Our Bones - Introduction

Identify 2 main functions of our skeletal system. Look for ligaments and tendons. What does each connect?

- [https://www.youtube.com/watch?v=ICwLlrQKVcg](https://www.youtube.com/watch?v=ICwLlrQKVcg)

3 min
Skeletal System Overview

Structure
- Skeletal bones
- Bone structure
- Joints

Function
- Support
- Protection
- Makes blood cells
- Stores calcium
- Movement (joints)

https://www.youtube.com/watch?v=2gerXkG_8ME
The Skeletal System

- Two subdivisions of the skeleton
  1. Axial skeleton
  2. Appendicular skeleton

- Parts of the skeletal system
  - Bones (skeleton)
  - Joints
  - Cartilages
  - Ligaments
Role of Our Skeleton

- FRAMEWORK for muscles and organs
- PROTECTS organs
  - Skull (brain)
  - Ribs (lungs, heart)
Bones Make Blood Cells

Blood is produced in the bone marrow.
Bones Store Calcium

- Organic parts of the matrix make bone flexible
- Calcium salts deposited in the matrix make bone hard

[Image: Healthy bone and osteoporotic bone with labels Compact bone and Spongy bone.]

got milk?
Sources of Calcium
Joints Provide Movements
Joint = place where 2 bones meet
Functions of Bones

- Support the body
- Protect soft organs
  - Skull and vertebrae protect brain and spinal cord
  - Rib cage protects thoracic cavity organs
- Attached skeletal muscles allow movement
- Store minerals and fats
  - Calcium and phosphorus
  - Fat in the internal marrow cavity
- Blood cell formation (hematopoiesis)
What is inside of bones?

- Spongy Bone
- Yellow Marrow
- Compact Bone
Bones of the Human Body

- The adult skeleton has 206 bones
- Two basic types of bone tissue
  1. Compact bone
     - Dense, smooth, and homogeneous
  2. Spongy bone
     - Small needle-like pieces of bone
     - Many open spaces
Figure 5.1 Flat bones consist of a layer of spongy bone sandwiched between two thin layers of compact bone.
Classification of Bones

- Bones are classified on the basis of shape, as:
  - Long
  - Short
  - Flat
  - Irregular

(a) Long bone (humerus)
(b) Irregular bone (vertebra), right lateral view
(c) Flat bone (sternum)
(d) Short bone (talus)
Classification of Bones

Long bones

- Typically longer than they are wide
- Shaft with heads situated at both ends
- Contain mostly compact bone
- All of the bones of the limbs are long bones (except wrist, ankle, kneecap)

Examples:

- Femur
- Humerus
Classification of Bones

Short bones

- Generally cube-shaped
- Contain mostly spongy bone
- Include bones of the wrist and ankle
- Sesamoid bones form within tendons (patella)

**Examples:**

- Carpals
- Tarsals
Classification of Bones

Flat bones
- Thin, flattened, and usually curved
- Two thin layers of compact bone surround a layer of spongy bone

Examples:
- Skull
- Ribs
- Sternum

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Classification of Bones

- Irregular bones
  - Irregular shape
  - Do not fit into other bone classification categories

- **Examples:**
  - Vertebrae
  - Hip bones

(b) Irregular bone (vertebra), right lateral view
Label the bone

- Spongy bone
- Compact bone
- Cartilage
- Red bone marrow
- Yellow bone marrow (in adults)
- Blood cells form here
Anatomy of a Long Bone

Diaphysis
- Shaft
- Makes up most of bone’s length
- Composed of compact bone

Periosteum
- Outside covering of the diaphysis
- Fibrous connective tissue membrane
- Perforating (Sharpey’s) fibers secure periosteum to underlying bone
Anatomy of a Long Bone

Epiphysis
- Ends of the bone
- Composed mostly of spongy bone enclosed by thin layer of compact bone

Articular cartilage
- Covers the external surface of the epiphyses
- Made of hyaline cartilage
- Decreases friction at joint surfaces
Anatomy of a Long Bone

Marrow (medullary) cavity
- Cavity inside the shaft
- Contains yellow marrow (fat) in adults
- Contains red marrow for blood cell formation in infants

- In adults, red marrow is situated in cavities of spongy bone and epiphyses of some long bones
Anatomy of a Long Bone

Epiphyseal plate

- Flat plate of hyaline cartilage seen in young, growing bone
- Causes lengthwise growth of long bone

Epiphyseal line

- Remnant of the epiphyseal plate
- Seen in adult bones
Label the bone
Figure 5.3a The structure of a long bone (humerus of arm).

