

**I. Unit 5: The Skeletal System**

**A. The Skeletal System**

**1. Parts of the skeletal system**

- a) Bones (skeleton)
- b) Joints
- c) Ligaments
- d) Cartilages

**2. Two subdivisions of the skeleton**

- a) Axial skeleton 80 bones
- b) Appendicular skeleton 126 bones

**3. Functions of Bones**

- a) Support the body
- b) Protect soft organs
- c) Allow movement due to attached skeletal muscles
- d) Store minerals and fats
- e) Blood cell formation - hematopoiesis

**4. Bones of the Human Body**

- a) The adult skeleton has 206 bones
- b) Two basic types of bone tissue
  - (1) Compact bone
    - (a) Homogeneous
    - (b) consists of osteons
  - (2) Spongy bone
    - (a) Small needle-like pieces of bone
      - (i) called trabeculae
    - (b) Many open spaces

**B. Classification of Bones on the Basis of Shape**

**1. Classification of Bones**

- a) Long bones

**a) Long bones**

- (1) Typically longer than they are wide**
- (2) Have a shaft with heads at both ends**
- (3) Contain mostly compact bone**
- (4) Example:**
  - (a) Femur**
  - (b) Humerus**

**b) Short bones**

- (1) Generally cube-shape**
- (2) Contain mostly spongy bone**
- (3) Example:**
  - (a) Carpals**
  - (b) Tarsals**

**c) Flat bones**

- (1) Thin, flattened, and usually curved**
- (2) Two thin layers of compact bone surround a layer of spongy bone**
- (3) Example:**
  - (a) Skull**
  - (b) Ribs**
  - (c) Sternum**

**d) Irregular bones**

- (1) Irregular shape**
- (2) Do not fit into other bone classification categories**
- (3) Example:**
  - (a) Vertebrae**
  - (b) Hip bones (coxal bones)**

**C. Anatomy of a Long Bone**

**1. Diaphysis**

**a) Shaft**

- a) Shaft
- b) Composed of compact bone

**2. Epiphysis**

- a) Ends of the bone
- b) Composed mostly of spongy bone

**3. Periosteum**

- a) Outside covering of the diaphysis
- b) Fibrous connective tissue membrane
- c) Sharpey's fibers (also called perforating fibers)
  - (1) Secure periosteum to underlying bone

**4. Arteries**

- a) Supply bone cells with nutrients

**5. Articular cartilage**

- a) Covers the external surface of the epiphyses
- b) Made of hyaline cartilage
- c) Decreases friction at joint surfaces

**6. Epiphyseal plate**

- a) Flat plate of hyaline cartilage seen in young, growing bone
- b) Epiphyseal line
  - (1) Remnant of the epiphyseal plate
  - (2) Seen in adult bones

**7. Medullary cavity**

- a) Cavity inside of the shaft
  - (1) Contains yellow marrow (mostly fat) in adults
  - (2) Contains red marrow (for blood cell formation) in infants

**D. Bone Markings**

**1. Surface features of bones**

- a) Sites of attachments for muscles, tendons, and ligaments
- b) Passages for nerves and blood vessels

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## 2. Categories of bone markings

- a) Projections or processes - grow out from the bone surface
- b) Depressions or cavities - indentations

## E. Microscopic Anatomy of Bone

### 1. Compact Bone

#### a) Osteon (Haversian system)

(1) A unit of bone containing central canal and matrix rings

(2) Central (Haversian) canal

(a) Opening in the center of an osteon

(b) Carries blood vessels and nerves

(3) Perforating (Volkman's) canal

(a) Canal perpendicular to the central canal

(b) Carries blood vessels and nerves

(4) Lacunae

(a) Cavities containing bone cells (osteocytes)

(b) Arranged in concentric rings

(5) Lamellae

(a) Rings around the central canal

(b) Sites of lacunae

(6) Canaliculi

(a) Tiny canals

(b) Radiate from the central canal to lacunae

(c) Form a transport system connecting all bone cells (osteocytes) to a nutrient supply

