



# Histology

faculty of medicine - JU2017

☒ Sheet

☐ Slides

Number

1

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**NOTE: Yellow highlighting=Correction/addition to the previous version of the sheet.**

**Histology (micro anatomy) :-** the study of tissues and how they are arranged into organs.

\*The word Histology derived from the Greek and it means: 1) Histo: tissue  
2) Logy: science

\***Our body** consists of many systems like: respiratory system, digestive system, circulatory system...etc and these systems consist of many organs , such as : the digestive system consists of (the stomach , esophagus , large intestine, small intestine , mouth ..etc )And each organ of these organs consists of two or more tissues

\***Tissues** consist mainly of 2 components : **1) cells**

**2) The extracellular material (matrix) (ECM)**

-**The ECM** consists of: **A) Clear gel** usually known as: ground substances, Tissue gel, Interstitial fluid or extracellular fluid.

**B) Fibrous proteins (fibers)**

-**The ground substance contain:** Water, Gases , Minerals , Nutrients , Waste products and other chemicals

**The four main basic types of tissues :**

**1) Epithelium tissue**

**2) Connective tissue**

**3) Muscular tissue**

**4) Nervous (Neural) tissue**

**These four types of tissues differ in :**

**1) Type and function of the cells that compose them**

**2) The characteristic of matrix:** the difference in the composition of the ground substances and fibers for each tissue.

**3) Relative amount of spaces between the cells**

\***Our body** consists of a huge number of cells, approximately **50 trillion** cells, but only **200** types of cells are specialized for a certain function such as: contraction, secretion, covering, connection, support...etc.

\***Examples of cells:** Bone cells, red blood cells, nerve cells, muscle cells

**The cell:** the basic or the microscopic unit of the human body

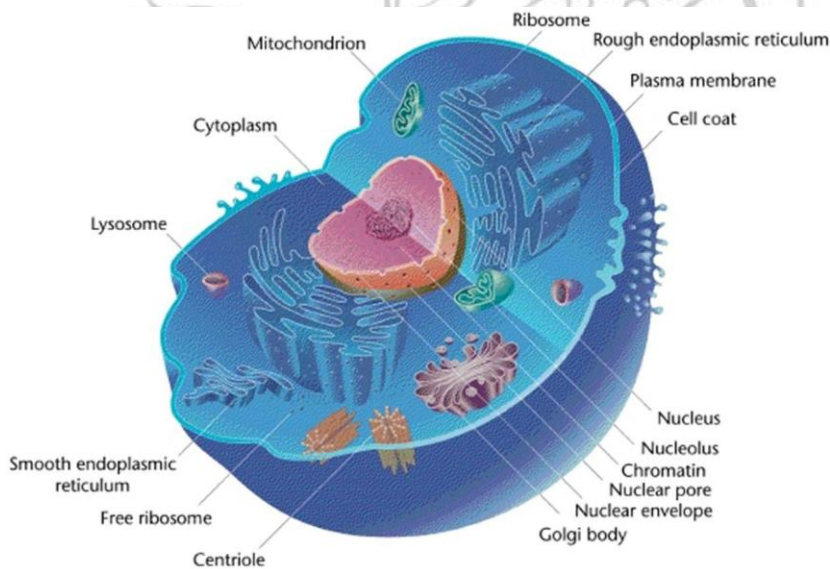
**\*Levels of organism:**

- 1) The Smallest level of organization are molecules and atoms that combine to form cells.
- 2) Many cells combine to form a tissue and this tissue does a specific function.
- 3) Many tissues combine to form an organ and this organ does more complex function.
- 4) Many organs combine to form a system which gives a higher order of function
- 5) Different systems build up our body (**the human body**)

**So: The smallest unit of life is:** The cells

**The highest unit is :** The human body

**The Cell** is surrounded by a plasma membrane and contains many organelles such as: mitochondria, Golgi Apparatus, Ribosomes as you can see in the picture below



**Although 50 trillion** cells form our body, but at first only one single cell (**the origin of the body**) is the first cell and it is the fertilized cell and we call it **Zygote (2n)**.

