HISTOLOGY OF BONE TISSUE

OBJECTIVE:

3. Describe the histology of bone tissue. (pp. 123 – 125)
4. Describe the remodeling and repair of the skeleton and discuss the homeostatic mechanisms responsible for regulating mineral deposition and turnover. (pp. 127 – 129)

<table>
<thead>
<tr>
<th>MATRIX</th>
<th>CELLS</th>
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ORGANIZATION OF COMPACT BONE
PART II: MICROSCOPIC STRUCTURE OF COMPACT BONE

As you have seen, spongy bone has a spiky, open-work appearance, resulting from the arrangement of the spicules of bony material, or trabeculae, that compose it, while compact bone appears to be dense and homogenous. Microscopic examination of compact bone, however, reveals that it is riddled with passageways carrying blood vessels, nerves, and lymphatic vessels that provide the living bone cells with needed substances and a way to eliminate wastes. Indeed, bone histology is much easier to understand when you recognize that bone tissue is organized around its blood supply.

Compact bone contains cylinders of calcified bone known as osteons or Haversian systems. The cylinders are made of concentric layers (lamellae) of bone. In Latin the term lamellae means "thin plates."

In the center of the osteons are central canals (Haversian canals). The central canals run lengthwise through the bone and contain blood vessels, nerves, and lymphatic vessels. Branching off the central canals are perforating (Volkmann's) canals. Perforating canals run at right angles to the central canal and extend the system of nerves and vessels outward to the periosteum and inward to the endosteum.

Found within the lamellae are lacunae or little spaces which house the osteocytes (bone cells). Radiating from the lacunae are thin canaliculi that contain slender extensions of the osteocytes. Nutrients and waste materials are transported to and from the blood vessels by passing from one osteocyte to the next.

Cells found in bone tissue include osteoblasts, osteocytes, and osteoclasts. Osteoblasts build bone and are usually found in growing parts of the bone. Osteoblasts become osteocytes after secreting a bony matrix. Osteocytes maintain bone and help release calcium from bone. Osteoclasts break down bone by reabsorbing the bony matrix. Osteoclasts are giant cells derived from monocytes.
1. Match the term with the correct description or function.

A. Central canals
B. Lacunae
C. Lamellae
D. Osteoblasts
E. Osteoclasts
F. Osteocytes
G. Osteon
H. Perforating canals
I. Trabeculae
J. Canaliculi

_____ Spicules of bony material found in spongy bone
_____ Cylinders of calcified bone found in compact bone
_____ Haversian systems
_____ Branches off the central canals that run at right angles to the central canal
_____ Volkmann’s canals
_____ Concentric layers of bone; means “thin plates” in Latin
_____ Little spaces that house the bone cells
_____ Contain slender extensions that connect one osteocyte to other osteocytes; carry nutrients and waste materials from one osteocyte to another
_____ Bone cells that build bone and are usually found in growing parts of the bone
_____ Mature bone cells that maintain bone and help release calcium from bone
_____ Giant cells derived from monocytes that break down bone by reabsorbing the bony matrix
_____ Located in the center of the osteon; contains blood vessels
2. The series of diagrams below represent the microscopic structure of compact bone tissue. Color the following parts on the diagrams.

- Articular cartilage (A)
- Lacuna (B)
- Collagenous fibers (D)
- Periosteum (F)
- Spongy bone (M)
- Compact bone (G)
- Lamellae (G)
- Central canal (H)
- Osteocyte (I)
- Canaliculi (J)
- Perforating canal (K)
- Blood vessel (L)
3. Examine the diagram at the right. Find a central (Haversian) canal. The central canal runs parallel to the long axis of the bone and carries blood vessels, nerves, and lymph vessels through the bony matrix. Identify the osteocytes (mature bone cells) in lacunae (chambers), which are arranged in concentric circles (concentric lamellae) around the central canal. A central canal and all the concentric lamellae surrounding it are referred to as an osteon or Haversian system. Also identify canaliculi, tiny canals radiating outward from a central canal to the lacunae of the first lamella and then from lamella to lamella. The canaliculi form a dense transportation network through the hard bone matrix, connecting all the living cells of the osteon to the nutrient supply. The canaliculi allow each cell to take what it needs for nourishment and to pass along the excess to the next osteocyte. Also note the perforating (Volkmann’s) canals in the pictures. These canals run into the compact bone and marrow cavity from the periosteum, at right angles to the shaft. With the central canals, the perforating canals complete the communication pathway between the bone interior and its external surface.

