

Skeletal System

Course

Anatomy and Physiology

Unit VI

Skeletal System

Essential Question

What are the tissues and systems of the human body?

TEKS

130.206(c)

1A

2E,2F

4A,4B,4C,4D

5A,5D,5E

7A,7B,7C

10A,10B

Prior Student Learning

Understanding of the cell & tissue biology.

Good understanding of body directional terms.

Estimated time

6-12 hours

Rationale

The skeleton is not just a framework of bones. It serves an attachment for muscles, as support for the body, and as protection for vital organs. Bones also store certain minerals, and contain special cells, that form red and white blood cells. The human body contains 206 bones.

Objectives

Upon completion of this lesson, the student will be able to:

- analyze forces and the effects of movement, torque, tension, and elasticity on the human body;
- define and distinguish terms pertaining to the skeletal system;
- label a diagram of the major bones of the skeletal system;
- analyze diseases and disorders of the skeletal system; and
- observe the structure of bone, bone marrow, and cartilage.

Engage

Discuss the injury of Christopher Reeve. Ask how and why he was hurt.

Why did he need breathing supplemented?

Explain why he could not breathe.

Or

Long Bone Demonstration

Contact the butcher for a long bone. Explain that it should be cut so that the student can easily identify the marrow and the internal parts of the bone.

Use this as an introduction to the skeletal system to spark interest. The long bone will have the following structures visible:

Hyaline cartilage
Compact bone (cancellous)
Spongy bone (compact)
Medullary cavity
Yellow marrow
Red marrow
Periosteum

Don't forget to wear gloves during the demonstration.

Key Points

1. Introduction
 - A. Bony framework of body

- B. 206 bones in adult
- C. Functions
 - 1. Support: body structure and shape
 - 2. Protection: vital organs surrounded
 - 3. Movement and anchorage of muscles (levers for muscular action)
 - a. Tendons: attach muscle to bone
 - b. Ligaments: attach bone to bone
 - 4. Mineral storage: calcium and phosphorus
 - 5. Blood cell formation - hematopoiesis
- 2. Bone Composition
 - A. Collagen: chief organic constituent (protein)
 - B. Inorganic calcium salts (Vitamin D essential for absorption of minerals i.e. calcium)
 - 1. Deposition favored by
 - a. Estrogen, testosterone
 - b. Alkaline phosphatase
 - c. Thyrocalcitonin
 - d. Mechanical stress, i.e. traction
 - 2. Withdrawal favored by
 - a. Alkaline phosphatase
 - b. Parathormone
 - c. Inactivity
 - C. Cells
 - 1. Osteoblasts: bone building, bone repairing cells in the periosteum
 - 2. Osteocytes: mature bone cells within the bone matrix
 - 3. Osteoclast: causes reabsorption of bone
 - D. Periosteum
 - 1. Dense, fibrous membrane covering bone
 - 2. Contains blood vessels
 - 3. Essential for bone cell survival and bone formation
- 3. Types of Bones Based on Composition
 - A. Compact bone
 - 1. Very dense, stress bearing
 - 2. Haversian systems
 - a. Lamellae: concentric cylinder shaped calcified structure
 - b. Lacunae: small spaces containing tissue fluid
 - c. Osteocytes: facilitate exchange of calcium between blood and bone
 - d. Canaliculi: canals connecting the lacunae together and to the haversian canal which carries nutrients and wastes to and from the osteocytes
 - B. Cancellous bone
 - 1. Light, spongy

2. Low stress areas where weight of bone would be a problem
 3. Found at ends of long bones, ribs, sternum, hips, vertebrae, cranium
 4. **No** haversian systems
 5. Web-like arrangement
4. Classification of Bones According to Shape
- A. Long bones (extremities): levers
 1. Epiphysis: at the ends, covered with hyaline cartilage for articulating bones; cancellous bone
 2. Diaphysis: shaft, covered with periosteum; medullary canal with yellow and red marrow (lined with endosteum); covered with periosteum for bone growth, repair, and nutrition; compact bone
 3. Femur, tibia, fibula, humerus, ulna, radius, clavicle
 - B. Short: cube shaped, allows flexible movement
 1. Cancellous bone covered by compact bone
 2. Carpals, tarsals, metacarpals, metatarsals, phalanges
 - C. Flat: flat plates; protect vital organs and provide broad surface area for muscle attachment
 1. Cranial bones, facial bones, scapula, sternum
 - D. Irregular: peculiarly shaped to provide support and protection, yet allow flexibility
 1. Vertebrae, ribs, ear, hip, hyoid
 - E. Sesamoid bones
 1. Extra bones found in certain tendons, i.e. patella
5. Bone Formation
- A. Initially collagen fibers secreted by fibroblasts
 - B. Cartilage deposited between fibers
 - C. Skeleton fully formed by 2nd month of fetal development (all cartilage)
 - D. After 8th week of fetal development ossification (mineral matter deposited and replaces cartilage) begins
 - E. Childhood and adolescence: ossification exceeds bone loss
 - F. Early adulthood thru middle age: ossification equals bone loss
 - G. After age 35: bone loss exceed ossification
 - H. Skull
 1. Begins as fibrous membrane
 2. Ossification center in the middle of the membrane: begins in the middle and radiates out
 3. Ossification not complete at birth: fontanel (soft spots) on infant's head allow molding of skull during birth and with the open joints allows for growth of the brain
 - I. Other bones
 1. Begin as hyaline cartilage

2. Short bones: one ossification center in middle and proceeds toward the periphery
 3. Long bones: three ossification centers (one at each end and one in the center of the shaft) → ossification from center toward each end and from each end toward the center
6. Bone Growth
- A. Grow in length at the epiphyseal line
 - B. Grow in width by the addition of bone to the surface
 - C. Controlled by the anterior pituitary (growth hormone)
 1. Dwarfism: hypofunction
 2. Giantism: hyperfunction
 3. Acromegaly: hyperfunction after puberty; enlarges bones of hands, feet, face
7. Bone Markings
- A. Purpose
 1. Join one bone to another
 2. Provide a surface for attachment of muscles
 3. Create an opening for passage of blood vessels and nerves
 4. Used as landmarks
 - B. Examples
 1. Process: bony prominence or projection
 2. Condyle: a rounded knuckle-like prominence usually at a point of articulation
 3. Epicondyle: small projection
 4. Head: a rounded articulating process at the end of a bone
 5. Spine: a sharp, slender projection
 6. Tubercle: a small rounded process
 7. Tuberosity: a large rounded process
 8. Trochanter: a large process for muscle attachment
 9. Fossa: a depression or hollow
 10. Foramen: a hole
 11. Crest: sharp ridge
 12. Line: a less prominent ridge of a bone than a crest
 13. Meatus: a tube-like passage
 14. Sinus/antrum: a cavity within a bone
 15. Depression: hollow region or opening
 16. Fissure: narrow, slit-like opening
 17. Sulcus: a groove
 18. Facet: a small area on a bone
8. Bone Marrow
- A. Yellow marrow
 1. Medullary cavity of long bones
 2. Fat storage

