CHAPTER 6 – SKELETAL SYSTEM

OBJECTIVES

On completion of this chapter, you will be able to:

- Describe the skeletal system.
- Describe various types of body movement.
- Describe the vertebral column.
- Identify abnormal curvatures of the spine.
- Describe the differences in the pelvis of a male and female.
- Describe various types of fractures.
- Describe skeletal differences of the child and the older adult.
- Analyze, build, spell, and pronounce medical words.
- Comprehend the drugs highlighted in this chapter
- Provide the description of diagnostic and laboratory tests related to the skeletal system.
- Identify and define selected abbreviations.
- Describe each of the conditions presented in the Pathology Spotlights.
- Complete the Pathology Checkpoint
- Complete the Study and Review section and the Chart Note Analysis.

OUTLINE

I. Anatomy and Physiology Overview (Fig. 6–1, p. 110)

The skeletal system consists of 206 bones that, along with cartilage, tendons, and ligaments, make up the framework or skeleton of the body. The skeleton is divided into the: axial skeleton consisting of 80 bones and the appendicular skeleton consisting of 126 bones. The principal bones of the axial skeleton are the skull, spine, ribs, and sternum. The principal bones of the appendicular skeleton are the shoulder girdle, arms, hands, pelvic girdle, legs and feet.

A. Bones – the primary organs of the skeletal system and are composed of about 50% water and 50% solid matter. The solid matter in bone is a calcified, rigid substance known as osseous tissue.

1. Classification of Bones (Table 6–1, p. 111, Fig. 6–2, p. 112) – bones are classified by their shape: flat, long, short, irregular, sesamoid, sutural or wormian.

2. Functions of Bones – the main functions are to:
   a. Provide shape, support, and framework of the body.
   b. Provide protection for internal organs.
   c. Serve as a storage place for mineral salts, calcium, and phosphorus.
   d. Play an important role in the formation of blood cells as hemopoiesis, which takes place in the bone marrow.
   e. Provide areas for the attachment of skeletal muscles.
   f. Help to make movement possible through articulation.
3. **Structure of a Long Bone (Fig. 6–3, p. 113)** – features are as follows:
   a. **Epiphysis** – ends of developing bone.
   b. **Diaphysis** – shaft of a long bone.
   c. **Periosteum** – membrane that covers bone except at their articular surfaces.
   d. **Compact Bone** – dense, hard layer of bone.
   e. **Medullary Canal** – narrow cavity throughout the length of the diaphysis.
   f. **Endosteum** – membrane that lines the medullary canal and contains bone marrow.
   g. **Cancellous or Spongy Bone** – reticular tissue that makes up most of the volume of bone.

4. **Bone Markings** – their role is to join bones together, provide areas for muscle attachments, and serve as passageways for blood vessels, ligaments and nerves (*Table 6–2, p. 113*).

B. **Joints and Movement** – also known as an **articulation**, a place where two bones connect. Joints are classified as follows (*Fig. 6–4, p. 114*):
   1. **Synarthrosis** – bones are in close contact with each other therefore there is no movement. There is no joint cavity, for example, cranial suture.
   2. **Amphiarthrosis** – permits very slight movement, for example, vertebra.
   3. **Diarthrosis** – allows free movement in a variety of directions, for example, the knee, hip, elbow, wrist, and foot.

   The following terms describe types of body movement that occur at the **diarthrotic joints** (*Fig. 6–5, p. 115*):
   a. **Abduction** – moving a body part away from the middle.
   b. **Adduction** – moving a body part toward the middle.
   c. **Circumduction** – moving a body part in a circular motion.
   d. **Dorsiflexion** – bending a body part backward.
   e. **Eversion** – turning outward.
   f. **Extension** – straightening a flexed limb.
   g. **Flexion** – bending a limb.
   h. **Inversion** – turning inward.
   i. **Pronation** – lying prone or faced downward; also the process of turning the hand so that the palm faces downward.
   j. **Protraction** – moving a body part forward.
   k. **Retraction** – moving a body part backward.
   l. **Rotation** – moving a body part around a central axis.
   m. **Supination** – lying supine; also turning the palm or foot upward.
C. **Vertebral Column (Fig. 6–6, p. 116)** – composed of a series of bones called *vertebrae*. They are connected in such a way as to form four spinal curves. These curves consist of the:
1. **Cervical Curve** – the first 7 vertebrae.
2. **Thoracic Curve** – the next 12 vertebrae.
3. **Lumbar Curve** – the next 5 vertebrae.
4. **Sacral Curve** – consists of the sacrum and coccyx or tailbone.

