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College of Medical Rehabilitation for Prosthetics
Humman Anatomy
First Stage
Lectuerer : Esraa Mohammed
Lec. 1

Introduction of Anatomy

Definition of the anatomy :

Anatomy is the science that deals with the study of the structure and function of the human body. The term anatomy is a Greek word that means "cutting ."

Types of anatomy :

Anatomy is divided into two main types:

- Gross anatomy (macroscopic)
- Microscopic anatomy (histology) .

Gross anatomy (Macroscopic): The study of anatomical features visible to the naked eye, such as internal organs and external features .

Microscopic anatomy (Histology): The study of minute anatomical structures on a microscopic scale, including cells and tissues.

The gross anatomy (Macroscopic) is divided into the following :

1. **Surface anatomy** (or superficial anatomy): is the study of external anatomical features without dissection.

2. **Regional anatomy**: focuses on specific external and internal regions of the body (such as the head or chest) and how different systems work together in that region .

3. **Systemic anatomy**: focuses on the anatomy of different organ systems, such as the respiratory or nervous system .

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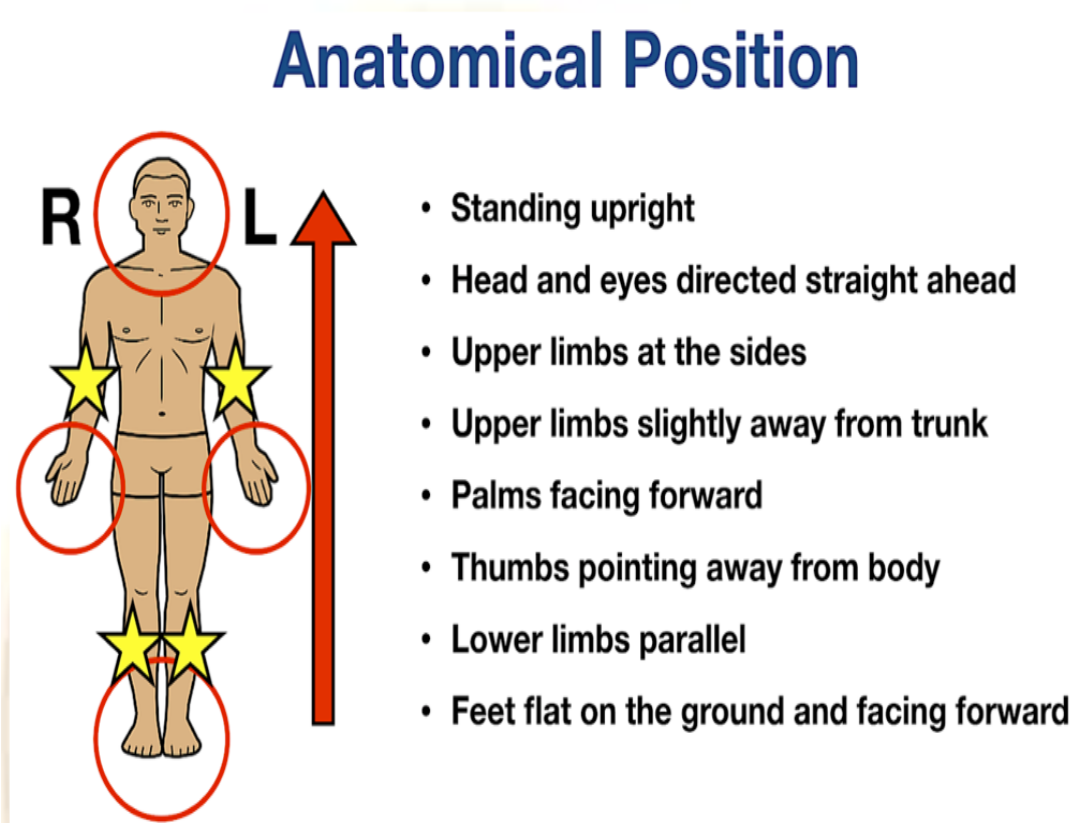
The microscopic anatomy (Histology) is divided into the following :

1. **Histology:** is the study of the organization and details of biological tissues .
2. **Cytology:** is the study of the structure and function of cells.

Anatomical Positions and Movement :

The anatomical position is the position in which the person is in an erect position (standing upright) with the upper limbs hanging by the sides and the palm directed anteriorly (forwards) .

The patient's anatomical positions were classified based on the points shown in the image below:



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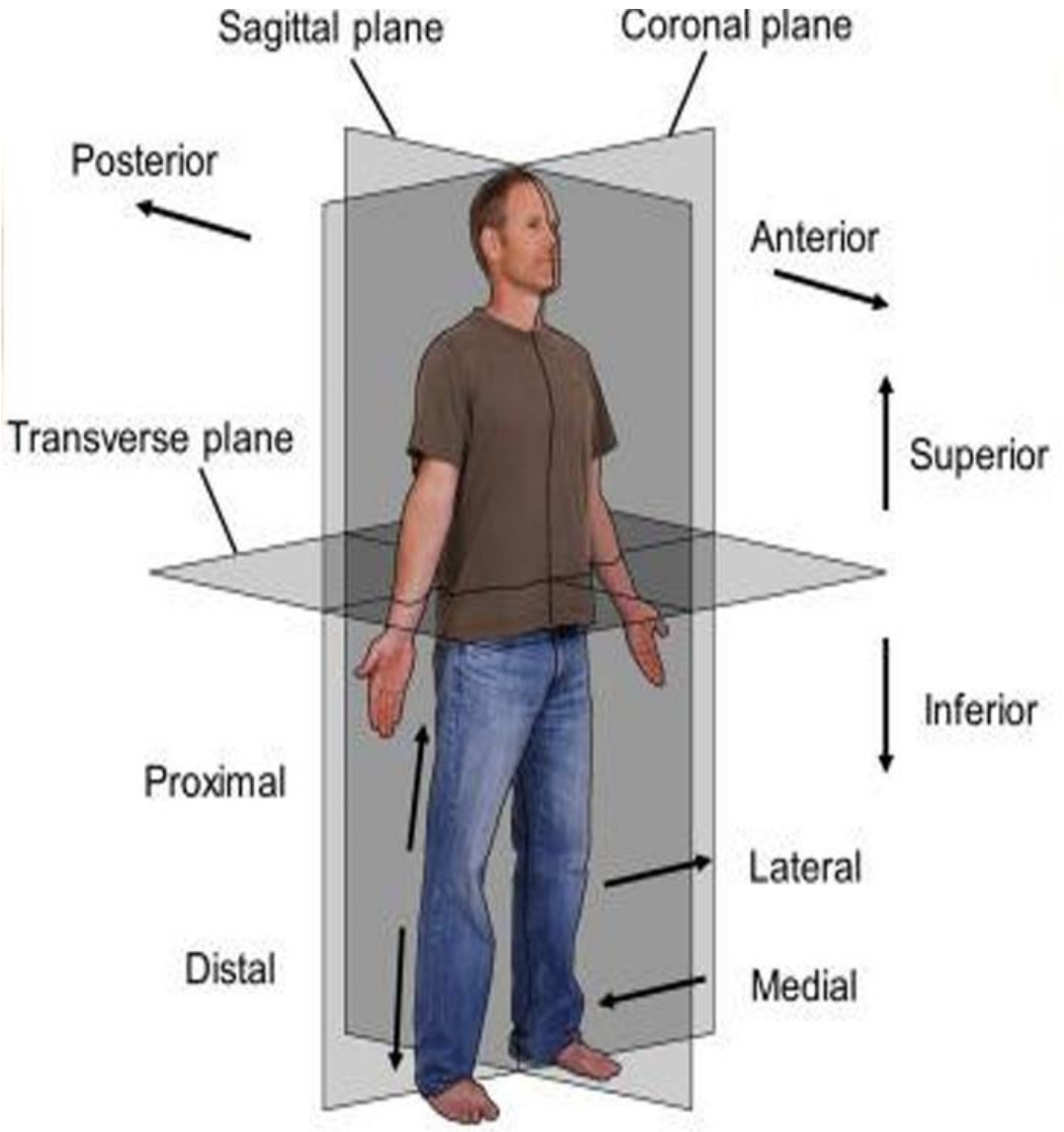
Orientation and Directional Terms

- **Anterior:** anything is nearer to the front. (front)
- **Posterior:** anything is nearer to the back. (back)
- **Superior (Cephalic):** is any point nearer to head. (above)
- **Inferior (Caudal):** is any point nearer to foot. (below)
- **Proximal:** any point nearer to the root of the limb. (such as: elbow is proximal to the wrist .(Near)
- **Distal:** any point farther from the root of the limb. (such as: wrist is distal to the elbow. (far)
- **Midline:** An imaginary vertical line that divides the body equally (right down the middle).
- **Lateral:** Farther from midline. (side)
- **Medial:** Nearer to midline. (middle)
- **Superficial:** Close to the surface of the body.
- **Deep:** Away from the surface of the body.



Anatomical Planes :

☒ **Axial plane** (horizontal, transverse or transaxial plane): horizontal plane perpendicular to the long axis of the body. Divides the body **into superior and inferior** parts .

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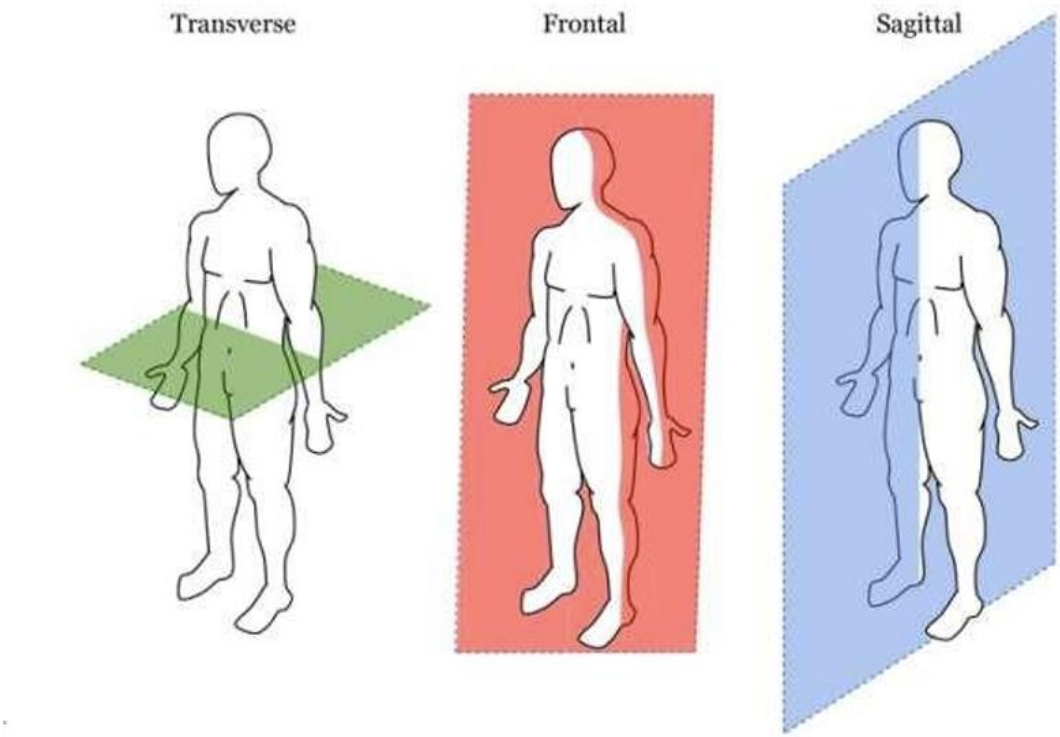

☒ **Sagittal plane:** is any imaginary plane passing through the body parallel to the median plane. Divides the body into **right half and left halves** .

