

Ministry of higher Education and Scientific Research

Foundation of Technical Education

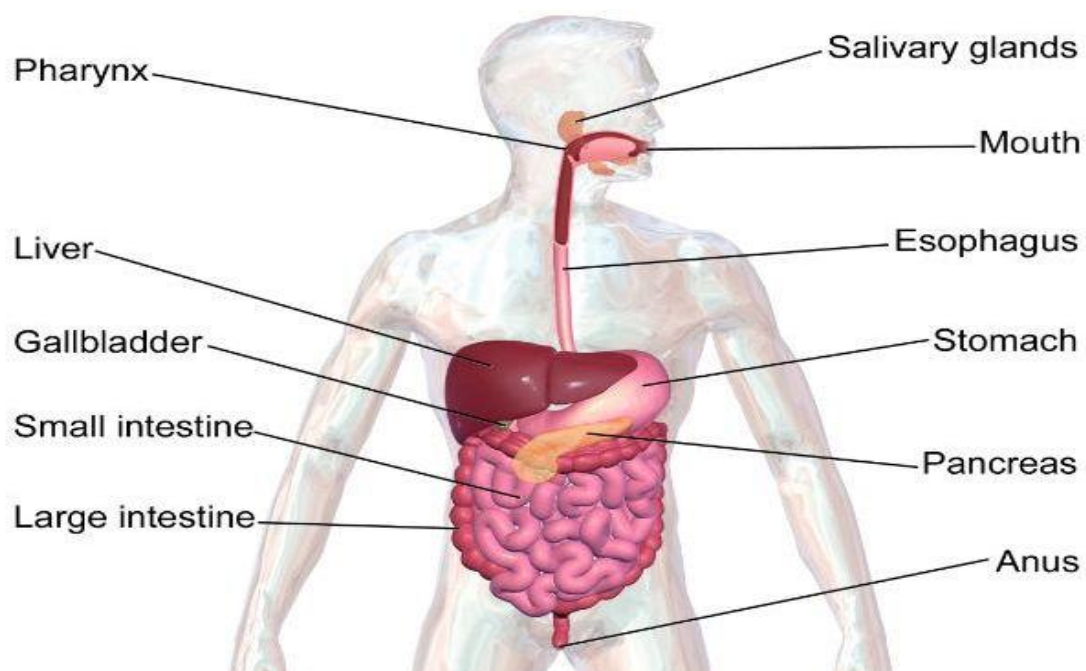
Institute of Medical Technology / Baqubq

Training package in Theoretical lecture

Histology and anatomy

For

Students of First Class Pathology Analysis Medical Laboratory Quality Control



By

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M. Sc. Biolog

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Microscope

The microscope: is an instrument which is used for examination of fine structure of objects . Micro = small . Scope = to view. It enlarges of the images of the objects which then can be seen by the eye .

Types of Microscope:

1-Simple microscope :It is made of single or combination of lenses which act as single position convex lens .

2-Compound microscope : It is made up of 2 lenses which are fitted in a brass tube , one of the tubes can be slided into the other so that the distance between lenses can be changed and adjusted.

Other types of microscopes :

- 1- **Bright field.** is the simplest of all the optical microscopy illumination techniques. and the most common used microscope in the laboratories.
- 2- **Dark-field.** Dark-field microscope is used to observe live spirochetes.
- 3- **Phase – contrast.** is used in biology to view unstained specimens. It is one of the types of microscopes used to study cells and cell parts like mitochondria,

lysosomes and Golgi bodies.

4- Fluorescent. Fluorescence microscope uses high-energy, short-wavelength light that excites the electrons of certain molecules present within the sample.

5- Scanning electron. Scanning Electron Microscope is characterized as a microscope that has lower magnifying power but can provide 3 dimensional viewing of objects.

Bright Field Microscope (The Compound Microscope)

1. Commonly used in bacteriology laboratory.
2. It depends on light.
3. It consider as compound microscope.

Bright Field Microscope parts :

1. **Base:** The bottom support of the microscope.
2. **Arm:** It helps in holding the microscope.
3. **Light source (illuminator):** A light source mounted under the stage.
4. **Body tube:** It hold the projector lenses that direct the light toward the ocular lenses.
5. **Nosepiece:** Hold the objectives (movable disk).
6. **Coarse adjustment knob:** Used to make relatively wide focusing adjustments to the microscope.
7. **Fine adjustment Knob:** Used to make relatively small adjustments to the microscope.
8. **Stage:** The flat plate where the slides are placed for observation.

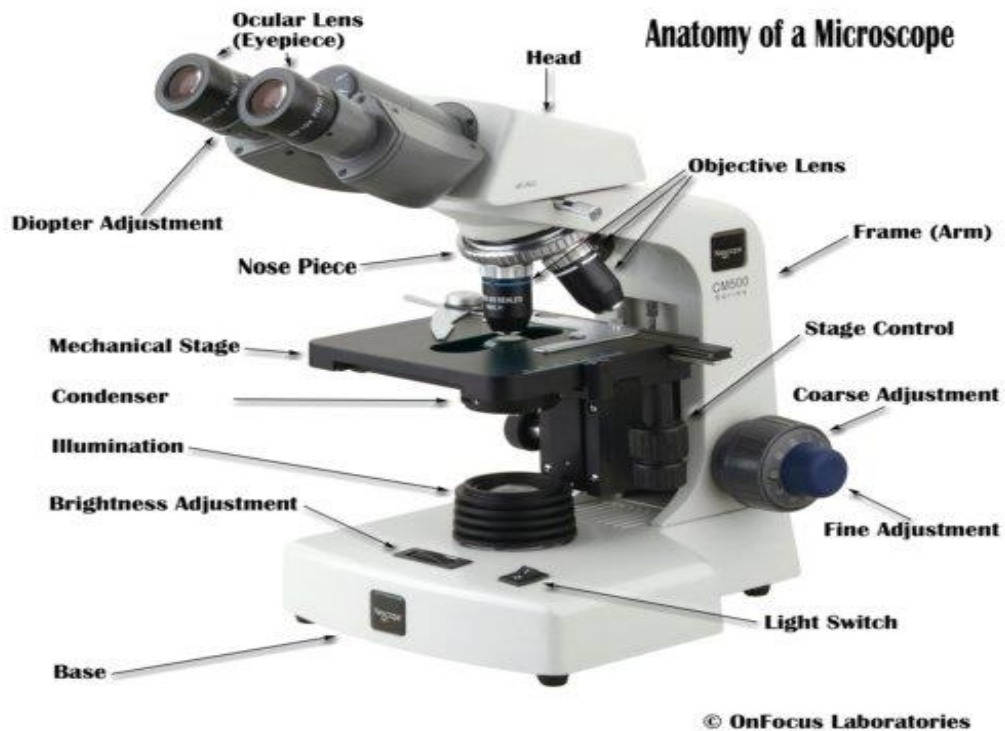
9. **Stage Clips:** Clips on the stage used to hold the slide in place.
10. **Condenser:** Focuses the light through the specimen.
11. **Iris diaphragm:** Vary the amount of light passing through the stage opening.
12. **Condenser adjustment knob:** Used to move the condenser up and down.
13. **Objective lenses:** Primary magnification (4 ×, 10 ×, 40 ×, 100 ×).
14. **Ocular lenses:** Final magnification 10 × (Eye Pieces).

Steps for using of oil immersion lens :

1. Focus very carefully with the 40 x objective over the stained specimen on the slide.
2. Rotate the nose piece half way.
3. Apply a small drop of oil on the slide directly over the area of the specimen to be examined.
4. Rotate 100 x objective into the immersion oil.
5. Use the fine adjustment for focusing.

Three important rules attend the use of oil immersion lens:

1. Never use an oil immersion lens without the oil.
2. Never get oil on any other lens.
3. Clean up all oil when finished.



Compound Microscope

Shapes of cell

Histology

Histology meaning the study of the tissue, it's the study of the fundamental tissues of the body. The term **histology** is derived from two Greek words:

Histos = Tissue

Logos = Science

Histology : deals with the study of minute structure of tissue in general.

Micro-anatomy : deals with the fine structure of all the tissue present in particular organ. Cytology: deals with the detailed study of individual cell and its internal components .

Cell :

Cell is the unit of structure and function in animals and plants. It was first named as cell by Robert Hooke in 1665, the cell is a membrane bound unit containing discrete organelles, protoplasm and nucleus, the organelles are organized forms of biological molecules which play an important role in the function of cell, example Mitochondria for providing energy, endoplasmic reticulum for producing secretions like enzymes and hormones.

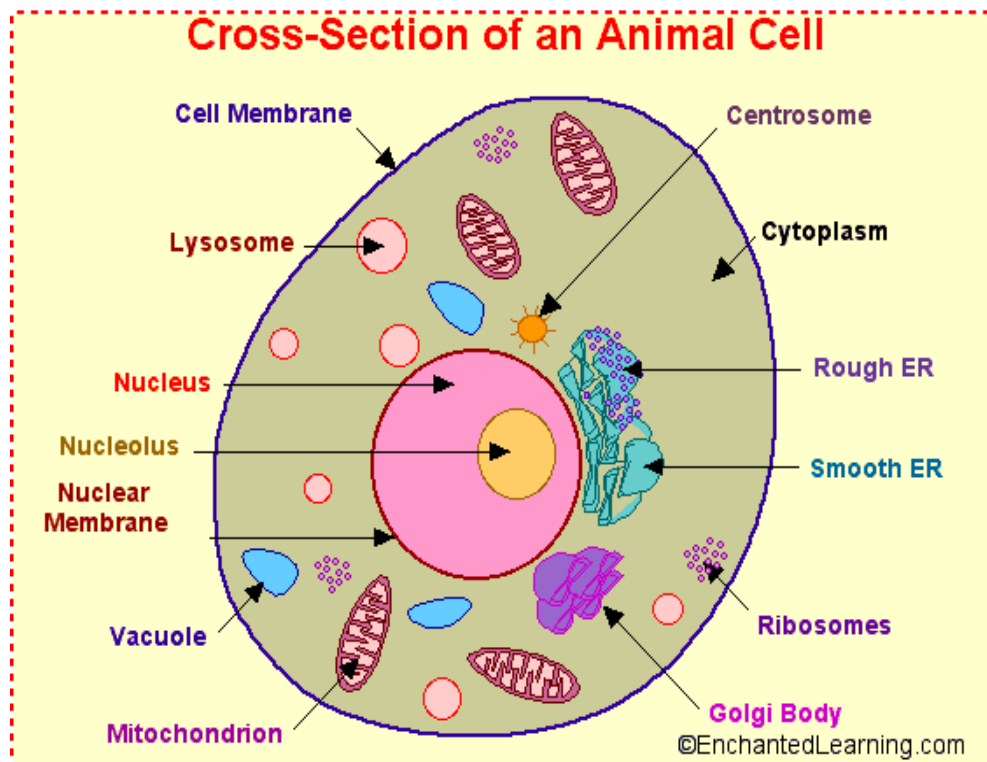
Cell membrane :

Each cell is limited by semi-permeable membrane called cell membrane (plasmalemma) in which cell protoplasm is limited, cell membrane is made of double layers of phospholipids and protein molecules.

Animal cell organelles :

- 1- Cell membrane** : the thin layer of protein and fat that surrounds the cell. The cell membrane is semipermeable, allowing some substances to pass into the cell and blocking others and give cell shape.
- 2- Cytoplasm** : the jelly like material outside the cell nucleus in which the organelles are located.
- 3- Nucleus** : spherical body containing many organelles, including the nucleolus. The nucleus controls many of the functions of the cell (by controlling protein synthesis) and contains DNA (in chromosomes). The nucleus is surrounded by the nuclear membrane.
- 4- Nuclear membrane** : the membrane that surrounds the nucleus.
- 5- Nucleolus** : an organelle within the nucleus - it is where ribosomal RNA is produced.
- 6- Mitochondria** : spherical to rod-shaped organelles with a double membrane. The inner membrane is infolded many times. The mitochondrion converts the energy stored in glucose into ATP (adenosine triphosphate) for the cell.

- 7- Endoplasmic reticulum: (ER) a vast system of interconnected, membranous, infolded and convoluted sacks that are located in the cell's cytoplasm (the ER is continuous with the outer nuclear membrane).
- 8- Ribosomes: small organelles composed of RNA-rich cytoplasmic granules that are sites of protein synthesis.
- 9- Golgi apparatus: **Golgi body** - : a flattened, layered, sac-like organelle that looks like a stack of pancakes and is located near the nucleus. It produces the membranes that surround the lysosomes. The Golgi body packages proteins and carbohydrates into membrane-bound vesicles for " export " from the cell.
- 10- **Lysosome**: (also called cell vesicles) round organelles surrounded by a membrane and containing digestive enzymes. This is where the digestion of cell nutrients takes place.
- 11- **Vacuole** - fluid-filled, membrane-surrounded cavities inside a cell. The vacuole fills with food being digested and waste material that is on its way out of the cell.



Cross Section of Animal cell

Tissue

Tissue : Is a group of similar cells specialised in common direction and set a part for performance of a common function .

Classification of Tissue Types :

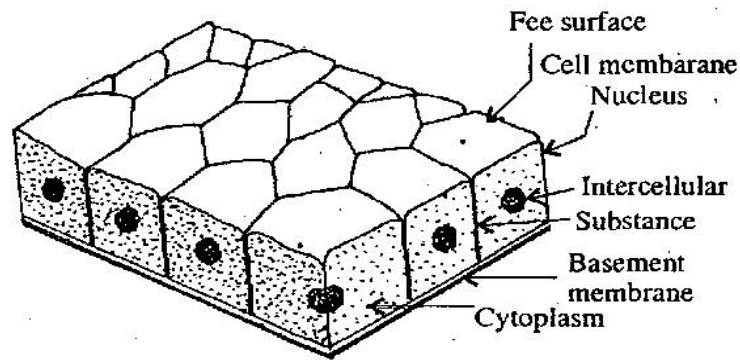
Tissues are classified into four primary tissues according to **structure** and **function** .

There are Four (4) Basic Types of Animal Tissue :

Epithelial Tissue	Connective Tissue	Muscular Tissue	Nervous Tissue
Covers body surfaces and lines body cavities	Binds and Supports body parts	Enables movement of structures within the body and movement of the entire person/animal	Enables responses to stimuli and coordinates bodily functions

Epithelial tissue :

Its is a cellular layer which lines the body surface , skin , mucous membranes and glands. Cells may be arranged in a single or multiple layers, the cells rest on abasement membrane which is made of non-cellular amorphous substances mainly mucopolysaccharides.