D. **Anatomical Differences in the Pelvis of a Male and Female** – the *pelvis* is the lower portion of the trunk of the body. It is bound anteriorly and laterally by the hip bones (ilium, pubis, and ischium) and posteriorly by the sacrum and coccyx.

1. **Male Pelvis** – shaped like a *funnel*, forming a narrower outlet than the female. It is heavier and stronger than the female pelvis making it suitable for lifting and running (Fig. 6–8A, p. 118).
2. **Female Pelvis** – shaped like a *basin*, it may be oval to round, and is wider than the male pelvis. It is constructed to accommodate the fetus during pregnancy and to facilitate its downward passage through the pelvic cavity in childbirth. It is broader and lighter than the male pelvis (Fig. 6–8B, p. 118).

II. **Life Span Considerations**

A. **The Child** – bone begins to develop during the second month of fetal life as cartilage cells enlarged, break down, disappear, and are replaced by bone-forming cells called *osteoblasts*. This is known as *endochondral ossification*. Bone cells deposit organic substances in the spaces vacated by cartilage to form bone matrix. As the process proceeds, blood vessels form within the bone and deposit salts that serve to harden the developing bone. The bones of children tend to bend before breaking but when they break, they heal more quickly. This occurs because there is a rich blood supply to the bone and their periosteum is thick and osteogenic activity is high. High calcium content is critical to the strength of bone ranging from 500 to 1300 mg according to age. The portions of developing bone are as follows:

1. **Epiphyseal Plate** – the center for longitudinal bone growth in children (Fig. 6–9, p. 119).
2. **Epiphyses** – the ends of the long bones.
3. **Diaphysis** – the shaft of long bones.

B. **The Older Adult** – women build bone until about the age of 35 then begin to lose about 1% of bone mass annually. Men start losing bone mass 10 to 20 years later. The changes in bone associated with age occur in the connective tissue. There is loss of bone mass and strength due to the loss of bone minerals. Calcium salts may deposit in the matrix and cartilage becomes hard and brittle. This is known as age related *osteoporosis*. Other changes involve the:

1. Diminished viscosity of synovial fluid of joints.
2. Degeneration of collagen and elastin cells.
3. Outgrowth of cartilaginous clusters in response of wear and tear.
4. Formation of scar tissue and calcification in the joint capsule.

Low levels of calcium can make older people susceptible to osteoporosis and stress fractures and result in bones healing slower due to osteoblasts being less able to use calcium to restructure bone tissue. The National Academy of Science recommends that individuals 51 and older consume 1200 mg of calcium per day to help strengthen their bones.

III. Building Your Medical Vocabulary
A. Medical Words and Definitions – this section provides the foundation for learning medical terminology. Medical words can be made up of four types of word parts:
1. Prefix (P)
2. Root (R)
3. Combining Forms (CF)
4. Suffixes (S)

By connecting various word parts in an organized sequence, thousands of words can be built and learned. In the text, the word list is alphabetized so one can see the variety of meanings created when common prefixes and suffixes are repeatedly applied to certain word roots and/or combining forms. Words shown in pink are additional words related to the content of this chapter that have not been divided into word parts. Definitions identified with an asterisk icon (*) indicate terms that are covered in the Pathology Spotlights section of the chapter.

