **Analyze** Between the ages of 20 and 50, what percentage of bone density do females lose compared with males? What percentage is lost between the ages of 50 and 80 for either sex?
3. **Analyze** Which sex shows the greater change in bone density as it ages? Between which ages does the greatest change occur?
4. **Cause and Effect** The hormone in females that prevents bone density from decreasing begins to diminish at the age of 50. Does this correlate with the changes in bone density reported in the chart? Use specific numbers in your answer.

**Figure 34.9**

Bones can store fat for use in times of need.

---

**Physical Science Connection**

(p. 904) Have students research how short wavelength electromagnetic radiation is used to treat cancer. X-rays are beamed on a cancerous growth in an attempt to destroy the tumor or prevent it from growing larger.

**Comparative Anatomy**

Have students who need an additional challenge compare the anatomy of the front limbs of a frog, bird, cat, whale, and bat with that of the human arm. Compare the number, shapes, and arrangements of bones.

---

**Challenge Activity**

---

**Problem-Solving Lab 34.2**

**Purpose**

Students will compare bone density data for males and females at various ages.

**Process Skills**

make and use tables, use numbers, think critically, interpret data, compare and contrast

**Teaching Strategies**

- Review the procedure for calculating percentages.
- Remind students that prior to calculating all values called for in the Thinking Critically section, the amount of final bone density for an age group must be subtracted from the original bone density to arrive at the amount of bone density lost. Use amount of bone density lost compared with original bone density to calculate percent of bone density lost.

**Example:** Find the percent bone density lost for females between the ages of 20 and 50.

**Step 1:** $0.895 - 0.797 = 0.098$

**Step 2:** $0.098/0.895 	imes 100 = 10.9\%$

**Thinking Critically**

1. Bone density decreases with age regardless of sex.
2. females from 20–50 = 10.9%; males from 20–50 = 13.0%; females from 50–80 = 23.8%; males from 50–80 = 14.9%
3. females, from age 50–80
4. Yes, from ages 20–50 a decrease in bone density of only 10.9% is measured for females, but from 50–80, the decrease is 23.8%.

**Assessment**

**Knowledge**

Have students research the benefits of exercise on bone density. Challenge them to correlate their findings with the need for exercise by the elderly. Students should summarize their research in their journals. Use the Performance Task Assessment List for Writing in Science in PASC, p. 159.
1. **axial skeleton**: the skull and the bones that support it; **appendicular skeleton**: bones associated with the appendages
2. **ball-and-socket joints**: movement in all directions, hips and shoulders; **pivot joints**: allow twisting around each other, between radius and ulna; **hinge joints**: back-and-forth movement, elbows, knees, fingers, toes; **gliding joints**: allow bones to slide past each other, wrists
3. **Compact bone** is made up of osteon systems. **Spongy bone** contains holes.
4. The **skeletal system** provides a framework for the tissues of the body, produces blood cells, and stores minerals.
5. The **structure of compact bone** would not allow growth from the inside.
6. (1) **embryo skeleton** is cartilage; (2) bone begins to replace cartilage—osteoblasts secrete a material in which calcium salts and other ions are deposited and harden to form bone; (3) bones continue to grow in length from the ends, and in diameter from the outer surface until around age 20.
Muscles for Locomotion

**Classifying Muscles**

**Concept Map** Copy the concept map onto a separate sheet of paper.

**Muscle Types**

1. located
2. cardiac
3. involuntarily
4. attached to bones
5. controlled
6. located

**Organize Information** As you read this section, complete the concept map to compare different types of muscles.

---

**Three Types of Muscles**

Nearly half of your body mass is muscle. A muscle consists of groups of fibers, or cells, bound together. Almost all of the muscle fibers you will ever have were present at birth. Figure 34.11 shows the three main kinds of muscles in your body. One type of tissue, smooth muscle, is found in the walls of your internal organs and blood vessels.

---

**Concept Map**

**Organize Information** After students have completed their reading and the concept map, give them a concept map filled in except for the bottom level. Have students fill in the missing answers as a quiz. 1. smooth; 2. skeletal; 3. walls of internal organs and blood vessels; 4. heart; 5. involuntarily; 6. voluntarily
Smooth muscle is made up of sheets of cells that are ideally shaped to form a lining for organs, such as the digestive tract and the reproductive tract. The most common function of smooth muscle is to squeeze, exerting pressure on the space inside the tube or organ it surrounds in order to move material through it. Examples include the movement of food through the digestive system and the movement of gametes through the reproductive system. Because contractions of smooth muscle are not under conscious control, smooth muscle is considered an involuntary muscle.

