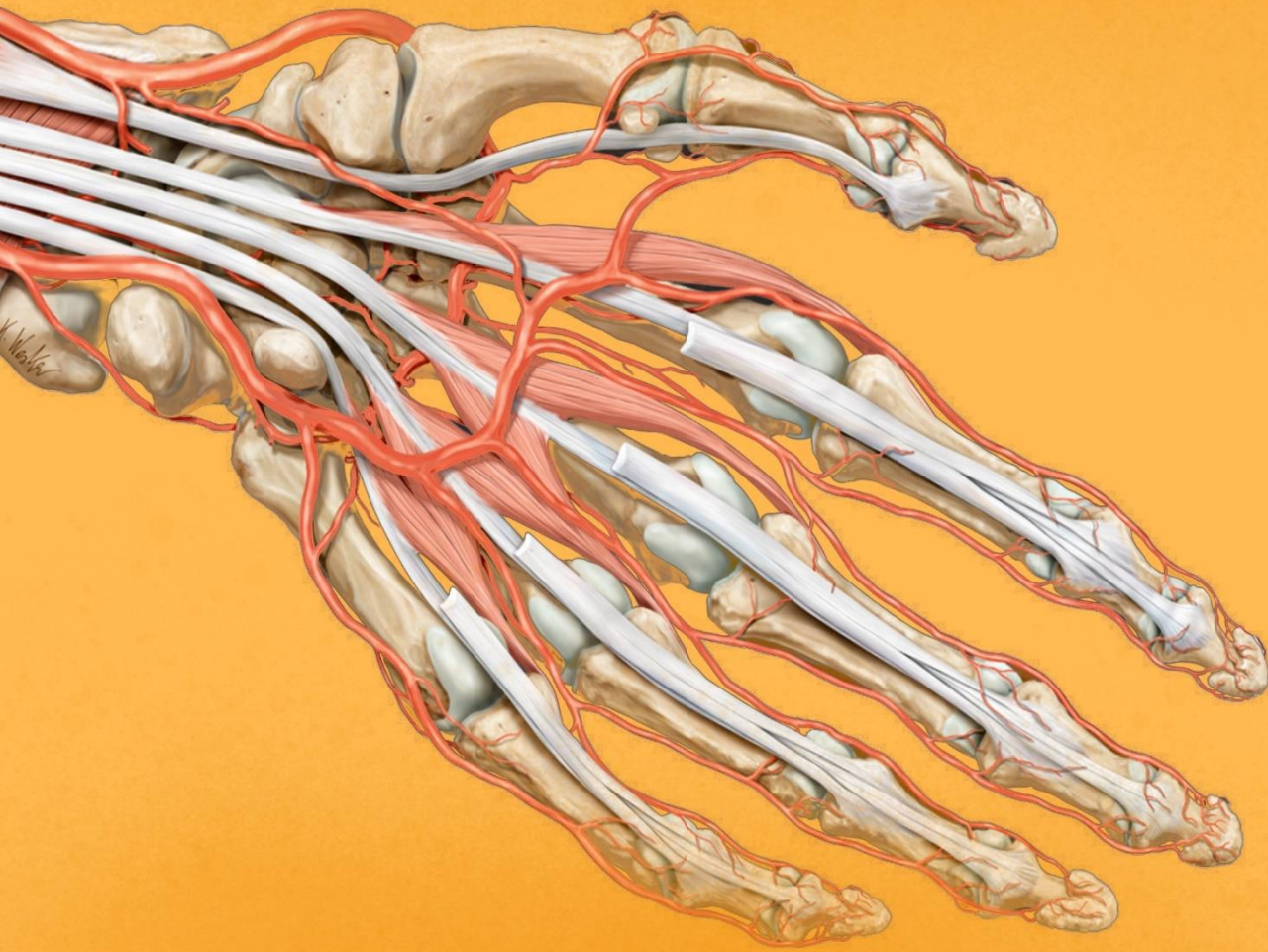


HATAHET ANATOMY



Basics of Skeletal System

Lecture: 2

Pages: 8

Lecture 2: Basics of Skeletal System

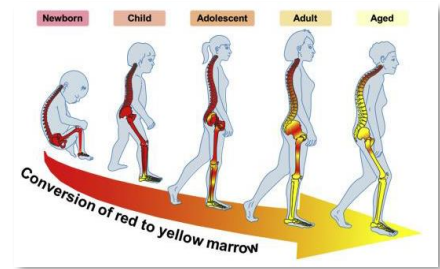
Introduction to Skeletal system

Definition & Functions

▪ **Skeletal system:** the entire framework of bones and their cartilages & joints

