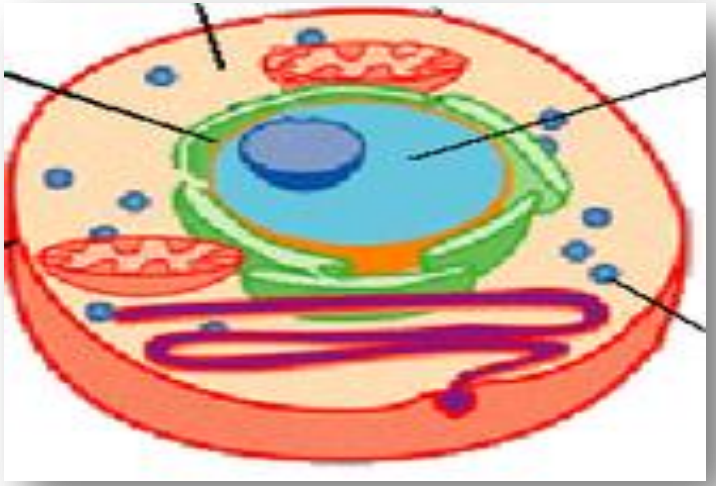
Practical cytology
3rd Level



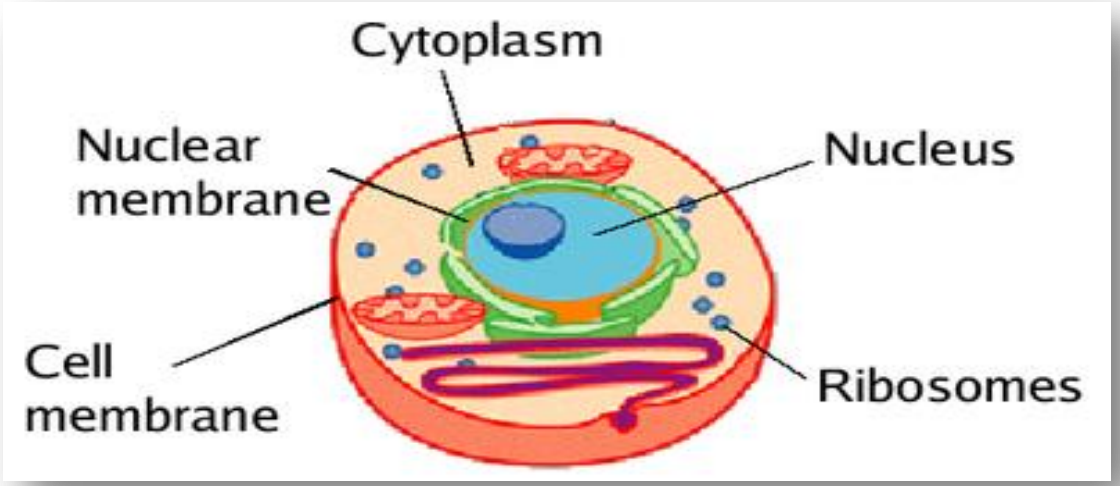
TOPICS	
Lab 1	Cytology
Lab 2	Structure of cell (cell wall)
Lab 3	Plasma membrane
Lab 4	Cytoplasm (Ribosomes , cytoskeleton)
Lab 5	Endoplasmic Reticulum
Lab 6	Golgi apparatus
Lab 7	Mitochondria
Lab 8	Plastids
Lab 9	Nucleus

Lab 1

Cytology

Cytology

Is that branch of life science that deals with the study of cells in terms of structure, function and chemistry.



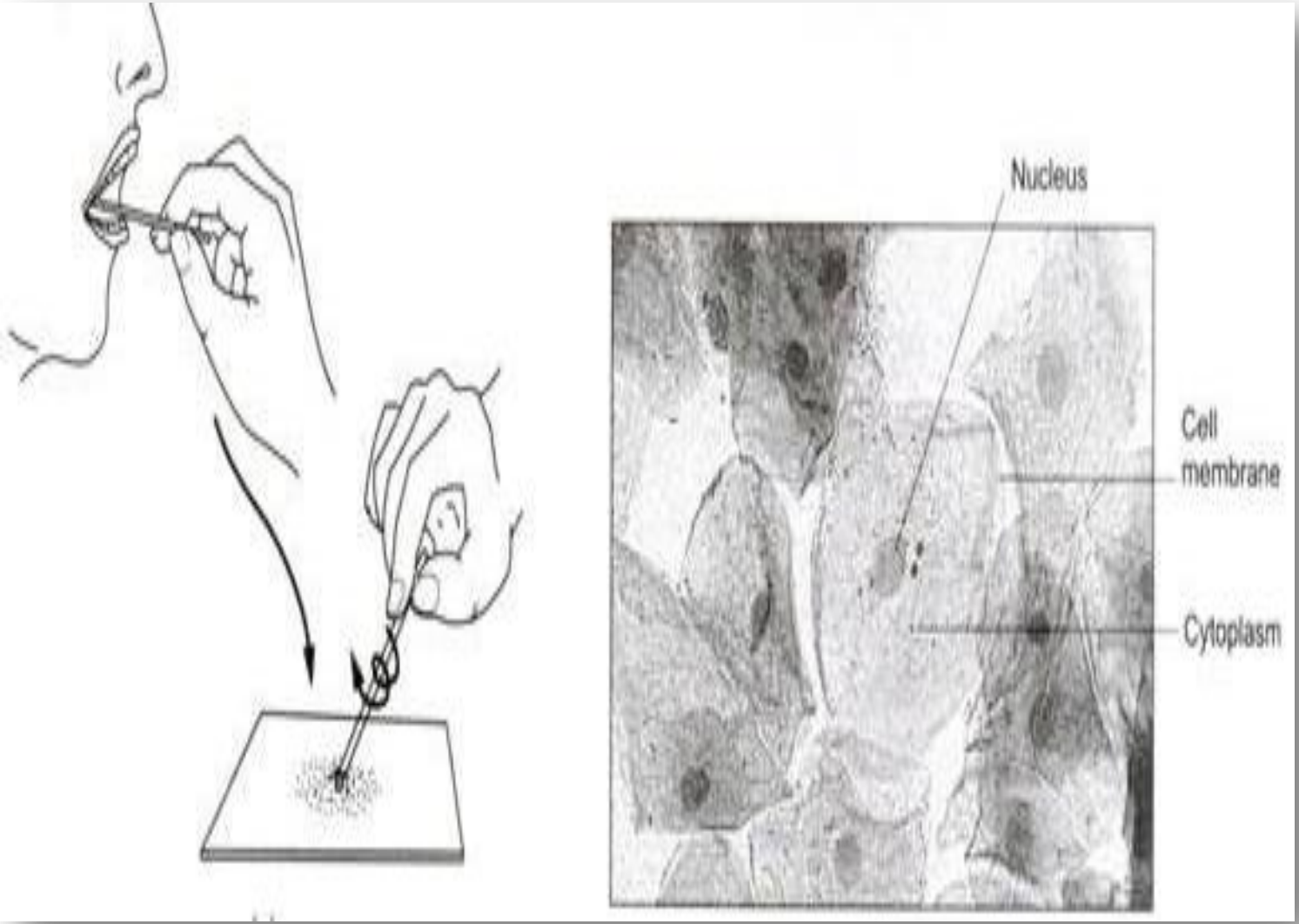
Electron Microscope	Light Microscope
source is beam of electrons.	source is light.
It is very large and complicated.	Microscope is small and handy
It has a cooling system to take out heat generated by high voltage electric current.	There is no cooling system.
magnification (up to 2 million times)	Magnification only up to 1000-2000 times.
using electromagnets	Use glass lenses
Specimen is coated with heavy metals in order to reflect electrons.	Specimen is stained by colored dyes.
Image is black and white.	Image is colored

