Welcome To

MD 203 Histology

Clinical Pharmacy

Faculty of Pharmacy

Mansoura University

Objectives

- To teach the students the basic histological structures of different cells and tissues of human body, preparing them for studying organs and systems.
- Making correlation between function and structure of various tissues.
- To prepare students for studying histopathology.

Histology

- Cytology is the science which deals with the study of cells.
- Histology is the science which deals with the study of body tissues.
- The cell is the smallest structural and functional unit of all living organisms.
- The tissue is a collection of cells that perform a similar function.
- The organ is a group of tissues that cooperate to perform a special function.
- The system is an organization of different organs.

HISTOLOGY: INTRODUCTION

"What is going on ?"

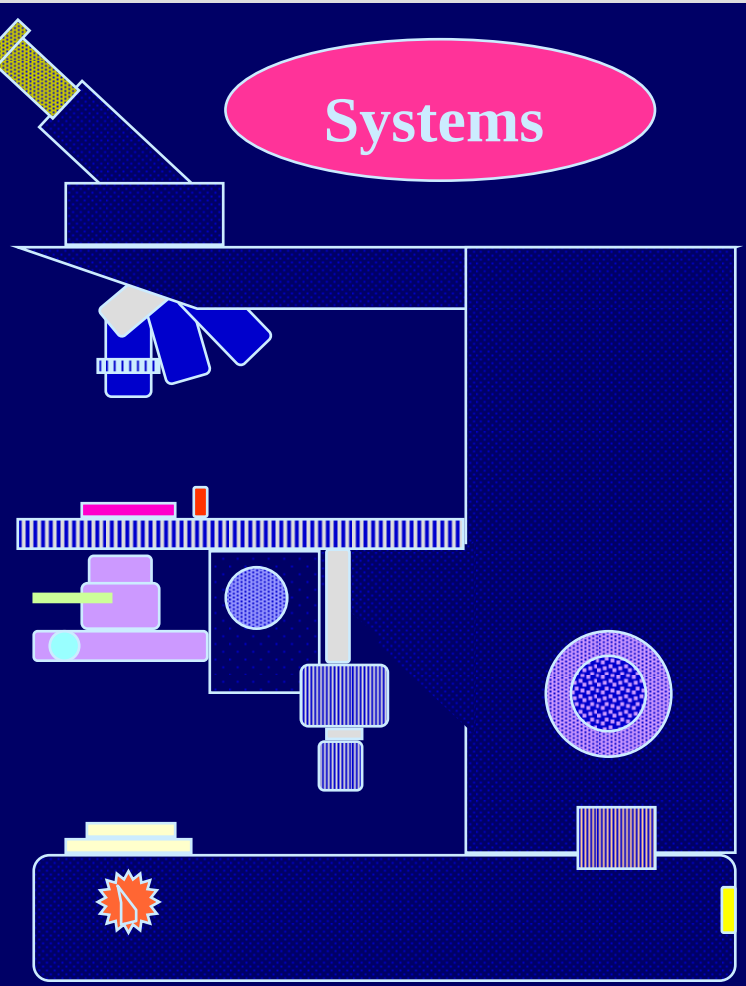
Regions

Systems

Organs

Parts

Tissues



Connections

Cells

Development

Organelles

Functions

Molecules

Pulling it together

Histology

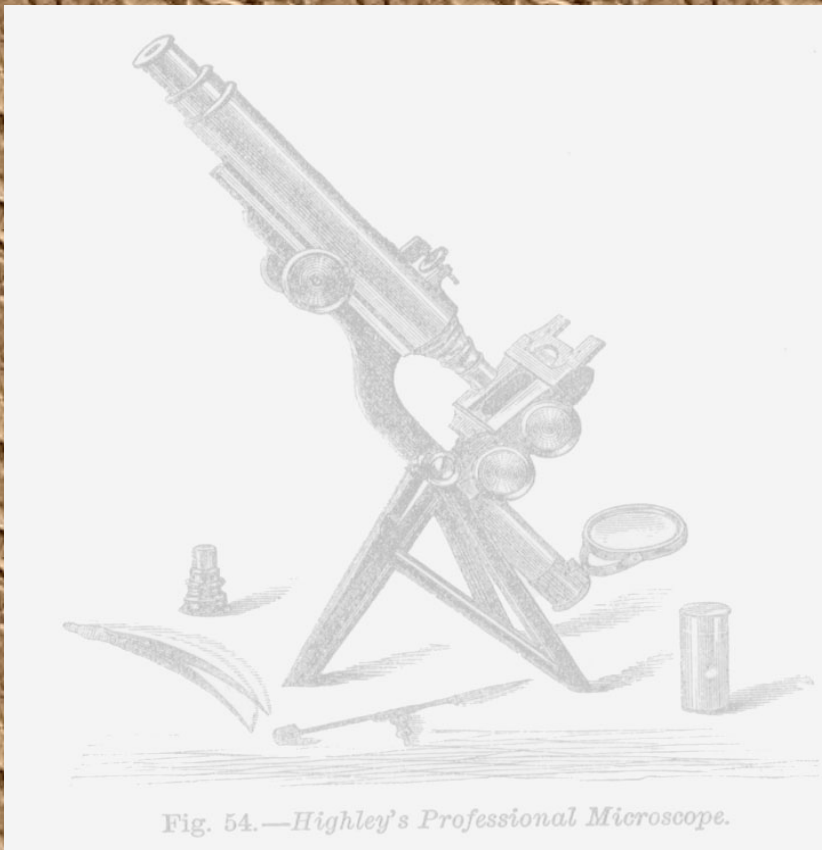


Fig. 54.—*Highley's Professional Microscope.*

General Histology

Special Histology

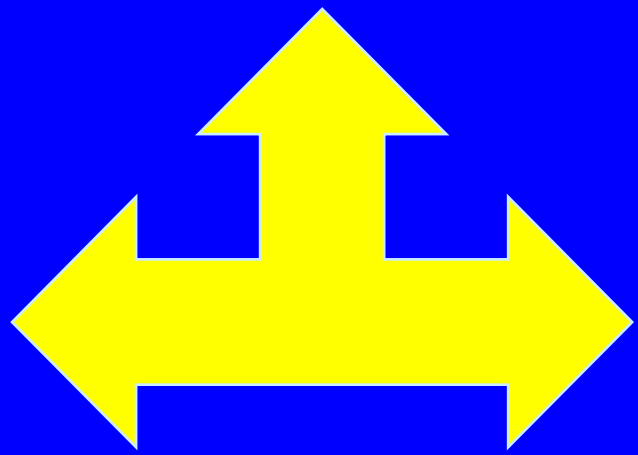
General Histology

Cytology

Tissues

- Epithelial
- Connective
- Muscular
- Nervous

Special Histology



Respiratory

Digestive

Urinary

Male Reproductive

Female Reproductive

Endocrine

Immune

Nervous

