PRACTICAL CELL BIOLOGY

المرحلة الأولى
ا.د.قتيبة شعيب محمد صالح
ا.د.شفاء مهدي صالح
ا.م.د. رغد محمد عبدالله
م.م. مها فلاح
م.م. أحلام شهاب

DIVERSITY OF CELLS

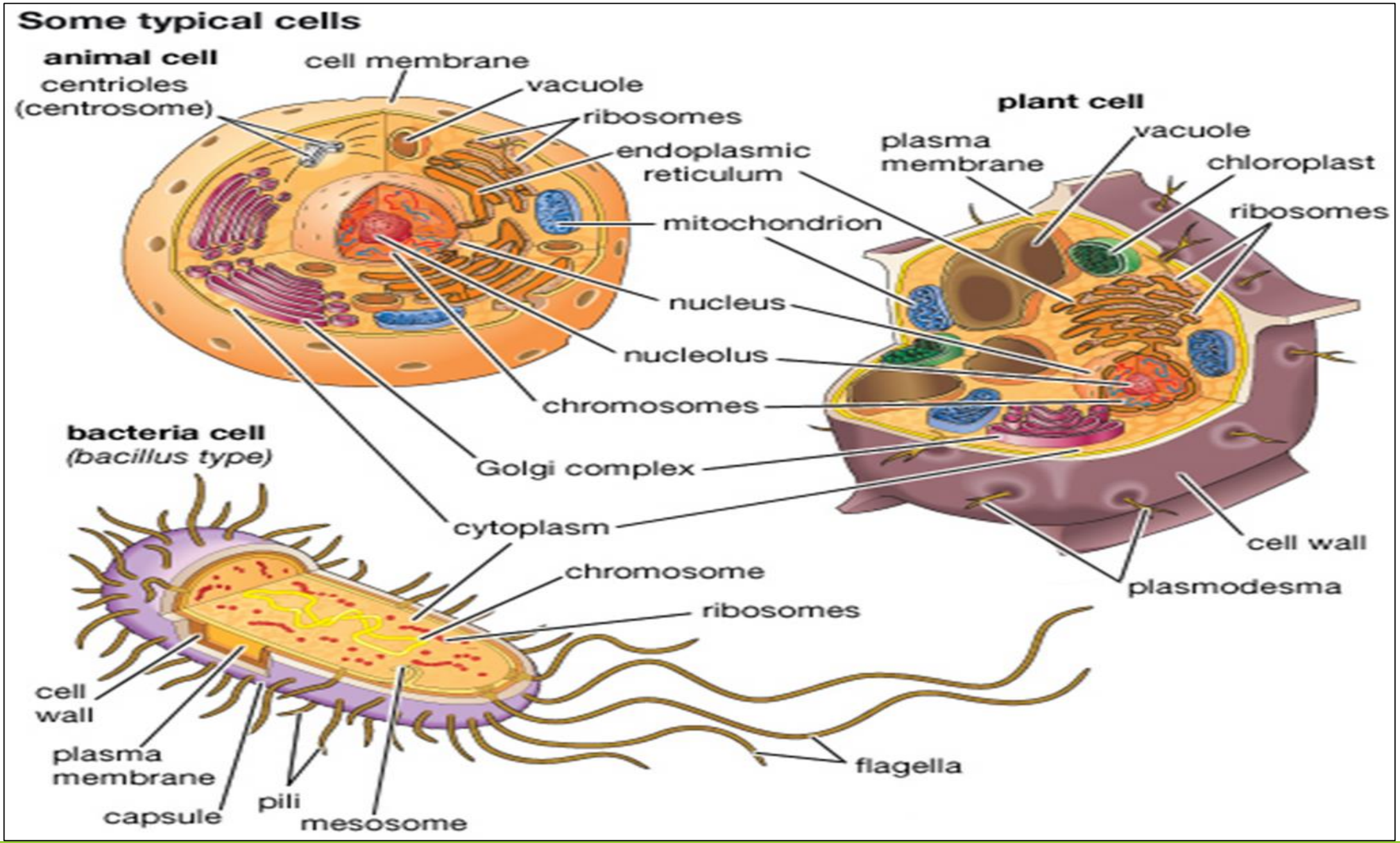
LAB. 3

TYPES OF CELLS

Cells based on the presence or absence of a nucleus can be divided into 2 types:

Prokaryotic cells; lack nucleus, unicellular and primitive.

Eukaryotic cells; have a nucleus, may be unicellular or multicellular and are more advanced than the prokaryotic cells


Some typical cells
animal cell
centrioles
(centrosome)
cell membrane
vacuole
ribosomes
endoplasmic
reticulum
mitochondrion
nucleus
nucleolus
chromosomes
Golgi complex
cytoplasm
plant cell
plasma
membrane
vacuole
chloroplast
ribosomes
cell wall
plasmodesma
bacteria cell
(bacillus type)
chromosome
ribosomes
cell
wall
plasma
membrane
capsule
pili
mesosome
flagella

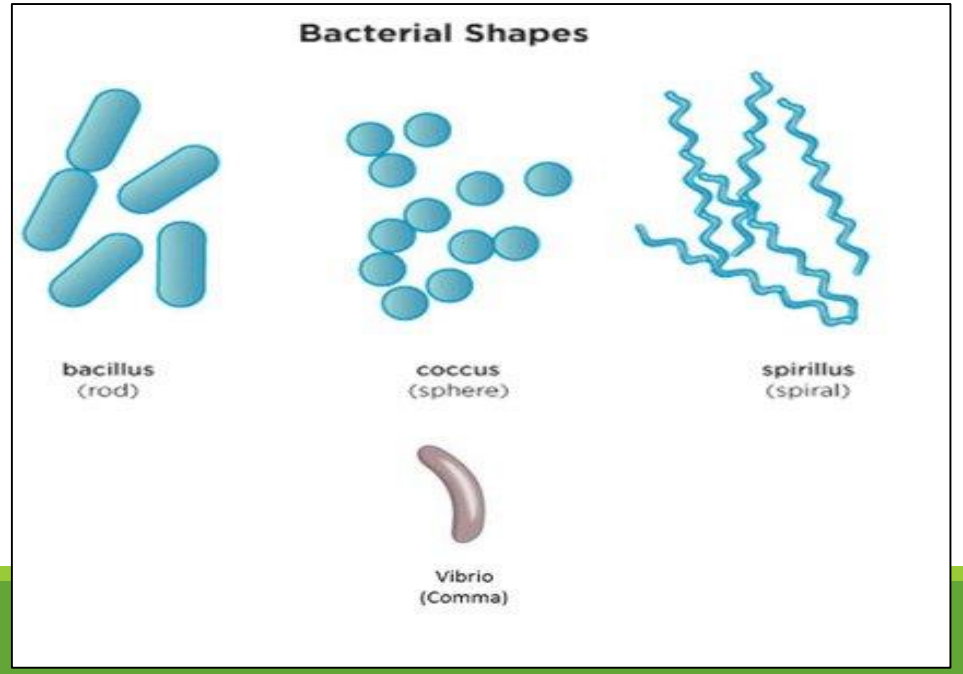
SHAPE OF THE CELL

The cell wall in bacteria, algae, fungi and plant cells give shape to the cells.

In animal cells which lack cell wall, the cell membrane provides the boundary.

Bacteria have different shapes and they are classified based on the shape as;

Bacilli (rod shaped),
Cocci (spherical shaped)
Vibrio (comma shaped),
Spirilla (spiral/helical shaped)



SHAPE OF THE CELL

In Eukaryotes (plant, animal, fungal cells), the shape of the cell depends on its function.

Humans have cells of various shapes; **circular and biconcave** (RBC), **amoeboid** (WBC), **long and stretched and branched cells** (nerve cells), **long and narrow cells** (columnar epithelium) etc.

Plant cells usually have **square or rectangle shape**. Even in plants some specialized cells have different shapes e.g. Guard cells of stomata (**kidney/Dumbell shaped**)

Single cellular fungi are usually spherical and some fungi are tubular and some form long chains of cells.

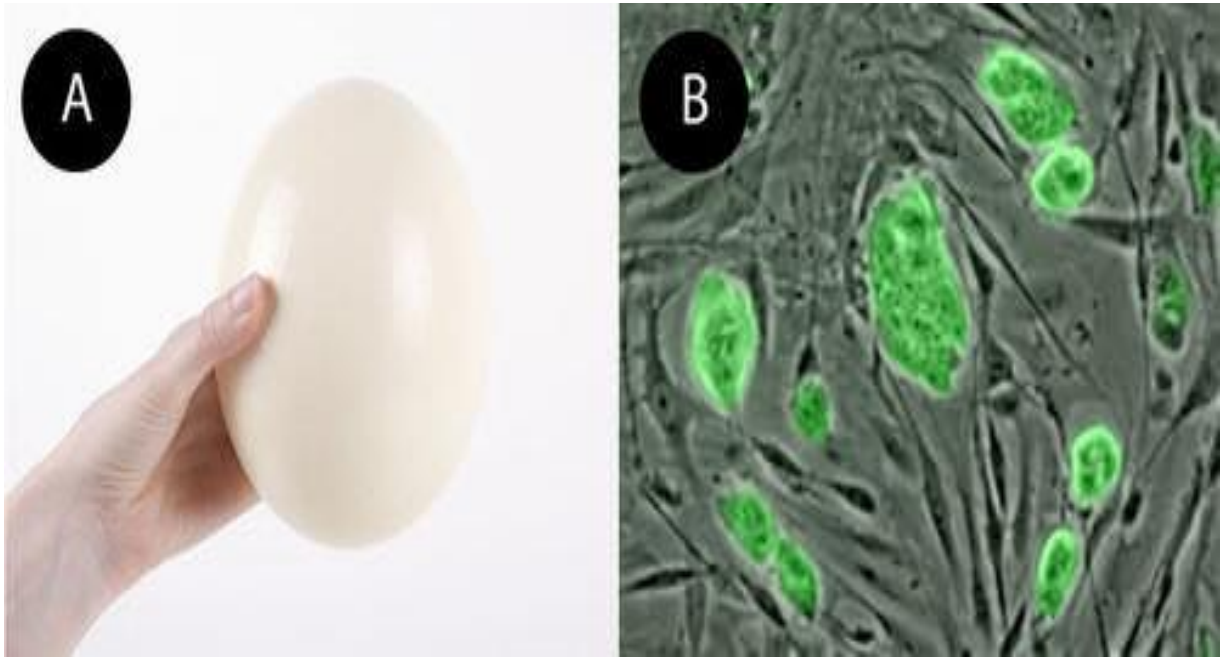
CELL SIZE

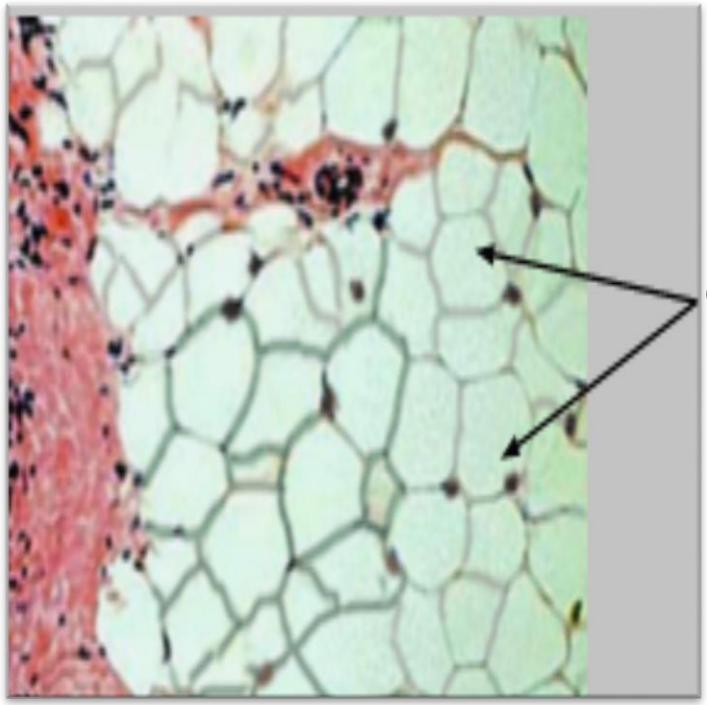
Three factors play an important role in the variation between cell sizes:

1. **The ratio of the amount of nuclear material to the amount of cytoplasmic material.**
2. **The ratio of the surface area of the cell to the volume of the cell.**
3. **The rate of chemical activity of the cell.**

CELL SIZE

The smallest **prokaryotic cell** currently known has a diameter of only 400 nm. **Eukaryotic cells** normally range between 1– 100µm in diameter. The ostrich egg in **Figure** at the bottom is over 10,000 times larger than the mouse cell.