General Structure of Epithelia

General functions of epithelial tissue :

- 1- **Selective diffusion.**
- 2- **Protection .**
- 3- **Transport :** mucous & particulate material is transported along the epithelial surface.
- 4- **Secretion :** in glandular epithelium.
- 5- **Excretion :** urine, sweat & CO_2 are diffused across the epithelial surfaces, they filter from blood the waste product of metabolism.
- 6- **Absorption :** as in intestinal epithelium.
- 7- **Sensory reception :** some epithelium cells are specialized for impulse transmission ,e.g: taste bud.
8. **Lubrication :** mucous secreted by epithelial cells act as lubricant.
9. Transitional epithelium has two important functions:
 - **It's capable of distension .**
 - **Provide a waterproof surface impermeable to urine .**

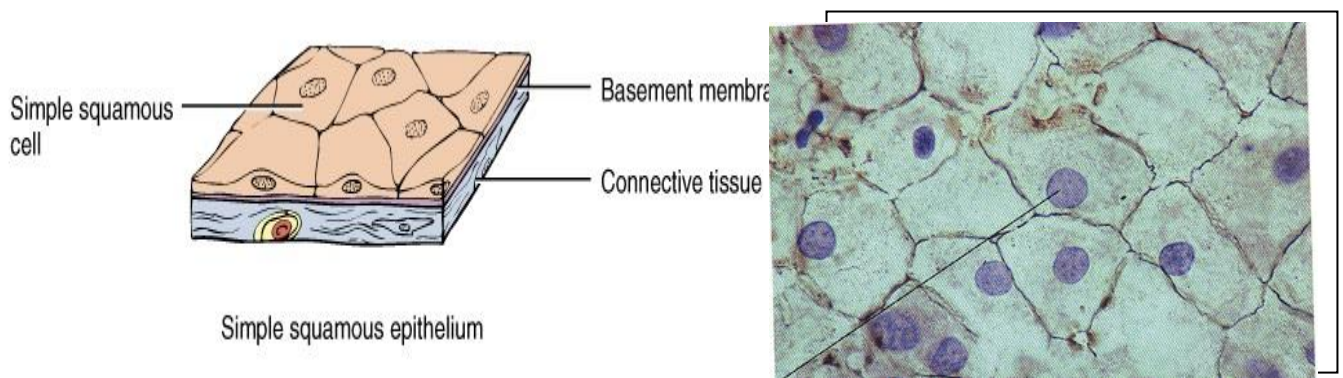
Classification of Epithelial tissue :

Classification of epithelium is based on the shape of the cells and the arrangement of the cells within the tissue, the arrangement of the cells is stated first, then the shape,

and is followed by “ **epithelium** ” to complete the naming (Ex. Simple Squamous Epithelium).

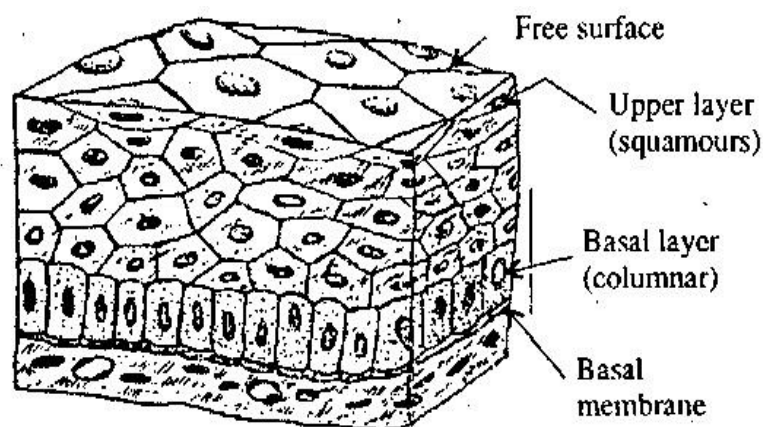
A - Arrangement of the cells :

1-**Simple epithelium tissue** : Cells are found in a single layer attached to the basement membrane.



2- Stratified epithelial tissue :

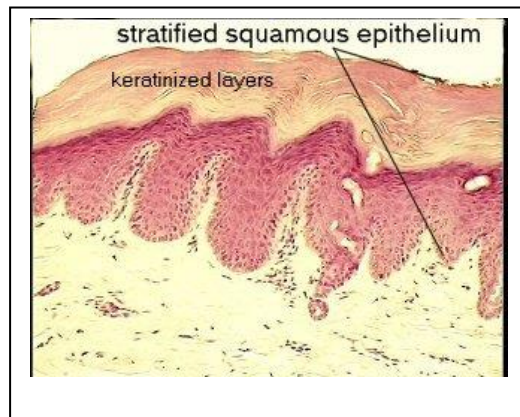
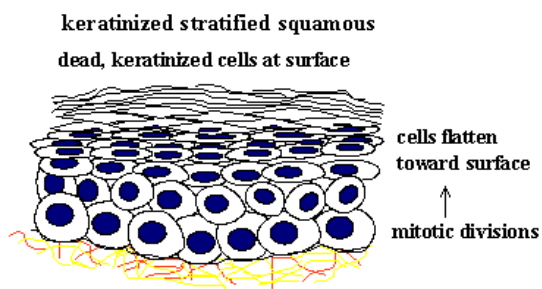
Cells are found in 2 or more layers stacked atop each other. the deepest layer consist of columnar cells arranged on basement membrane, middle layer or layers contain polyhedral cells and superficial are squamous cells (flattened cells). This tissue is specialized for resistance friction.



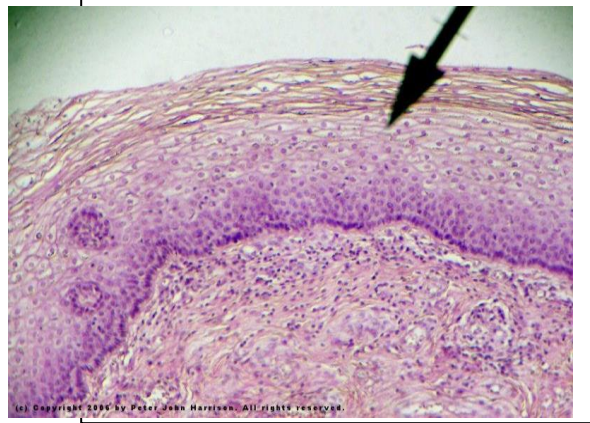
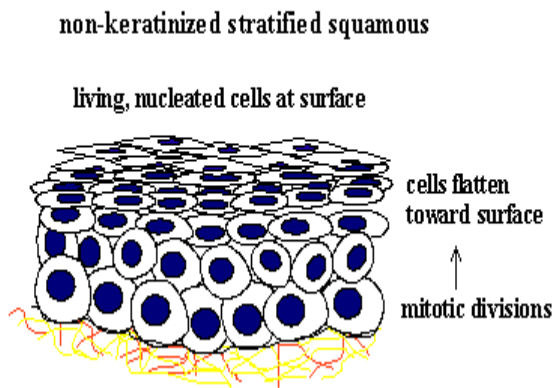
Stratified epithelium

There are 2 types of stratified squamous epithelium :

- ▶ **Keratinized :** As in epidermis (palm of hand) , where the superficial squamous cells are hardened due to a protein keratin .



- ▶ **Non-keratinised :** Example : cornea, oesophagus, skin frog .



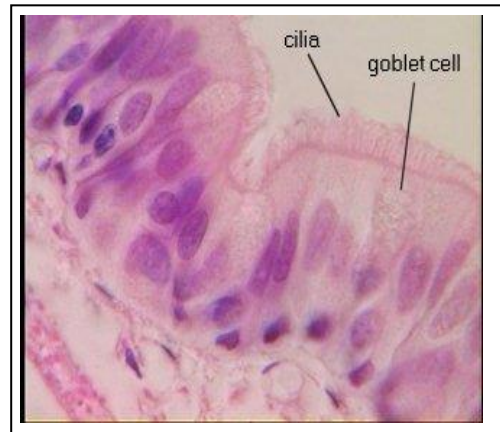
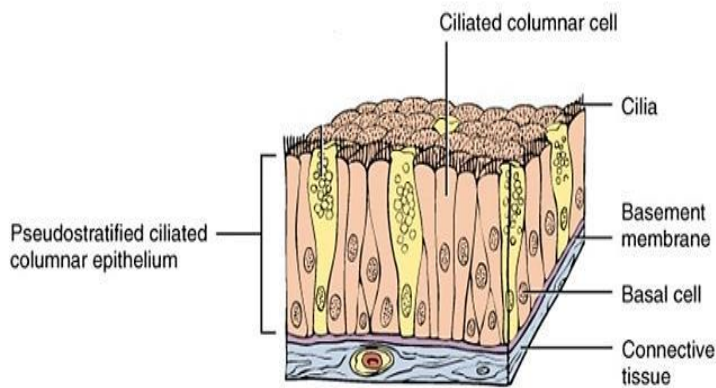
3- Pseudostratified epithelial tissue :

A single layer of cells that appears to be multiple layers due to variance in height and location of the nuclei in the cells. A single layer of cells set on a basement membrane but the height of the cells varies; all cells don't reach the surface, the nuclei too are present at different levels.

Function: Secretion, particularly of mucus; propulsion of mucus by ciliary action.

Location: Non-ciliated type in male's sperm-carrying ducts and ducts of large glands;

Ciliated variety lines the trachea, most of the upper respiratory tract.



4-Transitional epithelial tissue :

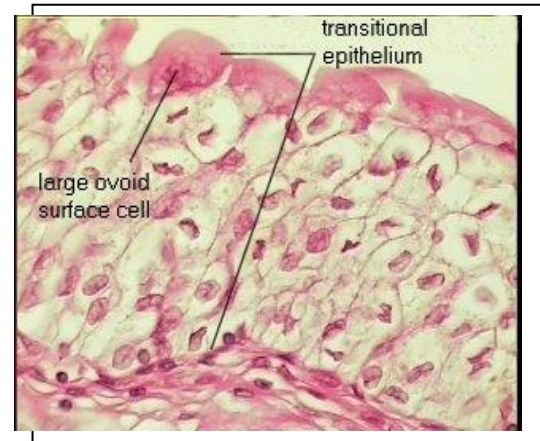
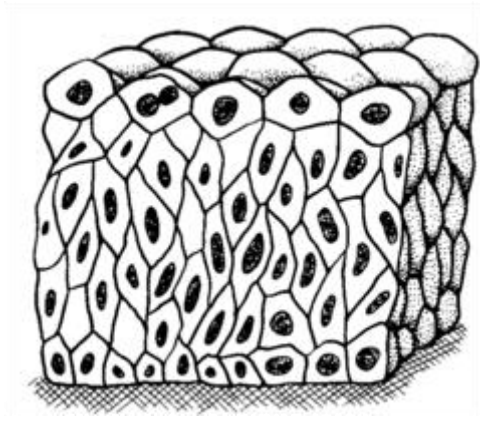
Cells are rounded. Its appearance varies with the state of distension or contraction of the wall, its characteristic of urinary bladder and part of urethra.

1- In the relaxed condition it has 5 to 6 layers, the basal cells are polyhedral, the middle ones are pear shaped with their conical ends touching the basement membrane cells, the superficial cells are dome shaped (umbrella) with the basal surface touching the rounded end of pear shaped cells of second layer.

2- In distended condition the cells of superficial layer get more flattened & those of middle layers get sandwiched between deeper cells.

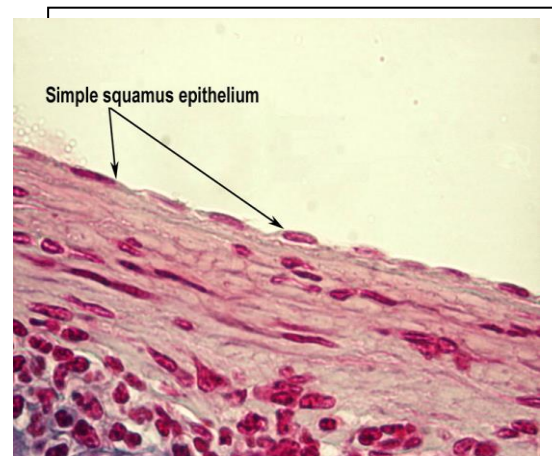
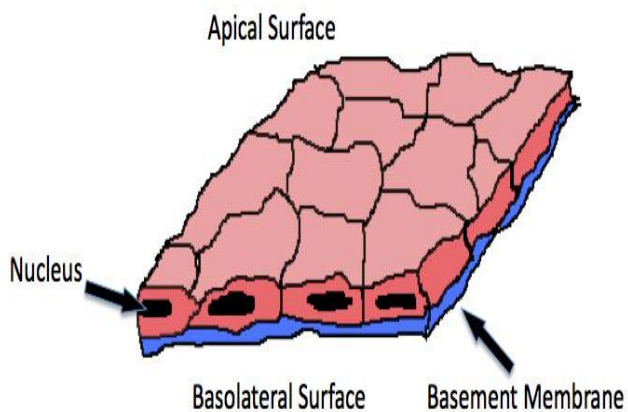
Function: stretches readily and permits distension of urinary organ by contained urine.

Location: lines the ureters, urinary bladder, and part of the urethra.



B-Shape of cell .

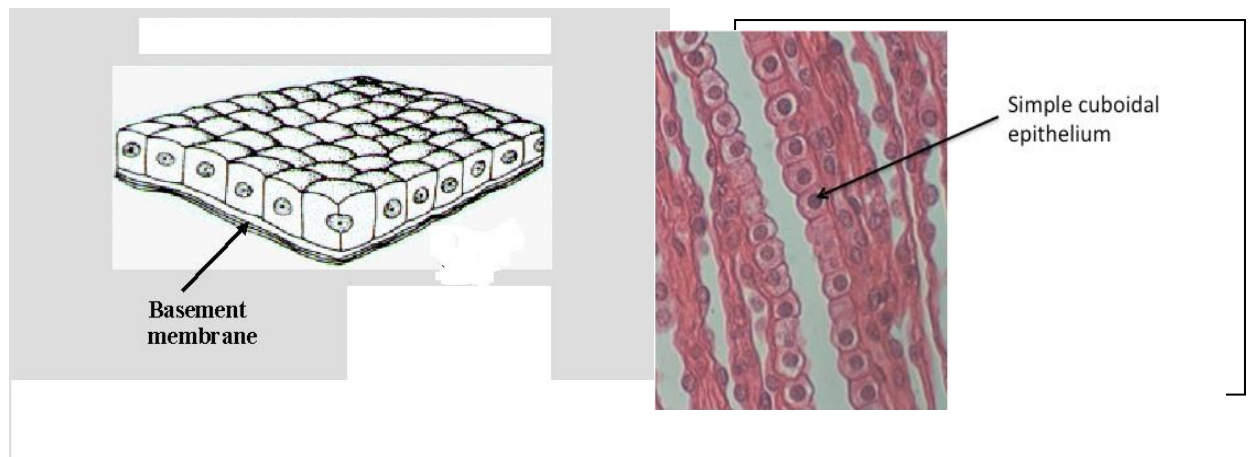
1-Simple squamous epithelial tissue : flat, thin, scale-like cells.: flat, thin, scale-like-cells.



2- Simple cuboidal epithelial tissue : cells that have a basic cube shape. Typically the cell's height and width are about equal.

Function: secretion and absorption.

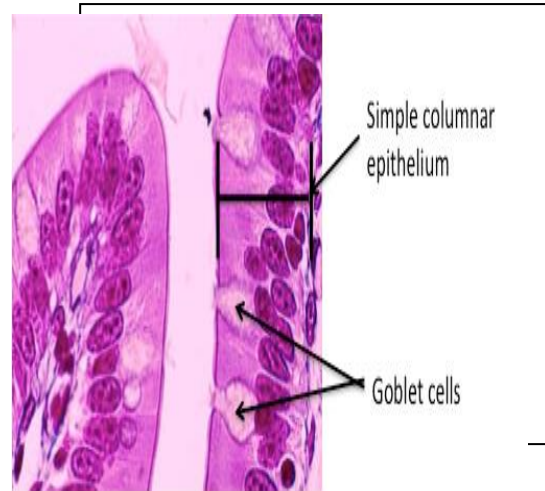
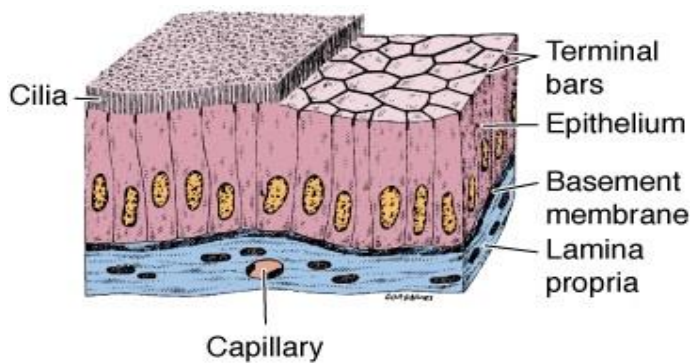
Location: Kidney tubules; ducts and secretory portions of small glands, ovary surface.



