

## Chapter 6: Skeletal System: Bones and Bone Tissue

### I. Functions

A. List and describe the five major functions of the skeletal system:

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_  
\_\_\_\_\_

### II. Cartilage

- A. What do chondroblasts do? \_\_\_\_\_
- B. When a chondroblast becomes surrounded by matrix it is called \_\_\_\_\_
- C. Perichondrium
  1. The outer layer is composed of \_\_\_\_\_
  2. The inner layer has \_\_\_\_\_
  3. Blood vessels penetrate \_\_\_\_\_
- D. Where is articular cartilage found? \_\_\_\_\_
- E. Describe appositional growth: \_\_\_\_\_
- F. Describe interstitial growth: \_\_\_\_\_

### III. Bone Histology

#### A. Bone Matrix

1. Composed of 35% \_\_\_\_\_ & 65% \_\_\_\_\_
2. Hydroxyapatite is \_\_\_\_\_
3. Functionally collagen fibers in bone \_\_\_\_\_
4. Functionally the mineral matrix in bone \_\_\_\_\_

#### B. Bone Cells

##### 1. Osteoblasts

- a. These cells produce \_\_\_\_\_ & \_\_\_\_\_
- b. In addition to various enzymes osteoblasts also form vesicles that accumulate \_\_\_\_\_ & \_\_\_\_\_
- c. All vesicles are released by \_\_\_\_\_
- d. Define ossification: \_\_\_\_\_

##### 2. Osteocytes

- a. When does an osteoblast become an osteocyte? \_\_\_\_\_
- b. Osteocytes produce components needed to \_\_\_\_\_
- c. Osteocytes sit in a space called a \_\_\_\_\_
- d. The spaces that contain osteocyte cell processes are called \_\_\_\_\_
- e. Nutrients and gases pass through \_\_\_\_\_

##### 3. Osteoclasts

- a. Describe an osteoclast \_\_\_\_\_
- b. Osteoclasts are responsible for \_\_\_\_\_

##### 4. Origin of Bone Cells

- a. Osteoblasts are derived from \_\_\_\_\_
- b. Osteocytes are derived from \_\_\_\_\_
- c. Osteoclasts are derived from \_\_\_\_\_

#### C. Woven and Lamellar Bone

1. In woven bone collagen fibers are \_\_\_\_\_
2. When is woven bone formed? \_\_\_\_\_ & \_\_\_\_\_
3. Explain remodeling: \_\_\_\_\_

4. Lamellar bone is organized into \_\_\_\_\_ called \_\_\_\_\_
  5. In lamellar bone the collagen fibers \_\_\_\_\_
  6. How are osteocytes arranged in lamellar bone? \_\_\_\_\_
- D. Cancellous and Compact Bone
1. Cancellous bone has \_\_\_\_\_ & \_\_\_\_\_
  2. Compact bone has \_\_\_\_\_ & \_\_\_\_\_
  3. Cancellous Bone
    - a. It consists of \_\_\_\_\_ called \_\_\_\_\_
    - b. The spaces are filled with \_\_\_\_\_ & \_\_\_\_\_
    - c. Trabeculae are oriented \_\_\_\_\_
  4. Compact Bone
    - a. The lamellae are oriented around \_\_\_\_\_
    - b. Blood vessels that run parallel to the bone's long axis are contained within \_\_\_\_\_ or \_\_\_\_\_
    - c. The concentric lamellae \_\_\_\_\_
    - d. An osteon (haversian system) consists of \_\_\_\_\_
      1. If cut in cross section it resembles \_\_\_\_\_
    - e. Describe the three types of lamellae:
      1. Concentric \_\_\_\_\_
      2. Circumferential \_\_\_\_\_
      3. Interstitial \_\_\_\_\_
    - f. How do perforating (Volkmann's) canals differ from central (haversian) canals? \_\_\_\_\_

#### IV. Bone Anatomy

- A. Describe each of the four basic bone shapes:
  1. Long bone \_\_\_\_\_
  2. Short bone \_\_\_\_\_
  3. Flat bone \_\_\_\_\_
  4. Irregular bone \_\_\_\_\_
- B. Structure of a Long Bone