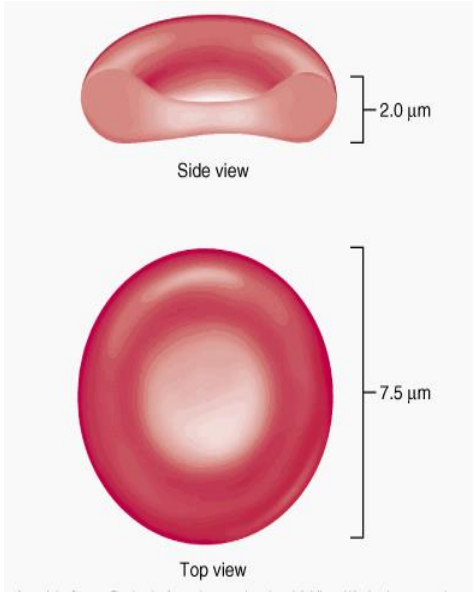


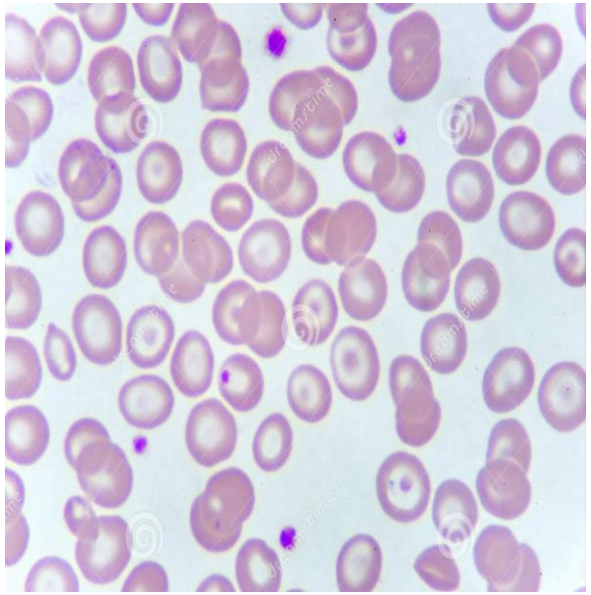


(Fat droplets)

Annular shape

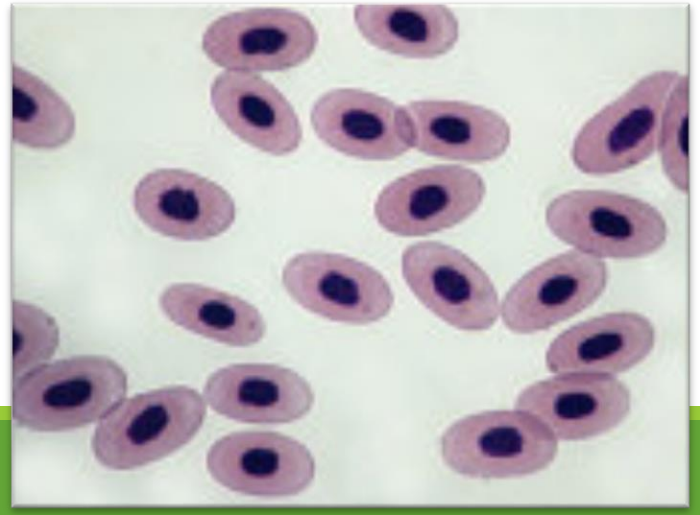
(Fatty tissue)





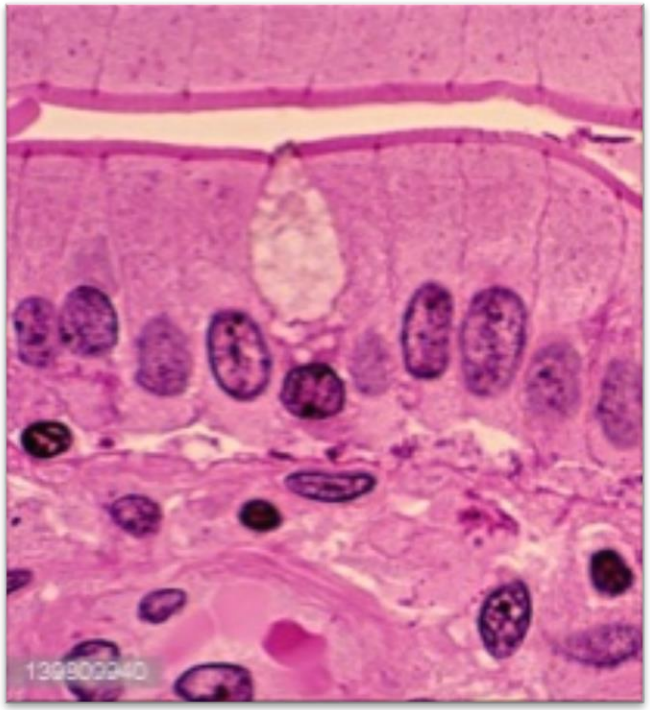
Circular and
Biconcave shape

(Human RBC)



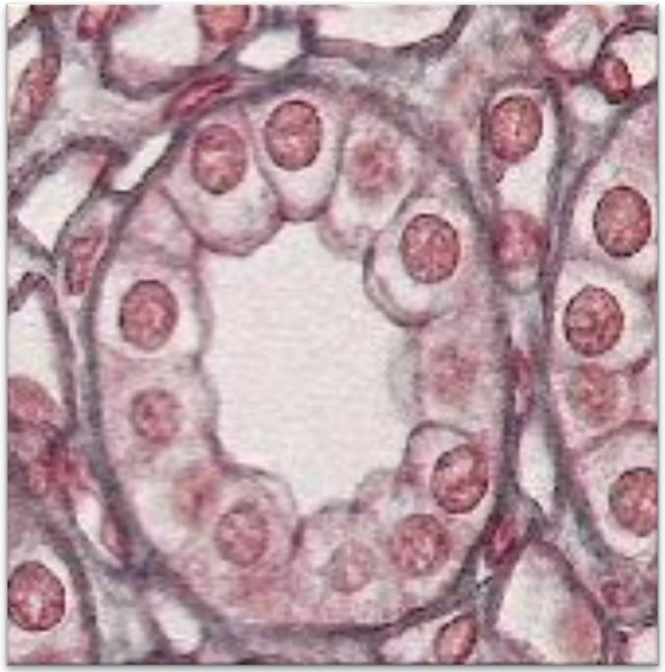
Oval shape

(RBC in Frog)



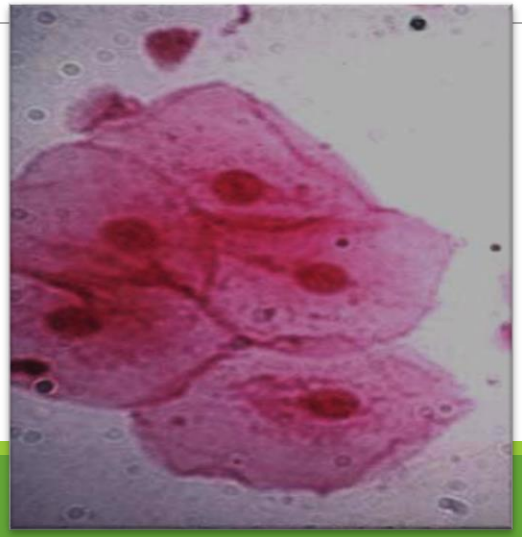
Columnar shape (Elongated)

(Columnar Epithelial tissue)



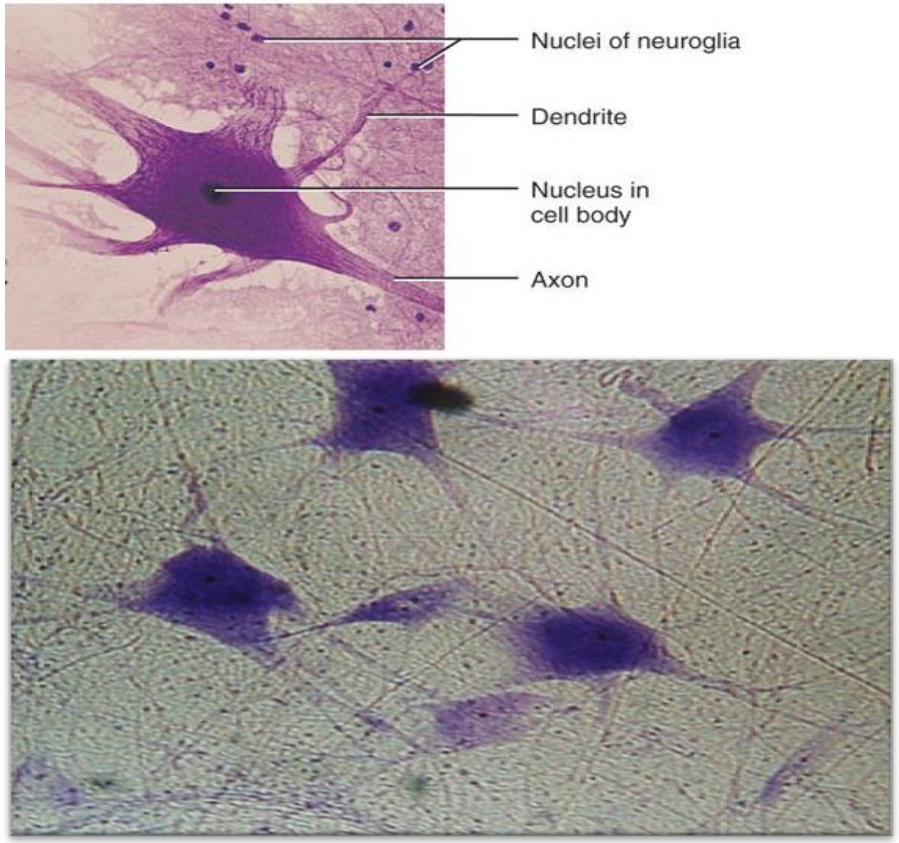
Cuboidal shape

(Cuboid Epithelial tissue)



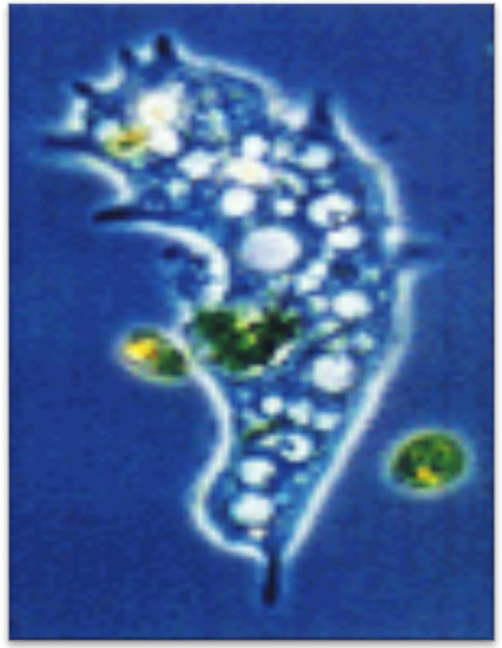
Squamous shape

(Epithelial Squamous tissue)