Another type of involuntary muscle is the cardiac muscle, which makes up your heart. Cardiac muscle fibers are interconnected and form a network that helps the heart muscle contract efficiently. Cardiac muscle is found only in the heart and is adapted to generate and conduct electrical impulses necessary for its rhythmic contraction.

The third type of muscle tissue, skeletal muscle, is the type that is attached to and moves your bones. The majority of the muscles in your body are skeletal muscles, and, as you know, you can control their contractions. A muscle that contracts under conscious control is called a voluntary muscle.

**Problem-Solving Lab 34.3**

Compare and Contrast

How are skin, bone, and muscle cells different? Cells that form skin (which includes epithelial cells), bone, and muscle are specialized to perform various functions. Each of these systems of the body contains different types of cells that work together to carry out the function of the tissue or organ.

**Solve the Problem**

Using the text and figures on pages 894, 902, 905, and 908, prepare a table that compares and contrasts the structure and function of skin, muscle, and bone cells.

**Thinking Critically**

Infer Protein analysis of an unknown tissue sample yields a high level of myosin and actin. Is this sample skin, bone, or muscle? What structures could you look for in an electron microscope to confirm the identity of this tissue?

**Figure 34.12**

When the biceps muscle contracts, the lower arm is moved upward (A). When the triceps muscle on the back of the upper arm contracts, the lower arm moves downward (B).

**Physical Science Connection**

(p. 907) Ask students to explain the difference between work and power. Power is the amount of work done divided by the time needed to do the work. The power needed to do a certain amount of work depends on the time over which the work is done. For example, the power needed to lift a 10-kg book bag 1 m high in 0.5 s is greater than the power needed to lift the book bag 1 m high in 2 s.

**Skeletal Muscle Contraction**

Whether you are playing tennis, pushing a lawn mower, or writing, some muscles contract while others relax as the action is performed. Figure 34.12 shows the movement of the lower arm as controlled by opposing muscles in the upper arm. The majority of skeletal muscles work in opposing pairs.
Muscle tissue is made up of muscle fibers, which are actually just very long, fused muscle cells. Each fiber is made up of smaller units called **myofibrils** (mi oh FIB rulz). Myofibrils are themselves composed of even smaller protein filaments that can be either thick or thin. The thicker filaments are made of the protein **myosin**, and the thinner filaments are made of the protein **actin**. Each myofibril can be divided into sections called **sarcomeres** (SAR kuh meerz), the functional units of muscle. How do nerves signal muscles to contract? Find out in Figure 34.13 on the next page.

The sliding filament theory currently offers the best explanation for how muscle contraction occurs. The **sliding filament theory** states that, when signaled, the actin filaments within each sarcomere slide toward one another, shortening the sarcomeres in a fiber and causing the muscle to contract. The myosin filaments, on the other hand, do not move. Learn more about the sliding filament theory and muscle contraction in the **MiniLab** on this page.

**Muscle Strength and Exercise**

How can you increase the strength of your muscles? Muscle strength does not depend on the number of fibers in a muscle. It has been shown that this number is basically fixed before you are born. Rather, muscle strength depends on the thickness of the fibers and on how many of them contract at one time. Regular exercise stresses muscle fibers slightly; to compensate for this added workload, the fibers increase in diameter by adding myofibrils.

Recall that ATP is produced during cellular respiration. Muscle cells are continually supplied with ATP from both aerobic and anaerobic processes. However, the aerobic respiration process dominates when adequate oxygen is delivered to muscle cells, such as when a muscle is at rest or during moderate activity. When an adequate supply of oxygen is unavailable, such as during vigorous activity, an anaerobic process—specifically lactic acid fermentation—becomes the primary source of ATP production.

**MiniLab 34.2**

**Purpose**

Students will measure the length of a sarcomere during muscle relaxation and contraction.

**Process Skills**

acquire information, apply concepts, collect data, compare and contrast, formulate models, interpret data, measure in SI, predict

**Teaching Strategies**

- Provide students with rulers.
- Review vocabulary terms prior to the start of this activity.

**Expected Results**

Actin filaments slide over myosin filaments resulting in shortening of sarcomeres during contraction.