(7) Only compact bone has osteons

### 2. Spongy Bone

#### a) Trabeculae

(1) Spongy bone

(2) Gives bone strength, yet reduces weight

(3) Spaces provide a supportive framework for red marrow

#### **F. Formation of the Human Skeleton**

1. In embryos, the skeleton is primarily hyaline cartilage

2. During development, much of this cartilage is replaced by bone

3. Cartilage remains in isolated areas

a) Bridge of the nose

b) Parts of ribs

c) Joints

4. Bone Growth (Ossification)

a) Intramembranous Ossification

(1) Bone forms between two sheet like membranes of connective tissue

(2) Flat bones are formed this way

b) Endochondral Ossification

(1) Hyaline cartilage model is replaced by bone

(2) Epiphyseal plates allow for lengthwise growth of long bones during childhood

(3) New cartilage is continuously formed

(4) Older cartilage becomes ossified

(a) Cartilage is broken down

(b) Enclosed cartilage is digested away, opening up a

(c) Bone replaces cartilage through the action of osteoblasts

(5) Long bones are formed this way

c) Bones are remodeled and lengthened until growth stops

(1) Bones are remodeled in response to two factors

(a) Blood calcium levels

(b) Pull of gravity and muscles on the skeleton

d) Bones grow in width (called appositional growth)

e) Types of Bone Cells

- (1) Osteogenic cells - give rise to osteoblasts that mature**
  - (a) Osteoblasts - bone-forming cells**
  - (b) Osteocytes - mature bone cells**
    - (i) maintain bone and sense bone stress and strain**
- (2) Osteoclasts - bone-destroying cells**
  - (a) Break down bone matrix for remodeling and release of calcium in response to parathyroid hormone (PTH)**
  - (b) Bone remodeling is performed by both osteoblasts and**

### **5. Bone Fractures**

- a) Fracture - break in a bone**
- b) Types of bone fractures**
  - (1) Closed (simple) fracture - break that does not penetrate the skin**
  - (2) Open (compound) fracture - broken bone penetrates through the skin**
- c) Bone fractures are treated by reduction and immobilization**
- d) Repair of Bone Fractures**
  - (1) Hematoma (blood-filled swelling) is formed**
  - (2) Break is splinted by fibrocartilage to form a callus**
  - (3) Fibrocartilage callus is replaced by a bony callus**
  - (4) Bony callus is remodeled to form a permanent patch**

### **G. The Axial Skeleton (80 Bones)**

- 1. Forms the longitudinal axis of the body**
- 2. Divided into three parts**
  - a) Skull**
  - b) Vertebral column**
  - c) Bony thorax**
- 3. The Skull**
  - a) Two sets of bones**
    - (1) Cranium (8 bones)**
      - (a) frontal, 2 parietals, 2 temporals, occipital, sphenoid, ethmoid**

**(2) Facial bones (14 bones)**

**(a) 2 zygomatic, 2 maxillae, 2 palatine, 2 lacrimal, 2, nasal, 2 inferior nasal conchae, vomer, mandible**

**b) Bones are joined by sutures**

**c) Only the mandible is attached by a freely movable joint**

**d) Paranasal Sinuses**

**(1) Frontal, maxillae, sphenoid, and ethmoid bones contain paranasal sinuses**

**(2) Hollow portions of bones surrounding the nasal cavity**

**(3) Functions of paranasal sinuses**

**(a) Lighten the skull**

**(b) Give resonance and amplification to voice**

**(c) Increase surface area for mucus production**

**(d) Humidify and warm inhaled air**

**e) The Hyoid Bone**

**(1) The only bone that does not articulate with another bone**

**(2) Serves as a moveable base for the tongue**

**(3) Aids in swallowing and speech**

**f) The Fetal Skull**

**(1) The fetal skull is large compared to the infant's total body length**

**(2) Fontanel - fibrous membranes connecting the cranial bones**

**(a) Allow the brain to grow**

**(b) Convert to bone within 24 months after birth**

**4. The Vertebral Column**

**a) Each vertebrae is given a name according to its location**

**b) There are 24 single vertebral bones separated by intervertebral discs**

**(1) Seven cervical vertebrae are in the neck**

**(2) Twelve thoracic vertebrae are in the chest region**

**(3) Five lumbar vertebrae are associated with the lower back**

(4) Nine vertebrae fuse to form two composite bones

(a) Sacrum (5 fused)