3- Simple columnar epithelial tissue: tall, rectangular or column-shaped cells. Typically taller than they are wide.

Function: Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliated action.

Location: nonciliated type lines most of the digestive tract (stomach to anal canal), gallbladder and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.



Special Features of Epithelium :

1-Cilia : (singular= cilium, Latin= eyelash) - hair-like appendages attached to the apical surface of cells that act as sensory structures or to produce movement.

2-Goblet cells : Specialized cells that produce mucus to lubricate and protect the surface of an organ .

3-Villi : (singular= **villus**, Latin= shaggy hair)- finger-like projections that arise from the epithelial layer in some organs. They help to increase surface area allowing for faster and more efficient absorption.

4-Microvilli : Smaller projections that arise from the cell's surface that also increase surface area. Due to the bushy appearance that they sometimes produce, they are sometimes referred to as the **brush border** of an organ.

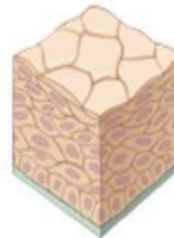
Simple squamous

- Lines blood vessels and air sacs of lungs
- Permits exchange of nutrients, wastes, and gases



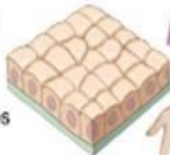
Stratified squamous

- Outer layer of skin, mouth, vagina
- Protects against abrasion, drying out, infection



Simple cuboidal

- Lines kidney tubules and glands
- Secretes and reabsorbs water and small molecules



Stratified cuboidal

- Lines ducts of sweat glands
- Secretes water and ions



Simple columnar

- Lines most digestive organs
- Absorbs nutrients, produces mucus



Stratified columnar

- Lines epididymus, mammary glands, larynx
- Secretes mucus



(a) Most epithelial tissues line or cover surfaces or body cavities

Connective Tissue :

Connective tissue (CT) is one of the four types of biological tissue that support, connect, or separate different types of tissues and organs in the body. The other three types are epithelial, muscle, and nervous tissue. Connective tissue is found in between other tissues everywhere in the body, including the nervous system. In the central nervous system, the three outer membranes (the meninges) that envelop the brain and spinal cord are composed of connective tissue.

Classification of Connective tissue :

1- Connective tissue **proper** :

♣ Loose connective tissue :

- **Areolar connective tissue.**
- **Adipose tissue.**
- **Reticular tissue.**

♣ Dense connective tissue :

- **Fibrous tissue.**
- **Elastic tissue.**

2- **Specialized connective tissue** :

Skeletal tissue : Bone and Cartilage

Cartilage :

- **Hyaline cartilage.**
- **Fibro cartilage.**
- **Elastic cartilage.**

Bone :

- **Compact bone.**
- **Spongy bone.**

Blood:

Lymph

All have a common embryonic origin known as mesenchyme. Mesenchyme's are undifferentiated loose connective tissue that are capable of developing into connective tissue, such as bone and cartilage.

Cells of Connective tissue:

1. Mesenchymal cells - embryonic cells which persist in the adult and are capable of differentiation and proliferation during regeneration.

2. Fibroblasts - large, flat, branching cells which appear spindle-shaped in a side view. Fibroblasts have large, oval and faint staining nuclei with one or two obvious nucleoli.

3. Macrophage (histiocyte) /next in abundance to the fibroblasts in loose connective tissue, these cells are initially non-motile. During inflammation, they become very actively amoeboid and phagocytic. The nucleus of this cell type is often indented and dark staining. These cells are an important component of the reticuloendothelial system (RES) located in the spleen, liver, lymph nodes and other organs.

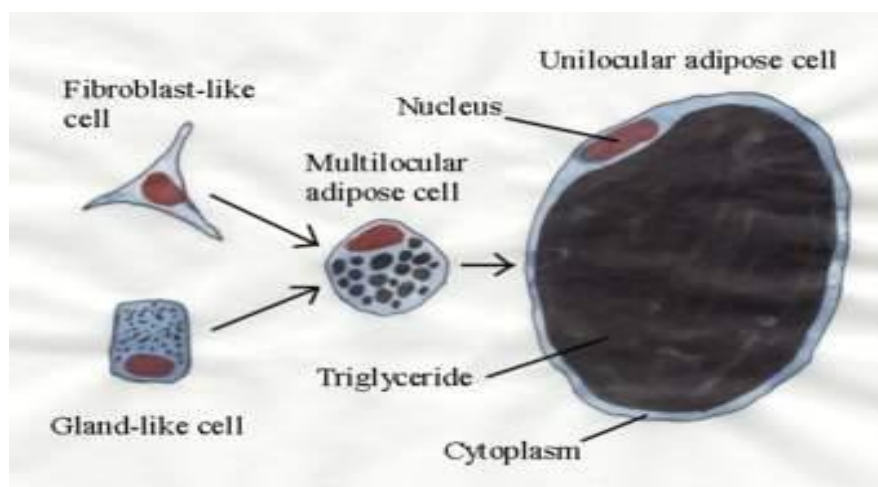
4. Adipose cells / These cells are commonly seen in loose connective tissue (areolar). They are often found arranged around small blood vessels. Initially they resemble fibroblasts but with numerous vacuoles of fat droplets.

5. Leukocytes - are white blood cells which wander into the connective tissues surrounding blood vessels.

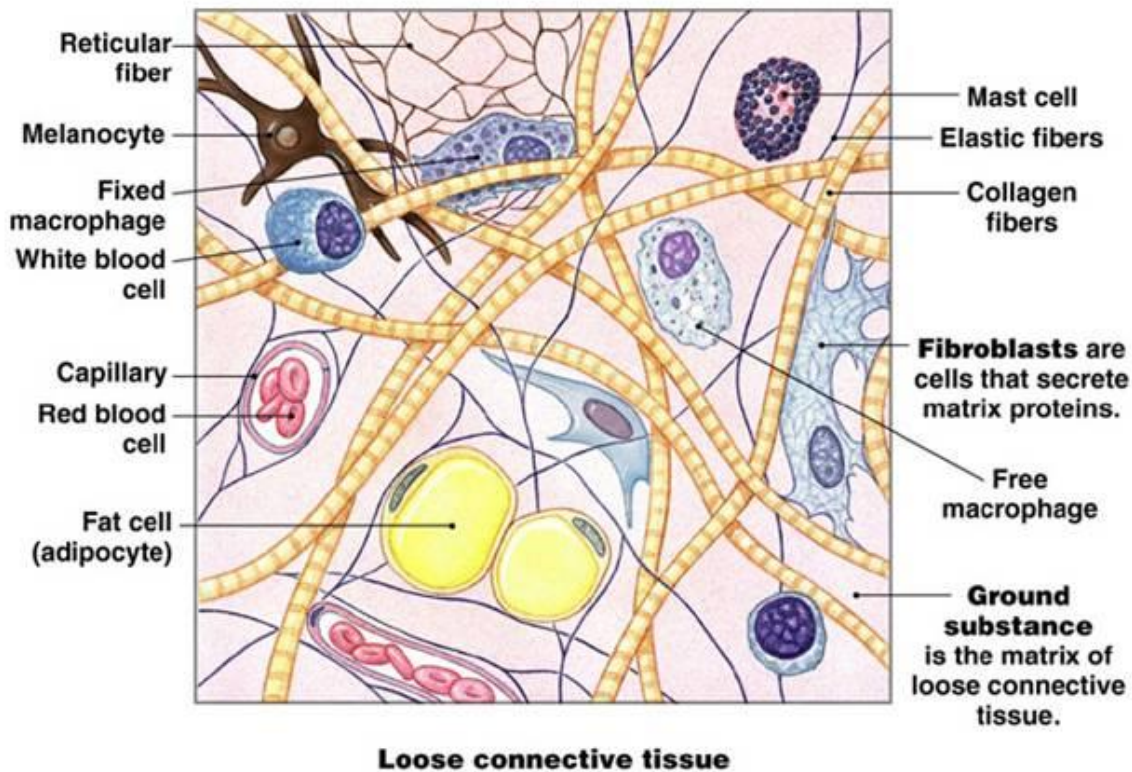
- **Eosinophiles** are very common throughout the respiratory and digestive tracts, as well as in active mammary tissue.

- **Neutrophils** are found at sites of inflammation. Plasma cells, derived from B-lymphocytes, are common in areas of chronic inflammation.

6. Mast cells - are large cells (20 to 30 μm) filled with deeply basophilic granules which often obscure the nucleus. They are usually adjacent to blood vessels. Like the blood basophils, these cells contain mediators of immediate hypersensitivity such as histamine, heparin and serotonin.



Cell connective tissue



Structural Elements of Connective Tissue :

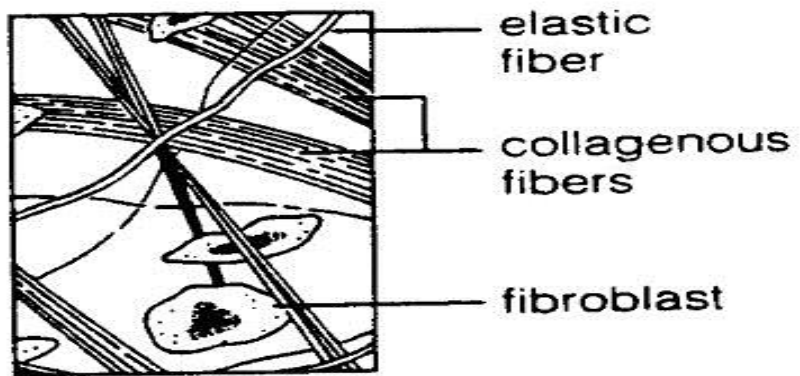
Connective tissues contains a matrix and 3 types of fibers :

Matrix : Matrix is produced by the cells of the tissue and can be fluid, gel-like, or solid

1- Collagenous fibers : Collagenous fibers provide **strength**. They are made of collagen and consist of bundles of fibrils.

2- Elastic fibers : Elastic fibers make tissue “**stretchable**” and are made of elastin.

3- Reticular fibers : Reticular fibers **join** connective tissues to other tissues. Reticular fibers consist of one or more types of very thin collagen fibers.



Section of Elastic Fiber

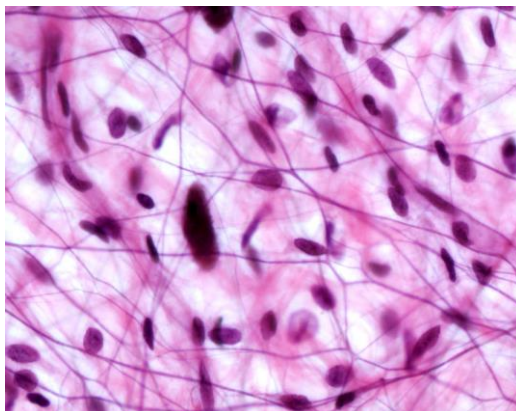
1- Connective Tissue Proper :

♣ Loose connective Tissue:

This type of tissue contains many cells, a loose arrangement of fibers, and moderately viscous fluid matrix.

1- Areolar :

Loose areolar connective tissue is the most widespread type of connective tissue proper. It underlies almost all of the epithelia in the body.



Functions : Support and binding of other tissues, holding body fluids, defending the body against infection, storing nutrients as fat.

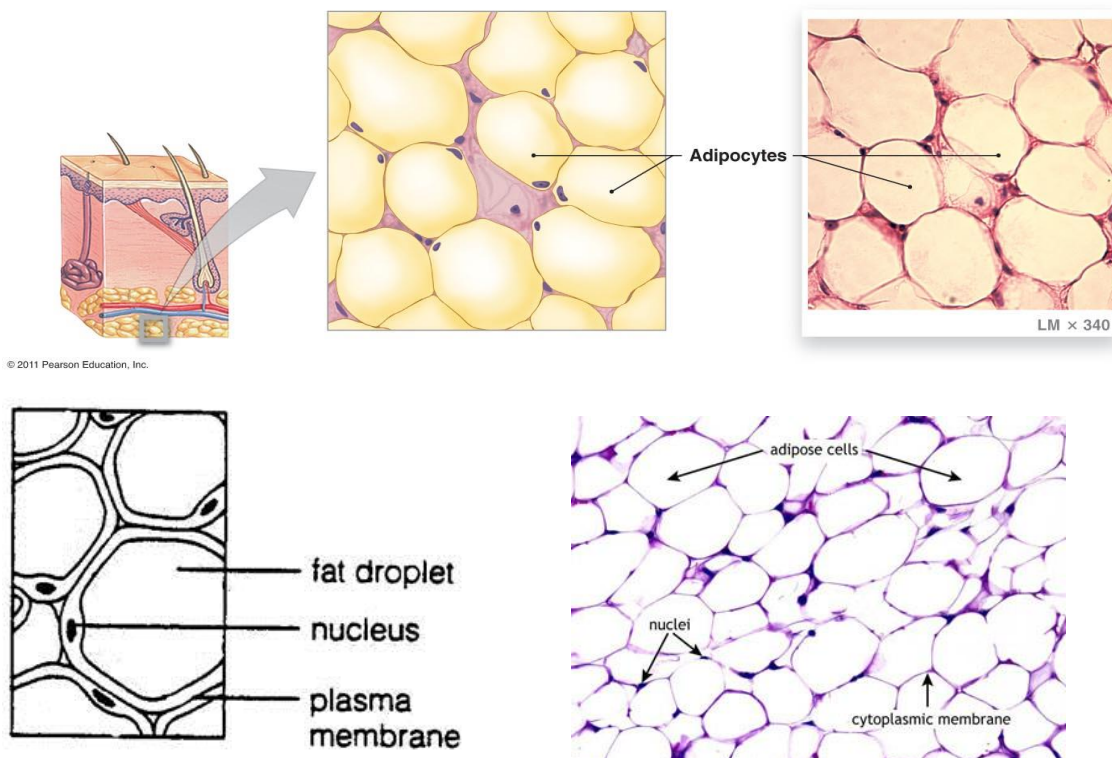
It contains 2 types of fibers :

- **White or collagenous fibers** . - **Yellow or elastic fibers** .

2-Adipose :

Loose adipose tissue is crowded with fat cells, which account for 90% of its mass. Adipose tissue is richly vascularized. It removes lipids from the bloodstream after meals and later releases them into the blood, as needed.

The structure of adipose tissue deep to the skin

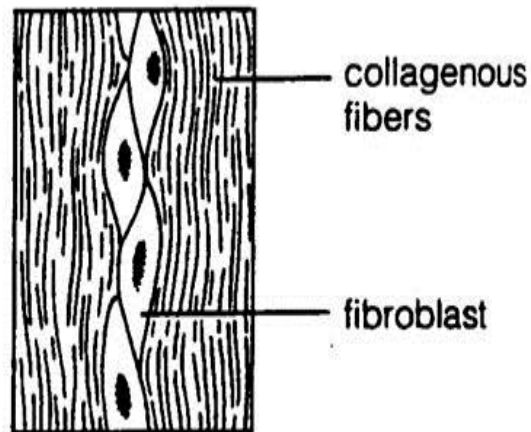


Function : Reserve food fuel, insulates against heat loss, supports and protects organs.