- Proximal epiphysis
  - Articular cartilage
  - Spongy bone
  - Epiphyseal line
  - Periosteum
  - Compact bone
  - Medullary cavity (lined by endosteum)

- Diaphysis

- Distal epiphysis
Figure 5.3b The structure of a long bone (humerus of arm).

Articular cartilage

Compact bone

Spongy bone
Bone Markings

Surface features of bones

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

Categories of bone markings

- Projections or processes—grow out from the bone surface
  - Terms often begin with “T”
- Depressions or cavities—indentations
  - Terms often begin with “F”
Table 5.1 Bone Markings

<table>
<thead>
<tr>
<th>Name of bone marking</th>
<th>Description</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projections that are sites of muscle and ligament attachment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuberosity</td>
<td>Large, rounded projection; may be roughened</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
<tr>
<td>Crest</td>
<td>Narrow ridge of bone; usually prominent</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
<tr>
<td>Trochanter (tro-kan’ter)</td>
<td>Very large, blunt, irregularly shaped process (the only examples are on the femur)</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
<tr>
<td>Line</td>
<td>Narrow ridge of bone; less prominent than a crest</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
<tr>
<td>Tubercle (too’ber-kl)</td>
<td>Small, rounded projection or process</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
<tr>
<td>Epicondyle</td>
<td>Raised area on or above a condyle</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
<tr>
<td>Spine</td>
<td>Sharp, slender, often pointed projection</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
<tr>
<td>Process</td>
<td>Any bony prominence</td>
<td><img src="image" alt="Illustration" /></td>
</tr>
</tbody>
</table>
### Table 5.1 Bone Markings (continued)

<table>
<thead>
<tr>
<th>Name of bone marking</th>
<th>Description</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Projections that help to form joints</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>Bony expansion carried on a narrow neck</td>
<td>![Diagram of Head]</td>
</tr>
<tr>
<td>Facet</td>
<td>Smooth, nearly flat articular surface</td>
<td>![Diagram of Facet]</td>
</tr>
<tr>
<td>Condyle (kon’dil)</td>
<td>Rounded articular projection</td>
<td>![Diagram of Condyle]</td>
</tr>
<tr>
<td>Ramus (ra’mus)</td>
<td>Armlike bar of bone</td>
<td>![Diagram of Ramus]</td>
</tr>
</tbody>
</table>
### Table 5.1 Bone Markings (continued)

<table>
<thead>
<tr>
<th>Name of bone marking</th>
<th>Description</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depressions and openings</strong></td>
<td>For passage of blood vessels and nerves</td>
<td></td>
</tr>
<tr>
<td>Groove</td>
<td>Furrow</td>
<td></td>
</tr>
<tr>
<td>Fissure</td>
<td>Narrow, slitlike opening</td>
<td></td>
</tr>
<tr>
<td>Foramen (fo-ra’men)</td>
<td>Round or oval opening through a bone</td>
<td></td>
</tr>
<tr>
<td>Notch</td>
<td>Indentation at the edge of a structure</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meatus (me-a’tus)</td>
<td>Canal-like passageway</td>
<td></td>
</tr>
<tr>
<td>Sinus</td>
<td>Cavity within a bone, filled with air and lined with mucous membrane</td>
<td></td>
</tr>
<tr>
<td>Fossa (fos’ah)</td>
<td>Shallow, basinlike depression in a bone, often serving as an articular surface</td>
<td></td>
</tr>
</tbody>
</table>
Microscopic Anatomy of Compact Bone

- Osteocytes are situated within cavities known as *lacunae*.
- Lacunae are arranged in concentric rings called *lamellae*.
- Lamellae are rings situated around the central (Haversian) canal.
Figure 5.4a Microscopic structure of compact bone.
Microscopic Anatomy of Bone

Central (Haversian) canal

- Opening in the center of an osteon
- Runs lengthwise through bone
- Carries blood vessels and nerves

Osteon (Haversian system)

- A unit of bone containing central canal and matrix rings
Bone Formation and Growth

Ossification (bone formation)

- **Hyaline cartilage**
  - New center of bone growth
  - Medullary cavity
  - Bone starting to replace cartilage
  - Bone collar
  - Hyaline cartilage model