☒ **Coronal plane(frontal):** is a plane perpendicular on median or sagittal planes. Divides the body into **anterior and posterior parts.**

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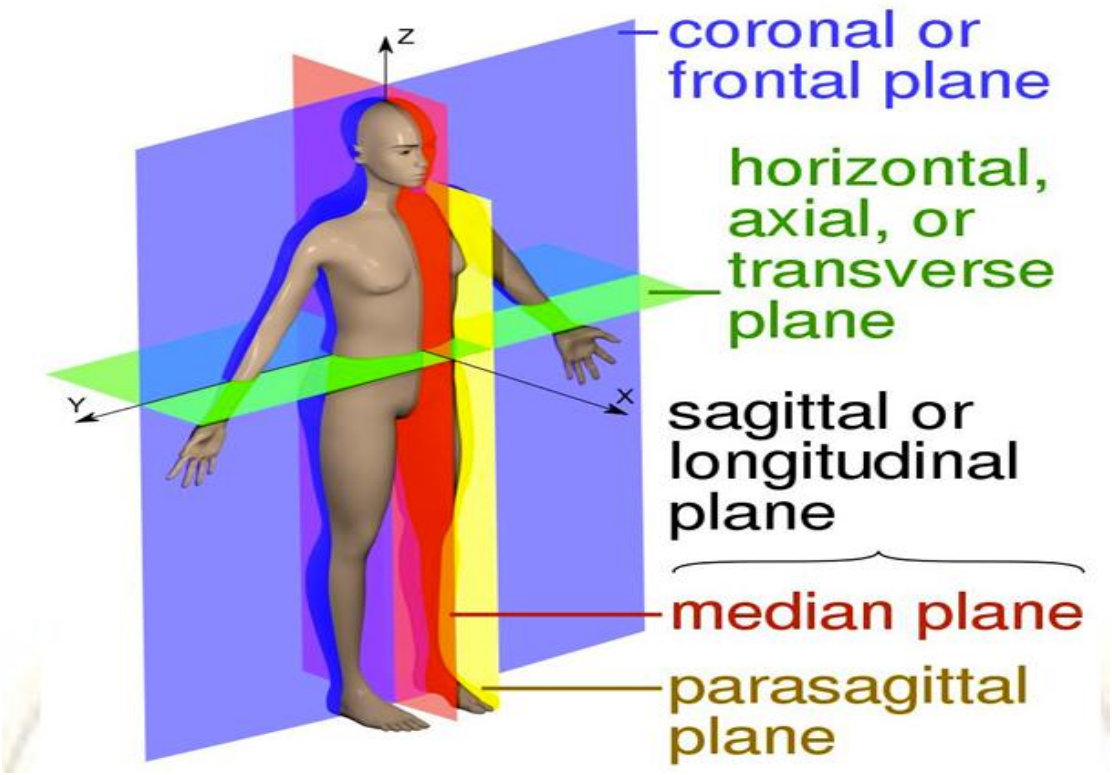

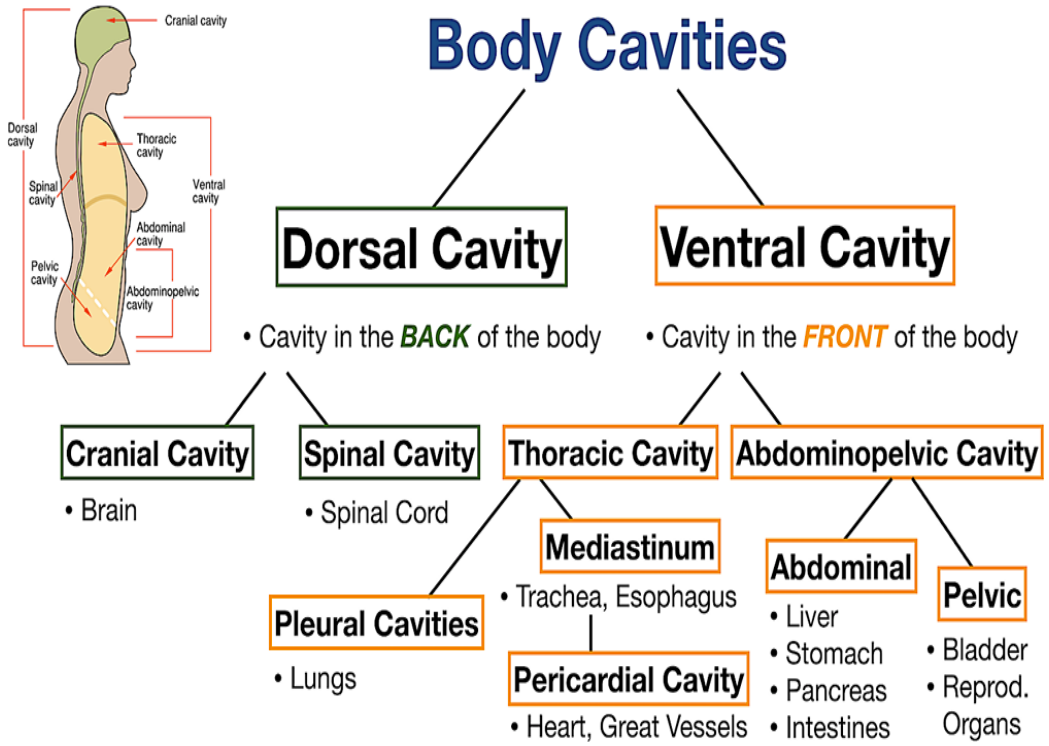

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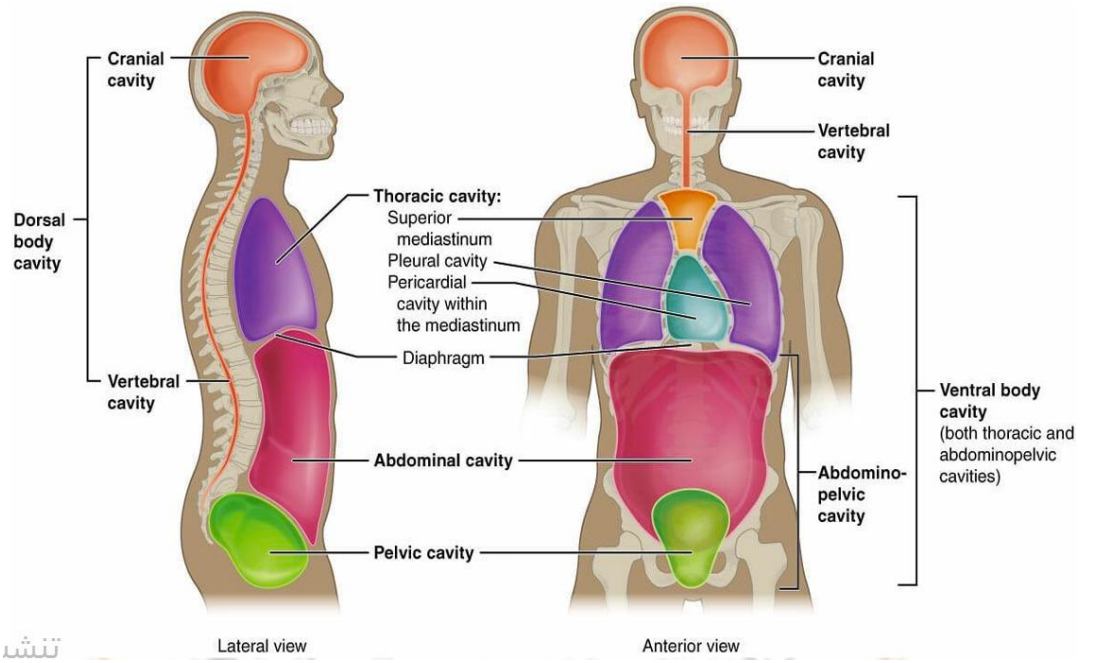

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Histology

Histology (microscopic anatomy) is the study of tissue and cell structure and how these tissues are arranged to constitute organ under a microscope.

The **word histology** from the **Greek words** histos, mean "tissue", and -logos, mean "study"

Every living organism begins its life, as **a single cell**, which is the fertilized egg or zygote, and this cell performs several successive divisions to form a large number of cells that are organized into **three layers** known as **the primary germ layers**, which is the **ectoderm,mesoderm and the endoderm**.

Cell: smallest unit of structure and function of body

↓

Tissue: group of cell + extracellular ground substance

↓

Organ: made up of tissue, have special shape , structure and function

↓

System: organs Which have related function get together

Classification of tissuee , Original four types of tissues :

Epithelial tissues – Covering surfaces or lining cavities

Connective tissues – to support other specialized tissues

Muscular tissues – contractile property

Nervous tissues – cells forming brain, spinal cord,nerves

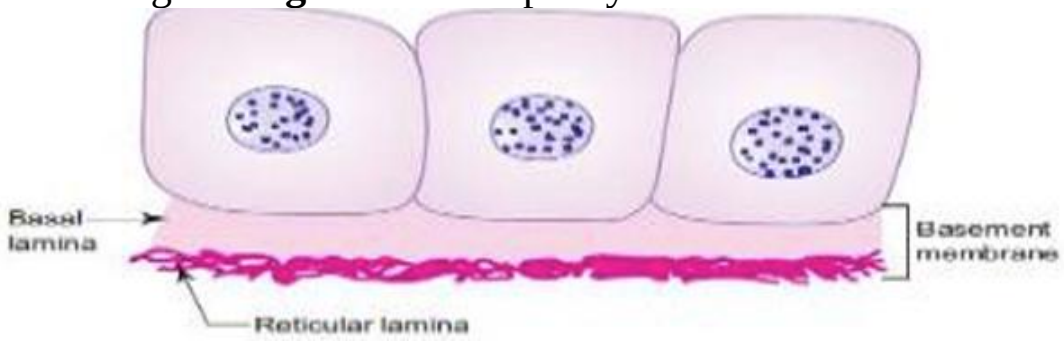
1=Epithelial Tissue

Epithelium (plural, epithelia) consists of sheets of cells that cover the external surfaces of the body, line the internal cavities, form various organs and glands and line their ducts.

Epithelial cells are in contact with each other, either in a single layer or multiple layers

General characters:

- Is made in a **single** layer or **multiple** layers
- the epithelium cell rests on a **basement membrane,** which separates it from the vascular connective tissue.
- No **blood vessels** nor lymphatics are found in the epithelium; nourishment is provided by diffusion from the adjacent supporting tissues.
- Has good **regenerative** capacity.



