C6

Images of Bone Tissue
(a) Partially sectioned humerus (arm bone)
(b) Partially sectioned humerus
OSTEOPROGENITOR CELL (develops into an osteoblast)

OSTEOBLAST (forms bone extracellular matrix)

OSTEOCYTE (maintains bone tissue)

OSTEOCLAST (functions in resorption, the breakdown of bone extracellular matrix)
From bone cell lineage

OSTEOPROGENITOR CELL (develops into an osteoblast)

OSTEOBLAST (forms bone extracellular matrix)

OSTEOCYTE (maintains bone tissue)

OSTEOCLAST (functions in resorption, the breakdown of bone extracellular matrix)

From white blood cell lineage

Ruffled border
(a) Osteons (haversian systems) in compact bone and trabeculae in spongy bone
Space for red bone marrow
Trabeculae

(b) Enlarged aspect of spongy bone trabeculae

Lacuna
Lamellae
Canaliculi
Osteocyte
Osteoclast
Osteoblasts aligned along trabeculae of new bone

(c) Details of a section of a trabecula
Partially sectioned tibia (shin bone)

2. Calcification: calcium and other mineral salts are deposited and extracellular matrix calcifies (hardens).

3. Formation of trabeculae: extracellular matrix develops into trabeculae that fuse to form spongy bone.

4. Development of the periosteum: mesenchyme at the periphery of the bone develops into the periosteum.
Development of cartilage model: mesenchymal cells develop into chondroblasts, which form the cartilage model.

Growth of cartilage model; growth occurs by cell division of chondrocytes.

Development of primary ossification center; in this region of the diaphysis, bone tissue has replaced most of the cartilage.

Development of the medullary (marrow) cavity: bone breakdown by osteoclasts forms the medullary cavity.

Development of secondary ossification centers: these occur in the epiphyses of the bone.

Formation of articular cartilage and epiphyseal plate: both structures consist of hyaline cartilage.

Twelve-week fetus. The red areas represent bones that are forming (calcified). Clear areas represent cartilage (uncalcified).
1 Development of cartilage model: mesenchymal cells develop into chondroblasts, which form the cartilage model.

2 Growth of cartilage model: growth occurs by cell division of chondrocytes.

3 Development of primary ossification center: in this region of the diaphysis, bone tissue has replaced most of the cartilage.

4 Development of the medullary (marrow) cavity: bone breakdown by osteoclasts forms the medullary cavity.

5 Development of secondary ossification centers: these occur in the epiphyses of the bone.

6 Formation of articular cartilage and epiphyseal plate: both structures consist of hyaline cartilage.

(a) Sequence of events
1 Development of cartilage model: mesenchymal cells develop into chondroblasts, which form the cartilage model.

2 Growth of cartilage model: growth occurs by cell division of chondrocytes.

3 Development of primary ossification center: in this region of the diaphysis, bone tissue has replaced most of the cartilage.

(a) Sequence of events
4 Development of the medullary (marrow) cavity: bone breakdown by osteoclasts forms the medullary cavity.

5 Development of secondary ossification centers: these occur in the epiphyses of the bone.

6 Formation of articular cartilage and epiphyseal plate: both structures consist of hyaline cartilage.

(a) Sequence of events
(a) Radiograph showing the epiphyseal plate of the femur of a 3-year-old

- Femur
- Epiphyseal Plate
- Tibia

(b) Histology of the epiphyseal plate

- Diaphyseal side
  - Developing bone of diaphysis
  - Zone of calcified cartilage
  - Zone of hypertrophic cartilage
  - Zone of proliferating cartilage
  - Zone of resting cartilage

LM 400x
(b) Twelve-week fetus. The red areas represent bones that are forming (calcified). Clear areas represent cartilage (uncalcified).
(c) Lengthwise growth of bone at epiphyseal plate

- Epiphysis
- Articular cartilage
- New chondrocytes are formed
- Old chondrocytes are replaced by bone
- New diaphysis

EPIPHYSEAL (GROWTH) PLATE:
- Zone of resting cartilage
- Zone of proliferating cartilage
- Zone of hypertrophic cartilage
- Zone of calcified cartilage
- Diaphysis
1. Ridges in periosteum create groove for periosteal blood vessel.

2. Periosteal ridges fuse, forming an endosteum-lined tunnel.

3. Osteoblasts in endosteum build new concentric lamellae inward toward center of tunnel, forming a new osteon.

4. Bone grows outward as osteoblasts in periosteum build new circumferential lamellae. Osteon formation repeats as new periosteal ridges fold over blood vessels.

(a) Microscopic details
(b) Macroscopic changes
STIMULUS
Disrupt homeostasis by decreasing

CONTROLLED CONDITION
Blood calcium (Ca^{2+}) level

RECEPTORS
Parathyroid gland cells

Input
Detect lowered Ca^{2+} concentration which increases production of cyclic AMP

CONTROL CENTER
Parathyroid hormone gene

Output
Gene "turned on" which increases release of PTH

EFFECTORS
Osteoclasts, Kidneys

Osteoclasts increase bone resorption
Kidneys retain Ca^{2+} in blood, excrete phosphate in urine, and produce calcitriol

RESPONSE
Increase in blood Ca^{2+} level

Return to homeostasis when the response brings blood Ca^{2+} level back to normal
(a) Normal bone

(b) Osteoporotic bone