

CHAPTER 7: SKELETAL SYSTEM

I. INTRODUCTION

The organs of the skeletal system include the bones and the structures that connect bones to other structures, including ligaments, tendons, and cartilages.

II. BONE STRUCTURE:

Bones are classified according to their **shape**:

A. **Long bones** consist of a shaft with two ends.

1. Examples include:

- a. thigh bone = femur,
- b. upper arm bone = humerus.

B. **Short bones** are cube-like.

1. Examples include:

- a. wrist bones = carpals,
- b. ankle bones = tarsals.

C. **Flat bones** are thin and usually curved.

1. Examples include:

- a. most skull bones,
- b. breast bone = sternum,
- c. shoulder blades = scapulae,
- d. ribs.
- e. see H below

D. **Irregular bones** are not long, short, or flat.

1. Examples include:

- a. vertebrae,
- b. auditory ossicles.

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- E. **Sesamoid bones** develop within a tendon.
 - 1. The patella is a human sesamoid bone.

- F. **Wormian bones** (or sutural bones) are tiny bones within the skull that lie between major skull bones.

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II. BONE STRUCTURE

G. Parts of a Long Bone

1. **Diaphysis** = shaft.
 - a. consists of a central medullary cavity (filled with yellow marrow)
 - b. surrounded by a thick collar of compact bone.
2. **Epiphyses** (pl) = expanded ends.
 - a. consist mainly of spongy bone
 - b. surrounded by a thin layer of compact bone.
3. **Epiphyseal line** = remnant of epiphyseal disk/plate.
 - a. cartilage at the junction of the diaphysis and epiphyses (growth plate).
4. **Periosteum** = outer, fibrous, protective covering of diaphysis.
 - a. richly supplied with blood & lymph vessels, nerves (nutrition):
 - **Nutrient Foramen** = perforating canal allowing blood vessels to enter and leave bone.
 - b. Osteogenic layer contains osteoblasts (bone-forming cells) and osteoclasts (bone-destroying cells);
 - c. serves as insertion for tendons and ligaments.
5. **Endosteum** = inner lining of medullary cavity.
 - a. contains layer of osteoblasts & osteoclasts.
6. **Articular cartilage** = pad of hyaline cartilage on the epiphyses where long bones articulate or join.
 - a. "shock absorber".

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LONG BONE STRUCTURE SUMMARY (Keyed at the end of this outline)

LONG BONE PART	DESCRIPTION	FUNCTION

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II. BONE STRUCTURE

H. Flat bones

1. covered by periosteum-covered compact bone;
 2. surrounding endosteum-covered spongy bone.
 3. In a flat bone, the arrangement looks like a sandwich:
 - spongy bone (meat), sandwiched between
 - two layers of compact bone (bread).
- * **Hematopoietic tissue** (red marrow) is located in the spongy bone within the epiphyses of long bones and flat bones.

I. Chemical Composition of Bone (both organic and inorganic)

1. Organic components (35%):

a. Cells:

○ osteoprogenitor cells

1. derived from mesenchyme,
2. can undergo mitosis and become osteoblasts.

○ osteoblasts

1. form bone matrix by secreting collagen,
2. cannot undergo mitosis.

○ osteocytes

1. mature bone cells derived from osteoblasts;
2. principle bone cell,
3. cannot undergo mitosis,
4. maintain daily cellular activities (i.e. exchange of nutrients & wastes with blood).

○ osteoclasts

1. functions in bone resorption (i.e. destruction of bone matrix),
2. important in development, growth, maintenance & repair of bone.

b. Osteoid

- primarily **collagen** which
- gives bone its high tensile strength.
- Also contains glycolipids and glycoproteins

2. Inorganic component (65%):

a. Hydroxyapatite (mineral salts), which is primarily

- **calcium phosphate** $[\text{Ca}_3(\text{PO}_4)_2(\text{OH})_2]$ which
- gives bone its hardness or rigidity.

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II. BONE STRUCTURE

J. Microscopic Structure of Compact Bone

1. **Compact Bone** is solid, dense, and smooth.
2. Structural unit = **Haversian system** or Osteon.
 - a. elongated cylinders cemented together to form the long axis of a bone;
 - b. Components of Haversian system:
 - o **osteocytes** (spider-shaped bone cells that lie in "**lacunae**") that have laid down a
 - o matrix of collagen and calcium salts in
 - o concentric **lamellae** (layers) around a
 - o central **Haversian canal** containing
 - o blood vessels and nerves.
 - c. Communicating canals within compact bone:
 - o **Canaliculi** connect the lacunae of osteocytes;
 - o **Volkman's canals** connect the blood & nerve supply of adjacent Haversian systems together.
 1. run at right angles to and connects adjacent Haversian canals.

