



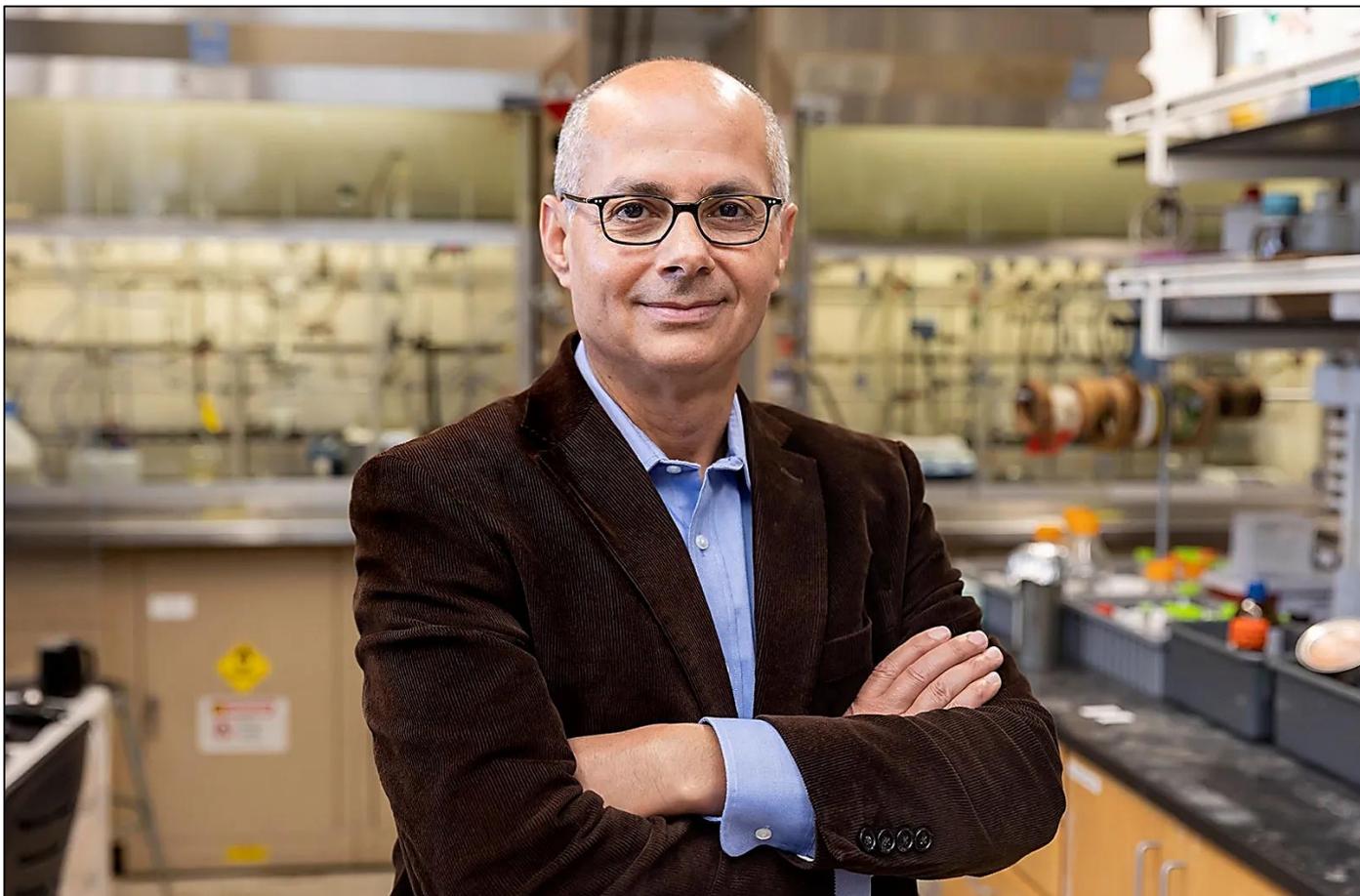
**WELCOME NEW CLASS**



**Think positive**

- **It is going to be hard, but hard does not mean impossible**
- **Don't stop when you're tired stop when you're done**





Omar M. Yaghi  
Nobel Prize in Chemistry /Winner 2025

# Introduction To Cell Biology



# Cell Biology

- The study of normal cells structures & functions  
(Cellular & Molecular levels)
- The cell is the smallest & the basic unit of a living body  
( The cell can carry on all the process of life)
- The living body is made of different types of cells
- Cells varies in size from 4 to 200 microns.
- The living organisms are either unicellular or multicellular
- The cell can't be seen by naked eye but only by microscope

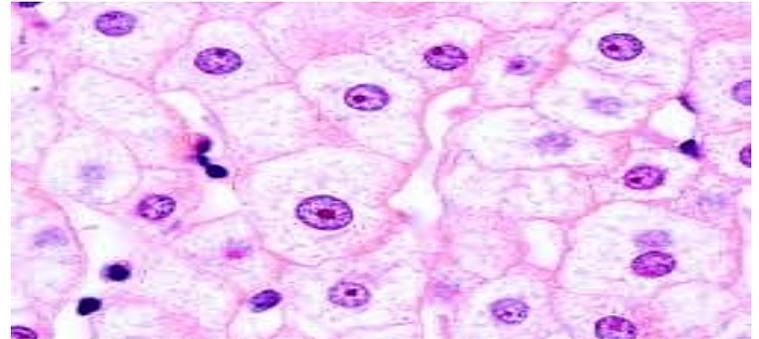


# Histology ( histo: tissue, ology : science):

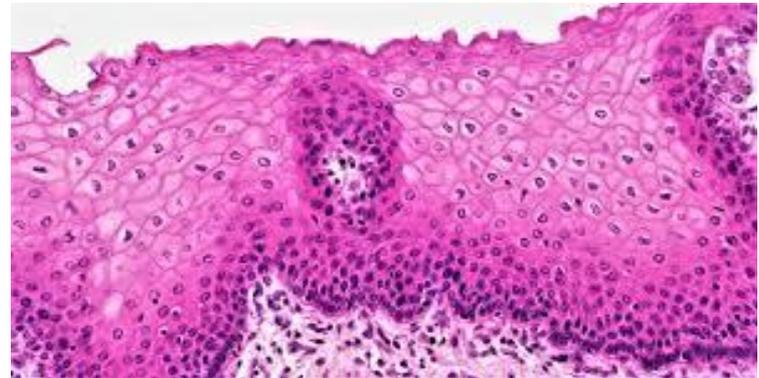
Microscopic study of tissues of the body and how these tissues form the organs



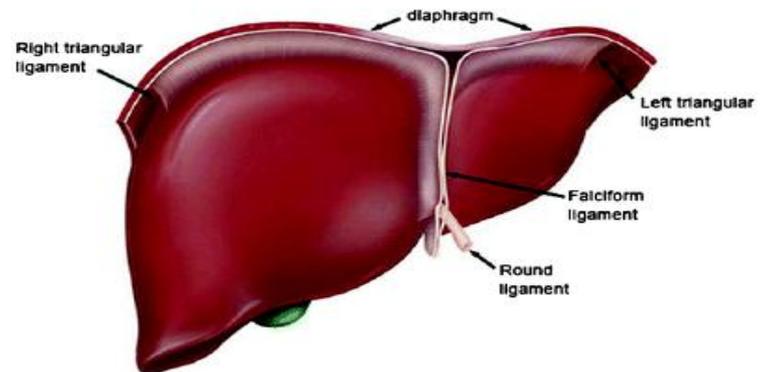
Cells

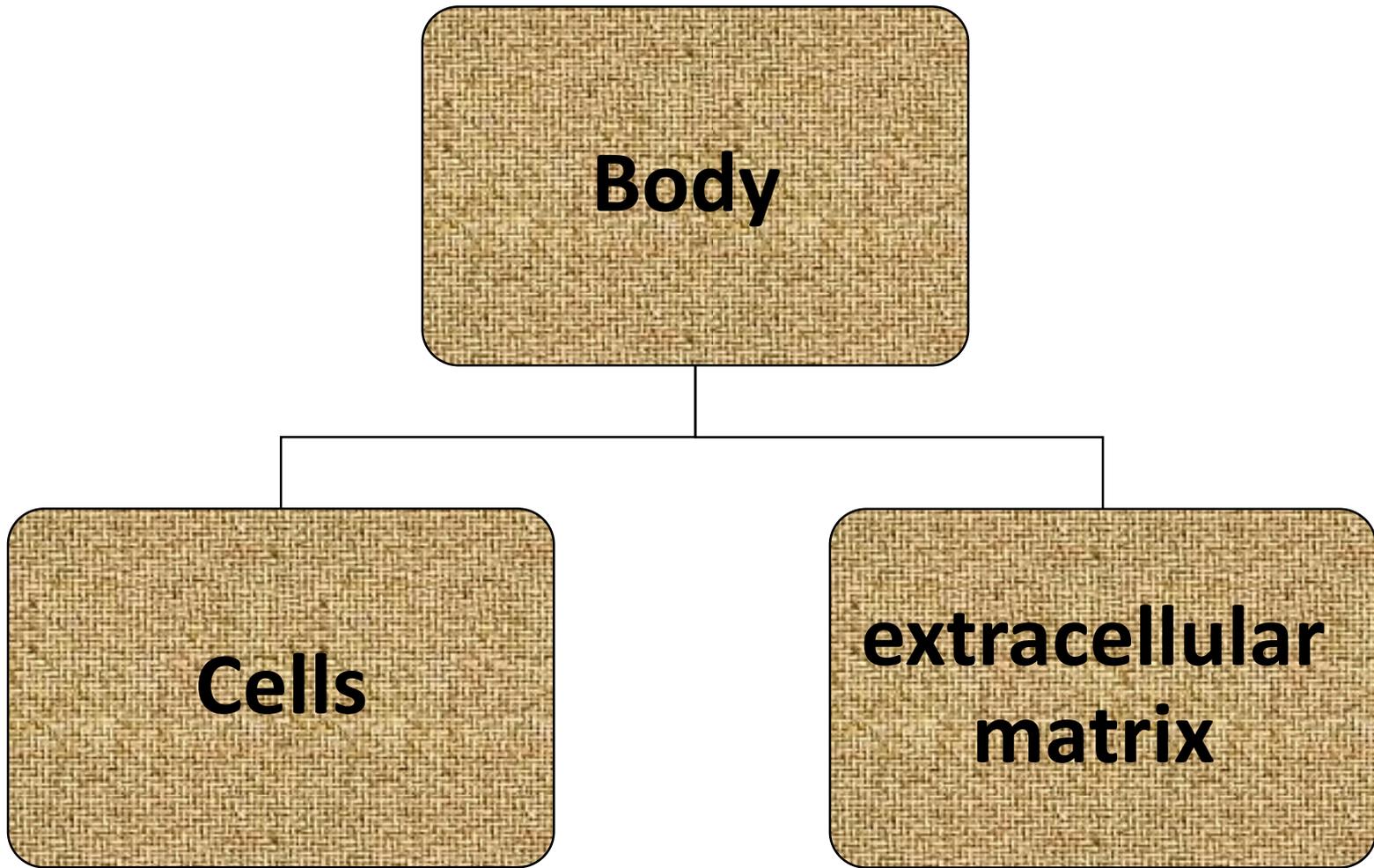


Tissue



Organ



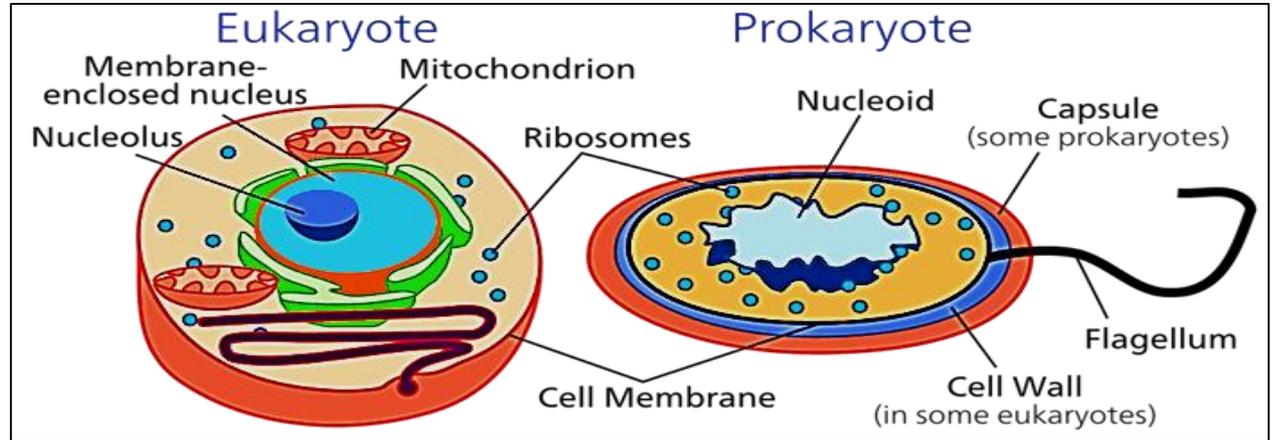


# 1- The cell

The cells are classified into :