	Animal Cell	Plant Cell
Cell wall	Absent	Present (formed of cellulose)
Shape	Round (irregular shape)	Rectangular (fixed shape)
Vacuole	One or more small vacuoles (much smaller than plant cells).	One, large central vacuole taking up 90% of cell volume.
Centrioles	Present in all animal cells	Only present in lower plant forms.
Chloroplast	Animal cells don't have chloroplasts	Plant cells have chloroplasts because they make their own food
Plastids	Absent	Present
Plasma Membrane	only cell membrane	cell wall and a cell membrane
Lysosomes	Lysosomes occur in cytoplasm.	Lysosomes usually not evident.
Cilia	Present	It is very rare

Preparation of temporary slides (animal epithelial cell)

Methods

1. Take a clean cotton swab and gently scrape the inside of your mouth.
2. Smear the cotton swab on the center of the microscope slide for 2 to 3 second
3. Add a drop of methylene blue solution and place a cover slip on top Remove any excess solution
4. Place the slide on the microscope with 4X or 10X objective in position and find a cell. 5.Then view at higher magnification.



Preparation of temporary slides (animal epithelial cell)

Lab 2

Cell Structure

Eukaryotic cell consists of the following components:

A. Cell wall and plasma membrane.

B. Cytoplasm.

C. Nucleus.

Cell Wall

- The outer structure of most plant cells is a dead and solid layer.
- It is composed of carbohydrates such as cellulose, pectin, hemicellulose ,lignin and waxes.
- There is a pectin-rich cementing substance between the walls of adjacent cells which is called middle lamella.
- The cell wall which is formed directly after the division of cell, called primary cell wall (composed of pectin, hemicellulose and loose network of cellulose micro fibrils)

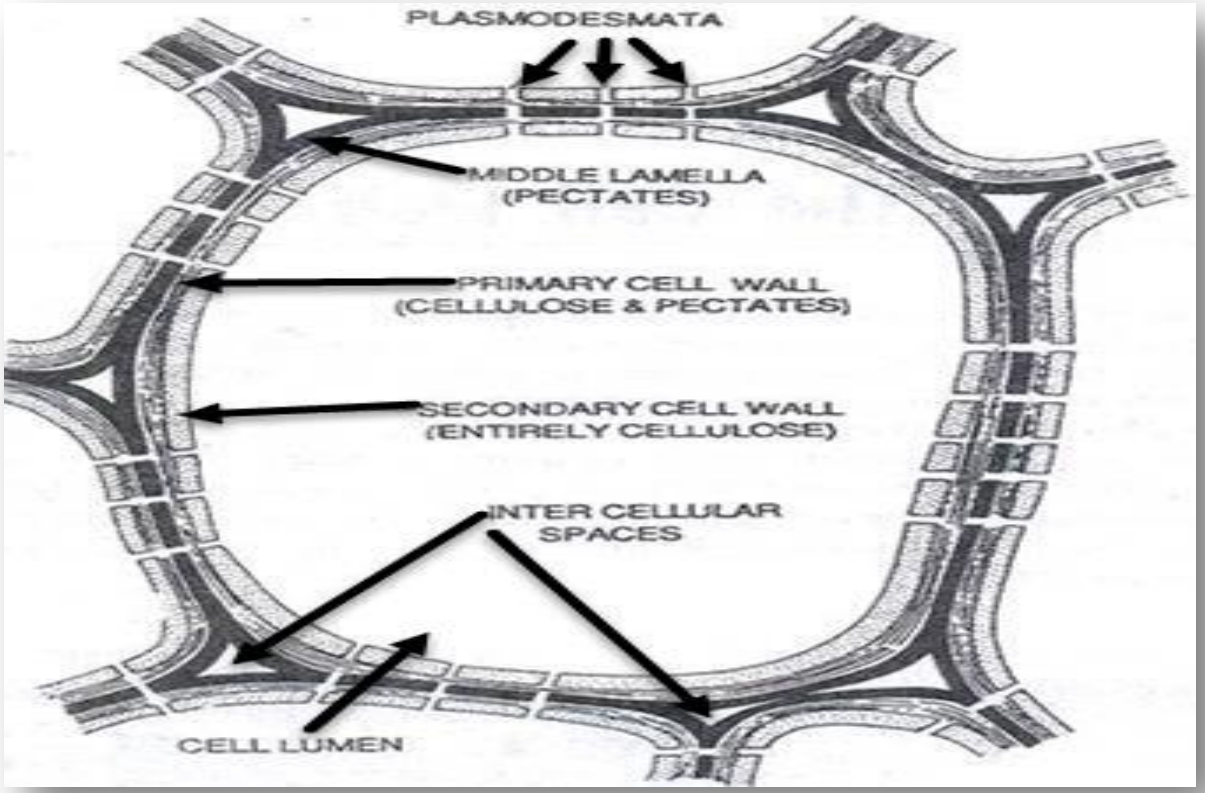
- **In certain types of cells such as phloem and xylem, the layer is added to the inner surface of the primary cell wall at a later stage. This layer is called secondary cell wall and it consists of cellulose, hemi cellulose and lignin.**
- **In many plant cells, there are tunnels through the cell wall called plasmodesmata which allow communication with the other cells in a tissue.**

Function:

1. provides protection

2. mechanical support to the plant cell

3. determines the shape of plant cell.