- B. Red marrow: hematopoietic tissue
 - 1. In all cancellous bone in children
 - 2. In adults: cancellous bone of vertebrae, hips, sternum, ribs, cranial bones, proximal ends of femur and humerus
 - 3. Forms RBCs, platelets, some WBCs, and destroys old RBCs and some foreign materials
- 9. Axial Skeleton
 - A. Skull: 22 bones
 - B. Cranium: houses and protects the brain with 8 bones
 - 1. Frontal: forms forehead and orbits of eyes; supraorbital margins (ridge to protect eyes)
 - 2. Ethmoid: forms roof of nasal cavity, very light bone has horizontal plate, perpendicular plate, and two lateral masses
 - 3. Parietal -- Right and Left: form sides and roof of skull, internal surface rough to accommodate the brain
 - 4. Temporal -- Right and Left: forms temple, cheek, ear openings
 - a. Squamous portion: forms temple
 - b. Zygomatic process: forms cheek
 - c. Petrous portion: forms auditory canal
 - d. Mastoid portion: behind the ear
 - e. Tympanic portion: walls of acoustic meatus
 - 5. Occipital: back of skull, inferior portion has foramen magnum where spinal cord passes through; sides of foramen have two projections (condyles) that articulate with the first cervical vertebra (atlas)
 - 6. Sphenoid: fills space between orbital plates, contains sphenoidal sinuses; upper surface has a depression called the sella turcica, where the pituitary gland rests
 - 7. Wormian Bones: extra bones formed by irregular connections of cranial sutures
 - 8. Cranial Sutures: unite the bones of the cranium; as child grows, irregular bands of connective tissue ossify and turns into hard bone
 - a. Coronal suture: between frontal and parietal bones
 - b. Sagittal suture: between right and left parietal bones
 - c. Lambdoidal suture: between parietal and occipital bones
 - d. Squamous suture: between temporal and parietal bones
 - e. Abnormalities
 - (1) Microcephalus: premature fusion

- (2) Hydrocephalus: delayed fusion (increases intracranial pressure)
- 9. Fontanelles: fusion of the cranial bones is not complete at birth, so a space between the bones remains
 - a. Anterior (Bregmatic): "soft spot", closes at 18 months
 - b. Posterior (Occipital): triangular, closes at 2-3 months
 - c. Anteriolateral (Sphenoidal): at 2 temples, closes at 2-3 months
 - d. Posterolateral (Mastoidal): behind ears (2), closes at 1 year
- C. Facial Bones: guard and support the eyes, ears, nose, and mouth; 14 bones
 - 1. Nasal bones (2): form bridge of nose
 - 2. Vomer: forms central nasal septum
 - 3. Maxillary (2): upper jaw bones, fusion occurs before birth (if not, cleft palate occurs), forms roof of mouth, walls of nose, floor of orbitals; body has maxillary sinuses, alveolar process → upper teeth, palatine process → anterior palate; largest bone of the upper face
 - 4. Mandible: lower jawbone, largest bone of face, two perpendicular portions called rami (have 2 processes: condylar process → posterior forms temporal-mandibular joint; coronoid process → anterior for muscle attachment)
 - 5. Zygoma (2): cheek bones
 - 6. Lacrimal (2): small bones form medial wall of eye socket, tear duct passes through, smallest, fragile
 - 7. Palatine (2): forms back roof of mouth and floor of nose, L-shaped
 - 8. Inferior turbinate (2): forms curved ledge inside side wall of nose
- D. Ear Bones: tiny bones in middle ear cavity in temporal bone
 - 1. Malleus (2): the hammer
 - 2. Incus (2): the anvil
 - 3. Stapes (2): the stirrups
- E. Hyoid Bone: u-shaped bone in the neck at the base of the tongue; the only bone that does not touch another bone.
- F. Cranial Sinuses: cavities within the cranium, function as resonance chambers in the production of the voice, decrease weight of skull, lined with mucous membrane
 - 1. Frontal sinuses (2): above eyebrows, open into nasal cavity
 - 2. Ethmoid sinuses (2): between eyes

3. Sphenoidal sinus (1): posterior to ethmoidal sinuses, opens into nasopharynx
4. Maxillary sinuses (2): on either side of nose, opens on lateral wall of nasal cavity

G. Vertebral Column

1. Functions
 - a. Supports trunk and neck
 - b. Protects spinal cord
 - c. Multiple joint spaces allow for bending and twisting
2. Curves: (lateral view) allow for resilience and spring for walking
 - a. Thoracic: present at birth
 - b. Sacral: low back
 - c. Cervical: begins at 3 months when infant first begins to lift head
 - d. Lumbar: begins when child first walks
3. Vertebrae: 26 separated by intervertebral disk to cushion joints for movement
 - a. Body: thick, disk-shaped anterior portion
 - b. Arch: encloses space for spinal cord (neural canal); has 3 processes for muscle attachment (spinous process → dorsally directed, 2 transverse processes)
 - c. Articular processes: provide for articulation with other vertebrae (2 superior and 2 inferior)
 - d. Pedicles (2): originate from body of vertebrae notched to allow spinal cord nerves to pass
 - e. Lamina: posterior wall of vertebrae, weakest point
4. Sections
 - a. Cervical (7): smallest, oblong bodies, wide transverse processes
 - (1) Atlas: 1st cervical vertebra; supports head by articulating with condyles of occipital bone; bony ring with no body; has short wing-like transverse processes; allows forward and backward motion
 - (2) Axis: 2nd vertebra; small body with projection called the odontoid process that acts as the axis of rotation of the skull
 - (3) 3rd, 4th, 5th, and 6th vertebrae forked to cradle strong ligaments of head
 - (4) 7th vertebra has very prominent spinous process called the vertebral prominence that can be felt at the base of the neck
 - b. Thoracic (12): progressively increase in size from

