Lecture (8)

BONES AND CARTILAGE

Learning objectives:
After this lecture, student should be able to:
-Know the structure of bone.
-Describe the different of types of bones.
-Know the growth and ossification of bones..
-Identify the bone marrow and periosteum.
-Identify the different types of cartilage in the body.
-Understand the role of bones in support and locomotion.
-Understand the definition and types of bone fractures.

The example (s) for long bones is (are)
A. Humerus. B. Femur. C. Clavicle.
D. A &B. E. A, B & C.

FUNCTIONS OF BONES

The human skeleton serves the following functions:

(a) Bodily Support: The skeletal system provides a framework for the human body.

(b) Protection: The skeleton protects certain soft structures within the human body. An example is the skull, which surrounds the brain and the thoracic cage which protect the heart and lungs.

(c) Motion: Muscles are attached to and move the bones. Bones provide leverage for motion.

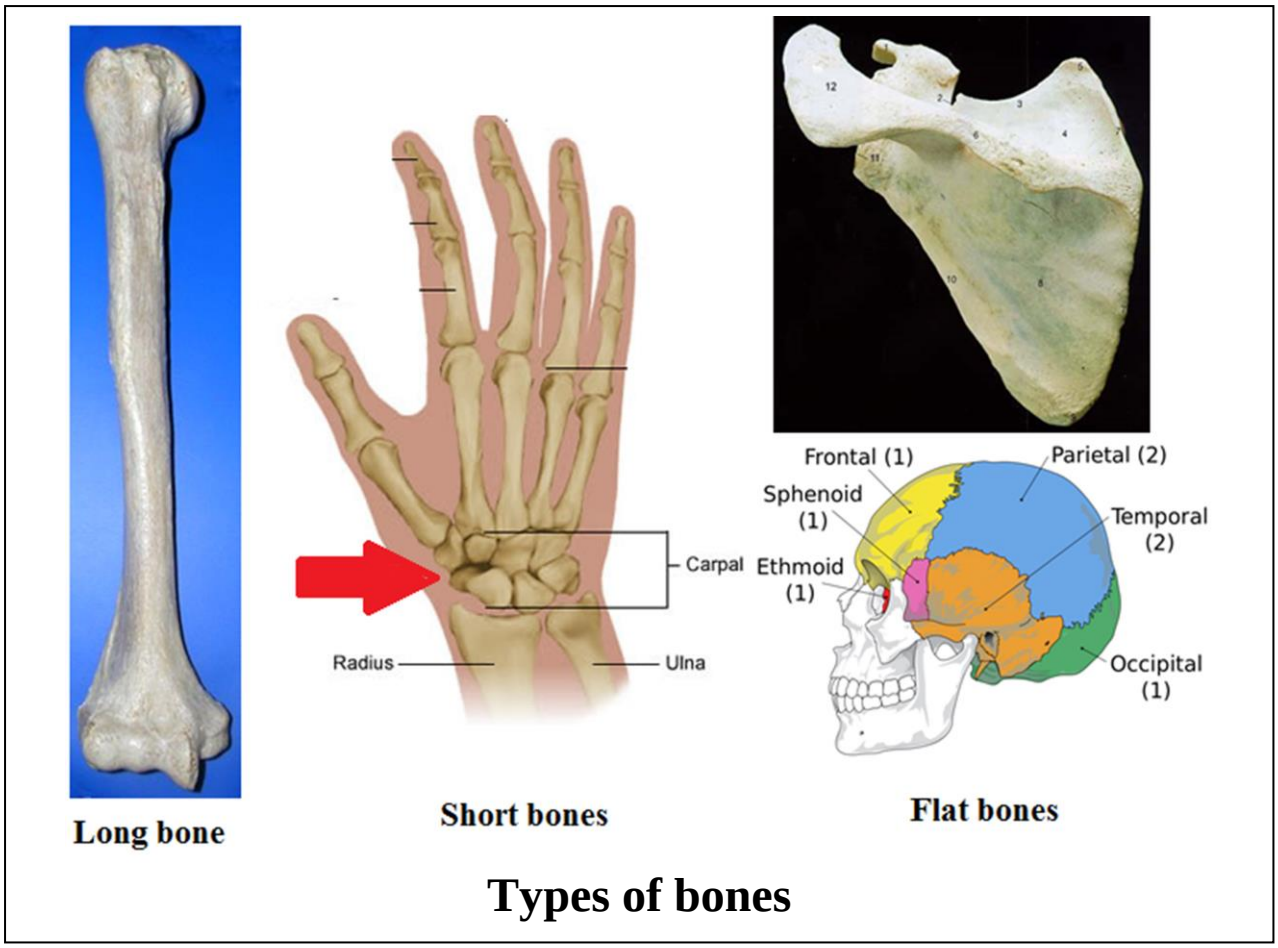
(d) Formation of Blood Cells (Hematopoiesis): Blood cells are manufactured in the red bone marrow, mainly found in flat bones.

(e) Storage for salts (e.g., calcium).

TYPES OF BONES according to its shape

a. Long Bones: Each bone has two ends and a shaft. Example: femur, clavicle and humerus.

b. Short Bones: The short bones, such as those of the wrist and feet, have a thin layer of compact bone surrounding an inner mass of spongy bone. Example: carpal and tarsal bones.



Types of bones

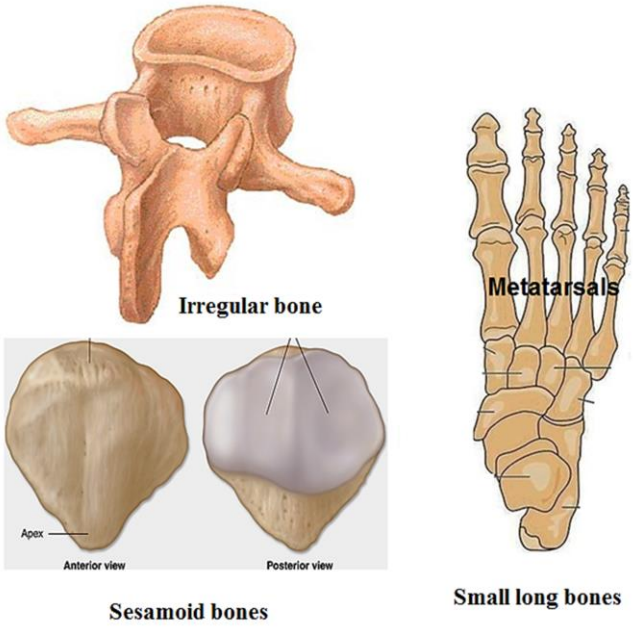
c. Flat Bones: The flat bones are constructed with two plates of compact bone which enclose between them a layer of spongy bone. The spongy bone is richly supplied with blood vessels and red marrow. Example: the scapula and the cranial bones.

d. Irregular Bones: The irregular bones are those that do not fit into the three categories above. Example: a vertebra.