➤ Functions of skeletal system:

- 1 Support and protection
- 2 Provide solid framework for skeletal muscles to attach
- 3 Assistance in moving (Leverage system - نظام الرافعات)
- 4 Mineral storage, like Calcium (Ca), Phosphorus (P), Manganese (Mn)
- 5 Site of **Hematopoiesis (Blood formation)** which occurs in the **red bone marrow**
- 6 Triglyceride (Fat) storage in the fatty **yellow bone marrow**



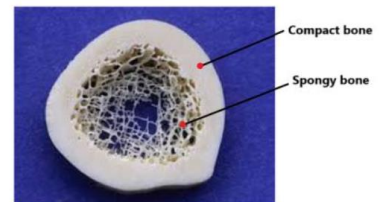
***Notes:

- ♦ As we age, the red bone marrow is slowly converted to yellow bone marrow, from the (**inferior → superior**), and in hematopoiesis will then be restricted to: (Ribs, Sternum, Proximal humerus and femur, Cervical vertebrae)
- ♦ We can determine the age of sheep while eating lamb based on its bone marrow color; the older the sheep, the paler (yellowish) the bone marrow will be

Histological classification of bones

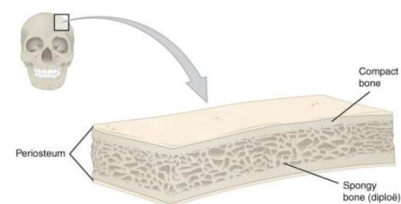
1) Compact bone

- the solid bony tissue that covers the outer surface of the bone
- it gives the bone protection and maintains its shape
- other names are (Cortical, Dense, Ivory)



2) Spongy bones

- the spikey type of bone interior to the bone, covered by compact bone
- composed of irregular pattern of thin spikey columns called (**Trabeculae**)
- spaces between trabeculae are where the bone marrow lives
- other names are (Cancellous, Trabecular)



***Note: The spongy bone between the 2 compact bone layers of cranial bones only is called **Diploë**

Morphological classification of bones

1) Long bones

- cylinder-like bones that have one dimension several times more than the other dimension
- these bones are big in length and very small in width
- they are slightly curved for more strength
- Ex: (Clavicle, Humerus, Radius, Ulna, Metacarpals, Phalanges UL, Femur, Tibia, Fibula, Metatarsals, Phalanges LL)

2) Short bones

- cube-like bones that have approximately equal length, width, and thickness
- Ex: (Carpals, Tarsals "**except the Calcaneus - the heel bone**")

3) Flat bones

- thin and curved bones that have some irregular features but the most evident feature that they are flat
- flat bones can also be described as two 2 parallel plates of compact bone enclosing a layer of spongy bone
- these bones have significant functions:

- ① provide very wide surface for muscle attachment
- ② the major site for hematopoiesis
- ③ shock absorber; the spongy bone within is more resistant to fracture than compact bone