1. The diaphysis is composed primarily of \_\_\_\_\_
2. Where is the diaphysis? \_\_\_\_\_
3. What is an epiphysis? \_\_\_\_\_
4. The epiphysis is composed primarily of \_\_\_\_\_ that is covered by a layer of \_\_\_\_\_ & at joints \_\_\_\_\_
5. What is the epiphyseal plate composed of? \_\_\_\_\_
6. Where is the epiphyseal plate located? \_\_\_\_\_
7. What occurs at the epiphyseal plate? \_\_\_\_\_
8. When the epiphyseal plate is ossified it is called \_\_\_\_\_
9. Inside the diaphysis is a large space called \_\_\_\_\_
10. Red marrow is the site of \_\_\_\_\_ while yellow marrow is \_\_\_\_\_
11. The outer surface of the bone is covered by the \_\_\_\_\_
  - a. The outer layer is composed of \_\_\_\_\_
  - b. The inner layer is composed of \_\_\_\_\_
12. How are tendons and ligaments attached to the bone? \_\_\_\_\_  
\_\_\_\_\_
13. The inside of the medullary cavity is lined by the \_\_\_\_\_
  - a. This membrane is composed of: \_\_\_\_\_

#### C. Structure of Flat, Short, and Irregular Bones

1. Flat bones have an interior \_\_\_\_\_ of \_\_\_\_\_ that is sandwiched between \_\_\_\_\_
2. Short and irregular bones have a surface layer of \_\_\_\_\_ that surrounds \_\_\_\_\_
3. Air filled spaces inside flat and irregular bones are called \_\_\_\_\_
  - a. These spaces are lined by \_\_\_\_\_

### V. Bone Development

#### A. Intramembranous Ossification

1. Begins when mesenchymal cells in the membrane become \_\_\_\_\_
2. These cells specialize to become \_\_\_\_\_

3. The osteoblasts produce \_\_\_\_\_ that surrounds \_\_\_\_\_  
\_\_\_\_\_
- a. This is a "center of ossification".
4. This process forms many tiny \_\_\_\_\_ of \_\_\_\_\_
5. The trabeculae enlarge as \_\_\_\_\_
6. As the trabeculae join together they form \_\_\_\_\_  
separated by \_\_\_\_\_
7. Cells within the spaces specialize to form \_\_\_\_\_
8. Cells surrounding the developing bone specialize & form \_\_\_\_\_
9. An outer surface of compact bone is formed by \_\_\_\_\_
10. The end product of intramembranous ossification:
  - a. Bones with outer \_\_\_\_\_ &
  - b. \_\_\_\_\_ centers
11. Remodeling forms \_\_\_\_\_ bone and \_\_\_\_\_

#### B. Endochondral Ossification

1. Begins as \_\_\_\_\_ aggregate \_\_\_\_\_
2. The cells become \_\_\_\_\_ & produce a \_\_\_\_\_  
having the approximate shape of the future bone
3. When surrounded by matrix the chondroblasts become \_\_\_\_\_
4. The cartilage model is surrounded by \_\_\_\_\_
5. Blood vessels penetrating the perichondrium cause \_\_\_\_\_  
\_\_\_\_\_ to become \_\_\_\_\_
6. When bone is being produced the perichondrium becomes \_\_\_\_\_
7. The osteoblasts produce \_\_\_\_\_ on the surface of the  
cartilage model forming a \_\_\_\_\_
8. The cartilage continues to grow by \_\_\_\_\_ & \_\_\_\_\_
9. Chondrocytes inside the cartilage model \_\_\_\_\_
10. The matrix between becomes \_\_\_\_\_ with \_\_\_\_\_  
is referred to as \_\_\_\_\_
11. The chondrocytes then \_\_\_\_\_ leaving \_\_\_\_\_

