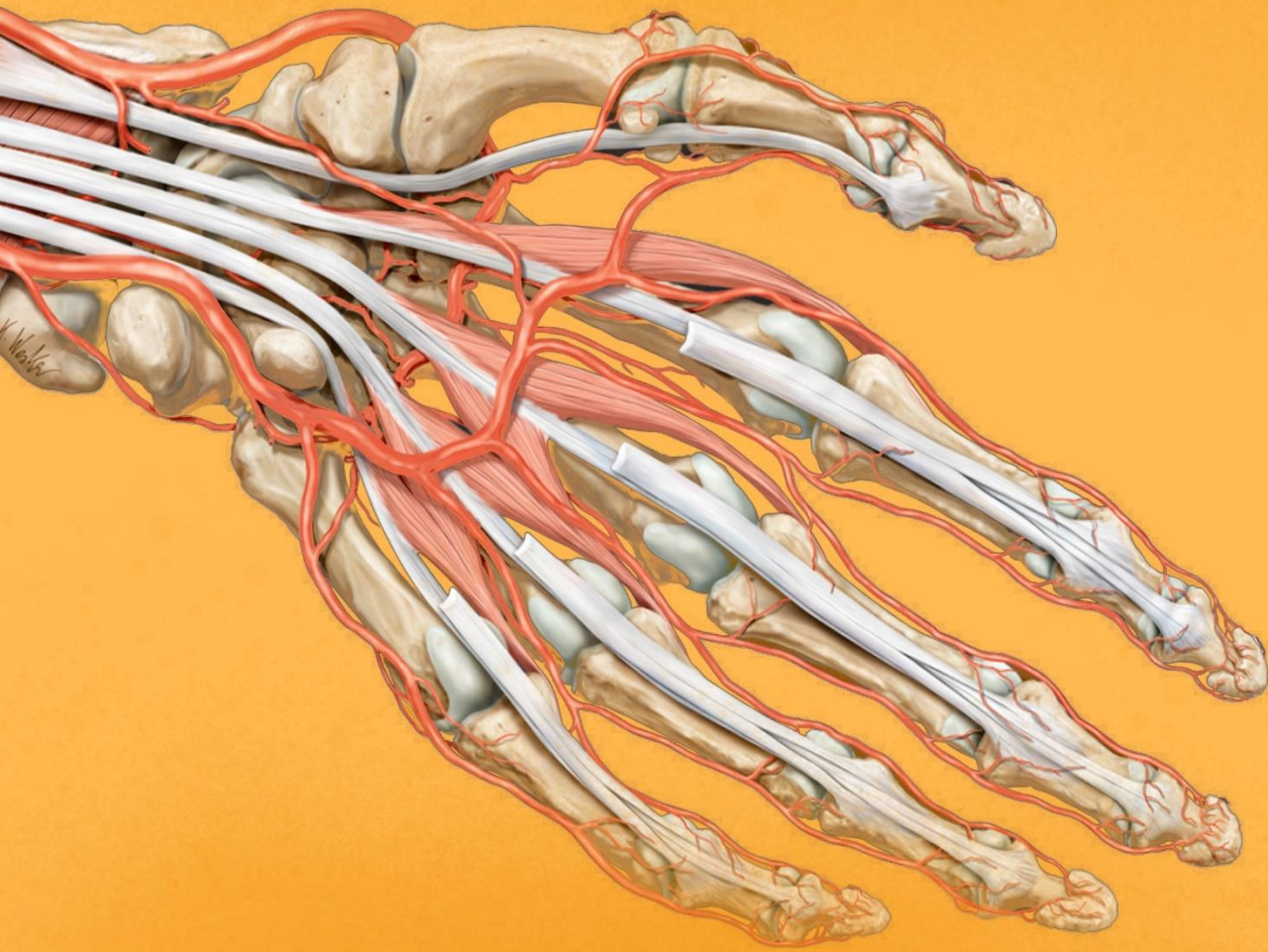


HATAHET ANATOMY



Basics of Skeletal System

Lecture: 2

Pages: 8

Lecture 2: Basics of Skeletal system

Basics: (Introduction)