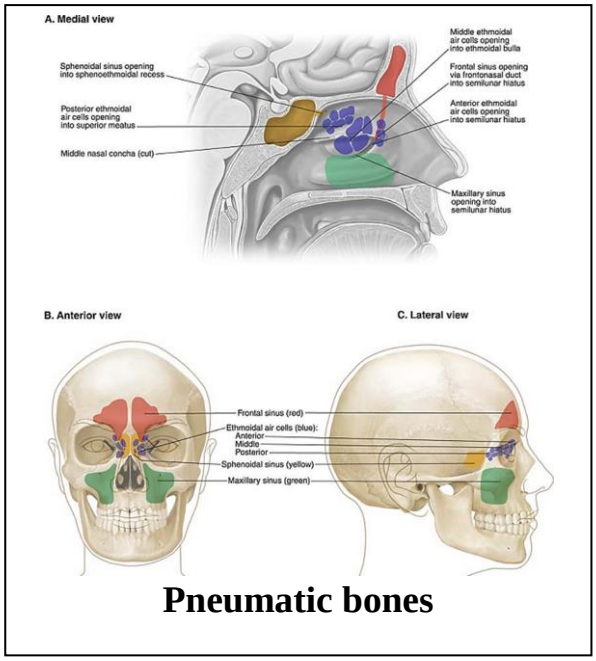
e. Pneumatic Bones: it has multiple air filled spaces Example: para nasal sinuses.

f. Small long Bones: it has single .epiphyses Example: metacarpal and metatarsal bones.

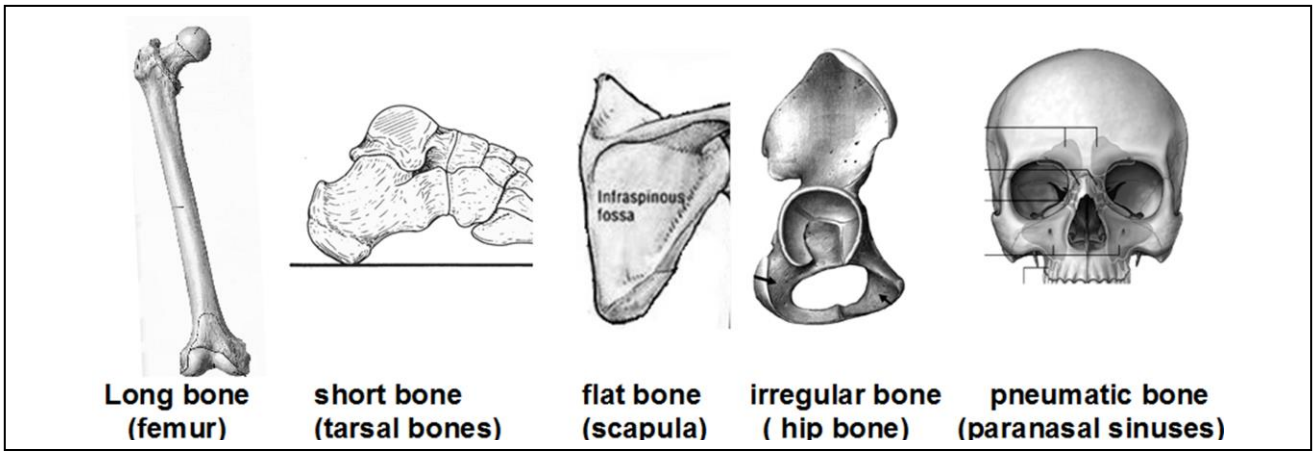
g. Sesamoid Bones: Sesamoid bones are small masses of bone that develop in tendons at points where great forces are applied to the tendons. The most obvious and largest sesamoid bone is the patella, or kneecap.



Types of bones



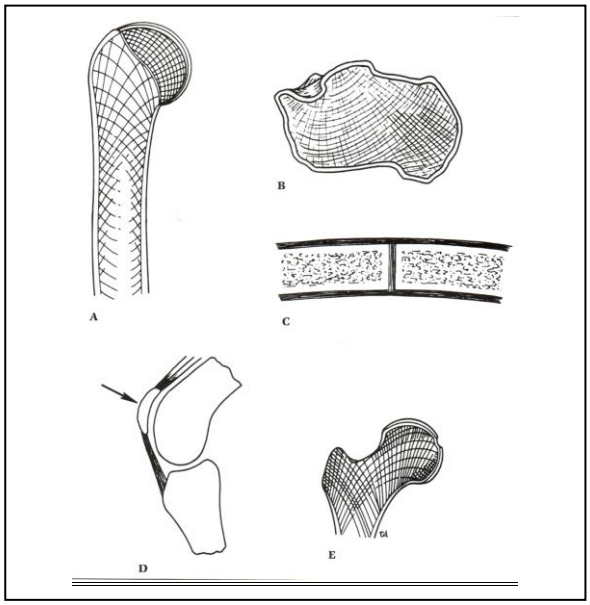
Pneumatic bones

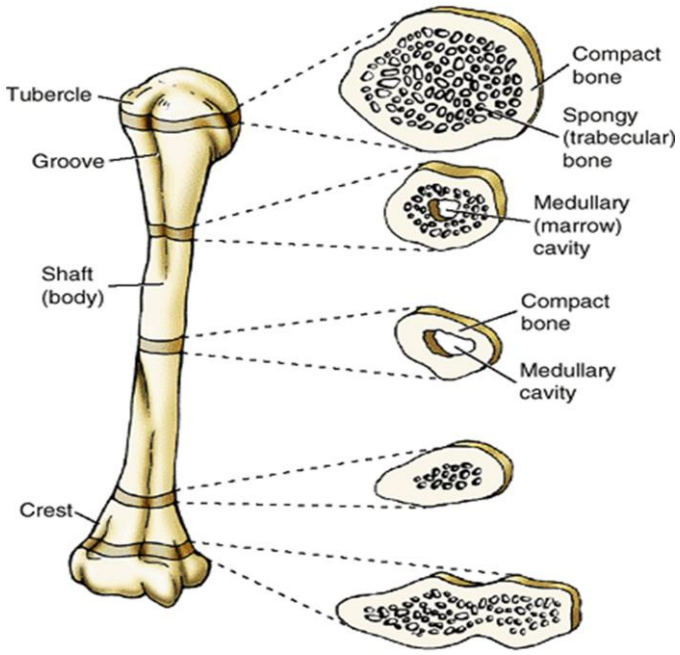


Another classification of bones based on the structure of the bones:

(a) Compact bone is dense, forms the tubular bodies of long bones and filled with yellow bone marrow;

(b) Cancellous (spongy) bone is lattice of bone spicules. It occurs in the ends of long bones and fills the flat and irregular bones .The spaces between the spicules are filled with red bone marrow.





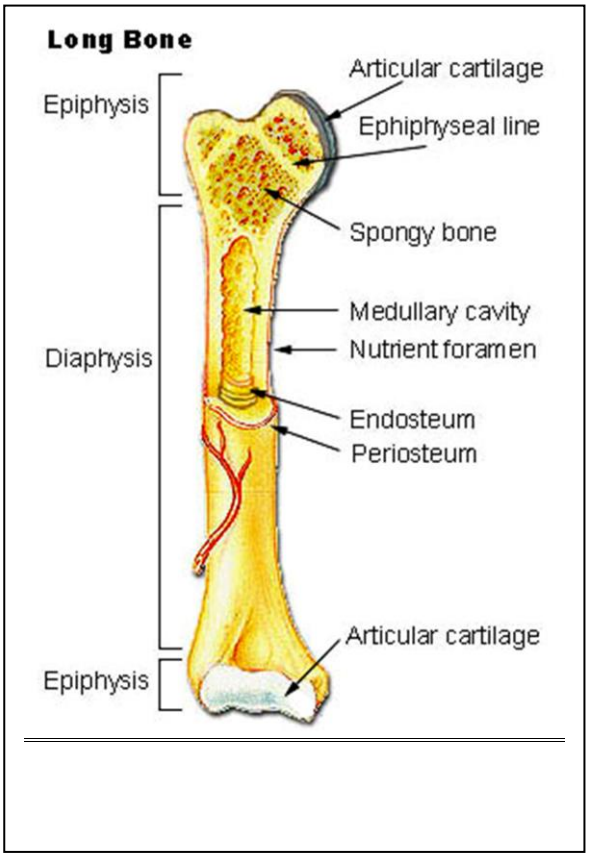
Structure of long bone

BASIC STRUCTURE OF AN INDIVIDUAL BONE

(1) Cortex: The cortex is the outer layer of the individua1 bone. It compact (dense) bony tissue.

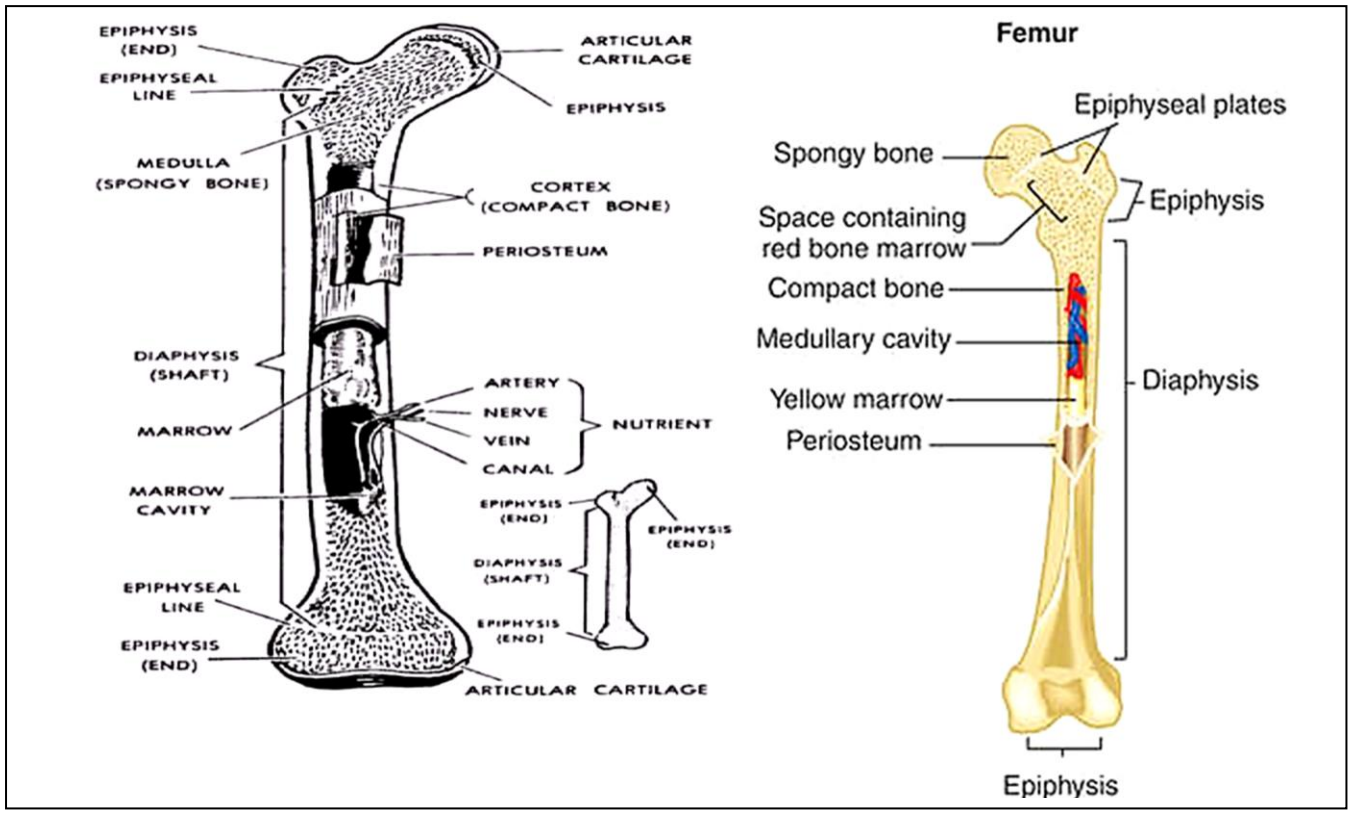
(2) Medulla: The medulla is the central portion of the individual bone. It generally consists of cancellous (spongy) bone tissue. In some bones, particularly long bones, the medulla may include a space without any bony tissue. This space is called the medullary or marrow cavity.