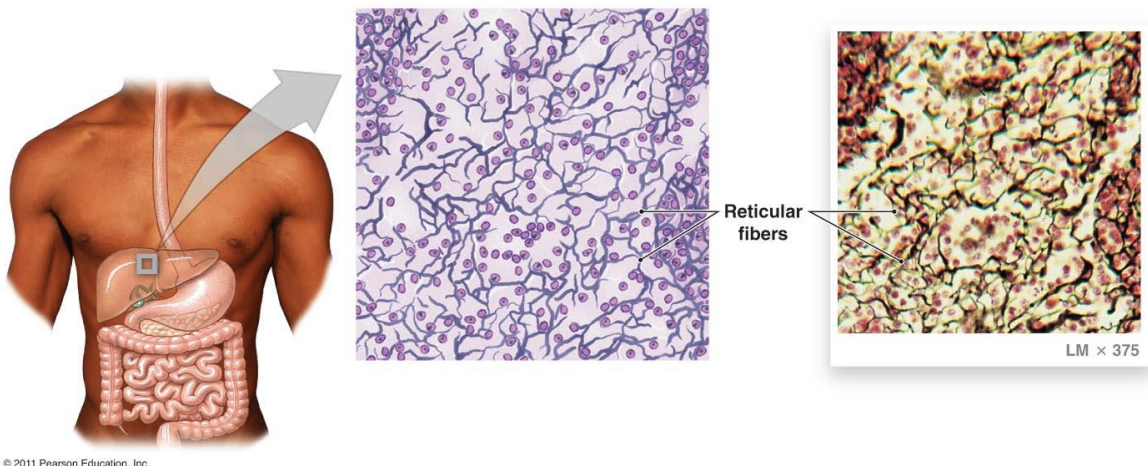
Location : Much of the body's adipose tissue is found in the hypodermis, but it is also abundant in the mesenteries and forms cushioning pads around the kidneys and behind the eyeballs.

3- Reticular :

Loose reticular tissue is similar to areolar tissue but the only fibers in its matrix are reticular fibers. Bone marrow, spleen and lymph nodes consist largely of reticular connective tissue.



The structure of reticular tissue in the liver



Function : Form a soft internal skeleton that supports other cell types like white blood cells, mast cells, macrophages.

♣ Dense Connective Tissue :

In this type of tissue, the collagen fibres are densely packed, and arranged in parallel. This type of tissue is found in ligaments (which link bone to bone at joints) and tendons (connections between bones or cartilage and muscle). These are powerfully resistant to axially loaded tension forces, but allow some stretch.

These three types of fibers are combined in different levels to produce connective tissue with different properties. For example, if a tissue has more elastin it will be **stretchy**. If the tissue has more collagenous fibers it will be **sturdy and strong**.

Dense connective tissue : include :

1- Dense Regular connective tissue :

Appearance: Fibers are “regular” in the sense that they all run parallel to each other or in the same direction.

Location: Tendons, Ligaments, Aponeurosis (similar to tendons)

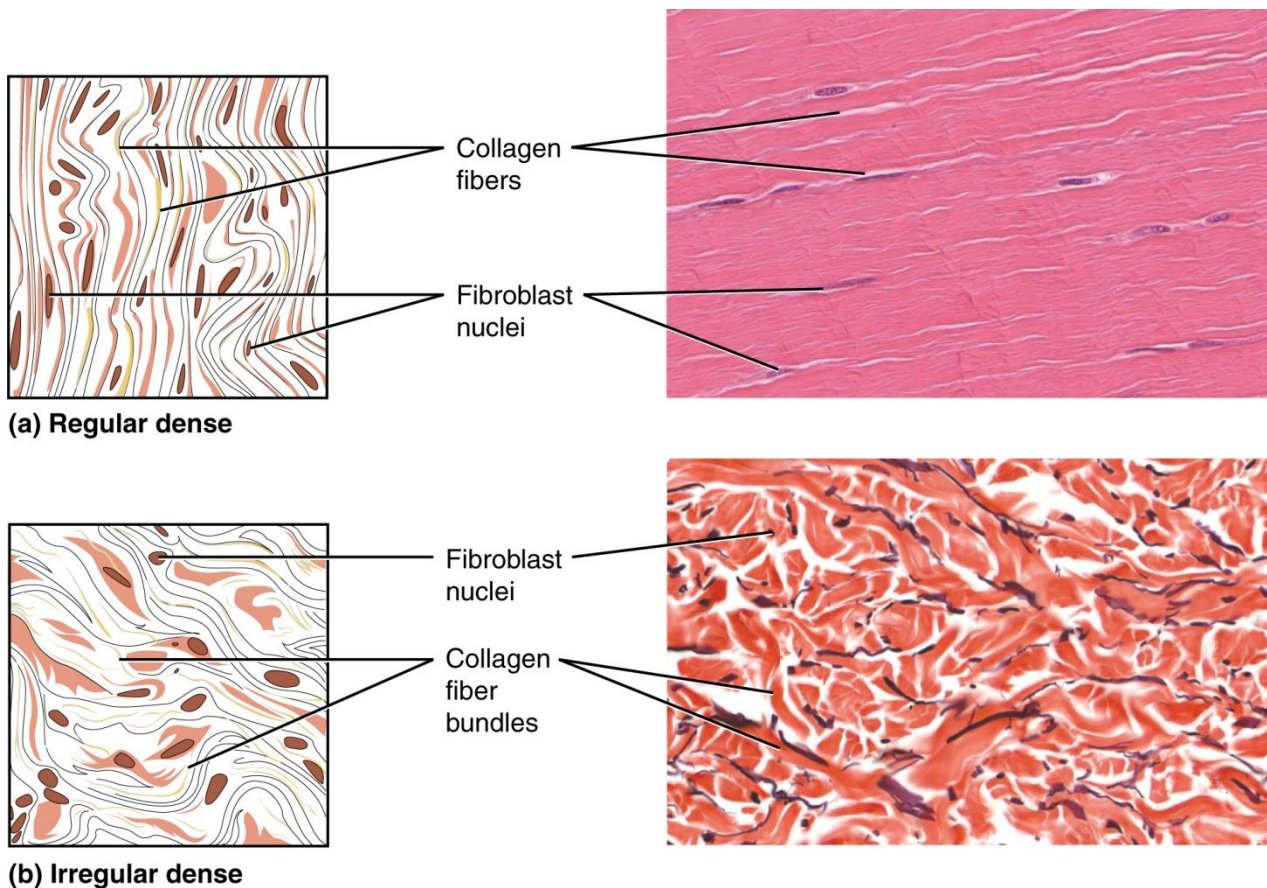
Function: Their main function is to support other tissues, but mainly in one direction because the fibers all run in one direction.

2- Dense Irregular connective tissue :

Appearance : Fibers are “irregular” in the sense that they run in multiple directions.

Location : Fibrous capsules of organs and joints, dermis of the skin, submucosa of the digestive tract.

Function: Dense irregular tissue functions to support tissues in multiple directions. This is because the fibers run in multiple directions.



3. Elastic connective tissue :

Has the ability to receive a relatively large amount of blood all at once with a lot of pressure. The aorta for example has to expand and recoil **RIGHT AWAY** because the next heart beat is on the way. It's just like a dense regular connective tissue but with a high proportion of elastic fibers instead.

Location : **Between vertebrae of the spinal column and in the blood vessel walls.**

Function: Stabilizes of vertebrae and penis cushions shocks, permits expansion and contraction of organs .

2- Specilised connective tissue :

Include : Skeletal tissue : Bone and Cartilage

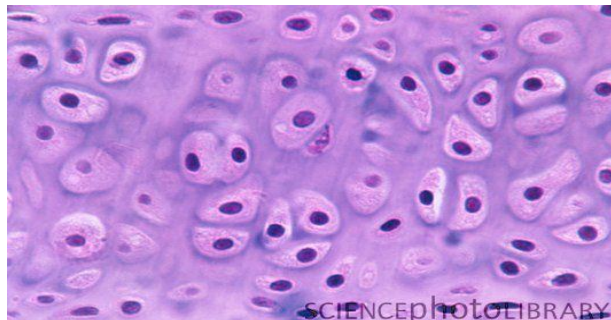
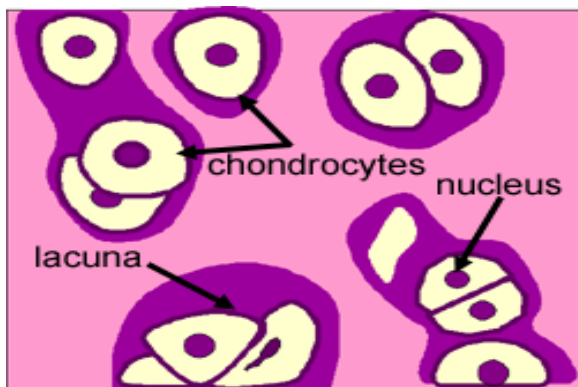
- **Cartilage :**

Is a flexible connective tissue , including the joints between bones, the rib cage, the ear, the nose, the bronchial tubes and the intervertebral discs. It is not as hard and rigid as bone, but it is stiffer and less flexible than muscle.

There are three types of cartilage:

1- Hyaline Cartilage :

This type of cartilage has a glassy appearance when fresh. **Hyaline cartilage** has widely dispersed fine **collagen fibres** ,which strengthen it. It has a **perichondrium**, and it is the **weakest** of the three types of cartilage.

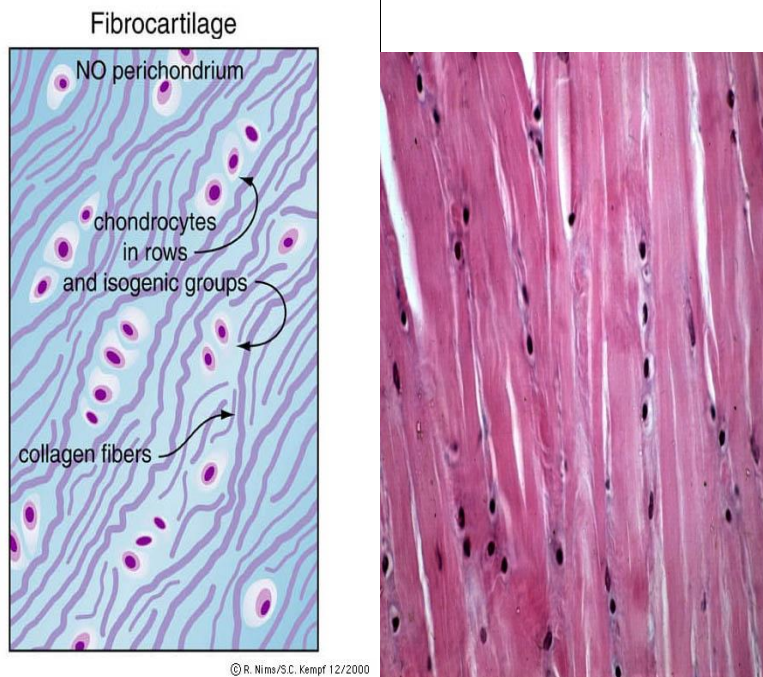


Function : Supports and reinforces

Location : found in the **ribs, nose, larynx, trachea**. Is a precursor of bone.

2 - Fibro cartilage :

Matrix is similar to hyaline cartilage but less firm. Thick collagen fibers predominate. This is the **strongest** kind of cartilage, because it has alternating layers of hyaline cartilage. This type of cartilage *does not* have a **perichondrium** as it is usually a **transitional layer** between hyaline cartilage and tendon or ligament.

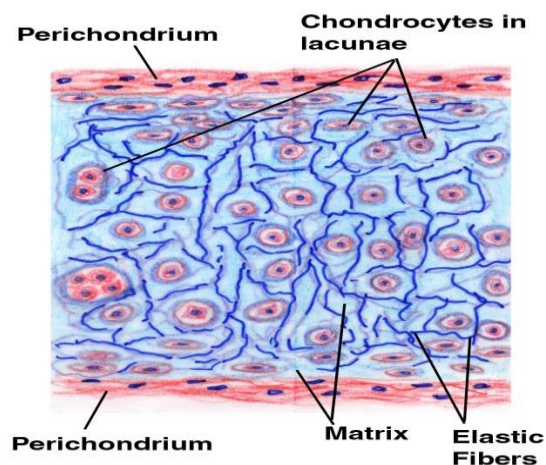


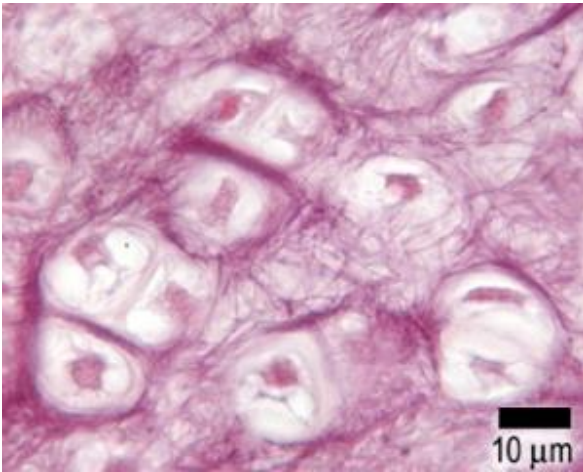
Function : Absorbs compressive shock.

Location : Is found in **intervertebral discs, joint capsules, ligaments.**

3- Elastic Cartilage :

Similar to hyaline cartilage but more elastic fibers in the matrix. In **elastic** cartilage, the chondrocytes are found in a threadlike network of elastic fibres within the matrix. **Elastic** cartilage provides strength, and elasticity, and maintains the shape of certain structure such as the external ear. It has a **perichondrium**.





Function: Maintains shape of structure while allowing great flexibility.

Location : Is found in the **external ear, epiglottis and larynx**.

- **Bone tissue :**

Bone tissue is a type of connective tissue that contains lots of calcium and phosphorous salts. About **25%** of bone tissue is water, another **25%** is made up of protein fibers like collagen. The other **50%** of bone tissue is a mixture of mineral salts, primarily calcium and phosphorous.

Bone cells :

1-Osteoblasts :- These are the bone forming cells (osteogenic). These are cuboidal or trapezoid in shape with the nuclei lying at one or the other. They have many processes. The cytoplasm is rich with RNA.

2-Osteocytes :- They flattened , ovoid shaped lying in the lacunae and each consists of darkly staining nucleus with small amount of cytoplasm and numerous branching processes. The processes of an osteocytes joined with the other osteocyte (adjacent cells) , their function generate osteoblasts when the bone has been laid down.

3-Osteoclasts:- These are large cells found on the surface bone where resorption are taken place. They are multinucleated with a vacuolated cytoplasm. They have important role in remodeling of bone.

Function :

1- Support: Bones provide a framework for the attachment of muscles and other tissues.

2- Protection: Bones such as the skull and rib cage protect internal organs from injury.

3- Movement: Bones enable body movements by acting as levers and points of attachment for muscles.