- neck; have long spinous process (pointed downward), 6 articular facets for rib attachment
- c. Lumbar (5): largest and strongest, have short projections for muscle attachment
- d. Sacral: 5 fused bones, triangular, forms dorsal part of pelvis, joins ileum bone at iliosacral joint
- e. Coccyx: 3-4 fused bones, articulates with tip of sacrum, slightly movable (to assist in childbirth)
- 5. Injuries and Diseases
 - a. Kyphosis: hunchback, posterior thoracic exaggerated
 - b. Lordosis: swayback, exaggerated anterior curve of lumbar region
 - c. Scoliosis: lateral curvature of the spine
 - d. Fractures & Dislocations: most often if fracture of lamina, can cause spinal cord damage, paralysis
 - e. Intervertebral disk herniation: causes pressure on spinal nerve, pain
 - f. Tuberculosis of spine: by tubercle bacillus, destroys body of vertebrae
- H. Thorax: 25 bones and cartilage; walls covered by skin and muscles; floor is formed by the diaphragm
 - 1. Functions
 - a. Protect and support heart and lungs
 - b. Supports bones of pectoral girdle
 - c. Plays a leading role in respiration
 - d. Ribs and sternum aid in RBC formation
 - 2. Sternum: breast bone; sword and handle shape
 - a. Manubrium: handle; notched for 1st 7 costal cartilage; articulates with acromium end of clavicle and 1st rib
 - b. Body: blade; notched for 1st 7 costal cartilage
 - c. Xiphoid process: tip; attachment site for diaphragm
 - 3. Costal cartilages: hyaline cartilage connecting ribs to sternum in 1-7 and to anterior ribs in 8-10
 - 4. Ribs (12 pairs): attached posteriorly with vertebrae and anteriorly with costal cartilage
 - a. True ribs: 1st seven pairs
 - b. False ribs: 8-12 (11 and 12 are floating ribs)
- 10. Appendicular Skeleton (126 bones)
 - A. Shoulder Girdle
 - 1. Clavicles (2): collar bones
 - 2. Scapulae (2): shoulder blade
 - B. Upper Extremities
 - 1. Humerus: upper arm

- 2. Radius: thumb side of forearm
- 3. Ulna: little finger side of forearm
- 4. Carpals (8): wrist bones
- 5. Metacarpals (5): hand bones
- 6. Phalanges (14): finger bones
- C. Pelvic Girdle
 - 1. Os coxae (2): contains the acetabulum (hip socket)
 - a. Ilium
 - b. Ischium
 - c. Pubis
 - 2. Sacrum
- D. Lower Extremities
 - 1. Femur: thigh bone
 - 2. Patella: kneecap
 - 3. Tibia: shin bone
 - 4. Fibula: lateral bone of lower leg
 - 5. Tarsals (7): ankle bones
 - a. Talus
 - b. Calcaneus
 - 6. Metatarsals (5): foot bones
 - 7. Phalanges (14): toe bones
- 11. Articulations
 - A. Synarthrotic: immovable
 - B. Amphiarthrotic: limited movement i.e. pubic symphysis, vertebral joints, sacroiliac joint
 - C. Diarthrotic: freely movable
 - 1. Gliding: wrist
 - 2. Pivot: between radius and ulna
 - 3. Ball and socket: hip
 - 4. Hinge: elbow
- 12. Diseases/Disorders
 - A. Arthritis: inflammation of the bones at the joints, usually with pain and changes in bone structure
 - B. Bunion: abnormal lateral displacement of big toe causing inflammation and thickening of the bursa
 - C. Bursitis: inflammation of the bursa, which is a sac or cavity filled with synovial fluid
 - D. Dislocation: the displacement of a bone from a joint, tearing ligaments, tendons, and capsules
 - E. Fracture: a break in a bone
 - 1. Simple
 - 2. Compound
 - 3. Spiral
 - 4. Comminuted
 - 5. Greenstick
 - F. Osteitis: inflammation or infection of the bone

- G. Osteomyelitis: bone infection that involves the bone marrow
- H. Osteoporosis: condition in which bones become softer and more brittle, and thus more liable to fracture due to loss of mineral content; associated with aging
- I. Rickets: condition in which bones fail to calcify and growth is hampered usually due to a deficiency of vitamin D and phosphorus in the diet
- J. Spina bifida: congenital defect in which the vertebrae fail to unite in the midline
- K. Sprain: wrenching of a joint with injury to ligaments

Activity

- I. Color code a diagram of the skeleton (axial and appendicular) then label the structures.
- II. Participate in the Hokie-Pokie Osteokey.
- III. Participate in Paper Bones Game.
- IV. Participate in Bag o' Bones Game.
- V. Participate in Skeletonary Game.
- VI. Complete the Skeletal System and Long Bones Laboratory Investigation.
- VII. Identify anatomical structures of skeletal system on dissected cat. *(This can be accomplished as a virtual tour on the internet, or if your budget allows, the students can dissect cats.)*
- VIII. Research and report on the cause and effect of disease, trauma, and congenital defects on the structure and function of cells, tissues, organs, and systems as well as research technological advances and limitations in the treatment of the skeletal system disorders.

Assessment

Successful identification of skeletal muscles
 Successful completion of activities
 Laboratory Investigation Rubric

Materials

Activity I- Diagram of the skeleton and colored pencils
 Activity II- no outside materials needed
 Activity III- Each group of students will need the following:
 Cardboard Halloween skeleton about four feet long
 Post-it stickers (1/2" x 2") – 25
 List of bones and labeled atlas (from text)
 Activity IV- disarticulated bones from a skeleton model
 Activity V- Modeling clay (2 sticks)
 Deck of cards (1 set) with the name of a bone on each

Desk and chair in front of room
List of bones and atlas

Activity VI –

Prepared slide of hyaline cartilage
Prepared slide of bone
Prepared slide of bone marrow
Microscope for viewing microscope slides
Stereomicroscope
Knife
Long bone from chicken leg - contact local butcher
Dissecting tray
Colored pencils

Activity VII- Dissection Cat 1 for every 2-4 students, and dissection tools
AND/OR computers with internet access

Activity VIII- Computers with internet access

Visit with a local butcher about making some special cuts on some cow joint
and long bones in order to show layers and function.

Utah State Office of Education, (2005). *Medical Anatomy and Physiology
Teacher Resource CD*. Utah.

Accommodations for Learning Differences

For reinforcement, the student will make flashcards of key terms.

For enrichment, the student will research and report on how forensic
scientists use the skeletal system when investigating homicides.

National and State Education Standards

National Health Science Cluster Standards

HLC01.01 Academic Foundations

Health care workers will know the academic subject matter required (in
addition to state high school graduation requirements) for proficiency within
their area. They will use this knowledge as needed in their role.