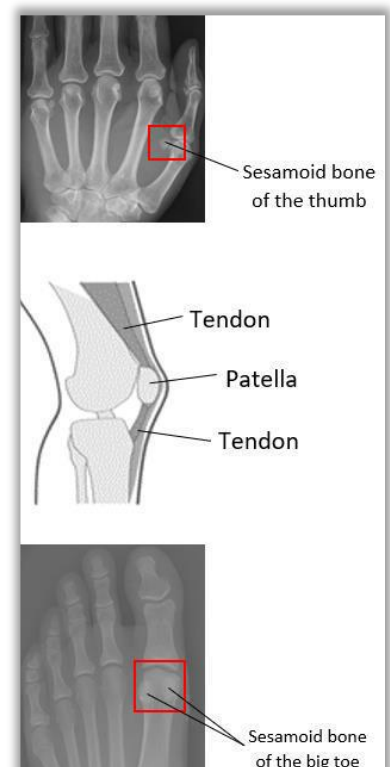
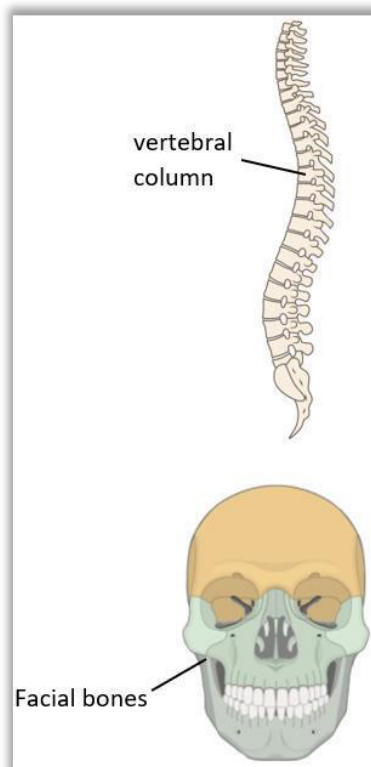
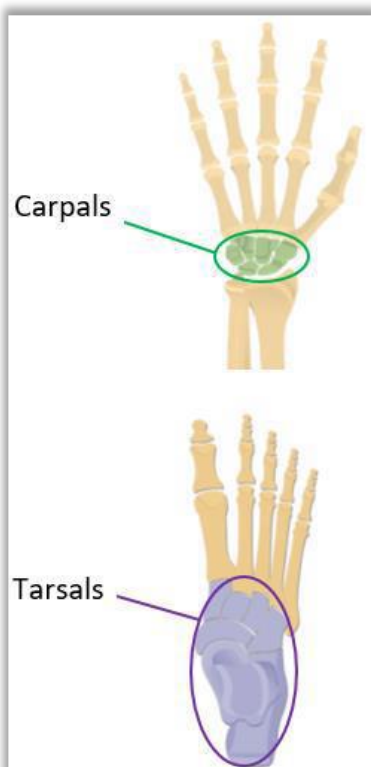
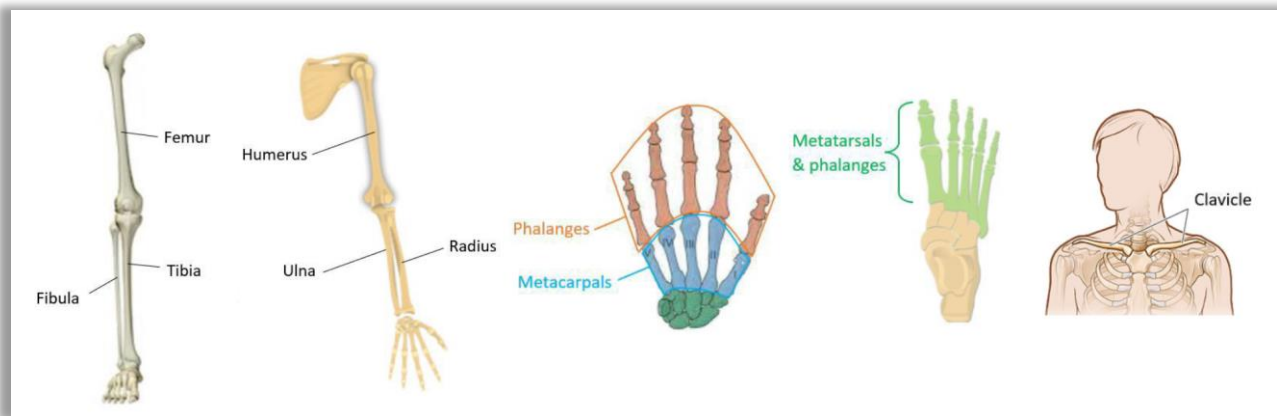
- Ex: (Sternum, Scapula, Ribs, Hip bones, Cranial bones “except Ethmoid and Sphenoid”)

