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 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 ______________________________

IV. 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? _______________________________________

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 ______________________________

   a. Zone of proliferation ______________________________

a. Zone of hypertrophy

a. 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 _______________

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E. Factors Affecting Bone Growth

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. ____________________