structure of cell wall

Lab 3

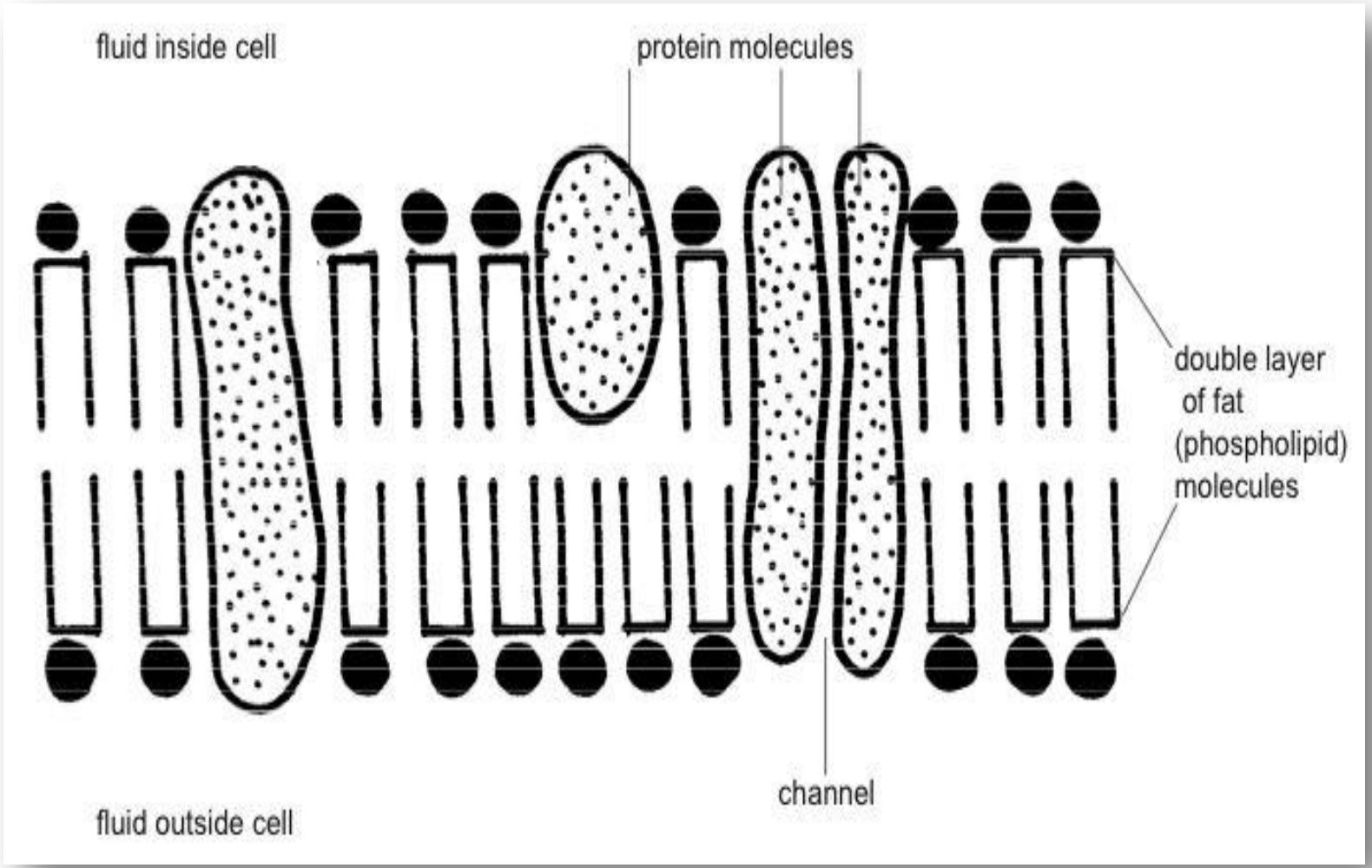
plasma membrane

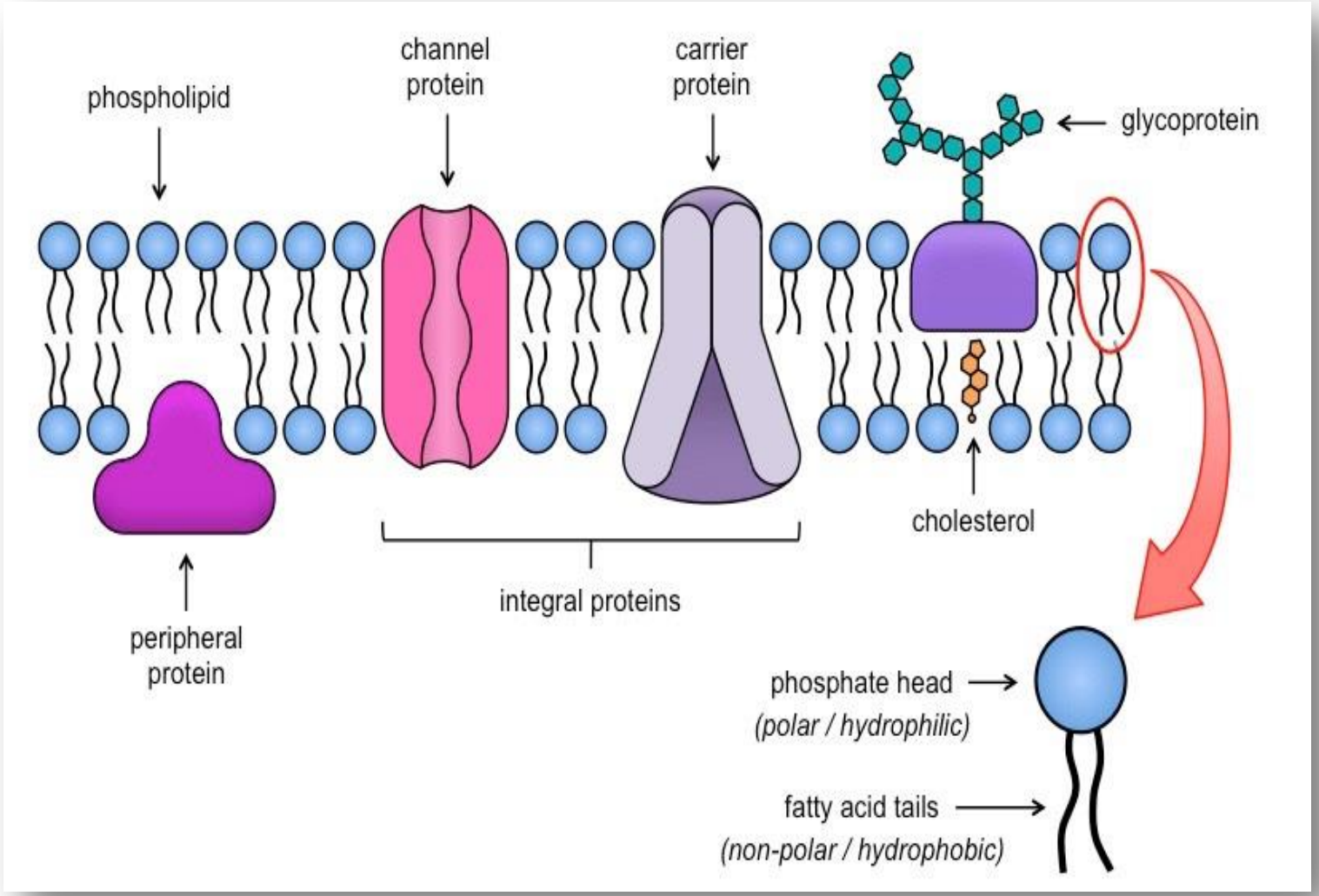
The Plasma membrane:

- **defines as the outer boundary of each cell, isolate it from environment condition, be the selective permeability which nutrients are allowed into and out of the cell.**
- **The plasma membrane is made of molecules called phospholipids, each of which has a hydrophilic (water-loving) head and hydrophobic (water-hating) tails.**

Plasma membranes often contain specific proteins:

A. **Integral proteins: these proteins embedded within the lipid bilayer. Some integral proteins (such as cell surface markers) emerge from only one side of the membrane, while others (such as receptor proteins and transport proteins) extend across the plasma membrane.**
B. **Peripheral proteins: such as the enzyme emerge from only one side of the membrane and are not embedded in the lipid bilayer.**


fluid inside cell
protein molecules
double layer
of fat
(phospholipid)
molecules
channel
fluid outside cell


phospholipid
channel protein
carrier protein
glycoprotein
cholesterol
peripheral protein
integral proteins
phosphate head
(polar / hydrophilic)
fatty acid tails
(non-polar / hydrophobic)

Function of plasma membrane:

1.The plasma membrane as a selectively permeable barrier, preventing some substances from crossing while allow other substances to enter and leave the cell.