Branched and long shape

(Nerve cells)

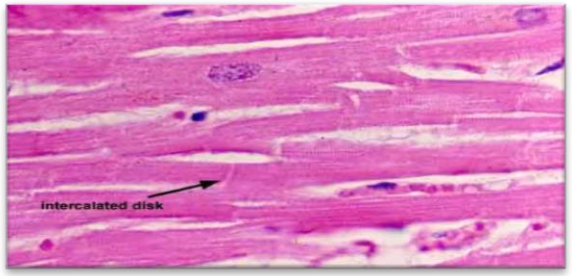


Amoeboid shape

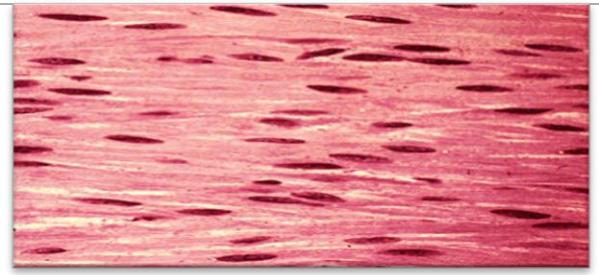
(Amoeba)

Cylindrical shape

(Skeletal muscle)

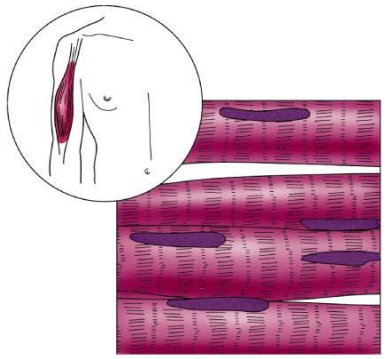


Branched Cylindrical shape
(Cardiac muscle)

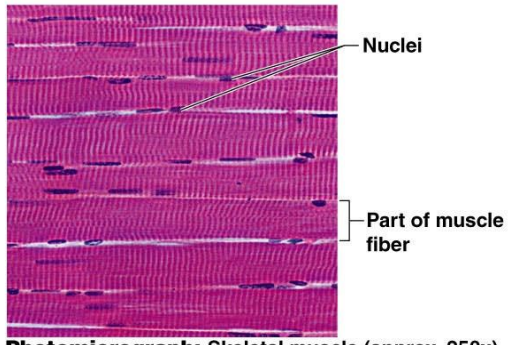


Fusiform shape

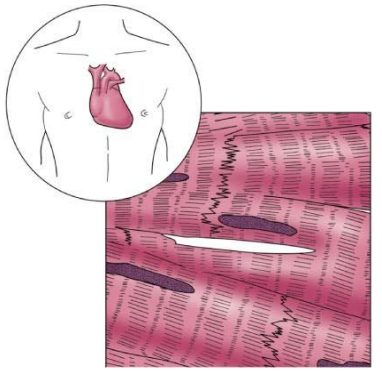
(Smooth muscle)



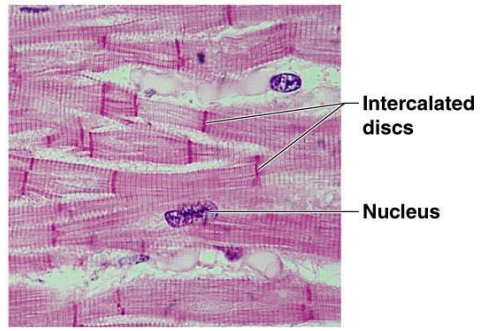
(a) Diagram: Skeletal muscle



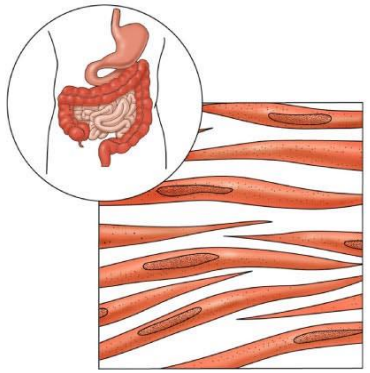
Photomicrograph: Skeletal muscle (approx. 250x).



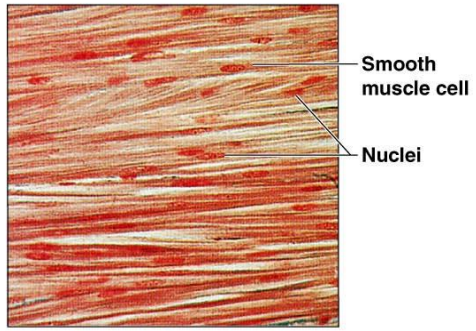
(b) Diagram: Cardiac muscle



Photomicrograph: Cardiac muscle (800x).



(c) Diagram: Smooth muscle



Photomicrograph: Sheet of smooth muscle (approx. 250x).

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THE CELL WALL AND PLASMA MEMBRANE

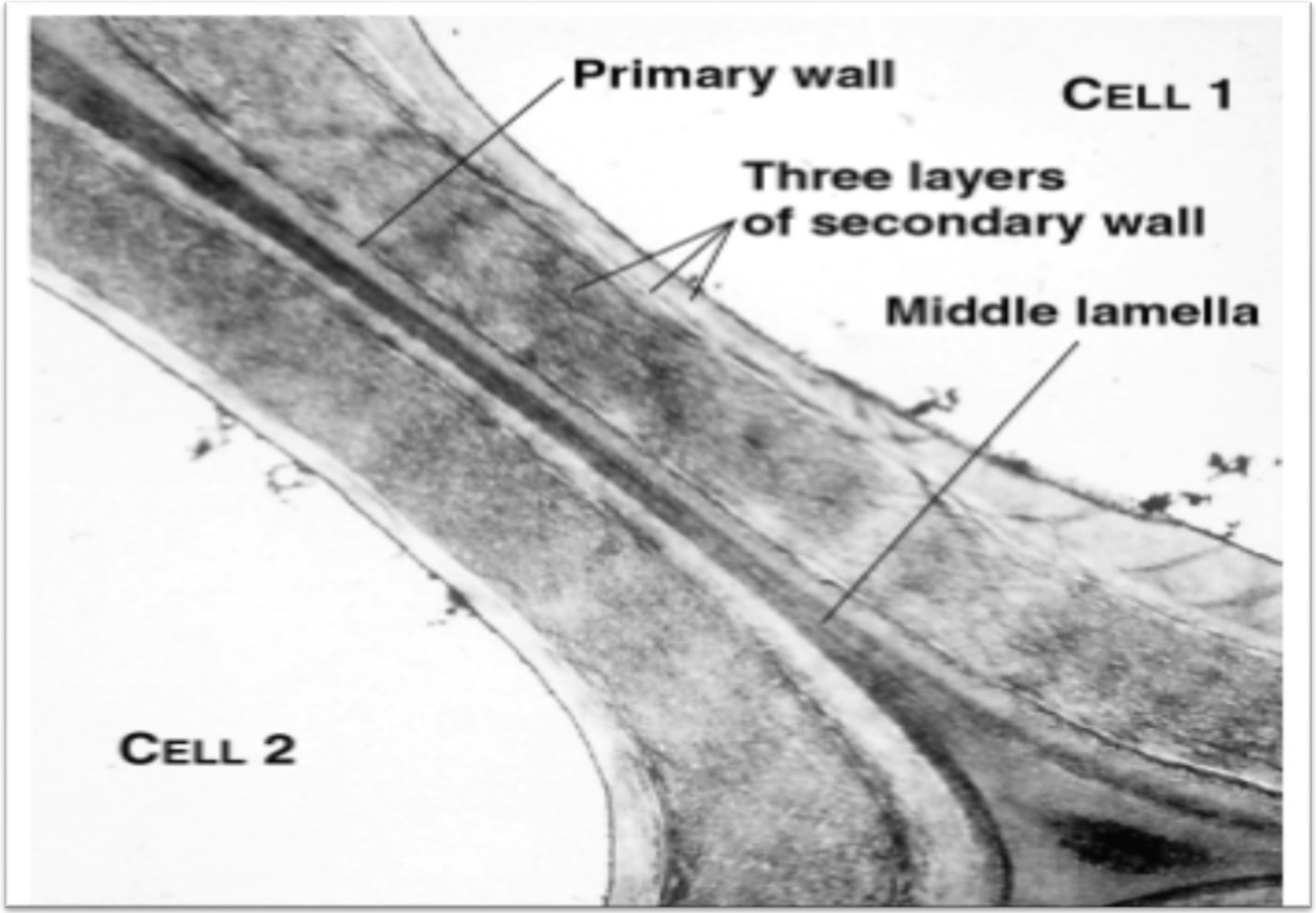
Lab. 4

The Cell Wall

Plant cells and some prokaryotic cells are distinguished by the presence of a cell wall that is bounded on the outside by the plasma membrane.

In eukaryotic cell a rigid cell wall enclose in the plant cell made of cellulose while in fungi the cell wall made of chitin but animal cells have no wall. Virus has a protein coat (capsid) made of protein subunits called capsomeres.

The plant cell wall consists of the following layers: Middle lamella, Primary cell wall and Secondary cell wall.



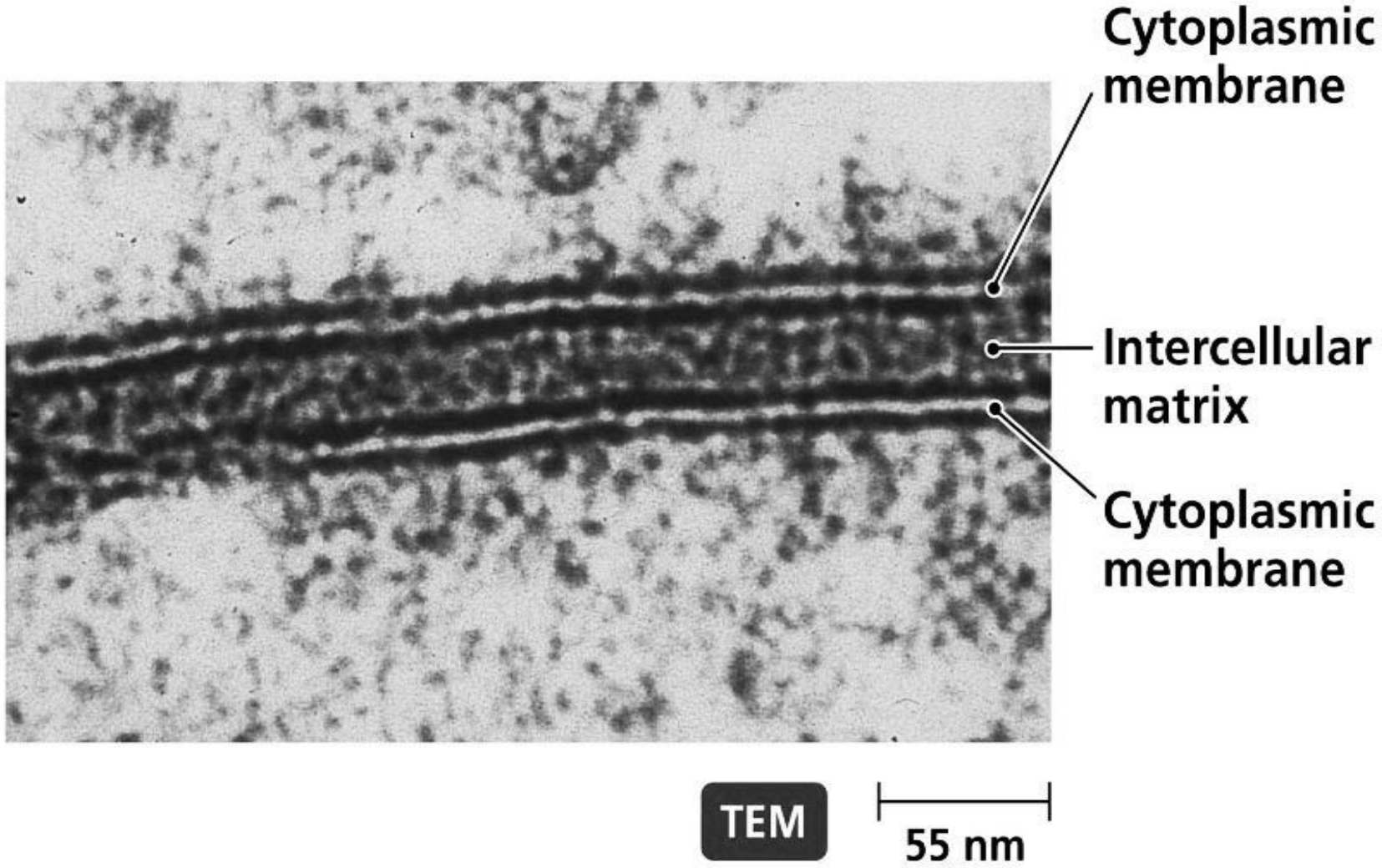
Ultrastructure of Cell wall

The Plasma Membrane

Is the membrane found in all cells that separates the interior of the cell from the outside environment.