- **Articular cartilage**
  - In an embryo
  - In a fetus
  - In a child
  - Growth in bone length
  - Growth in bone width
  - New bone forming

- **Spongy bone**
  - Invading blood vessels
  - New bone forming

- **Epiphyseal plate cartilage**
  - Bone collar
  - Hyaline cartilage model
  - New bone forming

- **Spongy bone**
  - Invading blood vessels
  - New bone forming

- **Epiphyseal plate cartilage**
  - Bone collar
  - Hyaline cartilage model
  - New bone forming
Bone Formation and Growth

Two major phases of ossification in long bones

1. Osteoblasts
   - Bone-forming cells
   - Cover hyaline cartilage model

2. Enclosed cartilage is digested away, opening up a medullary cavity
   - By birth, most cartilage is converted to bone except for two regions in a long bone:
     1. Articular cartilages
     2. Epiphyseal plates
   - New cartilage is formed continuously on external face of these two cartilages
   - Old cartilage is broken down and replaced by bony matrix
Figure 5.6 Growth and remodeling of long bones.

**Bone growth**

Bone grows in length because:

1. Cartilage grows here.
2. Cartilage is replaced by bone here.
3. Cartilage grows here.
4. Cartilage is replaced by bone here.

**Bone remodeling**

Growing shaft is remodeled as:

1. Articular cartilage
2. Epiphyseal plate
3. Bone is resorbed here.
4. Bone is added by appositional growth here.
5. Bone is resorbed here.
Bone Formation and Growth

- Bones grow in length and width
  - Appositional growth
    - Growth in diameter
- Controlled by hormones such as growth hormone
- Epiphyseal plates are converted to bone during adolescence
  - Growth in length ends
Bone Remodeling

- Bones are lengthened until growth stops
- Bones are remodeled throughout life in response to two factors:
  1. Blood calcium levels
  2. Pull of gravity and muscles on the skeleton
- Parathyroid hormone (PTH)
  - Released when blood calcium levels are low
  - Activates osteoclasts (bone-destroying cells)
  - Osteoclasts break down bone and release calcium ions into the blood
- Hypercalcemia (high blood calcium levels) prompts calcium storage to bones
Bone Fractures – break in a bone

Types of bone fractures

- Closed (simple) fracture: break that does not penetrate the skin
- Open (compound) fracture: broken bone penetrates through the skin
Bone Fractures

Bone fractures are treated by reduction and immobilization

- Closed reduction: bones are manually coaxed into position by physician’s hands
- Open reduction: bones are secured with pins or wires during surgery
Repair of Bone Fractures

- Hematoma (blood-filled swelling) is formed
- Fibrocartilage callus forms
  - Cartilage matrix, bony matrix, collagen fibers splint the bone
- Bony callus replaces the fibrocartilage callus
  - Osteoblasts and osteoclasts migrate in
- Bone remodeling occurs in response to mechanical stresses
Common Types of Fractures

- Comminuted: bone breaks into many fragments
- Compression: bone is crushed
- Depressed: broken bone portion is pressed inward
- Impacted: broken bone ends are forced into each other
- Spiral: ragged break occurs when excessive twisting forces are applied to a bone
- Greenstick: bone breaks incompletely
<table>
<thead>
<tr>
<th>Fracture type</th>
<th>Illustration</th>
<th>Description</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comminuted</td>
<td><img src="image1" alt="Illustration" /></td>
<td>Bone breaks into many fragments</td>
<td>Particularly common in older people, whose bones are more brittle</td>
</tr>
<tr>
<td>Compression</td>
<td><img src="image2" alt="Illustration" /></td>
<td>Bone is crushed</td>
<td>Common in porous bones (i.e., osteoporotic bones of older people)</td>
</tr>
<tr>
<td>Depressed</td>
<td><img src="image3" alt="Illustration" /></td>
<td>Broken bone portion is pressed inward</td>
<td>Typical of skull fracture</td>
</tr>
<tr>
<td>Impacted</td>
<td><img src="image4" alt="Illustration" /></td>
<td>Broken bone ends are forced into each other</td>
<td>Commonly occurs when someone attempts to break a fall with outstretched arms</td>
</tr>
<tr>
<td>Spiral</td>
<td><img src="image5" alt="Illustration" /></td>
<td>Ragged break occurs when excessive twisting forces are applied to a bone</td>
<td>Common sports fracture</td>
</tr>
<tr>
<td>Greenstick</td>
<td><img src="image6" alt="Illustration" /></td>
<td>Bone breaks incompletely, much in the way a green twig breaks</td>
<td>Common in children, whose bones are more flexible than those of adults</td>
</tr>
</tbody>
</table>
The Axial Skeleton

Forms the longitudinal axis of the body

- Divided into three parts
  1. Skull
  2. Vertebral column
  3. Bony thorax
Figure 5.8a The human skeleton.