HLC10.01 Technical Skills

Health Care Workers will apply technical skills required for all career
specialties. They will demonstrate skills and knowledge as appropriate.

TEKS

130.206(c)

130.206(c)(1)(A) demonstrate safe practices during laboratory and field
investigations;

130.206(c)(2)(E) plan and implement descriptive, comparative, and
experimental investigations, including asking questions, formulating testable
hypotheses, and selecting equipment and technology;

130.206(c)(2)(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;

130.206(c)(2)(H) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports;

130.206(c)(4)(A) analyze the chemical reactions that provide energy for the body;

130.206(c)(4)(D) analyze the effects of energy excess in disorders such as obesity as it relates to cardiovascular and musculoskeletal systems;

130.206(c)(5)(A) explain the coordination of muscles, bones, and joints that allows movement of the body;

130.206(c)(5)(D) analyze and describe the effects of pressure, movement, torque, tension, and elasticity on the human body;

130.206(c)(5)(E) perform an investigation to determine causes and effects of force variance and communicate findings;

130.206(c)(7)(A) illustrate conduction systems such as nerve transmission or muscle stimulation;

130.206(c)(7)(B) investigate the therapeutic uses and effects of external sources of electricity on the body system;

130.206(c)(7)(C) evaluate the application of advanced technologies such as electroencephalogram, electrocardiogram, bionics, transcutaneous electrical nerve stimulation, and cardioversion;

130.206(c)(10)(A) analyze the relationships between the anatomical structures and physiological functions of systems, including the integumentary, nervous, skeletal, musculoskeletal, cardiovascular, respiratory, gastrointestinal, endocrine, and reproductive;

130.206(c)(10)(B) evaluate the cause and effect of disease, trauma, and congenital defects on the structure and function of cells, tissues, organs, and systems; and

130.206(c)(10)(C) research technological advances and limitations in the treatment of system disorders.

Texas College and Career Readiness Standards

English Language Arts

II. B. Understand new vocabulary and concepts and use them accurately in reading, writing, and speaking.

III. B. Develop effective speaking styles for both group and one-on-one situations.

IV. A. Apply listening skills as an individual, and as a member of a group in a variety of settings.

IV. B. 2. Listen actively and effectively in one-on-one communication situations.

Science

1.A.1. Utilize skepticism, logic, and professional ethics in science.

1.A.2. Use creativity and insight to recognize and describe patterns in natural phenomena.

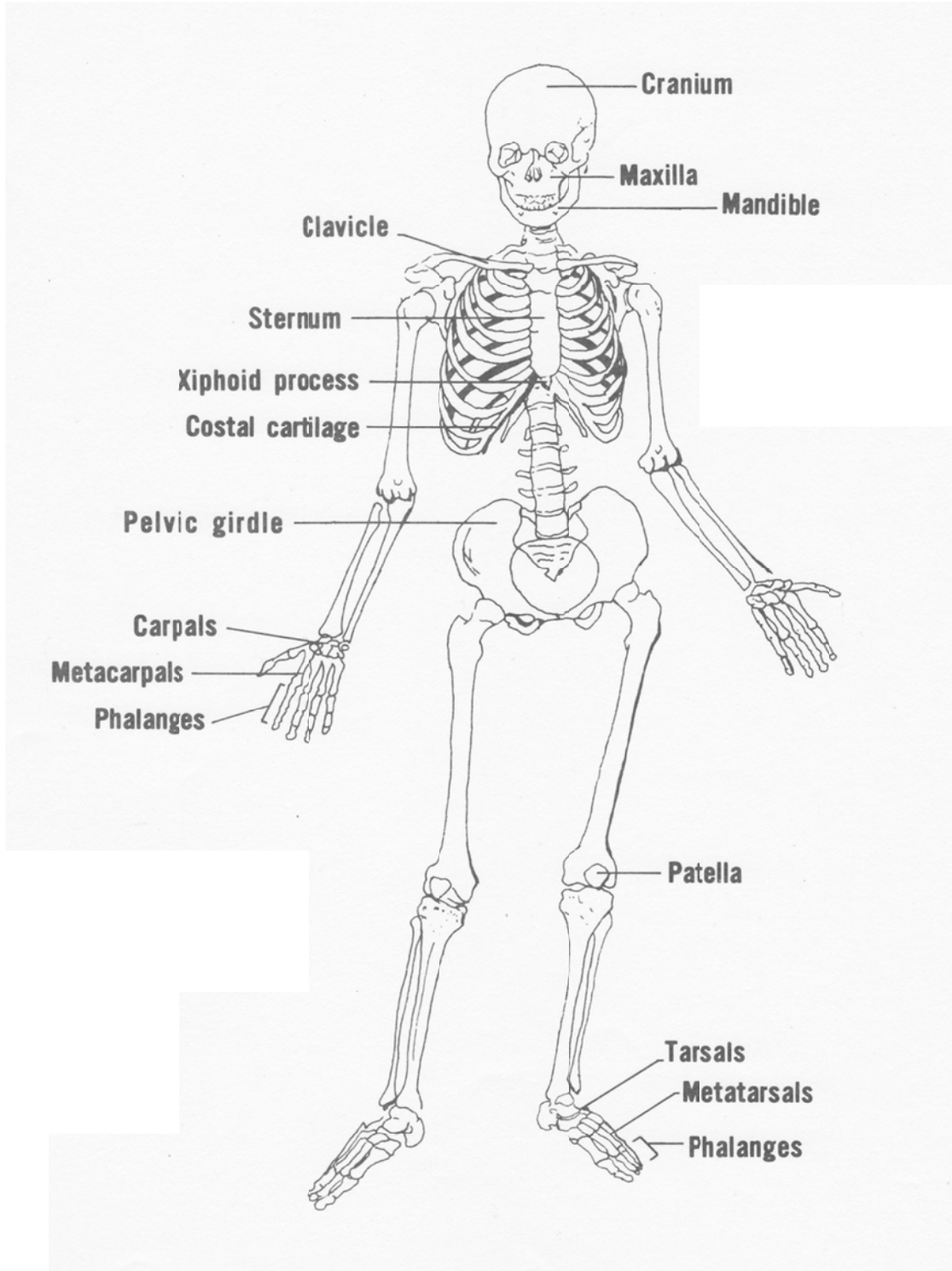
1.A.3. Formulate appropriate questions to test understanding of a natural phenomenon.

1.A.4. Rely on reproducible observations of empirical evidence when constructing analyzing, and evaluating explanations of natural events and processes.