The plasma membrane consists of a lipid bilayer that is semi-permeable and regulates the materials that enter and exit the cell.

There are another function of plasma membrane by the modification of it like cell connecting with each and absorption of nutrients.

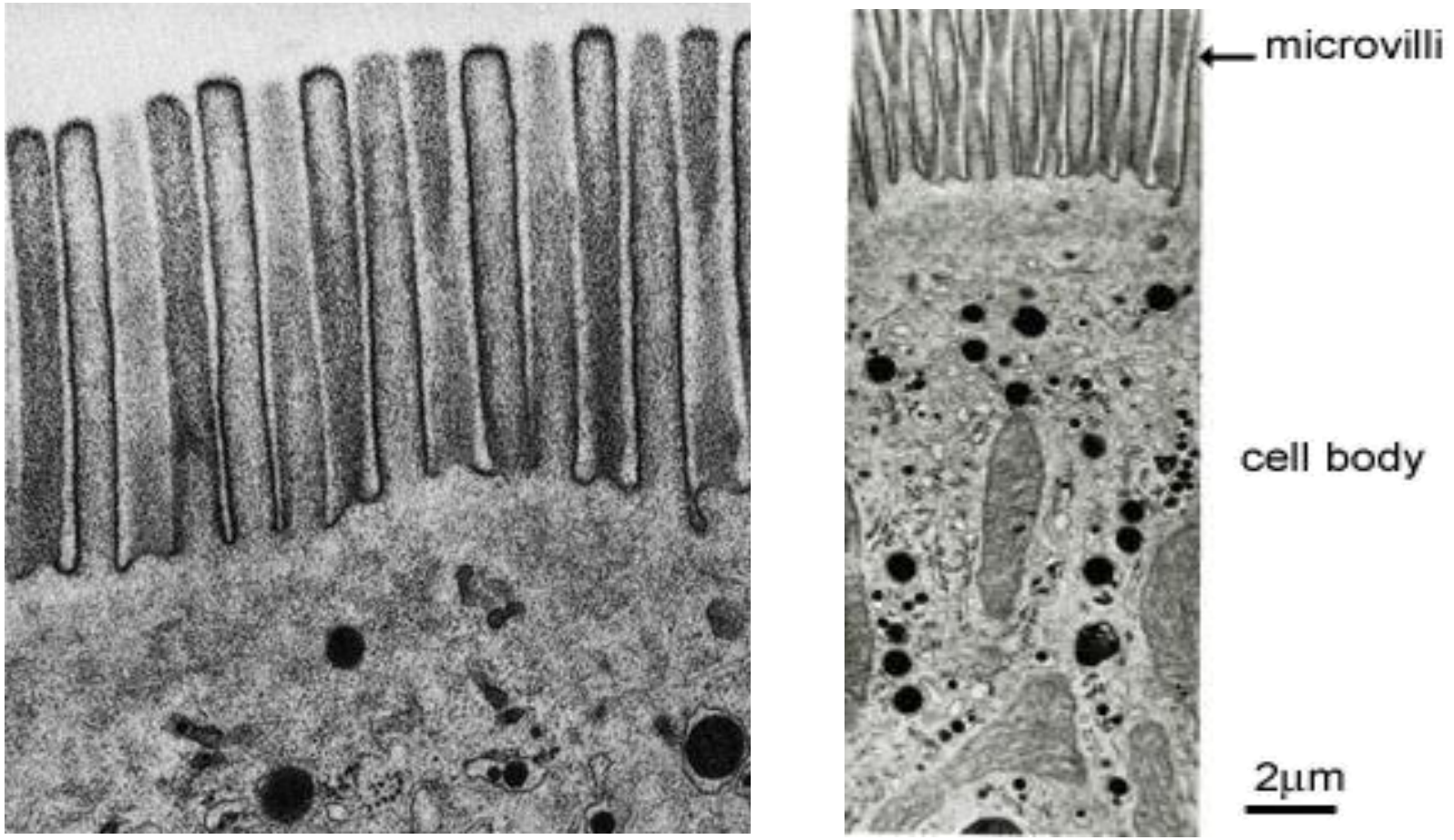


Ultrastructure of Cell membrane

modifications of cell membrane

1. Microvilli

- External folds like fingers from cell surface
- Increase the absorption surface
- There are thousands microvilli in one cell like in epithelial cells of digestive system
- Inside microvilli there are bands of actine filaments for the movement of microvilli .



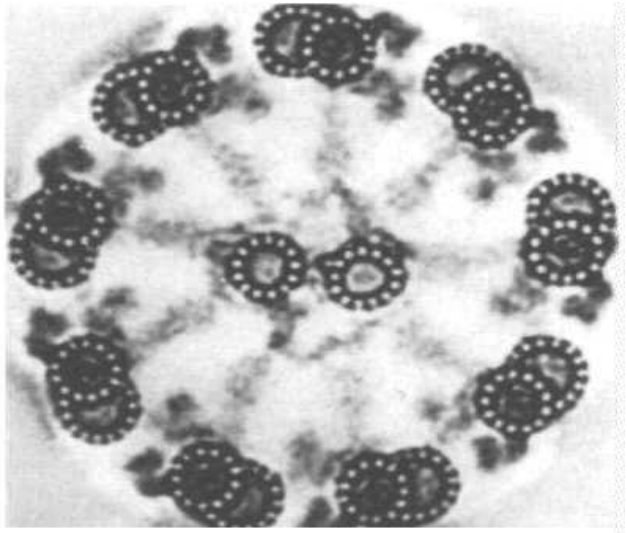
Ultrastructure of Microvilli

modifications of cell membrane

2. Cilia and Flagella

- **Cilia and flagella are formations on the apical surface of the plasma membrane.**
- **They are made up of microtubules.**
- **They are motile and designed either to move the cell itself or to move substances over or around the cell.**
- **The major difference is in their length.**

- **Cilia and flagella have the same internal structure, and are remarkably similar in their organization, possessing a central bundle of microtubules, called the axoneme, in which nine outer doublet microtubules surround a central pair of singlet microtubules. This characteristic “9 + 2”**



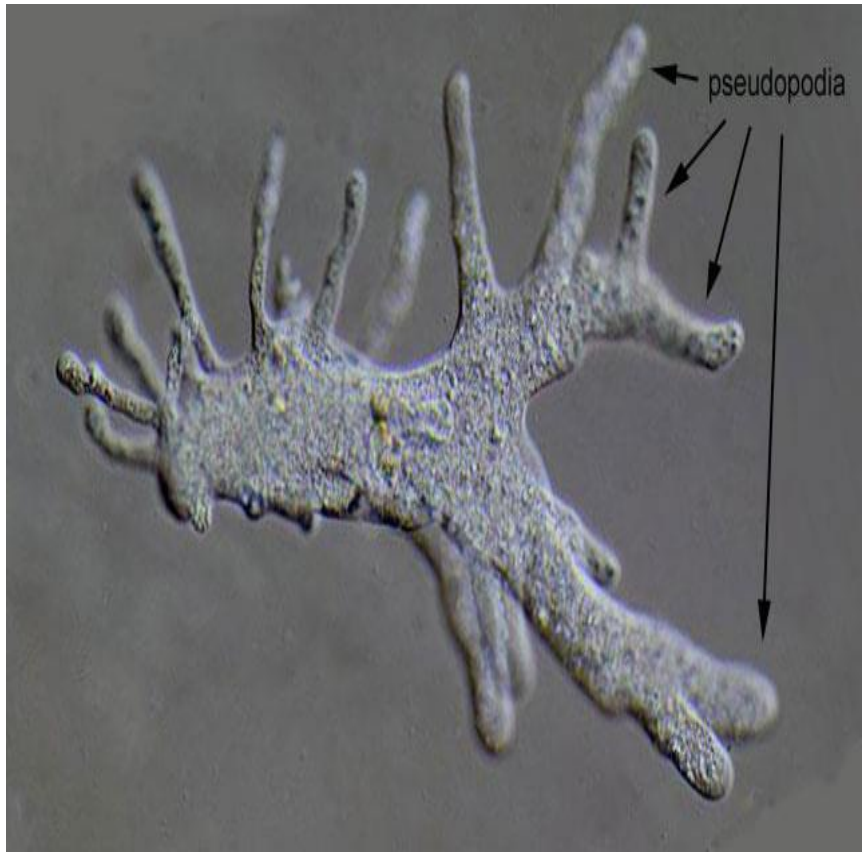
Ultrastructure of Cilia and Flagella

Cilia in Paramecium and Flagella in Euglena

modifications of cell membrane

3. Pseudopodia

- **Is in the form of extensions to the outside of the cell in eukaryotic cell membrane.**
- **Pseudopodia primarily consist of actin filaments and may also contain microtubules and intermediate filaments**
- **They are used for motility and ingestion. They are often found in amoebas.**



