Skeletal System—
The Infrastructure
Teacher’s Guide
INTRODUCTION
This Teacher’s Guide provides information to help you get the most out of Skeletal System: The Infrastructure. The contents in this guide will allow you to prepare your students before using the program and present follow-up activities to reinforce the program’s key learning points.

This video provides an introduction to the skeletal system, emphasizing its importance in providing structure and support for the body. A discussion of the major types of joints and bones, and the relationship between them, allows students to gain a solid understanding of why various parts of the body are able to achieve different degrees of motion. Vitamins and minerals required by the skeletal system are also highlighted.

LEARNING OBJECTIVES
After viewing the program, students will be able to:

- Understand the relationship between joints and bones.
- Discuss the purpose of the musculoskeletal system.
- Name and describe the parts of the musculoskeletal system.
- Name a variety of bones in the skeletal system.
- Name and describe the four major types of joints and the range of movement those joints provide.
- Name and describe the four major types of bones.
- Develop an awareness of the remodeling of our bones’ tissue and the necessary vitamins and minerals that aid this process.

EDUCATIONAL STANDARDS
National Standards
This program correlates with the National Science Education Standards from the National Academy of Sciences, Project 2061 Benchmarks for Science Literacy by the American Association for the Advancement of Science, and the National Health Education Standards: Achieving Health Literacy by the Joint Committee on National Health Education Standards. The content has been aligned with the following educational standards and benchmarks from these organizations.

- Comprehend concepts related to health promotion and disease prevention.
- Understand personal and community health.
- Understand form and function.
- Understand systems, order, and organization.
- Understand matter, energy, and organization in living systems.
- Understand that in many physical, biological, and social systems, changes in one direction tend to produce opposing (but somewhat delayed) influences, leading to repetitive cycles of behavior.
- Understand that a system usually has some properties that are different from those of its parts, but appear because of the interaction of those parts.
- Understand that a system can include processes as well as things.
- Understand that thinking about things as systems means looking for how every part relates to others. The output from one part of a system (which can include material, energy, or information) can become the input to other parts. Such feedback can serve to control what goes on in the system as a whole.
- Understand how things work and designing solutions to problems of almost any kind can be facilitated by systems analysis. In defining a system, it is important to specify its boundaries and subsystems, indicate its relation to other systems, and identify what its input and its output are expected to be.
- Understand that any system is usually connected to other systems, both internally and externally. Thus a system may be thought of as containing subsystems and as being a subsystem of a larger system.
- Understand that organs and organ systems are composed of cells and help to provide all cells with basic needs.
- Understand that the amount of food energy (calories) a person requires varies with body weight, age, sex, activity level, and natural body efficiency. Regular exercise is important to maintain a healthy heart/lung system, good muscle tone, and bone strength.

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Program Overview

This program discusses the musculoskeletal system. Various subjects include the relationship between joints and bones, range of motion, bone injury and disease, and the nutrients necessary to ensure healthy bones.

Main Topics

Topic 1: What is the Musculoskeletal System?
This section discusses the basic purpose of the skeletal system and how our musculoskeletal system acts as the infrastructure of our body by providing the support we need. Also mentioned are the components of the system, the interdependence of these components, and the five functions of the system.

Topic 2: Bones
In this section, the four types of bones are identified. Several major bones of the body are named and described. The purpose of a cast in healing a broken bone is also illustrated.

Topic 3: Joints
This section describes the purpose of joints and how joints work with bones to produce movement. The structure and function of various joints are introduced.

Topic 4: Bone Growth and Replacement
The last section describes the concept of remodeling. The minerals, vitamins, and hormones essential to proper bone growth and replacement are reviewed.
FAST FACTS

- The most important job of the musculoskeletal system is to provide movement or locomotion for the body.
- A joint is composed of bones that act like levers, providing movement for the body.
- The skeletal system depends on two types of connective tissues: cartilage and bones.
- Spaces between the hard components of bones provide channels for blood vessels, which provide the bone with nutrients.
- The spaces in the bones make the bones lighter. The distribution of the spaces determines whether the bones are compact or spongy.
- The bones serve as storage areas for mineral salts, calcium, phosphorus, and fats.
- Two vital functions of the skeletal system are to support the soft tissues of the body so the body can maintain its form and posture, and to protect the delicate structures like the brain, spinal cord, heart, lungs, and major blood vessels in the thoracic cavity.
- Blood cell production occurs in red bone marrow.
- The facial and cranial bones are the two sets of bones in the skull.
- There are 206 bones in the adult human body.
- The bones of the leg are the most commonly broken.
- The purpose of a cast is to immobilize the two ends of the bone and keep the bone in its appropriate alignment.