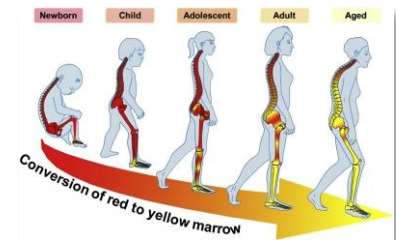
Definition & Functions

- **Skeletal system**: the entire framework of bones and their cartilages & joints
- **Osteology**: the study of bone structure and the treatment of bone disorders

• **Osteo** = bone
• **Chondro** = Cartilage
• **Myo** = Muscle

➤ Functions of skeletal system:

- 1 support and protection
- 2 provide solid framework for skeletal muscles to attach
- 3 assistance in moving (Leverage system – نظام العتلات و الرافعات)
- 4 mineral storage, like Calcium (Ca), Phosphorus (P), and Manganese (Mn)
- 5 site of **Hematopoiesis** 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**) of bones, and in elderly, the hematopoiesis will 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 colour; the older the sheep, the paler (more yellowish) the bone marrow will be

Classification of bones

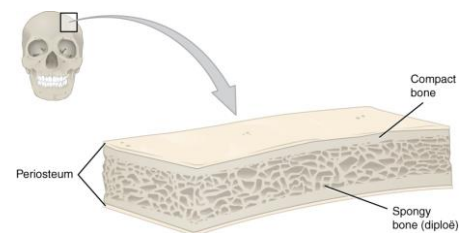
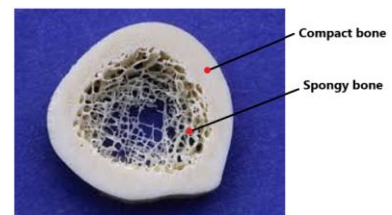
❖ Based on Histological compartments:

1) Compact bones

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

2) Spongy (Cancellous) bones

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

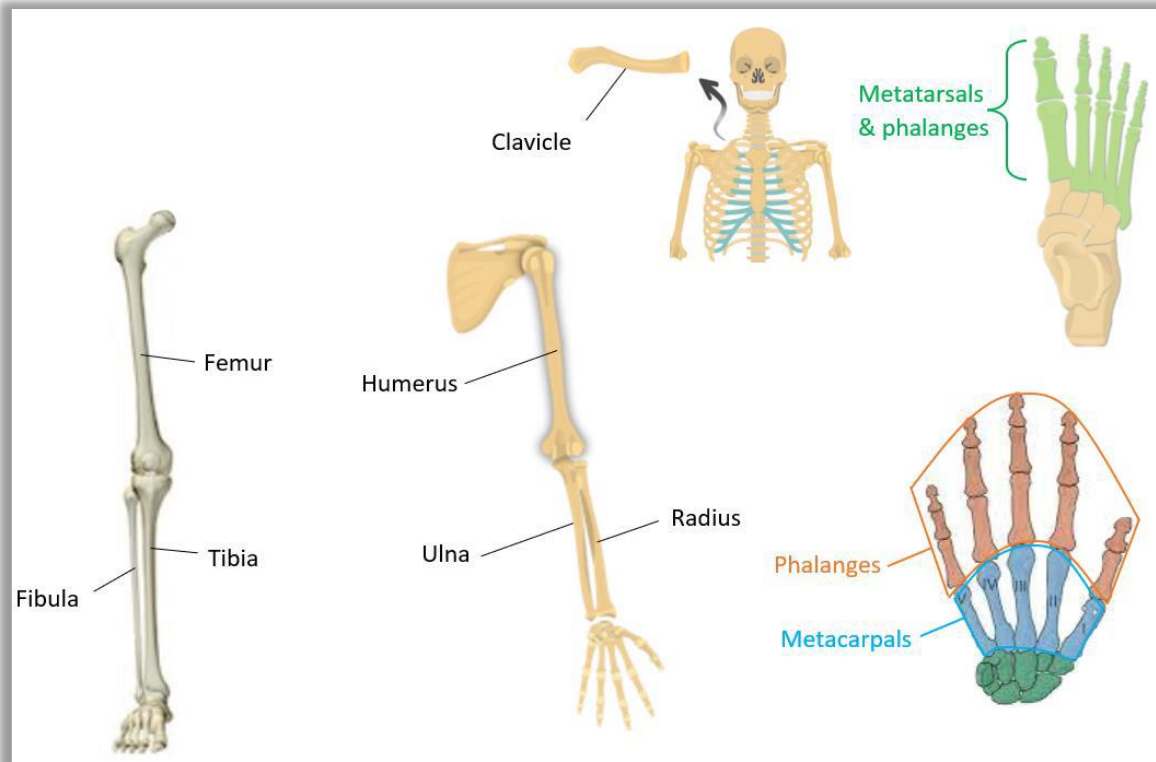


***Note: The spongy bone between the 2 compact bone layers of cranial bones only is called **Diploë**

❖ Based on Morphology (Shape):