K. Microscopic Structure of Spongy (Cancellous) Bone

1. consists of poorly organized **trabeculae** (small needle-like pieces of bone)
2. with a lot of open space between them.
3. nourished by diffusion from nearby Haversian canals.

III. BONE DEVELOPMENT AND GROWTH (Osteogenesis/ossification)

A. Introduction

1. The "skeleton" of an embryo is composed of fibrous CT membranes (formed from mesenchyme and hyaline cartilage) that are loosely shaped like bones.
2. This "skeleton" provides supporting structures for ossification to begin.
3. At about 6-7 weeks gestation, ossification begins and continues throughout adulthood.

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III. BONE DEVELOPMENT AND GROWTH (Osteogenesis/ossification)

B. Ossification follows one of two patterns:

Both mechanisms involve the replacement of preexisting CT with bone.

1. **Intramembranous Ossification** is when a bone forms on or within a fibrous CT membrane.
 - a. **Flat bones** are formed in this manner (i.e. skull bones, clavicles);
2. **Endochondral Ossification** occurs when a bone is formed from a hyaline cartilage model.
 - a. **Most bones** of the skeleton are formed in this manner.
 - b. **Primary Ossification** center hardens as fetus and infant.
 - c. **Secondary Ossification** centers develop in child and harden during adolescence and early adulthood.

During infancy and childhood, long bones lengthen entirely by growth at the epiphyseal plates (called longitudinal growth) and all bones grow in thickness by a process called appositional growth.

C. Growth at the Epiphyseal Plate

1. Structure of the Epiphyseal Plate or Disc (4 zones):
 - a. **Zone of resting cartilage**
 - o near epiphysis,
 - o small, scattered chondrocytes,
 - o anchor plate to epiphysis.
 - b. **Zone of proliferating cartilage**
 - o larger chondrocytes that resemble a **stack of coins**,
 - o Chondrocytes divide to replace those that die at the diaphyseal surface of the epiphysis.
 - c. **Zone of Hypertrophic cartilage**
 - o extremely large chondrocytes that are arranged in columns,
 - o maturing cells.

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III. BONE DEVELOPMENT AND GROWTH (Osteogenesis/ossification)

C. Growth at the Epiphyseal Plate

1. Structure of the Epiphyseal Plate or Disc (4 zones):
 - d. **Zone of calcified cartilage**
 - o only a few cells thick,
 - o consists of dead cells because the matrix around them became calcified,
 - o This calcified matrix is destroyed by osteoclasts and is then invaded by osteoblasts and capillaries from the diaphysis.
 - o The osteoblasts lay down bone on the calcified cartilage that persists.
 - o As a result, the diaphyseal border of the plate is firmly cemented to the bone of the diaphysis.
2. The **epiphyseal plate allows for bone lengthening** until adulthood. As a child grows
 - a. Cartilage cells are produced by mitosis on the epiphyseal side of the plate,
 - b. They are then destroyed and replaced by bone on the diaphyseal side of the plate.

* Therefore, the thickness of the plate remains almost constant, while the bone on the diaphyseal side increases in length.
3. The **rate of bone growth** is controlled by:
 - a. **human Growth Hormone (hGH)** from the pituitary
 - b. **sex hormones** from the gonads (see below)
4. Ossification of most bones is **completed by age 25**.

The cartilage of the epiphyseal plate is replaced by bone forming the **epiphyseal line**.

D. Appositional Growth

Along with increasing in length, bones increase in thickness or diameter.

1. occurs in osteogenic layer of periosteum;
2. Osteoblasts lay down matrix (compact bone) on outer surface.
3. This is accompanied by osteoclasts destroying the bone matrix at the endosteal surface.