(3) Marrow: Marrow serves as a filler of the inside of bones. There are two types of bone marrow--yellow bone marrow and red bone marrow:



Yellow bone marrow is mostly yellow fat tissue. Red bone marrow is the only site in adults for the formation of red blood cells (hematopoiesis).

(4) Periosteum: The periosteum is a covering of the bone surface area not covered by articular cartilage. The periosteum is well supplied with blood vessels and sensory-type nervous tissue.



Named Parts of an Individual Long Bone

Shaft (diaphysis): The shaft is the central portion of a long bone. Here, the cortex is thickened as required by applied physical stresses.

Ends (epiphyses): The ends of long bones are made up mainly of cancellous (spongy) bone tissue. An articular cartilage covers each area where a bone contacts another bone(s). This articular cartilage is made up of hyaline cartilage tissue and provides a smooth surface for motions.

Ossification Centers

An ossification center is a growing mass of actual bone within the preformed material.

(1) Initial bone formation involves destruction of the preforming material and replacement with bony tissue.

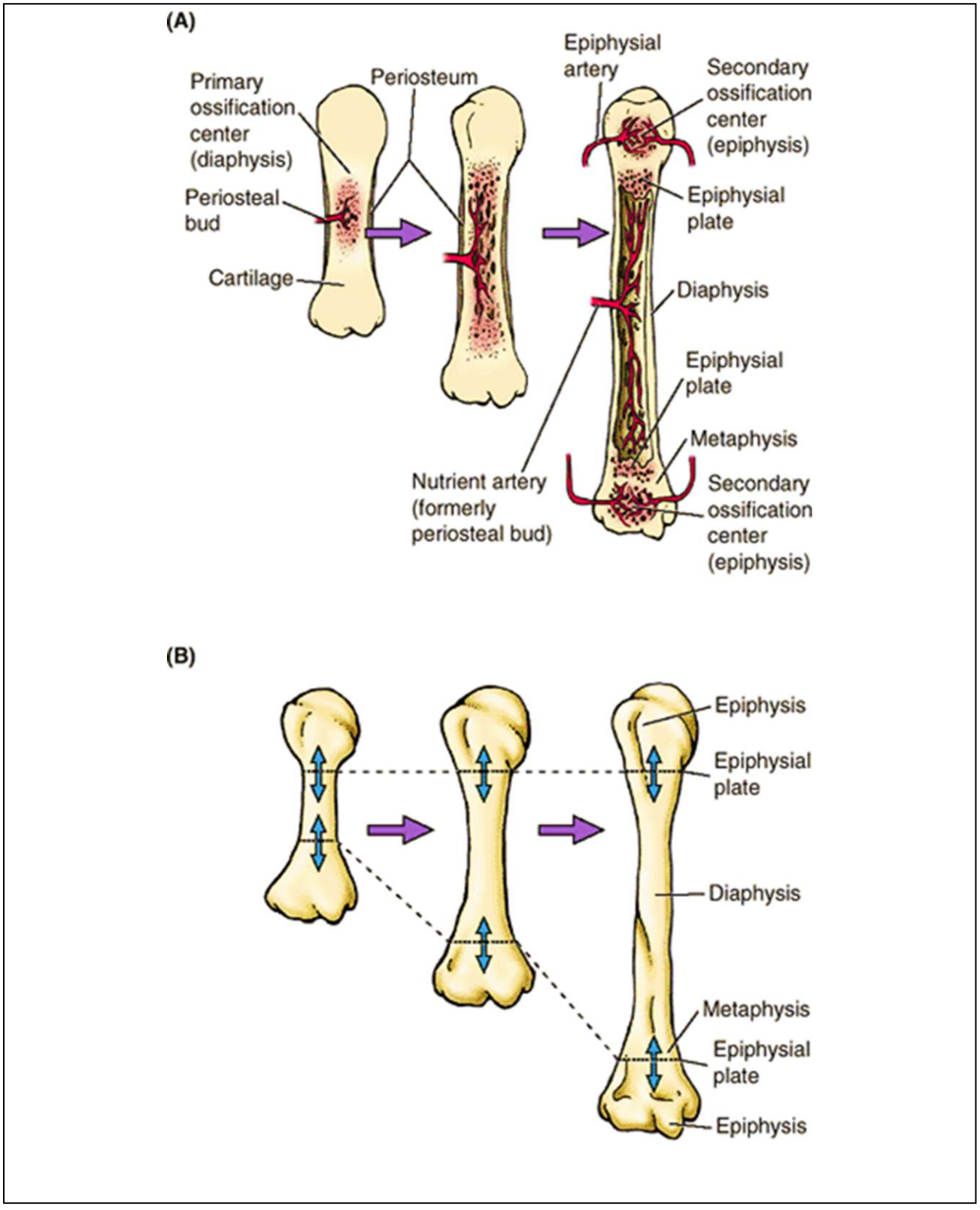
(2) In the development of long bones, there are two types of ossification centers:

(a) Diaphyseal--in the shaft region.

(b) Epiphyseal--in the end(s)

Blood Supply of an Individual Bone

A system of blood vessels enters and spreads out through the periosteum. Additional blood vessels, called "nutrient vessels," penetrate the cortex' of the bone and spread out through the marrow. The passageways for penetration of these vessels are called the nutrient canals.