2.As the cell's boundary with the outside environment.

Lab 4

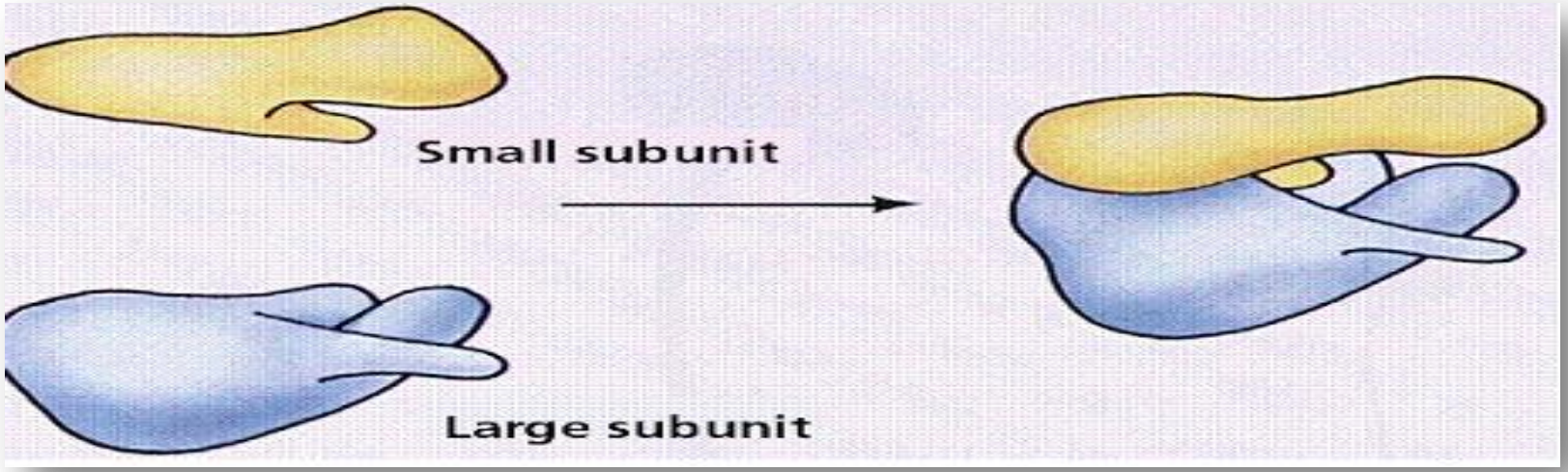
Cytoplasm

Types of organelles

1. **Non-Membranous-bound organelles (Ribosomes , cytoskeleton).**
2. **Membrane-bound organelles (Endoplasmic reticulum, Golgi apparatus , mitochondria , plastid , peroxisomes).**

Ribosome

- **The ribosome is a large and complex molecule, found within all living cells, the site of biological protein synthesis (translation).**
- **Ribosomes consist of two major components: the small subunit, which reads the RNA, and the large subunit, which joins amino acids to form a polypeptide chain.**



- **Prokaryotes have 70S ribosomes, each consisting of a small (30S) and a large (50S) subunit while Eukaryotes have 80S ribosomes, each consisting of a small (40S) and large (60S) subunit.**

Cytoskeleton

The cytoskeleton is a complex network of (filaments) and (tubules) that extend throughout the cytoplasm from the nucleus to the plasma membrane.

Function of Cytoskeleton:

1. Give mechanical support to the cell.

2. Maintain its shape.

Components of cytoskeleton (including human and all animal cells) :

1. Microtubule ---protein subunits(Tubulin).

---Function:

a. Cell motility as in cilia or flagella.

b. chromosome movement in cell division.

c. organelles movements.

2. Microfilament---protein subunits(Actin).

--- Function:

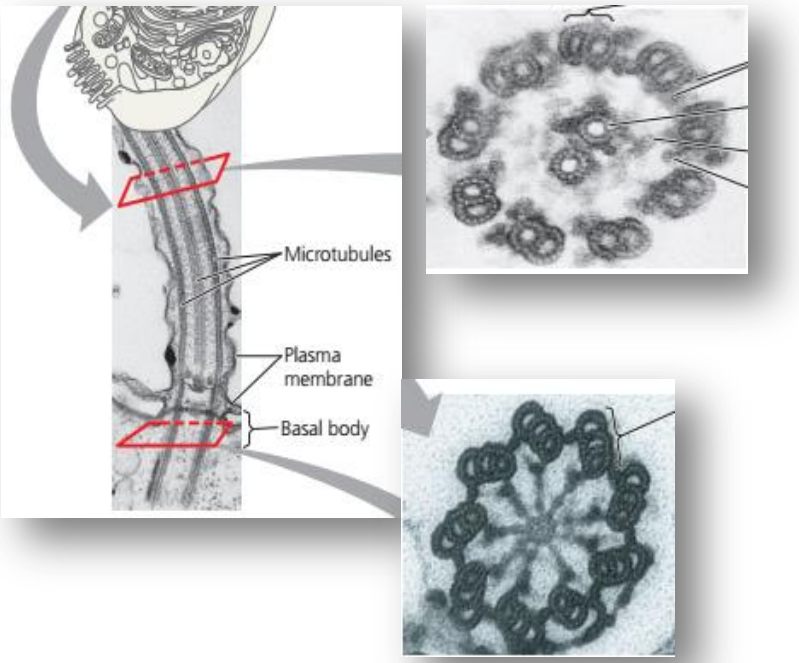
a. muscle contraction.

b. division of animal cells.

3. Intermediate filaments---protein subunits(different proteins such as keratins).

---Function:

formation of nuclear lamina.



A. Across section through cilium(9 +2)

The outer microtubule doublets are held together with the two central microtubules by flexible cross-linking proteins.

B. Across section through basal body(9+0)

The two central microtubules are not present because they terminate above The basal body (TEM).