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”)

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”)

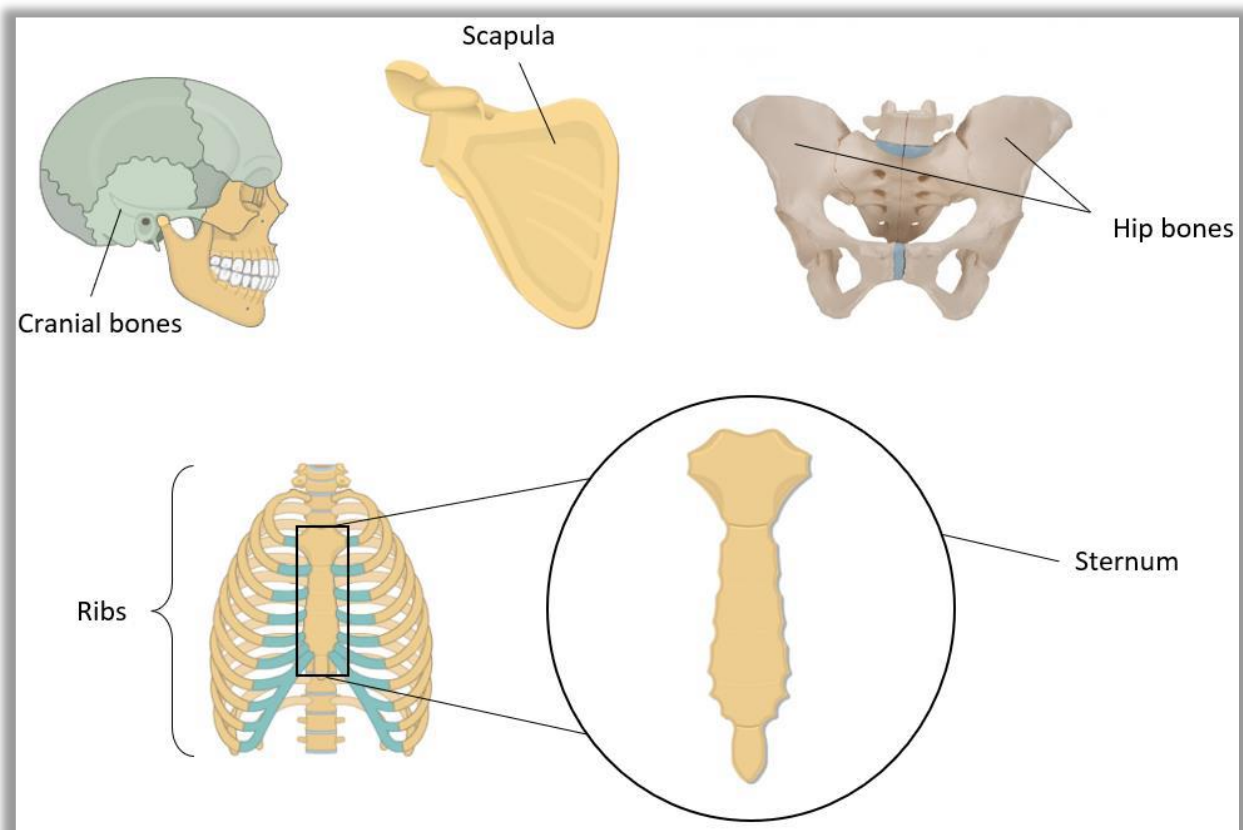
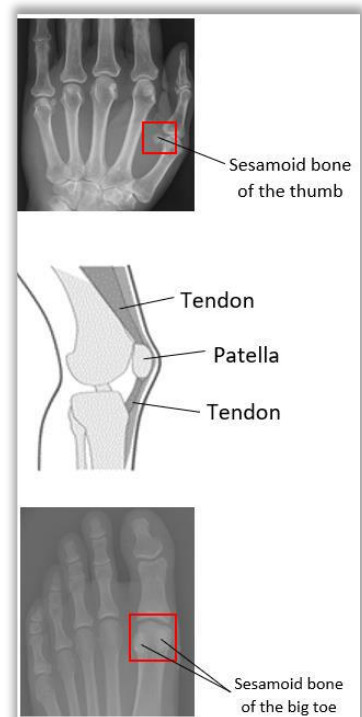
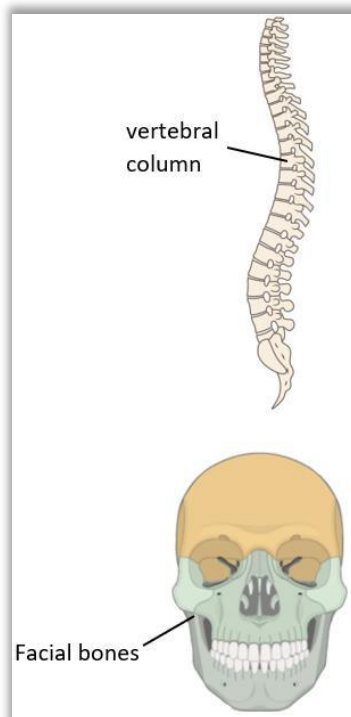
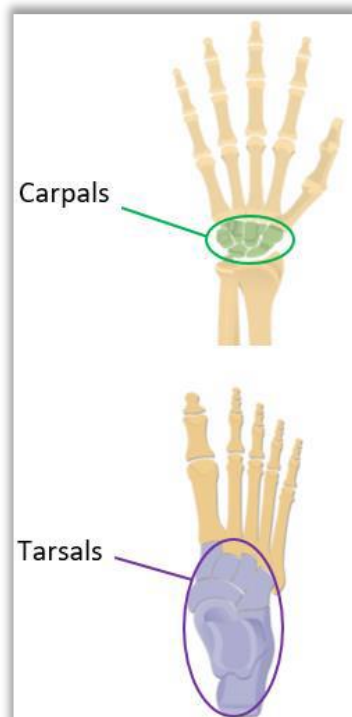
4) Irregular bones