Classification of Epithelial cells: by their shape and their arrangement

By shape (morphology):

• **Squamous** (flat, plate-like)

• **Cuboidal** (height and width similar)

• **Columnar** (height = 2x – 5x greater than width)

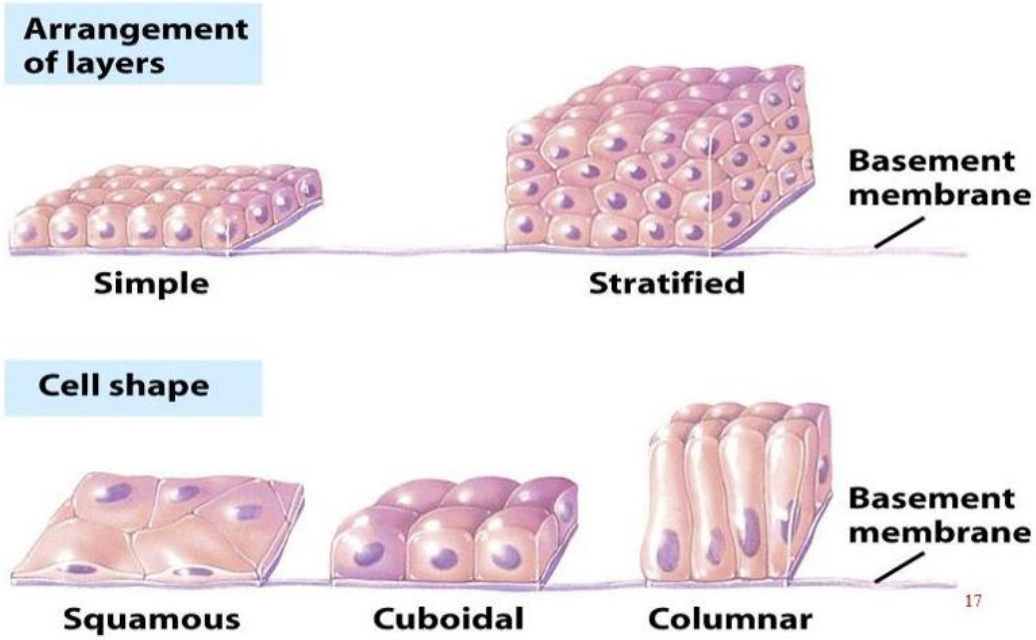
By arrangement

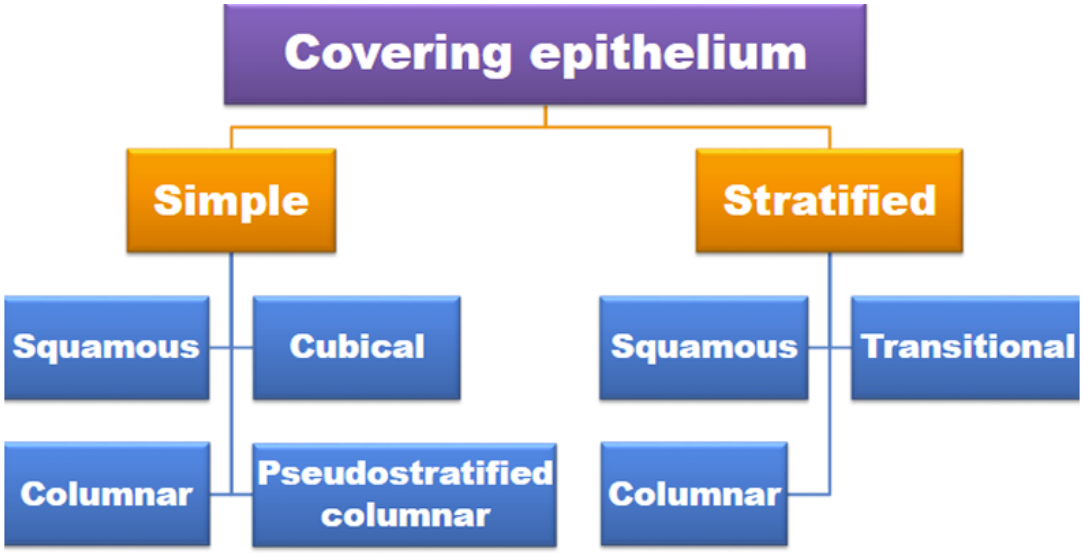
• **Simple**: forming a single layer

•**Stratified**: multiple layer of cell stacking

• **Pseudostratified**: cells appear arranged in layers, but all in contact with the extracellular matrix .

• **Transitional:** specialized epithelium only in the urinary tract, varies between cuboidal and squamous, depending on the degree of stretching.





Types of Epithelial tissues :

1. **Simple squamous epithelial tissues**: found in the alveoli of lungs, blood vessels)

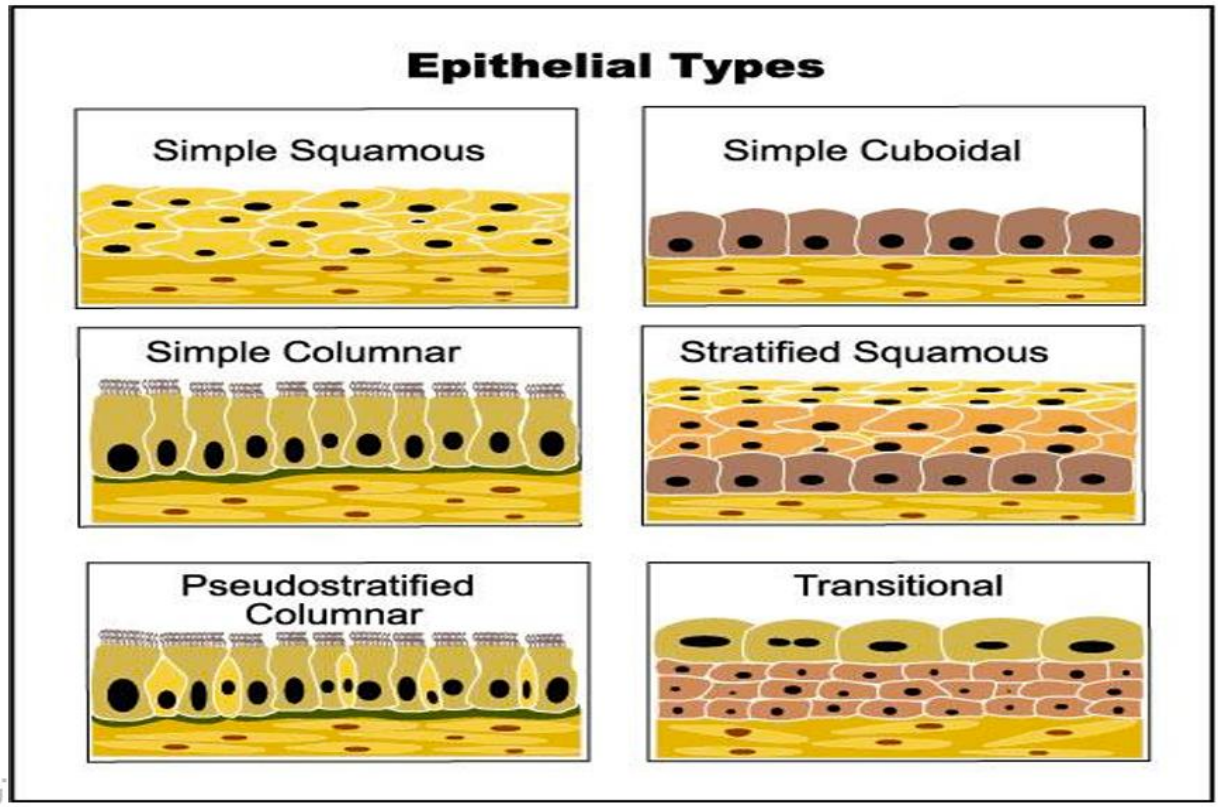
2. **Simple cuboidal epithelial tissues:** Makes up urinary tubules of the kidney, liver, pancreas ،thyroid.
3. **Simple columnar microvilli epithelial tissues**: makes up the lining of the intestine .
4. **Pseudo stratified columnar ciliated epithelial tissues**: Makes up lining of the respiratory tract

5. **Stratified squamous epithelium**

a) **keratinized,** stratified squamous epithelium. Skin

b) **un keratinized,** stratified squamous epithelium. The lining of the mouth cavity

6. **Stratified cuboidal epithelium** and **stratified columnar epithelium** can also be found in certain glands and ducts (salivary glands, and sweat glands.)
7. **Transitional epithelial tissues:** Makes up the lining of the urinary bladder

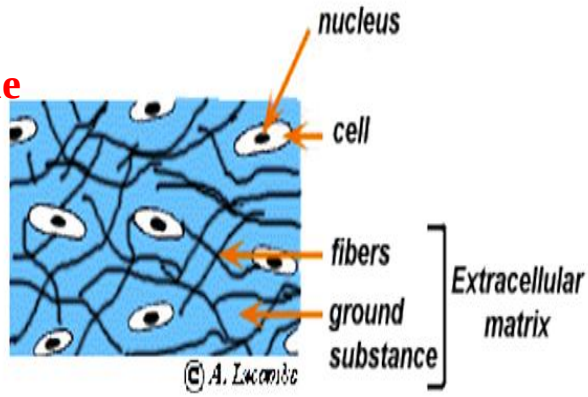


2=Connective tissue

Connective tissue is the most abundant and widely distributed tissue in the body . While some connective tissues are specialized (bone , blood)

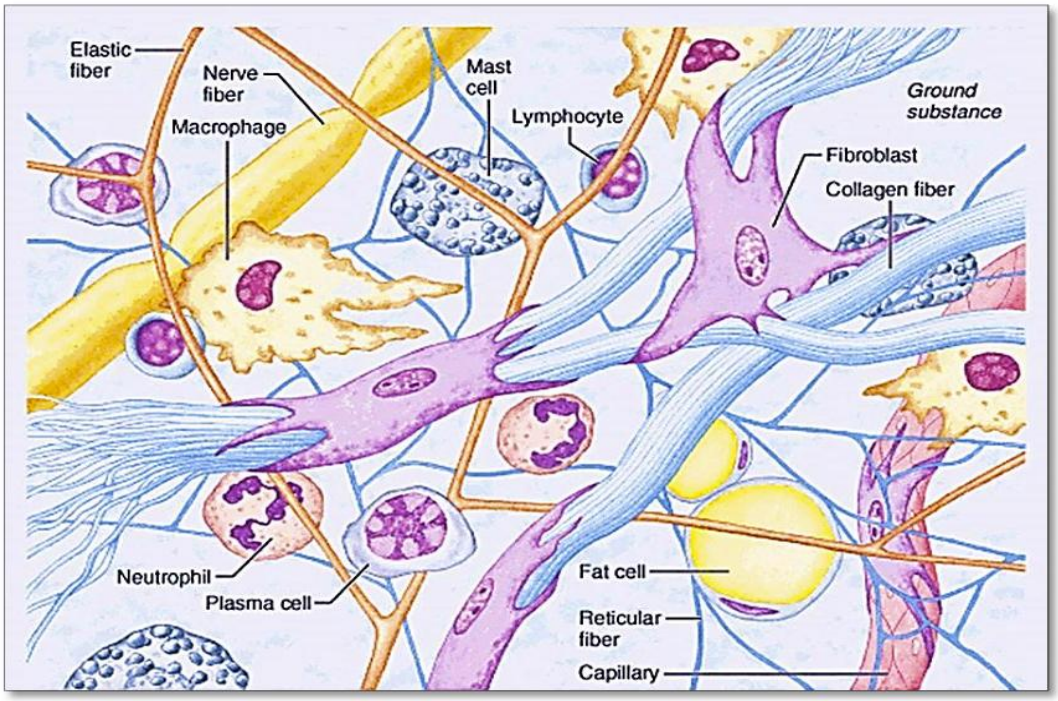
Components of Connective Tissue

1. Cells
2. Ground substance
3. Fibers



Connective tissue cells :

There are specialized cells in connective tissue which form and maintain extracellular matrix.



Fibers :

There are three types of connective tissue fibers :

1. **Collagen fibers (white fiber):**
2. **Elastic fibers (yellow fibers)**
3. **Reticular fibers**

Ground Substance

Ground substance: is a hydrated colorless and transparent, amorphous material consists of protein and carbohydrate molecules and variable amounts of water.

The ground substance may be **viscous** (as in blood), **semisolid (**as in cartilage), or **solid** (as in bone).