1. Prokaryote

2. Eukaryote



Prokaryotic cell:

Lack nucleus, the genetic material DNA (Genophore) is floating in the cytoplasm in area called Nucleoid & also has No membrane bounded cell organelles

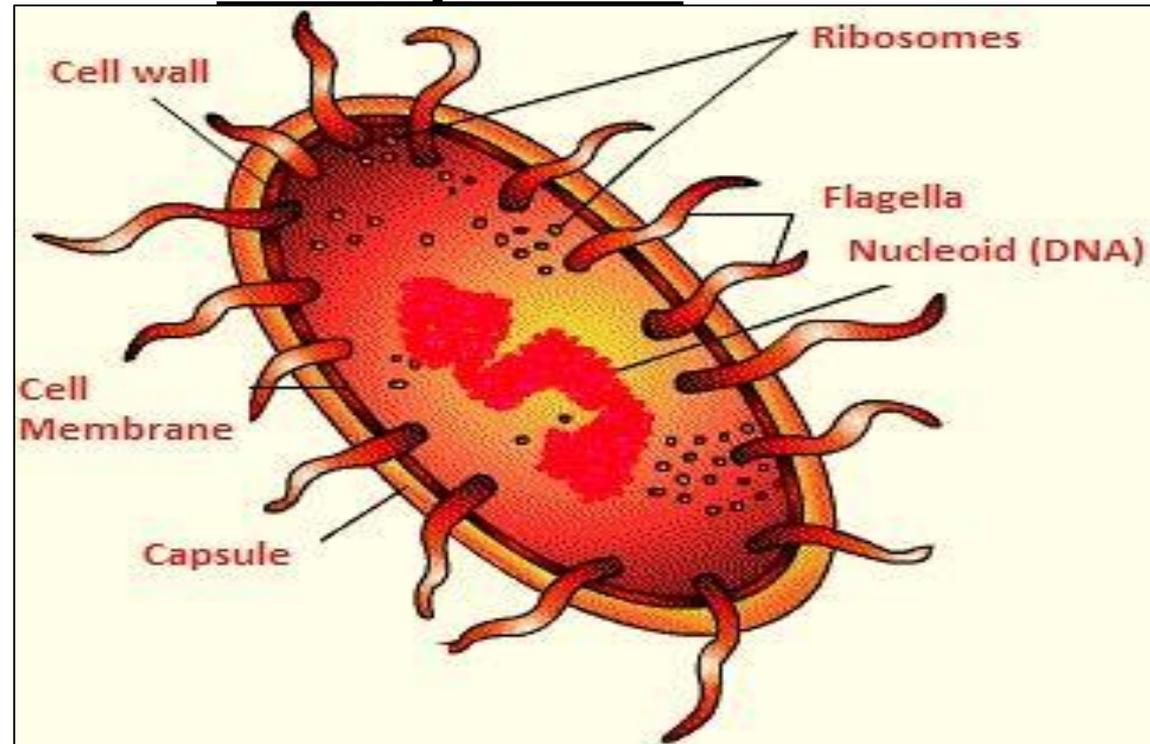
Eukaryotic cell

contains TRUE nucleus & membrane bounded organelles.

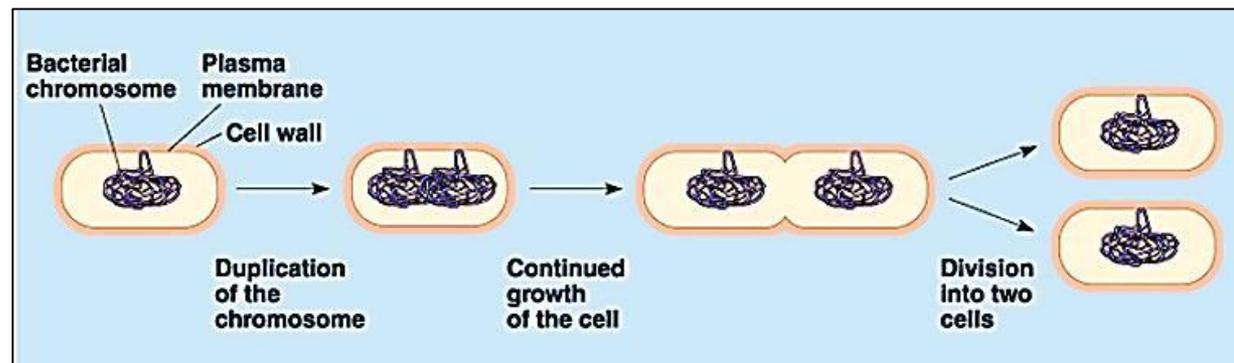
Both ( Pro & Eu ) share 4 key elements ( cell membrane, cytoplasm, genetic material, ribosomes)

# Prokaryote cell

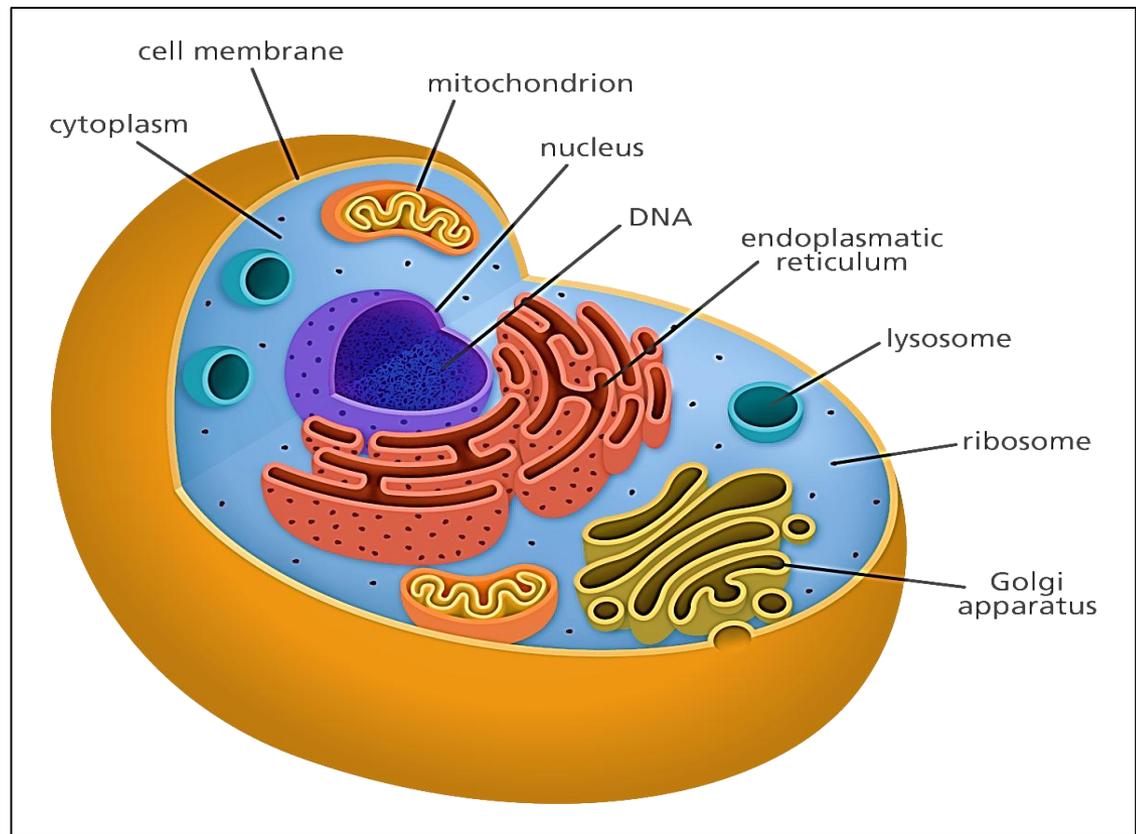
The DNA strand is circular and is called **gonophore** and found in area called nucleoid



Prokaryotes divide by process called **Binary fission**



# Eukaryote cell



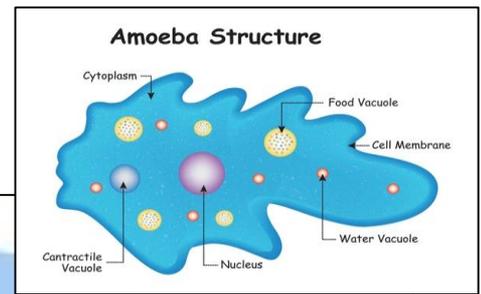
## Equivalent lengths:

**1 millimeter (mm) = 1000 micrometer (micron)**

**1 micrometer (um)= 1000 nanometer**

**1 nanometer(nm)= 10 angstrom**

# Prokaryote vs. Eukaryote



## Prokaryotic

- no membrane bound organelles
- no true nucleus
- unicellular
- 0.1-5 micrometers
- has cell wall
- asexual reproduction

DNA circular

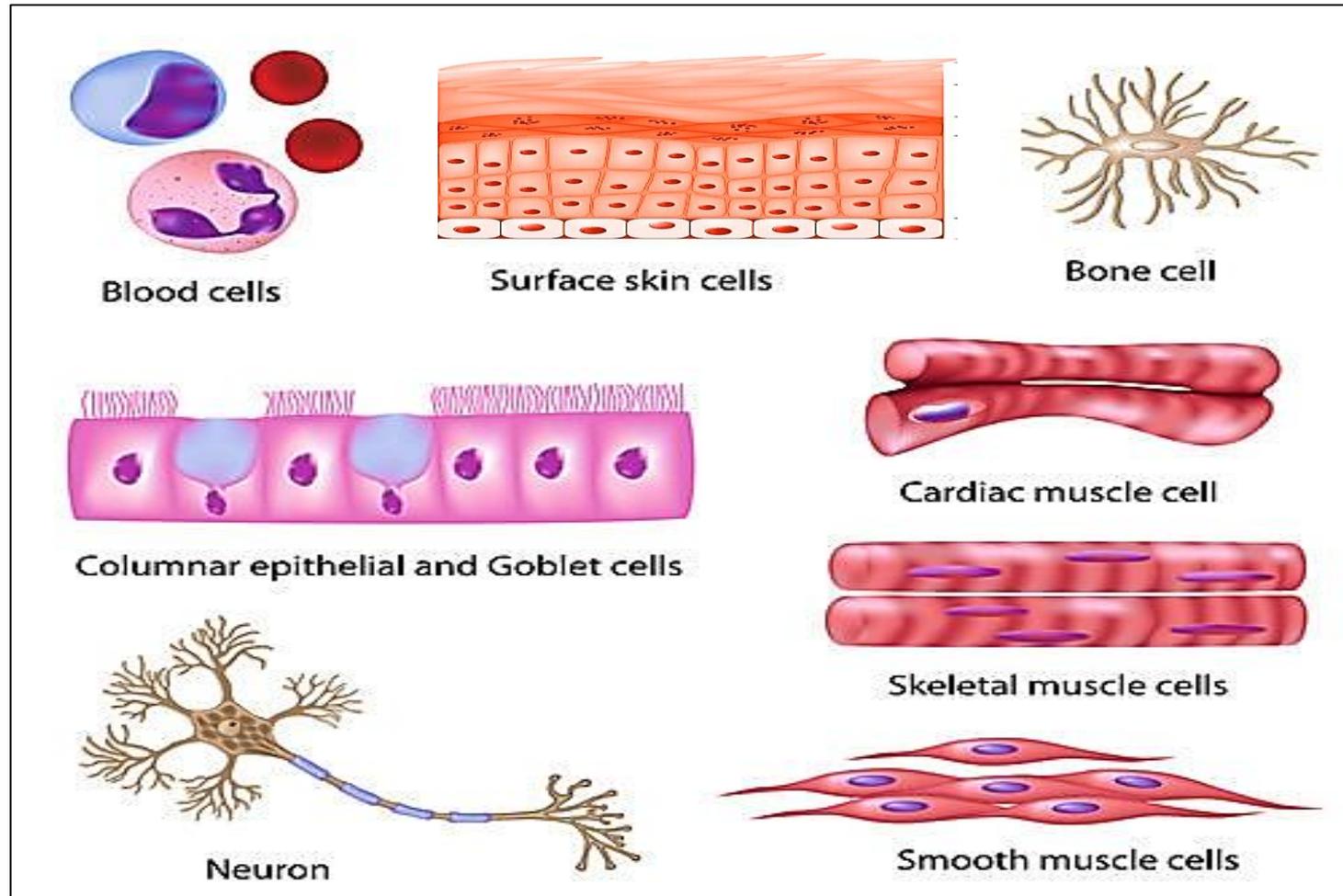
## Eukaryotic

- contains membrane bound organelles
- contains true nucleus
- uni-, multicellular
- 10-100 micrometers
- asexual and sexual reproduction

DNA linear organized into chromosomes

- Ribosomes
- Cell membrane
- Has DNA
- Cytoplasm

There are around 200 cell types in the human body.  
Cell types look different and carry out different functions