4. Use the diagram in #3 above to help you match the structure from the structure with the correct letter from the diagram.

_____ Canaliculi
_____ Central canal
_____ Lamellae
_____ Osteocyte
_____ Osteon
5. Examine the laminated **Microscopic Structure of Bone** card. Use the diagrams on page 4 to help you match the structure with the correct number from the card.

- _____ Central canal
- _____ Compact bone
- _____ Osteocyte
- _____ Osteon
- _____ Perforating canal
- _____ Periosteum
- _____ Spongy bone

6. Examine the laminated **Compact Bone** card. The pictures on this card were taken through a microscope under low power (100X) and under high power (500X). Located the structures described and listed in questions 3, 4, and 5. Remember: central canals are also called Haversian canals.

7. Examine the laminated **Bone Slides** cards. Match the structure with the correct letter from the diagram. Use the **Compact Bone** card and the diagram in #3 for help.

- _____ Canaliculi
- _____ Central canal
- _____ Lamellae
- _____ Matrix
- _____ Osteocyte
- _____ Osteon

**PART III: QUESTIONS**

8. Osteocytes are surrounded by a dense, bony matrix. How do they get the nutrients they need to survive?

________________________________________________________________________
________________________________________________________________________

9. How is the matrix of bone different from that in other connective tissues?

________________________________________________________________________

10. What materials are normally found in the matrix of bone tissue?

________________________________________________________________________

11. The mineral deposits in the bony matrix give bone its (hardness or flexibility?

________________________________________________________________________

Skeletal System Activity #2 page 6
12. The collagen fibers in the bony matrix give bone its (hardness or flexibility)?

_____________________________________________________________

13. A bone placed in vinegar for several days becomes so flexible you can bend it into a “U” shape. Based on what you know about the contents of the matrix in bone, what material did the acid in the vinegar remove from the matrix?

_____________________________________________________________

14. A bone baked at a low temperature for several days becomes so brittle it shatters when you try to bend it. Based on what you know about the contents of the matrix in bone, what material did the heat remove from the matrix?

_____________________________________________________________

15. In children suffering from rickets, the bones are so flexible they bow under the child’s weight. What component in the bony matrix is missing from children suffering from rickets?

_____________________________________________________________

16. In an individual suffering from osteoporosis, the bones are so brittle that they often break under the weight of the individual. What component in the bony matrix is missing from this individual?

_____________________________________________________________

17. What happens during bone remodeling? (p. 127)

_____________________________________________________________

18. What is the relationship between bone remodeling and stress? (p. 127)

_____________________________________________________________

19. What happens if the calcium concentration in body fluids increases by 30%? (p. 127)

_____________________________________________________________
20. What happens if the calcium concentration in body fluids decreases by 35%? (p. 127)

_____________________________________________________________

What happens if the calcium levels decrease by 50%? (p. 127)

_____________________________________________________________

21. Complete the following chart comparing the effects of the hormones listed on calcium levels in body fluids.

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Increase or decrease calcium levels in body fluids?</th>
<th>Store calcium in bone or release calcium from bone?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parathyroid Hormone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calcitriol</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calcitonin</strong></td>
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22. Listed below are the steps in the repair of a bone fracture. Put the steps in the correct order. (p. 128)

______ Internal callus forms as network of spongy bone unites the inner surfaces; external callus of cartilage and bone forms to stabilize the outer edges of the bone

______ Remodeling of spongy bone; initially swelling eventually disappears

______ Formation of a massive blood clot called a fracture hematoma

______ Cartilage in external callus replaced with bone; spongy bone unites broken ends; dead bone fragments removed and replaced

23. Why would you expect the bones of a weight lifter to be thicker and heavier than those of a jogger? (p. 127)

_____________________________________________________________

24. Why is osteoporosis more common in older women than older men? (p. 128)

_____________________________________________________________