*Type of Connective tissues :

According to these characteristics of the matrix, connective tissues are classified into:

I. Embryonic connective tissue:

1) **Mesenchymal connective tissue** (developing embryo & fetus)
2) **Mucus connective tissue** (umbilical cord)

II. Connective tissue proper:

A. Loose connective tissue

1) Areolar tissue
2) Adipose tissue
3) Reticular tissue

B. Dense connective tissue

1) Regular dense connective tissue
2) Irregular dense connective tissue
3) Elastic connective tissue

III. Specialized connective tissue:

1) Bone
2) Cartilage
3) Blood

3=Muscle Tissue

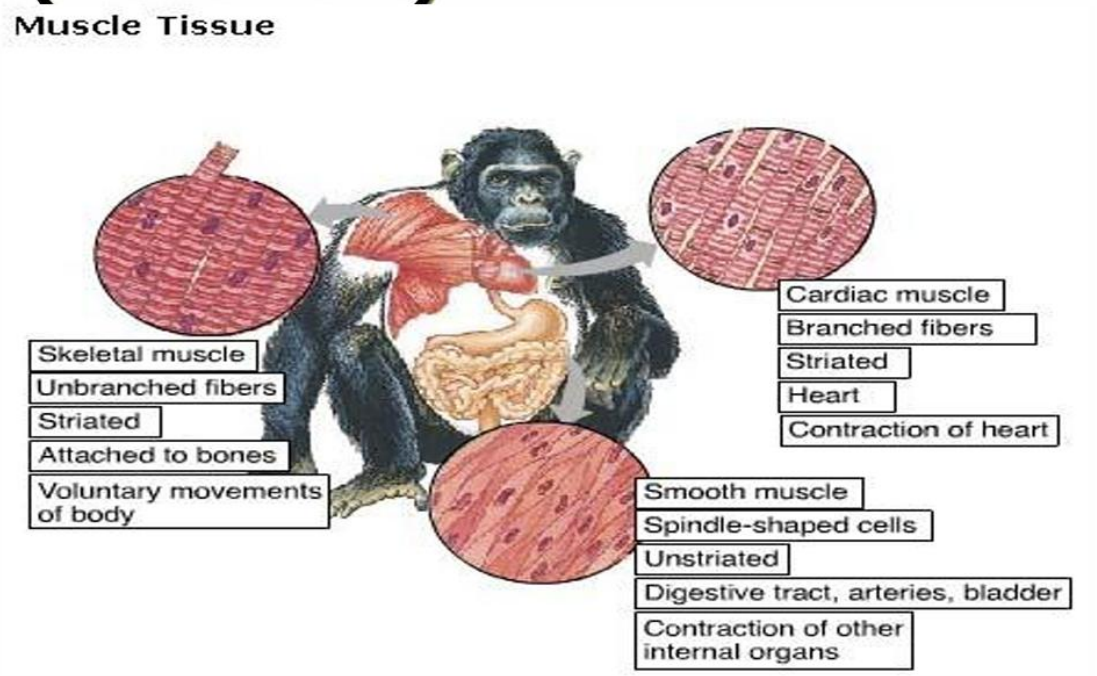
Muscular tissue • is a tissue specialized for contraction to produce voluntary or involuntary movement

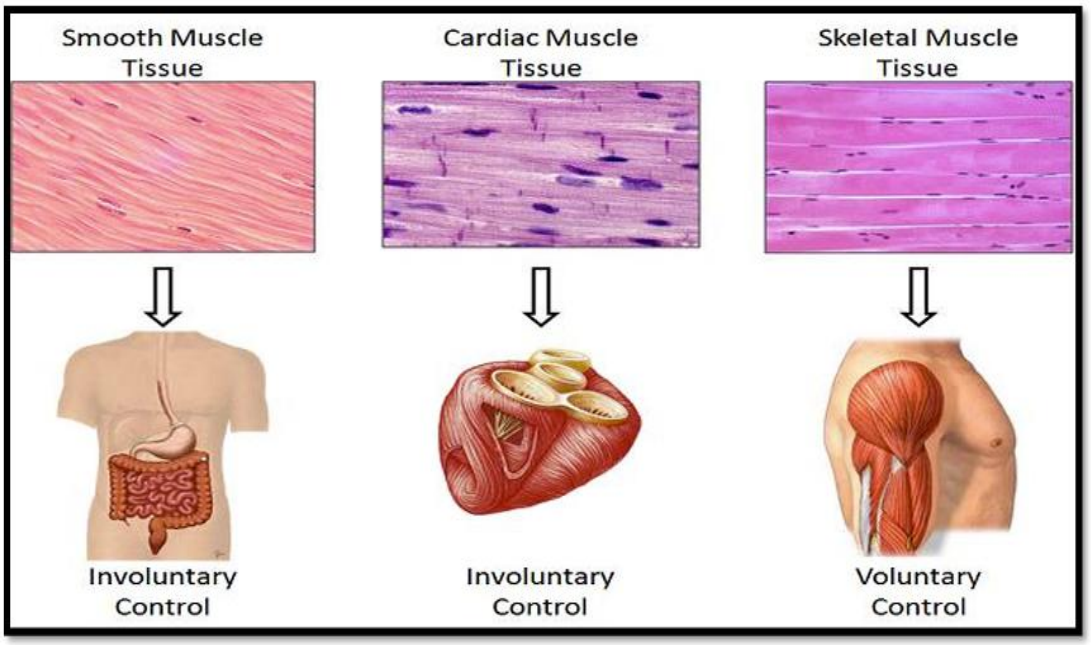
Types:

1. **Skeletal Muscle (voluntary)**
2. **Smooth Muscle (involuntary, visceral)**
3. **Cardiac Muscle (heart)**

Muscle Tissue (Movement)

- Composed of long cells called muscle fibers
- Contraction → movement

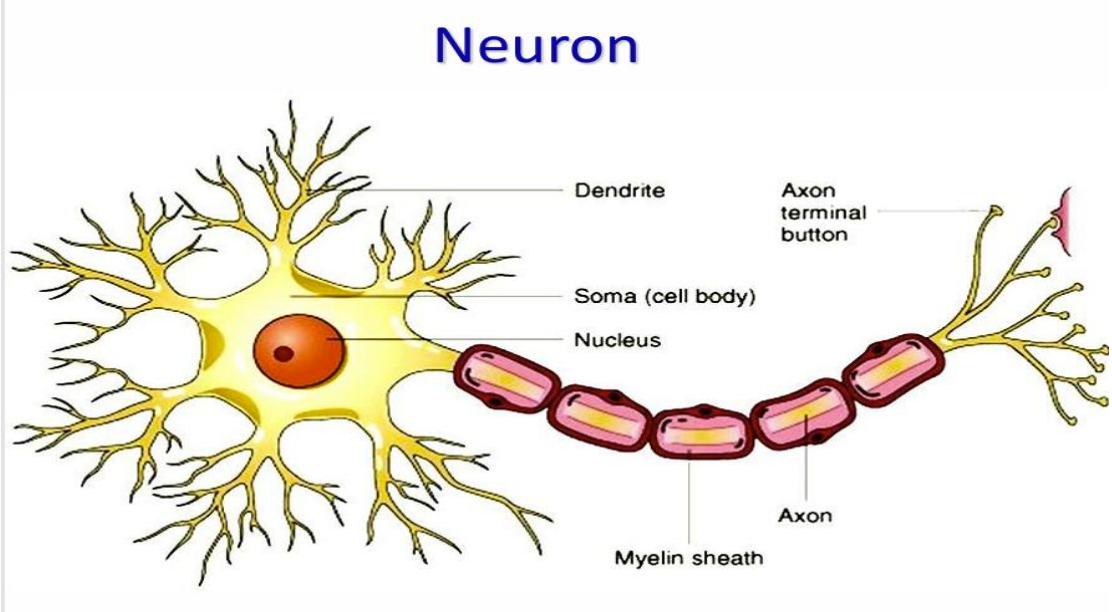


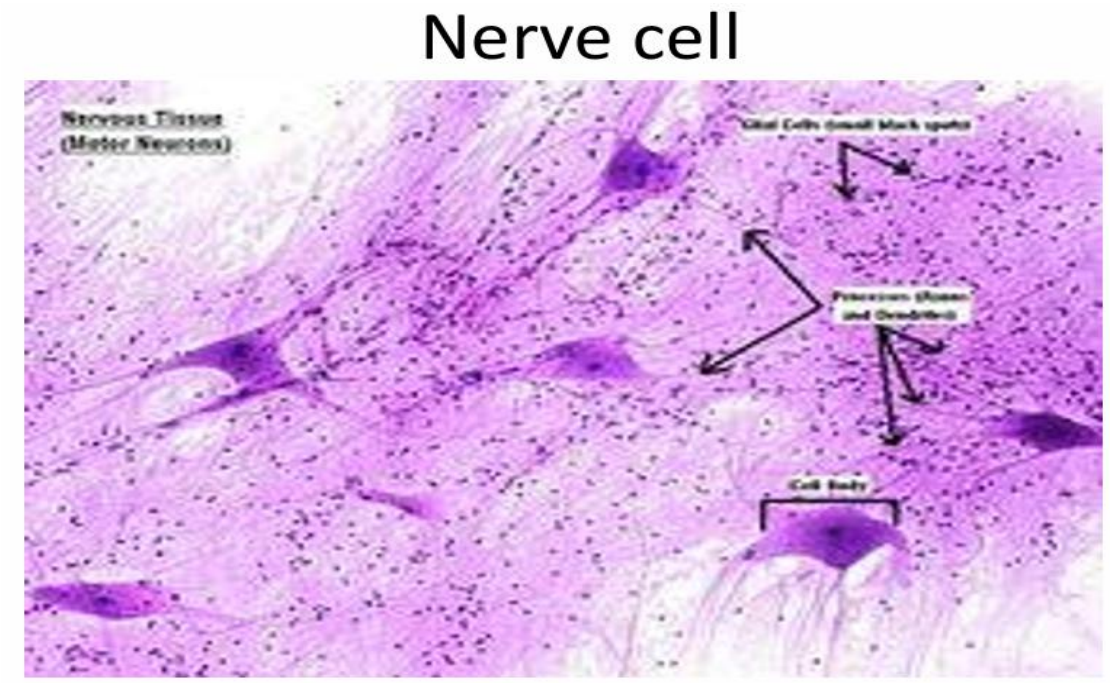


4=Nervous Tissue

Neurons

Neurons (also called **nerve cells**) are the fundamental units of the brain and nervous system, the cells responsible for receiving sensory input from the external world, for sending motor commands to our muscles, and for transforming and relaying the electrical signals .





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Osteology

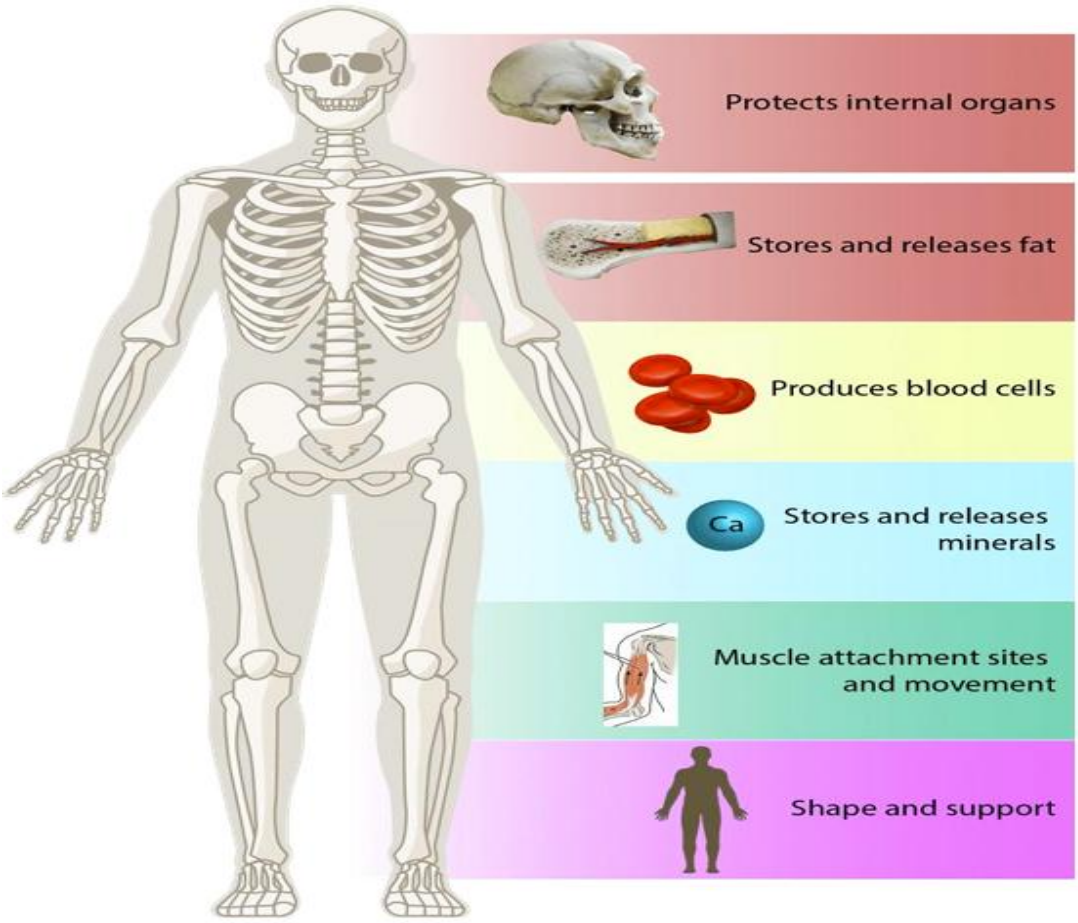
Osteology is the science that deals with the study of the structure and function of the bones. The term Osteology is a Greek word that **"OSTEO" meane for bone.**

Bones are rigid specialized connective tissue consisting of cells embedded in an abundant hard intercellular material. The presence **calcium salts and other salts** contributes to **hardness and resistance** to compression forces. And its possesses a **degree of elasticity** because of the presence of **organic fibers**.