Lab 5

Membrane-bound Organelles
Endoplasmic Reticulum

The endoplasmic reticulum (ER)

- **is a system of membranous tubes and sacs called cisternae ,is continuous with the outer membrane of the nuclear envelope.**
- **The amount of ER inside a cell mutable, depending on the cell's activity.**
- **There are two types of ER: rough and smooth.**

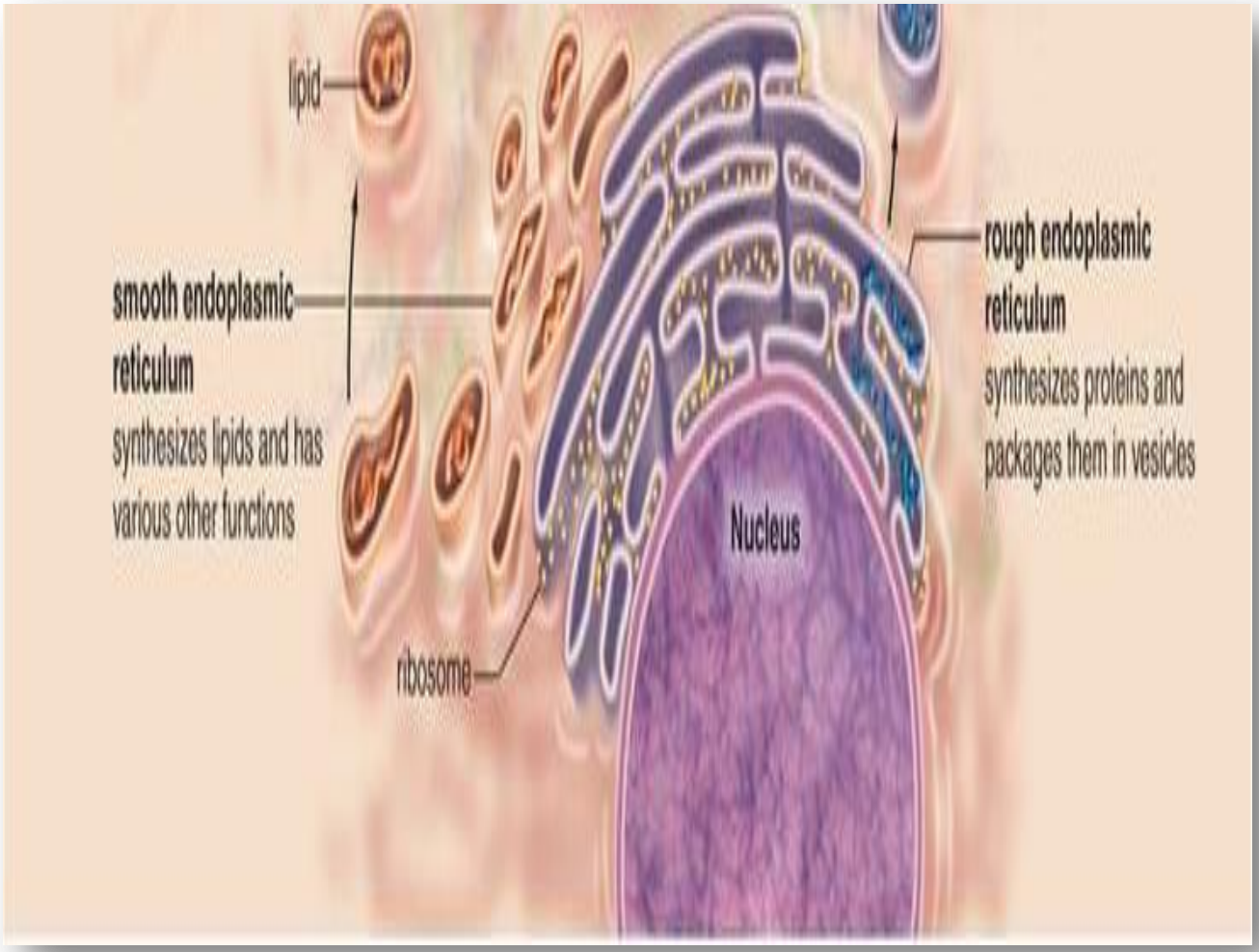
- **Rough Endoplasmic Reticulum**

The rough endoplasmic reticulum is a system of flattened sacs covered with ribosomes. The rough ER produces proteins. Certain types of proteins are made on the rough ER. These proteins are later exported from the cell or inserted into one of the cell's own membranes.

Rough ER is most numerous in cells that produce large amounts of protein for export, such as cells in digestive glands and antibody-producing cells

- **Smooth Endoplasmic Reticulum**

The smooth ER lacks ribosomes.


lipid
smooth endoplasmic reticulum
synthesizes lipids and has various other functions
rough endoplasmic reticulum
synthesizes proteins and packages them in vesicles
Nucleus
ribosome

Function of Endoplasmic Reticulum:

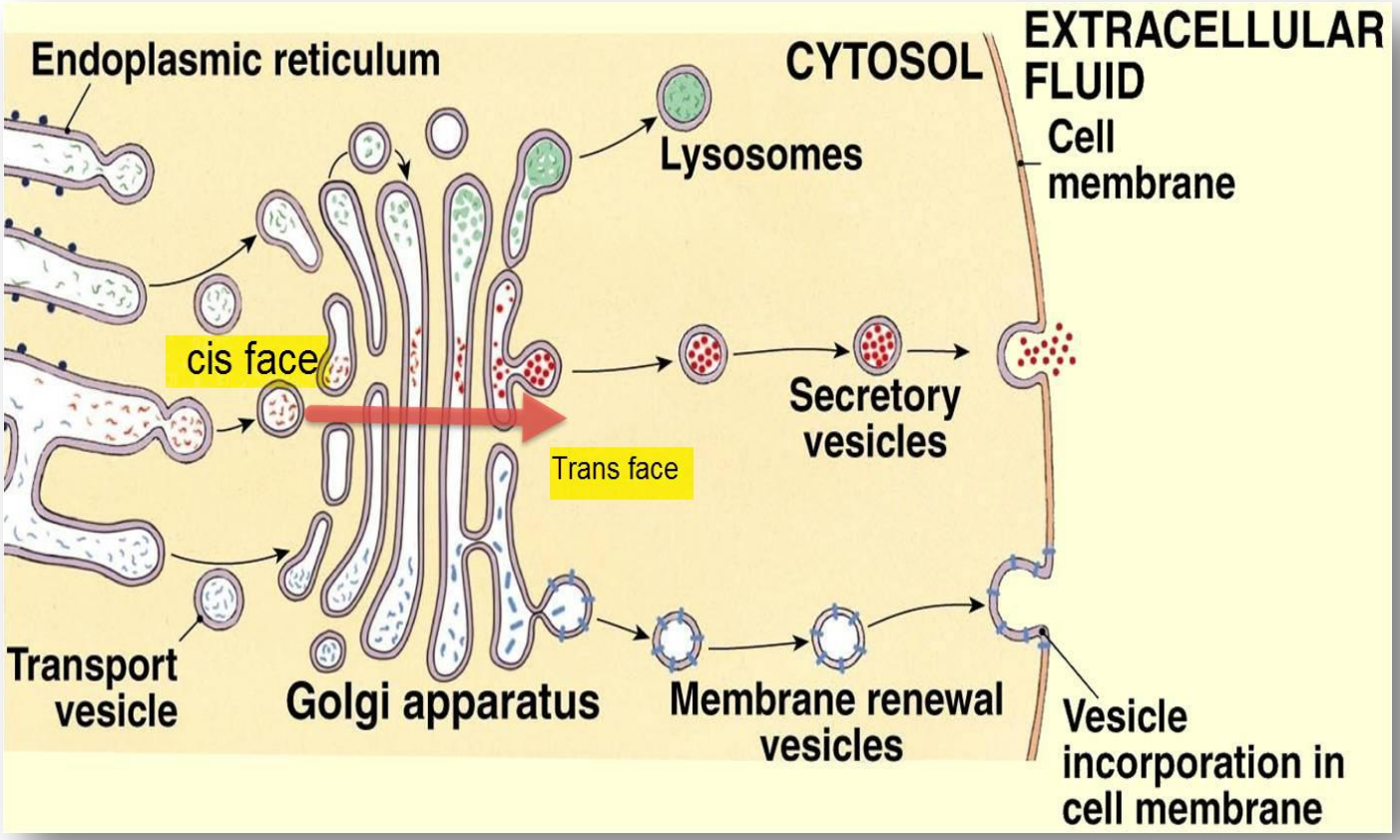
1. **produce lipids such as cholesterol.**
2. **In the ovaries and testes produces the steroid hormones estrogen and testosterone.**
3. **In skeletal and heart muscle cells releases calcium which stimulates contraction.**
4. **In liver and kidney cells, it helps detoxify drugs and poisons.**