Different types of cells of the body

# The 4 basic types of tissues that make the human body

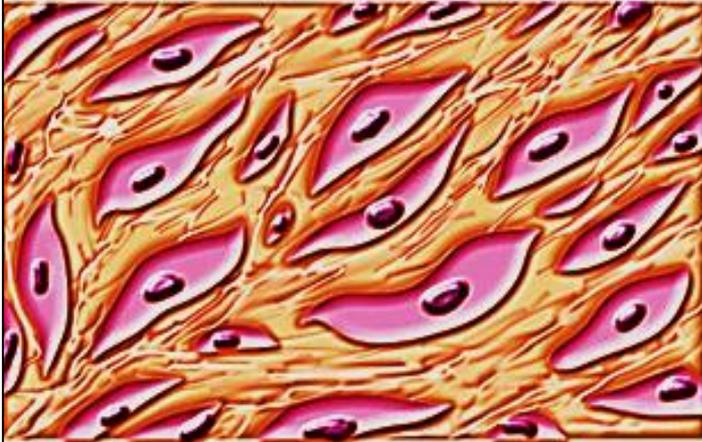
**1- Epithelial tissue** : refers to groups of cells that cover the exterior surfaces of the body, line internal cavities and passageways, and form certain glands

**2- Connective tissue** : binds the cells and organs of the body together

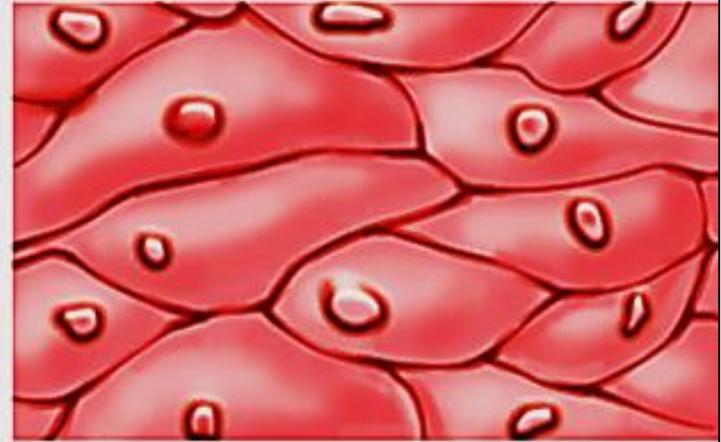
**3- Muscular tissue**: contracts forcefully when excited, providing movement

**4- Nervous tissue**: is also excitable, allowing for the generation and propagation of electrochemical signals in the form of **nerve impulses** that communicate between different regions of the body

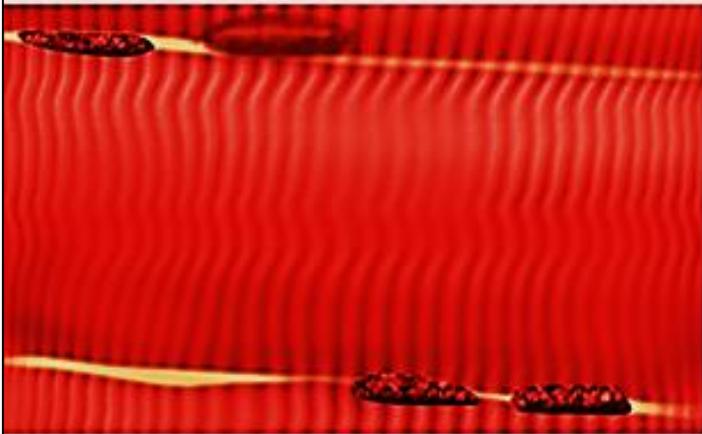
## Four types of tissue



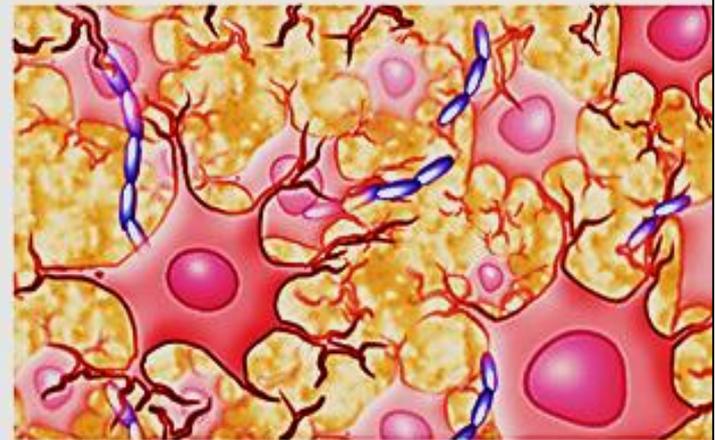
**2-** Connective tissue



**1-** Epithelial tissue



**3-** Muscle tissue



**4 -** Nervous tissue

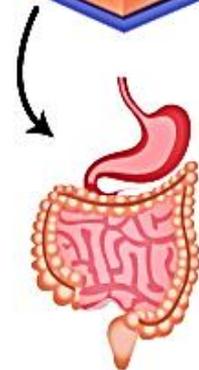
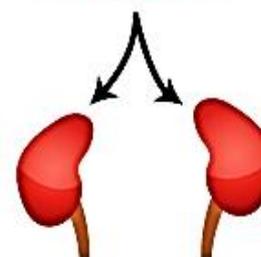
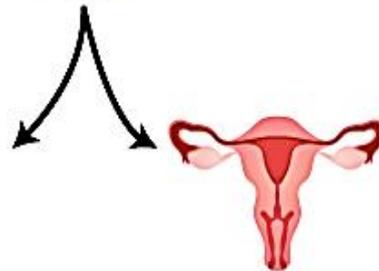
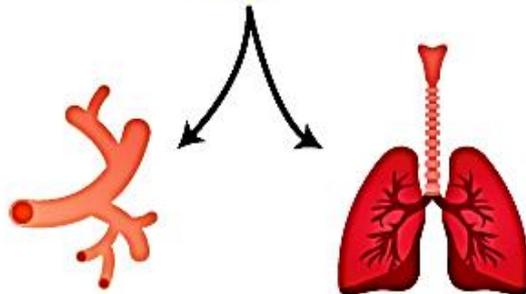
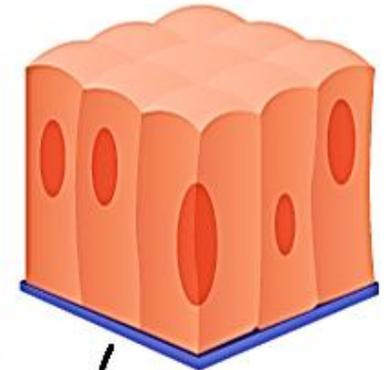
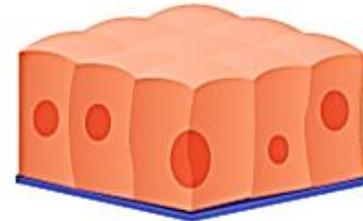
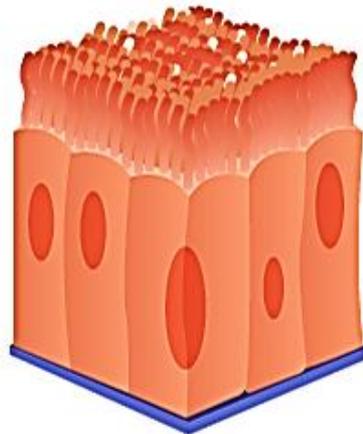
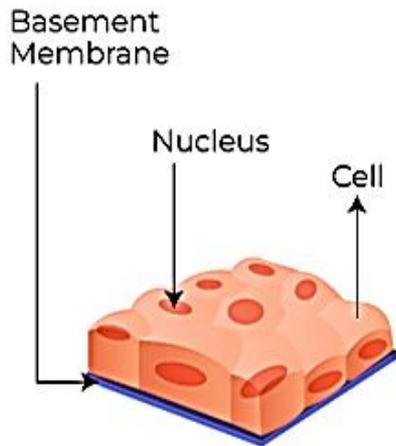
# Epithelial Cell

Single Squamous Epithelium

Ciliated Columnar Epithelium

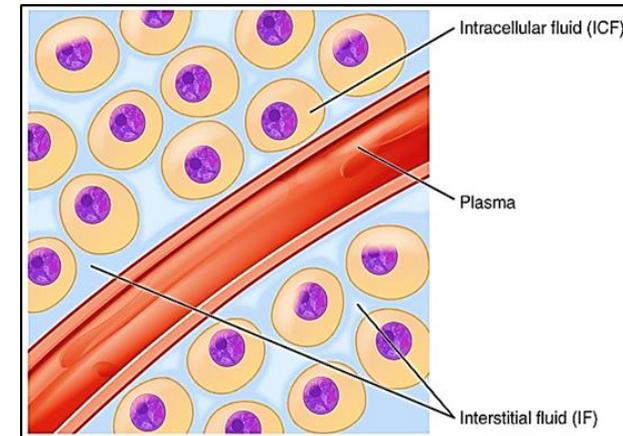
Simple Cuboidal Epithelium

Simple (smooth) Columnar Epithelium



## 2- Extracellular matrix (ECM)

- is the substance (non cellular) that fills the spaces between cells & it is secreted by the cells
- Composed of proteins and other molecules that provides structural & biochemical support to the surrounding cells
- The extracellular matrix helps cells **attach to**, and **communicate** with, nearby cells, and plays an important role in **cell growth**, **cell movement**, and other cell functions



# Types of Extracellular matrix (ECM)

The ECM has **two basic forms**

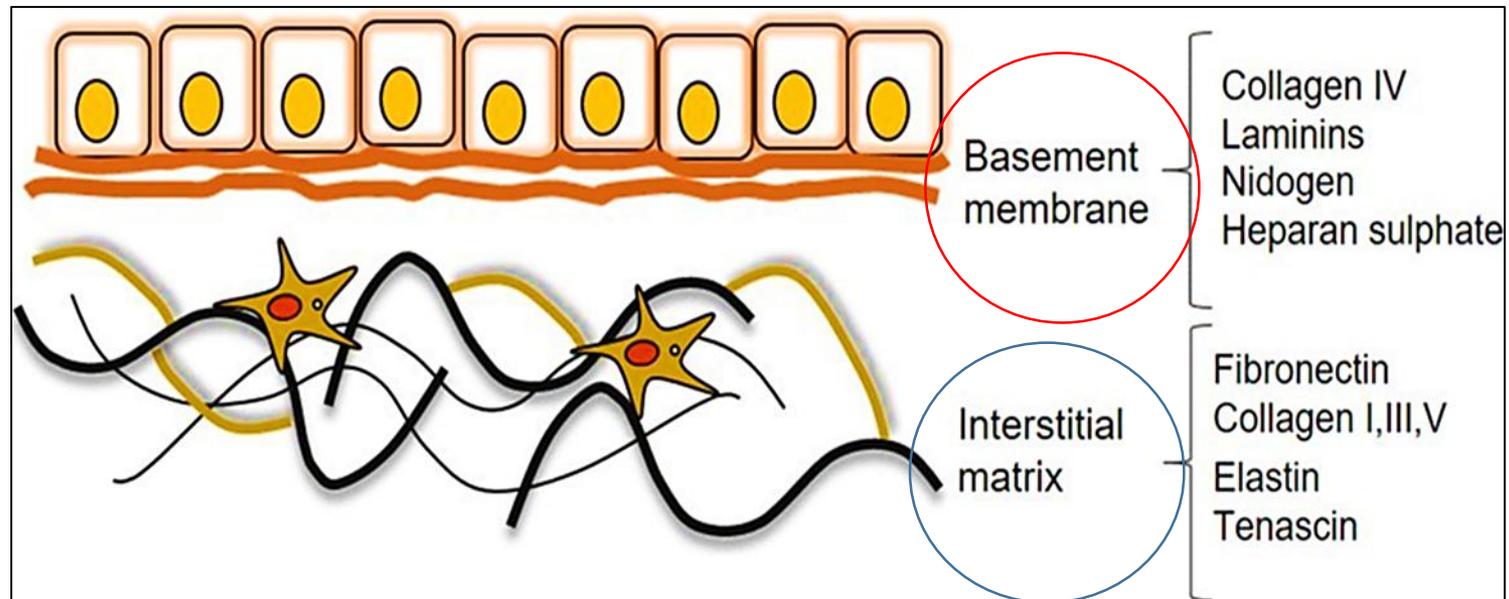
## 1-Basement Membrane

is sheet-like depositions of ECM  
at the base of epithelial cells &  
surround muscle cells

