Osteology

Bio 250
Anatomy & Physiology

Classification of Bones on the Basis of Their Shape

- Long bones, e.g. arms and legs
  - Epiphysis covered with articular cartilage
  - Diaphysis or shaft
  - Periosteum
  - Compact (cortical) bone (Functional unit: Osteon)
  - Cancellous or spongy (trabecular) bone
  - Marrow (medullary) cavity
  - Endosteum
  - Metaphysis

FIGURE 4.2
Classification of bones on the basis of shape.
Classification of Bones

- Short bones, e.g. wrists and ankles
  - Cubical shape
  - Compact outer shell
  - Cancellous inner core
  - Marrow
  - Periosteum
  - Articular cartilage

Classification of Bones

- Flat bones, e.g. ribs and some skull bones
  - Inner/outer surface of compact bone
  - Inner core of cancellous bone
  - Marrow
  - Periosteum

Classification of Bones

- Irregular bones, e.g. mandible and vertebrae
  - Outer compact bone
  - Inner core of cancellous bone
  - Periosteum
  - Can have articular cartilage
Sesamoid bones ("looks like" sesame seed), e.g. patella

- Formed within fibrous membrane
- Sutural or Wormian bones of skull

Compact (Cortical) Bone

- Organized into Osteons (Haversian Systems)
- Microscopic unit of structure/function
- Central canal with blood supply
- Lamellae composed of matrix
- Lacunae with osteocytes
- Canaliculi containing interstitial fluid
- Perforating canal's containing blood vessels interconnecting osteons.

Cancellous (Trabecular) Bone

- Also called spongy bone
- Formed of interconnecting bone rods or plates called trabeculae
- Trabeculae consist of lamellae containing osteocytes
- Typically no blood vessels penetrate the trabeculae
- Found primarily lining the medullary cavities and forming the interior of epiphyses
Bone Growth and Development

- No osseus tissue prior to 10 weeks in fetus
- Early skeleton composed of:
  - Fibrous membrane in flat bones of skull
  - Hyaline cartilage in rest of skeleton
- By 10-12 weeks bony tissue begins to replace fibrous tissue and cartilage

Intramembranous Ossification

- Membrane-like layers of connective tissue
- Undifferentiated connective cells
- Many blood vessels
- Some cells form osteoblasts and produce cancellous bone matrix
- Cells on outside form periosteum
- Osteoblasts inside periosteum form compact bone

Fontanels

- “Soft” spots at the corners of adjoining bone plates
- Aids in the birthing process
- Close by 20-24 months after birth
Endochondral Ossification

- Primary ossification center in diaphysis
- Secondary centers form in epiphyses
- **Epiphyseal (growth) disk** remains between end and shaft of bone
  - Disk consists of resting, young reproducing, old enlarging and dying cells
  - Disk responsible for longitudinal growth in long bones
- Hyaline cartilage remains on the articular surfaces

Bone Growth

- Long bones can grow in circumference during our entire life
- Long bones can grow LONGER only while there is a functional epiphyseal disk of hyaline cartilage
### Longitudinal Bone Growth

- Requirements for longitudinal growth:
  - Functional epiphyseal disk (Achondroplasia)
  - Growth hormone (Pituitary Dwarfism)
  - Vitamin D (Rickets / Osteomalacia)
  - Vitamin A (Bone resorption during development)
  - Vitamin C (Collagen synthesis)
  - Thyroid Hormone (Promotes ossification of Cartilage)

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**Figure 4.13** Two siblings at the right, grown with her Kaprezian at normal height. In an achondroplastic dwarf with a height of about 120 cm tall, the parents were of normal height. Both females with this dwarfism are osteoarthropathic. Achondroplasia has little effect on the metaphysis of the long bones.

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### Longitudinal Bone Growth

- Ossification occurs at the diaphyseal side of growth disk
- Expansion of the growth disk occurs by mitosis of chondrocytes on the epiphyseal side of the growth disk
- As long as these processes are balanced, long bones continue to lengthen
Bone X-ray showing presence of growth disks

**Figure 7.11**
The presence of epiphyseal disks (arrows) in a child's bone indicates that the bone is still lengthening.