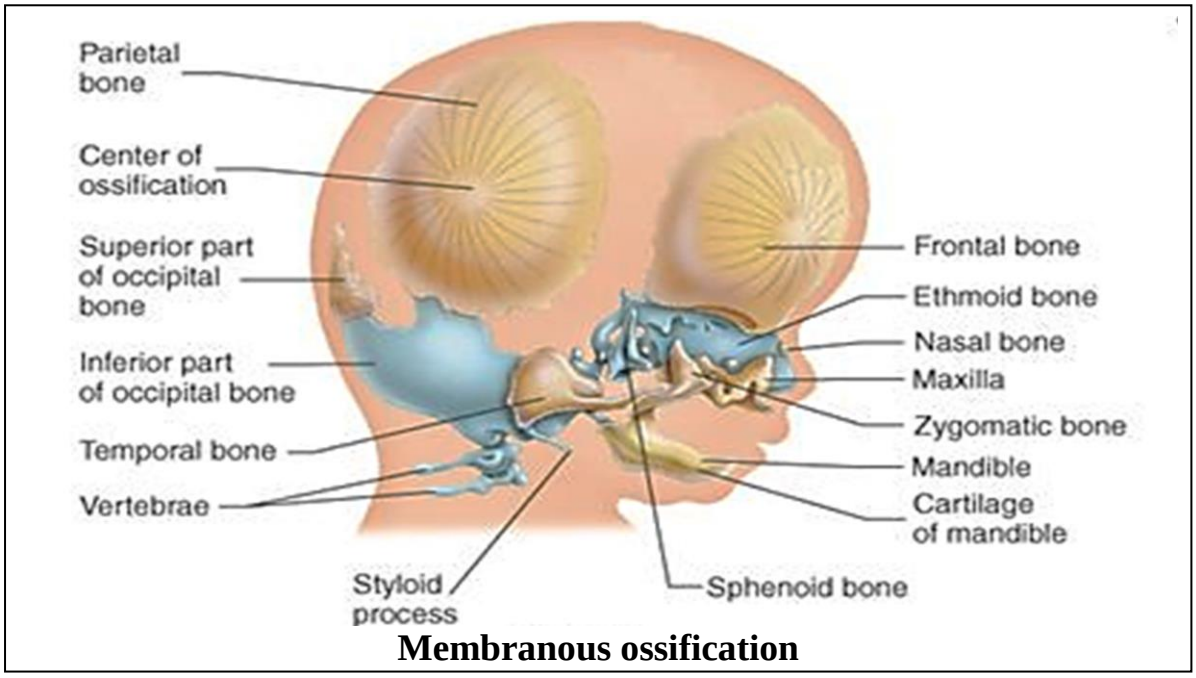


DEVELOPMENT OF AN INDIVIDUAL BONE

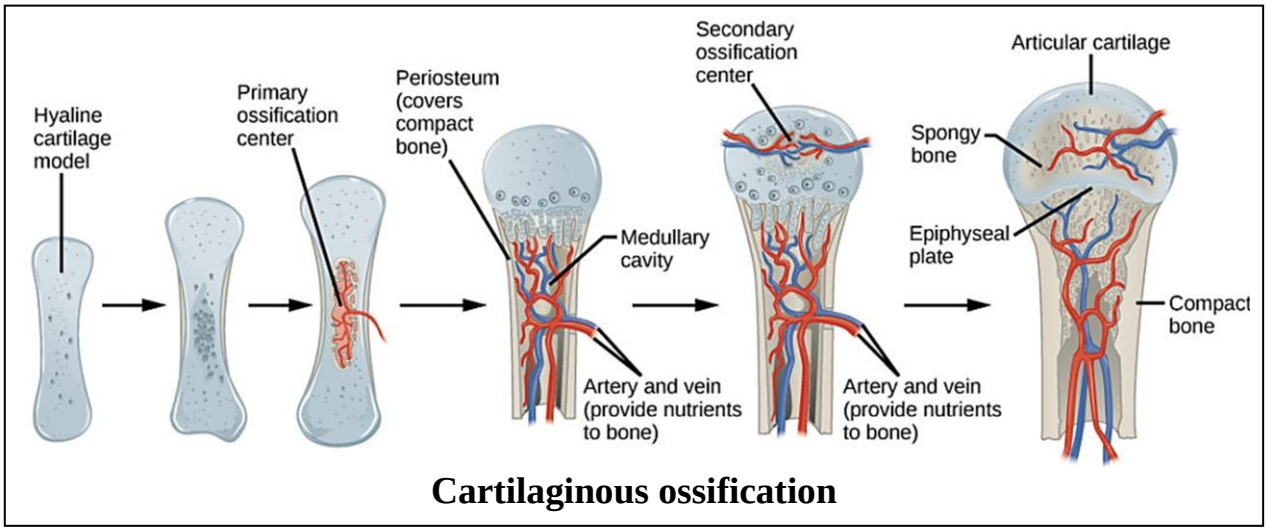
The human skeleton is "preformed" early in the fetus, but the early form is not of bony material. There are two types of bones according to their preformed basis: membranous bones and cartilage bones.

1) Membranous bones: The outer skull bones and the clavicle are an example of membranous bones. Osteoblasts invade a membrane to form a center of ossification (formation of bone). Bone-forming activity spreads out from this center until a full bone plate is formed.

(**2) Cartilage bones:** In the fetus, many bones, for example, long bones exist first as models formed of cartilage. Cartilage models of the bones form from mesenchyme during the fetal period, and bone subsequently replaces most of the cartilage.



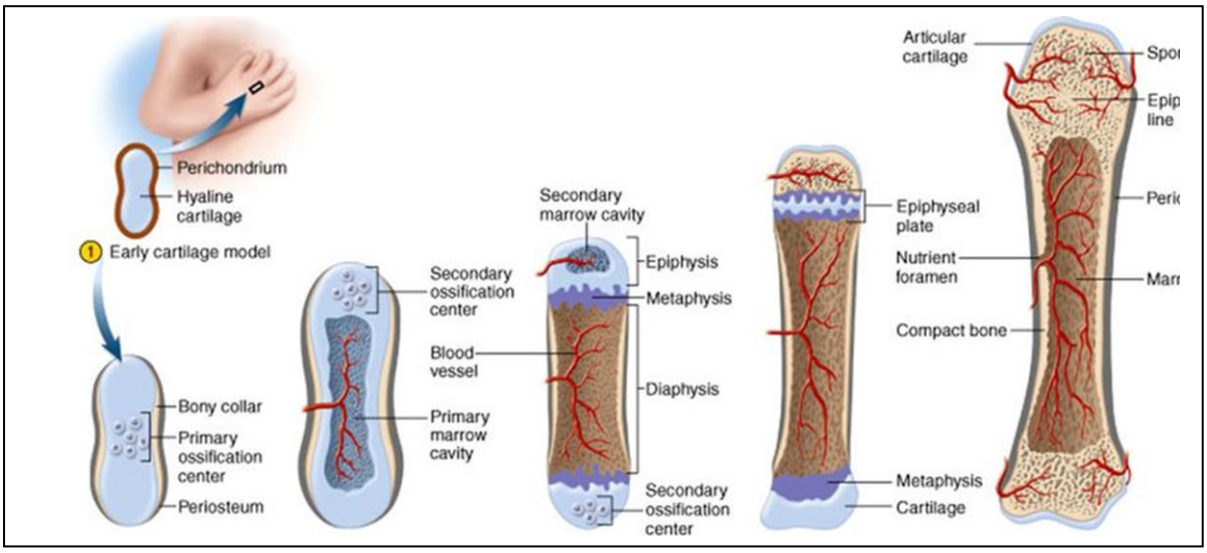
Membranous ossification



Cartilaginous ossification

A brief description of endochondral ossification helps to know how long bones grow:

The mesenchymal cells condense and differentiate into chondroblasts, (dividing cells in growing cartilage tissue) thereby forming a cartilage bone model. In the midregion of the model, the cartilage calcifies with calcium salts), and periosteal capillaries (capillaries form the fibrous sheath surrounding the model) grow into the calcified cartilage of the bone model and supply its interior. These blood vessels, together with associated osteogenic (bone-forming) cells, form a periosteal bud.

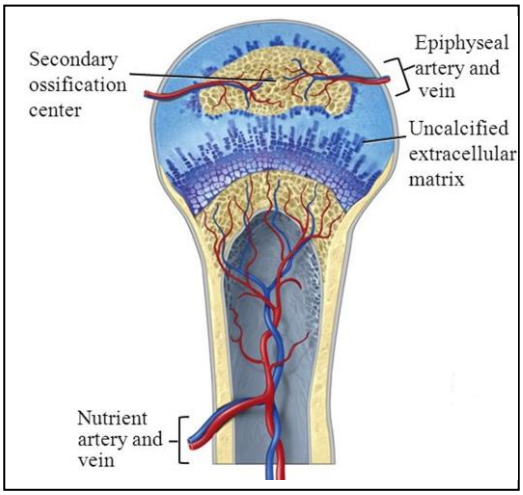


The capillaries initiate the primary ossification centre, so named because the bone tissue it forms replaces most of the cartilage in the main body of the bone model.

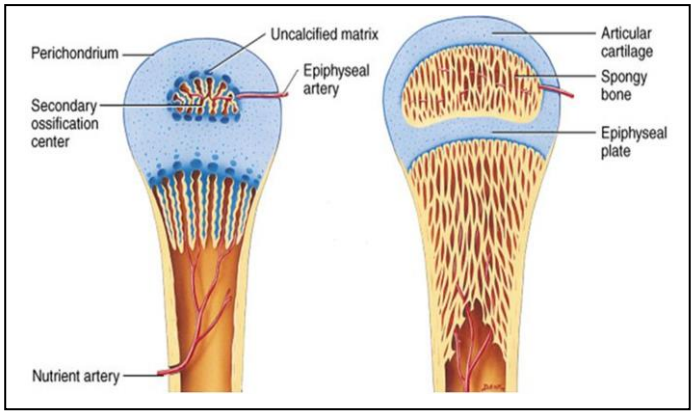
The shaft of a bone ossified from the primary ossification center grows as the bone develops.

♦Most secondary ossification centers appear in other parts of the developing bone after birth; the parts of a bone ossified from these centers are epiphyses.

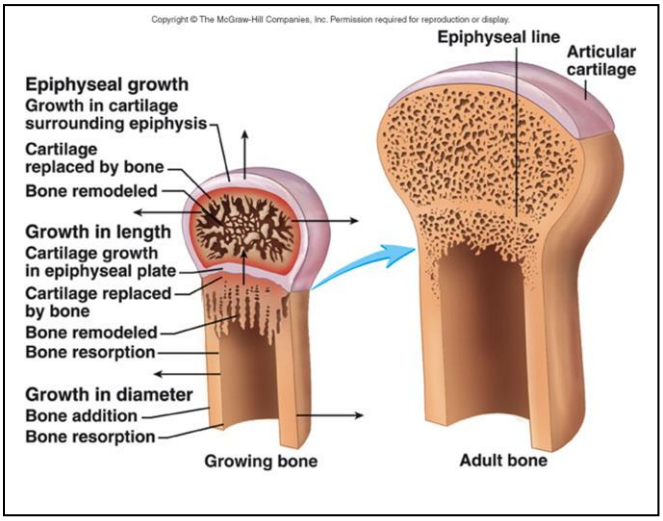
The chondrocytes in the middle of the epiphysis hypertrophy, and the bone matrix (extracellular substance) between them calcifies. Epiphysial arteries grow into the developing cavities with associated osteogenic cells.



♦ The flared part of the diaphysis nearest the epiphysis is the metaphysis. For growth to continue, the bone formed from the primary center in the diaphysis does not fuse with that formed from the secondary centers in the epiphyses until the bone reaches its adult size.



Thus, during growth of a long bone, cartilaginous epiphysial plates intervene between the diaphysis and epiphyses. These growth plates are eventually replaced by bone at each of its two sides, diaphysial and epiphysial. When this occurs, bone growth ceases, and the diaphysis fuses with the epiphyses.



Longitudinal growth in a growing long bone is liable to be interrupted prematurely, if a fracture passes through which of the following?

a-Metaphysis b-Diaphysis

c-Epiphyseal plate. d-Epiphyseal line

THE HUMAN SKELETON

a. The human skeleton is a collection of individual bones articulated (joined) together.

b. The major subdivisions of the skeleton are the axial skeleton and the appendicular skeleton.