(a) Anterior view

Skull
- Facial bones
- Cranium

Thoracic cage (ribs and sternum)
- Clavicle
- Scapula
- Sternum
- Rib
- Humerus
- Vertebra
- Radius
- Ulna
- Carpals

Vertebral column
- Sacrum

Lower limb
- Femur
- Patella
- Tibia
- Fibula

Feet
- Tarsals
- Metatarsals
- Phalanges
Figure 5.8b The human skeleton.

- Bones of pectoral girdle
  - Clavicle
  - Scapula
- Upper limb
  - Rib
  - Humerus
  - Vertebra
  - Radius
  - Ulna
  - Carpals
- Bones of pelvic girdle
  - Pelvis
  - Femur
  - Tibia
  - Fibula
- Lower limb
  - Phalanges
  - Metacarpals

(b) Posterior view
The Skull

Two sets of bones

1. Cranium bones enclose the brain
2. Facial bones
   - Hold eyes in anterior position
   - Allow facial muscles to express feelings

- Bones are joined by sutures
- Only the mandible is attached by a freely movable joint
The Skull

8 cranial bones protect the brain

1. Frontal bone
2. Occipital bone
3. Ethmoid bone
4. Sphenoid bone
5–6. Parietal bones (pair)
7–8. Temporal bones (pair)
There are 14 facial bones. All are paired except for the single mandible and vomer.

1–2. Maxillae
3–4. Zygomatics
5–6. Palatines
7–8. Nasals
9–10. Lacrimals
11–12. Inferior nasal conchae
13. Mandible
14. Vomer
Figure 5.9 Human skull, lateral view.

- Coronal suture
- Parietal bone
- Temporal bone
- Lambdoid suture
- Squamous suture
- Occipital bone
- Zygomatic process
- External acoustic meatus
- Frontal bone
- Sphenoid bone
- Ethmoid bone
- Lacrimal bone
- Nasal bone
- Zygomatic bone
- Maxilla
- Alveolar processes
- Mandible (body)
- Mental foramen
- Mastoid process
- Styloid process
- Mandibular ramus
Figure 5.10 Human skull, superior view (top of cranium removed).

- Frontal bone
- Sphenoid bone
- Ethmoid bone
- Temporal bone
- Internal acoustic meatus
- Parietal bone
- Occipital bone
- Foramen magnum
- Cribriform plate
- Crista galli
- Optic canal
- Sella turcica
- Foramen ovale
- Jugular foramen
Figure 5.11 Human skull, inferior view (mandible removed).

- Maxilla
  - (palatine process)
  - Palatine bone
- Zygomatic bone
- Temporal bone
  - (zygomatic process)
- Vomer
- Mandibular fossa
- Styloid process
- Mastoid process
- Temporal bone
- Parietal bone
- Occipital bone
- Foramen ovale
- Foramen magnum
- Carotid canal
- Jugular foramen
- Occipital condyle
- Foramen magnum

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Coronal suture
Parietal bone
Nasal bone
Sphenoid bone
Ethmoid bone
Lacrimal bone
Zygomatic bone
Frontal bone
Superior orbital fissure
Optic canal
Temporal bone
Middle nasal concha of ethmoid bone
Inferior nasal concha
Vomer
Alveolar processes
Paranasal Sinuses

- Hollow portions of bones surrounding the nasal cavity
- Functions of paranasal sinuses
  - Lighten the skull
  - Amplify sounds made as we speak

Frontal sinus
Ethmoid sinus
Sphenoidal sinus
Maxillary sinus
Figure 5.13b Paranasal sinuses.