-**The zygote** undergoes mitosis division and cleavage to give a huge number of identical cells

-**At a certain point** this cell will undergo differentiation that will give us the first tissue (**the embryonic tissue**)

**\*The first tissue consists of 3 germ layers (primary germ layers):**

- 1) Ectoderm
- 2) Mesoderm
- 3) Endoderm

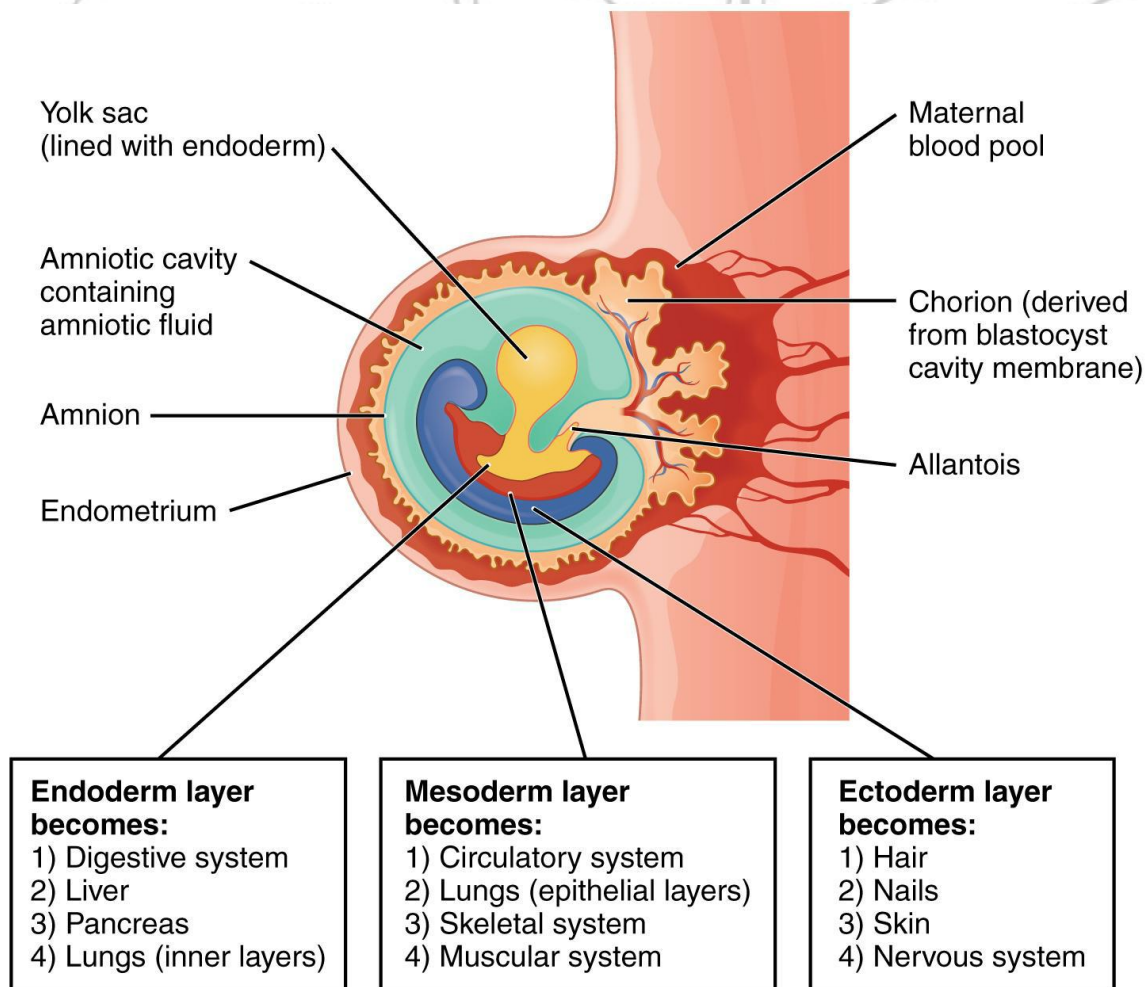
-All tissues in our body arise from the embryonic tissue.