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IV. BONE FUNCTION

A. Support

1. The bones in legs and pelvis support the trunk,
2. The atlas (1st vertebra) supports the skull, etc.

B. Protection of underlying organs

1. The skull protects the brain,
2. The rib cage protects the heart and lungs, etc.

C. Body Movement

1. Skeletal muscles attached to bones by tendons.
 - a. serve as levers to move bones.

D. Hematopoiesis

1. Definition = Blood Cell Formation
 - a. All blood cells are formed in the red marrow of certain bones.

E. Inorganic Salt Storage

1. Bone stores many minerals
 - a. calcium,
 - b. phosphorus
 - c. others.
2. Also a means of calcium homeostasis
3. See section V: Bone Remodeling and Repair

F. Energy Storage

1. Yellow marrow in the shaft of long bones
2. serve as an important chemical energy reserve.

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V. BONE REMODELING AND REPAIR

Once a bone has been formed, it is continuously being remodeled throughout life. This process involves the action of osteoblasts and osteoclasts, two hormones (calcitonin & parathyroid hormone) and in turn affects blood calcium homeostasis.

A. Rate of Remodeling Varies:

1. Distal femur is replaced every four months.
2. Diaphysis may not be fully replaced during one's lifetime.

B. **Osteoclasts** are large multinucleated cells responsible for bone resorption;

1. secretes lysosomal enzymes that digest the organic matrix;
2. secrete acids that decompose calcium salts into Ca^{++} and PO_4^- ions, which can then enter blood.

C. **Control of Bone Remodeling/ Calcium Homeostasis**

1. involves 2 hormones (negative feedback):

a. **Parathyroid hormone (PTH)**, which is secreted by the parathyroid glands when blood calcium levels are low:

- o stimulates osteoclast activity (resorption of bone occurs), which releases Ca^{++} into the blood;
- o causes kidney tubules to reabsorb Ca^{++} back into the blood
- o causes intestinal mucosa to increase dietary absorption of Ca^{++} and therefore,
- o causes an increase in blood calcium levels (back to normal).

B. **Calcitonin**, which is secreted by the thyroid gland when blood calcium levels are high:

- o inhibits bone resorption, increases osteoblast activity (i.e. causes a deposition of bone matrix);
- o causes the kidney tubules to secrete excess Ca^{++} into the urine and therefore,
- o results in a decrease in blood calcium levels (back to normal).

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V. BONE REMODELING AND REPAIR

C. Control of Bone Remodeling/ Calcium Homeostasis

2. Negative Feedback Loop

Thyroid Gland Hormone: Calcitonin

Stress: blood Ca^{++}

1. Osteoblasts use excess Ca^{++} to lay down bone matrix;
2. Kidney tubules secrete excess Ca^{++} into urine.

□ blood Ca^{++}

Normal Blood Ca^{++}

□ blood Ca^{++}

Stress: □ blood Ca^{++}

1. Osteoclasts reabsorb bone matrix;
2. Kidney tubules reabsorb Ca^{++} back into bloodstream
3. Intestinal mucosa absorbs Ca^{++}

Parathyroid Hormone Parathyroid Glands

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V. BONE REMODELING AND REPAIR

D. Factors Affecting Bone Development, Growth and Repair

1. **Minerals** needed for bone remodeling:
 - Calcium (component of hydroxyapatite matrix);
 - Phosphorus (component of hydroxyapatite);
 - Magnesium (needed for normal osteoblast activity);
 - Boron (inhibits calcium loss);
 - Manganese (needed for new matrix).

2. **Vitamins** needed for bone growth, remodeling, repair
 - **Vitamin D** greatly increases intestinal absorption of dietary calcium & retards its urine loss.
 - a. Deficiency causes rickets in children and osteomalacia in adults.
 - **Vitamin C** helps maintain bone matrix (collagen synthesis)
 - a. Deficiency causes scurvy.
 - **Vitamin A** is required for bone resorption, controls the activity, distribution and coordination of **osteoblasts & osteoclasts** during development.
 - **Vitamin B₁₂** may play a role in osteoblast activity.

3. **Hormones** needed for bone growth & remodeling
 - **Human Growth Hormone (hGH):**
 - a. secreted by pituitary;
 - b. responsible for the general growth of all tissues;
 - Stimulates reproduction of cartilage cells at epiphyseal plate.
 - **Sex hormones**
 - a. estrogens & androgens (testosterone);
 - aid osteoblast activity (i.e. promote new bone growth);
 - also degenerate cartilage cells in epiphyseal plate (i.e. close epiphyseal plate).
 - Estrogen effect is greater than androgen effect,
 - **Thyroid hormones (T₃ and T₄)**
 - a. T₃ = Triiodothyronine
 - b. T₄ = Thyroxine
 - Stimulates replacement of cartilage by bone in epiphyseal plate.
 - **PTH & Calcitonin (discussed previously)**

4. **Exercise** increases bone growth.