Lab 6

Golgi apparatus

Golgi apparatus:

- **the Golgi apparatus is another system of flattened, membranous sacs**
- **the Golgi has two sides of a stack: the *cis* face (directed toward the ER) and the *trans* face (directed toward the plasma membrane.**
- **The Golgi bodies receives protein or lipid filled vesicles that bud from the ER. It is contains enzymes that modify proteins and lipids. For example, it can add a chain of sugars to proteins, there by making them glycoprotein and glycolipid, which are molecules found in the plasma membrane.**

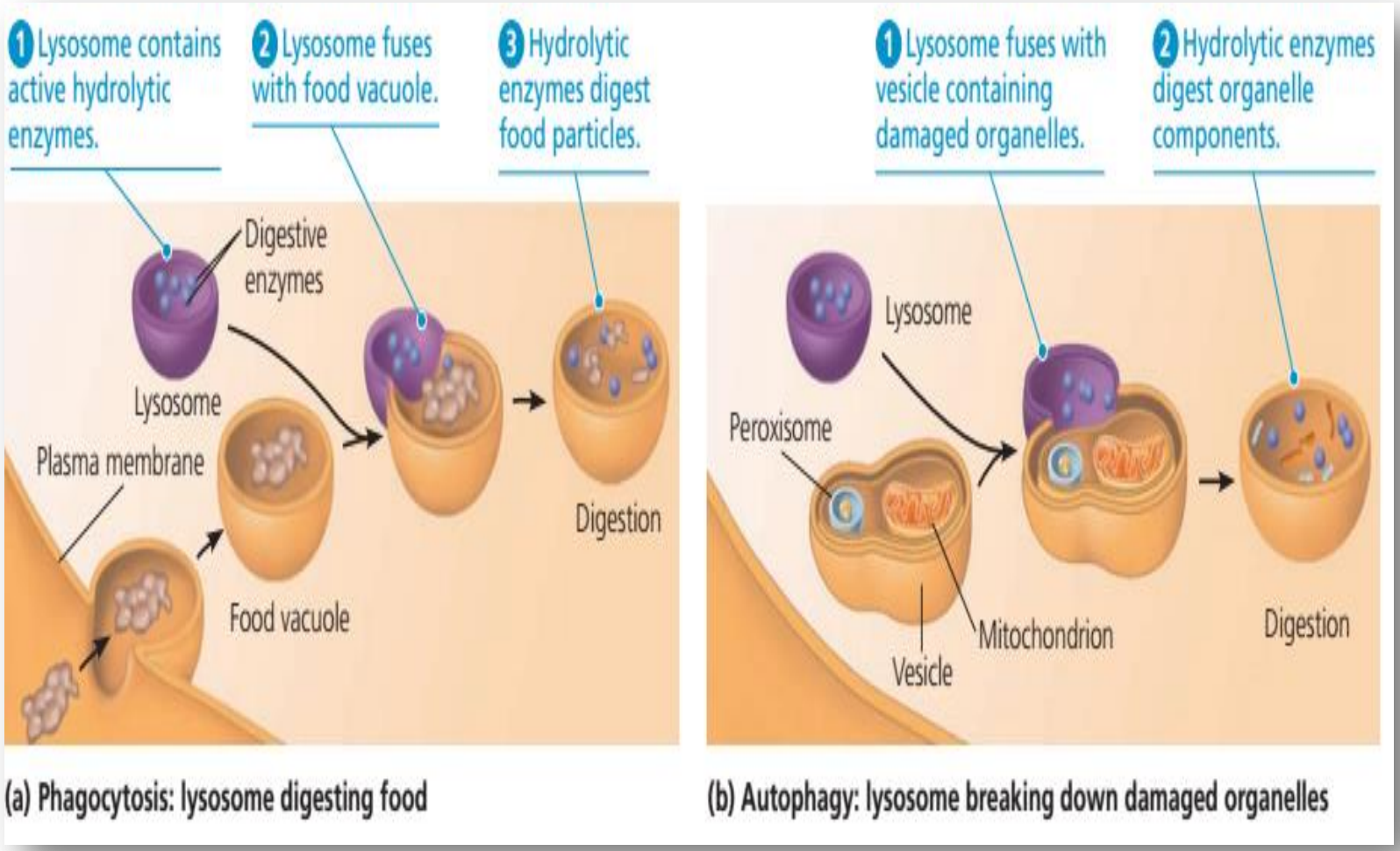


Function: Modifies lipids and proteins from the ER sorts and packages them in vesicles.

Lysosomes
are vesicles that bud from the Golgi apparatus and that contain digestive enzymes. These enzymes can break down large molecules, such as proteins, nucleic acids, carbohydrates, and phospholipids.

Function:

- **In the liver, lysosomes break down glycogen in order to release glucose into the bloodstream.**
- **Certain white blood cells use lysosomes to break down bacteria (Phagocytosis).**
- **Lysosomes digest worn-out organelles in a process called autophagy.**
- **Lysosomes are also responsible for breaking down cells when it is time for the cells to die by the enzymes of their own lysosomes is called autolysis.**



(a) Phagocytosis: lysosome digesting food

(b) Autophagy: lysosome breaking down damaged organelles

Peroxisomes:

Are similar to lysosomes but contain different enzymes and are not produced by the Golgi apparatus. Peroxisomes are numerous in liver and kidney cells.