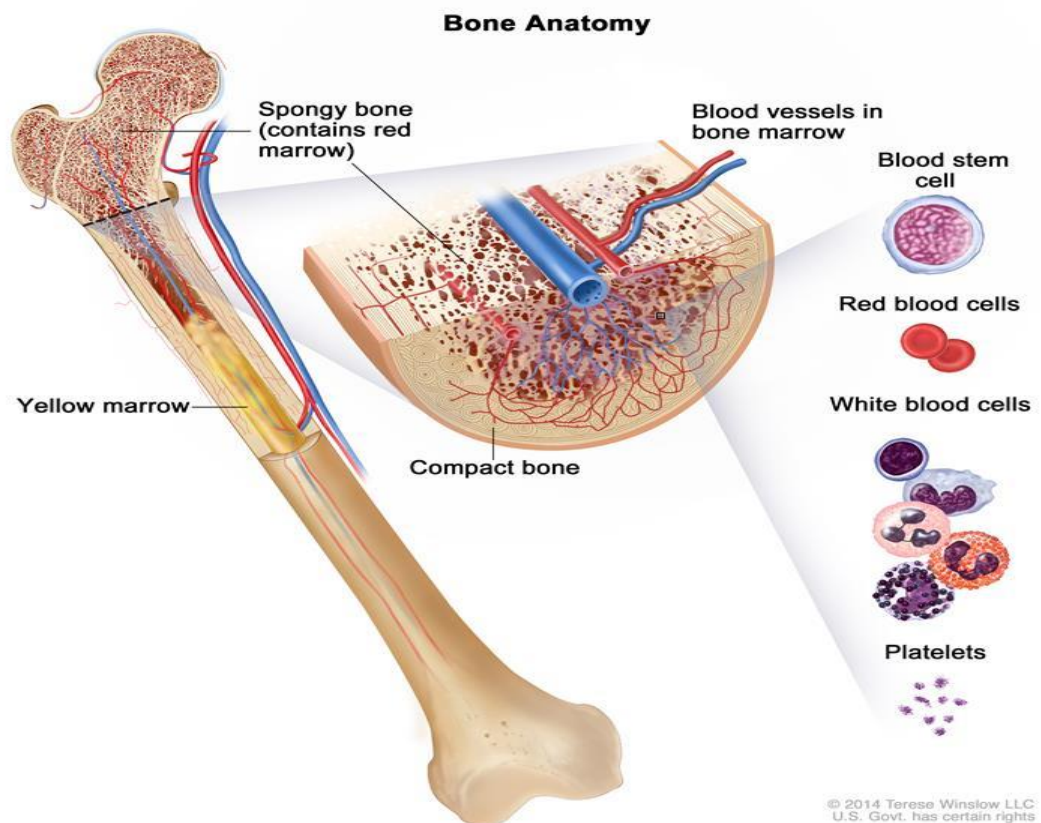
4- Mineral storage: Bones serve as a reservoir for calcium and phosphorus, essential minerals for various cellular activities throughout the body.

5- Blood cell production: The production of blood cells, or hematopoiesis, occurs in the red marrow found within the cavities of certain bones.

6-Energy storage: Lipids, such as fats, stored in adipose cells of the yellow marrow serve as an energy reservoir.

Bone marrow :

It is present in the cavity of compact and spongy bone , consist of reticular connective tissue , fibers ,RBC,WBC ,platelets, fat cells and blood vessels . They are two types of bone marrow :



Types of Bone Tissue :

There are two different types of bone tissue: Compact and Spongy bone.

Compact bone :

- Is made up of concentric rings of matrix that surround central canals which contain blood vessels.
- Embedded in this bone tissue are small cave-like spaces called **lacunae**, which are connected to each other through small tunnels called **canalicula**.
- The lacunae contain **osteocytes cells**. Osteocytes help maintain healthy bone tissue and are involved in the bone remodeling process (lifelong process where mature bone tissue is removed from the skeleton and new bone tissue is formed)

Spongy bone :

- Looks like an irregular latticework (or sponge) with lots of spaces throughout.
- These spaces are filled with red bone marrow which is the site of **hemopoesis** or formation of blood cell.

- (a) Compact bone is a dense matrix on the outer surface of bone.
 (b) Compact bone is organized into rings called osteons.
 (c) Osteoblasts surround the exterior of the bone.

Function : Supports and protects, provides levers for the muscles to act on, stores calcium and other minerals and fat. Marrow inside bones is site of blood cell formation.

3- Blood :

Blood/ is the most atypical connective tissue. It does not bind things together or give mechanical support. It is classified as connective tissue because it develops from mesenchyme and consists of blood cells surrounded by a non living matrix. Blood tissues are found inside the blood vessels. (arteries, arterioles, capillaries, venules and veins).

Some white blood cells are also found in other types of body tissues, for example lymphocytes are also found in the lymphatic system.

Even though it has a different function in comparison to other connective tissues it does have an extracellular matrix. The matrix consists of the plasma, while red blood cells, white blood cells, and platelets are suspended in the plasma.

Function : Transport of respiratory gases, nutrients and wastes .

Location : Within the blood vessels .

4- Lymph

Lymph is another type of fluid connective tissue. This clear fluid originates from blood plasma that exits blood vessels at capillary beds. A component of the lymphatic system, lymph contains immune system cells that protect the body against pathogens.

Muscular tissue

Muscle/ is an organ specializing in the transformation of chemical energy into movement.

Functions of muscle tissue:

- 1-Body movement (Locomotion)
- 2-Heart beat.
- 3-Maintenance of posture.
- 4- Production of body heat (Thermogenesis)
5. Stabilizing joints.
6. Respiration (Diaphragm and intercostal contractions)
7. Communication (Verbal and Facial)
8. Constriction of organs and vessels
 - Peristalsis of intestinal tract
 - Vasoconstriction of blood vessels and other structures (pupils).

Characteristics:

- 1- Excitability:** Capacity of muscle to respond to a stimulus
- 2- Contractility:** Ability of a muscle to shorten and generate pulling force
- 3- Extensibility:** Muscle can be stretched back to its original length
- 4-Elasticity:** Ability of muscle to recoil to original resting length after stretched.

There are 3 Types of muscle tissue :

Skeletal muscle

1-

- These muscles are responsible for movement of skeleton (locomotion), facial expressions, posture, respiratory movements and other types of body movement.
- Under voluntary (conscious) control; controlled by somatic motor neurons
- Appears striated under the microscope
- Skeletal muscle contains three layers of connective tissue:

Epimysium—this layer surround the entire muscle.

Perimysium—this layer is continuous with the epimysium and it surrounds bundles of muscle fibers.

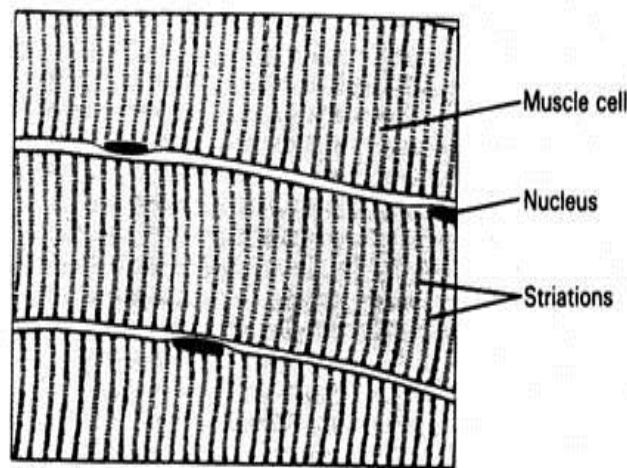
Endomysium—this layer is continuous with the perimysium and it surrounds individual muscle fibers. It contains capillaries and nerve fibers that supply the muscle fiber.

- The cells of skeletal muscle are referred to as **muscle fibers**. The fibers are long, tapering cells that contain many nuclei (i.e., **multinucleated**). The cell membrane is called the **sarcolemma** and the cytoplasm is called the **sarcoplasm**.

Classification of muscle fibers :

There are three kinds of muscle fibers found in skeletal muscle :

- 1- **Red fibers:** these are small diameter fibers that contain an abundant amount of **myoglobin**, which is functionally similar to hemoglobin, and many **mitochondria**. (i.e., “dark meat”).
- 2- **White fibers:** these are larger diameter fibers that contain lesser amounts of myoglobin and mitochondria. These fibers can contract more rapidly than red fibers, but they also fatigue more rapidly (i.e., “white meat”).
- 3- **Intermediate fibers:** these fibers have characteristics of both red and white fibers.



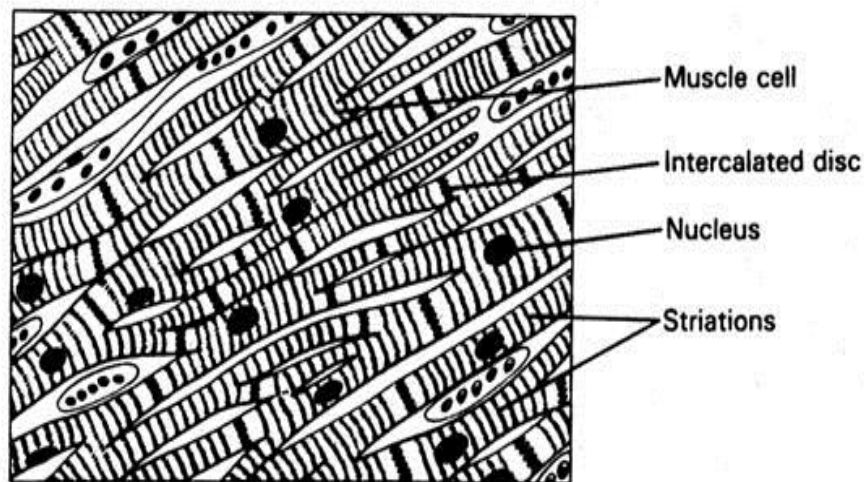
section of skeletal muscle

2-

Cardiac muscle

Cardiac muscle is found only in the **heart**. Similar to skeletal muscle, cardiac muscle has a single, centrally-located nucleus.

- This muscle is responsible for movement of heart (and blood).
- Under involuntary (unconscious) control involuntarily by endocrine and autonomic nervous systems.
- Also appears striated under the microscope.



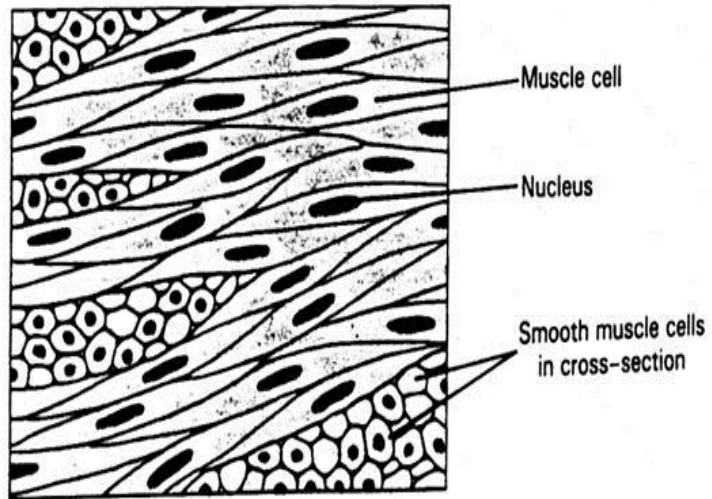
Section of Cardiac muscle

3-

Smooth

Smooth muscle cells have a single, centrally-located nucleus and are spindle shaped. The walls of blood vessels, the tubes of the digestive system, and the tubes of the reproductive systems are composed primarily of smooth muscle.

- This muscle is responsible for movement of hollow organs such as digestive tract, uterus, bladder, blood vessels, skin, eye, glands.
- Also under involuntary (unconscious) control involuntarily by endocrine and autonomic nervous systems.
- Does not appear striated under the microscope.



Section of Smooth muscle

Nervous tissue :

Nervous tissue is one of four major classes of vertebrate tissue. It is the specialized tissue that makes up **the central nervous system** and **the peripheral nervous system**. Nervous tissue is the main component of the nervous system: the [brain](#), [spinal cord](#), and nerves.

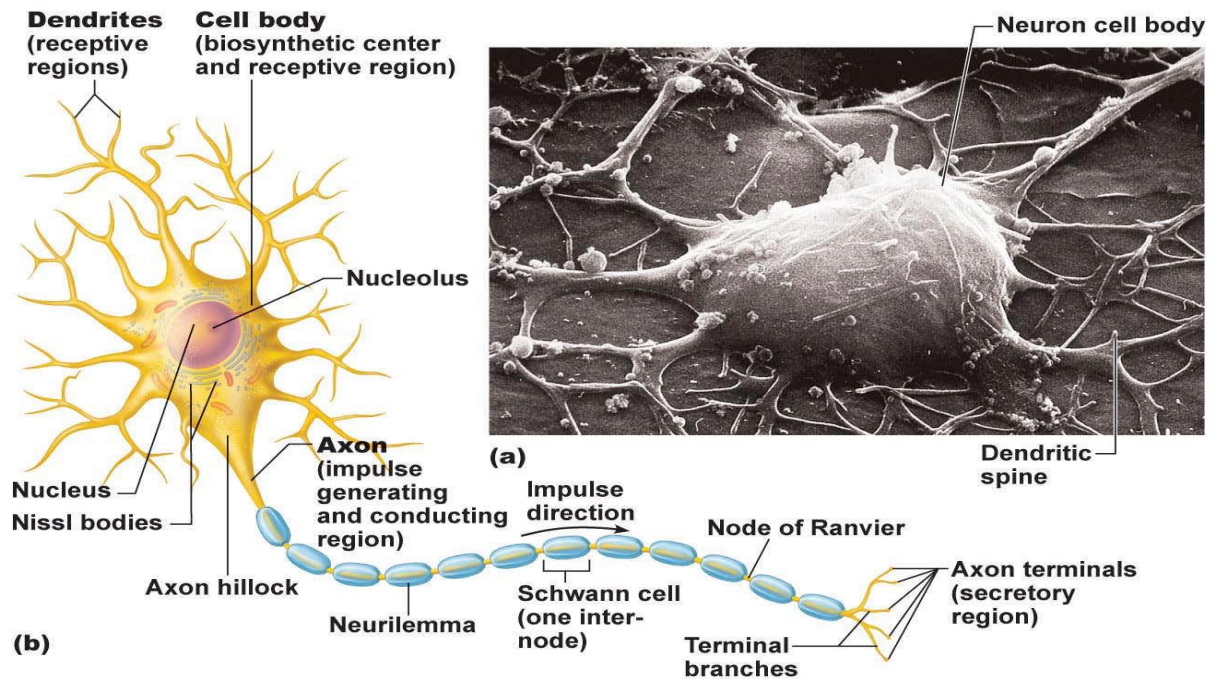
Nerve tissue :

Nerve tissue is composed of 2 main types of cells :

Neurons - nerve cells that are specialized to detect and react to stimuli, by generating and conducting nerve impulses.

Neuroglial cells - accessory cells for filling spaces and supporting neurons.

All neurons have a cell body called **soma** which contains a nucleus, organelles, and a modified endoplasmic reticulum called **Nissl body**. Although there is **DNA** in the neuron, somehow DNA replication and mitosis do not occur, resulting in the neurons lack of ability to reproduce or regenerate.



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Extensions of the soma form nerve such as **dendrites** which conduct nerve impulses toward the soma, and **axon** which conducts nerve impulses away from the soma (to another neuron, or to an effect or organ).

- The number of dendrites ranges from 1(in unipolar and bipolar neurons) to thousands (in multipolar neurons).
- All neurons only contain 1 axon.
- Longer axons are enclosed by a lipoprotein substance called **myelin sheath** produced by a type of neuoglia cell called **Schwann cells**.