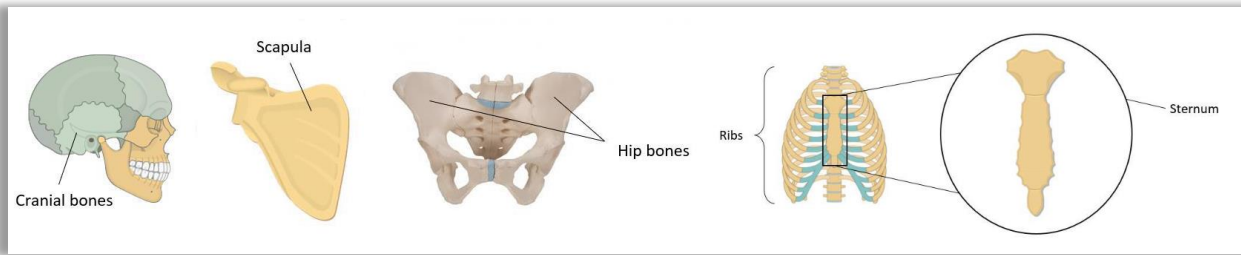
4) Irregular bones

- complex bones that don't have specific shape to describe
- vary in the amount of spongy bone and compact bone
- Ex: (Vertebrae, Facial bones, Calcaneus, Ethmoid and Sphenoid)

5) Sesamoid bones

- small and rounded bones embedded in tendons and don't articulate with bones
- their function is to decrease stress in the tendons
- Ex: (Patella, within the thumb, within the big toe)





Basic Anatomy of skeletal system

Anatomy of Long bones

- **Epiphysis**, the proximal & distal ends of the bone, both are covered with hyaline cartilage to provide smoothness
- **Diaphysis (Shaft/Body)**, the long component of the long bone
- **Metaphysis**, the connection point between diaphysis and each epiphysis
- **Articular cartilage**, the cartilage that provides smoothness to the articulating surface between two bones
- **Epiphyseal plate (Growth plate)**, the point of bone growth in length, located between epiphysis and metaphysis
- **Epiphyseal line**, the remnants of the epiphyseal plate, appears after the bone is completely grown in adults as a thin line using X-ray
- **Periosteum**, the layer that covers the outer surface of the bone (**except the articular cartilage**) and consists of 2 main layers:

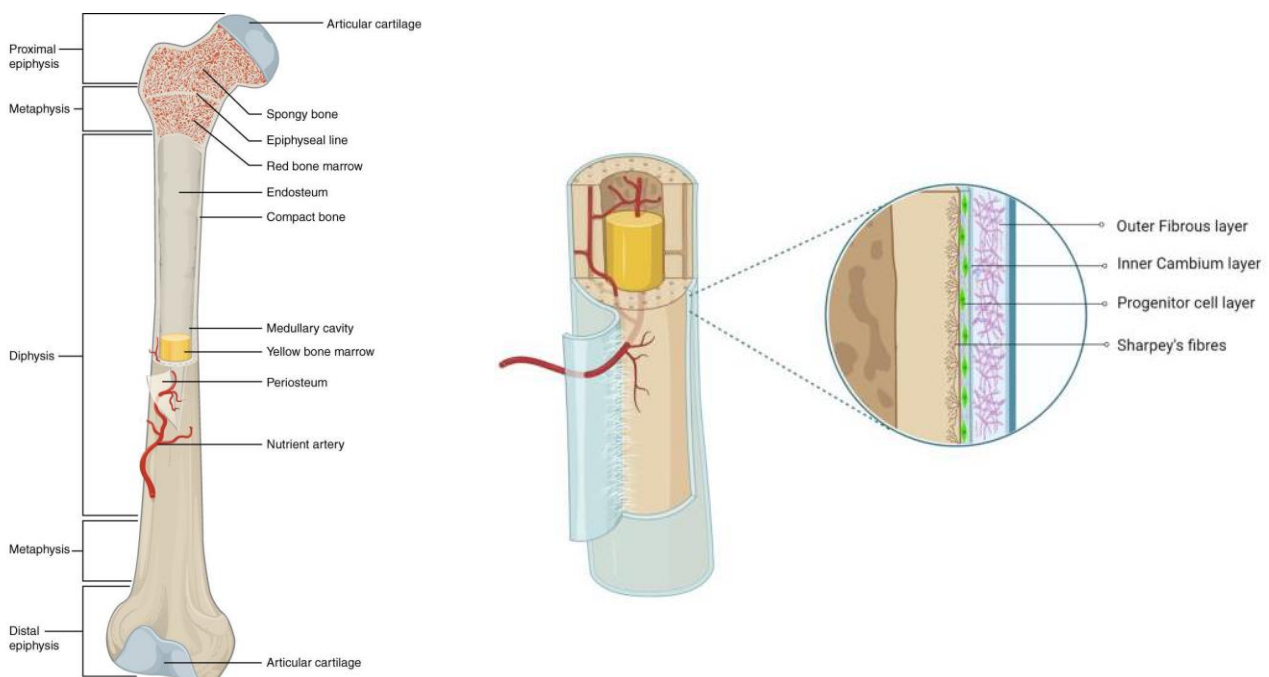
- ♦ **Outer fibrous layer** → made of connective tissue and is the layer that hardens the bones
- ♦ **Inner cellular layer (Osteogenic layer)** → houses both osteogenic cells and osteoblasts