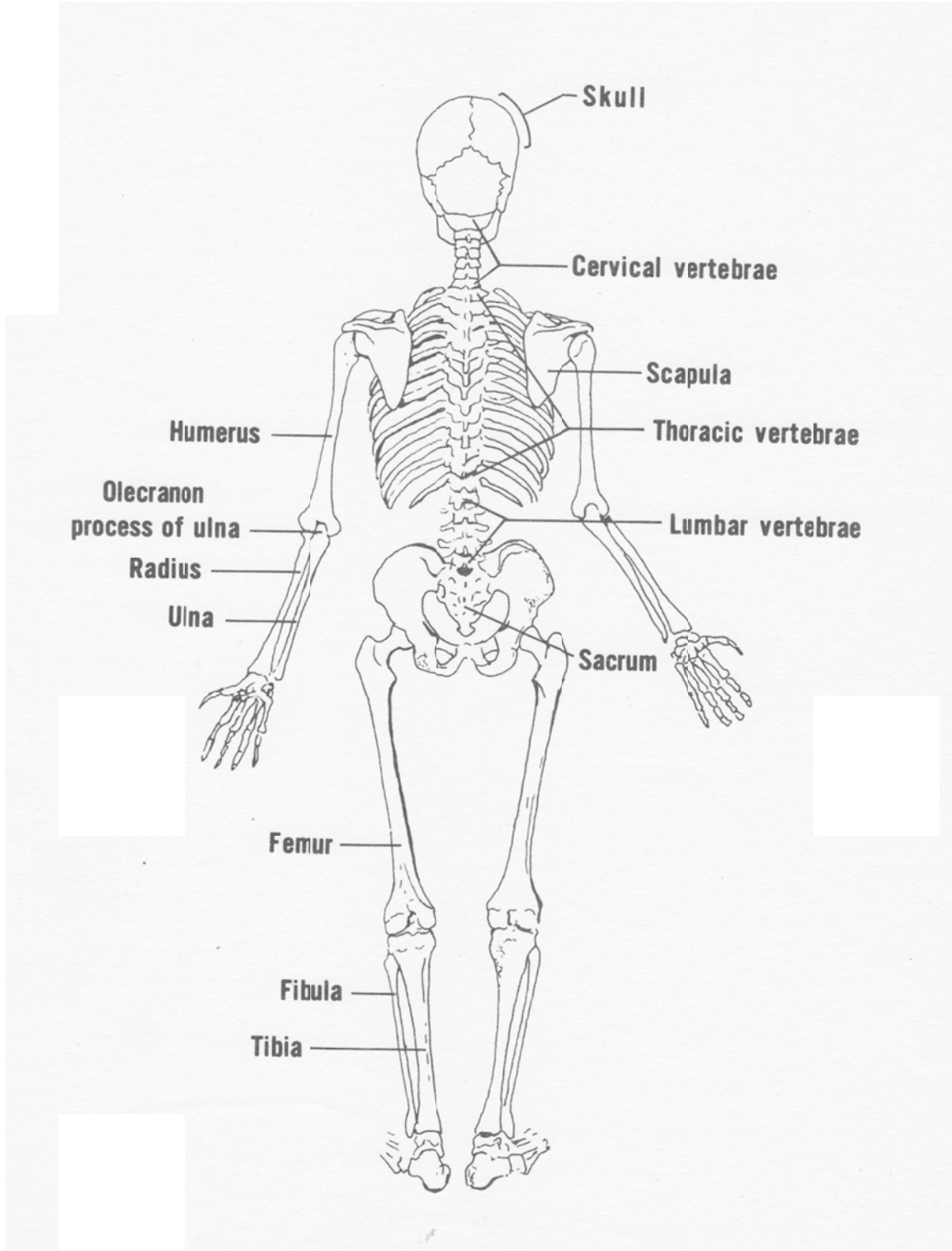
1.E.2. Use essential vocabulary of the discipline being studied.