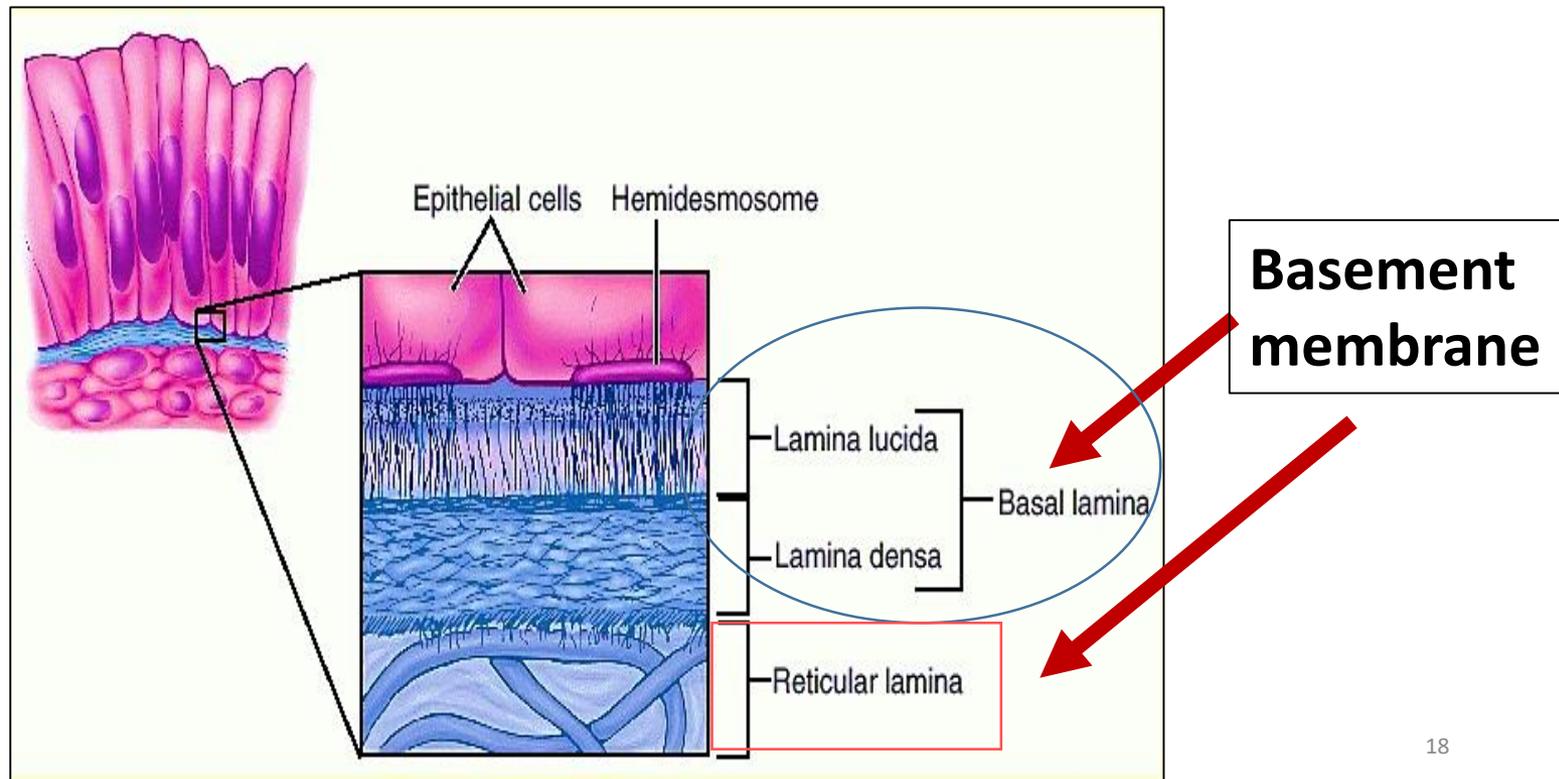
(always under epithelial cells)

## 2-Interstitial fluid

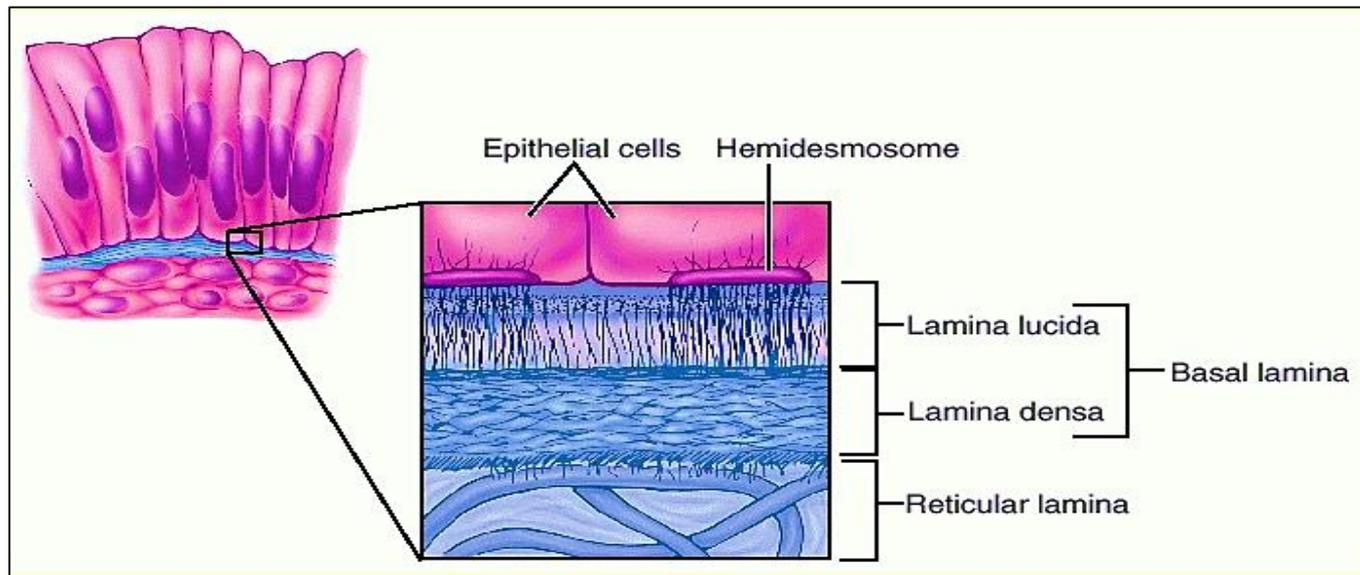
**thin layer of fluid fill the spaces  
between the cells : H<sub>2</sub>O, proteins,  
electrolytes, acids, hormones ,  
waste materials**



- Most epithelial cells are separated from the connective tissue beneath it by a sheet of extracellular material called basement membrane
- The basement membrane is usually visible with light microscope
- Is formed by 2 layers Basal lamina & Reticular lamina

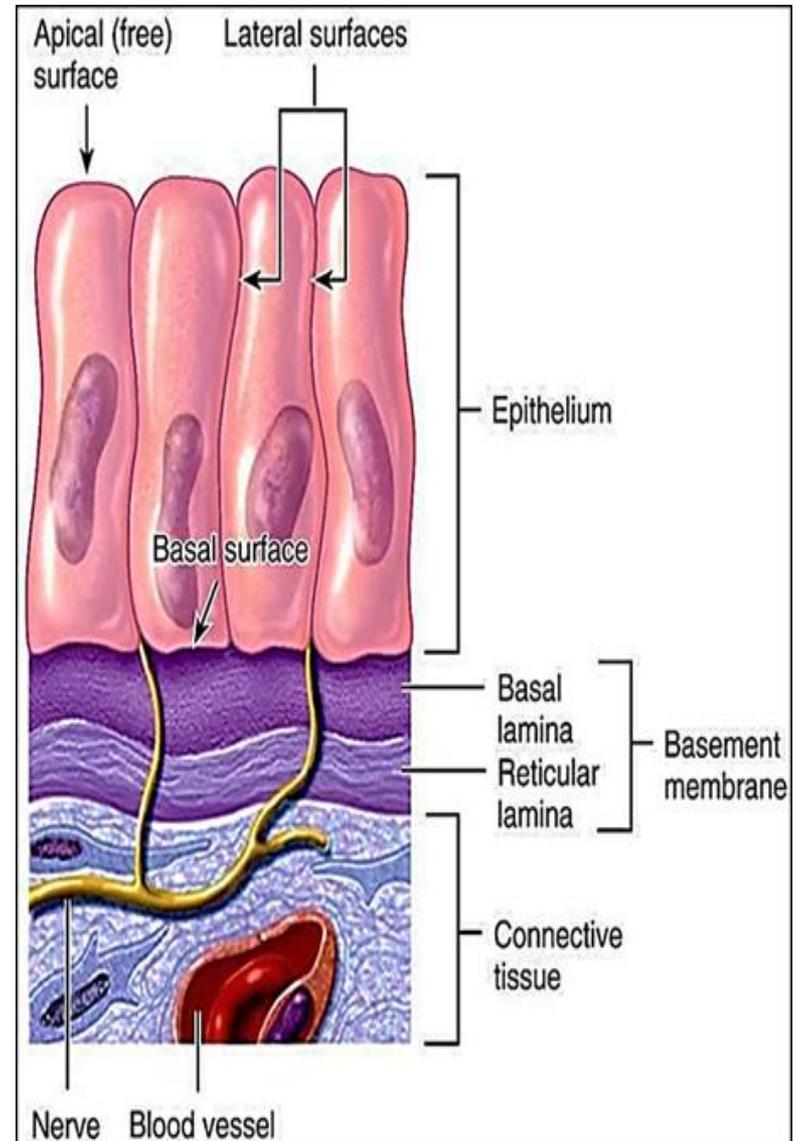


- The basal lamina itself is visible with EM about 20 -100 nm in thickness. secreted by epithelial cells
- Basal lamina consists of 2 layers lamina lucida & lamina densa



- **NB: in diabetes mellitus , the basement membrane of small blood vessels especially in retina & kidney became thick**

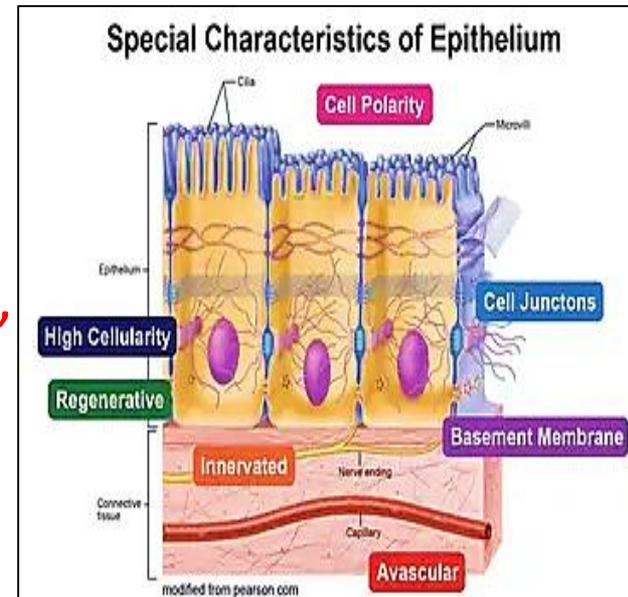
- The main components of basal lamina are: **type IV (4) collagen**
- **The reticular lamina** is formed by reticular fibers, usually thicker than basal lamina, secreted by connective tissue cells (fibroblasts)



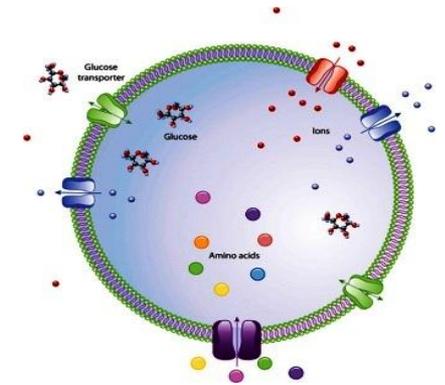
- Epithelia tissue composed of cells laid together in sheet & tightly connected to one another. Epithelial cells are avascular but innervated so it gets its nourishment from the underlying connective tissue

- Function of basement membrane :

- 1- Anchoring epithelial cells to underlying tissue,
- 2- Pathway for cell migration,
- 3- Wound healing,
- 4- Barrier between epithelial cells & CT,
- 5- Participate in filtration of blood in kidney,
- 6- Early stages in cancer called carcinoma in situ ( limited to epithelial layer)



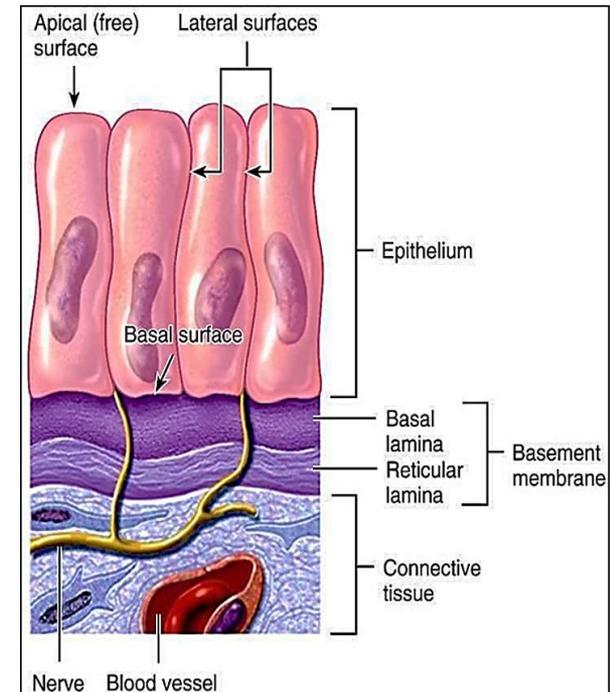
- **Plasma Membrane**: also called **cell membrane** surrounds the cell & separates the interior of the cell from the outside & provides protection for the cell