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VI. SKELETAL ORGANIZATION - Axial

The skeletal system consists of 206 bones and joints that allow for the many functions discussed above in the overview. In the next sections we will not only name and locate the bones of the skeleton, but we will study the structure of each. That is that many bones contain holes that allow blood vessels and/or nerves to pass through (i.e. foramina), and many bones have distinct markings that allow for attachment of muscles and therefore movement.

The skeleton is divided into two major divisions, an **axial and appendicular** portion.

The **AXIAL skeleton** includes the bones of the skull, hyoid bone, vertebral column and thoracic cage.

The appendicular skeleton includes the **limbs** of the upper and lower extremities, **and** the bones that attach those limbs to the trunk (**pectoral and pelvic girdles**).

We will cover the AXIAL skeleton first.

A. **SKULL** = cranium (brain case) and facial bones:

All the bones of the skull (except the mandible) are firmly interlocked along structures called **sutures**.

*A suture is the area where skull bones fuse together or articulate (join).

1. **Cranium** = brain case or helmet.

The cranium is composed of eight bones including the frontal, occipital, sphenoid, and ethmoid bones, along with a pair of parietal and temporal bones.

a. **Frontal bone** = forehead.

- articulates with parietal bones along **coronal suture**;
- forms superior portion of orbit;
- contains 2 **frontal (paranasal) sinuses**

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VI. SKELETAL ORGANIZATION- Axial

A. SKULL

1. Cranium (continued)

b. **Parietal bones** = behind frontal bone; bulging sides of skull.

o Articulations:

1. anteriorly with frontal bones at **coronal suture**;
2. posteriorly with occipital bone at **lambdoidal suture**;
3. laterally with temporal bones at **squamous suture**;
4. between bones at **sagittal suture**

c. **Occipital bone** = base of skull.

- o articulates with paired parietal bones along the lambdoidal suture;
- o **Foramen magnum** ("large hole") = opening in occipital bone where nerve fibers pass from brain into spinal cord;
- o **Occipital condyles** = rounded processes on either side of foramen magnum which articulate with the first vertebra (atlas).

d. **Temporal bones** lie inferior to parietal bones at squamous suture.

- o **Zygomatic process** = bar-like extension that meets the zygomatic bone;
- o **External auditory meatus** = opening in tympanic region which opens to the inner portions of the ear;
- o **Styloid process** = needle-like extension (attachment for some neck muscles);
- o **Mastoid process** = a rounded process that extends down from mastoid region of temporal bone (attachment for neck muscles).
- o **Mandibular fossa** = depression where mandibular condyle articulates.

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VI. SKELETAL ORGANIZATION- Axial

A. SKULL

1. Cranium (continued)

- e. **Sphenoid bone** = butterfly shaped bone that spans the length of the cranial floor.
 - o lateral portions are wedged between many other skull bones = "keystone";
 - o contains two **sphenoid (paranasal) sinuses**
 - o **Sella turcica** = portion of sphenoid bone which rises up and form a saddle-shaped mass that houses the **pituitary gland**.

- f. **Ethmoid bone** = complex shaped bone composed of two masses on either side of the nasal cavity;
 - o contains two **ethmoid (paranasal) sinuses**;
 - o Cribriform or **horizontal plate** connects two masses of ethmoid bone horizontally;
 - o **Perpendicular plate** projects downward from cribriform plate to form superior portion of **nasal septum**;
 - o **Nasal concha** = delicate scroll-shaped plates that project into nasal cavity;
 - o **Crista galli** = process that extends from horizontal plate that serves as the **attachment for meninges** (membranes) that surround the brain

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VI. SKELETAL ORGANIZATION- Axial