The skeletal system is composed of **bones, cartilage, and ligaments** joined tightly to form a strong, flexible framework for the body**.**

The skeletal system performs the following critical **functions** for the human body:

1. **Support.** Bones of the limbs and vertebral column support the body; the mandible and maxilla support the teeth; and some viscera are supported by nearby bones.
2. **Protection.** Bones enclose and protect the brain, spinal cord, lungs, heart, and pelvic viscera.
3. **Movement.** Movements of the limbs and other movements such as breathing, are produced by the action of muscles on bones.
4. **Blood formation.** Red bone marrow is the major producer of blood cells.
5. **Storage.** The skeleton is the body's main reservoir of calcium and phosphorus and releases them according to the body's physiological needs.



Component of bones

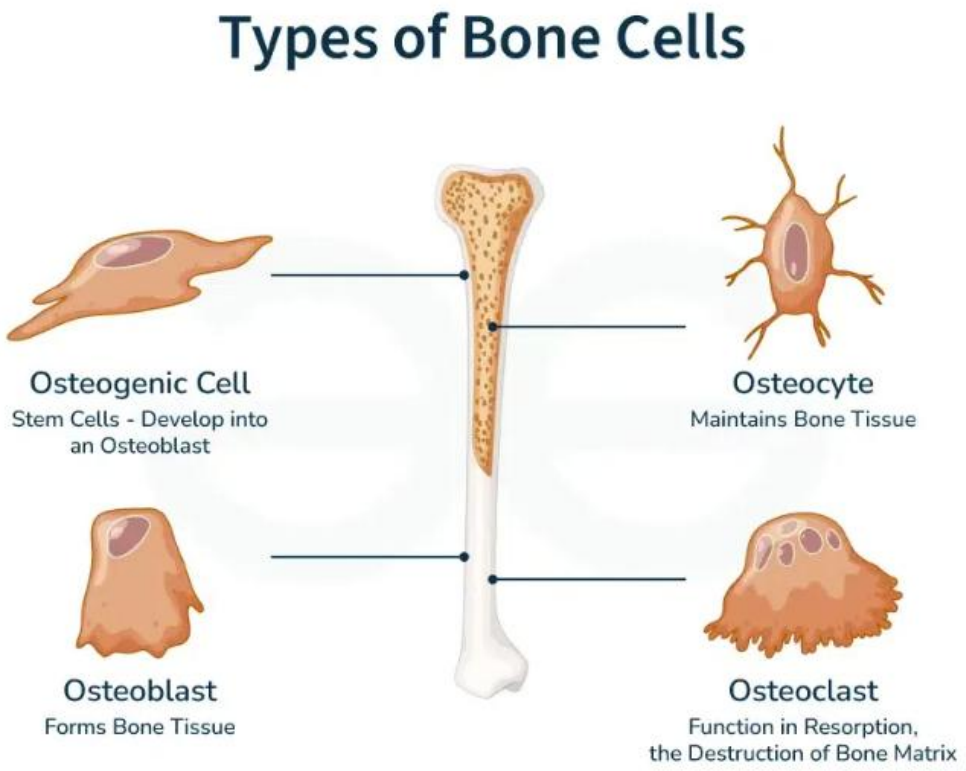
Bone cells (Osteocytes): **Osteocytes** are the most abundant cells in bone, but other cells types are also present , These cell names all start with "OSTEO" because that is the Greek word for bone.

The bone cell types are:

1- **Osteoprogenitor cells**, also known as **osteogenic cells,** are undifferentiated cells. Can divided to replace themselves and become osteoblast.
2- **Osteoblasts** (OS-tē-ō-blasts; blast, precursor) produce new bone, in a process called **ossification or osteogenesis.** These are responsible for making new bone and repairing older bone.

3- **Osteocytes** are mature bone cells. They maintain normal bone structure by recycling the calcium salts in the bony matrix and by helping in repairs.

4- **Osteoclasts** (OS-tē-ō-clasts; clast, break) are giant cells with more than one nucleus. They secrete acids and enzymes that dissolve the bony matrix and release the stored minerals through **osteolysis**, or **resorption**. This process helps regulate calcium and phosphate concentrations in body fluids.



Type of bones

There are two basic types of bone :

Compact bone is dense and looks smooth and homogeneous,

spongy bone has a spiky, open appearance like a sponge

Classification of bones :

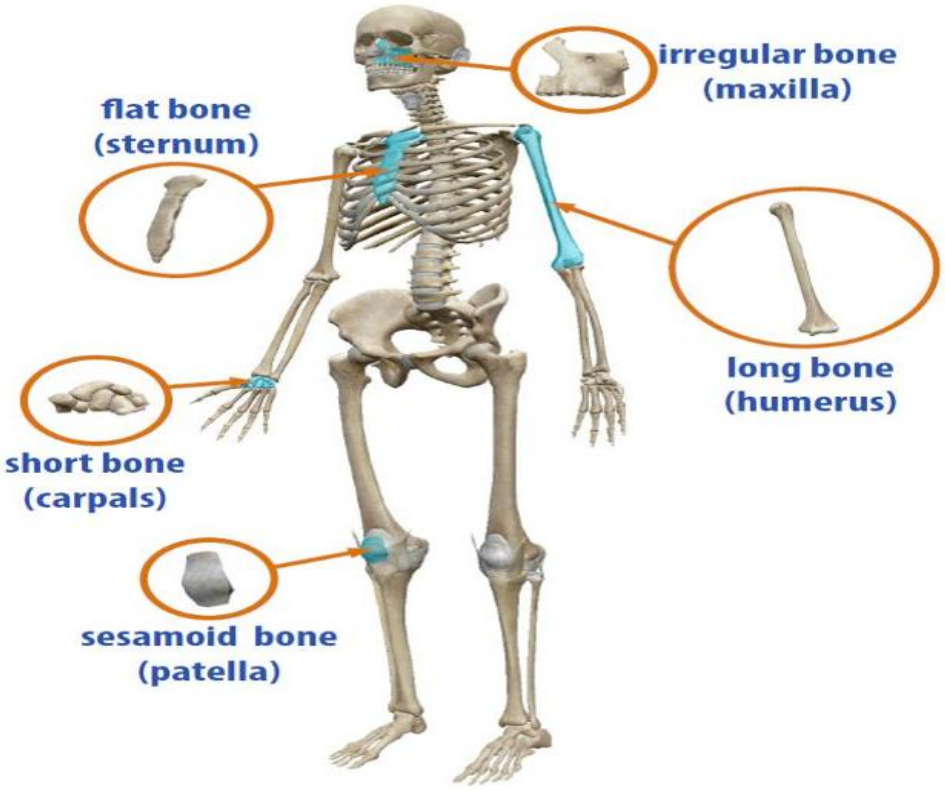
Bones can be classified **regionally or according to their general shape.**

In the regional classification; the bones are organized into two main groups: **the axial and appendicular skeletons.**

- **The axial skeleton** consists of the elements forming the central axis of the body (skull, vertebral column, and thoracic cage).
- **The appendicular skeleton** consists of the bones forming the shoulder, pelvis, upper limb, and lower limb

In the general shape classification the bones are organized into five categories: **Long, Short, Flat, Irregular, and Sesamoid**.

1- **long bones** : As their name suggests, long bones are typically **longer** than they are wide. All the bones of the **limbs,** except **the patella (kneecap)** and the wrist and ankle bones.
2- **Flat bones:** are **thin, flattened**, and usually **curved.** Most bones of the **skull, the ribs, and the sternum** (breastbone) are flat bones.
3- **Short bones:** are generally **cube-shaped**. The bones of the **wrist and ankle** are short bones.
4- **Irregular bones:** Bones that do not fit one of the preceding categories are called irregular bones. The **vertebrae,** which make up the vertebral column.
5- **Sesamoid bones:** which **form within tendons**, are a special type of **short bone**. The best-known example is **the patella.**



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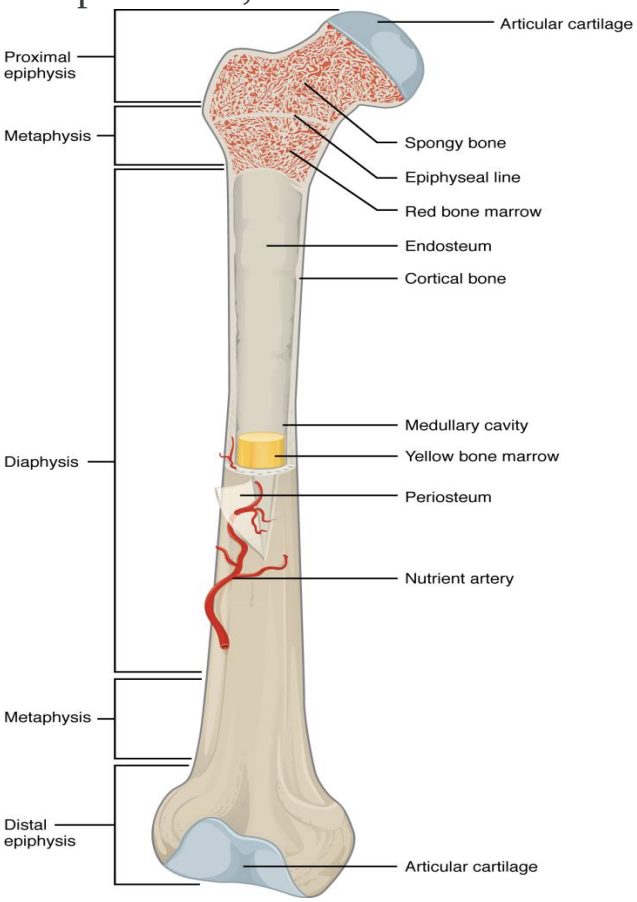
Gross Anatomy of Bones

A long bone has two main regions:

the diaphysis and the epiphysis

The **diaphysis** is the hollow, tubular shaft that runs between the proximal and distal ends of the bone.

Inside the diaphysis is the **medullary cavity**, which is filled with **yellow bone marrow** in an adult. The outer walls of the diaphysis (cortex, cortical bone)are composed of dense and hard compact bone, a form of osseous tissue.



Anatomy of a Long Bone: A typical long bone showing gross anatomical features.

The wider section at each end of the bone is called the **epiphysis** (plural = epiphyses), which is filled internally with spongy bone, another type of osseous tissue.**Red bone marrow fills** the spaces between the spongy bone in some long bones.

Each epiphysis meets the diaphysis at the metaphysis**.** During growth, **the metaphysis** contains the **epiphyseal plate**, the site of long bone elongation. When the bone stops growing in early adulthood (approximately 18–21 years), the epiphyseal plate becomes an **epiphyseal line** .