Skin

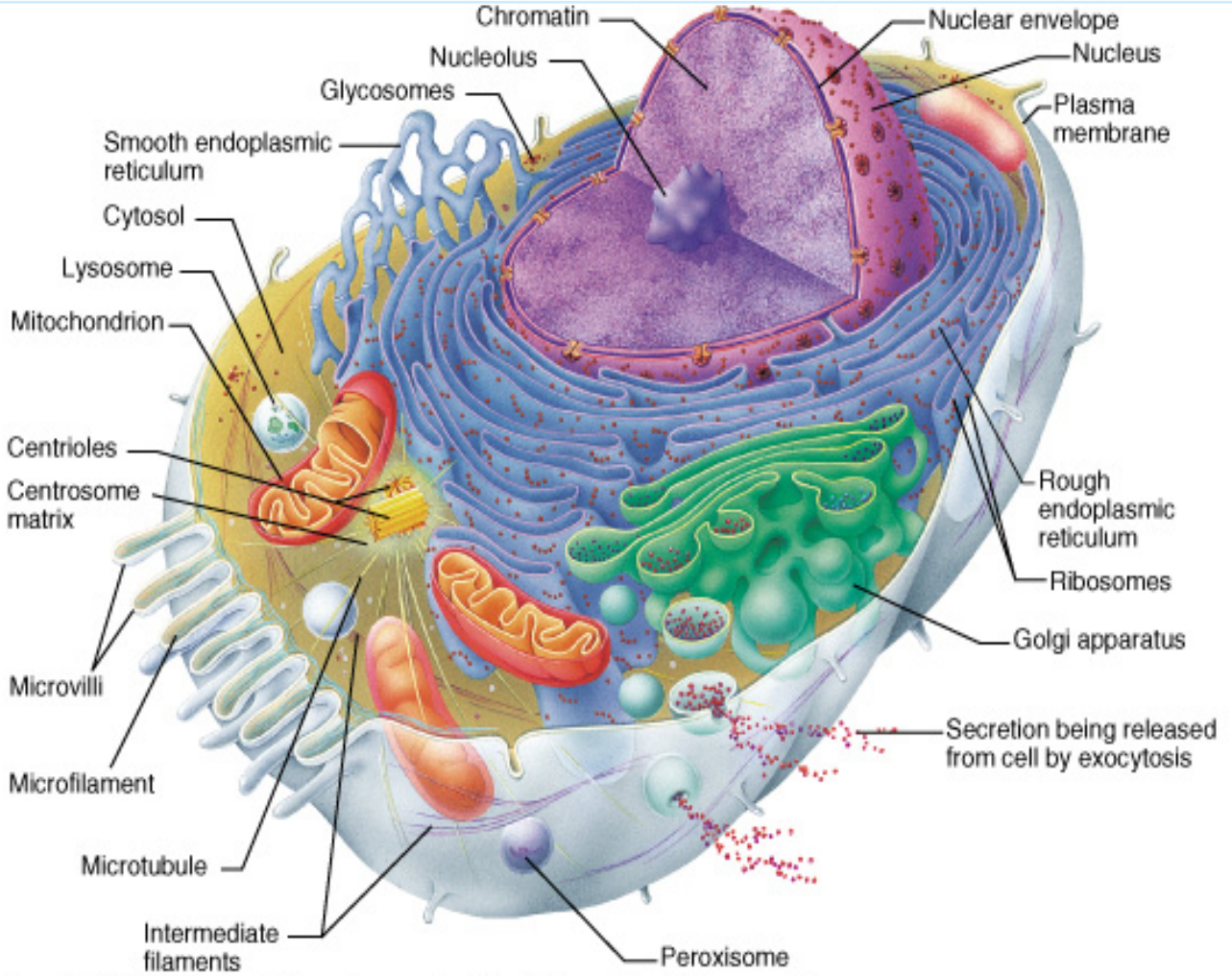
Eye & Ear

The Cell

Cytology

Protoplasm

Cytoplasm **Nucleus**



Cytoplasm

Organelles

Permanent Living Cytoplasmic structures

Perform specific or vital functions.

Inclusions

Temporary Lifeless

Accumulation of metabolites.

Such as pigments and stored food.

Cytoskeleton

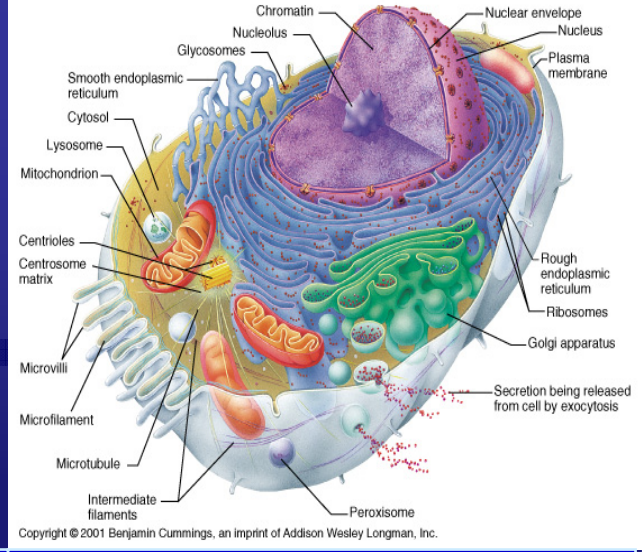
Complex network of minute filaments and microtubules.

Cytoplasmic organelles

Membranous

Non- membranous

Membranous



Non-Membranous

The membranous organelles are:

Cytoplasmic organelles that posses a bounding membrane of their own.
They include:
Cell membrane
Mitochondria
Endoplasmic reticulum
Golgi apparatus
Lysosomes
Peroxisomes