A. SKULL

2. The **facial skeleton** shapes the face and provides attachment for various muscles that move the jaw and control facial expressions.
 - a. **Maxillary bones (maxillae)** = upper jaw.
 - o contains two **maxillary (paranasal) sinuses**;
 - b. **Palatine bones** = complete posterior portion of hard palate;
 - c. **Zygomatic bones** = cheek bones.
 - o **temporal process** projects posteriorly and articulates with the zygomatic process of temporal bone.
 - * These two processes compose the **zygomatic arch**;
 - d. **Lacrimal bones** = median walls of orbit.
 - o Orbit; composed of seven bones.
 - o Contains lacrimal foramen for tear drainage.
 - e. **Nasal bones** = bridge of nose.
 - f. **Vomer** = inferior portion of nasal septum.
 - o The perpendicular plate of the ethmoid bone forms the superior portion of nasal septum;
 - g. **Inferior Nasal Conchae**
 - h. **Mandible** = lower jaw.
 - o largest, strongest bone in the face;
 - o mandibular condyle articulates with the mandibular fossa of the temporal bone at **temporomandibular joint (TMJ)**.
 - o only movable bone in the skull.
3. **Orbit**

B. Hyoid Bone

1. Location: in neck, between lower jaw and larynx; held in place by muscles and ligaments.
2. Function: supports tongue.

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VI. SKELETAL ORGANIZATION- Axial

C. **Infantile Skull-** differs from the adult skull in the following ways;

1. Fontanel
 - soft spots
 - allow “molding” of skull in birth canal
2. Large forehead and small face
3. Larger orbits

D. **Vertebral Column:**

1. 33 infantile or 26 adult irregular bones are divided into **5 regions**:
 - a. **Cervical** region = 7 vertebrae (bones) in neck;
 - atlas
 - axis
 - b. **Thoracic** region = 12 vertebrae in thoracic cavity.
 - c. **Lumbar** region = 5 large vertebrae in abdominal cavity.
 - d. **Sacrum** = 5 fused vertebrae that articulate with coxal bones of pelvis;
 - e. **Coccyx** = 3-5 vertebrae which makeup the tailbone;
2. **4 Curvatures** exist in the Sagittal plane.
 - a. Primary curvatures
 - exist at birth
 - are concave anteriorly
 - **thoracic curvature** is in thoracic region
 - **pelvic curvature** is in the sacral and coccygeal regions
 - b. Secondary curvatures
 - develop during infancy
 - are convex anteriorly
 - **cervical curvature** is in cervical region
 - develops as baby starts to hold up head
 - **lumbar curvature** is in lumbar region
 - develops as baby begins to stand
3. **Intervertebral disk** = protective pad of fibrocartilage between individual vertebra;
 - a. a slightly movable joint.

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VI. SKELETAL ORGANIZATION- Axial

D. Vertebral Column:

4. A Typical Vertebra

- a. **body** = discoid shaped anterior region;
- b. **vertebral arch** = posterior region;
 - o pedicle = short bony posterior projection;
 - o lamina = flattened plates that articulate posteriorly into spinous process;
- c. **vertebral foramen** = opening between body and vertebral arch through which the spinal cord passes;
- d. **spinous process** = midline posterior projection;
- e. **transverse processes** = laterally from pedicle.

5. Specific Structure of Vertebrae:

In lab, you will be able to compare and contrast the structure of vertebra from different regions of the spine.

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VI. SKELETAL ORGANIZATION- Axial

E. **Thoracic Cage** includes the ribs, sternum, thoracic vertebrae, and costal cartilages.

1. **Ribs:**

a. 12 pairs

- o articulate anteriorly with sternum through **costal (hyaline) cartilage**;
- o articulate posteriorly with thoracic vertebrae;
- o Three types:
 1. **True ribs** = upper 7 pairs that articulate directly with sternum;
 2. **False ribs** = remaining 5 pairs of ribs;
 3. **Floating ribs** = 11th and 12th pair;
These ribs do **not** articulate anteriorly.
- o Typical Rib Structure:
 1. Head
 - a. superior facet
 - b. inferior facet
 2. Neck
 3. Tubercle
 - a. articular
 - b. non-articular
 4. Costal Angle
 5. Costal groove
 6. Body

2. **Sternum**

a. Three parts:

- o **manubrium** = upper portion.
 1. resembles handle;
 2. articulates with clavicle.
- o **body** = middle vertical portion;
 1. site where most ribs articulate anteriorly.
- o **xiphoid process** = lower extension from body.