-And each germ layer gives us a type of tissues in our body

A) **Ectoderm**: gives rise for tissues on the surface of the body like **Epidermis** and **Nervous tissue**

B) **Mesoderm**: gives rise to **Muscle, Connective tissue** such as: **Bone and Blood**

C) **Endoderm**: gives rise to mucus membrane of the **Digestive, Respiratory tract** and **the digestive glands.**



**So: Tissues (according to the above-mentioned statements):** Group of similar cells that arise from the same embryonic origin and work together to form a specific structure.

**A Closer look at the four types of tissues :**

**1)Epithelium tissue:**

-Covers the exposed surfaces, and lines the internal passages.



- Consists of large number of layers of flat shaped cells closely packed to each other (one or more cell thickness) with a little amount of ECM between the cells.

-Epithelial is a polar cell: we have an apical (upper) and basal part of the cell; the apical part is exposed to the environment or the internal part of the body (tracts) such as: respiratory tract, digestive tract, urinary tract...etc.

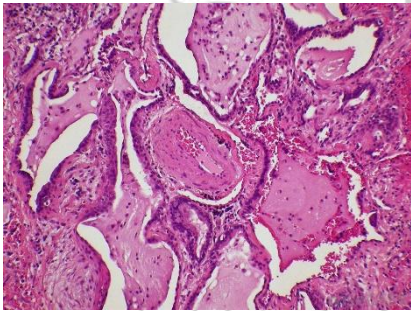
**-Places where the Epithelium is present in our body:**

**A)** The lining of the blood vessels, respiratory and digestive tract

**B)** The Epidermis of our skin

**C)** Glands

**-Glandular Epithelium:** A specialized type of Epithelium modified for secretion



## **2)Connective tissue:**

**-Function:**

**A)** Fill in the internal spaces between other tissues

**B)** Provide structural support

**C)** Storage (Energy storage)

**D)** Movement and defense

-Not closely packed like Epithelium

**-Consists Of: 1)** Many fibers such as: collagen, elastic fibers

**2)** Many Ground Substances

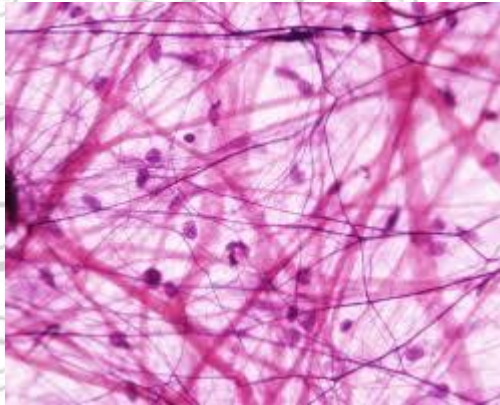
**3)** Widely Separated cells

-The most abundant type of tissues

**-Example:** Tendons and ligaments are connective tissues that bind a bone to another bone or to a muscle.

**-Connective tissues include:**

- 1) Bone (hard)
- 2) Cartilage (Semihard)
- 3) Blood (fluid)
- 4) Fats



**3) Muscular Tissue:**

**-Consists Of:** Elongated cells that are specialized to respond for stimulation by contracting

**It has 3 Types:**

- 1) Skeletal Muscular Tissue: helps us to move and lift things
- 2) Cardiac Muscular Tissue: Forms the heart of our bodies
- 3) Smooth Muscular Tissue: forms a layer in our digestive tract like in the stomach or large intestine and it forms a layer in the blood vessels and the respiratory tract

**Functions:**

- A) Movement of the body
- B) Digestion in the digestive tract
- C) Breathing in the respiratory system
- D) Waste elimination in the urinary system
- E) Blood Circulation
- F) Speech ( talking )