➤ Functions of the periosteum are:

- ① protects the bones
- ② assists in bone fractures repair
- ③ serves as an attachment point for tendons and ligaments
- ④ associated with bone growth in width

Osteogenic → bone tissue stem cell
Osteoblast → builds bone tissue
Osteoclast → dissolves bone tissue

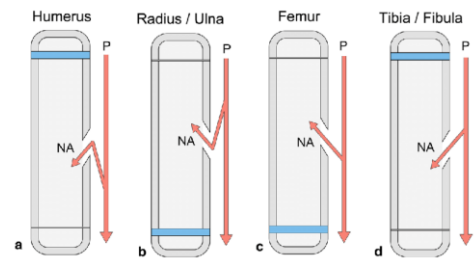
- **Medullary cavity**, hollow cavity inside diaphysis of long bones which contains yellow bone marrow. This cavity minimizes the weight of the bone by reducing the dense bones where it is least needed
- **Endosteum**, a thin membrane that lines the medullary cavity, and it has **the same structure as the periosteum**
- **Perforated fibers (Sharpey's fibers)**: collagen fibers extending from the periosteum through lamella, making it hard to separate the periosteum from the lamella



Definition & Functions

Bones are **living organs** that consist of cells which are in **high demand for blood supply**:

- ❶ **Periosteal artery**, supplies the periosteum & outer compact bone
- ❷ **Metaphyseal artery**, supplies the spongy bone in the metaphysis
- ❸ **Epiphyseal artery**, supplies the spongy bone in the epiphysis
- ❹ **Nutrient artery**, penetrates the diaphysis through an opening called (**Nutrient foramen**) and goes in oblique direction, based on the bone it nourishes ➡ **Go to the elbow, Flee from the knee** ➡



Basic Biochemistry of skeletal system

Patterns of bone formation

- 1) **Intramembranous ossification** → formation of bones directly from mesenchyme, in a sheet-like arrangement
 ➡ Bones formed in this pattern are: (Flat bones of skull, Facial bones, Middle end of the clavicle)
- 2) **Endochondral ossification** → formation of bones from hyaline cartilage that was developed from mesenchyme
 ➡ Bones formed by this pattern are: (the remaining skeleton other than the listed above)

Bone growth mechanism

- ❖ **Growth in Length**: the growth of the epiphyseal plate in metaphyses of long bones by replacing the cartilage with bone, this process is called the (**Endochondral ossification**). This occurs in the diaphysis side of the epiphyseal plate
- ❖ **Growth in Thickness (Diameter)**: the division of the inner periosteal layer to increase the thickness of the bone, this process is called the (**Appositional growth**)