- 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)

***Note: There is no straight bones in the human body



Basics: (Anatomy)

Anatomy of long bones

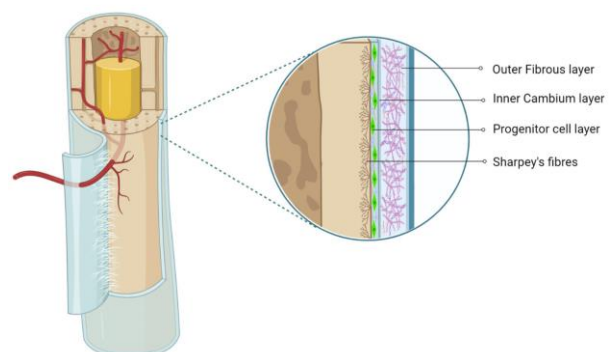
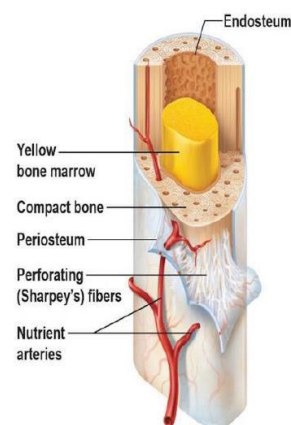
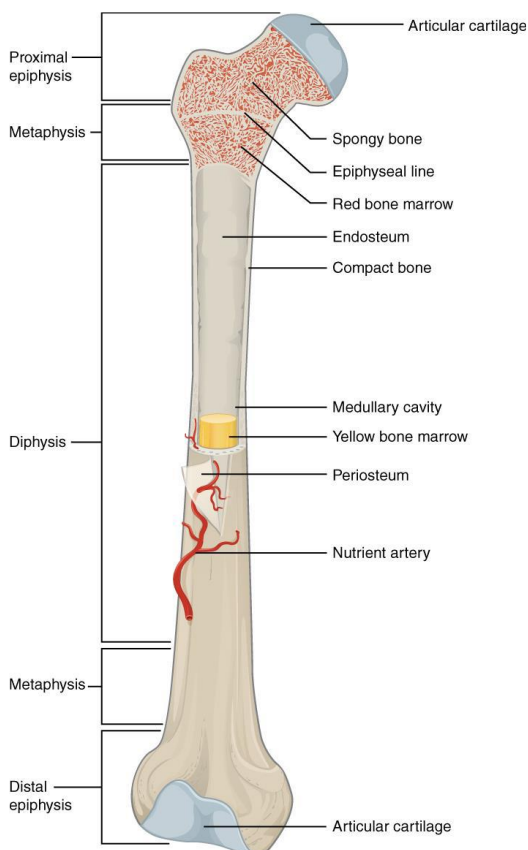
- **Epiphysis**, the proximal & distal ends of the bone, both are covered with hyaline cartilage to provide smoothness
- **Diaphysis (Shaft/Body)**, the long component of the long bone
- **Metaphysis**, the connection point between diaphysis and each epiphysis
- **Articular cartilage**, the cartilage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

- **Outer fibrous layer** → made of connective tissue and it hardens the bones
- **Inner cellular layer (Osteogenic layer)** → houses both osteogenic cells and osteoblast

➤ 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**

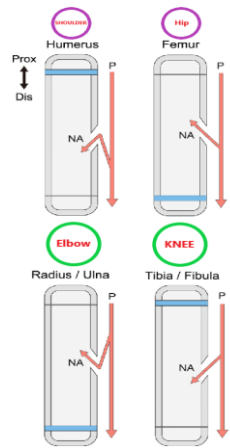
- **Medullary cavity**, hollow cavity inside the long bone along with the diaphysis which contains yellow bone marrow. This cavity minimizes the weight of the bone by reducing the dense bones where it is least needed
- **Endosteum**, a thin membrane that lines the medullary cavity, and it has the same 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



Blood supply of the bones

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

- **Periosteal artery**, supplies the periosteum & outer compact bone
- **Metaphyseal artery**, supplies the spongy bone in the metaphysis
- **Epiphyseal artery**, supplies the spongy bone in the epiphysis
- **Nutrient artery**, penetrates the diaphysis through the Nutrient foramen, and goes in oblique direction, based on the bone it nourishes. ⚡ **Go to the elbow, Flee from the knee** ⚡



*****Note:** The bones are rich in sensory nerves that carry pain, tearing, and tension sensations

Basics: (Histology)

Bone tissue cells

1) Osteoprogenitors (Osteogenic cells)

- stem cells that live in the inner layer of the periosteum
- they are the only cells in the bone tissue that **can undergo cell division & differentiation**
- these cells will differentiate into (Osteoblasts)

2) Osteoblasts

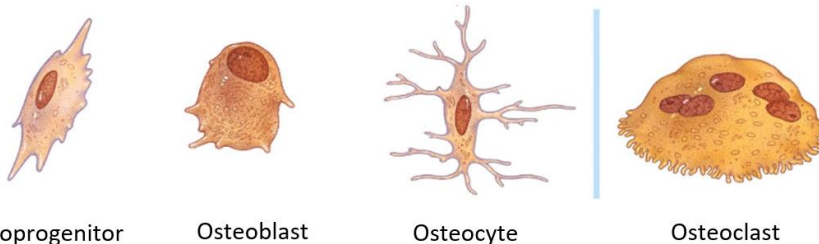
- develop from osteoprogenitor cells
- they form the bone by **secreting extracellular matrix** around themselves
- surrounding themselves as a result, and converting into (Osteocytes)

