**Chapter 6**

1. **INTRODUCTION**
2. Bone is made up of several different tissues working together**: bone cartilage, dense connective tissue, epithelium, various blood forming tissues, adipose tissue, and nervous tissue.**
3. Each individual bone is an organ; the bones, along with their cartilages, make up **the skeletal system.**

**II. FUNCTIONS OF THE SKELETAL SYSTEM**

1. Bones support the...**soft tissues and provide attachment sites for muscles, thereby serving as the structural framework for the body.**
2. Many of the body’s internal organs are protected **by bony coverings**.
3. Bones assist skeletal muscles to **produce movement**.
4. Bones store and release several minerals, especially **calcium and phosphorus**, to help maintain mineral homeostasis.
5. Hemopoiesis, blood cell formation, occurs **in the red marrow of bones**.
6. Yellow marrow of adult bones serves as a site of **triglyceride storage**.
7. **STURCTURE OF BONE**
8. The structure of bone can be analyzed by studying a **long bone**.
9. A typical long bone consists of numerous parts.
10. The diaphysis is the **shaft of the long bone**.
11. The epiphyses are the **ends of the bone**.
12. The metaphyses are the areas between the epiphysis and diaphysis and include the epiphyseal plate in growing bones.
13. Hyaline cartilage (articular cartilage) at the...**ends of the bones reduces friction and absorbs shock at freely movable joints.**
14. The periosteum is a connective tissue covering of the surface of the bone which contains osteogenic cells,...**protects bone, assists in fracture repair, helps nourish bone tissue, and serves as an attachment point for ligaments and tendons.**
15. The space within the diaphysis is the **marrow cavity**.
16. The endosteum is the **lining of the medullary cavity**.
17. **HISTOLOGY OF BONE TISSUE**
18. The matrix of bone contains inorganic salts, primarily hydroxyapatite and some calcium carbonate, and collagen fibers.
19. **These and a few other salts are deposited in a framework of collagen fibers in a process called calcification or mineralization.**
20. **Mineral salts confer hardness on bone while collagen fibers give bone its great tensile strength.**
21. The process of calcification occurs...**only in the presence of collagen fibers.**
22. Bone (osseous) tissue consists of widely separated cells surrounded by large amounts of matrix.
23. There are four principal types of bone cells.
24. **Osteogenic cells undergo cell division and develop into osteoblasts.**
25. **Osteoblasts are bone-building cells.**
26. **Osteocytesare mature bone cells and the principle cells of bone tissue.**
27. **Osteoclasts are derived from monocytes and serve to break down bone tissue.**
28. Depending on the size and distribution of the spaces between the hard components of bone, the regions of a bone may be categorized as compact or spongy.
29. Compact Bone
30. Compact bone is arranged in units called osteons or Haversian systems.
31. Osteons...**contain blood vessels, lymphatic vessels, nerves, and osteocytes, along with the calcified matrix.**
32. Osteons are aligned in the same direction along **lines of stress.**. These lines can change as the stresses on the **bone changes.**
33. Spongy Bone
34. Spongy (cancellous) bone does not contain osteons. It consists of trabeculae surrounding many red marrow filled spaces.
35. **It forms most of the structure of short, flat, and irregular bones and the epiphyses of long bones.**
36. Spongy bone tissue is...**light and supports and portects the red bone marrow.**
37. A bone scan is a diagnostic procedure that can detect **certain bone abnormalities or disorders.**
38. **BLOOD AND NERVE SUPPLY OF BONE**
39. Bone is richly supplied with **blood**.
40. **The arterial supply to bone involves several tissues.**
41. The periosteal arteries pass through Volkmans’ canals to a multitude of vessels that supply the outer compact bone region.
42. The nutrient artery passes through the nutrient canal and sends branches into the central Haversian canals to provide for osteocytes .
43. The metaphyseal artery enters the metaphysis while the epiphyseal arteries enter the epiphyses.
44. **Veins that carry blood away from long bones are evident in three places**
45. One or two nutrient veins follow the nutrient artery in the diaphysis.
46. Epiphyseal and metaphyseal veins accompany epiphyseal and metaphyseal arteries in the epiphysis.
47. Periosteal veins exit with their periosteal arteries in the periosteum.
48. Nerves...**follow blood vessels into bone tissue and the periosteum where they sense damage and transmit pain messages.**
49. **BONE FORMATION**
50. Bone formation is termed osteogenesis or ossification and begins when mesenchymal cells provide the template for subsequent ossification. Two types of ossification occur.
51. Intramembranous ossification is the...**formation of bone directly from or within fibrous connective tissue membranes.**
52. Endochondrial ossification is the...**formation of bone from hyaline cartilage models.**
53. Intramembranous ossification forms the **flat bones of the skull and the mandible.**
54. An ossification center forms from mesenchymal cells as they convert to osteoblasts and lay down osteoid matrix.
55. The matrix surrounds...**the cell and then calcifies as the osteoblast becomes an osteocyte.**
56. The calcifying matrix centers join to form bridges of trabeculae that **constitute spongy bone with red marrow between**.
57. On the periphery the mesenchyme condenses and develops into the periosteum.
58. Endochondrial ossification involves...**erplacement of carliage by bone and forms most of the bones of the body.**