THE AXIAL SKELETON

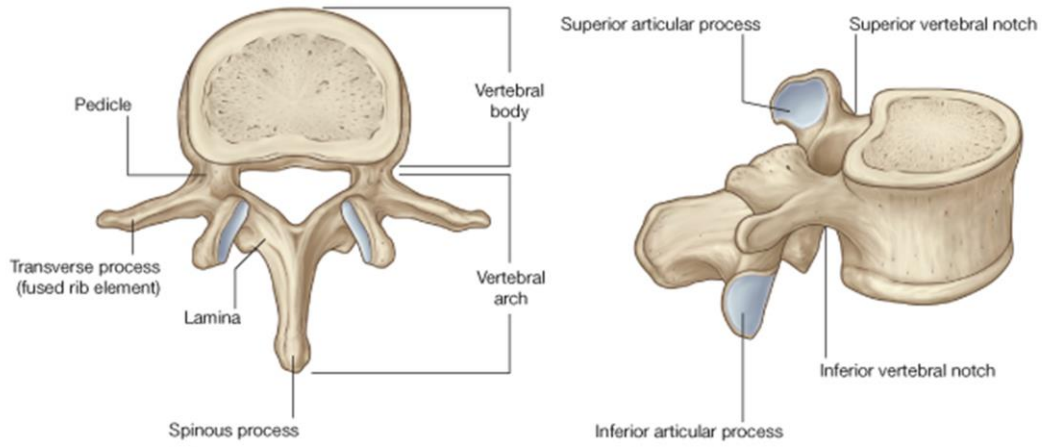
The axial skeleton is the central framework of the human body. It includes the skull, the hyoid bone, the vertebral column (spine), and the thoracic cage (chest or rib cage).

a. Vertebral Column (Spine): The vertebral column, or spine, is made up of a vertical series of bony blocks called vertebrae. These vertebrae are joined together in such a way as to form a semiflexible rod. The spine is the central support for the trunk, yet allows trunk movements.

(1) Anatomically and functionally, a typical vertebra major parts:

(a) The vertebral body is a drum-shaped cylindrical inferior surfaces are flat. Its function is primarily weight-bearing.

(b) The neural arch extends posteriorly, arching over and protecting the spinal cord of the central nervous system. From the neural arch are several processes. These processes serve as attachment areas for the trunk muscles. They also act as levers during various trunk motions.



Parts of the vertebra

(2) The vertebral column has 32-33 vertebrae, one on top of the other. These vertebrae are arranged in regions. The vertebrae of each region have a characteristic shape. The regions are as follows:

(a) Cervical (neck) region, with seven cervical vertebrae.

(b) Thoracic (chest) region, with twelve thoracic vertebrae.

(c) Lumbar (low back) region with five lumbar vertebrae.

(d) The sacrum, which is a bony fusion of five sacral vertebrae.

(e) The coccyx ,with 3-4 coccygeal vertebrae together.

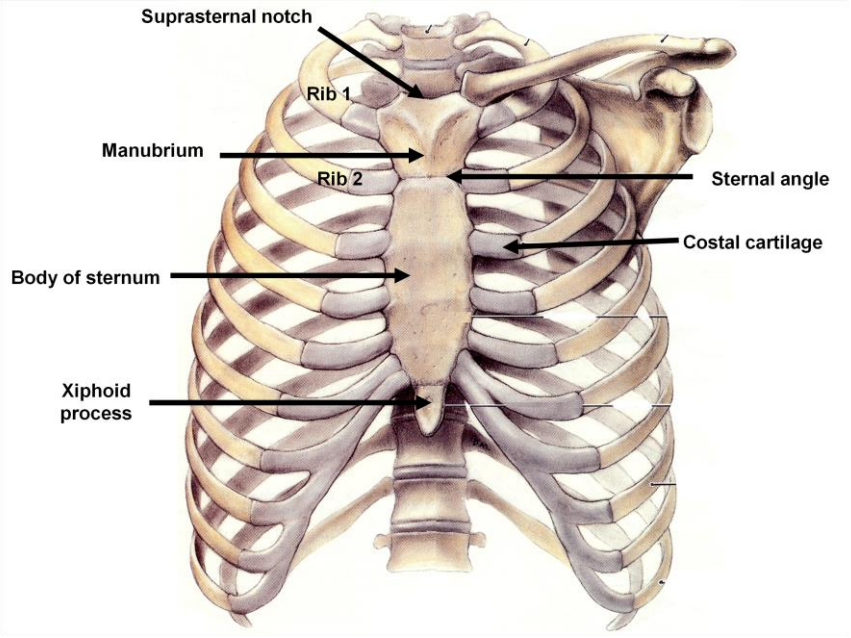
(3) The vertebrae are held together in two ways:

(a) The intervertebral disc holds the bodies of adjacent vertebrae together. The intervertebral disc is a fibrous ring (annulus fibrosus) with a soft center (nucleus pulposus). This disc allows the vertebral bodies to move on one another. This joint between the vertebral bodies is a secondary cartilaginous joint.

(b) The various parts of adjacent vertebrae are held together by ligaments. A ligament is a dense fibrous connective tissue structure which extends from bone to bone. These ligaments extend along the vertebral column from the base of the skull all the way down to the coccyx.

b. **The Thoracic (Rib) Cage**: The rib cage forms a protective enclosure for the vital organs contained within the thorax (chest) such as the heart and lungs. It also allows the movements of breathing to take place.

(1) The sternum lies in the midline of the thorax anteriorly. It is made up of three parts: the manubrium at the top, the body as the main part, and the xiphoid process below.



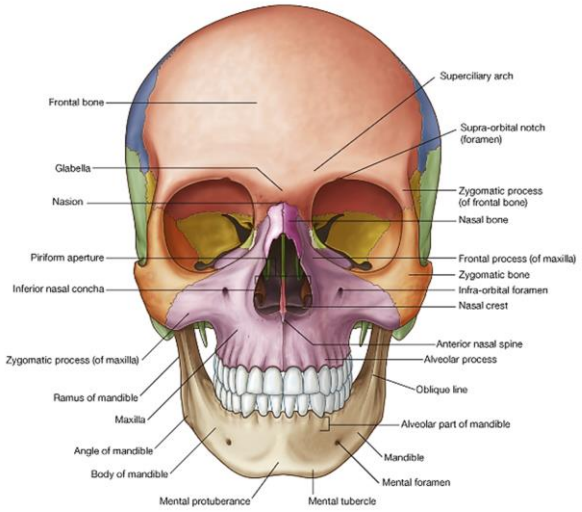
The Thoracic cage

(2) The rib cage consists of the 12 thoracic vertebrae,12 pairs of ribs, and the sternum. Each rib is curved laterally from back to front. All 12 pairs of ribs are attached posteriorly' to the thoracic vertebrae. The upper seven pairs of ribs are attached directly to the sternum by their costal cartilages (by attaching to the costal cartilage of the rib above). Rib pairs 11and 12 do not attach to the sternum. Instead, they are embedded in the trunk wall muscles.

c. **The Skull**: The skull is the bony framework (skeleton) of the head region. It has two major subdivisions: the cranium which encases and protects the brain and the facial skeleton which is involved with the beginnings of the digestive and respiratory systems. The special sense organs (eyes, ears, etc.) are included and protected within the skull.