**4) Nervous (Neural) tissue :**

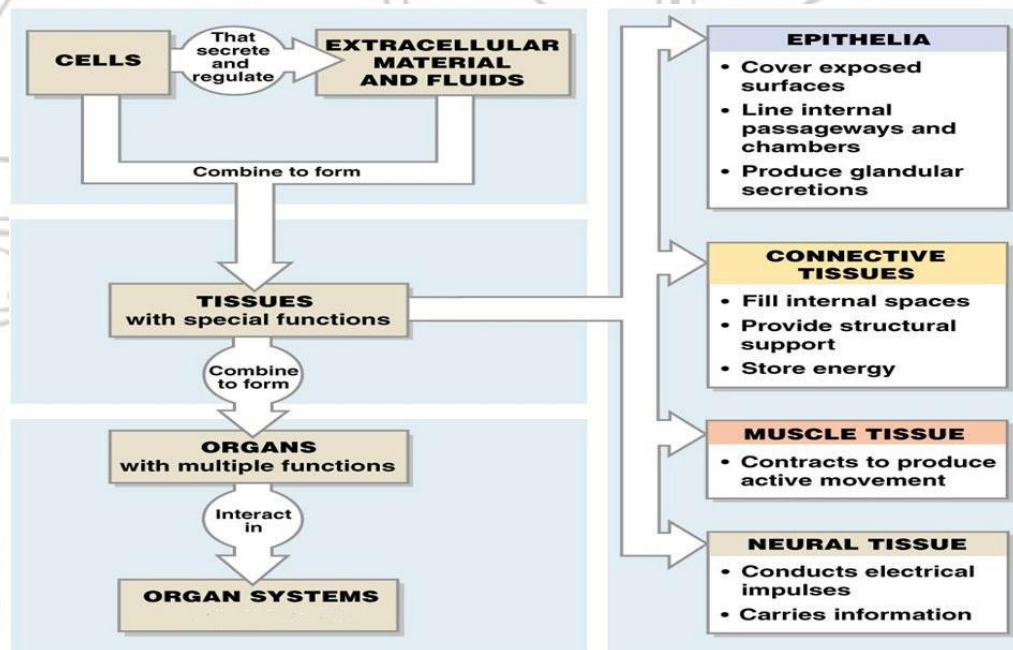
**-Consist of:** Neurons and supporting cells called **Neuroglia cells (Glial cells)** that assist the neurons.

**-Neurons** are specialized to detect the stimuli, respond quickly and transmit the information to **other cells** that might be other neurons, muscle cells, glands...etc.

**\*The Organ:** A Structure with discrete boundaries that consists of 2 or more types of tissues like in **the stomach**

**-in the stomach:**

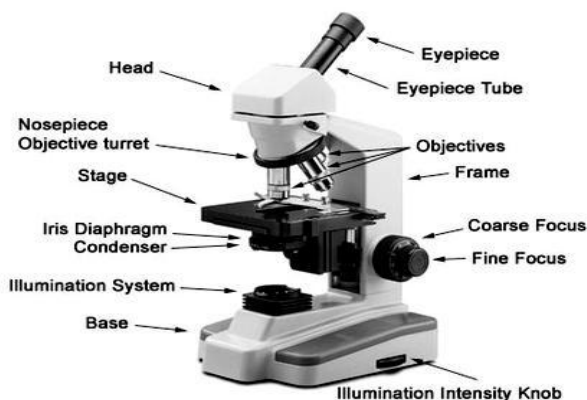
- A) The lining is Epithelium
- B) Under the Epithelium is the connective tissue
- C) Then smooth muscular tissue
- D) Ganglia (Nervous tissue)



**\*The system:** A group of 2 or more organs that work together to perform a specific function

**\*To study the cells and tissues of our body :** We use an instrument called Microscope

**\*Microscope:** An instrument used to observe the details of a very small object



**\*For a clearer image: Check slide 27**

## Types of Microscopes :

1) Light Microscope

2) Electron Microscope **And It has 2 types:** A) Transmission electron

B) Scanning electron

	Light Microscope	Electron Microscope
Magnification	10-1000 X Lower	<b>1000-50,000 X up to 2,000,000 X</b> Higher
What passes through the specimen	Visible Light	<b>A beam of electrons</b>

Transmission electron microscope	Scanning Electron Microscope
<b>Detailed study of the ( Internal Ultra Structures )</b>	<b>Detailed Study of the Topography of the specimen (surface of the specimen) 3D image</b>

**\*In scanning electron microscope** we coat the specimen with a layer of heavy metals such as: gold.

**\*Microtechnique :** The preparation of tissues to study them under the microscope

### **\*The Preparation of tissues :**

**-Aim:** embed the tissue in a solid medium like paraffin or wax to give hardness or rigidity for the specimen to support the tissue to enable a thin section to be cut without damaging the tissue with preservation of the structure.