VOCABULARY TERMS

amphiarthroses: Slightly moveable joints, for example, the sternum.
cartilage: A firm, elastic, flexible type of connective tissue.
diarthroses: Joints that move freely, such as the elbow and the knee.
estrogen: A female hormone important for bone growth.
flat bones: Bones that are generally thin and composed of two parallel plates of compact bone that encase a layer of spongy bone.
irregular bones: Bones that have complex shapes and cannot be grouped in other categories, for example, the vertebrae and specific facial bones.
joint: The moveable or fixed place or part where two bones or elements of a skeleton join.
ligament: A band of tissue, usually white and fibrous, serving to connect bone to bone.
long bones: Bones greater in length than width composed of a shaft with two knob-like ends which are larger than the shaft in diameter.
musculoskeletal system: The body system composed of the skeleton, muscles, tendons, ligaments, and other components of joints.
osteocytes: Mature bone cells.
osteoporosis: A progressive decrease in the density of bones that weakens them and makes them more likely to fracture.
remodeling: The replacement of old bone tissue by new bone tissue.
short bones: Bones that are rather cube-shaped and nearly equal in length and width; they have a spongy texture except at the surface, where there is a thin layer of compact bone.
synarthroses: Immovable joints, for example, the bones of the skull.

PRE-PROGRAM DISCUSSION QUESTIONS

1. Have you ever broken a bone, or known someone who has? Describe the experience. What difficulties were encountered?
2. If we did not have a skeleton, what would our bodies be like? What limitations would we have regarding the structure of our body and its ability to function?
3. Human beings differ from other animals because we have a skeleton that allows us to stand and walk upright. How has our skeleton assisted us in dominating the animal kingdom? Think of other examples of how our skeleton has assisted us in surpassing other animals.
4. Why do you think joints are an important part of movement?
5. Name five bones that it would be impossible to live without. Why did you choose those bones?
POST-PROGRAM DISCUSSION QUESTIONS
1. How does the muscular system work with the skeletal system to provide movement for our body?
2. How would loss of gravity impact our bones and musculoskeletal system?
3. The musculoskeletal system can be compared to the infrastructure of a building. How and why?
4. Explain this statement: “If disease or injury affects one part of the system, the whole system is affected.” Why is this true? Draw an analogy to support your answer.
5. What would happen if bones didn’t grow or stopped growing too soon? What are some ways to help with this problem?

GROUP ACTIVITIES
Schedule an Operation
Develop a game similar to “Operation” using the correct terminology related to bones and joints. Include at least fifteen bones or joints to “operate” on.

Guest Chiropractor
Visit a chiropractor’s office, or have a chiropractor speak to the class about the structure of the spine, ways to keep the spine healthy, how the health of the spine is connected to the health of the body, and the job of a chiropractor.

Skeleton Songs
With a partner or in a small group, write a song or poem incorporating the information you have learned about the musculoskeletal system. Have fun with it, but be sure to include factual information.

X-Ray Vision
Arrange a trip to the X-ray department of a local hospital, or invite a technician to visit the class. Observe several different X-rays of a variety of bones. Compare two different X-rays of a broken bone: one of the bone when it first was broken, and the second of the bone after it has healed. Is the break visible on the X-ray? Does the bone change in appearance or size after it has healed? Draw diagrams of the “before” and “after” X-rays and highlight areas of interest.

INDIVIDUAL STUDENT PROJECTS
My Skeletal System
Draw a life-size poster of your body. Fill in and label the skeletal system with the major bones and joints.

Range of Motion
Choose three different movements, from very simple to more complex. Present these movements to the group using some form of visual aid (model, poster, etc.). Identify the bones and joints involved in each movement and the subtype(s) of joint involved. (The subtypes are gliding joint, hinge joint, pivot joint, ellipsoidal joint, saddle joint, and ball and socket joint.) Discuss how the subtype affects the range of motion.

Research
How do three members of the medical profession work together to aid people in the health of their skeletal system? Research their jobs and how they work together to provide assistance. How are they interdependent? Write a short summary of each profession.

INTERNET ACTIVITIES
Injuries and our Musculoskeletal System
Research an injury to the musculoskeletal system. Discuss body part(s) affected, systems, and treatment and prevention, as well as other pertinent and interesting facts. Use the Internet to gather your information. Present your finding by writing an article that would appear in a magazine or newspaper.

Bones in Space
Weakening of the bones, due to weightlessness in space, is a potential hazard faced by astronauts. Using the Internet, research the effect weightlessness has on bones and how astronauts protect themselves from this problem while in space. Investigate ways in which observations of astronauts in space can aid researchers in understanding the causes of osteoporosis and developing ways to cure and prevent it. Visit NASA’s website to get started: http://science.nasa.gov.
ASSESSMENT QUESTIONS

Q: What is the most important job of the musculoskeletal system?
A: The most important job of the musculoskeletal system is to provide movement or locomotion for the body.
Feedback: Movement occurs when the body signals the muscles to contract. The muscles pull on the bones and joints to cause movement.

Q: How do ligaments and tendons share similar functions?
A: Both are dense connective tissue which attach one part of the musculoskeletal system to another.
Feedback: Tendons, however, attach muscle to bone, while ligaments attach bone to bone.

Q: _______ provide the bones with nutrients.
   (a) Blood vessels
   (b) Red blood cells
   (c) Ligaments
   (d) Osteocytes
A: (a)
Feedback: Spaces between the hard components of the bone provide channels for the blood vessels to pass through.