**Analysis**

1. Students will learn that actin and myosin do not change in length.
2. Actin filaments slide over myosin filaments, shortening the sarcomere.

**Assessment**

**Knowledge**

Using the diagram of relaxed muscle, have students explain why skeletal muscle has a striated appearance when viewed under the microscope. Provide students with a slide of striated muscle tissue to verify their explanations. Use the Performance Task Assessment List for Making Observations and Inferences in PASC, p. 89.

**Challenge Activity**

**Sports Medicine**

Ask advanced students to prepare and conduct an interview with a person who works in the field of sports medicine. Students should include questions on how their programs relate to muscle fitness and health.

**Inclusion Strategies**

**English Language Learners: Linguistic**

Have students who are having difficulty make flash cards that show an anatomical term on one side of the card and its meaning and location on the other side. Have students work in pairs to review the cards.

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**California Content Standards**

Pages 906-907: Biology/Life Sciences 9h*
A Muscle

**Purpose**
Students gain further understanding of the way muscle cells contract.

**Teaching Strategies**
- Have students describe the structure of skeletal muscle.
- Ask students to describe the differences between actin and myosin filaments.

**Visual Learning**
Ask students what makes up a single muscle fiber. Many myofibril units Elicit what chemical stimulates the formation of attachments between myosin and actin filaments. Calcium

**Critical Thinking**
The nerve signal causes calcium to be released in the muscle. The calcium causes actin and myosin filaments to bind together. The actin filaments are then pulled inward, resulting in a muscle contraction.

**Assessment**
Knowledge Have students write a short summary of why lactic acid builds up in muscle cells during intense exercise.

**BioLab**
The BioLab at the end of the chapter can be used at this point in the lesson.

**Tying to Prior Knowledge**
Point out that myofibrils of the muscles are a special type of microfilament, as discussed previously. This is a good time to review ATP, along with aerobic and anaerobic metabolism.

**Modeling Body Movement: Visual-Spatial** Have students working in groups construct models to show how bones and muscles work together to move appendages. More advanced students may wish to work together to prepare a model that demonstrates the sliding filament theory.

**Physically Challenged**
Locate a physically challenged spokesperson who has a musculoskeletal disease and who is willing to speak to the class about the disorder. The focus of the discussion should be on the nature of the disease, restrictions the disease places on the person, and treatments for the disease.
Think about what happens when you are running in gym class or around the track at school. Figure 34.14 illustrates how an athlete’s need for oxygen changes as the intensity of his or her workout increases. At some point, your muscles are not able to get oxygen fast enough to sustain aerobic respiration and produce adequate ATP. Thus, the amount of available ATP becomes limited. For your muscle cells to get the energy they need, they must rely on lactic acid fermentation as well. Figure 34.14B indicates how, at a certain intensity, the body shifts from aerobic respiration to the anaerobic process of lactic acid fermentation for its energy needs.

During exercise, lactic acid builds up in muscle cells. As the excess lactic acid is passed into the bloodstream, the blood becomes more acidic and rapid breathing is stimulated. As you catch your breath following exercise, the need for oxygen goes up in predictable increments.

As an individual increases the intensity of his or her workout, the rate of oxygen consumption increases. This is illustrated in Figure 34.14A. As the workload becomes greater, the body is able to shift toward anaerobic metabolism for its energy needs.

Muscle strength depends on the thickness of the muscle fibers and how many of the fibers contract at one time. Exercise stresses muscles and causes them to increase in size and strength. Exercise cannot change muscle function. They must use lactic acid fermentation to produce ATP. Figure 34.14B shows that exercise is accompanied by an increase in the presence of lactic acid in the bloodstream. This increase indicates the amount of oxygen available to muscle cells.

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Before You Begin
The movement of body parts results from the contraction and relaxation of muscles. In this process, muscles use energy from aerobic respiration and lactic acid fermentation. When exercise is continued for a long period of time, the waste products of fermentation accumulate and muscle fibers are stressed, causing fatigue. How does fatigue affect muscles? In this lab you will investigate the effects of fatigue on the ability of muscles to perform a task.

**Problem**
How does fatigue affect the number of repetitions of an exercise you can accomplish?

**Hypotheses**
Hypothesize whether or not muscle fatigue has any effect on the amount of exercise muscles can accomplish. Consider whether fatigue occurs within minutes or hours.