3.A.1. Use correct applications of writing practices in scientific communication

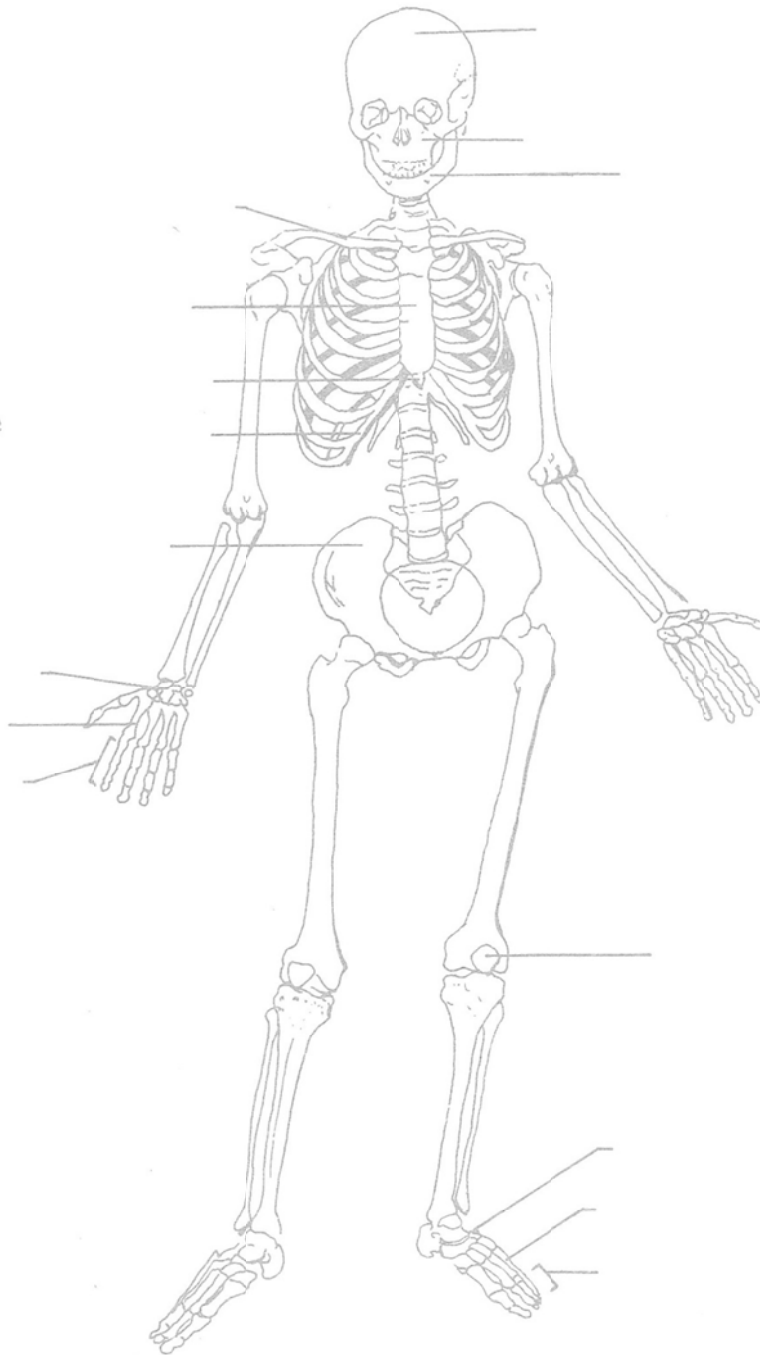
Skeleton, Anterior View



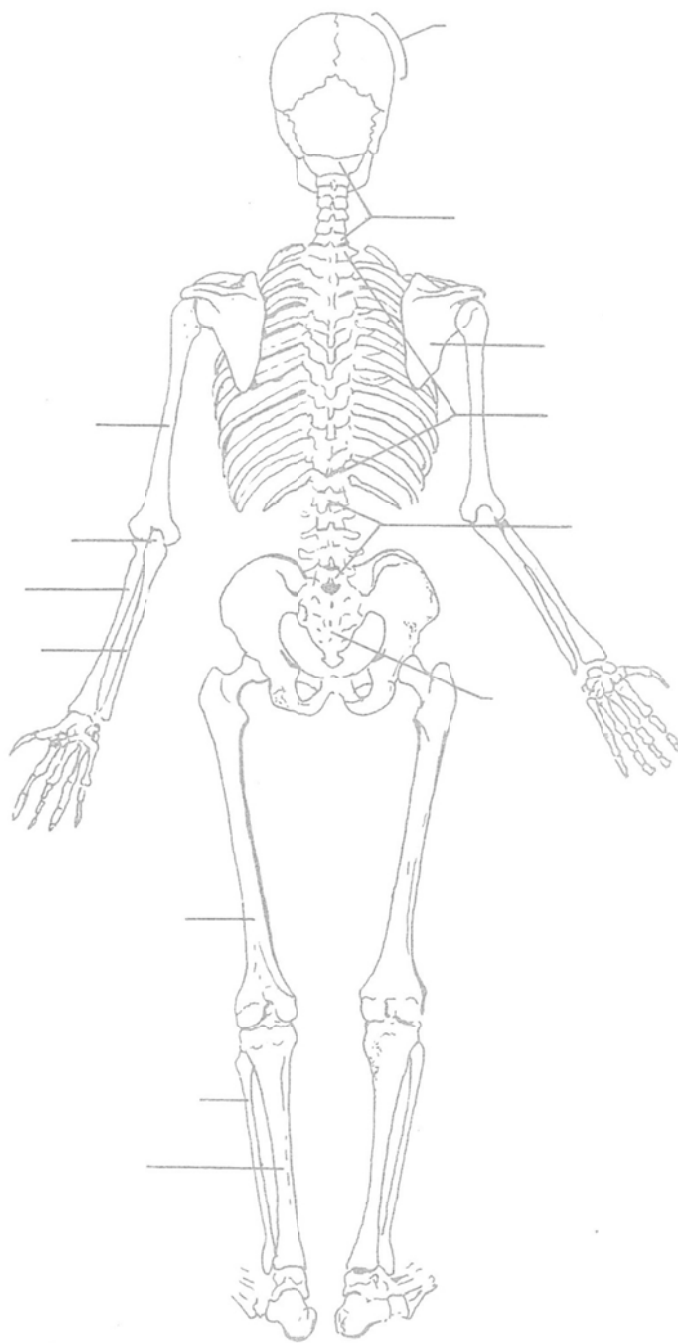
Skeleton, Posterior View



Label the Skeleton, Anterior View



Label the Skeleton, Posterior View



Activity: Hokie-Pokie Osteokey

Objective:

Help students practice location of bones.

Instructions:

1. Write the following anatomical terms on the board:

Phalanges (hands)
Left patella
Right humeral head
Olecranon
Coccyx
Left ulna
Right tarsals
Left innominate
Cranium
Right tibia
Left calcaneus
Mandible
Right radius
Left great toe
Right parietal
Right carpals
skeleton

2. Ask students to stand. (It's fun to get everyone in a circle.)
3. Have everyone sing Hokey-pokey song and substitute bones on board for usual body parts.

“Put your phalanges in. Take your phalanges out.
Put your phalanges in and shake them all about.
Do the hokey-pokey and turn yourself around. That's what it's all about!”

Clap, Clap.

Paper Bones

Objective: Label bones on a cardboard “Halloween-type” skeleton

Materials: Each group of students will need the following:

1. Cardboard Halloween skeleton about four feet long
2. Post-it stickers (1/2” x 2”) – 25
3. List of bones and labeled atlas (from text)

Warm-up

1. Break the class into groups of 3 or 4 (no more)
2. Give each group the materials above and tell them to choose a place to work together (table top or floor)
3. Give them ten minutes to correctly label all the bones they can find on the list
4. Have each group present their labeled skeleton while the class critiques and gives feedback. The students are encouraged to defend their choices using the reference atlas. The instructor is the referee.
5. Repetition of this process for each group reinforces the learning.

Competition

1. Have each group choose a team name (related to anatomy, e.g., Patellas)
2. Each group prepares to start the exercise over but without the atlas.
3. This time they must label the skeleton as quickly as possible while they are being timed. Give them a few minutes to organize task assignments before starting. Be sure they do not fill out the label beforehand.
4. Give the starting signal and keep track of the time.
5. Instruct them that when finished they should signal completion by standing up and holding the labeled skeleton up.
6. Note times and finishing order on the board.
7. Have the groups represent their labeling results in order with group critique.
8. Score by adding 10-15 seconds per error to their elapsed time.
9. The team with the fastest resulting time wins.
10. Present an award.

Comment

Be certain that most of the bones are accurately portrayed on the cardboard skeleton. If there is an error, point it out before play starts and agree to call it something.