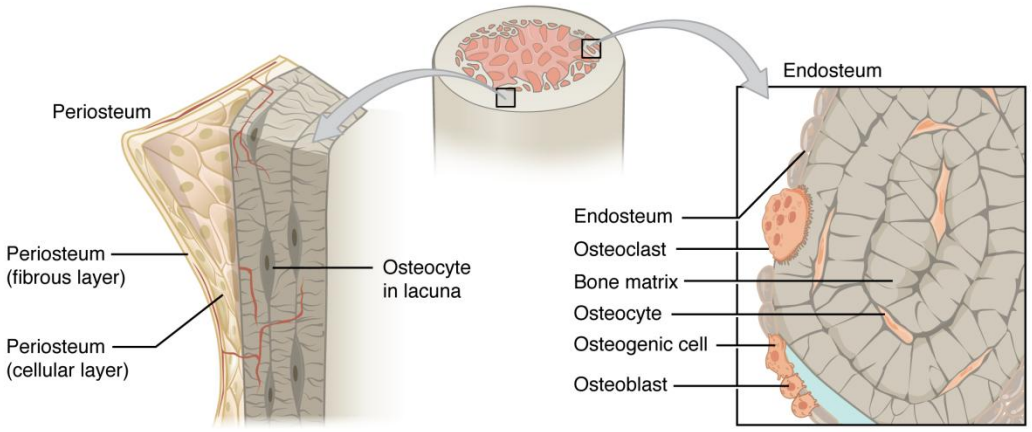
Lining the bone

the inside of the bone adjacent to the medullary cavity is a layer of bone cells called the **endosteum** (endo- = "inside"; osteo- = "bone"). These bone cells cause the bone to grow, repair, and remodel throughout life.

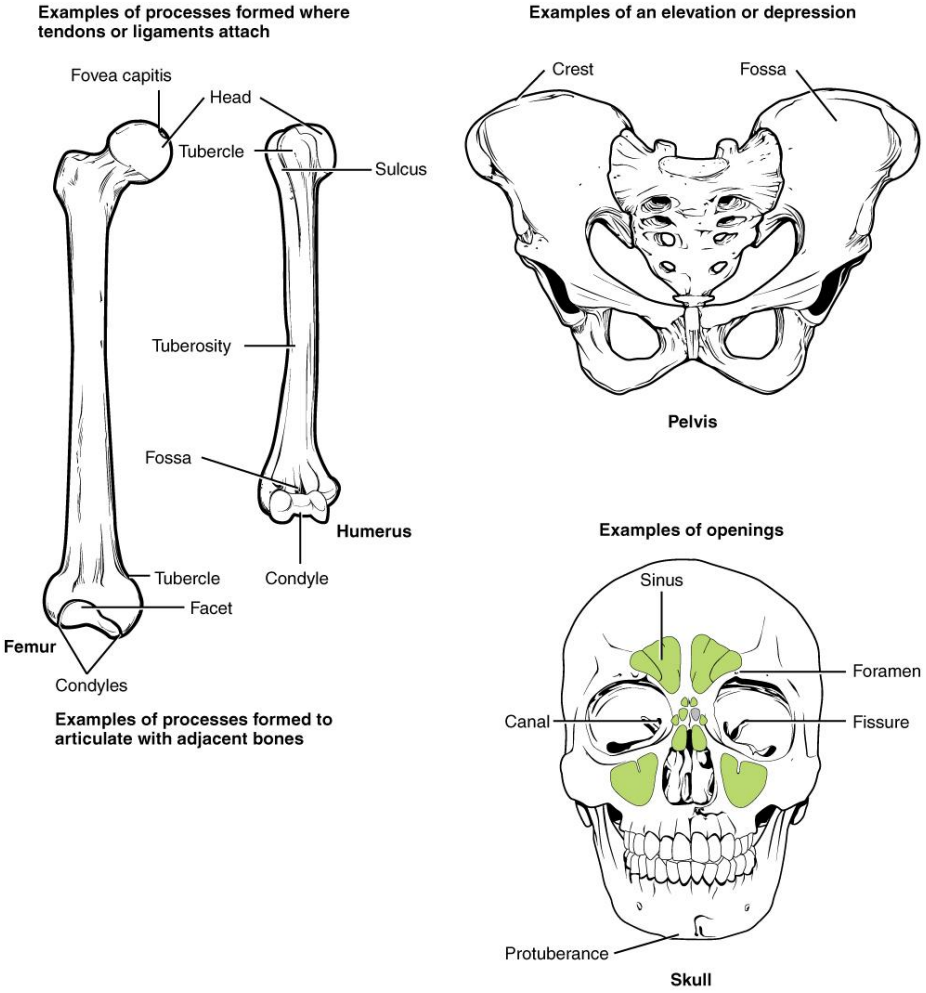
On the outside of bones there is another layer of cells that grow, repair and remodel bone as well. These cells are part of the outer double layered structure called the **periosteum** (peri– = "around" or "surrounding").

The periosteum also contains blood vessels, nerves, and lymphatic vessels that nourish compact bone.

Tendons and ligaments attach to bones at the periosteum. The periosteum covers the entire outer surface except where the epiphyses meet other bones to form joints In this region, the epiphyses are covered with **articular cartilage**, a thin layer of hyaline cartilage that reduces friction and acts as a shock absorber.



Anatomy of a Flat Bone: This cross-section of a flat bone shows the spongy bone (diploë) covered on either side by a layer of compact bone.



Bone Features: The surface features of bones depend on their function, location, attachment of ligaments and tendons, or the penetration of blood vessels and nerves.

Osseous Tissue: Bone Matrix and Cells

Bone Matrix

Osseous tissue is a connective tissue and like all connective tissues contains relatively few cells and large amounts of extracellular matrix. By mass, osseous tissue matrix consists of 1/3rd collagen fibers and 2/3rds calcium phosphate salt.

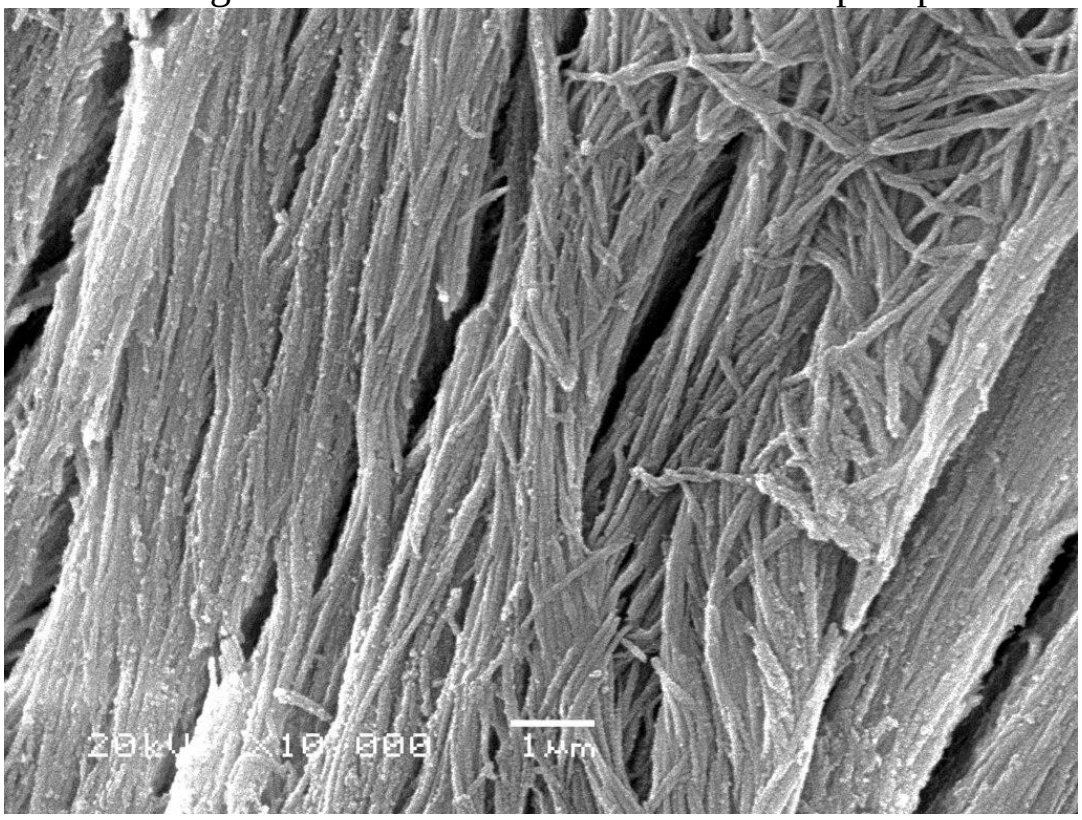
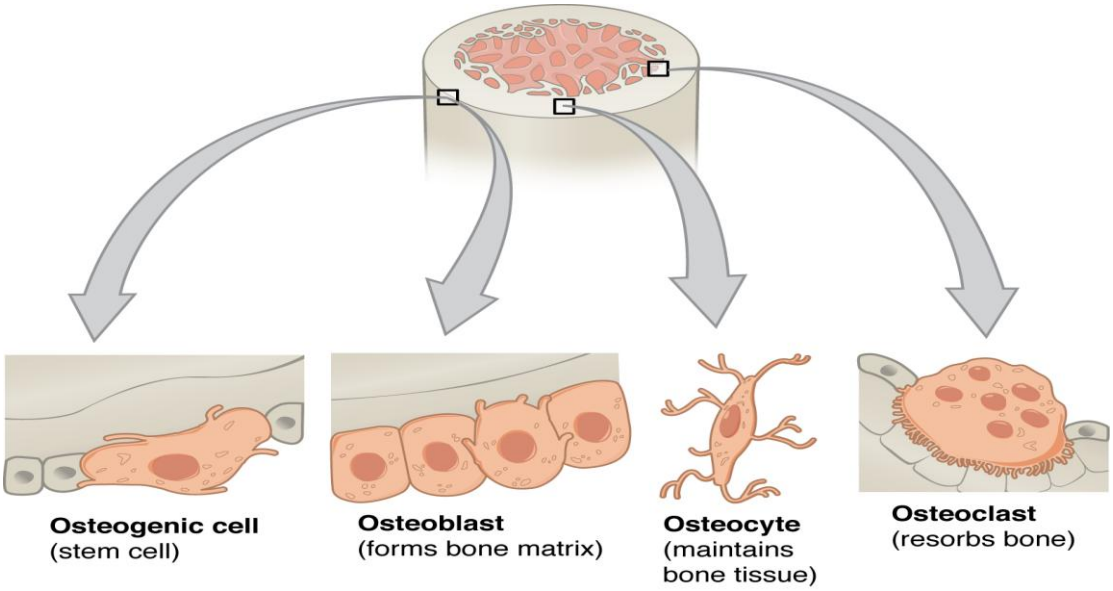


Figure 6.3.5 Calcified collagen fibers from bone (scanning electron micrograph, 10,000 X, By Sbertazzo – Own work, CC BY-SA 3.0

Bone Cells

Although bone cells compose less than 2% of the bone mass, they are crucial to the function of bones. Four types of cells are found within bone tissue: osteoblasts, osteocytes, osteogenic cells, and osteoclasts.



Bone Cells: Four types of cells are found within bone tissue. **Osteogenic cells** are undifferentiated and develop into osteoblasts. **Osteoblasts** deposit bone matrix. When osteoblasts get trapped within the calcified matrix, they become **osteocytes. Osteoclasts** develop from a different cell lineage and act to resorb bone.