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VII. SKELETAL ORGANIZATION- Appendicular

The appendicular skeleton includes the **limbs** of the upper and lower extremities, **and** the bones that attach those limbs to the trunk (**pectoral and pelvic girdles**):

- A. The **pectoral (shoulder) girdle** connects the upper limbs to the rib cage and consists of two pairs of bones.
 - 1. anterior **clavicles** (2) = collar bones:
 - medial sternal ends;
 - lateral acromial end;
 - provide attachments for many muscles.
 - 2. posterior **scapulae** (2) = shoulder blades:
 - flattened, triangular bones;
 - Glenoid cavity (fossa) = small fossa that articulates with the head of the humerus;
 - Coracoid process = anterior projection of superior portion (looks like a bent finger); attachment for biceps muscle;
 - Acromion = uppermost point of shoulder;
 - Spine = diagonal posterior surface;
 - Body = flattened triangular region;
 - medial & Lateral Border
 - inferior Angle.
- B. **Upper limbs:**
 - 1. **humerus** = upper arm bone:
 - a. typical long bone;
 - b. note location of:
 - proximal head;
 - distal capitulum and trochlea (articulate with radius and ulna, respectively);
 - greater/lesser tubercles;
 - deltoid tuberosity;
 - body;
 - medial/lateral epicondyles;
 - olecranon fossa.

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VII. SKELETAL ORGANIZATION- Appendicular

B. Upper limbs

2. **Radius** = forearm bone on same side as **thumb**;
 - a. Note location of
 - head;
 - neck;
 - radial tuberosity;
 - ulnar notch (distal);
 - styloid process (lateral prominence).
3. **Ulna** = forearm bone on same side as **pinky**;
 - a. Note location of
 - olecranon (process)= prominence of elbow;
 - trochlear notch = receives trochlea of humerus;
 - Coronoid process;
 - head (distal)
 - styloid process (medial prominence).
4. **Hand** – wrist, palm, and fingers
 - a. **Carpus** = 8 carpals (wrist; short) bones.
 - b. **Metacarpus** = 5 metacarpals (hand; long) bones.
 - c. **Phalanges** (plural); phalanx (singular) = finger bone or digit.
 - Thumb (pollex) = 2 digits;
 - Fingers = 3 digits;
 - Total per limb = 14 digits or phalanges.

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VII. SKELETAL ORGANIZATION- Appendicular

C. **Pelvic (hip) Girdle** = connects lower limbs to the vertebral column

1. Composed of a pair of **coxal bones**: coxae

a. which articulate:

- anteriorly at the symphysis pubis, posteriorly with the sacrum.

b. Each coxal bone consists of 3 separate bones during childhood, but these bones are securely fused in adults:

1. **ilium** = largest uppermost flaring portion of coxal bone.

iliac crest = prominence of the hip (i.e. hands on hips).

- The socket that articulates with head of femur is called the **acetabulum**.

- The hole in each coxal bone is called the **obturator foramen**.

2. **ischium** = lowest L-shaped portion of coxal bone (i.e. area we sit on).

- Note ischial spine

3. **pubis** = anterior portion of coxal bone; bladder rests upon it.

- * The pubis (coxal) bones articulate anteriorly at the **symphysis pubis** (fibrocartilage disc).

2. **Greater and Lesser Pelves**

a. Pelvic brim is border between the greater (false) and lesser (true) pelvis

b. Lesser (true) pelvis is passageway for fetus during birth

3. **Differences Between Male and Female Pelves**

a. Female ilium is more flared

b. Female has wider pubic arch

c. Pelvic curvature is flatter in female

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VII. SKELETAL ORGANIZATION- Appendicular

D. Lower Limbs:

1. **Femur** = thighbone:
 - a. largest, longest, strongest bone in skeleton;
 - b. note the location of:
 - head,
 - neck,
 - greater & lesser trochanters,
(attachment for thigh and buttock muscle),
 - linea aspera,
 - lateral & medial condyles (tibia),
 - epicondyles,
 - patellar surface (patella).
2. **Patella** = kneecap; sesamoid bone.
3. **Tibia** = shin bone:
 - a. very strong;
 - b. note location of:
 - medial/lateral condyles;
 - tibial tuberosity;
 - medial malleolus (bulge of ankle).
4. **Fibula** = thin bone lateral to tibia:
 - a. Note the location of:
 - head,
 - lateral malleolus (lateral ankle bulge).
5. **Foot** – ankle, instep, and toes.
 - a. **Tarsus** = 7 tarsal (ankle) bones.

Body weight is carried on 2 largest tarsals:

 - **Talus** = uppermost tarsal which articulates with the tibia and fibula;
 - **Calcaneus** = heel bone.
 - b. **Metatarsus** = 5 metatarsal (foot) bones.
 - c. **Phalanges** = toe bones or digits (14 total).