Bag o' Bones

Objective: Identify a bone in a bag by touch only

Materials: 1. A set of disarticulated bones
2. Pillowcase

1. Divide the students randomly into two teams and decide on team names (anatomy names).
2. The instructor places a bone into the pillowcase in such a manner that the students cannot see it (students can be asked to put their heads down, or the instructor can select the bone behind a cabinet door).
3. Flip a coin to determine which team starts. That team puts forth the first player to represent them.
4. The student player is given the choice of feeling the bone inside the bag or feeling the bone from the outside (which is more difficult through the cloth). Award one point for inside and two points for outside examination.
5. Give the student only 10 seconds (you can vary this according to the skill of your students) to feel the bone, counting during the examination.
6. After withdrawing his hand, the student is given another 10 seconds to announce the name of the bone.
7. If the student chooses to examine the bone from outside the bag, he is given only 5 seconds and then 5 seconds to announce the bone name.
8. If correct, the instructor takes the bone out of the bag and awards the points accordingly (1 point for in-bag exam or 2 points for external exam).
9. Ask the student to point out what features caused them to decide on the bone name.
10. If the bone named is incorrect, the instructor give an opportunity to a student on the other team and that team may now reap the points. The process continues to alternate from one team to the other until it is correctly identified. Obviously the chance for success becomes greater with each wrong answer put forth. Eventually someone will identify the bone.
11. The instructor (or a designated student) keeps track of the team scores.
12. After every student has had at least one turn, the game is finished and a winner declared.

Comments

This game should only be played when the class is fairly familiar with the bones and their surface features. It is a good opportunity to point out features like the hinge-like joint on the proximal end of the ulna that help differentiate this bone from the radius. The process also reinforces some of the anatomic features like the tibia is much thicker than fibula. It is best to use the long bones and the irregular bones. Small bones (carpals, tarsals, and phalanges) are difficult to exactly identify. Vertebrae can be a challenge, but it is possible to state from what region on the spine the bone comes from (cervical, thoracic).

Skeletonary

Objective: Make clay images of the bones

Materials:

1. Modeling clay (2 sticks)
2. Deck of cards (1 set) with the name of a bone on each
3. Desk and chair in front of room
4. List of bones and atlas

Competition

1. Divide the class into two equal groups and have them sit on opposing sides.
2. Have each team choose a name.
3. Flip a coin to decide which team will go first and then have the team choose one member to start. This person comes to the front of the class.
4. The student randomly chooses a card from the deck of bones and shows it to the teacher.
5. For one point, the student must identify the bone on the atlas (unseen by the class).
6. Sitting at the desk, in front of the room, the student has 30 –40 seconds to mold the clay into a suitable representation of the selected bone.
7. The team members then have 30 seconds to make three guesses. If correct, the team gets one more point.
8. If not guessed correctly, the other team has an opportunity to guess once and get the point.
9. Then the student-sculptor is given an additional question by the teacher related to the selected bone. If answered correctly, the team gets one more point. Maximum points are three per turn.
10. The other team then takes a turn.
11. The team with the highest score wins and each team member gets an award.

Additional Rules

1. The sculptor may not speak during their clay rendition. Speaking nullifies the point.
2. The sculptor may hold the clay model to their body to show its location.
3. Any sculpted form is allowable to give the hint. More than one bone may be made and the sculptor can then point to the unknown bone.

Comments

This game develops psychomotor skills and encourages creativity in remembering features of the bones. For instance, the sculptor with the task of communicating the metacarpal may take all five of them with the attached phalanges or carpal bones and then point to the metacarpals. Kids get creative.

Skeletal System and Long Bones Laboratory Investigation

Purpose:

In this lab, students will observe closely the structure of bone and cartilage. Students will also observe closely the structure of long bones and become familiar with bone marrow.

Background Information:

Materials:

Prepared slide of hyaline cartilage
Prepared slide of bone
Prepared slide of bone marrow
Microscope for viewing microscope slides
Stereomicroscope
Knife
Long bone from chicken leg
Dissecting tray
Colored pencils

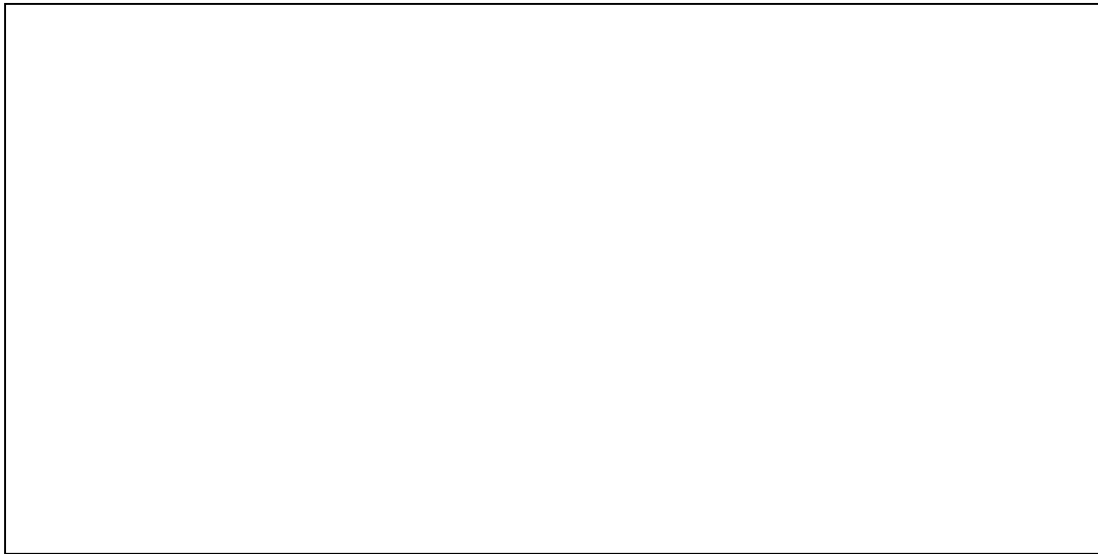
Procedure and Observations:

I. Observing the Structure of a Long Bone

1. Obtain a long bone of a chicken leg and place it in a dissecting tray. Observe the outside covering and features of the bone. Note the smooth covering at both ends of the bone. Also notice the presence of small holes along the surface of the bone. Describe the surface of the chicken leg bone.
2. With a knife, cut one end of the bone to expose the fine structure of the spongy bone and some bone marrow. *Be careful when handling the knife. Be sure to cut in a direction away from your hands and body. If you are having trouble cutting, see your instructor for help.*
3. Using your book for a diagram of the long bone as a guide, continue to observe the chicken bone. For better observation of structures, you will want to use a dissecting microscope at this point. Observe the *periosteum*, which covers and protects bone. Beneath the periosteum is a hard dense layer called *compact bone*. Notice the softer *spongy bone* is near the ends of the bone. Spongy bone contains many small spaces.