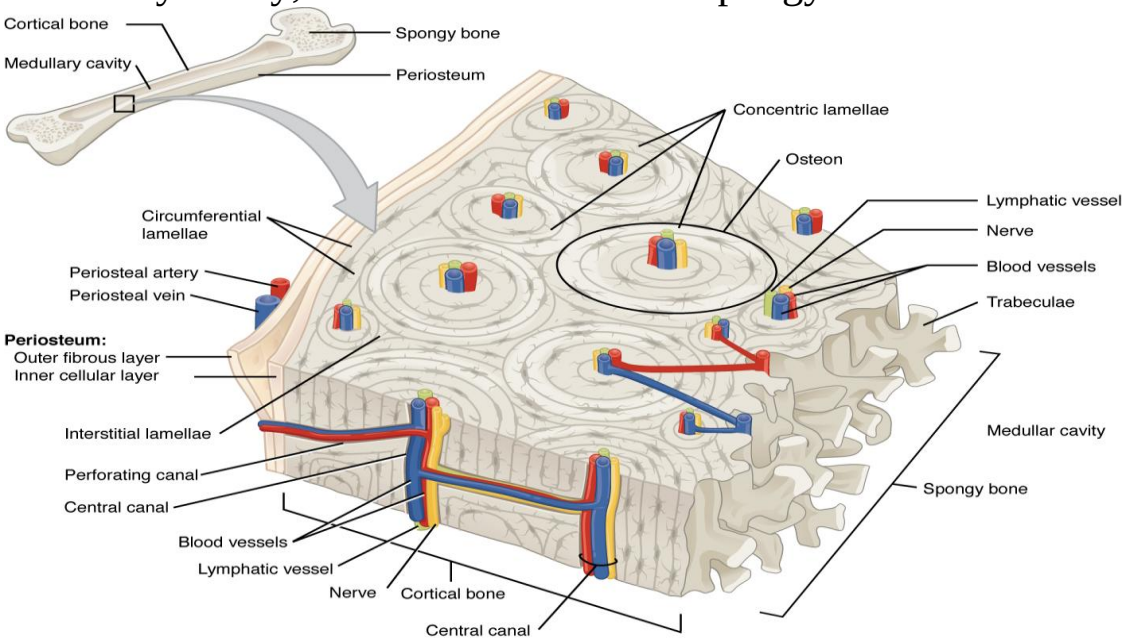
osteocyte, the primary cell of mature bone and the most common type of bone cell. Each osteocyte is located in a small cavity in the bone tissue called a **lacuna (lacunae for plural)**.They can communicate with each other and receive nutrients via long cytoplasmic processes that extend through **canaliculi** (singular = canaliculus), channels within the bone matrix. Osteocytes are connected to one another within the canaliculi via gap junctions.

the **osteogenic (osteoprogenitor) cell**. These osteogenic cells are undifferentiated with high mitotic activity and they are the only bone cells that divide.

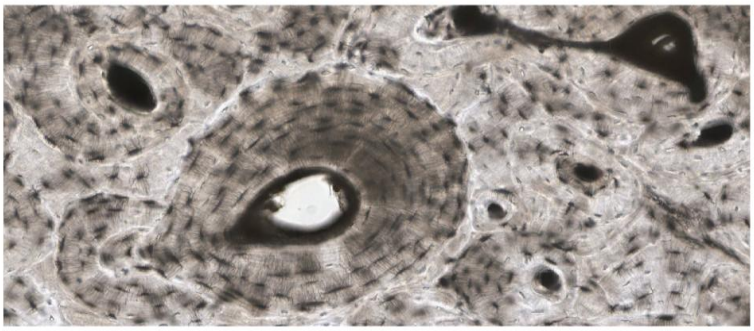
Compact and Spongy Bone

Compact Bone

Compact bone is the denser, stronger of the two types of osseous tissue. It makes up the outer cortex of all bones and is in immediate contact with the periosteum. **In long bones**, as you move from the outer cortical compact bone to the inner medullary cavity, the bone transitions to spongy bone.

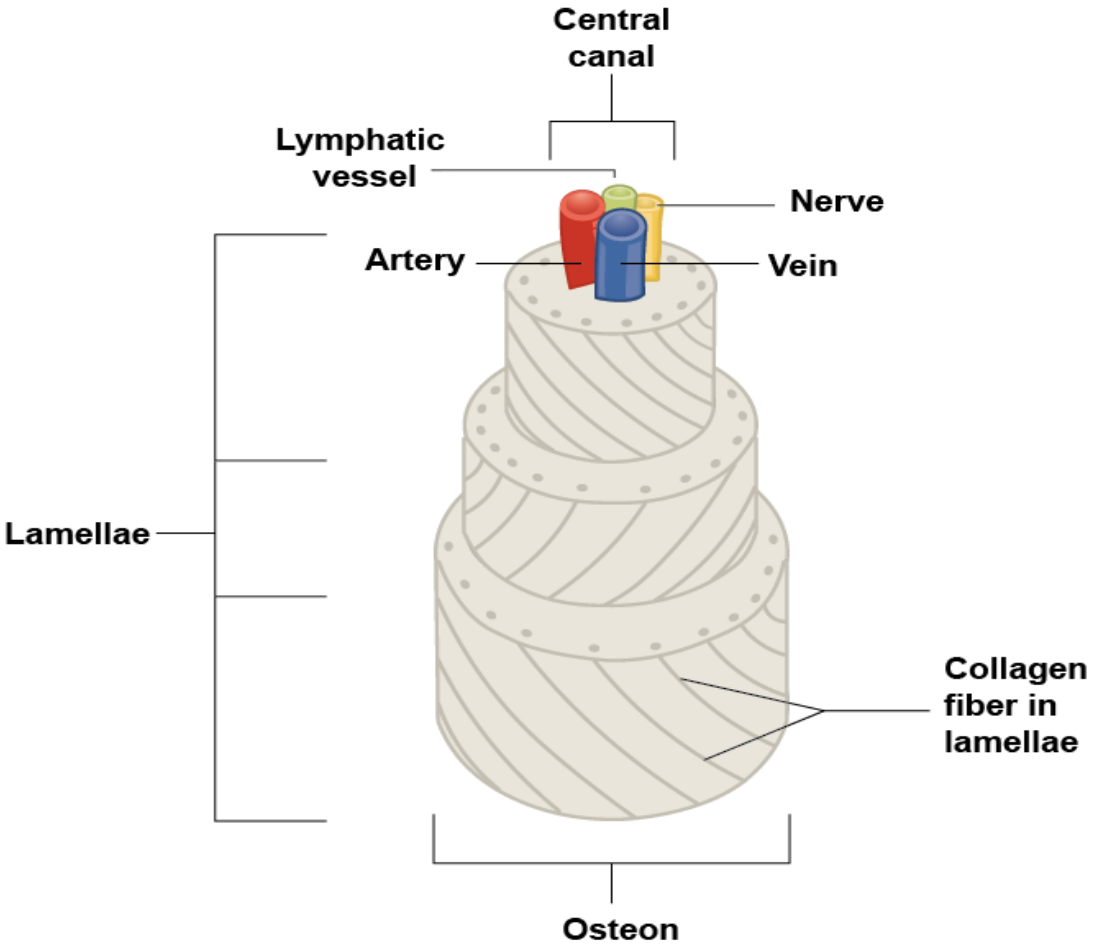


(a)



(b)

Diagram of Compact Bone: (a) This view of compact bone shows several osteons, (b) In this micrograph of the osteon



If you look at compact bone under the microscope, you will observe a highly organized arrangement of concentric circles that look like tree trunks.

Each group of concentric circles (each "tree") makes up the microscopic structural unit of compact bone called an **osteon** (this is also **called a Haversian system)**

Each ring of the osteon is made of collagen and calcified matrix and is called a **lamella** (plural = lamellae). Running down the center of each osteon is the **central canal**, or Haversian canal, which contains blood vessels, nerves, and lymphatic vessels. These vessels and nerves branch off at right angles through a **perforating canal**, also known as Volkmann's canals, to extend to the periosteum and endosteum.

Spongy (Cancellous) Bone

Like compact bone, **spongy bone**, also known as **cancellous bone,** contains osteocytes housed in lacunae, but they are not arranged in concentric circles., the lacunae and osteocytes are found in a lattice-like network of matrix spikes called **trabeculae** (singular = trabecula) The trabeculae are covered by the endosteum, which can readily remodel them. The trabeculae may appear to be a random network

Spongy bone provides balance to the dense and heavy compact bone by making bones lighter so that muscles can move them more easily. In addition, the spaces in some spongy bones contain red bone marrow, protected by the trabeculae, where hematopoiesis occurs.

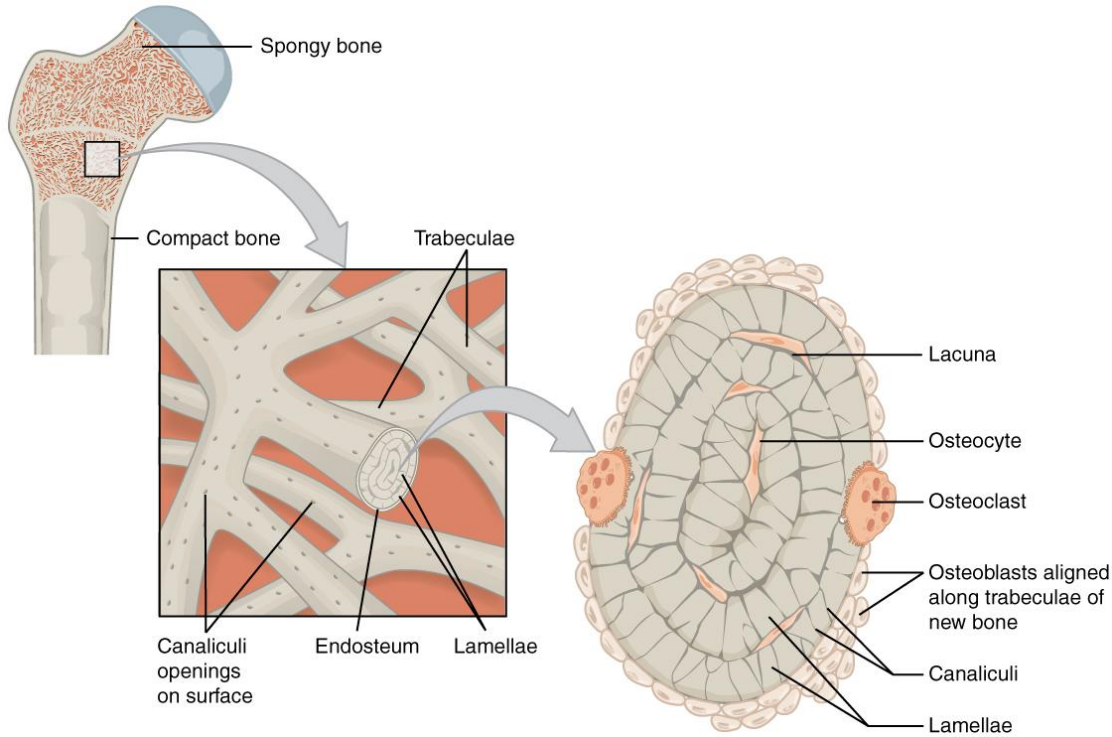


Diagram of Spongy Bone: Spongy bone is composed of trabeculae that contain the osteocytes. Red marrow fills the spaces in some bones.

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Arthrology

Arthrology: A branch of anatomy studies the joints and articulation.

Articulation: is the site where the rigid elements of the skeleton are meet.

Joints: Are the places of the union between two or more skeleton elements.

is a point of contact between two bones, between bone and cartilage or between bone and teeth. flexible connective tissues forms joints,

Some joints permit no movement, others permit slight movement and others afford fairly free movement.

Classification of joints

A.Classification based on structure.

B.Classification based on function.

Structural classification of joints depends on the type of connective tissue that combines the bones together and whether there is a space between the articulating bones or not **(synovial cavity),** and this Classification is as the following:

1. **Fibrous joints:** the bones are held together by fibrous connective tissue, and there is no synovial cavity.

2. **Cartilaginous joints:** the bones are held together by cartilage, and there is no synovial cavity.
3. **Synovial joints:** the bones are held together by capsule and ligaments, and there is a synovial cavity.

