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. ___________________________