IV. Drug Highlights
A. Anti-inflammatory Agents – are classified as steroidal (corticosteroids) and nonsteroidal. These drugs are used to relieve swelling, tenderness, redness, and pain of inflammation.
2. Nonsteroidal (NSAIDs) – agents that are used to treat arthritis and related disorders.

B. Disease-Modifying Antirheumatic Drugs (DMARDS) – may influence the course of the disease progression. They should be introduced in early rheumatoid arthritis diagnosis to limit irreversible joint damage.

C. Cox-2 Inhibitors – Cyclooxygenase (COX) is an enzyme involved in normal cellular function and also in the inflammatory response. It is found in joints and other areas affected by inflammation. Inhibition of COX-2 reduces the production of compounds associated with inflammation and pain.

D. Antitumor Necrosis Factor Drugs (Anti-TNF) – slow or halt the destruction of the joint by disrupting the activity of tumor necrosis factor (TNF), a substance involved in the body’s immune response.
E. **Agents Used to Treat Gout** – acute attacks are treated with colchicines. Once acute attacks of gout are controlled, drug therapy to control hyperuricemia can be initiated.

F. **Agents Used to Treat or Prevent Postmenopausal Osteoporosis** – medications reduce the activity of the cells that cause bone loss and increases the amount of bone in most patients.

G. **Analgesics** – agents that relieve pain without causing loss of consciousness. They are classified as narcotic and non-narcotic.

V. **Diagnostic and Lab Tests**

A. **Arthrography** – diagnostic examination of a joint in which air, and then, a radiopaque contrast medium are injected into the joint space and x-rays are taken.

B. **Arthroscopy** – examination of the internal structure of a joint via an arthroscope. Usually done after arthrography and before joint surgery.

C. **Goniometry** – the measurement of joint movement and angles via a goniometer.

D. **Photon Absorptiometry** – a bone scan that uses a low density beam of radiation to measure bone-mineral density and bone loss in the lumbar vertebrae in diagnosing and monitoring osteoporosis.

E. **Thermography** – the process of recording heat patterns of the body surface.

F. **X-ray** – the examination of bones by the use of an electromagnetic wave of high energy produced by the collision of a beam of electrons with a target vacuum tube.

G. **Alkaline Phosphatase Blood Test** – a blood test to determine the level of alkaline phosphatase.

H. **Antinuclear Antibodies (ANA)** – present in a variety of immunologic diseases.

I. **Bone Mineral Density Test (BMD)** – used to measure bone mass or bone mineral density. Different machines measure density in different bony areas.

J. **Calcium (Ca) Blood Test** – an increase in calcium levels in the blood may indicate metastatic bone cancer, acute osteoporosis, prolonged immobilization, and the healing of fractures. Levels may be decreased in osteomalacia and rickets.

K. **C-Reactive Protein Blood Test** – positive results may indicate RA, acute inflammatory changes, and widespread metastasis.

L. **Phosphorus (P) Blood Test** – levels of phosphorus in blood may increase in osteoporosis and fracture healing.

M. **Serum Rheumatoid Factor (RF)** – an immunoglobulin present in the serum of 50 to 95% of adults with RA.

N. **Uric Acid Blood Test** – uric acid is increased in gout, arthritis, multiple myeloma, and rheumatism.
VI. Abbreviations (p. 132)

VII. Pathology Spotlights

A. Abnormal Curvatures of the Spine

1. **Scoliosis (Fig. 6–18C, p. 133)** – an abnormal lateral curvature of the spine, which usually appears in adolescence, during a period of rapid growth. Treatment may range from application of cast to surgery.

2. **Lordosis (Fig. 6–18B, p. 133)** – an abnormal anterior curvature of the spine. The condition may be referred to as swayback as the abdomen and buttocks protrude due to an exaggerated lumbar curvature.

3. **Kyphosis (Fig. 6–18A, p. 133)** – normal thoracic curvature becomes exaggerated, producing a humpback appearance, which may be caused by a congenital defect, a disease process, a malignancy, compression fracture, faulty posture, osteoarthritis, rheumatoid arthritis, etc.