**Objectives**
In this BioLab, you will:
- **Hypothesize** whether or not muscle fatigue affects the amount of exercise muscles can accomplish.
- **Measure** the amount of exercise done by a group of muscles.
- **Make a graph** to show the amount of exercise done by a group of muscles.

**Possible Materials**
- stopwatch or clock
- graph paper
- with second hand
- small weights

**Safety Precautions**
CAUTION: Do not choose an exercise that is too difficult. Do not overexert yourself. Wear appropriate footwear and clothing for exercise.

**Alternative Materials**
Stopwatches are not necessary if a clock with a second hand is visible to all students.

**Possible Hypotheses**
- If a muscle becomes fatigued, then the muscle will not be able to do as much work.
- If a muscle becomes fatigued, its capacity to do work will not be diminished.

**Teaching Strategies**
- One student should act as timekeeper. The exerciser should count the number of times he or she can carry out the exercise in a given time period, such as 3 minutes.
- Trials should be performed as closely together as possible, so that little muscle rest occurs between trials.
- Place a sample graph on the chalkboard to help students prepare their graphs.

**Possible Procedures**
Students could choose an exercise such as jumping jacks, hopping or jogging in place, or stepping up and down from the bottom step of stairs. They should repeat the experiment 4 or 5 times so that the muscles become fatigued.
2. Work in pairs, with one member of the team being a timekeeper and the other member performing the exercise.

3. Compare your design with those of other groups.

Check the Plan
1. Be sure that the exercises are ones that can be done rapidly and cause a minimum of disruption to other groups in the classroom.
2. Consider how long you will do the activity and how often you will record measurements.
3. Make sure your teacher has approved your experimental plan before you proceed further.
4. Make a table in which you can record the number of exercise repetitions per time interval.
5. Carry out the experiment.
6. On a piece of graph paper, plot the number of repetitions on the vertical axis and the time intervals on the horizontal axis.

ANALYZE AND CONCLUDE

1. Make Inferences What effect did repeating the exercise over time have on the muscle group?

2. Compare and Contrast As you repeated the exercise over time, how did your muscles feel?

3. Recognize Cause and Effect What physiological factors are responsible for fatigue?

4. Think Critically How well do you think your fatigued muscles would work after 30 minutes of rest? Explain your answer.

5. Hypothesize Form a hypothesis about how different amounts of resistance would affect the rate of fatigue. Design an experiment to test your hypothesis. Identify the independent and dependent variables.

6. Error Analysis Compare your results to those of other student groups. How can you explain the differences in results? If you were to perform this experiment again, how would you improve it?

Apply Your Skill

Project Design an experiment that will enable you to measure the strength of muscle contractions.

Web Links To find out more about muscles, visit ca.bdel.glencoe.com/muscles

Data and Observations
Student graphs should show that the number of exercise repetitions goes down over time as the muscles become tired.

Apply Your Skill

Project Ask students how athletes such as marathon runners continue to exercise at a high level for hours. Why don’t their muscles fatigue after a few minutes?

Assessment

Portfolio Have students place their laboratory reports, including their tables and graphs, in their journals. Use the Performance Task Assessment List for Science Journal in PASC, p. 175. L2
X Rays—The Painless Probe

X rays are a form of radiation emitted by X-ray tubes and by some astronomical objects such as stars. Machines that use X rays to view concealed objects are so common that you have probably had contact with one recently. Dentists use them to examine teeth, doctors to inspect bones and organs, and airports to look inside your carry-on and checked baggage.

Wilhelm Roentgen, a German physics professor, accidentally discovered the X ray in 1895. As he was studying cathode rays in a high-voltage vacuum tube, he noticed that a special screen lying nearby was giving off fluorescent light. He eventually determined that rays given off by the tube were able to penetrate the black box that enclosed it and strike the screen, causing it to glow. Because he did not know what these rays were, he called them X rays, “X” standing for “unknown.” He made a film of his wife’s hand, exposing the bones—the first permanent X ray of a human. Two months later, he published a short paper. Within a month of its publication, doctors in Europe and the U.S. were using X rays in their work.

Noninvasive diagnosis In medicine, X rays are passed through the body to photographic film. Bones and other dense objects show up as white areas on the film. As a result, the position and nature of a break is clearly visible. The contours of organs such as the stomach can be seen when a patient ingests a high-contrast liquid; other organs can be marked with special dyes.