(b) Coccyx (4 fused)

(i) "Tailbone," or remnant of a tail that other vertebrates have

c) The spine has a normal curvature

(1) Primary curvatures are the spinal curvatures of the thoracic and sacral regions

(a) Present from birth

(2) Secondary curvatures are the spinal curvatures of the cervical and lumbar regions

(a) Develop after birth

#### 5. The Bony Thorax

a) Forms a cage to protect major organs

b) Consists of three parts

(1) Sternum

(a) Manubrium, body (gladiolus), and xiphoid process

(2) Ribs

(a) Attached to thoracic vertebrae

(b) True ribs (pairs 1-7)

(c) False ribs (pairs 8-12)

(d) Floating ribs (pairs 11-12)

#### H. The Appendicular Skeleton

1. Composed of 126 bones

a) Limbs (appendages)

b) Pectoral girdle

c) Pelvic girdle

2. The Pectoral (Shoulder) Girdle

a) Composed of two bones

(1) Clavicle - collarbone



(2) Scapula - shoulder blade

(3) These bones allow the upper limb to have exceptionally

### 3. Bones of the Upper Limbs

#### a) Humerus

(1) Forms the arm

(2) Single bone

#### b) The forearm has two bones

(1) Ulna

(a) Medial bone in anatomical position

(2) Radius

(a) Lateral bone in anatomical position

#### c) The hand

(1) Carpals - wrist

(a) Scaphoid, lunate, triquetrum, pisiform, trapezium, trapezoid, capitate, and hamate

(2) Metacarpals - palm

(3) Phalanges - fingers

### 4. Bones of the Pelvic Girdle

a) Formed by two coxal (ossa coxae) bones

b) Composed of three pairs of fused bones

(1) Ilium

(2) Ischium

(3) Pubis

c) The total weight of the upper body rests on the pelvis

d) It protects several organs

(1) Reproductive organs

(2) Urinary bladder

(3) Part of the large intestine

e) The Pelvis

**(1) Gender Differences of the Pelvis**

- (a) The female inlet is larger and more circular**
- (b) The female pelvis as a whole is shallower, and the bones are lighter and thinner**
- (c) The female ilia flare more laterally**
- (d) The female sacrum is shorter and less curved**
- (e) The female ischial spines are shorter and farther apart; thus the outlet is larger**
- (f) The female pubic arch is more rounded because the angle of the pubic arch is greater**

**f) Bones of the Lower Limbs**

**(1) The thigh has one bone**

- (a) Femur**
- (b) The heaviest, strongest bone in the body**

**(2) The lower leg has two bones**

- (a) Tibia**
  - (i) Shinbone**
  - (ii) Larger and medially oriented**
- (b) Fibula**
  - (i) Thin and sticklike; laterally oriented**

**(3) The foot**

- (a) Tarsals**
  - (i) Two largest tarsals**
    - (a) Calcaneus (heelbone)**
    - (b) Talus**
  - (ii) Navicular, cuboid, lateral cuneiform, intermediate cuneiform, and medial cuneiform**
- (b) Metatarsals - sole**
- (c) Phalanges - toes**
- (d) Arches of the Foot**