- Frontal sinus
- Ethmoid sinus
- Sphenoidal sinus
- Maxillary sinus

(b) Medial view
The Hyoid Bone

- Closely related to mandible and temporal bones
- The only bone that does not articulate with another bone
- Serves as a movable base for the tongue
- Aids in swallowing and speech
Figure 5.15b The fetal skull.
The Appendicular Skeleton

Composed of 126 bones

- Limbs (appendages)
- Pectoral girdle
- Pelvic girdle
Figure 5.8a The human skeleton.

(a) Anterior view

- Skull
  - Facial bones
- Thoracic cage (ribs and sternum)
- Vertebral column
  - Sacrum
- Clavicle
- Scapula
- Sternum
- Rib
- Humerus
- Vertebra
- Radius
- Ulna
- Carpals
- Phalanges
- Metacarpals
- Femur
- Patella
- Tibia
- Fibula
- Tarsals
- Metatarsals
- Phalanges
Figure 5.8b The human skeleton.

- Cranium
- Clavicle
- Scapula
- Rib
- Humerus
- Vertebra
- Radius
- Ulna
- Carpals
- Phalanges
- Metacarpals
- Femur
- Tibia
- Fibula

Bones of pectoral girdle

Upper limb

Bones of pelvic girdle

Lower limb

(b) Posterior view
Joints Provide Movements

Joint = place where 2 bones meet
Types of Joints

- Immovable
- Hinge
- Ball-and-Socket
- Pivot
- Gliding
Joints and Body Movement

• [https://www.youtube.com/watch?v=ijCFTMLsVCo](https://www.youtube.com/watch?v=ijCFTMLsVCo) 2 min

• As you watch, pay attention to the movement of each of the types of joints.
Joints

- Joints are articulations
  - Two or more bones meet

- Functions of joints
  - Hold bones together
  - Allow for mobility

- Two ways joints are classified
  - Functionally
  - Structurally
Functional Classification of Joints

- Synarthroses
  - Immovable joints
- Amphiarthroses
  - Slightly movable joints
- Diarthroses
  - Freely movable joints
Structural Classification of Joints

- Fibrous joints
  - Generally immovable
- Cartilaginous joints
  - Immovable or slightly movable
- Synovial joints
  - Freely movable
Fibrous Joints

- Bones united by fibrous tissue
- Types
  - Sutures
    - Immobile
  - Syndesmoses
    - Allow more movement than sutures but still immobile
    - Example: Distal end of tibia and fibula
  - Gomphosis
    - Immobile
Figure 5.30a Types of joints.

(a) Suture

Fibrous joints

Fibrous connective tissue
Figure 5.30b Types of joints.

Fibrous joints

Tibia

Fibula

Fibrous connective tissue

(b) Syndesmosis
Cartilaginous Joints

- Bones connected by fibrocartilage
- Types
  - Synchondrosis
    - Immobile
  - Symphysis
    - Slightly movable
  - **Example:** Pubic symphysis, intervertebral joints
Figure 5.30c Types of joints.

(c) Synchondrosis

Cartilaginous joints

- First rib
- Hyaline cartilage
- Sternum
Figure 5.30d Types of joints.

- **Cartilaginous joints**

(d) Symphysis

- Vertebrae
- Fibro-cartilage
Cartilaginous joints

(e) Symphysis

- Pubis
- Fibro-cartilage
Synovial Joints

- Articulating bones are separated by a joint cavity
- Synovial fluid is found in the joint cavity
- Four distinguishing features of synovial joints
  1. Articular cartilage
  2. Articular capsule
  3. Joint cavity
  4. Reinforcing ligaments
Figure 5.30f Types of joints.

(f) Multiaxial joint
(shoulder joint)
Figure 5.30g Types of joints.

(g) Uniaxial joint
(elbow joint)

- Humerus
- Articular (hyaline) cartilage
- Articular capsule
- Radius
- Ulna
Figure 5.30h Types of joints.

Synovial joints

(h) Biaxial joint
(intercarpal joints of hand)
Synovial Joints

- Bursae—flattened fibrous sacs
  - Lined with synovial membranes
  - Filled with synovial fluid
  - Not actually part of the joint
- Tendon sheath
  - Elongated bursa that wraps around a tendon
Synovial Joints

- Types of synovial joints based on shape:
  - Plane joint
  - Hinge joint
  - Pivot joint
  - Condylar joint
  - Saddle joint
  - Ball-and-socket joint
Figure 5.31 General structure of a synovial joint.
Figure 5.32a Types of synovial joints.