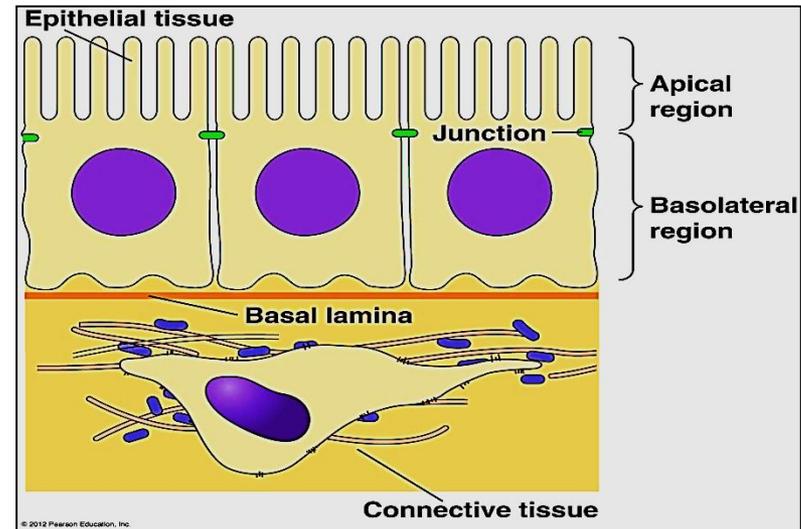
- **Basal Lamina**: thin sheet of ECM which is made by and located underneath the epithelial cells

- **Basement Membrane**: sheet-like form of extra cellular matrix underlie epithelial cells & surround muscle cells

- **Intracellular Matrix**: the substance that fill the inside of the cell = cytoplasm



- ECM amount varies according to tissue type (**minimal** in **epithelium** and **plenty** in **connective tissue**)



ECM consistency varies:

It may be **jelly like** e.g. connective tissue proper

It may be **rubbery** e.g. cartilage

It may be **hard** e.g. bone

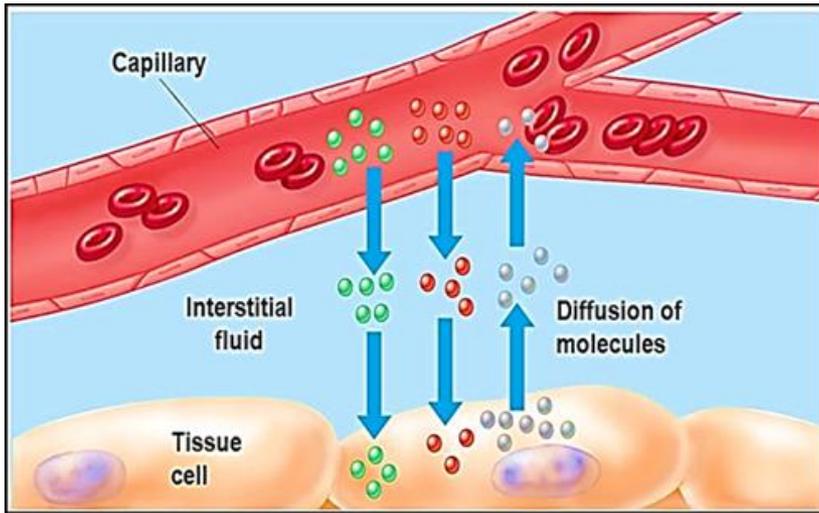
It may be **fluid** e.g. blood

### Functions:

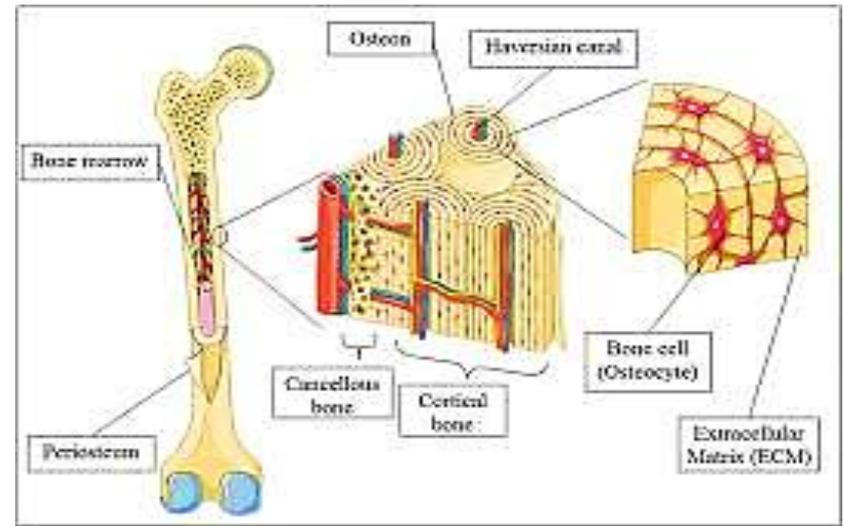
1-Support of cells

2-Supply of nutrition and oxygen, communication

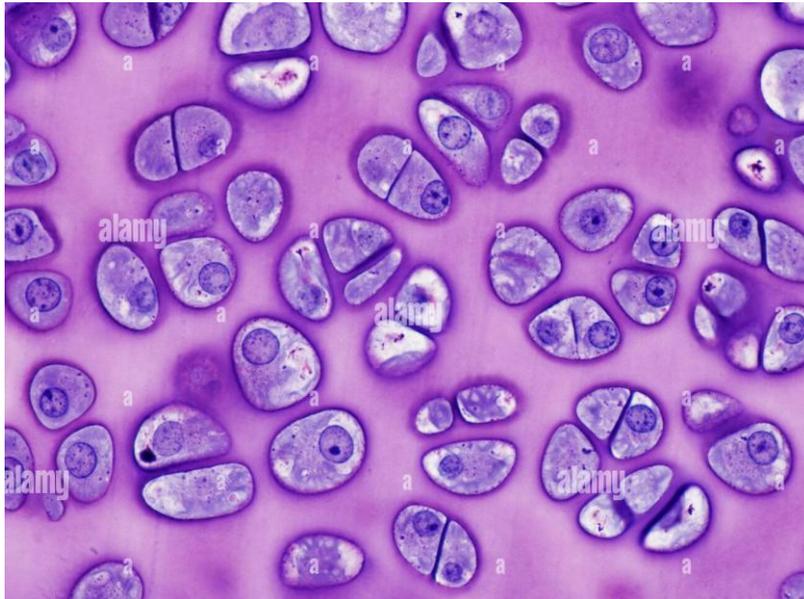
3-Removal of waste products



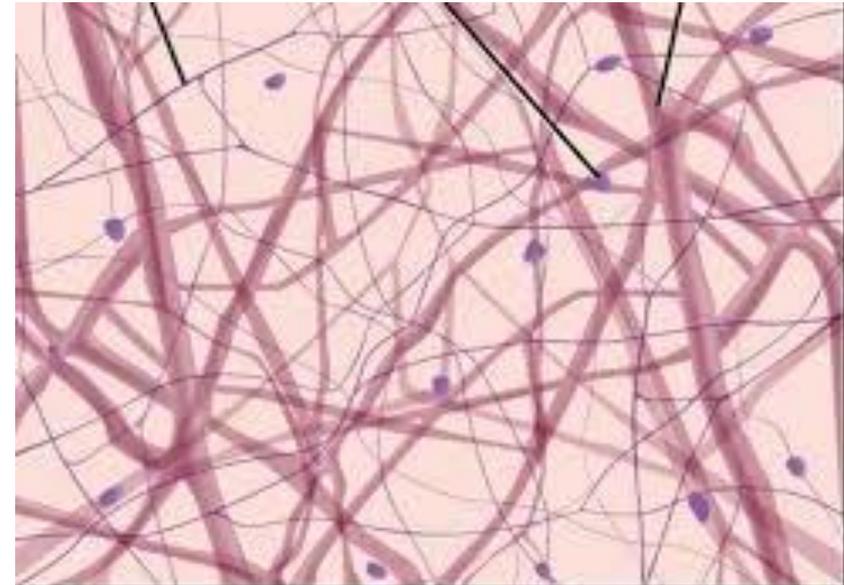
ECM in blood



ECM in bone



ECM in cartilage

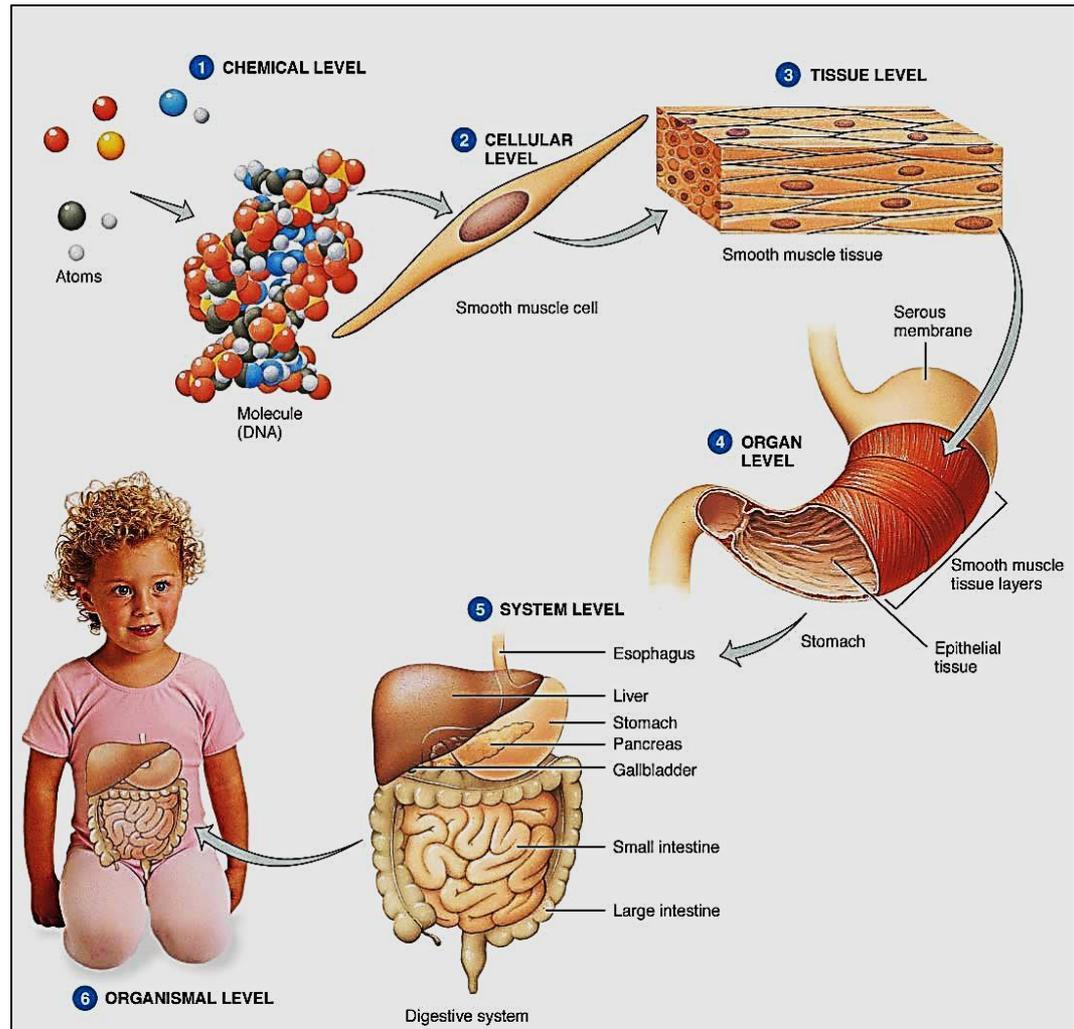


ECM in CT proper

# Organization of the human body

Human body is organized as follow:

1. Cells
- ↓
2. Tissues
- ↓
3. Organs
- ↓
4. Systems

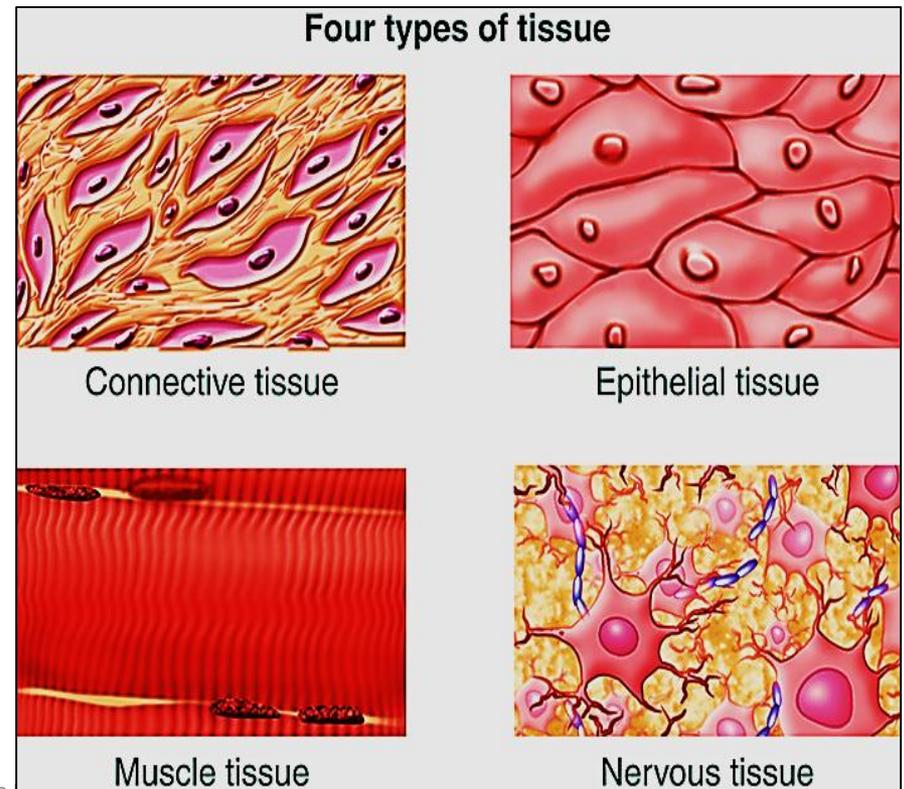


# Tissues

- Each **basic tissue** is formed of special types of cells have the same general features and perform specific functions.

## The four basic tissues are:

1. Epithelial tissue
2. Connective tissue
3. Muscular tissue
4. Nervous tissue



# Organs

Each organ is formed of different kinds of tissues that perform together a special function.

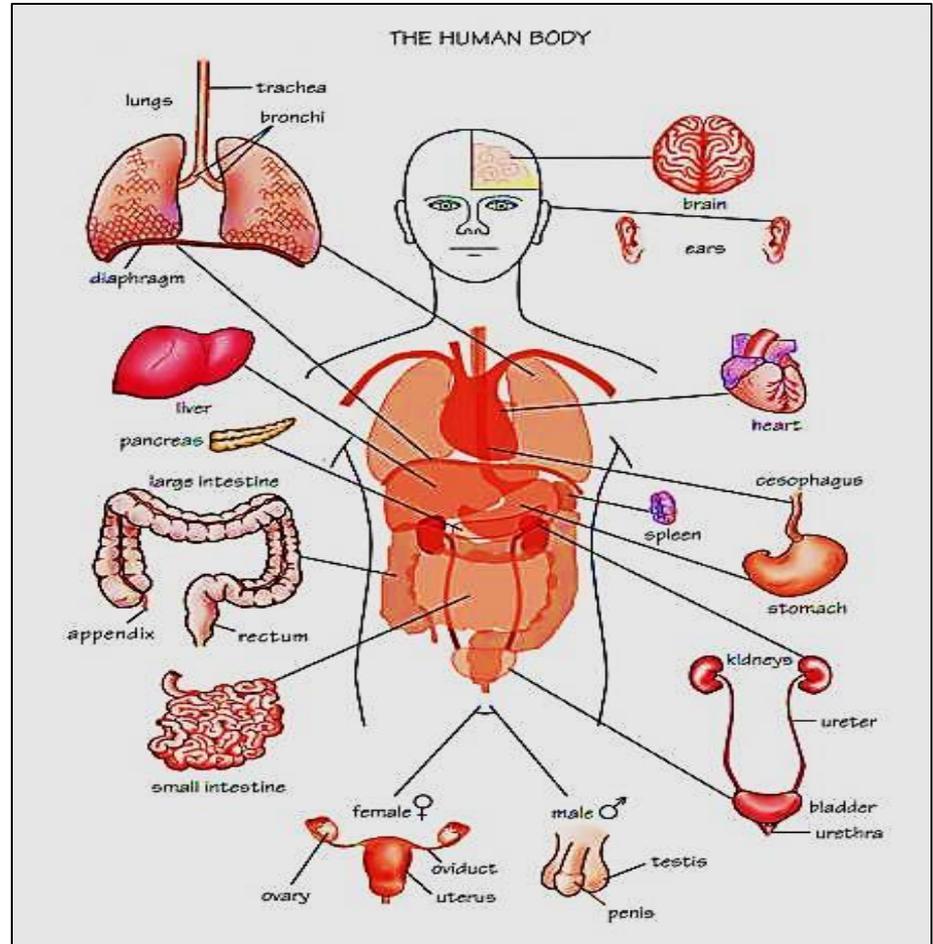
**Examples of organs :**

The kidney

The liver

The lung

The stomach



# Systems

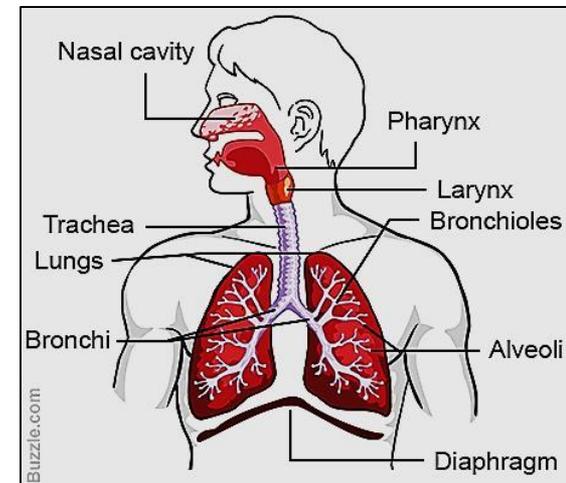
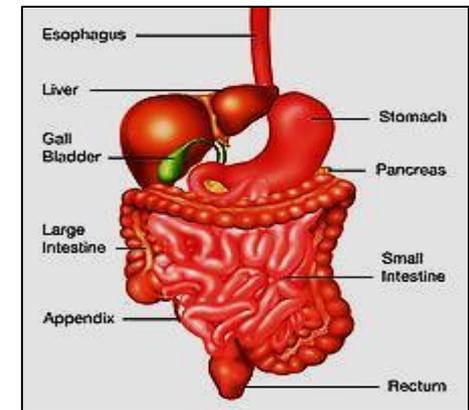
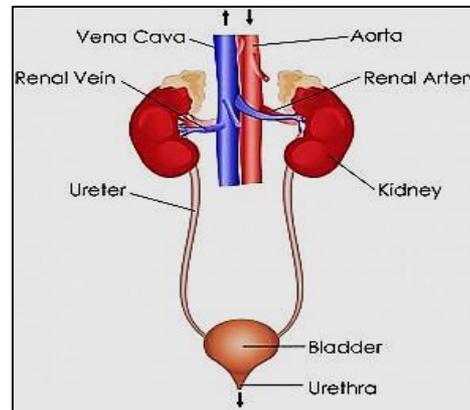
A system is an organization of different organs that together perform integrated complex functions of the body.

## Examples of systems :

The urinary system

The digestive system

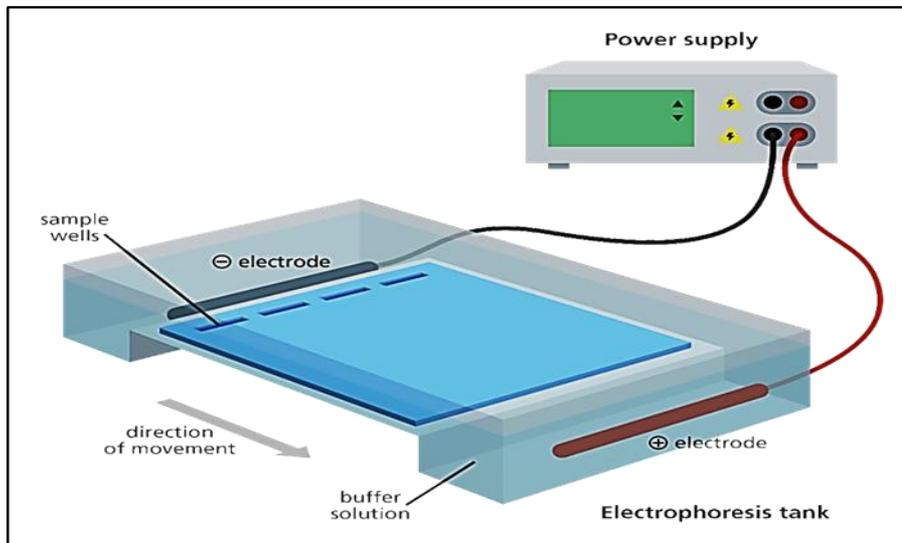
The respiratory system



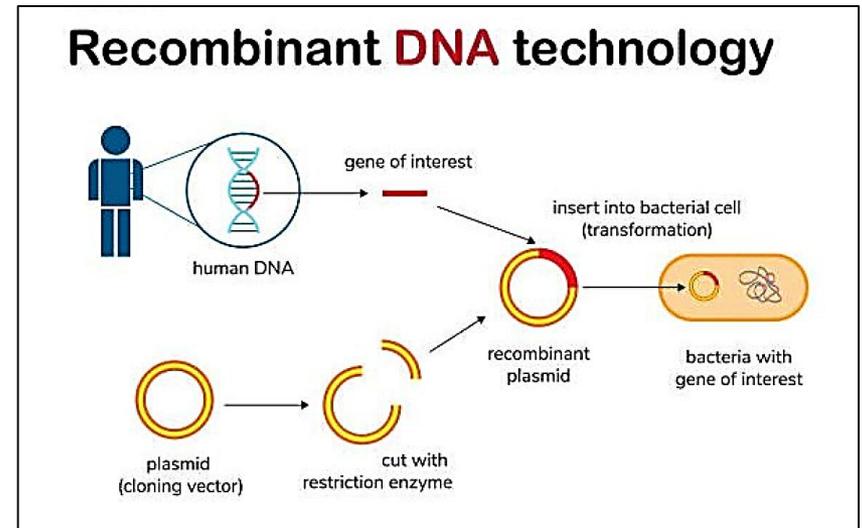
# Methods Of Studying Cell Biology

- **Cell culture**: isolating the cells and make them grow under controlled lab conditions
- **Cell fractionation**: breaking the cells & separating its cellular components ( nuclei, mitochondria) while persevering the individual functions of each component by process called centrifugation
- **Chromatography**: chemical analysis done in the lab for separation of a mixture into its component composed of 2 phases mobile & stationary phase

- **Electrophoresis:** separating of charged molecules using an electrical field ( size & charge)
- **Genetic technology:** study the structure and function of genes ( Isolating gene, copy genes = cloning, determine unknown DNA sequence



**Gel electrophoresis**



**recombinant DNA technology**

# Microscopy

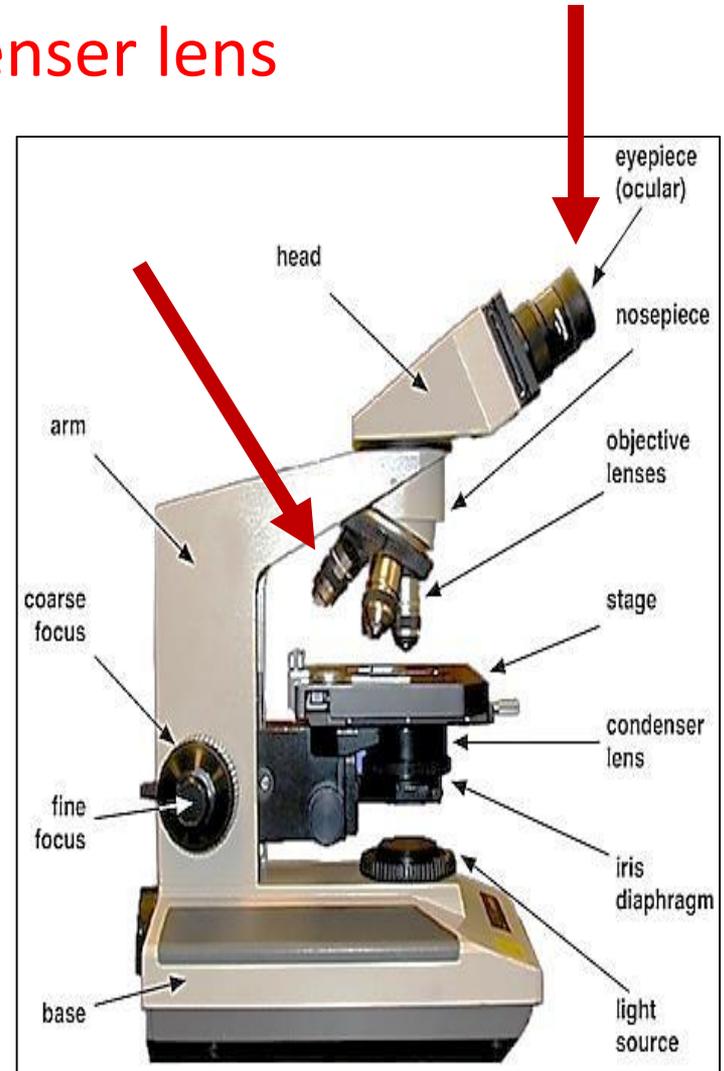
Is the standard optical instrument for generating magnified image & to examination of histological

## Types:

1. Light microscope (LM)
2. Electron microscope (Transmission and scanning)
3. Phase contrast microscope
4. Differential interference microscope
5. Fluorescence microscope
6. Confocal microscope

# 1- Light microscopy (LM)

- The widely used microscope
- LM uses visible **light source** + **condenser lens** (to send light through the object).
- The image of this object is magnified by two sets of lenses:
  1. **Ocular lens** (10)
  2. **Objective lenses** (5 ,10 , 40)
- Total magnification power =  $1 \times 2$   
e.g.  $10 \times 40 = 400X$  times



• The capacity of microscopes depends on:

1. **Magnification power**: the power to enlarge objects .