In long bones the spongy bone also contains *red marrow*, which produces red and white blood cells. Note the internal cavity of the bone, which may contain some fat-storing *yellow marrow*. On the outer edge of the end of the bone, find the plate of *articular cartilage*. Remember that this cartilage helps in bone movement. Each of the wide ends of a long bone is called the *epiphysis*, whereas the long shaft of the bone is called the *diaphysis*.

4. Sketch the internal structure of the chicken leg bone. Label the *periosteum*, *compact bone*, *spongy bone*, *red marrow*, *yellow marrow*, *articular cartilage*, *epiphysis*, *diaphysis*.



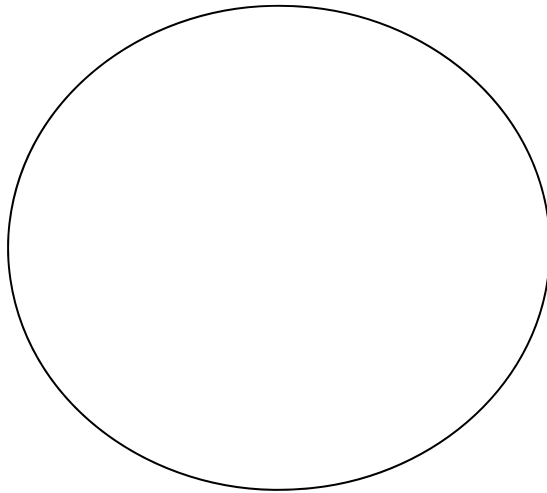
5. Answer the following questions about the chicken leg bone.
- a. Why is it necessary that the ends of the bones be smooth?

 - b. What is the function of the small holes in the bone surface?

 - c. What is the importance of compact and spongy bone?

II. Observing Cartilage, Bone and Bone Marrow

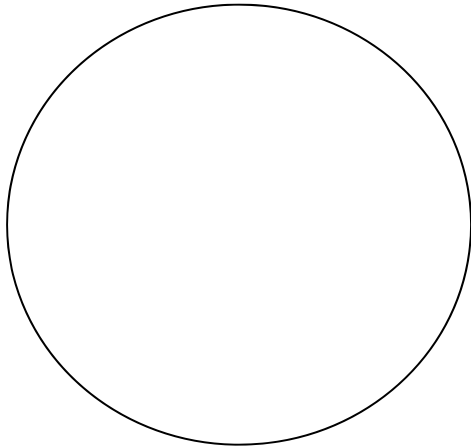
1. Cartilage is more flexible than bone, thus it can take a great deal of stress. Live cartilage cells, called *chondrocytes*, are found in cavities called *lacunae*. Cartilage contains no blood vessels. Materials enter and exit the chondrocytes by diffusion to and from the blood vessels in adjacent layers of tissue. *Hyaline cartilage* is composed of close collagen fibers, making it tough and slightly flexible. Hyaline cartilage is found on the articular surfaces of bones. It also connects the ribs to the sternum and is the chief component of the embryonic skeleton.
2. Obtain a slide of *hyaline cartilage*. Note the *chondrocytes* within the *lacunae*. The collagen fibers are too fine to be seen using ordinary staining procedures and ordinary microscopes. Look around the slide and assure yourself that the cartilage is indeed avascular.
3. Draw the hyaline cartilage. Be sure and label the *chondrocyte* and the *lacunae*.



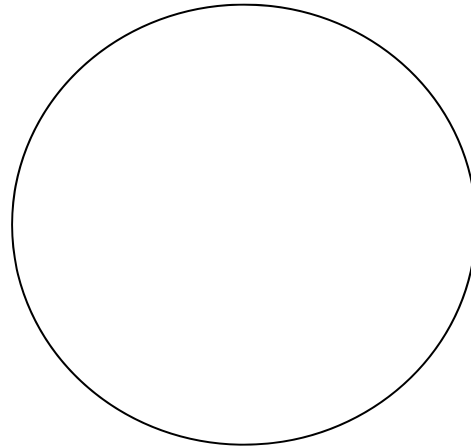
4. Bone is the hard tissue chemically identified by crystals of *calcium phosphate* or *calcium carbonate*. The calcium salts are quite strong but are brittle. The main component of the rest of bone is *collagen*. Collagen fibers are long, straight, unbranched, three-ply protein chains that are highly flexible. Since the calcium salts are organized around the collagen fibers, the combined portions of the osseous tissue exhibit the best of both worlds. The result is a strong, flexible and relatively shatter resistant structure. Remember back to the histology unit when we studied about bones. We learned about the *Haversian systems* which are responsible for supplying the bone with nutrients and removing wastes. Making up the bone are many thin, concentric circles known as *lamella*. The black spaces within the lamella are the *lacunae*, wherein reside the *osteocyte or bone cell*. The *canaliculi* are the canals running between the lacunae. In addition to housing the cytoplasmic streamers of the osteocytes, the canaliculi serve as

the passageway for the osteocytic nutrients and waste products. Within the *central canal* or the *Haversian canal*, are the blood vessels of the bone. The Haversian vessels and canals are longitudinal. The bone also contains transverse vessels found in the transverse *perforating canals* (or Volkmann's canals or communicating canals).

5. Obtain a prepared slide of ground bone tissue. (The term "*ground*" means the tissue proper. In other words, the bone is complete with a matrix and assorted landmarks.) Sketch what you see. Label the *lamella*, *lacuna*, *canaliculi*, and the *Haversian canal*.



Bone



Bone Marrow

6. Bone marrow is the region in which blood cells are made. Even though we have not studied hemopoiesis in detail, try to identify some of the tissues and cells that you see. Refer to the lesson on blood and see how much you can actually identify. Draw, in the circle above, and label what you see.
7. Answer the following questions about the microslides.
- Why is red bone marrow important?
 - How is cartilage similar to bone?
 - How do cartilage and bone differ?

Laboratory Investigation Rubric

Student: _____

Course: _____

Date: _____

Scoring Criteria	4 Excellent	3 Good	2 Needs Some Improvement	1 Needs Much Improvement	N/A
Problem is appropriately identified.					
Problem is precise, clear, and relevant.					
Association between the problem and the predicted results is direct and relevant.					
All variables are clearly operationalized.					
Demonstrates comprehension of the use of scientific concepts and vocabulary.					
All significant data is measured.					
Data is recorded effectively and efficiently.					
Conclusion relates directly to hypothesis.					
Conclusion has relevancy in resolution of the original problem.					
Conclusion relates the study to general interest.					