Structure of nervous cell

- This myelin sheath insulates the axon against depolarization, and forces action potential to occur in the gaps (**node of Ranvier**) in between the myelin sheath.

- Axons enclosed by myelin sheath are called myelinated axons which make up the **white matter** in the nervous system; while axons that have no myelin sheath are called unmyelinated axons which make up the **gray matter** in the nervous system.

Synapse :

A synapse/ is the junction between two neurons, or between a neuron and an effector organ (muscle or gland).

Each synapse consists of:

Presynaptic neuron, Axon , Synaptic knobs , Synaptic vesicles, Synaptic cleft, Dendrite, Postsynaptic neuron.

Classification of neurons

A- Classification based on structure :

- Unipolar neuron** - a single nerve fiber is extended from the soma, and it divides into a dendrite and an axon (sensory neurons that conduct reflexes or detect various stimuli).
- Bipolar neuron** - a dendrite and an axon extend from the soma independently (sensory neurons involved in special senses such as vision, olfaction, and hearing).
- Multipolar neuron** - one axon and many dendrites extend from the soma (interneurons located inside the brain and spinal cord).

B- classification based on function

- Sensory or afferent neuron:**

- conducts nerve impulses from the body to the brain or spinal cord.
- endings of its dendrite may be modified to become nerve receptors.
- usually unipolar in structure

b) Interneuron:

- relays nerve impulse from sensory neuron to motor neuron .
- located totally inside the tissues of the brain or spinal cord.
- involved in the processing and integration in the nervous system.
- usually multipolar in structure.

c) Motor or efferent neuron:

- conducts nerve impulses from the brain or spinal cord to the effector organ (muscles or glands).
- usually multipolar in structure.

Classification of Neuroglia :

Neuroglia: are the supporting cells of the nervous system.

1. Astrocytes: star shaped cells found between neurons and blood vessels.

Function: structural support, transport of substance between blood vessels and neurons.

2. Microglial cells: small ovoid cells.

Function: structural support and phagocytosis (immune protection).

3. Ependymal cells: cuboidal or columnar shaped cells.

Function: form a porous layer through which substances diffuse between the interstitial fluid and the cerebrospinal fluid.

4. Oligodendrocytes: resemble astrocytes but have less processes and arranged in rows along nerve fibers.

Function: produce myelin sheath within the brain spinal cord.

Anatomy

Anatomy/ is the identification and description of the structures of living things.

Anatomy is a branch of biology and medicine.

Anatomy can be divided into three broad areas:

1- Human anatomy.

2- Zootomy (animal anatomy).

3- phytotomy (plant anatomy).

The word anatomy comes from the Greek *ana-* meaning "up", and *tome-* meaning "a cutting". Anatomy, especially in the past, has depended heavily on dissection. In

Greek and Latin the words "anatomy" and "dissection" have virtually the same meanings. Although both words have similar origins, anatomy has evolved to become a broad discipline of its own, while dissection remains a technique of anatomical science.

Anatomy can be divided into Gross Anatomy (macroscopic anatomy) and Microscopic Anatomy.

What is Gross Anatomy

Gross anatomy In medicine, also known as topographical anatomy or macro anatomy, refers to the study of the biological structures that may be seen with the naked eye.

Gross anatomy may involve dissection or noninvasive methods; the aim is to acquire data about the larger structures of organs and organ systems. .

In dissection, the human or animal cadaver is cut open and its organs are studied. Endoscopy, inserting a tube with a camera at the end, might be used to study structures within living animals. There are non-invasive way of studying, for example, the blood vessels of living animals or humans; an opaque dye may be inserted into the animal to observe the circulatory system (angiography). Live beings may also be studied using [MRI](#) (magnetic resonance imaging) or X-ray.

Medical and dental students, as part of their course, will have to perform some kind of practical work in gross human anatomy, this will involve dissection. In many cases, the students dissect human corpses (cadavers).

Human anatomy :

Human anatomy- including histology and gross human anatomy, is the study of the structures of the human body. .

Most health care related studies require some or extensive training in gross anatomy and histology. Examples include people preparing to become paramedics, physical therapists (UK: physiotherapists), occupational therapists, medical doctors, orthotists, prosthetists, and biological scientists.

Medical students will be required to do practical anatomical work, which involves dissection and inspecting cadavers.

Digestive system

Digestive system/ is made up of a group of organs working together. The digestive tract is made up of the mouth, esophagus, stomach, small intestine, and the large intestine. There are also associated organs that support the digestive tract.

Parts of the human digestive system:

1- Mouth/the first of the digestive tract the entry point of the food, the smell and sight of food, stimulates salivary glands to secrete fluid called saliva (consisting of water and enzymes).

Salivary glands/ are glands in the mouth that produces saliva to begin the chemical digestion of food.

The purpose of the saliva is to lubricate the food for swallowing, dissolve water soluble food particles, and start chemical digestion of carbohydrates (starch) into smaller molecules.

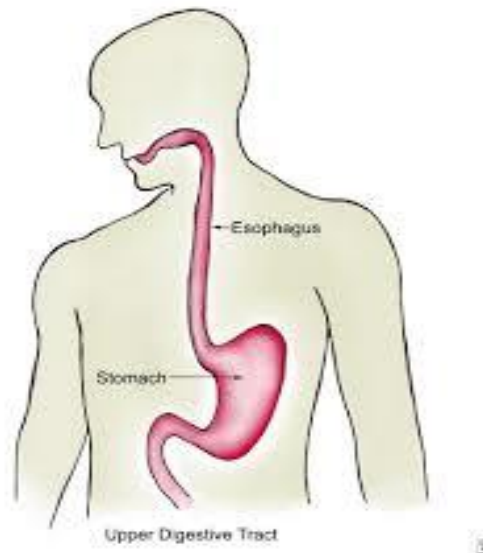
2- Esophagus/ muscular tube that connecting the mouth to the stomach running through the **thoracic cavity**, the site of esophagus lies behind trachea.

The trachea has an epiglottis which prevents food from entering the trachea, moving the food to the esophagus while swallowing.

Food travels down the esophagus, through a series of rhythmic contractions (wave-like) called **peristalsis**.

The lining of the esophagus secretes mucus, lubricating to support the movement of food.

The end of esophagus linked with the upper part of stomach by cardiac sphincter, its muscular ringed valve, the role of sphincter is to prevent stomach acids from back flowing in to the esophagus creating a burning feeling known as heart burn.



Section of esophagus

3-The Stomach: the stomach is a muscular J-shaped organ found in the **abdominal cavity**. food is temporary stored in the stomach.

The stomach is consists of **three layers of muscle fibers** which performs mechanical digestion by **churning** the food and **mixing** it with the gastric juices, (**HCL, salts, enzymes, water** and **mucus**) secreted by the **lining** of the **stomach**.

The stomach does not digest itself because of three protective mechanisms:

First mechanisms / the stomach only secrete small amounts of gastric juices until food is present.

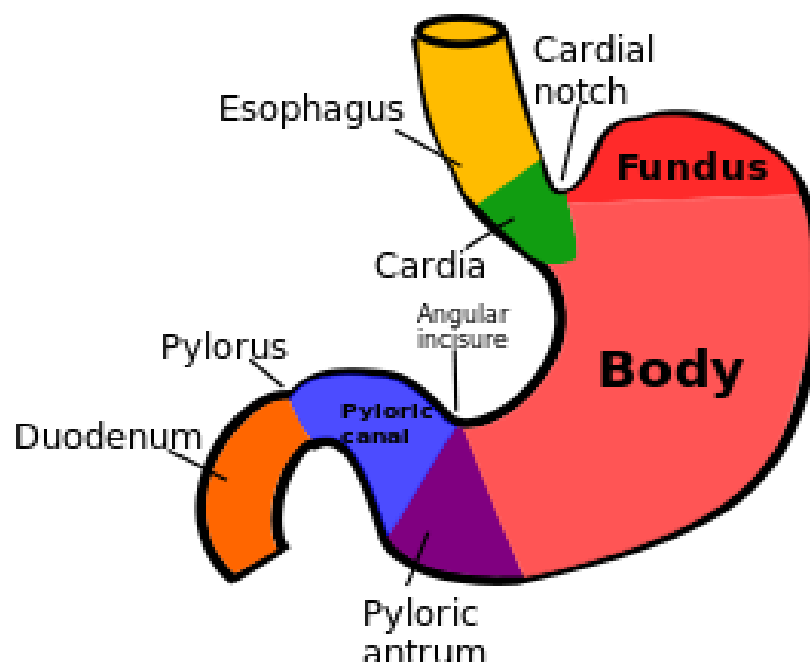
Second mechanisms / the secretion of mucus coat the lining of the stomach protecting it from the gastric juices.

Third mechanisms /the digestive enzyme pepsin is secreted in a inactive protein called pepsinogen.

Pepsinogen is converted to **pepsin** in the increased presence of hydrochloric acid (pH 1).

Chyme –is a thick liquid produced in the stomach and made of digested food combined with gastric juice.

The lower part of stomach linked with **small intestine** by muscular ringed sphincter called the **pyloric sphincter**.



Section of Stomach

4-Small intestine:

The small intestine is responsible for the complete digestion of all macromolecules and the absorption of their component molecules (glucose, fatty acids, amino acids).

The small intestine up of three parts:

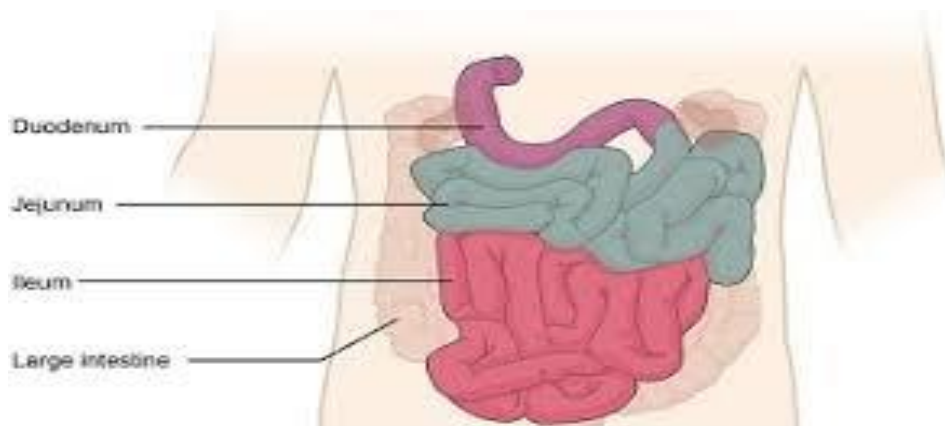
1- Duodenum/ it's a first part, U shaped organ, length 30cm approximately, the area completes most of the digestion process.

Enzymes are secreted in to the duodenum from the pancreas and gall bladder.

The duodenum lined by folds of villi, the villi are covered by microvillus its increase the surface area of the small intestine **increase the rate of absorption.**

2-The jejunum / the long 2.5m approximately .although some digestion is completed here it has more villi and microvilli, its role is absorption for nutrients.

3- The ileum /the long 3m approximately and has fewer villi and microvilli , its responsible for pushing the waste materials in to the large intestine.



Small intestine section

5--Large Intestine/the waste material move from the small intestine and moves in to large intestine it consist of:

a- Ascending colon.

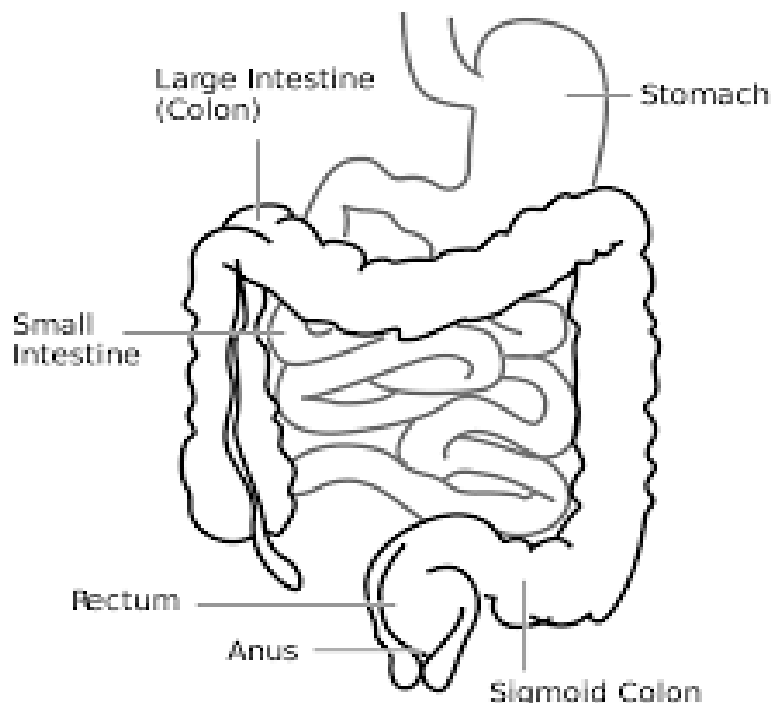
b- Transverse colon.

c- Descending colon.

The large intestine is approximately 1.5m, in length. the 90% of water is reabsorbed back in to the blood stream.

The anaerobic bacteria in the colon breaks down the waste material producing **vitamins, folic acid, B vitamins** and **vitamin k**, which is transported to the blood stream.

The rectum stores the fecal matter until eliminated by the anus.



Section of Large Intesti

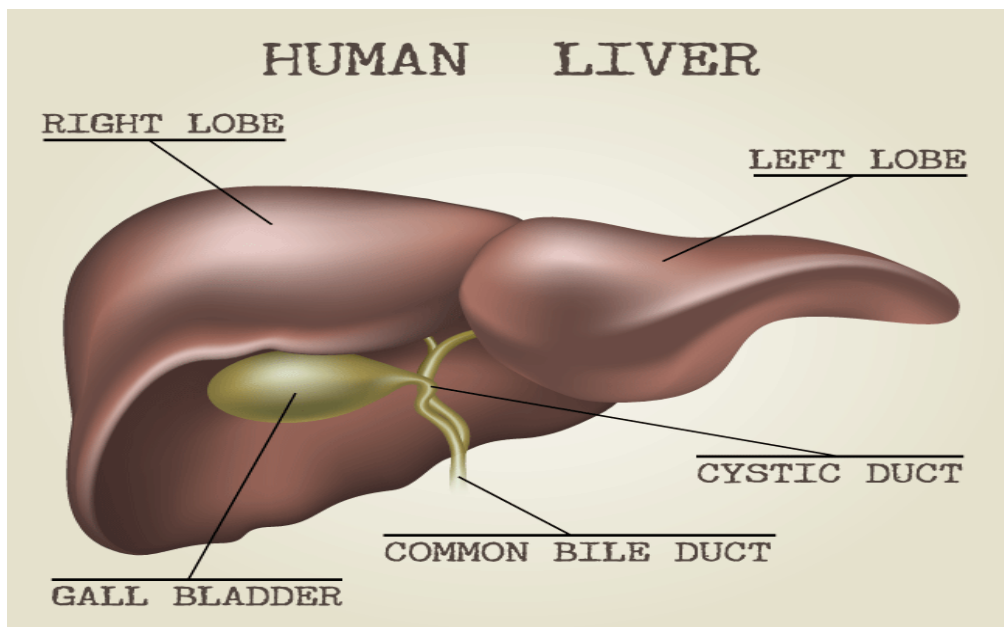
The (accessory) associated organs

The **accessory organs** that support the digestive system but not part of the digestive tract are: **Liver**, **gallbladder** and **pancreas**, these organs secrete fluids into the digestive tract and are connected by ducts, It contains:

1-Liver/ is the largest of these organs about the size of a football and a mass of about 1.5kg. meaty organ that sits on the right side of the abdomen, reddish-brown in color and feels rubbery to the touch.

