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. _________________