B. **Arthritis** – inflammation of one or more joints occurring in males and females of all ages. Treatment varies and is aimed at reducing pain and discomfort along with preventing disabilities. Medications, exercise activity modifications, and surgery are included. Types of arthritis include:

1. **Osteoarthritis (OA) (Fig. 6–19, p. 134)** – the most common form of arthritis in the United States, resulting from years of accumulated wear and tear of weight bearing joints and those of the fingers. Risk factors include obesity, trauma, and various genetic and metabolic diseases.

2. **Gout (Fig. 6–20, p. 134)** – a hereditary metabolic disease seen most often in men over the age of 40. The causes include hyperuricemia, excessive amounts of uric acid in the blood, the deposit of urates of sodium in and around the joints, and by the formation of crystals in the joint resulting in inflammation.

3. **Rheumatoid Arthritis (Fig. 6–21, p. 135)** – an autoimmune disorder that affects both males and females of all ages. Symptoms may include joint pain and swelling, morning stiffness, warmth around a joint, redness of the skin around a joint, reduced ability to move a joint. Treatment depends on the cause and severity of the disease but can include exercise, medications, and heat and cold treatments.

C. **Carpal Tunnel Syndrome (Fig. 6–22, p. 136)** – results from pressure on the median nerve resulting in numbness, pain, and eventually, hand weakness occurring because of repetitive movement of the wrist in people 30 to 60 years old. Treatment includes night splints, modifying the work area, medications, and a surgery called carpal tunnel release (the release of pressure on the median nerve).
D. **Fractures** (Fig. 6–23, p. 137) – are classified according to their external appearance, the site of the fracture, and the nature of the crack or break in the bone. The summary of fractures is as follows:

1. **Closed or Simple Fractures** – completely internal; skin is not broken.
2. **Open or Compound Fracture** (Fig. 6–24, p. 137) – fractured ends protrude through the skin leading to the possibility of infection or hemorrhage.
3. **Comminuted Fracture** – the affected part is shattered into a multitude of bony fragments.
4. **Transverse Fracture** – break the shaft of the bone across its longitudinal axis.
5. **Greenstick Fracture** – occurs usually in children whose long bones have not fully ossified; only one side of the shaft is broken, and the other side is bent.
6. **Spiral Fracture** – spread along the length of the bone and are produced by twisting stresses.
7. **Colles’ Fracture** – break in the distal portion of the radius, usually resulting from reaching out to cushion a fall.
8. **Pott’s Fracture** – occurs at the ankle and affects both bones of the lower leg.
9. **Compression Fracture** – occurs in vertebrae subjected to extreme stresses.
10. **Epiphyseal Fracture** – a fracture seen exclusively in children occurring where the matrix is undergoing calcification and chondrocytes are dying.

E. **Osteoporosis** (Fig. 6–25, p. 138) – condition characterized by the progressive loss of bone density and thinning of bone tissue. Occurs when the body fails to form enough new bone, or when too much old bone is reabsorbed by the body, or both. Osteoporosis frequently occurs with calcium deficiency. The body will use calcium stored in the bone, weakening them and making them vulnerable to breaking. Sufficient amounts of vitamin D are also needed for calcium absorption. Risk factors include:

- Family history
- Lack of exercise
- Thin, small frame
- Never been pregnant
- Early menopause
- Tendency to fractures and loss of height in recent years
- Avoidance of dairy products as a child
- Use of cigarettes and alcoholic beverages
- Diet high in salt, caffeine, or fat
- Insufficient intake of vitamin D

Tests such as bone mineral density (BMD) testing are most frequently used for diagnosis and evaluation of osteoporosis. The result of the test is
called a T-score. A patient is considered osteoporotic if the bone mass is at least 20% below normal. A score of -2.5 or less is considered high risk. Treatments for osteoporosis focus on slowing down or stopping bone loss, preventing bone fractures, and controlling pain.

VII. Pathology Checkpoint

IX Study and Review (pp. 140–146)

X. Practical Application: SOAP: Chart Note Analysis