Another practical application of X rays includes their use in tests that measure bone density. Recall that osteoporosis is a disease that results in bones becoming porous and brittle, causing them to fracture more easily. Bone density scans use X rays to measure the density of an individual’s bones, such as those found in the hip and the spine. These scans are painless, low-risk scans that yield highly accurate results.

Radiation treatments As X rays bombard atoms of tissues, electrons are knocked from their orbits, resulting in damage to the exposed tissue cells. To protect healthy tissues, absorptive metals are used as shields. You’ve probably had a dental X ray where the dental assistant spread a heavy lead apron across your chest. The destructive nature of high doses of X rays has proven useful in the treatment of cancers, where cancerous cells are targeted and destroyed.

Researching in Biology

Research Evaluate the impact of X rays on scientific thought and society by researching how physicians diagnosed skeletal disorders prior to the invention of X rays. Investigate what other types of painless probes are available today, such as those used for facial recognition and iris scans.

To find out more about X rays, visit ca.bdel.glencoe.com/physics

Prior to the invention of X rays, physicians had to make a diagnosis of a broken bone by touch. Bullets were located by exploring the wound using fingers or a metal probe. Students could include information on MRIs, PETs, CT scans, sonograms, and the newest technology of facial recognition and iris scans.
Chapter 34 Assessment

Section 34.1
Skin: The Body’s Protection

Key Concepts
- Skin is composed of the epidermis and dermis, with each layer performing various functions.
- Skin regulates body temperature, protects the body, and functions as a sense organ.
- Skin responds to injury by producing new cells and signaling a response to fight infection.

Vocabulary
- dermis (p. 895)
- epidermis (p. 893)
- hair follicle (p. 896)
- keratin (p. 893)
- melanin (p. 895)

Section 34.2
Bones: The Body’s Support

Key Concepts
- The skeleton is made up of the axial and appendicular skeletons.
- Joints allow movement between two or more bones where they meet.
- Osteocytes are living bone cells.
- Bones are formed from cartilage as a human embryo develops.
- The skeleton supports the body, provides a place for muscle attachment, protects vital organs, manufactures blood cells, and serves as a storehouse for calcium and phosphorus.

Vocabulary
- appendicular skeleton (p. 899)
- axial skeleton (p. 899)
- bursa (p. 900)
- compact bone (p. 902)
- joint (p. 899)
- ligament (p. 899)
- osteoblast (p. 902)
- osteocyte (p. 902)
- red marrow (p. 903)
- spongy bone (p. 902)
- tendon (p. 900)
- yellow marrow (p. 903)

Section 34.3
Muscles for Locomotion

Key Concepts
- There are three types of tissue: smooth, cardiac, and skeletal. Smooth muscle lines organs, contracting to move materials through the body. Cardiac muscle contracts rhythmically to keep the heart beating. Skeletal muscle is attached to bones and contracts to produce body movements.
- Muscle tissue consists of muscle fibers, which can be divided into smaller units called myofibrils.
- Muscles contract as filaments within the myofibrils slide toward one another.

Vocabulary
- actin (p. 907)
- cardiac muscle (p. 906)
- involuntary muscle (p. 906)
- myofibril (p. 907)
- myosin (p. 907)
- sarcomere (p. 907)
- skeletal muscle (p. 906)
- sliding filament theory (p. 907)
- smooth muscle (p. 905)
- voluntary muscle (p. 906)

Use the ExamView®Pro Test Bank CD-ROM to:
- Create multiple versions of tests
- Create modified tests with one mouse click for inclusion students
- Edit existing questions and add your own questions
- Build tests aligned with state standards using built-in State Curriculum Tags
- Change English tests to Spanish with one mouse click and vice versa

Key Concepts
Summary statements can be used by students to review the major concepts of the chapter.

Visit ca.bdllglencoe.com/self_check_quiz/vocabulary_puzzlemaker/chapter_test/standardized_test

For additional help with vocabulary, have students access the Vocabulary PuzzleMaker online at ca.bdllglencoe.com/vocabulary_puzzlemaker

FOLDABLES™
Have students use their Foldables to review the content of Section 34.1. On the back of the paper, have students identify where the different tissue types of the body are located in the skin.
**Chapter 34 Assessment**

**Vocabulary Review**
Review the Chapter 34 vocabulary words listed in the Study Guide on page 913. Match the words with the definitions below.