Pseudopodia in Amoeba

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CYTOPLASMIC ORGANELLES

LAB. 5

Golgi complex

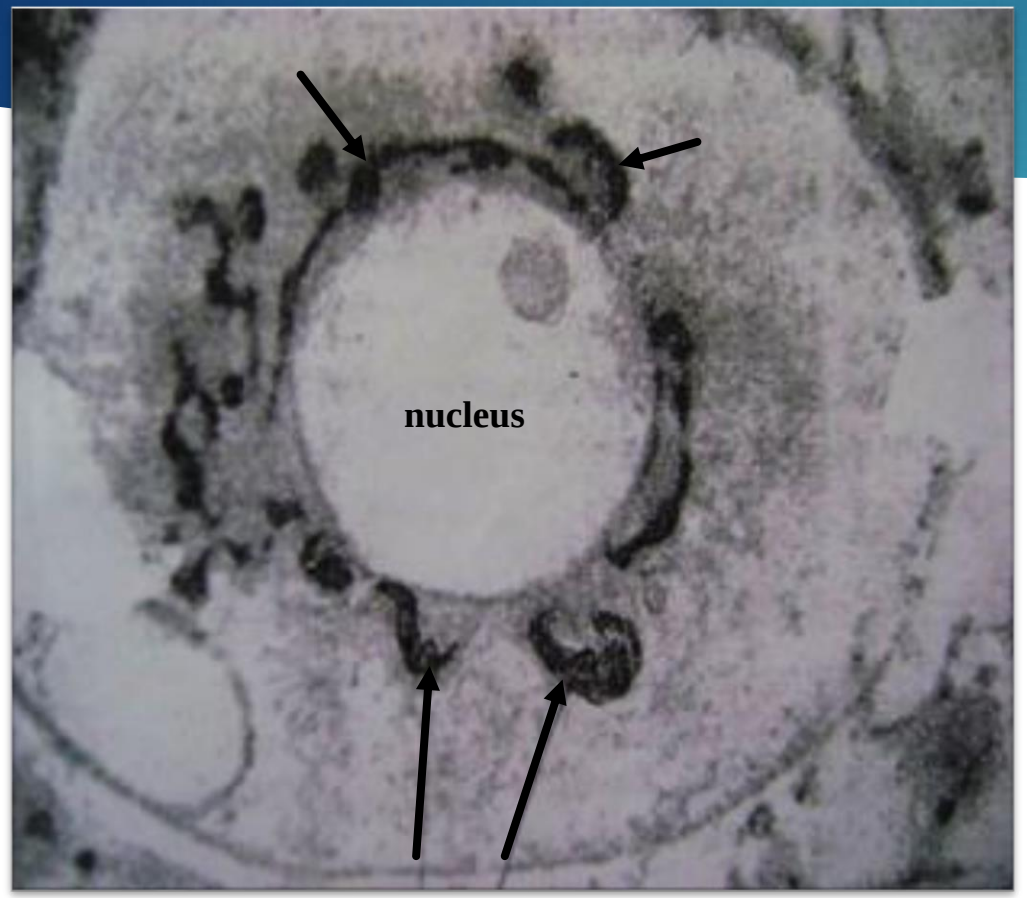
It consist of flattened curved sacs called cisterna

Has convex face called forming face (*cis* face) and concave face called maturing face (*trans* face)

There are large vesicles near to the maturing face releasing from the cisterna containing the secretions called secretory vesicle

It shown under the light microscope in the form of black sheets or grains due to the deposition of osmium or silver particles used in the dyeing process.

Golgi complex has many functions like secretion enzymes and hormones and the formation of lysosomes.



Optional microscope image of golgi complex

Note the precipitation of black silver nitrate within the complex plates around the nucleus

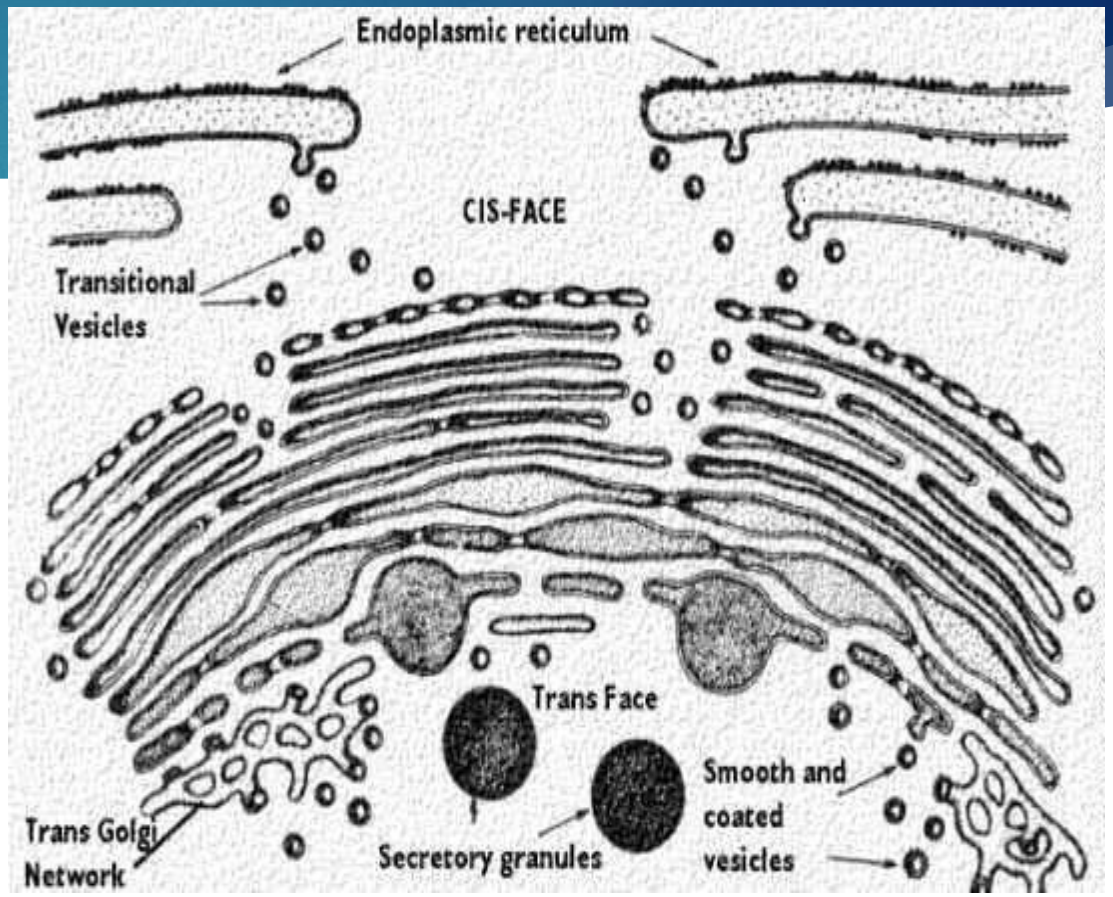


Diagram showing Ultrastructure of Golgi apparatus

Ultrastructure of Golgi apparatus

Endoplasmic reticulum

It consist of membranous structures contain cavities filled with cytoplasm, their shapes are like cisterna or vesicles or may be tubular. There are many functions of this organelle:

1-wall formation in plant cell.

2-nuclear envelope formation during cell division.

3-store calcium in muscle cells.

4-help in metabolism.

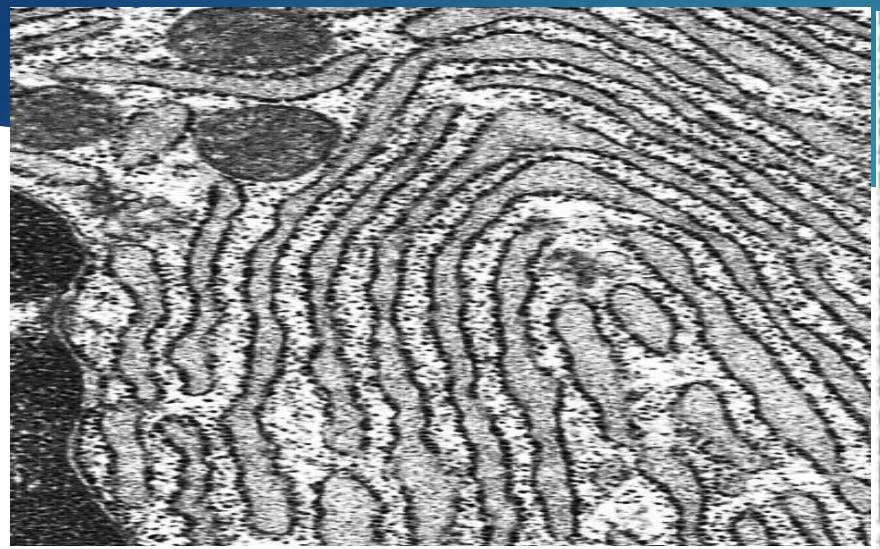
Types of Endoplasmic reticulum

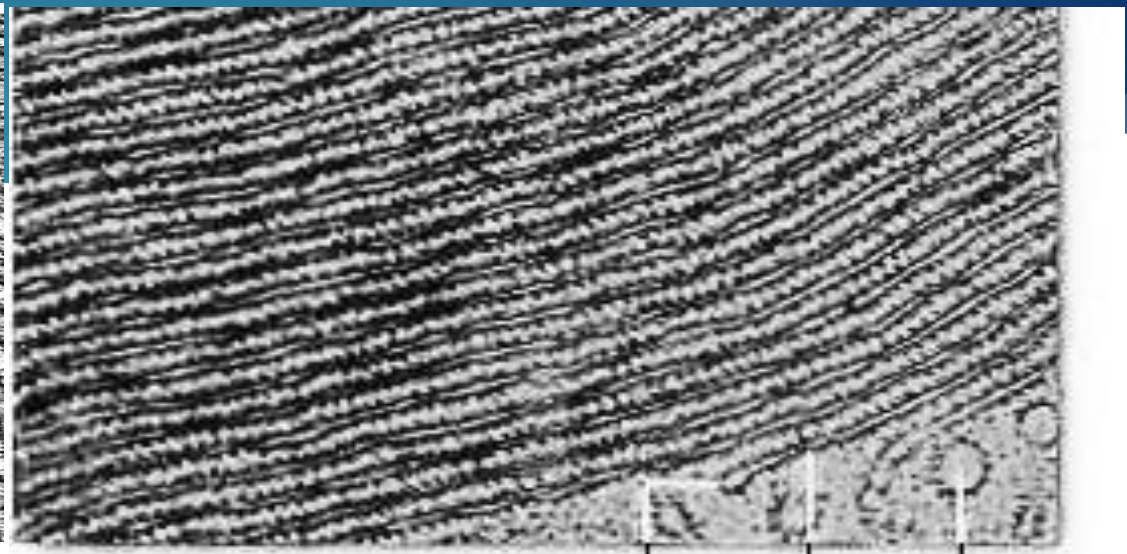
1. Rough endoplasmic reticulum (RER):

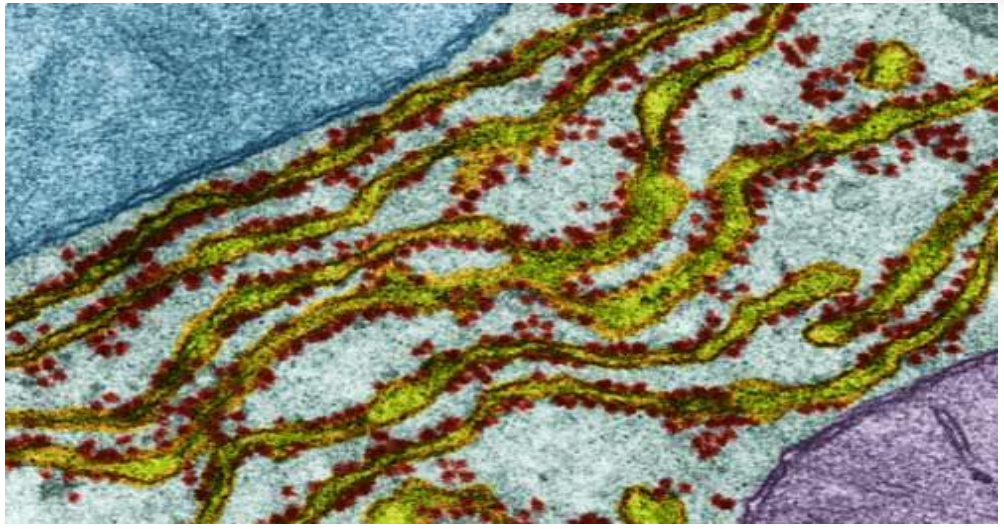
The ribosomes are found on the outer surface of membranes therefor it looks rough or granular. They are found in active cells where protein synthesis like liver.

2. Smooth endoplasmic reticulum (SER):

It has tubular shape and has no ribosomes on its surface therefor it looks smooth, found in muscle cells.