2. **The resolution power** : is the smallest distance between two particles that can still be seen by eye or camera as two separate objects & not as a single object ( done by : lenses)

The magnification valuable only when accompanied by high resolution.

• The resolution power of:

1. Healthy naked eye = 0.2 millimeter

2. L M = 0.2 micrometer (um)

3. EM = 0.2 nanometer (nm)

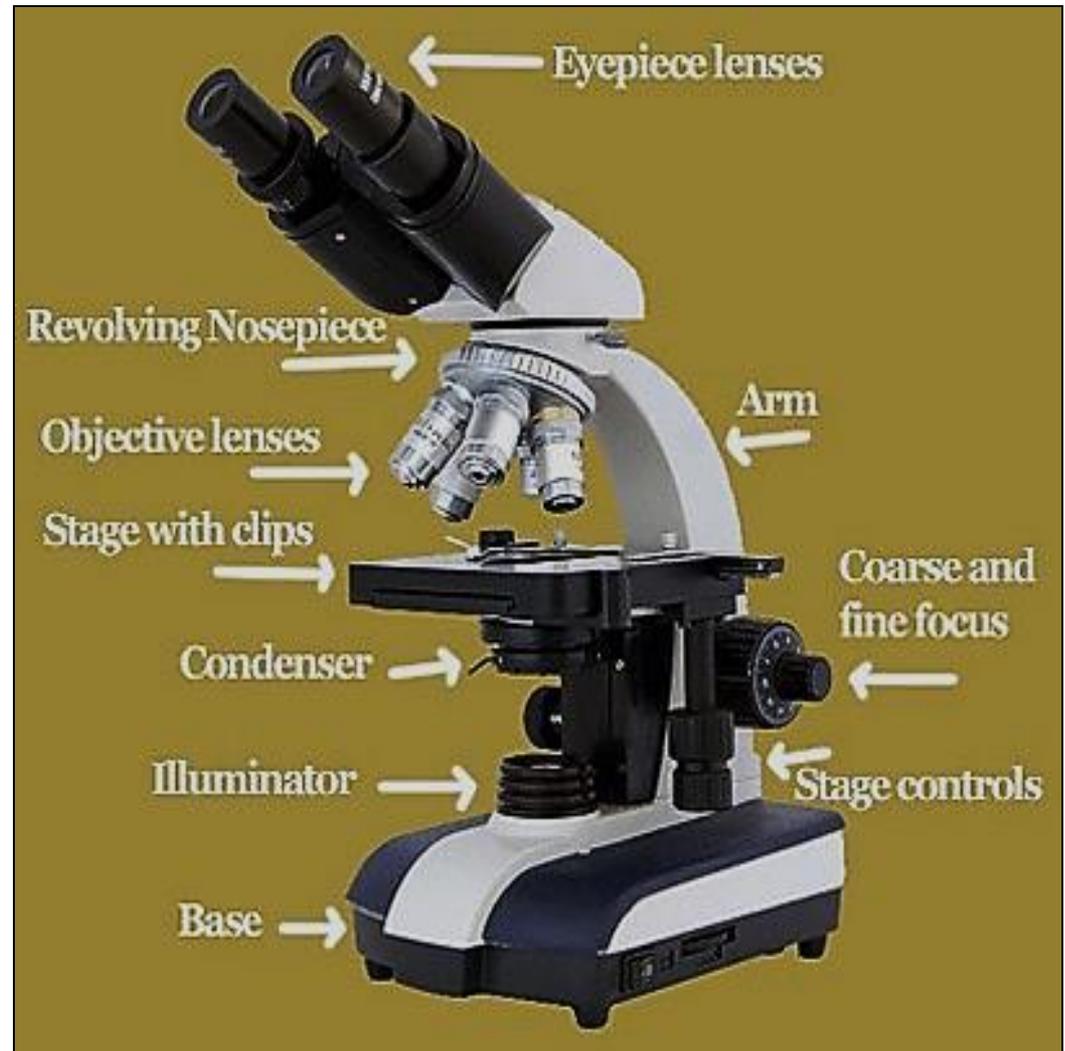
## Equivalent lengths:

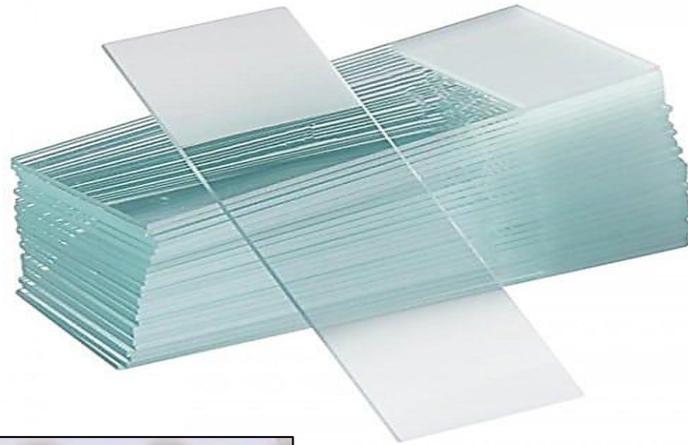
1 millimeter (mm) = 1000 micrometer (micron)

1 micrometer (um)= 1000 nanometer

1 nanometer(nm)= 10 angstrom

## Binocular light microscopy





Glass Slides Stained with H& E for light microscope

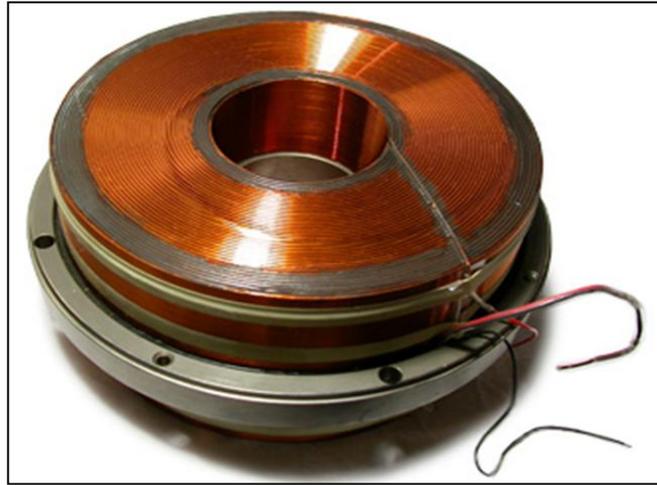
## 2- The Electron Microscope (EM)

- Technique is used to obtain high resolution images
- **Beam of electrons** is used as source of light
- The image is formed from the interaction of the electrons with the specimen as the beam travelling through it
- Beam passes through a vacuum tube
- The lenses are electromagnetic coils instead of glass lenses



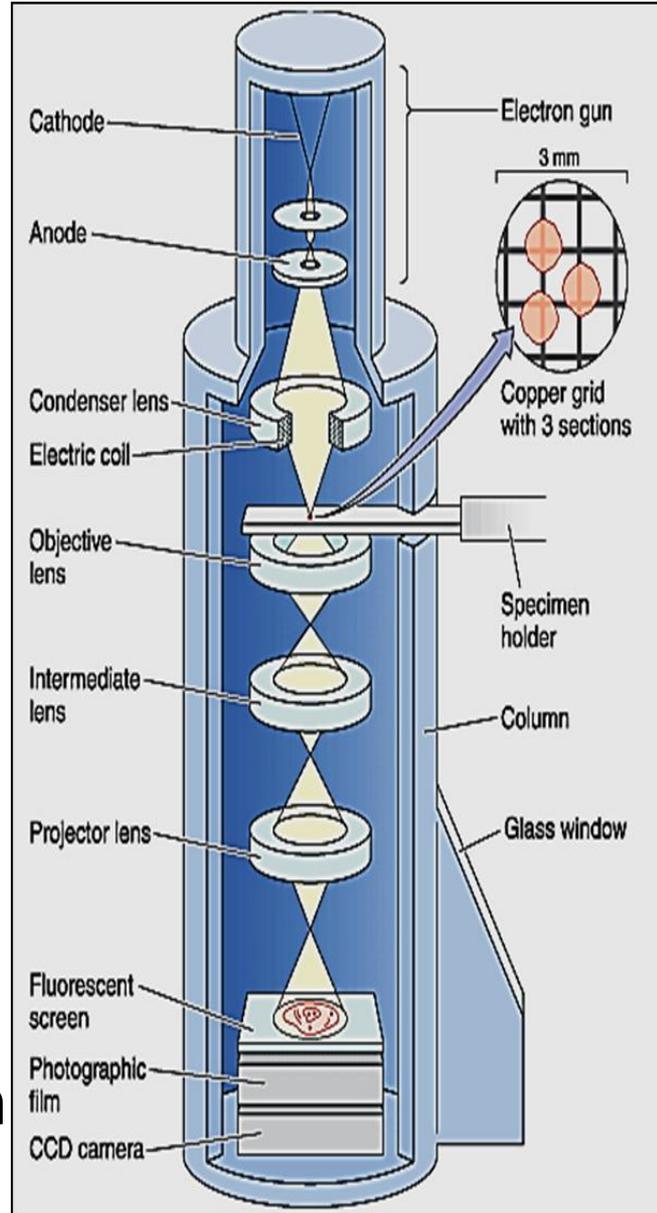
- The lenses are electromagnetic coils instead of glass lenses

Electromagnetic lens



Illuminating system consists of:  
Consists of: electron gun & condenser lens

- Condenser lens is capable of generating circular magnetic field that act to focus electrons on the specimen

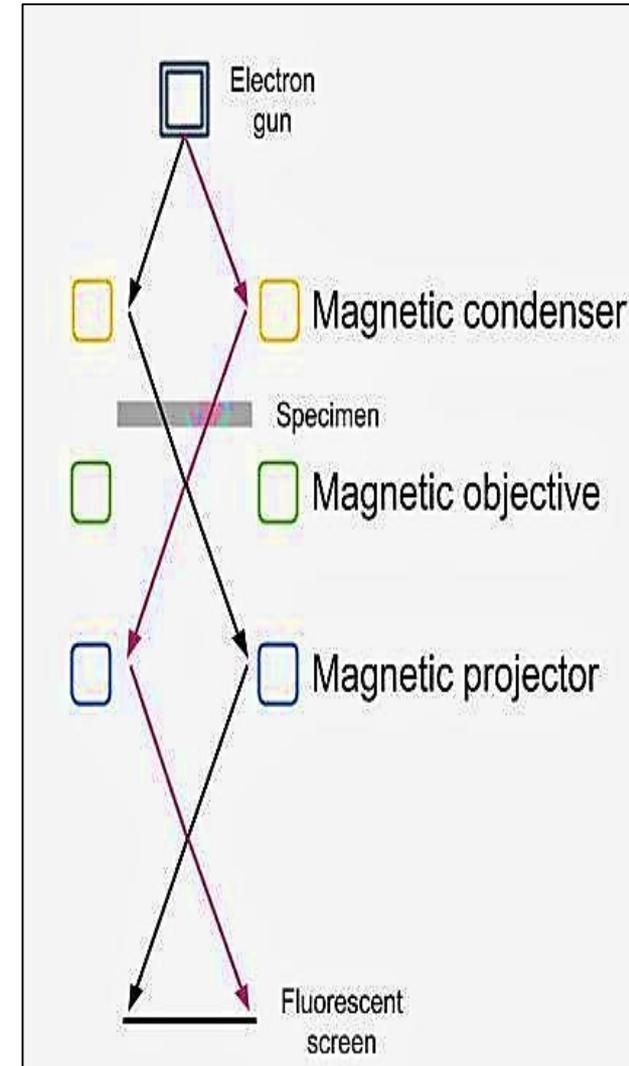


## Imaging system consists of :

**A-** Another electromagnetic lenses (2-3)

**B-** Screen

- The objective lens is used to refocusing the electrons after they pass through the specimen & form image
- The projector lens is to enlarge the image of the object and projecting it into the fluorescent screen