**So basically the aim is:** Obtaining a very thin section of the specimen that can transmit the light.

### **-Steps**

1) Fixation

2) Dehydration

3) Clearing



4) Infiltration and Embedding

5) Sectioning

6) Sliding

7) Staining

8) Mounting

**\*A closer look to these steps:**

**1) Fixation:** to preserve the tissue structure and prevent alteration of tissue, autolysis, Bacterial digestion.

-**procedure:** pieces of organs are placed as soon as possible after removing from the body in a solution called **Fixatives**

-**Fixatives:** Stabilizing or cross linking compounds like **10% Formalin** which consists of **37% Formaldehyde**.

**Note(not in slides) :** we use formalin for light microscope and we can use it or **Glutaraldehyde** for electron microscope

**\*Glutaraldehyde treated tissues** are then immersed in **Osmium Tetroxide** which preserves and stains cellular lipids and proteins.

**2) Dehydration:** the process of having the water extracted by using an increasing concentration of **ethyl alcohol**. For example we start by 30% then we increase it gradually until we reach 100% alcohol.

**3) Clearing:** The process that is used to prepare for the next step (Embedding)

-The alcohol is replaced by a solvent that must be:

**A) Organic**

**B) Miscible in both (Alcohol (dehydration reagent) and the embedding reagent)**

**Examples of clearing reagents:** Benzene/benzol, Chloroform, xylene/xylol, Cedar wood oil, Benzyl benzoate, methyl benzoate.

-The most commonly used are: **Xylene and Chloroform**.

**4) Infiltration and Embedding:**

**Impregnation (infiltration):** The tissue is kept in a wax bath containing molten paraffin wax (paraffin heated to 60 degree: melting point).

**Embedding:** It is done by transferring the tissue which has been cleared of the alcohol and impregnated with wax to a mold filled with molten wax and is allowed to **cool & solidify**.

-After solidification, a wax block is obtained which is then sectioned to obtain ribbons.

-**Paraffin wax** is the most frequently used agent.

\***note not in the slide:** we use plastic resins for electron microscope and it differs from paraffin that it avoids the higher temperatures which helps avoid tissue distortion

**5) Sectioning:** The hardened block of the tissue and surrounding embedding medium is placed for sectioning in an instrument called **Microtome**

\* We can adjust the thickness in the Microtome up to 25  $\mu\text{m}$  but usually it is 5-10  $\mu\text{m}$  thick

**Then the sections are placed on:**

- 1) Glass slides  $\rightarrow$  light microscope
- 2) Metal Grids  $\rightarrow$  electron microscope

**6) Sliding:** A Clean microscopic glass slide is taken and the section which is floated in warm water is put on the glass slide in such a way that no air bubble is trapped between them.

**7) Staining :** Because the tissues of our body are colourless and there details are difficult to study, we use staining techniques which **enhance** natural contrast and permits distinction to be made between the tissues.

-**Basic dyes (positively charged):** Acidic components (**basophilic**) with a net **negative** charge have affinity for basic dyes like **Hematoxylin**.

**For example:** DNA, RNA, Ribosomes, Rough ER are stained by **Hematoxylin**.

\***Yes, DNA is an acid due to the phosphate groups.**

-**Acidic dyes (negatively charged):** Basic components (**acidophilic**) with a net **positive** charge have affinity for acidic dyes like **Eosin**.

**For example:** Proteins, collagen, cytoplasm are stained by **Eosin**.

-**Hematoxylin and Eosin (H&E)** is the most used combination

**8) Mounting:** Covering the slide with **thin glass coverslips** to protect the section.

**The end.**