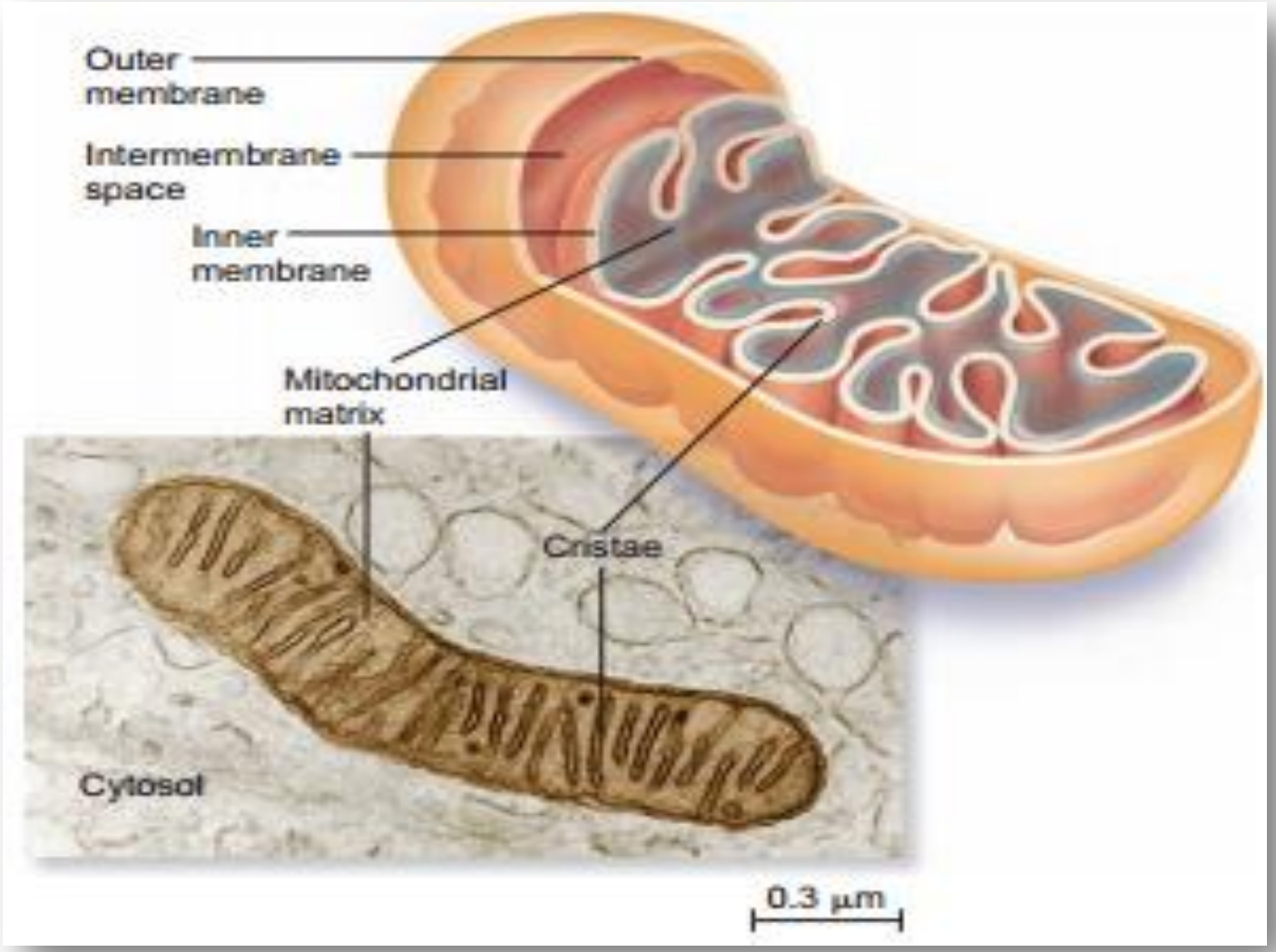
Function:

1. **neutralize free radicals (oxygen ions that can damage cells).**
2. **Detoxify alcohol and other drugs.**
3. **also break down fatty acids, which the mitochondria can then use as an energy source.**

Lab 7

Mitochondria

- **Mitochondria (singular *mitochondrion*) are tiny organelles that transfer energy from organic molecules to adenosine triphosphate (ATP).**
- **Hundreds of mitochondria found in active cell such as muscle cells , in fat-storage cells, have few mitochondria.**
- **A mitochondrion has an outer membrane and an inner membrane separated by a region called the intermembrane space. The inner membrane is folded called cristae. These folded increase the surface area of the inner membrane, which is the site where ATP is made. The matrix contains many different enzymes as well as the mitochondrial DNA and ribosomes.**


Outer membrane
Intermembrane space
Inner membrane
Mitochondrial matrix
Cristae
Cytosol
0.3 µm

Lab 8

Plastids

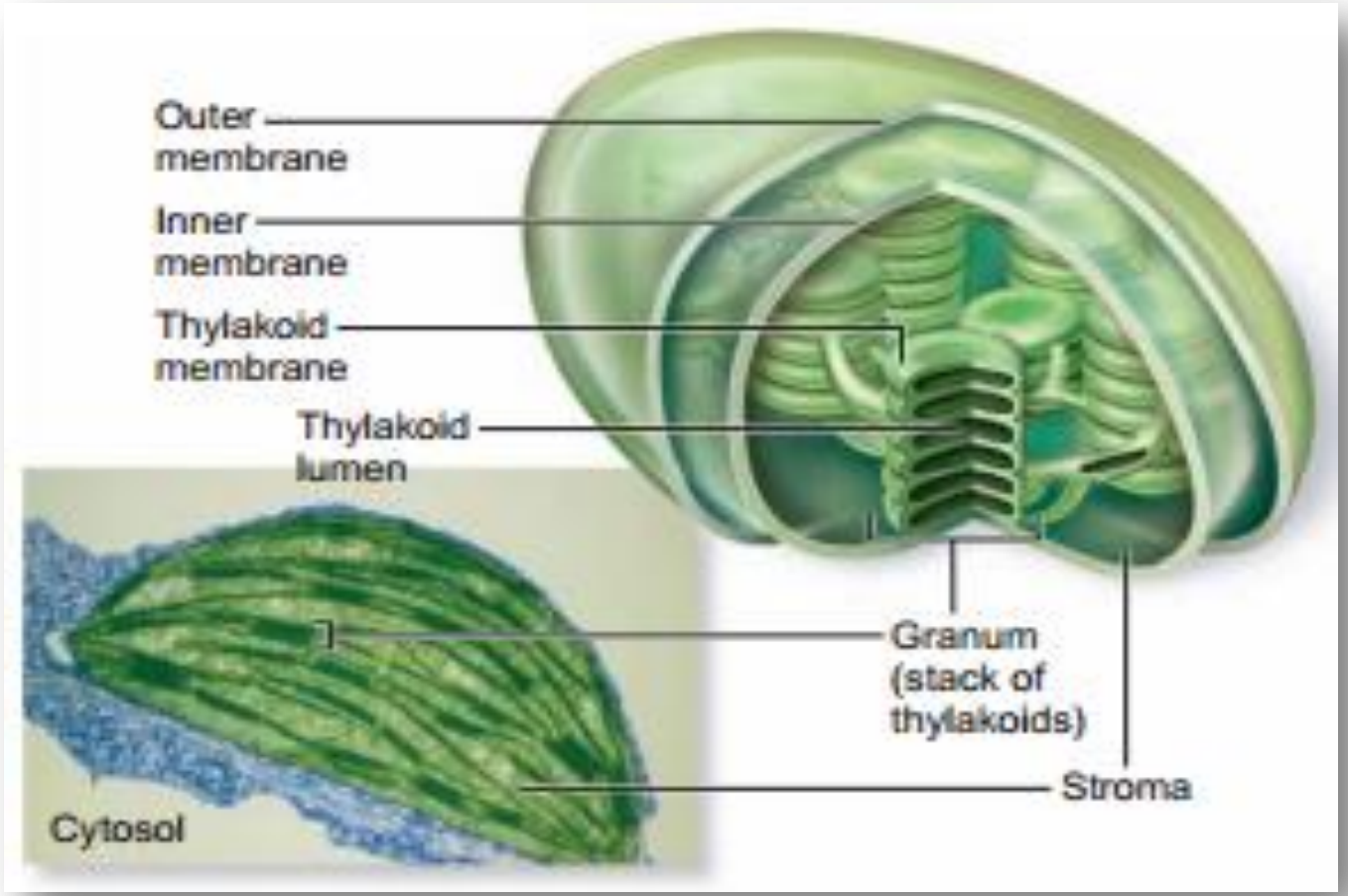
❖ **Plastids**

Plastids found only plant cells. Plastids are organelles that, like mitochondria, are surrounded by a double membrane and contain their own DNA. There are several types of plastids, including chloroplasts, chromoplasts, and leucoplasts.