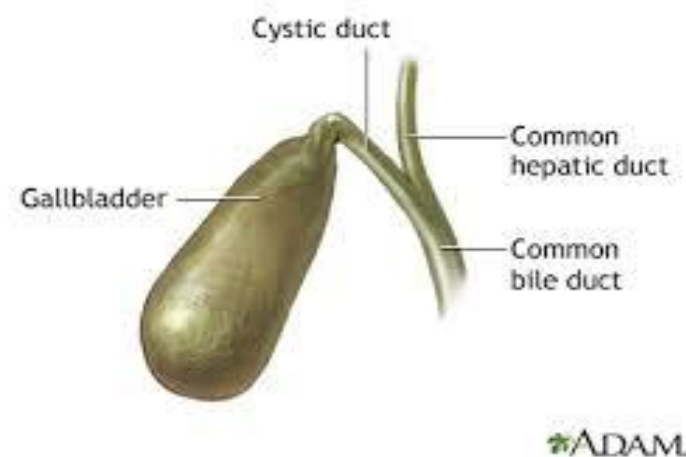
the liver has two large sections, called the right lobes and the left lobes.

the liver produces bile, a greenish –yellow pigment made up of bile pigments and bile salts, as it breaks down old red blood cells.



Section of liver

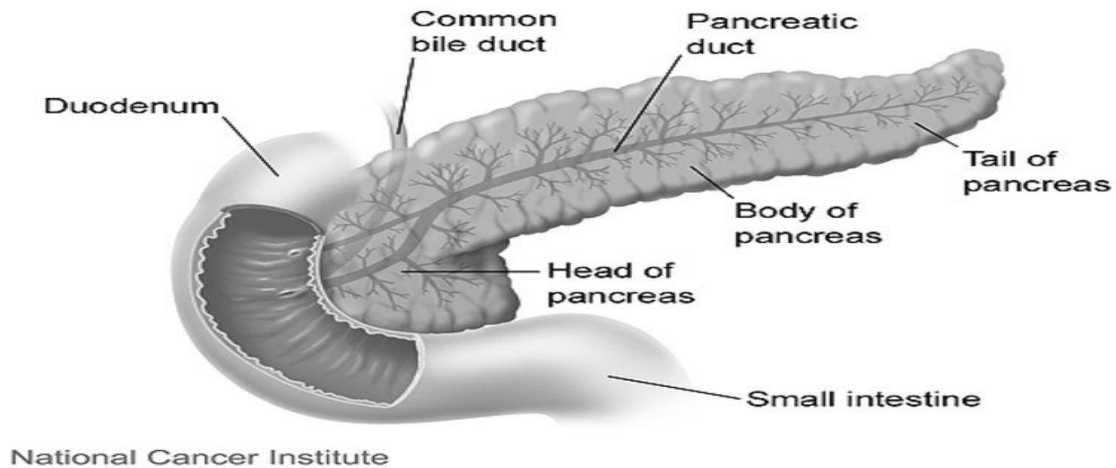
2- Gallbladder /a storage sac in which bile is secreted into. the gallbladder sits under the liver, along with parts of the pancreas and intestines, the bile salts are stored here between meals. the bile salts are secreted into the small intestine to digest fates.



Section of gall bladder

Pancreas/ the pancreas is about 6 inches long and sites across the back of the abdomen, behind the stomach. the head of the pancreas is on the right side of the abdomen and is connected to the duodenum through a small tube called pancreatic duct..

Secretes a number of different enzymes into the small intestine to digest carbohydrates, lipds and proteins completely. the pH of the small intestine to a PH of 8. The pancreas will secrete about 1.0 L. of pancreatic fluids per day.



Section of pancreas

Spleen

The spleen /is a small organ, typically located on the left side of the body, behind the **ribcage** and **stomach**. It is the largest organ in the body's [lymphatic system](#), varies in size and **fat shape, purple color**, the long **12cm** and wide **7cm** , which is responsible for promoting immune function, filtering the blood, and managing blood volume.

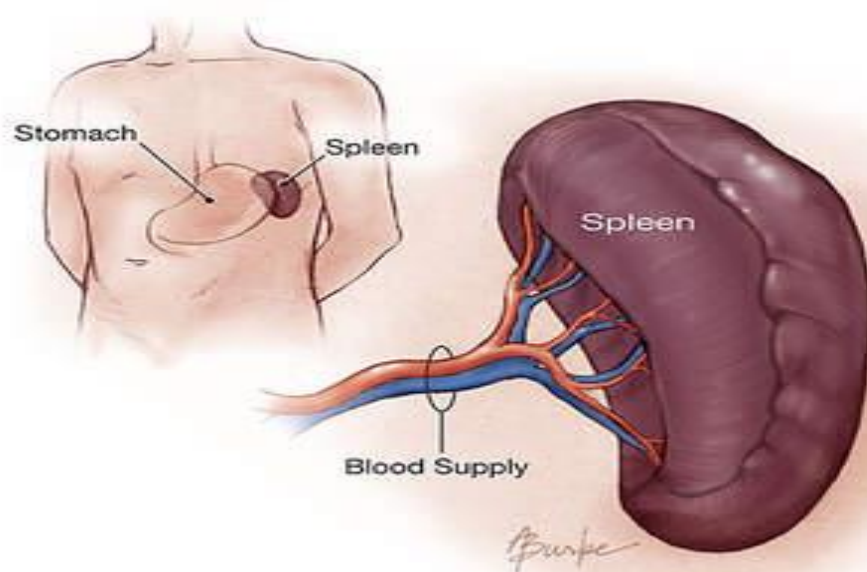
The spleen is consist of two(2) different parts of tissues **Red pulp** and **White pulp**.

White pulp/The white pulp of the spleen contains typical lymphoid elements, such as [plasma](#) cells, [lymphocytes](#), and lymphatic nodules, called **follicles** in the spleen. Similar to the lymph nodes, the spleen reacts to microorganisms and other [antigens](#) that reach the blood stream by releasing special [phagocytic](#) cells known as macrophages.

Red pulp/The **red pulp** of the [spleen](#) is composed of connective tissue known as the [cords of Billroth](#) and many [splenic sinuses](#) that are engorged with blood, giving it a red color. Its primary function is to filter the blood of [antigens](#), microorganisms, and defective or worn-out red blood cells.

Spleen Function:

- 1-Making antibodies.**
- 2-Storing red blood cells.**
- 3-Storing white blood cells.**
- 4- Breaking down waste products from dead cells.**
- 5-Recycling useful components such as iron for use in future red blood cells.**



Section of Spleen

Papillae

Taste papillae(singular papilla)/ are the small nipple sensory -like structures located in the upper surface of the tongue of vertebrate , its found also on the soft palate, upper esophagus and epiglottis, these structures involved in detecting the **five** elements of tested perception: **salty, sour, bitter, sweet** and **umami**. The taste receptor cells send information detected by clusters of various receptors and ion channels to the gustatory areas of the brain via the **seventh, ninth** and **tenth cranial nerves** It contains two kinds of cells:

1-Supporting cells.

2-gustatory cells.

Types of papillae:

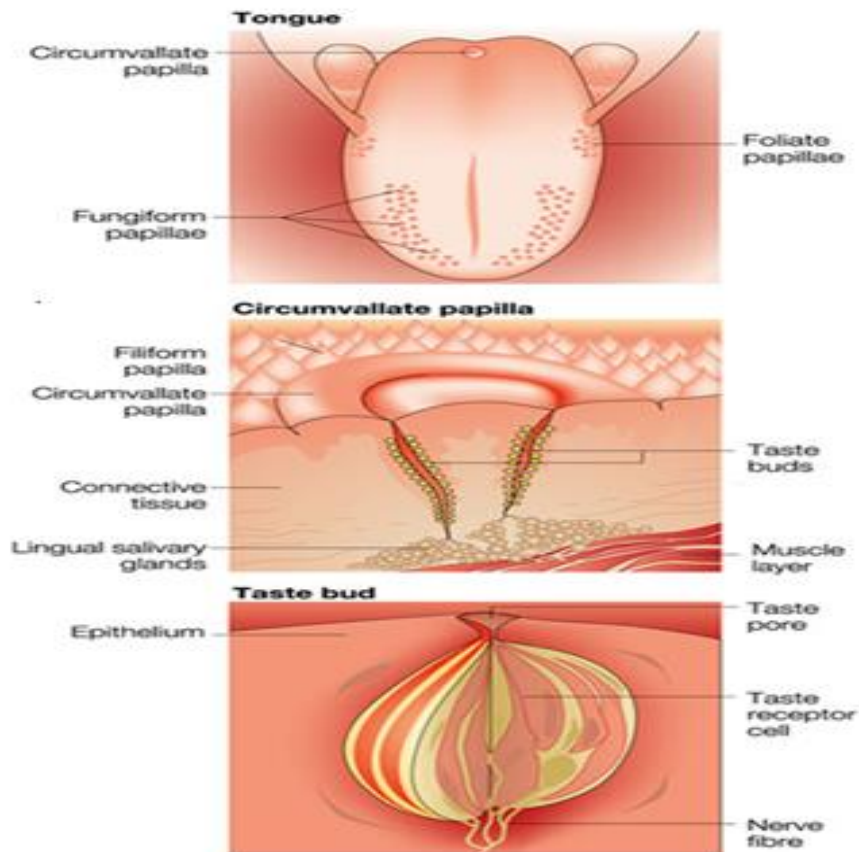
1-Fungiform papillae / as the name suggests, these are slightly mushroom-shaped if looked at in longitudinal section. These are present mostly at the apex (tip) of the tongue, as well as at the sides. Innervated by facial nerve.

Filiform papillae / these are thin, long papillae “V”-shaped cones that don’t contain taste buds but are the most numerous. These papillae are mechanical and not involved in gestation. They are characterized by increased keratinization.

Foliate papillae / these are ridges and grooves towards the posterior part of the roof of the mouth found on lateral margins. Innervated by facial nerve (anterior papillae) and glossopharyngeal nerve (posterior papillae).

Circumvallate papillae/there are only about 10 to 14 of these papillae on most people, and they are present at the back of the oral part of the tongue. They

are arranged in a circular-shaped row just in front of the sulcus terminalis of the tongue. They are associated with ducts of Von Ebner's glands, and are innervated by the glossopharyngeal nerve.



Section of Papillae

Circulatory system

The circulatory system /is composed of the heart and blood vessels, including arteries, veins, and capillaries. Our bodies actually have two circulatory systems: The pulmonary circulation is a short loop from the heart to the [lungs](#) and back again, and the systemic circulation (the system we usually think of as our circulatory system) sends [blood](#) from the heart to all the other parts of our bodies and back again it divided to:

1- Cardio-vascular system

A - Heart.

B - Arteries.

C - Veins.

2- Lymph vascular system:

A - Conducting channels.

B - Lymphatic organs.

The Heart

The heart /is a hollow muscular organ of a somewhat conical form; it lies between the lungs in the middle mediastinum and is enclosed in the pericardium It is placed obliquely in the chest behind the body of the sternum.

The heart has four chambers:

1- Right atrium.

2- Right ventricle.

3- Left atrium.

4- Left ventricle.

In General the blood vessels divided in to:

1- Arteries/ carry blood from the heart to all parts of the body; all arteries (except the pulmonary arteries) carry oxygenated, red blood.

•

2-Veins/carry blood from all parts of the body back to the heart; all veins (except the pulmonary veins) carry blood that is depleted of oxygen and therefore bluish in color.

•

3- Capillaries /very narrow, they connect the ends of all arteries to veins; they deliver and pick up gases, nutrients, and waste products.

Artery/ is a muscular tube lined by smooth tissue and has:

1- Tunica intima/ the inner layer lined by a smooth tissue called endothelium.

2- Tunica media/ a layer of muscle that lets arteries handle the high pressures from the heart.

3- Tunica adventitia/ connective tissue anchoring arteries to nearby tissues.

Types of arteries:

1-Elastic arteries/ are the conducting arteries in the body that are consisted of a large amount of elastin and collagen fibers in the tunica media of the wall.

Function/ They are directly receiving the oxygenated blood from the heart.

Location /Aorta and pulmonary artery.

The Aorta/ is the largest artery in the circulatory system. It branches into smaller arteries called arterioles and capillaries.

Function/They are directly receiving the oxygenated blood from the heart.

The pulmonary artery /is unique and different since it carries low oxygen blood from the heart to lungs.

Location / Femoral artery and coronary arteries.

Function/ Distribute blood to various part of the body.

Arterioles/ are a small diameter blood vessel extends and branches from the artery and leads to capillaries, it usually contains only one to two layers of smooth muscle.

Function/ Transport blood from the artery to capillaries and Regulator of blood flow and pressure.

All arteries are supplied by sympathetic nerve fiber.

Veins/ are blood vessels which carry deoxygenated blood back to the heart, the vein is contain to valves it act on prevent blood from flowing back.

Types of veins/

1-large vein: Superior vena cava And Inferior vena cava.

A- Superior vena cava/ collected the blood from the head, neck, upper lamb and part of thorax and pours in right atrium.

B- Inferior vena cava/ collected the blood from the anther parts of the body.

2-Middle vein

3-Venules/ they branch into larger veins which eventually carry the blood to the largest veins in the body.

The vein is containing to valve it automatically close when blood pushes in the wrong direction.

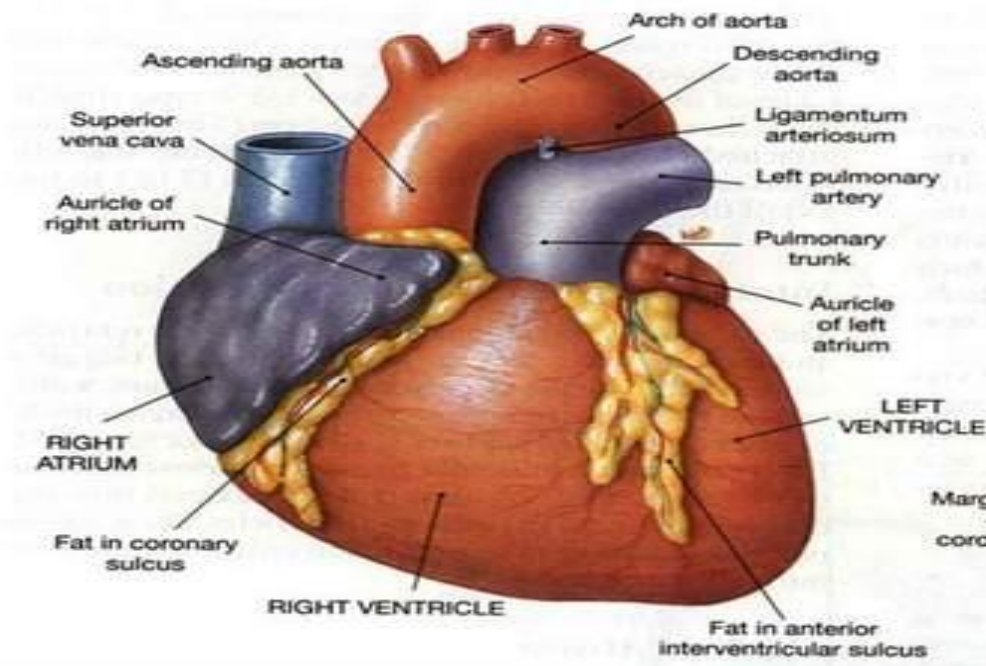
Capillaries / are network of a tiny blood vessel that connects an arteriole with a venule. The capillary plays an important role in the circulatory system.