**Growth**
Bone grows in length because:

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

**Articular cartilage**

**Remodeling**
Growing shaft is remodeled by:

1. Bone resorbed here
2. Bone added by appositional growth here
3. Bone resorbed here

**Epiphyseal plate**

**Epiphyseal cartilage**

**Epiphyseal lines**
Puberty brings end to long bone growth

- Sex hormones rise during puberty
- Stimulate ossification at growth disk
- Cause “closure” of growth disk
- Growth typically ceases by age 18 in girls; 20 in boys

Circumferential Bone Growth

- Osteogenic layer of periosteum produces osteoblasts
- Osteoblasts add additional bone matrix
- Osteoclasts remodel interior of medullary cavity to lighten bone

Structure/Growth of the Periosteum

Fig. 3-4: Diagram of the process whereby bone increases in circumferential. New layers of bone are produced by cells of the osteogenic layer of periosteum in appositional growth.
Bone Matrix

- Bone is a hard connective tissue
- Matrix about 1/3 organic (mostly bone collagen)
- Matrix about 2/3 inorganic (mostly calcium phosphate (85%) and calcium carbonate (10%); some fluoride, magnesium, potassium, sulfate, hydroxyl and sodium ions that are adsorbed to the calcium phosphate crystals)

Bone and Mineral Homeostasis

- Osteoblasts deposit minerals from blood into bone matrix after meal (Calcitonin)
- Osteoclasts remove and release minerals from bone into blood during fasting (PTH)
- Actions of osteoblasts and osteoclasts important in bone remodeling and mineral homeostasis
- Dietary deficiency of Calcium causes demineralization of osseus tissue
Control of Bone Remodeling

- The extensive remodeling that occurs constantly is regulated by two different processes
  - One process works to maintain mineral homeostasis in the blood (previous slide)
  - One process works to strengthen bones along lines of stress (next slide)
    » to make bones strong as needed to support the stresses placed on the body
    » Compression and tensional forces create weak electrical currents that stimulate osteoblasts

Wolff’s law-
Bones remodel in response to stresses placed on them
Note: Stresses are primarily on the bones surfaces so they can be hollow (light) and have needed strength.

Fracture Repair
Bone Marrow

- Yellow bone marrow in most adult bones and all medullar cavities
- Red bone marrow (hemopoietic tissue):
  - bodies of vertebrae
  - flat bones of skull
  - sternum
  - ribs
  - proximal epiphyses of femur and humerus
  - pelvis

Articulations (Joints)

- **Synarthroses** (Fibrous joints)
  - immovable joints
  - bones separated by fibrous tissue
  - e.g. sutures of skull
- **Amphiarthroses** (cartilaginous joints)
  - slightly movable joints
  - bones separated by cartilage disk
  - e.g. pubic symphysis, intervertebral disks

Articulations (Joints)

- **Diarthroses** (Freely movable joints)
  - Articular cartilage
  - Joint capsule
  - Synovial membrane
  - Synovial fluid
    - Lubricates joint surfaces
    - Distributes nutrients for cartilage
    - Absorbs shock in joints subjected to compression
  - Joint cavity
Diarthrotic Joints-Accessory Parts

- **Meniscus**: A pad of fibrocartilage situated between opposing bones within a synovial joint. These articular disks may subdivide a joint cavity, channel synovial fluid, or allow for variations in the shapes of articular surfaces.

- **Fat pads**: Localized masses of adipose tissue that protect articular cartilages and act as packing material.
Diarthrotic Joints-Accessory Parts

- **Ligaments** - The joint capsule that surrounds the entire joint is continuous with the periosteum of the articulating bones.
- **Accessory ligaments** are localized thickenings of the capsule that reinforce and strengthen the capsule and may also limit rotation of the joint.
- **Extracapsular ligaments** interconnect articulating bones and pass across the outside of the capsule and provide additional support to the wall of the joint.
- **Intracapsular ligaments** help to prevent extreme movements that might damage the joint.

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Diarthrotic Joints-Accessory Parts

- **Tendon** - not part of the joint itself but in passing across or around joint, may limit movement or provide mechanical support.
- **Bursa** - a small, fluid-filled pocket in connective tissue. They may be connected to the joint cavity or completely separate. Form where structures rub together. They function to reduce friction and act as a shock absorber. (Bursitis)
Types of diarthrotic joints include: Hinge joints, pivot joints, ball & socket joints, etc.