59. The first step in endochondrial ossification is the **development of the cartilage model.**
60. Step two is the **growth** of the cartilage model.
61. In step three, the primary ossification center develops in the diaphysis.
62. The medullary (marrow) cavity **develops and fills with red marrow.**.
63. Step four involves the development of secondary ossification centers in the epiphysis.
64. **The final process is the formation** of articular cartilage and the epiphyseal plate.
65. **BONE GROWTH**
66. Growth in Length
67. To understand how a **bone grows in length**, one needs to know details of the epiphyseal or **growth plate**.
68. The epiphyseal plate consists of four zones: the zone of resting cartilage, zone of proliferation cartilage, zone of hypertrophic cartilage, and zone of calcified cartilage.
69. The activity of the epiphyseal plate is the only means by which the diaphysis can increase in length.
70. When the epiphyseal plate closes, is replaced by bone, the epiphyseal line appears and indicate **the bone has completed its growth in length.**
71. Growth in Thickness
72. Bone can grow in...**thickness or diameter only by appositional growth.**
73. The steps in these process are:
74. Periosteal cells differentiate into osteoblasts which secrete collagen fibers and organic molecules to form the matrix.
75. Ridges fuse and the periosteum becomes the endosteum.
76. New concentric lamellae are formed.
77. Osetoblasts under the peritsteum form new circumferential lamellae.
78. Factors Affecting Bone Growth
79. **Adequate dietary intake of minerals and vitamins is necessary for growth and maintenance of bone.**
80. **Calcium and phosphorous** are needed for bone growth in large concentrations, with other minerals needed in smaller amounts.
81. Vitamins C, K, B12, and A are **needed for bone growth.**.
82. The most important hormones for stimulation of bone growth during childhood are the **insulinlike growth factors** (IGFs), which are stimulated by **human growth hormone** (hGH).
83. Thyroid hormones and insulin are also necessary hormones for bone growth.
84. At puberty the sex hormones, estrogen and testosterone,...**stimulate sudden growth and modifications of the skeleton to create the male and female forms.**
85. Hormonal abnormalities can **affect growth in height**.
86. **BONES AND HOMEOSTASIS**
87. Bone Remodeling
88. Remodeling is the **ingoing replacement of old bone tissue by new bone tissue**.
89. Old bone is constantly destroyed by **osteoclasts**, whereas new bone is constructed by **osteoblasts**.
90. In orthodontics teeth are moved by **braces**. This places stress on bone in the sockets causing osteoclasts and osteablasts to **remodel the sockets so that the teeth can be properly aligned**.
91. Several hormones and calcitrol control **bone growth and bone remodeling**.
92. Fracture and Repair of Bone
93. A fracture is **any break in the bone**.
94. Common fractures include...**open (compound) fracture, closed (simple) fracture, comminuted fracture, greenstick fracture, impacted fracture, Pott’s fracture, and Colles’s fracture.**
95. A stress fracture is a **series of microscopic fissures in bone that forms without any evidence of injury to other tissues.**
96. Fracture repair involves formation of a clot called a fracture hematoma, organization of the fracture hematoma into granulation tissue called a procallus (subsequently transformed into a fibrocartilaginous [soft] callus), conversion of the fibrocartilaginous callus into the spongy bone of a bony (hard) callus, and, finally, remodeling of the callus to nearly original form.
97. **Treatments for fractures include the anatomic realignment of the bone fragments, immobilization to maintain realignment, and restoration of function.**
98. Bone’s Role in Calcium Homeostasis
99. Bone is the **major reservoir** for calcium ions (Ca2+) in the body; the blood level calcium ions (Ca2+) are very closely regulated due to calcium’s importance in **cardiac, nerve, enzyme, and blood physiology**.
100. An important hormone regulating Ca2+ exchange between bone and blood is parathyroid hormone (PTH), secreted by the parathyroid gland. **It increases blood calcium ion levels**.
101. Another hormone that contributes to the homeostasis of blood Ca2+ is calcitonin (CT). It is secreted by the **thyroid gland and decreases blood Ca2+ levels.**
102. Vitamin D is also involved in **calcium homeostasis**.
103. **EXERCISE AND BONE TISSUE**
104. Within limits, bone has the ability to alter its strength in response to...**mechanical stress by increasing deposition of mineral salts and production of cooagen fibers.**
105. Removal of mechanical stress weakens bone through **demineralization (loss of bone minerals) and collagen reduction.**
106. Weight-bearing activities, **such as walking or moderate weightlifting**, help **build and retain bone mass**.
107. **AGING AND BONE TISSUE**
108. Of two principal effects of aging on bone, the first is **loss of calcium** and other minerals from bone matrix (demineralization) which may **result in osterporosis.**
109. The second principal effect of aging on the skeletal system is **a decreased rate of protein synthesis**, resulting in decreased production of matrix components (mostly collagen) and making bones **more susceptible to fracture.**
110. **DISORDERS: HOMEOSTATIC IMBALANCES**
111. Osteoporosis is…**is a decrease in the amount and strength of bone tissue owing to decreases in hormone output.**
112. In osteoporosis, bone resorption **outpaces bone formation.**
113. Rickets and osteomalacia are disorders **in which bones fail to calcify.**