Q: What determines whether bones are compact or spongy?
A: The distribution of spaces within the bone.
Feedback: These spaces make the bone lighter.

Q: Blood cell production occurs in the__________.
   (a) heart
   (b) osteocytes
   (c) red bone marrow
   (d) ligaments
A: (c)
Feedback: Red bone marrow also produces some white blood cells and platelets. The process is called hematopoiesis.

Q: How are bones categorized?
A: Bones are categorized by shape.
Feedback: There are four major types of bones, categorized according to shape. They are long, short, flat, and irregular.

Q: A cast helps bones to heal by immobilizing the two ends of the bone. (True or False)
A: True
Feedback: This immobilization helps the parts of broken bone to stay in appropriate alignment as the bone heals.

Q: Describe the two ways joints are classified.
A: Structural classification of joints is determined by the absence or presence of a joint cavity and the type of connective tissue that binds the bones together. Functional classification of joints is determined by the degree of movement the joint is capable of.
Feedback: The functional classification includes three types of joints: synarthroses, or immovable joints; amphiarthroses, or slightly moveable joints; and diarthroses, or joints that move freely.

Q: _______ is a female hormone that is important for bone growth.
   (a) Progesterone
   (b) Calcium
   (c) Testosterone
   (d) Estrogen
A: (d)
Feedback: Many women lose estrogen as they age. This loss can lead to a condition known as osteoporosis.

Q: Which nutrients are essential to normal bone growth and bone replacement?
A: The body requires sufficient quantities of calcium, phosphorus, and vitamins A, C, and D.
Feedback: Calcium and phosphorus help make bones strong and dense. Vitamin D helps our body absorb calcium and use it in our bones.
ADDITIONAL RESOURCES

Human Anatomy Online
www.innerbody.com

Pennsylvania State University: Biology 129: Skeletal System
www.bio.psu.edu/faculty/strauss/anatomy/skel/skeletal.htm

eMuseum® Minnesota State University, Mankato: The Skeletal System
www.emuseum.mnsu.edu/biology/humananatomy/skeletal/skeletalsystem.html

Community Learning Network: Skeletal System Theme Page
www.cln.org/themes/skeletal.html

Kid’s Health: How the Body Works
http://kidshealth.org/teen
(Search on “skeletal system”)

OTHER PRODUCTS

The Skeletal and Muscular Systems (DVD/VHS)
This program deconstructs the human skeletal and muscular systems, two interdependent assemblies that endow the body with structure and movement. Beginning with an introductory overview, the video identifies the body’s bones by dividing the skeleton into its axial and appendicular components, analyzes bone composition, describes the process of bone repair, and categorizes bone and joint types. The program then shifts focus to the skeletal muscular system—a detailed study of muscle cells, fibers, bundles, and connective tissue. The ATP-fueled process of muscle contraction is addressed as well. A viewable/printable instructor’s guide is available online. A Films for the Humanities & Sciences Production. A part of the series The Human Body: How It Works. (20 minutes) © 2009
Order #: 39510, www.films.com, 1-800-257-5126

The Anatomy of Movement (DVD/VHS)
Gunther von Hagens, the world’s leading expert in human dissection, reveals the kinetic framework of the body in this program—as well as the neural expressway that enables the structure to move. Von Hagens’ dissection shows how the skeleton operates like a system of levers, giving viewers a detailed look at the shape, composition, and mobility of bones, muscles, ligaments, tendons, and cartilage. Special attention is also given to the brain and spinal cord, both of which von Hagens carefully exposes and removes. The cortex, corpus callosum, basal ganglion, and other brain parts are identified, along with the flexibility and protection provided by the spinal column. Viewer discretion is advised. Contains clinically explicit language and demonstrations. A part of the series Anatomy for Beginners. (50 minutes) © 2005

Physiology: Muscles and Bones (DVD/VHS)
This program looks at the human body in motion, studying the interaction of the skeleton and muscles and the ways in which engineers and designers imitate these systems. Demonstrating how bones allow mobility while also providing protection, the program examines skeletal strength, calcium’s importance, the internal structure of bones, and their dependence on muscles for cohesion and power. Linking architecture, machine design, computer science, and other disciplines, this Science Screen Report offers a fresh way of understanding human anatomy. A viewable/printable instructor’s guide is available online. Produced in association with the Accreditation Board for Engineering and Technology and the Junior Engineering Technical Society. (14 minutes) © 2001
Order #: 34125, www.films.com, 1-800-257-5126

Integumentary, Nervous, and Musculoskeletal Systems (CD-ROM, Windows/Mac)
This multimedia CD-ROM highlights the inner workings of the body's integumentary, nervous, and musculoskeletal systems. Engaging graphics and interactive exercises help students master the parts and functions of each system. The program also illustrates how all of these systems are linked with each other. Correlates to National Science Education Standards and National Health Education Standards. A viewable/printable instructor’s guide is available online. A Cambridge Educational Production. © 2004

Systems of the Body Poster Set
Order #: 37009, www.cambridgeeducational.com, 1-800-468-4227