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SUMMARY TABLE (See partial sample key at the end of the outline)

NAME OF BONE:			
SCIENTIFIC			
COMMON			
AXIAL OR APPENDICULAR SKELETON?			
CLASSIFICATION BY SHAPE			
HOW MANY IN SKELETON?			
SPECIAL FEATURES OR MARKINGS			
SPECIFIC ARTICULATION(S)			
SPECIAL FUNCTIONS			

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SUMMARY TABLE (See partial sample key at the end of the outline)

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VIII. LIFE SPAN CHANGES

- A. Age related skeletal changes are apparent at the cellular and whole body level.
 - 1. Height begins to decrease incrementally at around age 33.
 - 2. Bone loss gradually exceeds bone replacement.
 - After menopause, females lose bone more rapidly than males.
 - By age 70, bone loss between sexes is similar.
 - 3. Fractures increase as bones age.

IX HOMEOSTATIC DISORDERS

- A. Sickle cell disease.
- B. Pituitary dwarfism.
- C. Fractures.
- D. Osteoporosis.
- E. Mastoiditis.
- F. Cleft palate.
- G. Vertebral Disorders.
- H. Cleidocranial dysplasia.
- I. Polydactyly.
- J. Others.

X. CLINICAL TERMS RELATED TO THE SKELETAL SYSTEM

XI. INNERCONNECTIONS of the skeletal system with other organ systems:

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CHAPTER 7: THE SKELETAL SYSTEM

OVERVIEW OF LONG BONE STRUCTURE

LONG BONE PART	DESCRIPTION	FUNCTION
Diaphysis	long shaft of bone; collar of compact bone surrounding medullary cavity filled with yellow marrow (fat storage)	rigidity
Epiphyses	expanded ends of long bone; spongy bone filled with red bone marrow	hematopoiesis; form synovial joints
Periosteum	dense fibrous CT that surrounds outer surface of the bone; inner layer is osteogenic layer composed of osteoblasts & osteoclasts; A nutrient foramen serves as passageway for nutrient artery to penetrate bone.	protection, attachment site for muscles, bone remodeling
Endosteum	inner lining of medullary cavity with osteogenic layer	lining, bone remodeling
Articular cartilage	covers epiphysis	shock absorber, forms synovial joint
Epiphyseal Line	at junction of epiphysis and diaphysis	remnant of growth plate

CHAPTER 7: SKELETAL SYSTEM

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SAMPLE OF BONE SUMMARY TABLES

NAME of bone: SCIENTIFIC	<i>SCAPULA</i>	<i>TEMPORAL</i>	<i>PHALANX</i>
COMMON	<i>SHOULDER BLADE</i>		<i>DIGIT (FINGER)</i>
AXIAL OR APPENDICULAR SKELETON?	<i>APPENDICULAR</i>	<i>AXIAL</i>	<i>APPENDICULAR</i>
CLASSIFICA- TION BY SHAPE	<i>FLAT</i>	<i>FLAT</i>	<i>LONG</i>
HOW MANY IN SKELETON?	<i>2</i>	<i>2</i>	<i>56</i>
SPECIAL FEATURES OR MARKINGS	<i>ACROMION ARTICULATES WITH CLAVICLE; GLENOID FOSSA ARTICULATES WITH HEAD OF HUMERUS; CORACOID PROCESS SERVES AS ORIGIN FOR BICEPS BRACHII; TRIANGULAR; POSTERIOR SPINE;</i>	<i>EXT.AUD.MEATUS FOR EAR CANAL; MASTOID & STYLOID PROCESSES SERVE AS ATTACHMENT FOR NECK MUSCLES, ZYGOMATIC PROCESS ARTICULATES WITH TEMPORAL PROCESS OF ZYGOMATIC TO FORM ARCH</i>	
ARTICULA- TION(S)	<i>SEE ABOVE</i>	<i>SEE ABOVE</i>	<i>WITH ONE ANOTHER TO FORM FINGERS</i>
SPECIAL FUNCTIONS	<i>ATTACHMENT SITE OF UPPER LIMBS; HEMATOPOIESIS</i>	<i>PROVIDES INLET FOR SOUND WAVES, PROTECTION OF SKULL</i>	<i>MANIPULATION</i>