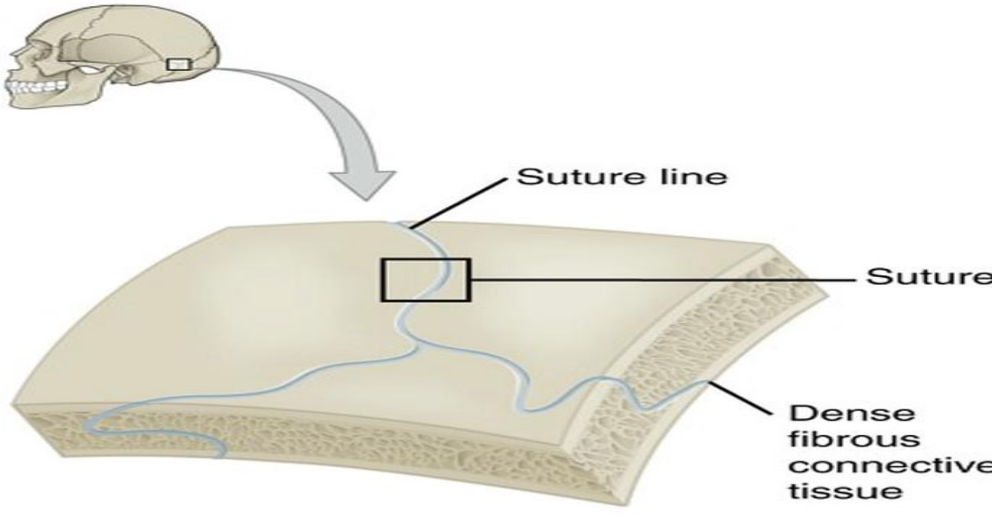
Functional classification of the joints relates to the degree of movement they permit, as the following:

1. **Synarthrosis:** An immovable joint.
2. **Amphiarthrosis :** A slightly movable joint.
3. **Diarthrosis :** A freely movable joint.

• NOTE: all Diarthrosis are Synovial joints.

Types of fibrous joints :

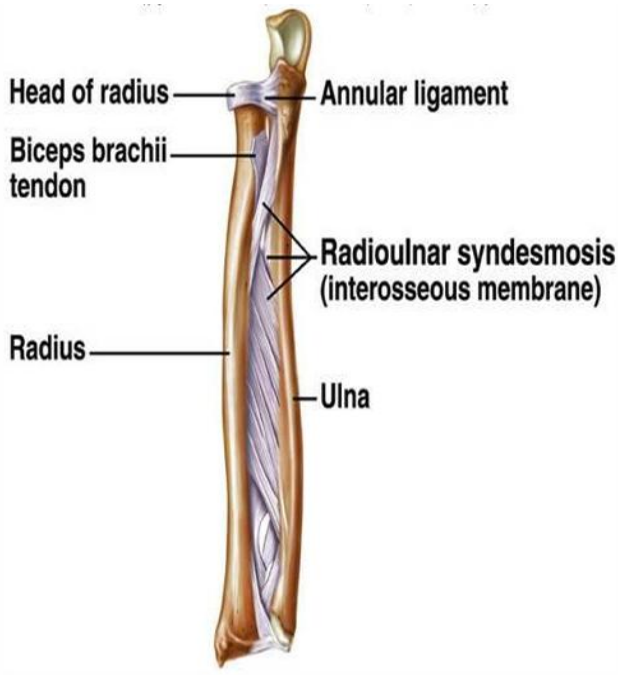
1. **Sutures :** as the sagittal suture or the coronal suture of the **skull** which is fixed immovable. Thin layer of dense fibrous connective tissue united bones of the skul, Irrigular edge to add a strenght and prevent fracture so they are classified functionally as **synarthrosis**

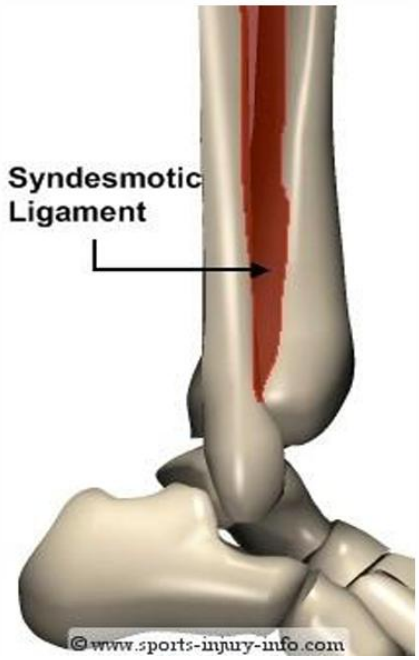


2. **Syndesmoses :** (band or ligament) is a fibrous joint in where there is a greater distance between the articulating bones and more fibrous connective tissue than in sutures.

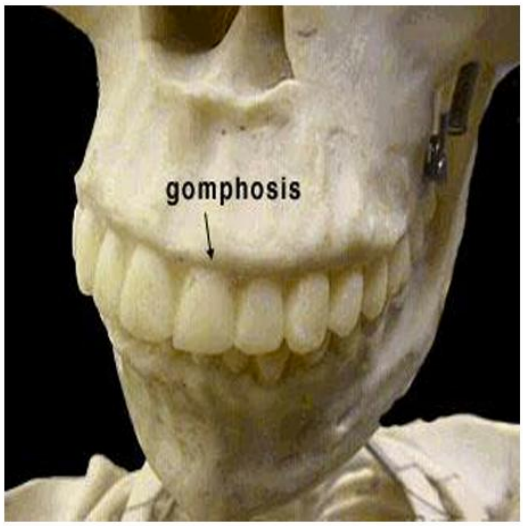
Ex. The interosseous membrane between the parallel borders of **radius and ulna bone (middle radioulnar joint)**

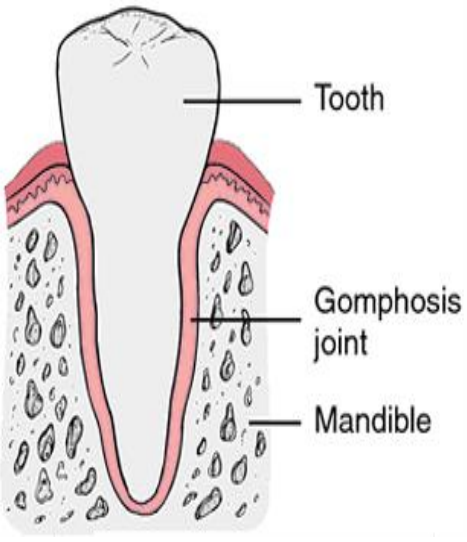
and between the parallel borders of **the tibia and fibula (middle tibiofibular joint).** Because it allows **slight movement** it is classified functionally as an **amphiarthrosis.**





3. **Gomphosis** is a type of fibrous joint in which a **A cone-shaped peg fits into a socket**. The only An example in the body is the roots of teeth and their sockets in the maxilla and the Mandible bones. A gomphosis is classified functionally as a **synarthrosis,** an immovable joint.





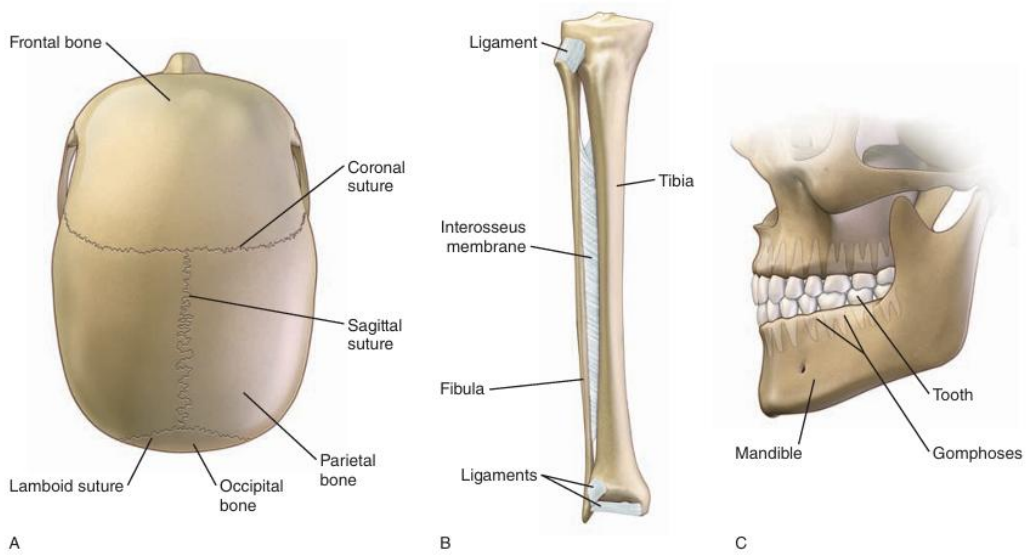
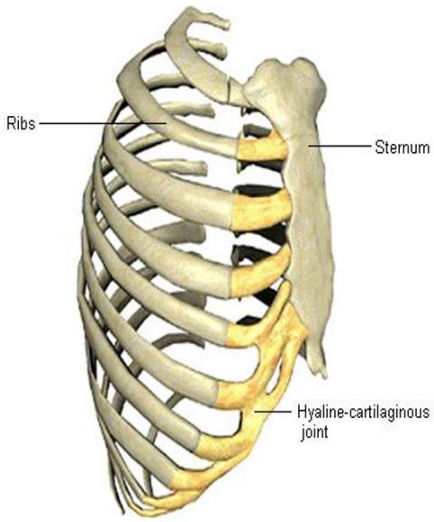


FIGURE 2.4 Fibrous joints. Strong fibrous connections between bones prevent movement at these joints. **A.** Sutures of the skull. **B.** Syndesmosis formed by the ligaments and interosseous membrane of the lower leg. **C.** Gomphoses between the teeth and their sockets in the mandible.

Types of cartilaginous joints:

1.**Synchondroses:** **example** is the epiphyseal plate that connects the epiphysis with the diaphysis of the long bone. **Another example** is the joint between the first rib and the sternum bone. Functionally it is classified as a **synarthrosis.**



2. Symphyses : in which the ends of the articulating bones are covered by hyaline cartilage, but The bones are connected by a broad, flat disc of fibrocartilage. All symphyses are present in the **midline of the body**, e.g., the joint between the manubrium and the body (parts) of the sternum, the joint between the two hip bones called pubic symphyses, the joints between the bodies

of the vertebrae forming the intervertebral joints. A symphysis is an **amphiarthrosis,** slightly movable joint.

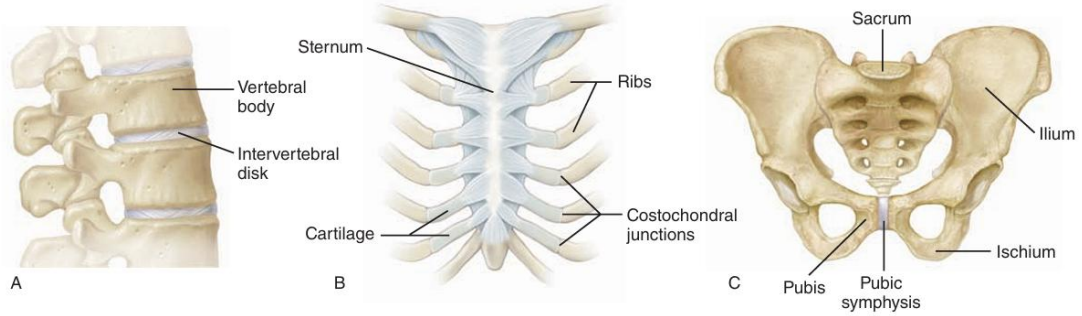


FIGURE 2.5 Cartilaginous joints. Cartilage increases the pliability of these joints, allowing slight movement. **A.** Intervertebral disks of the spine. **B.** Costochondral junctions of the ribcage. **C.** Pubic symphysis of the pelvis.

Types of synovial joints:

• Although all synovial joints are similar in structure, the shapes of the articulating surfaces vary. Accordingly, synovial joints are divided into **six subtypes: Planer, Hinge, Pivot, Condyloid, Saddle, and ball and-socket joints.**

• Most movable joint in the body

• There is a joint cavity (synovial fluid and synovial cavity)

• Articular cartilage cover the end of oppsing bones.

Articular Capsules form complete **envelopes** for the freely movable joints. Each capsule consists of two strata (layers)—an external (stratum fibrosum) composed of white fibrous tissue, and an internal (stratum synoviale) which is a secreting layer and is usually described separately as the synovial membrane.