12. What grows into the enlarged lacunae? \_\_\_\_\_
13. This results in osteoblasts forming \_\_\_\_\_, which changes the calcified matrix of the diaphysis into \_\_\_\_\_
  - a. The area of bone formation in the diaphysis is called \_\_\_\_\_
14. As ossification proceeds:
  - a. The cartilage model \_\_\_\_\_
  - b. More perichondrium \_\_\_\_\_
  - c. The bone collar \_\_\_\_\_
  - d. Within the diaphysis \_\_\_\_\_
15. Remodeling converts \_\_\_\_\_ bone to \_\_\_\_\_ bone and \_\_\_\_\_
16. Osteoclasts \_\_\_\_\_
17. Cells within the medullary cavity \_\_\_\_\_
18. Secondary ossification centers appear \_\_\_\_\_
  - a. What happens differently at secondary ossification centers compared to primary ossification centers? \_\_\_\_\_
19. Eventually all cartilage in the model is replaced by bone except:
  - a. In the \_\_\_\_\_
  - b. And on \_\_\_\_\_

## VI. Bone Growth

A. Occurs only by \_\_\_\_\_ growth

### B. Growth in Bone Length

1. Growth at the epiphyseal plate involves \_\_\_\_\_ of new \_\_\_\_\_ by \_\_\_\_\_ growth followed by \_\_\_\_\_ bone growth.
2. Describe the events in each of the four zones of the epiphyseal plate:
  - a. Zone of resting cartilage \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
  - b. Zone of proliferation \_\_\_\_\_  
 \_\_\_\_\_

\_\_\_\_\_

c. Zone of hypertrophy \_\_\_\_\_

\_\_\_\_\_

d. Zone of calcification \_\_\_\_\_

\_\_\_\_\_

3. What part of the bone is increasing in length? \_\_\_\_\_

4. The thickness of the epiphyseal plate stays the same because:

a. Rate of \_\_\_\_\_ on the \_\_\_\_\_ side is

b. Equal to \_\_\_\_\_ on the \_\_\_\_\_ side

5. When the epiphyseal plate stops growing and is ossified it is \_\_\_\_\_

#### C. Growth at Articular Cartilage

1. Growth at the articular cartilage increases size of \_\_\_\_\_

2. How does this process differ from what occurs at the epiphyseal plate?

\_\_\_\_\_

3. How long does the articular cartilage remain on the epiphyses? \_\_\_\_\_

#### D. Growth in Bone Width

1. Bones increase in width due to \_\_\_\_\_ under \_\_\_\_\_

2. When growth in width is rapid:

a. Osteoblasts lay down bone in \_\_\_\_\_  
with \_\_\_\_\_ between them

b. Periosteum covers the ridges and grooves and one or more \_\_\_\_\_  
\_\_\_\_\_ of the periosteum lie \_\_\_\_\_

c. The ridges increase in size eventually forming \_\_\_\_\_

d. Since the periosteum of the tunnel is now lining bone it is a \_\_\_\_\_

e. Concentric lamellae are formed by \_\_\_\_\_ of the \_\_\_\_\_

f. Eventually this fills in the tunnel and forms an \_\_\_\_\_

3. When growth in width is slow:

a. Circumferential lamellae are formed making the bone surface \_\_\_\_\_

b. Remodeling breaks down the \_\_\_\_\_ & forms \_\_\_\_\_

## E. Factors Affecting Bone Growth / Nutrition

### 1. Nutrition

- a. What role does Vitamin D play in bone growth? \_\_\_\_\_
- b. What role does Vitamin C play in bone growth? \_\_\_\_\_

### 2. Hormones

- a. Growth hormone stimulates:
  1. \_\_\_\_\_ &
  2. \_\_\_\_\_
- b. Thyroid hormone is required for \_\_\_\_\_
- c. Estrogen and testosterone:
  1. Initially \_\_\_\_\_
  2. Also stimulate ossification of \_\_\_\_\_
- d. Why are females usually shorter than males? \_\_\_\_\_  
\_\_\_\_\_