Bone development

Bones start as cartilages and then they will be converted into bone tissue as the following:

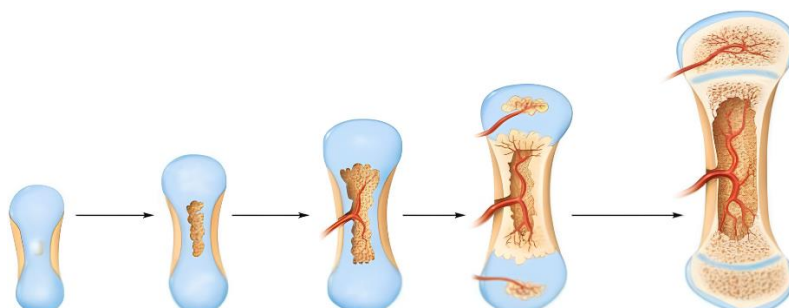
➤ Phase 1

- ❶ blood vessels invade the center of the diaphysis
- ❷ a process of differentiation will change the cartilage in the diaphysis into a bone called (**Primary ossification center**)
- ❸ the bone will grow from the center towards both ends, producing in the medullary cavity

➤ Phase 2

- ❹ blood vessels invade the epiphyses
- ❺ a process of differentiation will change the cartilage into cancellus (spongy) bone called (**Secondary ossification center**)
- ❻ the bone will grow away from the epiphysis towards the diaphysis

❖ When both ossifications meet, they will form the (**Epiphyseal plate**) and all the future growth of the long bone will occur in this plate



Bone remodeling

▪ **Bone remodeling**: the ongoing replacement of old bone tissue by new one (**Bone resorption + Bone deposition**)

- ♦ **Resorption**: the removal of minerals and collagen fibers from bone, **by osteoclasts**
- ♦ **Deposition**: the addition of minerals and collagen fibers to bone, **by osteoblasts**

***Notes:

- ♦ Even after bones have reached their adult shape and size, old bone is continually destroyed and replaced with new one
- ♦ Every year, 10% of our skeleton is remodeled, so every decade (**10 years**) **we will have a brand-new skeleton**

Skeletal System Terminology

Structure/Term	Description	Description in Arabic
Depressions and Openings		
Fissure	narrow slit/opening between adjacent parts of bones through which blood vessels and nerves pass	شق صغير
Foramen	opening through which blood vessels, nerves, or ligaments pass	فتحة أو ثقب
Fossa	shallow depression	تجويف
Sulcus	furrow/groove along bone surface that accommodates a blood vessel, nerve, or tendon	أخدود
Meatus	tube-like opening	قناة أسطوانية
Projections (which form the joints)		
Condyle	oval-shaped protuberance with smooth articular surface at the end of the bone	بروز بيضوي
Facet	smooth, slightly concave or convex articular surface	سطح أملس
Head	usually, rounded articular projection supported on the neck	رأس
Projections (which form attachment points for muscles and ligaments)		
Neck	constriction below the head	عنق
Crest	prominent ridge or elongated projection	حافة سميقة
Line	less prominent ridge than a crest	حافة غير سميقة
Epicondyle	rough projection above a condyle	ما يعلو البروز البيضوي
Spinous process (Spine)	sharp, slender and elongated projection	بروز مستعرض
Trochanter	very large projection	بروز ضخم
Tubercle	variable-sized rounded projection	بروز متوسط
Tuberosity	variable-sized projection that has a rough, bumpy surface	حدبة خشنة

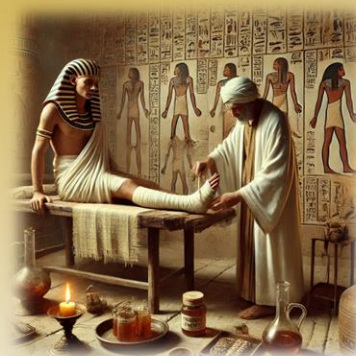
Examples on each term are displayed in the lecture video once uploaded 😊

Osteology in Ancient Egypt

Ancient Egyptian doctors were highly skilled at treating broken bones. They used wooden splints, papyrus bandages, and honey to prevent infections. In more serious cases, they even placed raw meat on the wound to help it heal.