Ultrastructure of Rough Endoplasmic Reticulum

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Mitochondria

The power house in Eukaryotic cells

release energy from food as adenosine triphosphate molecules ATP in process called aerobic respiration.

It has own genome (mit. DNA) therefor its replication is not coupled to cell division.

* **Janus Green B:** is a basic dye and vital stain used in histology. It is also used to stain mitochondria.

It can be seen under a light microscope in living cells, after staining them with *Janus green dye and tetrazolium salts, and then mitochondria appear as bright granules tending to a greenish-blue color, and after a few minutes their color changes to red and then disappears.

The ultrastructure of mitochondria

Outer membrane, inner membrane and there is space between them.

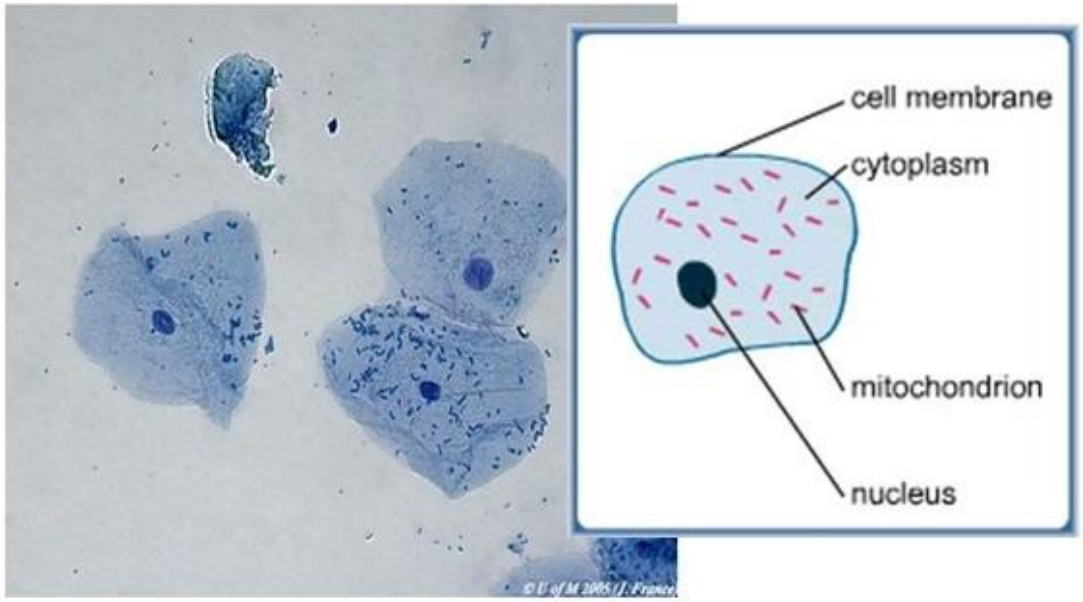
There are many folding from inner membrane called cristae to increase the surface of inner membrane for increasing the production of ATP. finally the matrix contain ribosomes, DNA and RNA.

Living cells differ in their mitochondria in several things:

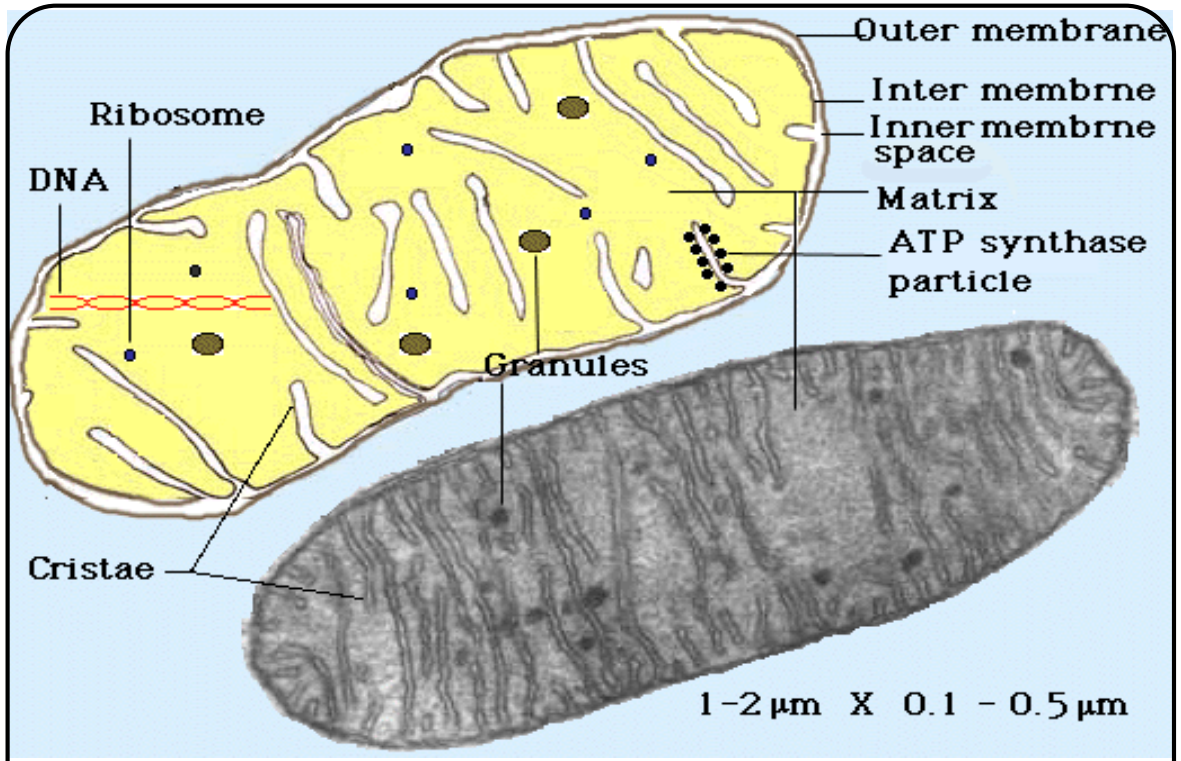
1. **The number: Their number is greater in cells with a higher rate of activity.**

2. **Distribution: Generally random, but it may follow for certain considerations**

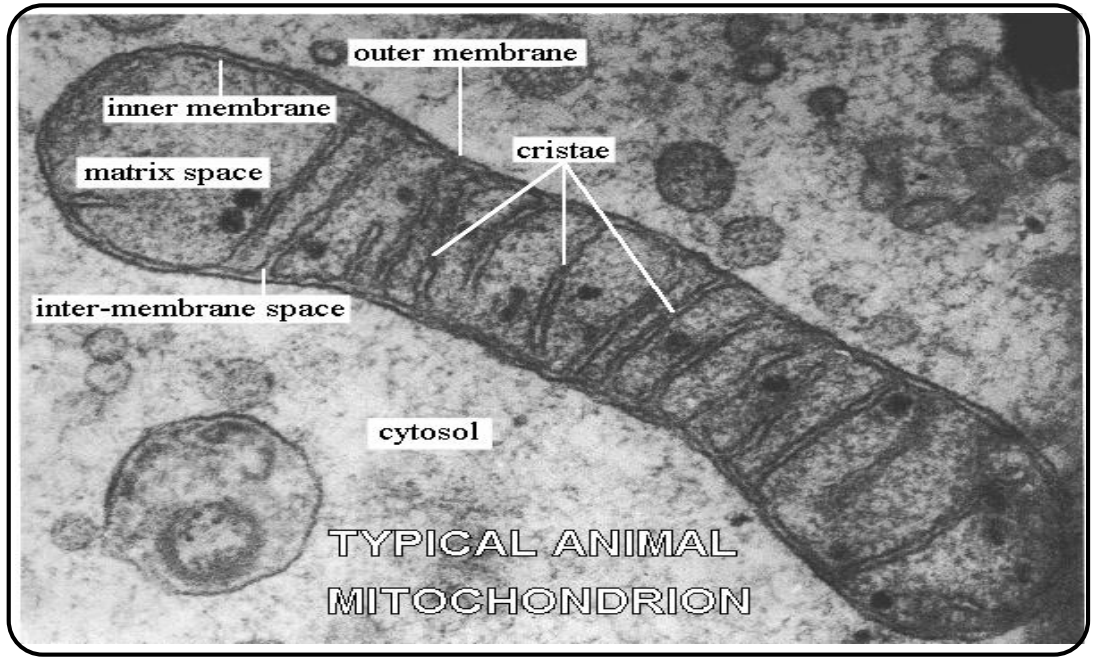
3. **The shape: It differ in their forms such as, spherical, elongated, cylindrical, dumbbell or racket.**