**(d) Arches of the Foot**

**(i) Bones of the foot are arranged to form three strong arches**

**(ii) Two longitudinal**

**(iii) One transverse**

**I. Joints**

**1. Articulations of bones**

**2. Functions of joints**

**a) Hold bones together**

**b) Allow for mobility**

**3. Ways joints are classified**

**a) Functional Classification of Joints - how much movement**

**(1) Synarthroses**

**(a) Immovable joints**

**(2) Amphiarthroses**

**(a) Slightly moveable joints**

**(3) Diarthroses**

**(a) Freely moveable joints**

**b) Structural Classification of Joints - how they are made**

**(1) Fibrous joints**

**(a) Generally immovable**

**(2) Cartilaginous joints**

**(a) Immovable or slightly moveable**

**(3) Synovial joints**

**(a) Freely moveable**

**4. Summary of Joint Classes**

**a) Fibrous Joints**

**(1) Bones united by fibrous tissue**

**(2) Example:**

**(a) Sutures**

**(a) Sutures**

**(b) Syndesmoses**

**(i) Allows more movement than sutures**

**(ii) Example: Distal end of tibia and fibula**

**b) Cartilaginous Joints**

**(1) Bones connected by cartilage**

**(2) Example:**

**(a) Pubic symphysis**

**(b) Intervertebral joints**

**c) Synovial Joints**

**(1) Articulating bones are separated by a joint cavity**

**(2) Synovial fluid is found in the joint cavity**

**(3) Articular cartilage (hyaline cartilage) covers the ends of bones**

**(4) A fibrous articular capsule encloses joint surfaces**

**(5) A joint cavity is filled with synovial fluid**

**(6) Ligaments reinforce the joint**

**(7) Structures Associated with the Synovial Joint**

**(a) Bursae - flattened fibrous sacs**

**(i) Lined with synovial membranes**

**(ii) Filled with synovial fluid**

**(iii) Not actually part of the joint**

**(b) Tendon sheath**

**(i) Elongated bursa that wraps around a tendon**

**(8) Inflammatory Conditions Associated with Joints**

**(a) Bursitis - inflammation of a bursa usually caused by a blow**

**(b) Tendonitis - inflammation of tendon sheaths**

**(c) Arthritis - inflammatory or degenerative diseases of joints**

**(i) Over 100 different types**

**(ii) The most widespread crippling disease in the United States**

**(ii) The most widespread crippling disease in the United States**

**(iii) Clinical Forms of Arthritis**

**(a) Osteoarthritis**

**(i) Most common chronic arthritis**

**(ii) Probably related to normal aging processes**

**(b) Rheumatoid arthritis**

**(i) An autoimmune disease - the immune system attacks the joints**

**(ii) Symptoms begin with bilateral inflammation of certain joints**

**(iii) Often leads to deformities**

**(c) Gouty arthritis**

**(i) Inflammation of joints is caused by a deposition of uric acid crystals from the blood**

**(ii) Can usually be controlled with diet**

## **J. Developmental Aspects of the Skeletal System**

**1. At birth, the skull bones are incomplete**

**a) Bones are joined by fibrous membranes called fontanels**

**(1) Fontanels are completely replaced with bone within two years**

**2. Ossification Centers in a 12-week-old Fetus**

**3. Skeletal Changes Throughout Life**

**a) Fetus**

**(1) Long bones are formed of hyaline cartilage - endochondral**

**(2) Flat bones begin as fibrous membranes - intramembranous**

**(3) Flat and long bone models are converted to bone**

**b) Birth**

**(1) Fontanels remain until around age 2**

**c) Adolescence**

**(1) Epiphyseal plates become ossified and long bone growth ends**

**(2) Size of cranium in relationship to body**

- (a) 2 years old - skull is larger in proportion to the body compared to that of an adult**
- (b) 8 or 9 years old - skull is near adult size and proportion**
- (c) Between ages 6 and 11, the face grows out from the skull**

**(3) Curvatures of the spine**

- (a) Primary curvatures are present at birth and are convex posteriorly**
- (b) Secondary curvatures are associated with a child's later development and are convex anteriorly**
- (c) Abnormal spinal curvatures (scoliosis, kyphosis, and lordosis) are often congenital**

**d) Old age**

**(1) Osteoporosis**

- (a) Bone-thinning disease afflicting
  - (i) 50% of women over age 65**
  - (ii) 20% of men over age 70****
- (b) Disease makes bones fragile and bones can easily fracture**
- (c) Vertebral collapse results in kyphosis (also known as dowager's hump)**
- (d) Estrogen aids in health and normal density of a female skeleton**