Surprisingly, this method worked; X-rays of mummies show that many of fractures healed properly. Their knowledge of bone healing was advanced for their time.

While their treatments may seem strange today, they were effective in helping people recover and get better



Multiple Choice Questions

1) Which of the following is NOT a function of the skeletal system?

- A. Blood cell production
- B. Hormone secretion
- C. Fat storage
- D. Mineral storage

Answer: B

2) Which type of bone is primarily responsible for hematopoiesis?

- A. Short bones
- B. Irregular bones
- C. Flat bones
- D. Sesamoid bones

Answer: C

3) Which bone type is found embedded in tendons?

- A. Long bones
- B. Flat bones
- C. Irregular bones
- D. Sesamoid bones

Answer: D

4) The diaphysis of an adult long bone contains which structure?

- A. Yellow bone marrow
- B. Red bone marrow
- C. Trabecular bone
- D. Epiphyseal plate

Answer: A

5) What process is responsible for the formation of most bones in the body?

- A. Intramembranous ossification
- B. Endochondral ossification
- C. Fibrocartilaginous ossification
- D. Appositional growth

Answer: B

6) The epiphyseal plate is responsible for which type of bone growth?

- A. Growth in thickness
- B. Growth in length
- C. Growth in density
- D. None of the above

Answer: B

7) Which type of bone cell is responsible for breaking down bone tissue?

- A. Osteoblast
- B. Osteoclast
- C. Osteocyte
- D. Chondroblast

Answer: B

8) Which of the following is an example of a short bone?

- A. Scapula
- B. Two answers are correct
- C. All carpals
- D. All tarsals

Answer: C

9) Which part of the bone contains blood vessels that supply nutrients to the diaphysis?

- A. Metaphyseal artery
- B. Epiphyseal artery
- C. Periosteal artery
- D. Nutrient artery

Answer: D

10) The periosteum is composed of how many layers?

- A. One
- B. Two
- C. Three
- D. Four

Answer: B

11) What is the function of Sharpey's fibers?

- A. Connect the periosteum to bone
- B. Store calcium
- C. Protect the epiphysis
- D. Assist in hematopoiesis

Answer: A

12) The spongy bone between two compact bone layers of cranial bones is called:

- A. Diploë
- B. Trabeculae
- C. Lamellae
- D. Perichondrium

Answer: A

13) Bone remodeling consists of which two processes?

- A. Endochondral and intramembranous ossification
- B. Resorption and deposition
- C. Growth and differentiation
- D. Expansion and contraction

Answer: B

14) The primary ossification center forms in which part of a long bone?

- A. Epiphysis
- B. Metaphysis
- C. Periosteum
- D. Diaphysis

Answer: D

15) What is the primary function of the epiphyseal line?

- A. Support the diaphysis
- B. Store fat
- C. Indicate completion of bone growth
- D. Aid in fracture repair

Answer: C

16) A 12-year-old boy fractures his femur while playing football. The doctor explains that his bone will continue to grow in length until adulthood. Which structure is responsible for this growth?

- A. Epiphyseal plate
- B. Periosteum
- C. Medullary cavity
- D. Articular cartilage

Answer: A

17) A 65-year-old woman is diagnosed with osteoporosis (هشاشة العظام), a condition where bones become weak and fragile due to excessive bone resorption. Which type of cell is most responsible for this process?

- A. Osteoblasts
- B. Osteoclasts
- C. Chondrocytes
- D. Osteocytes

Answer: B

18) Which of the following is TRUE regarding bone growth and development?

- A. Bones only grow in length, not width
- B. Bone remodeling stops once a person reaches adulthood
- C. The periosteum plays a role in bone repair and growth
- D. Endochondral ossification only occurs in flat bones

Answer: C

19) Which of the following is TRUE about spongy bone?

- A. It is also called cortical bone
- B. It contains trabeculae instead of osteons
- C. It is found only in flat bones
- D. It has a solid, dense structure

Answer: B