3) Osteocytes

- develop from osteoblast
- have multiple processes going in all directions that help **maintaining the structure** of the bone tissue

4) Osteoclasts

- macrophages that are large and has multiple nuclei and little processes
- these cells are responsible for **Bone remodeling** (Resorption + Deposition)



Osteoprogenitor

Osteoblast

Osteocyte

Osteoclast

- **Haversian system (Osteon)**: the building unit of the compact bone

Basics: (Biochemistry)

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 1)

Bone growth mechanism

- ❖ **Growth in Length:** the growth of the epiphyseal plate in metaphyses of long bones by replacing the cartilage with bone, a process called (**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, a process called (**Appositional growth**)

Bone development

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

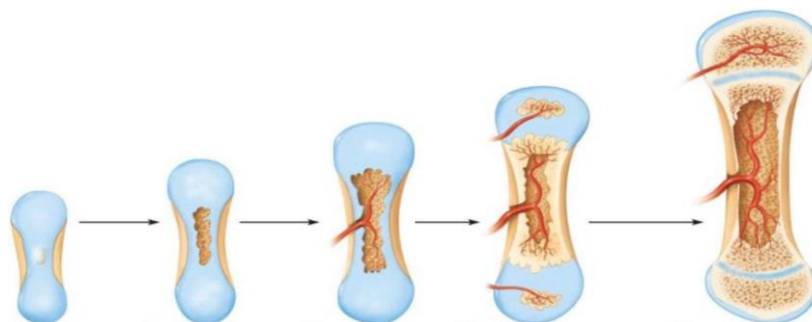
✦ Phase 1:

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

✦ Phase 2:

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

- ♦ When both ossifications meet, they will form a plate called (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 !!!

Basics: (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 a bone surface that accommodates a blood vessel, nerve, or tendon	أخدود
Meatus	tube-like opening	فتحة اسطوانية (أنبوبية)
Projections (that form 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 (that form attachments points for connective tissue)		
Neck	constriction below the head	عنق
Crest	prominent ridge or elongated projection	حافة سميقة
Line	less prominent ridge than a crest	حافة مش سميقة
Epicondyle	rough projection above a condyle	ما يعلو البروز البيضوي
Spinous process	sharp, slender and elongated projection	بروز طولي (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

Questions

1) Both ends of any long bone are called:

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

2) Some bones are described as **2** thin parallel plates of compact bone enclosing **1** layer of spongy bone, which are:

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

3) Which of the following is the correct definition of a trochanter?

- A. Oval-shaped protuberance with smooth articular surface
- B. Prominent ridge or elongated projection
- C. Constriction below the head
- D. Very large projection

4) Which of the following statements are FALSE regarding the long bones:

- A. Medullary cavity minimizes the weight of bones by reducing the dense bony material where it is least needed
- B. Epiphyseal line is the precursor of the Epiphyseal plates in adults
- C. Metaphysis is the connection point between diaphysis and each epiphysis, also known as the (Body/Shaft)
- D. None of the above are false

5) The INCORRECT statement regarding the bone tissue is:

- A. Osteocytes develop from osteoblasts
- B. Osteogenic cells are large, multi-nuclei cells that responsible for bone remodeling
- C. Osteoblasts form the bone lamina by secreting extracellular matrix around themselves
- D. The stem cells that are able to differentiate into osteoblasts are the Osteoprogenitors

6) All of the following are CORRECT regarding the periosteum of compact bone, EXCEPT:

- A. the outer fibrous layer is the hard layer that houses the osteogenic cells
- B. No correct answers, all are FALSE
- C. Sharpey's fibers are collagen fibers extending from the periosteum through lamella of a bone
- D. the periosteum helps protecting the bones and assists in fractures repair

7) All of the following are examples on flat bones, EXCEPT:

- A. Sternum
- B. Cranial bones
- C. Facial bones
- D. Scapula

Answers

1	2	3	4
A	C	D	C
5	6	7	
B	A	C	