❖ **Chloroplasts**

Use light energy to make carbohydrates from carbon dioxide and water. Each chloroplast contains a system of flattened, membranous sacs (tubules) called thylakoids. These tubules top of each other to form a structure called agrana (granum).

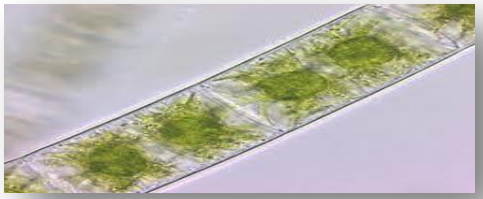
The stroma is the compartment of the chloroplast that is enclosed by the inner membrane but outside the thylakoid membrane. Thylakoids contain the green pigment chlorophyll, the main molecule that absorbs light


Outer membrane
Inner membrane
Thylakoid membrane
Thylakoid lumen
Granum (stack of thylakoids)
Stroma
Cytosol

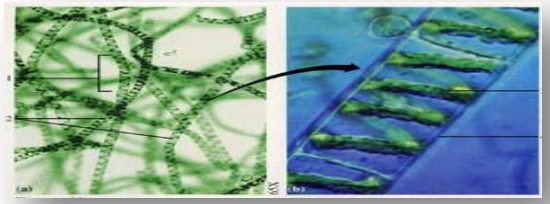
- **Chromoplasts, a second type of plastid, function in synthesizing and storing the yellow, orange, and red pigments known as carotenoids. Chromoplasts give many fruits and flowers their colors. In autumn, the chromoplasts also give many leaves their yellow, orange, and red colors.**
- **leucoplasts, typically lacks pigment molecules. An amyloplast is a leucoplast that synthesizes and stores starch. Amyloplasts are common in underground structures such as roots and tubers.**

Shape of Plastids

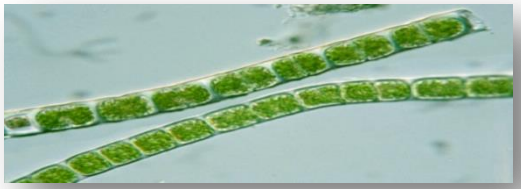
band-shaped (*Ulothrix*)



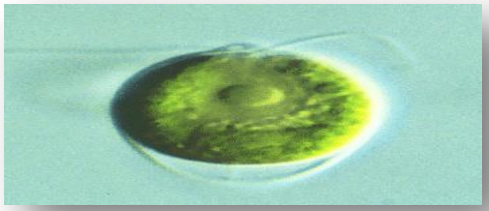
star shape (*Zygnema*)



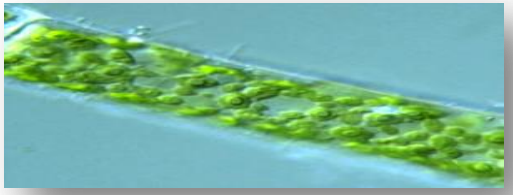
spiral shape (*Spirogyra*)



Reticulate shape (*Oedogonium*)



cup-shaped(*Chalmydomonas*)



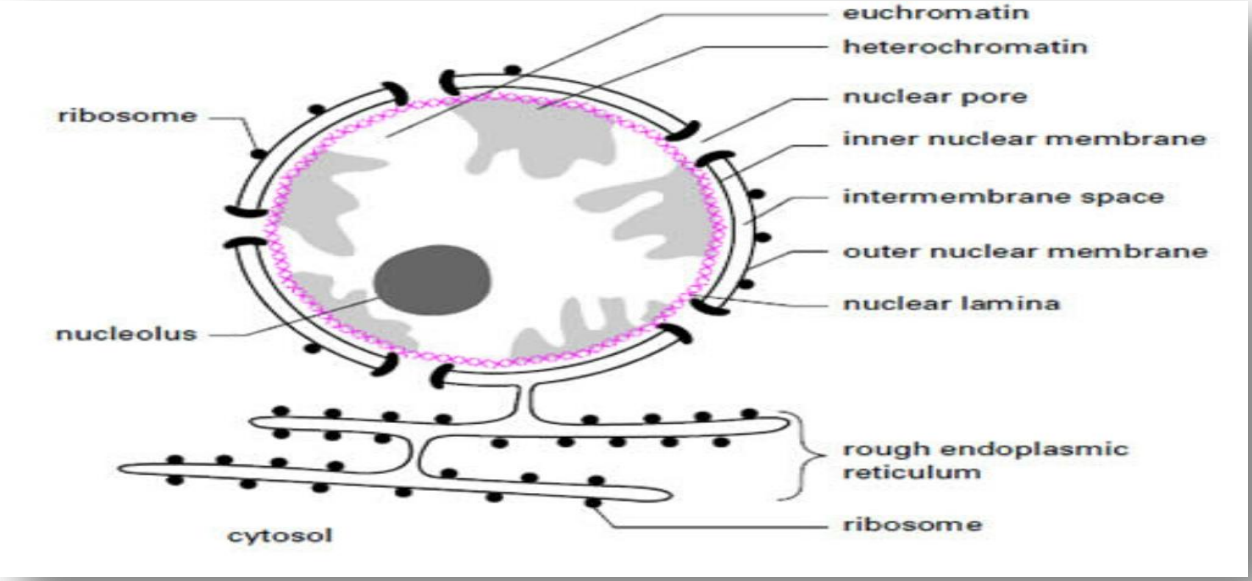
many small oval (*Cladophora*)

Lab 9

Nucleus

- **The nucleus encloses by the nuclear envelope separating its contents from the cytoplasm.**
- **The nuclear envelope is a double membrane. The envelope is perforated by pore called a pore complex that plays an important role in the cell by regulating the entry and exit of molecules as well as large complexes of macromolecules.**
- **At the pores, the nuclear side of the envelope is lined by the nuclear lamina.**

- **Within the nucleus, the DNA is organized into discrete units called chromosomes.**
- **Nucleoplasm: It is slimy, non-staining, granular, colorless fluid inside the nuclear membrane. It is also known as nuclear sap or karyolymph.**



Functions of nucleus:

- **It is controlling of all the vital activities of the cell.**
- **Have main role in growth and cell division**
- **It contains chromosomes and genes.**

There are 3 types of RNA, each encoded by its own type of gene:

- **mRNA - Messenger RNA: Encodes amino acid sequence of a polypeptide.**
- **tRNA - Transfer RNA: Brings amino acids to ribosomes during translation.**
- **rRNA - Ribosomal RNA: With ribosomal proteins, makes up the ribosomes, the organelles that translate the mRNA.**