Mitochondria under light microscope

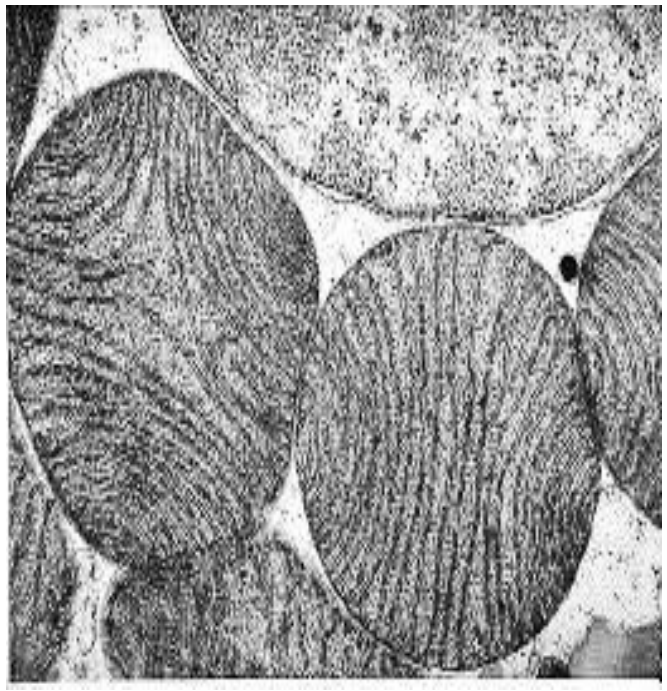


Ultrastructure of Mitochondria

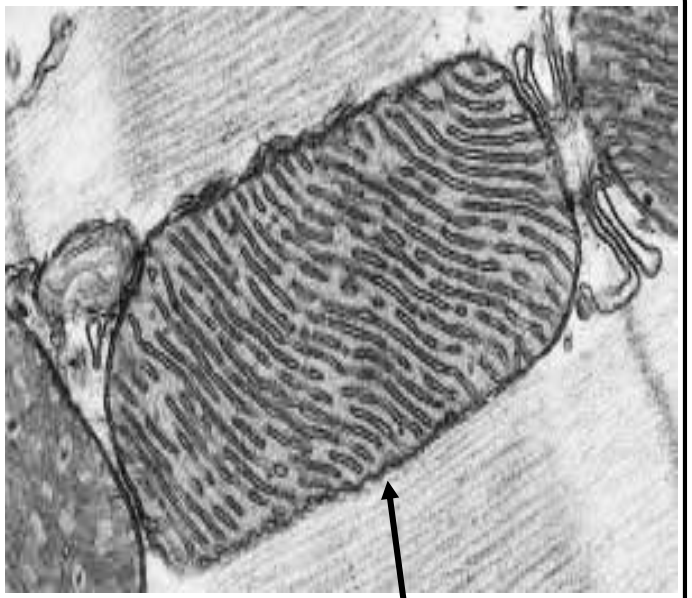


Elongated shape

Oval shape

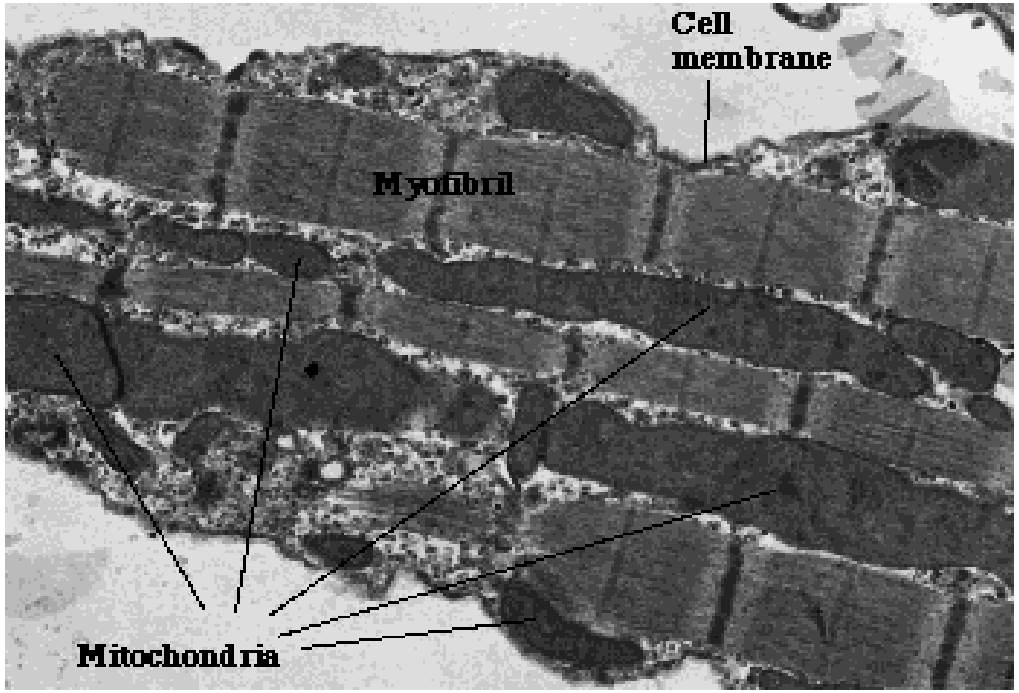


Spherical shape

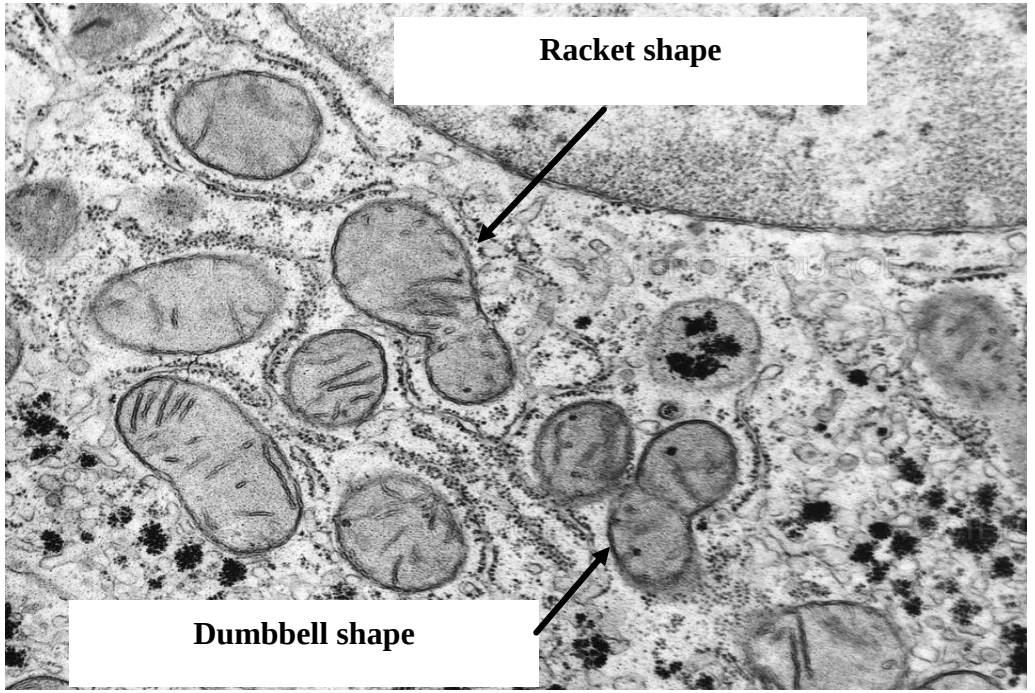


Cylindrical shape

Elongated shape



Uniform distribution of mitochondria



Random distribution of mitochondria

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Paraplasm

LAB. 8

Paraplasm

The non-vital contents of living protoplasm, such as yolk-granules, oil-drops, etc.

1. Secretory granules

Secretory granules are specialized intracellular organelles that serve as a storage pool for selected secretory products. The exocytosis of secretory granules is markedly amplified under physiologically stimulated conditions.

The presence of secretory granules is one of the main features in storage cells, whether they are neurosecretory, glandular or epithelial. Example include zymogen granules, which are secretory granules that collect in the cells involved in the secretion process in the form of droplets or small-sized granules of many numbers, including tears, acids, digestive enzymes, mucous substances, milk and protein substances.

2. Lipid droplets

Fats appear in the form of small droplets, the largest of which are in the adipose tissue concerned with the manufacture and storage of fats.

***In other types of cells, fat droplets are an immediate source of stored energy,**

***or they are involved in the manufacture of some cell components such as membranes and secretory materials of a fatty nature.**

3. Cytoplasmic pigments

Also called chromatophore, which are responsible for skin color and the color of certain internal organs.

Chromatophores are cells that produce color, of which many types are pigment-containing cells, or groups of cells, found in a wide range of animals including amphibians, fish, reptiles, crustaceans and cephalopods. Mammals and birds, in contrast, have a class of cells called melanocytes for coloration. Melanin granules are among the most popular types of pigments.

A pigment is a natural colouring matter found in plant or animal cells or tissues.

***It is capable of changing the colour of reflected or transmitted light and it does so via wavelength-selective absorption.**

***For example, the presence of a pigment chlorophyll imparts a green color to the leaves of plants.**

4. Crystals

Crystals appear as irregularly in some cells, and the indication for their presence is unknown.

***It turns out that most of their composition is protein, and these bodies are stripped of their membranes, but they appear in beautifully organized geometric shapes.**
***They may be 5 microns in length and 3 microns in width. Its existence is not limited to the cytoplasm.**
***Its presence often indicates a deterioration in the health status of the cell, as in red blood cells, when the hemoglobin changes from the dissolved form to the crystalline form.**
***The shape of the crystal is also useful in diagnosing the quality of its constituent materials and the health status of the cell.**
***Crystals appear in various forms (needle, rhombic, rectangular and irregular in shape).**

5. Glycogen and Starch granules

*Glycogen is a storage form of energy in animals.

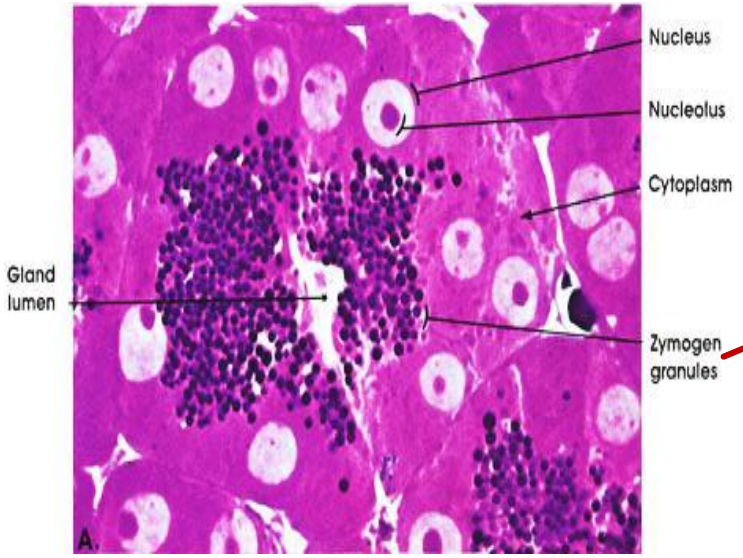
*It is a branched polymer composed of glucose units, but is more extensively branched and compact than starch.

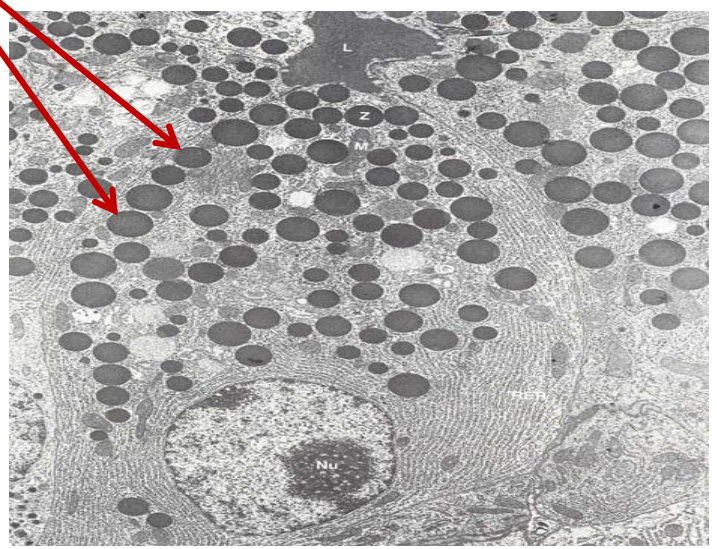
*Both are white powders in their dry state.

*Starch is a storage form of energy in plants.

*It contains two polymers composed of glucose units: amylose (linear) and amylopectin (branched).

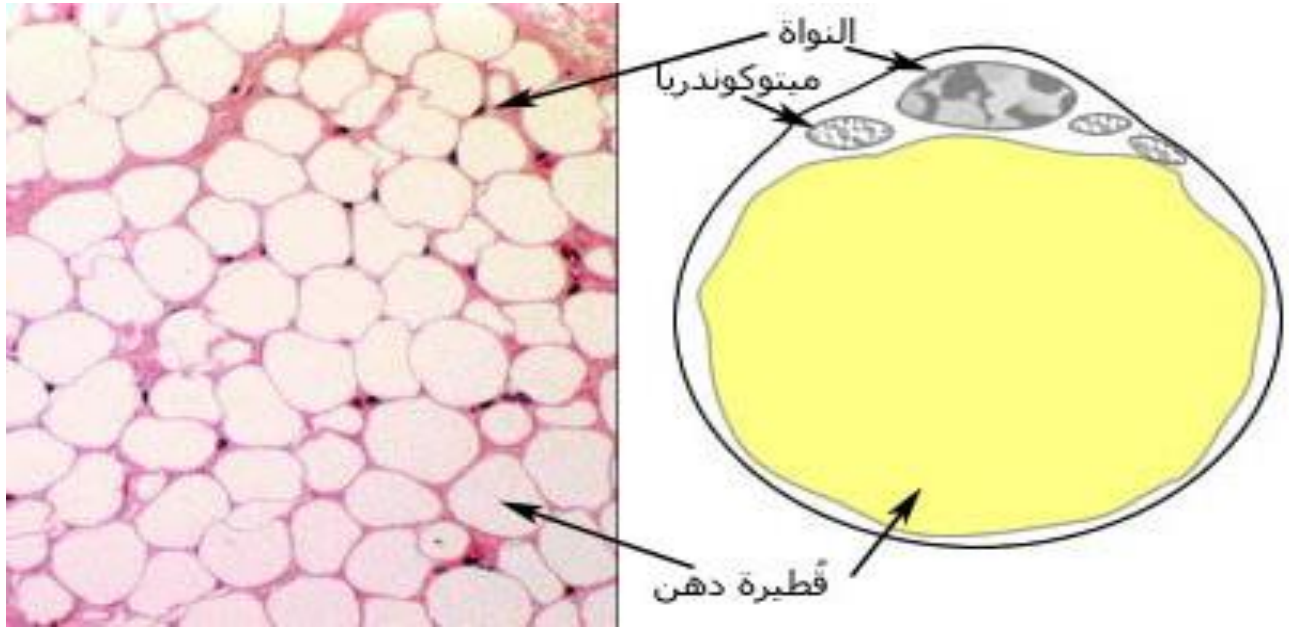
Zymogen granules under electron microscope