Types of capillaries:

1- Fenestrated capillaries.

2- Continuous capillaries

The walls of capillaries act as semipermeable membranes that permit the exchange of various substances, including fluids and the gases oxygen and [carbon dioxide](#), between the blood stream and the tissues of the body by diffusion, phagocytosis and pinocytosis.



Human Heart Section

Lymph node

Lymph node/ the small, bean-shaped masses of lymphoid tissue enclosed by a capsule of connective tissue that occur in association with the lymphatic vessels. its found about 600 lymph nodes distributed in the body, As part of the lymphatic system, lymph nodes serve as filters for the blood, providing specialized tissues where foreign antigens can be trapped and exposed to cells of the immune system for destruction.

Each lymph node is divided into two general regions:

1- The capsule.

2- The cortex.

The capsule/ is an outer layer of connective tissue. Underlying the capsule is the cortex, a region containing mostly inactivated B and T lymphocytes plus numerous accessory cells such as macrophages.

The cortex/ is further divided into two functional areas: **the outer cortex and inner cortex**, or **paracortex**.

These regions surround an inner medulla, which consists primarily of activated antibody-secreting plasma cells.

Location / A- Superficial lymph ex nicks, axillary.

B- Deep lymph ex hilum, Thoracic, Portal.

Zones of lymph node:

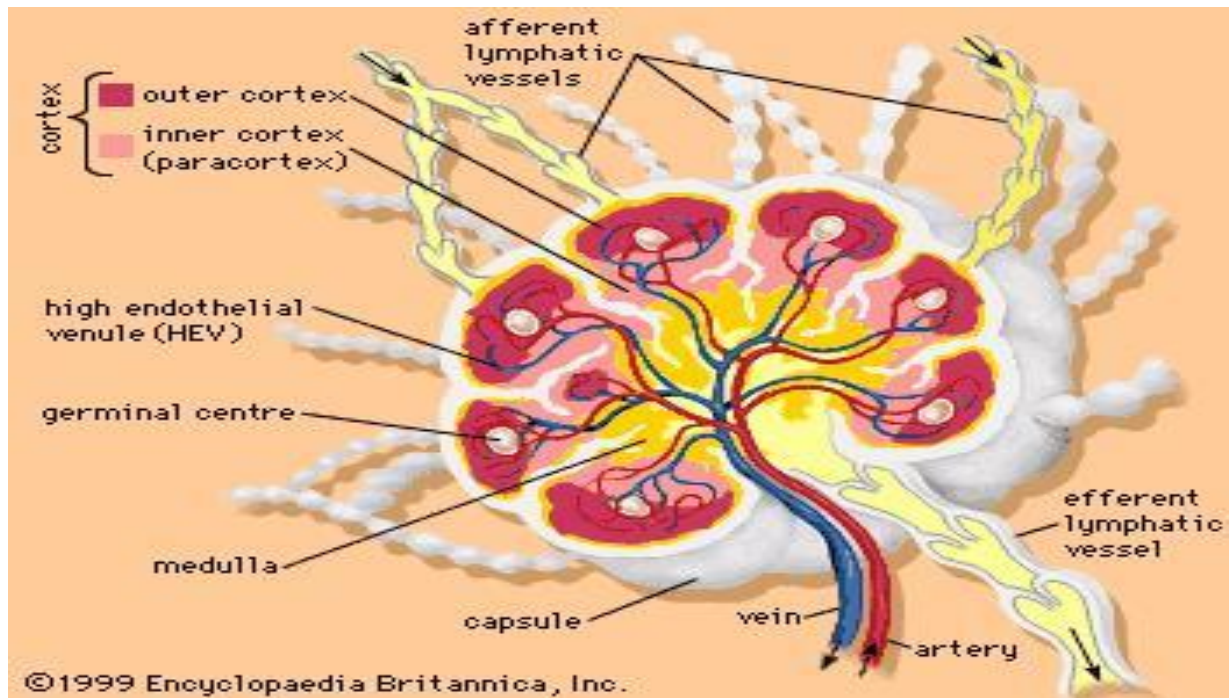
1-Peripheral zone/ is the peripheral part of lymph nodules. It extends in the medullary cords and consists of small lymphocytes, macrophages and plasma cells.

2- Middle zone/ consists of the outer part of nodules and paracortex. Paracortex is the region between the nodules and medulla.

3-Inner zone or the 3rd zone includes the germinal centre of the follicles.

Functions of lymph node:-

- 1- Site of lymphocytic production T and B lymphocytes.
- 2- Protection from foreign particles.
- 3- Phagocytosis by macrophages.
- 4- Antibody production by T and B lymphocytes.



Section of lymph node

Urogenital system of the frog

Urogenital system of the frog consist of organs that function are reproduction and excretion

Male Frog:

1-Kidneys: its excrete organ it act to filter the blood and remove wastes to make urine.

Urinary ducts: its organ act to carry urine from the kidney to the cloacae.

Urinary bladder/the organ that collects and store urine until released.

Testes: It is one paired, yellowish color, oval shaped which is encircled by peritoneum (mesorchium) and are attached to the dorsal wall of the kidney produce the sperms.

Vasa efferentia: It is a group of 10- 12 ducts that arise from testis and opens in to Bidder's canal.

Seminal vesicle: enlarged distal sections of the male frogs the sperms are stored until they are ejected out during copulation.

Urino-genital ducts: Also called ureter or collecting duct that collect sperm prior to entry in to the cloaca.

Fat bodies/masses of the fat in the body cavities of the frogs-needed for hibernating and mating.

Female reproductive organ

It consists of following parts

Ovary: Paired yellowish black colored, reproductive organ in the female produce the eggs during breeding season.

Oviduct: tubes of the female frogs It act to carry eggs from the ovaries to the cloaca.

Uterus: It is the middle part near the cloaca which is wide, thin-walled structure and forms uterus. After the ovulation it act to stores the eggs.

Kidney

Kidneys/ are two [bean](#)-shaped [organs](#) found on the left and right sides of the body in [vertebrates](#). They are located at the back of the [abdominal cavity](#) in the [retroperitoneal space](#).

Parts of kidney(Renal):

1-The renal cortex/ is the outer part of the kidney. It contains the glomerulus and convoluted tubules.

The renal medulla/The renal medulla is the smooth, inner tissue of the kidney. It contains the loop of Henle as well as renal pyramids.

3- Renal pelvis it's a part which collecting the urine, it connect with the ureter in the haalm reign in renal collecting in apex of pyramids.

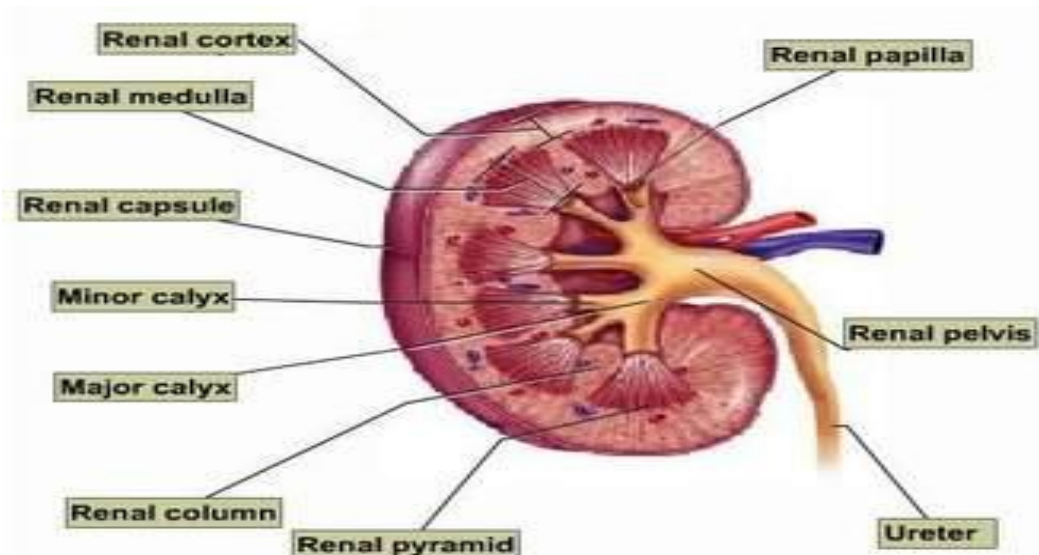
Nephron:

A nephron is the basic structural and functional unit of the kidneys each adult kidney contains around one million nephrons.

The function of nephron is regulates water and soluble substances in the blood by filtering the blood.

Kidney functions:

- 1- Filtration of blood.
- 2- Excretion.
- 3- Produce hormones.
- 4- Reabsorption.
- 5- Homeostasis EX regulating [acid-base balance](#).



Section of Kidney

Skin

Skin/The skin is the largest organ of the body, with a total area of about 20 square feet. It's a vital organ that covers the entire outside of the body, forming a protective barrier against pathogens and injuries from the environment.

Parts of the skin (Sink layers):

Skin has 3 layers:

A- Epidermis / The epidermis, the outermost layer of skin, provide a waterproof barrier and create our skin tone.

The epidermis is divided into five layers or strata:

1- stratum basal

2-stratum spinosum

3-stratum granulosum

4-stratum lucidum

5-stratum corneum

B- Dermis / The dermis, beneath the epidermis, contain tough connective tissue, hair follicles and sweat glands.

C- Hypodermis / The deeper subcutaneous tissue (hypodermis) is made of fat and connective tissue.

The components of the skin include:

1- Blood vessels/To help keep your body a constant temperature, blood vessels in the skin dilate in response to heat or constrict in response to cold.

2- Sebaceous glands / The sebaceous glands secrete sebum, an oily substance that helps keep skin from drying out. Most of the glands are located in the base of hair follicles. Acne starts when the tiny hair follicles become plugged with these oily secretions.

3- Sweat glands / when your body gets hot or is under stress, these glands produce sweat, which evaporates to cool you. Sweat glands are located all over the body but are especially abundant in your palms, soles, forehead, and underarms.

4- Hair follicle / every hair on your body grow from a live follicle with roots in the fatty layer called subcutaneous tissue.

5- Collagen/Collagen is the most abundant protein in the skin, making up 75% of your skin. This is also your fountain of youth as it's responsible for warding off wrinkles and fine lines. Over time, environmental factors and ageing diminish your body's ability to produce collagen.

6- Elastin / when you hear the word elastin, think elastic. This protein is found with collagen in the dermis and is responsible for giving structure to your skin and organs. As with collagen, elastin is affected by time and the elements. Diminished levels of this protein cause your skin to wrinkle and sag.

7- Keratin - Keratin is the strongest protein in your skin. It's also dominant in your hair and nails. Keratin is what forms the rigidity of your skin.

The skin's color is created by special cells called **melanocytes**, which produce the **pigment melanin**. Melanocytes are located in the epidermis.

There are 3 main types of glands found on human skin:

1- Eccrine glands/ secrete sweat through pores found in the palms of hands, soles of feet, and forehead.

2- Sebaceous glands/ secrete oily sebum and are found on the chest, back, scalp, face, and forehead.

3- Apocrine glands / secrete sweat via canals along hair follicles in the under arms, pubic area, anus, and nipple area.

Functions of Skin:

- 1. Protection** / its provides protection against invasion of microorganisms, ultra violet rays (UV), mechanical, thermal and chemical injuries and prevents dehydration. of the human body.
- 2. Sensation**/skin has many sensory receptors act by transmitting to the brain information for pain and pressure.
- 3. Temperature regulation.**
- 4. Immunity** by the role of the skin within the immune system.
- 5. Enables movement and growth without injury.**
- 6. Excretion** from the body of certain types of waste materials.
- 7. Endocrine** function by synthesis Vitamin D.
- 8. Storage** /acts as a storage center for lipids.

Appendages of the skin:/

1- Hair

2- Nails

3- Skin glands

Hairy skin/ its term when the skin have hair

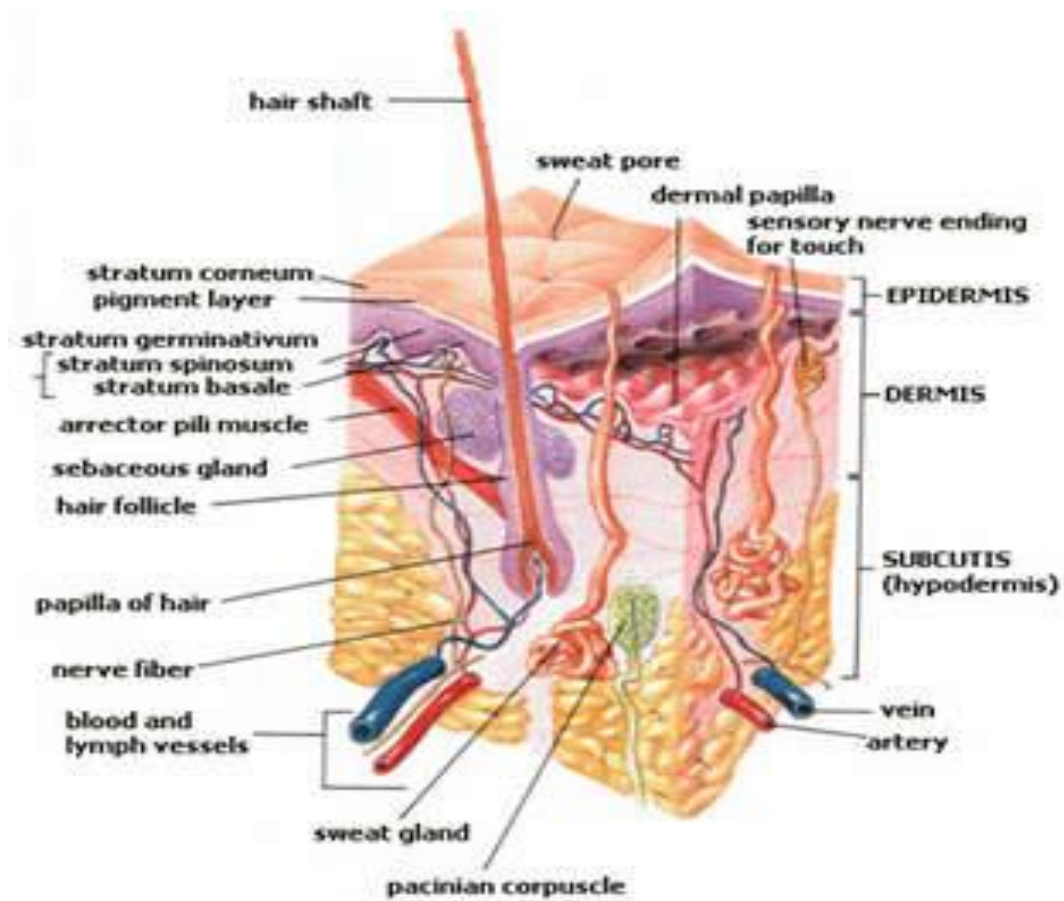
The parts of hair/ the skin consist of many parts:

1-Shaft/ the free portion over the skin surface

2- Root/the portion embedded in the skin

3- Hair follicle / the hair root enclosed by outer connective tissue, sheath derived from the dermis and inner epithelial tissue sheath derived from epidermis.

2-Nails: the nail is composed of clear flattened cells with degenerated nuclei, they contain hard keratin.



Section of Skin