- The image appears on screen plate which glows when being hit by electrons

- Images can be detected as:  
Light areas (**electron lucent**) &  
dark areas (**electron dense**)  
Corresponding to areas through  
which electrons readily passed



The tissues and cells need special preparation & then cut into very thin sections

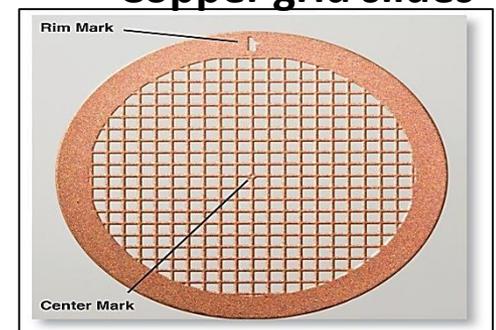
(**ultra thin sections** = 0.01 of the micron)

Then collected on a copper metal grid



Embedding in resin

Copper grid slides

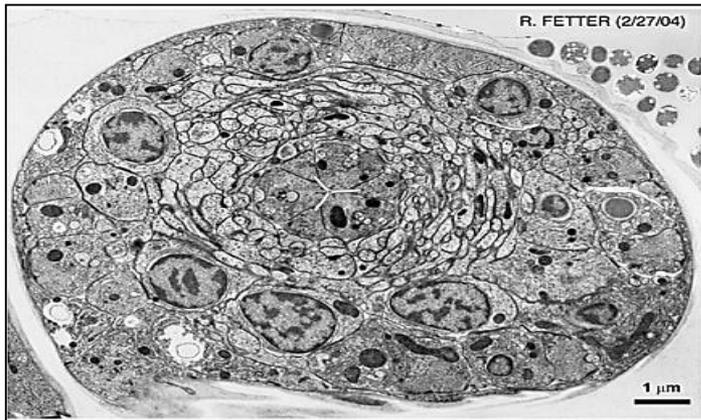


- During preparation sections are stained with salts of heavy metals like **lead nitrate** and **uranyl acetate** that precipitate in tissues.
- EM can magnify the image thousands of times (up to 200.000 times).
- The resolution power = 0.2 nanometer(nm)
- For permanent records, **photos are made**

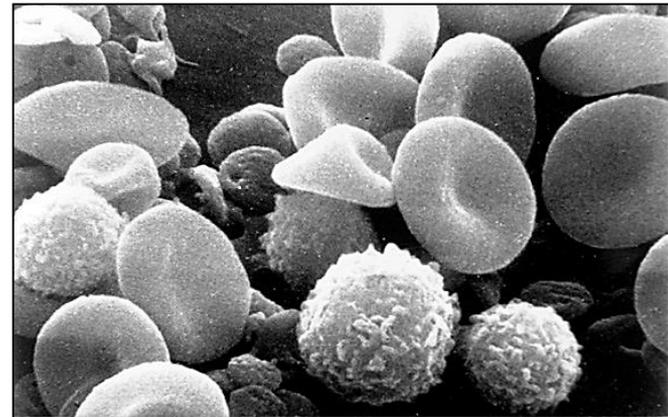
# Types of EM

• **Transmission EM (TEM)** : where electron beams pass through the specimen. It shows the details of internal structures of cells. **Resolution power: 0.2 nanometer**

TEM



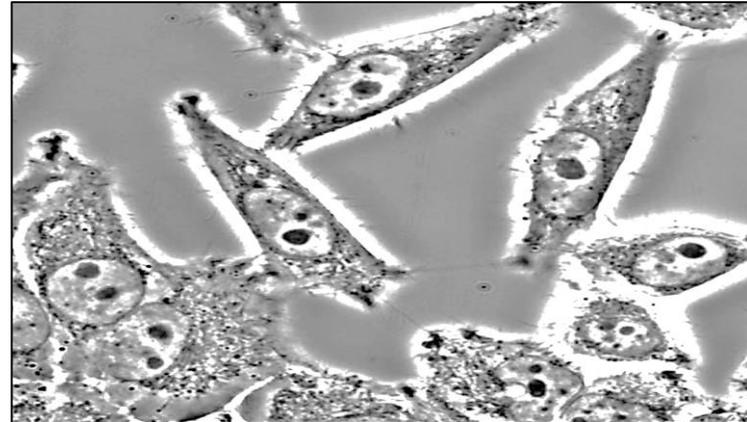
SEM



• **Scanning EM (SEM)** : a special type of EM where electron beams are reflected from the surface of coated specimen. This gives a three dimensional image of a specimen. **Resolution power: 10 nanometer**

# 3-Phase contrast microscope

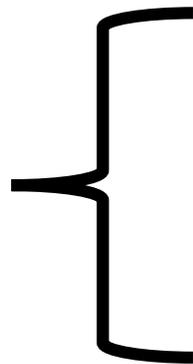
- It depends on the idea that some lens systems can produce visible images from **transparent objects (unstained)**.
- The principal is that light changes speed when passes through cellular and extracellular structures & with different refractive indices.
- Objects appear lighter or darker to each others.
- It is useful in examining **living cells & tissue cultures e.g. blood cells and sperms**



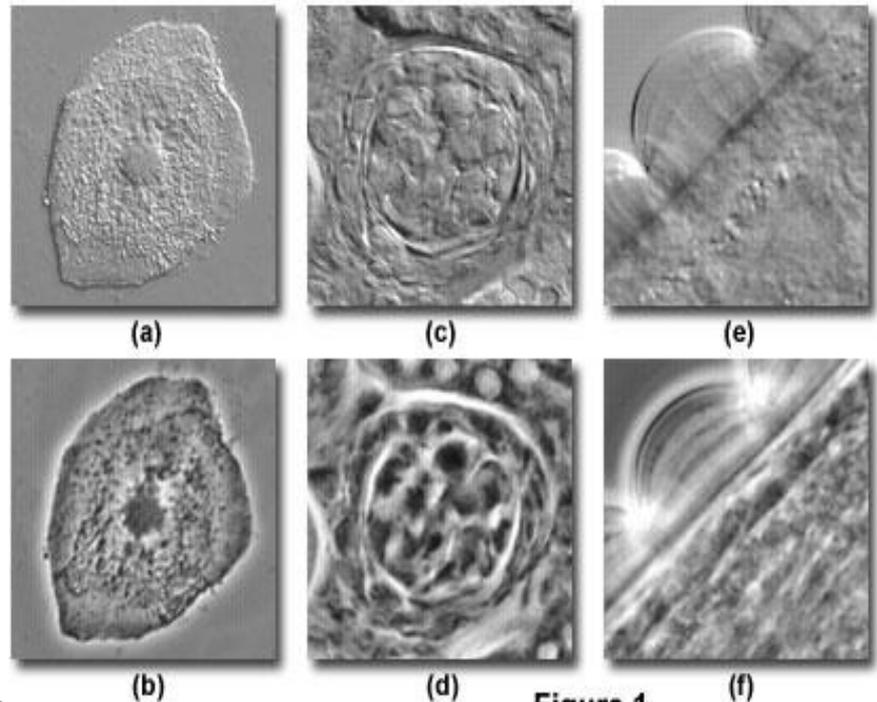
## 4- Differential interference contrast microscope

- is advanced version of phase contrast microscope ( **used for transparent or unstained, live samples**).
- The obtained image appears **3D- like-appearance gives depth & texture perceptions**
- It utilizes **two separate beams of polarized light**.

Phase contrast  
microscopy



Transparent Specimens in Phase Contrast and DIC

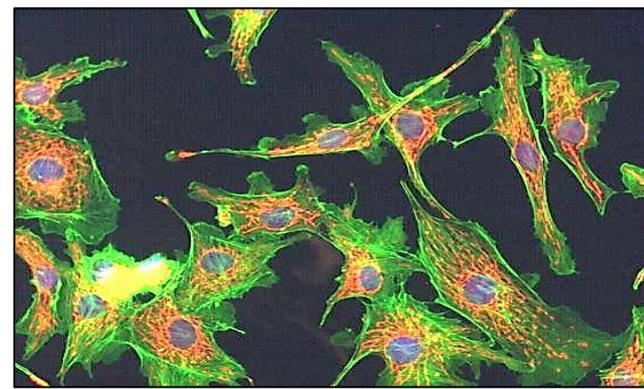


Prof Di

Figure 1

# 5- Fluorescence Microscopy

- Certain substances absorb invisible ultraviolet light of short wavelength
- and emit (reflect) it as visible light of long wavelength and are known to exhibit **fluorescence** (physical property).
- This microscope is provided with **special lamp** that can **emit ultraviolet rays** which pass through the tissue.
- It can be used to **visualize DNA, RNA, proteins and antigen antibody complex (antibodies labeled with fluorescence)**



## 6- Confocal Laser Microscope (3D)

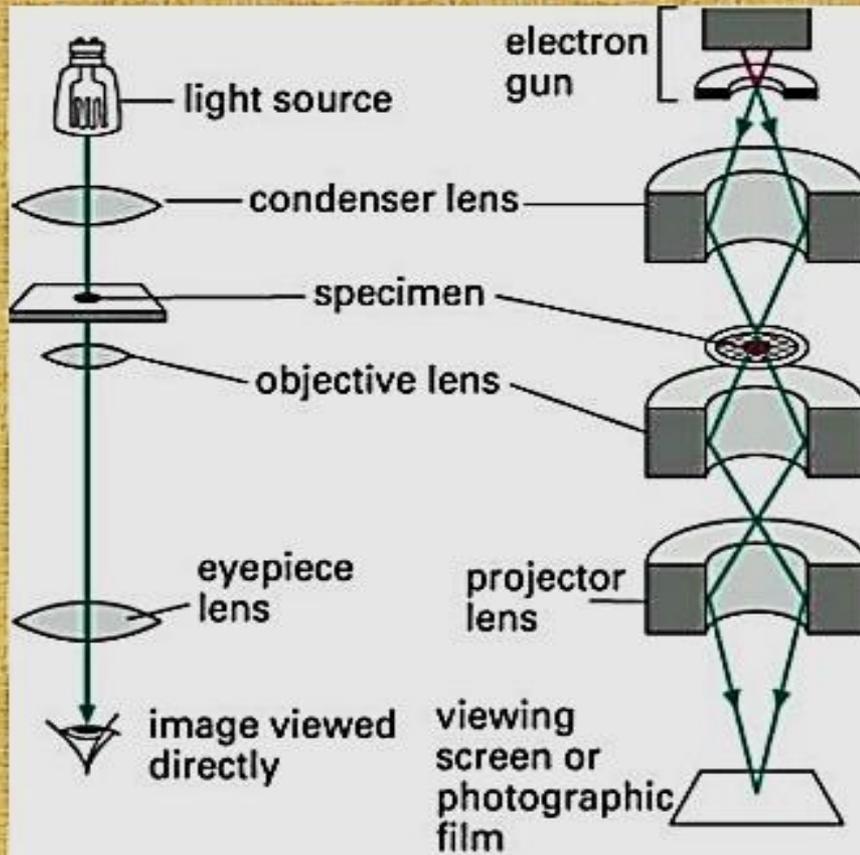
- \* The illumination is provided by a **laser source**.
- The specimen should be **labeled by fluorescent** molecules
- Uses: increase optical resolution and contrast (better image)
- The **LASER** light passes **through a small hole (to avoid photo bleaching) to examine fine details**
- It is connected to a computer system to reconstruct full image of the specimen



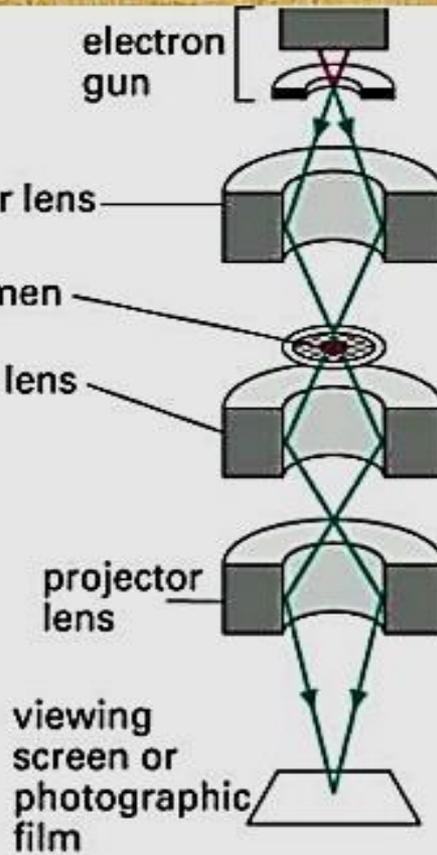
# LM & EM



## LM



## EM



# Thank you