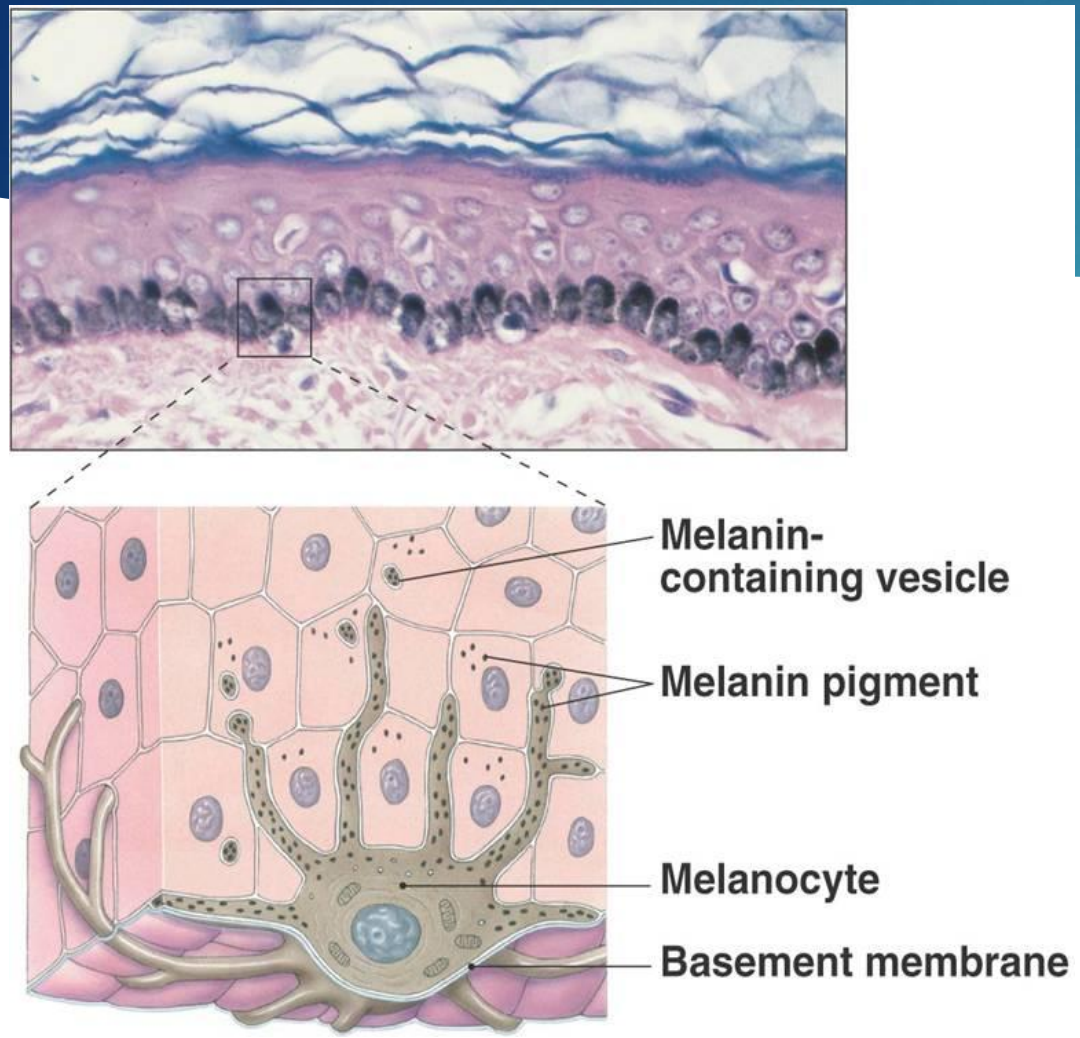
Zymogen granules under light microscope

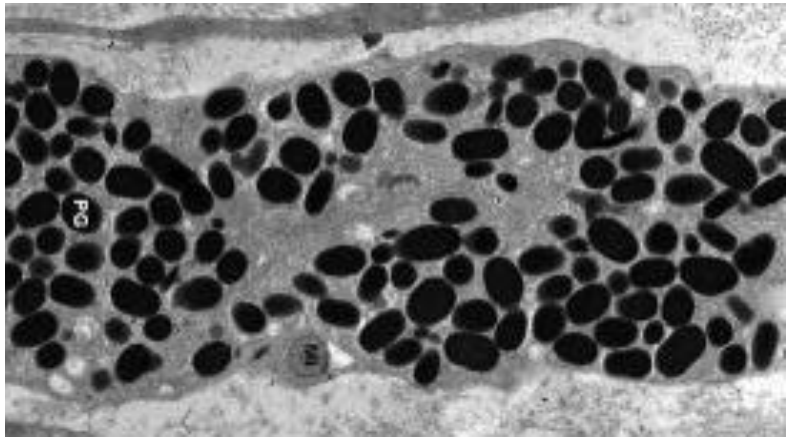
SECRETORY GRANULES



Lipid droplets

Adipose tissue

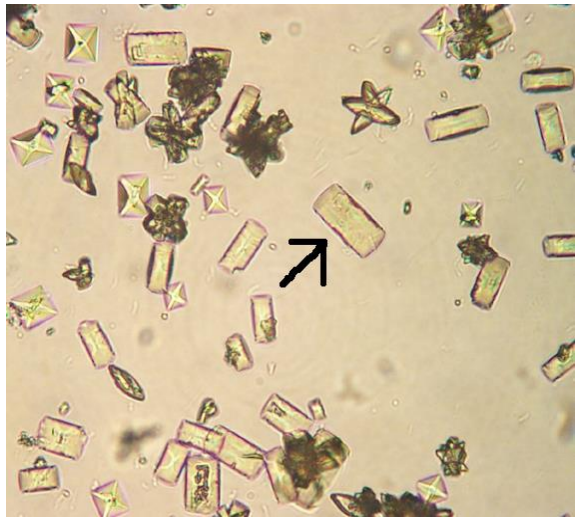




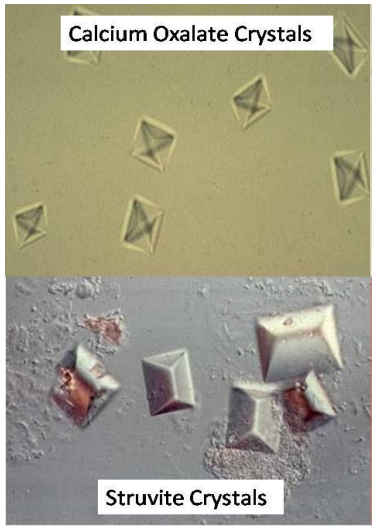
حبيبات الميلانين MELANIN GRANULES

(صورة بالمجهر الالكتروني)

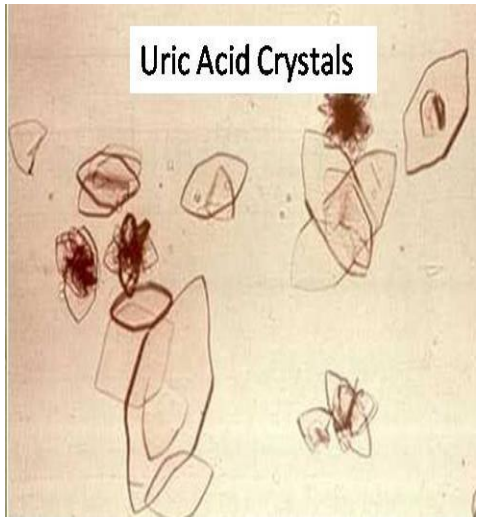
MELANIN GRANULES



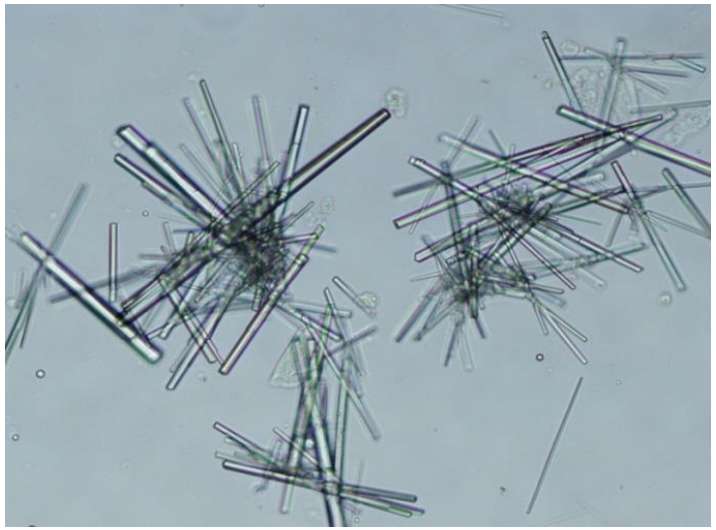
Rectangular crystals



Rhombic crystals



Irregular crystals

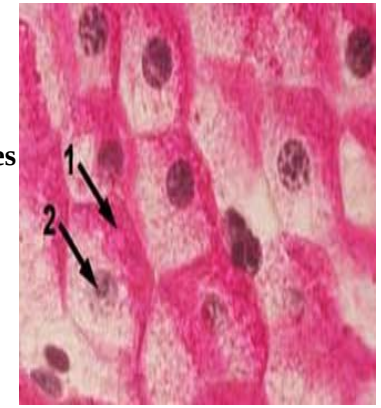


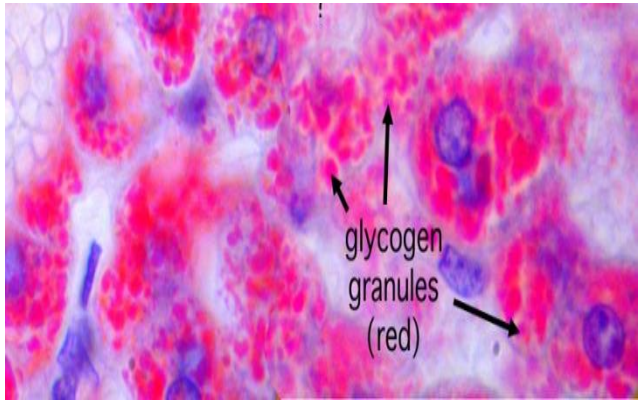
Needle crystals

CRYSTALS

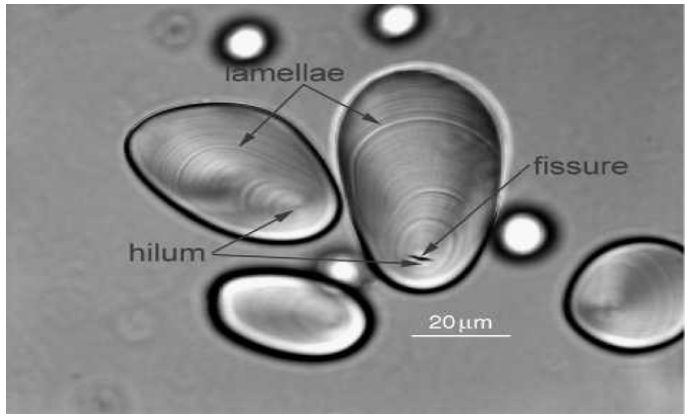
1. Glycogen granules

2.Nucleus





GLYCOGEN GRANULES



STARCH GRANULES

GRANULES