1. epidermis
2. ligaments
3. osteocytes
4. smooth muscle
5. myosin

**Understanding Key Concepts**

1. Which of the following is a skin pigment that protects cells from solar radiation damage?
   - A. keratin
   - B. epidermis
   - C. melanin
   - D. dermis

2. Which of the following is nourished by blood vessels that run within this structure?
   - A. dermis
   - B. osteocyte
   - C. epidermis
   - D. sarcomere

3. All of the following are types of muscle except ________.
   - A. epidermal
   - B. cardiac
   - C. smooth
   - D. skeletal

4. Skin plays a role in ________.
   - A. storing calcium
   - B. regulating body temperature
   - C. manufacturing blood cells
   - D. supporting the body

5. The axial skeleton includes bones from ________.
   - A. the skull
   - B. the ribs
   - C. the sternum
   - D. all of the above

**Constructed Response**

12. Muscles attach to the skeletal system and are able to develop force by pulling against the bone, causing movement.

13. Ligaments attach bone to bone across joints. Injury to the ligament could result in dislocation of a joint, not having full range of movement, pain, and swelling at the joint.

14. The sliding filament theory offers an explanation of how muscle fibers contract. Strengths: it has been modeled, tested, and validated with quantitative data in the laboratory; Weaknesses: as new data is collected and evaluated, the theory may need to be revised based on new findings.

15. Infer You view three tissue slides under the microscope. Slide A has an outer layer containing flat, dead cells. The cells of Slide B have nuclei and are striated. Slide C contains repeating circular units with capillaries at the center. Identify each slide as skin, bone, or muscle tissue, and explain the function of each.

16. **REAL WORLD BIOCHALLENGE** Osteoporosis is a health threat for many Americans. Visit ca.bdol.glencoe.com to find out more information about this disease. What are the risk factors? Why are the elderly at greater risk for this disease? Analyze the importance of nutrition and exercise in the prevention of osteoporosis.

17. Red bone marrow produces red blood cells, white blood cells, and clotting fragments. Tissues of the other systems would die from lack of oxygen or possible infections.

18. The continual rubbing on bare skin causes the epidermis to produce more cells.

**Thinking Critically**

15. Slide A: epidermis; protection; Slide B: either cardiac or skeletal muscle cell; Slide C: bone; support, movement, mineral storage, red blood cell production

16. Risk factors: sex hormone levels, diet, medications, smoking, excessive alcohol use, inactive lifestyle, age, gender, body size, ethnicity and family history. The elderly are at risk because bones become less dense as people age. Adequate amounts of calcium in diet and regular weight-bearing exercise can help prevent the onset of osteoporosis.
17. **Hypothesize** How would the destruction of red bone marrow affect other systems within the body?

18. **Infer** During summer months many people go barefoot and the skin on their feet thickens. Why does this thickening occur?

The assessed California standard appears next to the question.

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**Part 1 Multiple Choice**

Use the graph to answer questions 19–21.

**Calcium Levels in Contracting Muscle**

<table>
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<td>100</td>
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</tr>
</tbody>
</table>

19. The highest levels of calcium are found at approximately what time?
   - A. 10 milliseconds
   - B. 50 milliseconds
   - C. 30 milliseconds
   - D. 70 milliseconds

20. Which conclusion could be reached about the relationship between calcium and muscle contraction?
   - A. Calcium is not involved in muscle contraction.
   - B. Calcium is released after the muscle has finished contracting.
   - C. Calcium is released before the muscle reaches its greatest force of contraction.
   - D. Calcium is released the entire time the muscle contracts.

21. At what time is the force of the muscle contraction strongest?
   - A. 10 milliseconds
   - B. 50 milliseconds
   - C. 30 milliseconds
   - D. 70 milliseconds

---

**Part 2 Constructed Response/Grid In**

Record your answers for Questions 24 and 25 on a separate sheet of paper.

24. **Open Ended** What are the similarities and differences between first-degree burns, second-degree burns, and third-degree burns? Include in your response information about which layers of the skin are damaged, symptoms, and treatment.

25. **Open Ended** Describe how muscle cells are supplied with energy during exercise.

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**California Standards Practice**


24. First-degree burns involve the death of epidermal cells and are characterized by redness and mild pain. Second-degree burns involve damage to skin cells of the dermis and can result in blistering and scarring. Third-degree burns destroy both the epidermis and the dermis so skin function is lost. Skin grafts may be required to replace lost skin.

25. Muscle cells begin by undergoing aerobic respiration to produce ATP. If oxygen supplies are low, cells will switch to lactic acid fermentation to produce ATP.