## VII. Bone Remodeling

### A. Bone remodeling:

1. Converts \_\_\_\_\_ bone to \_\_\_\_\_ bone
2. Is involved in \_\_\_\_\_
3. Changes in \_\_\_\_\_
4. Adjustment of bone to \_\_\_\_\_
5. Bone \_\_\_\_\_
6. \_\_\_\_\_ in the body

### B. Remodeling causes the diameter of the medullary cavity to \_\_\_\_\_ as the bone increases in length and width.

1. What is the advantage to having a medullary cavity? \_\_\_\_\_  
\_\_\_\_\_

### C. Remodeling is also involved in the formation of \_\_\_\_\_ in bone.

### D. What do interstitial lamellae represent? \_\_\_\_\_



## VIII. Bone Repair

### A. Hematoma Formation

1. A hematoma is \_\_\_\_\_
  - a. The blood usually forms a \_\_\_\_\_ that \_\_\_\_\_
2. What happens to the bone tissue adjacent to the fracture site? \_\_\_\_\_

### B. Callus Formation

1. A callus is \_\_\_\_\_
  - a. Internal callus
    1. Forms between \_\_\_\_\_ & in the \_\_\_\_\_
    2. As the clot dissolves:
      - a. Macrophages \_\_\_\_\_
      - b. Osteoclasts \_\_\_\_\_
      - c. Fibroblasts produce \_\_\_\_\_
    3. A denser fibrous network is formed when \_\_\_\_\_
      - a. This helps to \_\_\_\_\_
    4. Chondroblasts begin to \_\_\_\_\_
    5. Osteoblasts produce \_\_\_\_\_ that \_\_\_\_\_
  - b. External Callus
    1. Forms a \_\_\_\_\_
    2. Osteoblasts produce \_\_\_\_\_ & chondroblasts produce \_\_\_\_\_
      - a. Therefore the external callus is a \_\_\_\_\_ collar
    3. The external callus \_\_\_\_\_ the \_\_\_\_\_ of the broken bone

### C. Callus Ossification

1. The cartilage in the external callus is replaced by \_\_\_\_\_ through \_\_\_\_\_
  - a. This results in a \_\_\_\_\_ external callus
2. When is the internal callus ossified? \_\_\_\_\_  
\_\_\_\_\_

### D. Remodeling of Bone

1. Repair is not complete until \_\_\_\_\_ and \_\_\_\_\_

## IX. Calcium Homeostasis

- A. Blood calcium levels are important for normal function of \_\_\_\_\_ & \_\_\_\_\_
- B. When blood calcium levels are too low \_\_\_\_\_
- C. When blood calcium levels are too high \_\_\_\_\_
- D. Parathyroid hormone secretion increases when \_\_\_\_\_
- E. Functionally parathyroid hormone:
1. Increases the numbers of \_\_\_\_\_
  2. Causes osteoblasts to \_\_\_\_\_
  3. Increases calcium uptake by \_\_\_\_\_
  4. Increases calcium reabsorption \_\_\_\_\_
- F. Calcitonin is secreted by the \_\_\_\_\_
- G. Calcitonin is secreted in response to \_\_\_\_\_
- H. Functionally calcitonin \_\_\_\_\_

## X. Effects of Aging on the Skeletal System

- A. The most significant changes affect the \_\_\_\_\_ & \_\_\_\_\_ of matrix
- B. What does decreased collagen production do to bone matrix? \_\_\_\_\_
- C. Osteoblasts become slower than osteoclasts resulting in \_\_\_\_\_
- D. Cancellous bone is lost \_\_\_\_\_ as the trabeculae \_\_\_\_\_ & \_\_\_\_\_
- E. What happens when trabeculae become disconnected from each other? \_\_\_\_\_
- F. Most loss of compact bone occurs \_\_\_\_\_
- G. Incomplete bone remodeling causes \_\_\_\_\_
- H. Loss of trabeculae greatly increases the chance of \_\_\_\_\_
- I. Loss of bone can cause:
1. \_\_\_\_\_
  2. Loss of \_\_\_\_\_
  3. \_\_\_\_\_ & \_\_\_\_\_
  4. \_\_\_\_\_