- Nonaxial
- Uniaxial
- Biaxial
- Multiaxial

(a) Plane joint
Figure 5.32b Types of synovial joints.

- (a) Biaxial joint
- (b) Hinge joint
- (c) Uniaxial joint
- (d) Multiaxial joint
- (e) Hinge joint
- (f) Nonaxial joint

- Humerus
- Ulna
Figure 5.32c Types of synovial joints.

(f) Pivot joint

Ulna
Radius

(c) Pivot joint
Figure 5.32d Types of synovial joints.

Nonaxial
Uniaxial
Biaxial
Multiaxial

Metacarpal
Phalanx

(d) Condylar joint
Figure 5.32e Types of synovial joints.

- Nonaxial
- Uniaxial
- Biaxial
- Multiaxial

(e) Saddle joint
Figure 5.32f Types of synovial joints.

- **Nonaxial**
- **Uniaxial**
- **Biaxial**
- **Multiaxial**

(f) Ball-and-socket joint

Head of humerus

Scapula

(a)  
(b)  
(c)  
(d)  
(e)  
(f) Ball-and-socket joint
Inflammatory Conditions Associated with Joints

- Bursitis—inflammation of a bursa, usually caused by a blow or friction
- Tendonitis—inflammation of tendon sheaths
- Arthritis—inflammatory or degenerative diseases of joints
  - Over 100 different types
  - The most widespread crippling disease in the United States
  - Initial symptoms: pain, stiffness, swelling of the joint
Clinical Forms of Arthritis

- Osteoarthritis (OA)
  - Most common chronic arthritis
  - Probably related to normal aging processes
- Rheumatoid arthritis (RA)
  - An autoimmune disease—the immune system attacks the joints
  - Symptoms begin with bilateral inflammation of certain joints
  - Often leads to deformities
Figure 5.33 X-ray image of a hand deformed by rheumatoid arthritis.
Clinical Forms of Arthritis

- Gouty arthritis (gout)
  - Inflammation of joints is caused by a deposition of uric acid crystals from the blood
  - Can usually be controlled with diet
  - More common in men
Developmental Aspects of the Skeletal System

- Fontanels
  - Allow brain growth and ease birth passage
  - Present in the skull at birth
  - Completely replaced with bone within 2 years after birth
Developmental Aspects of the Skeletal System

- Growth of cranium after birth is related to brain growth
  - Increase in size of the facial skeleton follows tooth development and enlargement of the respiratory passageways.
Figure 5.34 Ossification centers in the skeleton of a 12-week-old fetus are indicated by the darker areas. Lighter regions are still fibrous or cartilaginous.
Skeletal Changes Throughout Life

- **Fetus**
  - Long bones are formed of hyaline cartilage
  - Flat bones begin as fibrous membranes
  - Flat and long bone models are converted to bone

- **Birth**
  - Fontanels remain until around age 2
Skeletal Changes Throughout Life

- Adolescence
  - Epiphyseal plates become ossified, and long bone growth ends
- Size of cranium in relationship to body
  - 2 years old—skull is larger in proportion to the body compared to that of an adult
  - 8 or 9 years old—skull is near adult size and proportion
  - Between ages 6 and 11, the face grows out from the skull
Figure 5.35a Differences in the growth rates for some parts of the body compared to others determine body proportions.

(a) Human newborn Human adult
Figure 5.35b Differences in the growth rates for some parts of the body compared to others determine body proportions.
Skeletal Changes Throughout Life

- Curvatures of the spine
  - Primary curvatures are present at birth and are convex posteriorly
  - Secondary curvatures are associated with a child’s later development and are convex anteriorly
  - Abnormal spinal curvatures (scoliosis and lordosis) are often congenital
Figure 5.18 Abnormal spinal curvatures.

(a) Scoliosis  (b) Kyphosis  (c) Lordosis
Skeletal Changes Throughout Life

- **Osteoporosis**
  - Bone-thinning disease afflicting
    - 50 percent of women over age 65
    - 20 percent of men over age 70
  - Disease makes bones fragile, and bones can easily fracture
  - Vertebral collapse results in kyphosis (also known as “dowager’s hump”)
  - Estrogen aids in health and normal density of a female skeleton
Figure 5.36 Osteoporosis.
Figure 5.37 Vertebral collapse due to osteoporosis.

Age 40                Age 60                Age 70