(1) The bones of the cranium form a spherical case around the brain. With age, the sutures between the cranial bones become more solid. The cranium has a base with several openings for the passage of blood vessels and nerves. The vault (or calvaria) is made up of flat bones arching over and covering the brain

(2) The facial skeleton consists of bones which surround the nose and the mouth. These are mainly flat and irregular bones.



The skull

Bones of the facial skeleton also form part of the orbit of each eye.

(3) The upper jaw (maxilla) and the lower jaw (mandible) are parts of the facial skeleton which surround the mouth.

(5) The hyoid bone is located at the junction between the head and the neck. It is not articulated directly with the other bones. It is held in place and moved around by groups of muscles above and below.

THE APPENDICULAR SKELETON

a. The appendicular skeleton is made up of the skeletal elements of the upper and lower limbs (often referred to as the "extremities"). These limbs are appended (attached) to the axial skeleton.

CARTILAGE

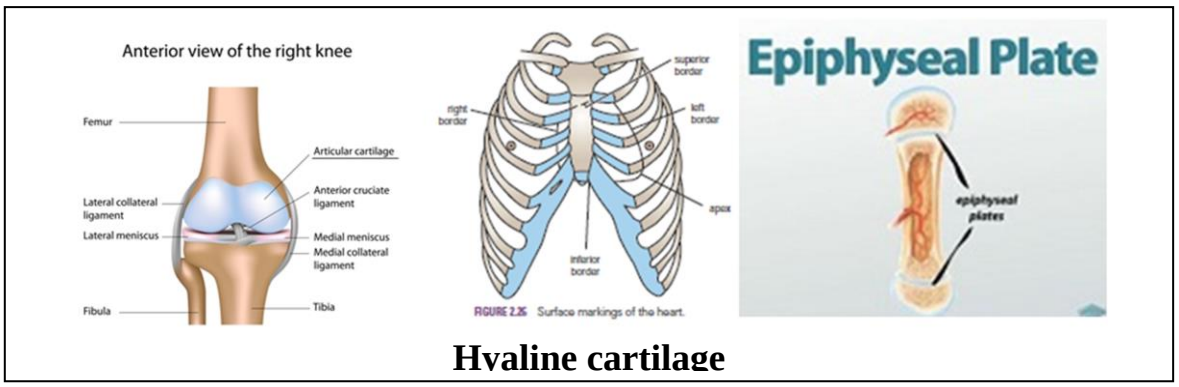
A type of connective tissue in which the cells and fibers are embedded in gel like matrix, covered by fiberous membrane called perichondrium.

<u>There are three types of cartilage:</u>

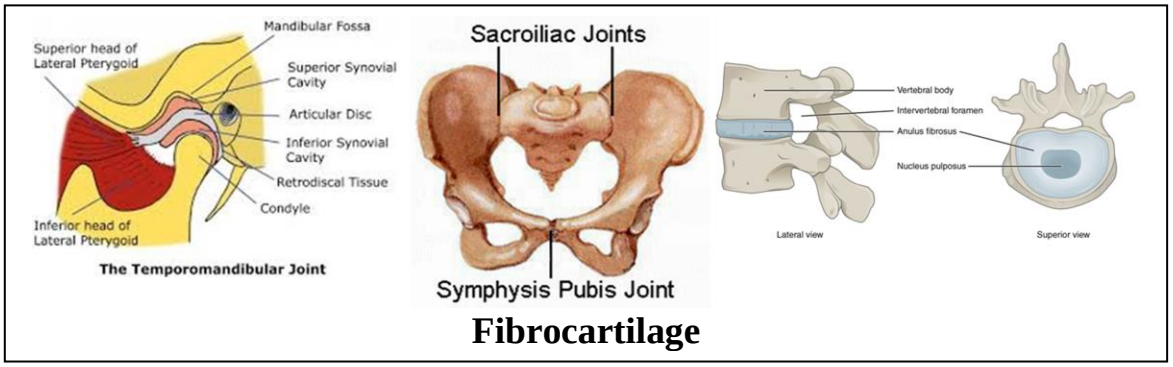
-Hyaline cartilage: in epiphyseal plate, articular cartilage, foetal bones, costal cartilage It is 2nd most flexible cartilage.

- White fibrocartilage: in intra-articular disc, intervertebral disc, symphysis pubis. It is the least flexible.

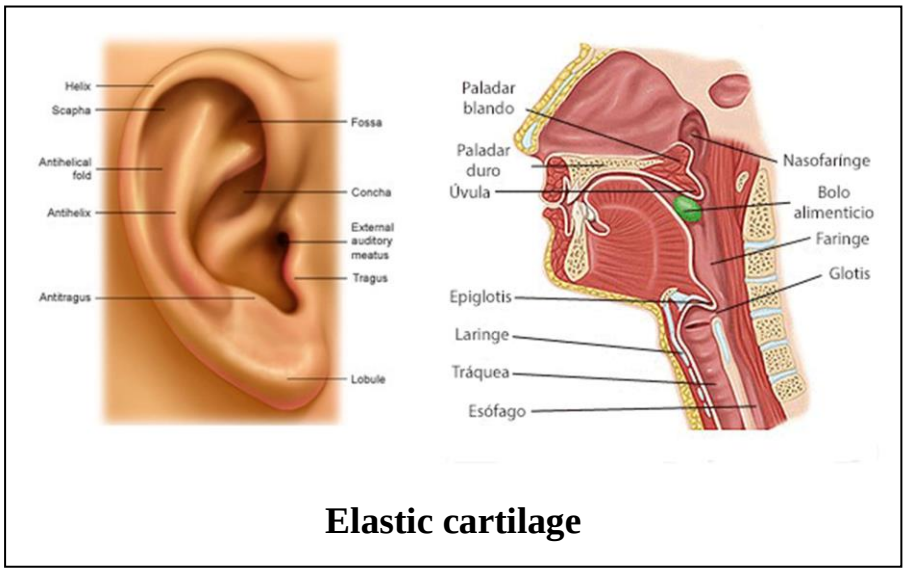
-Yellow elastic cartilage: in ear auricle, auditory tube, epiglottis, external auditory meatus. It is most flexible cartilage



Hyaline cartilage



Fibrocartilage



Elastic cartilage