Unites used for measurements

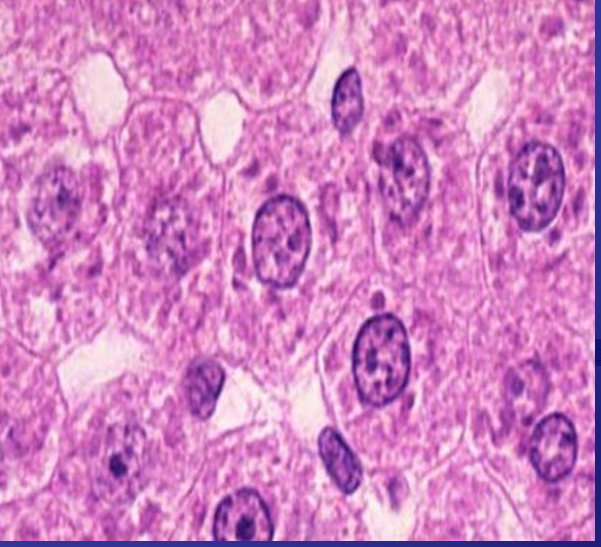
Micron (μm) = 1 X 10 -3 Millimeter

Nanometer (nm) = 1 X 10 -3 Micron

Angstrom (A)°= 1/10 nm

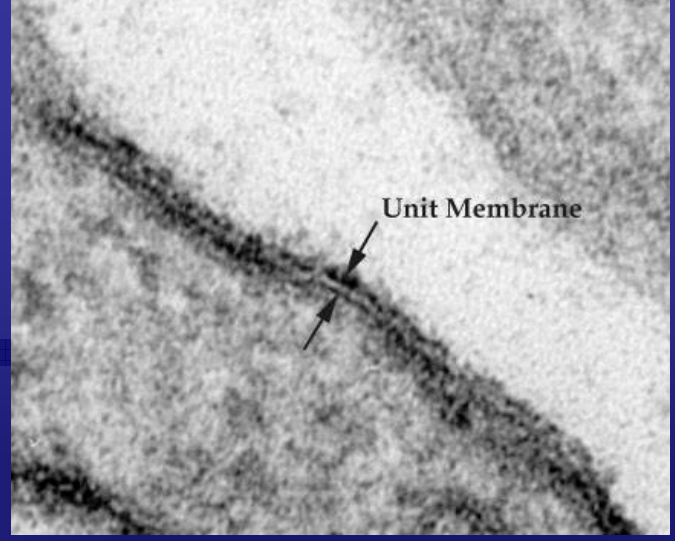
The non-membranous organelles are:

Cytoplasmic organelles that posses no bounding membrane of their own.
They include:
Ribosomes
Centrioles



With light microscope (LM):

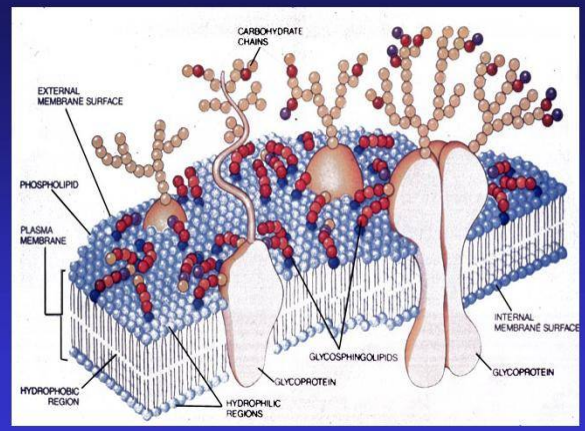
It is too thin (8-10 nm) to be seen.



With electron microscope (EM):

It appears as a **trilaminar** structure.

Consisting of outer and inner electron-dense layers separated by an intermediate electron-lucent layer.



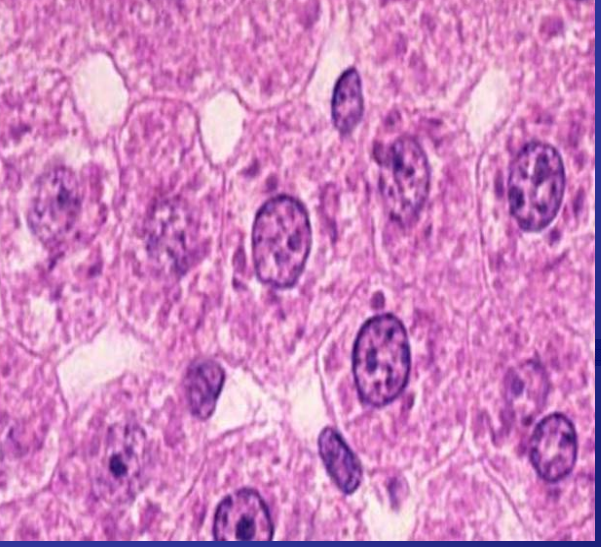
The Molecular Structure of the Cell Membrane (Fluid mosaic model).

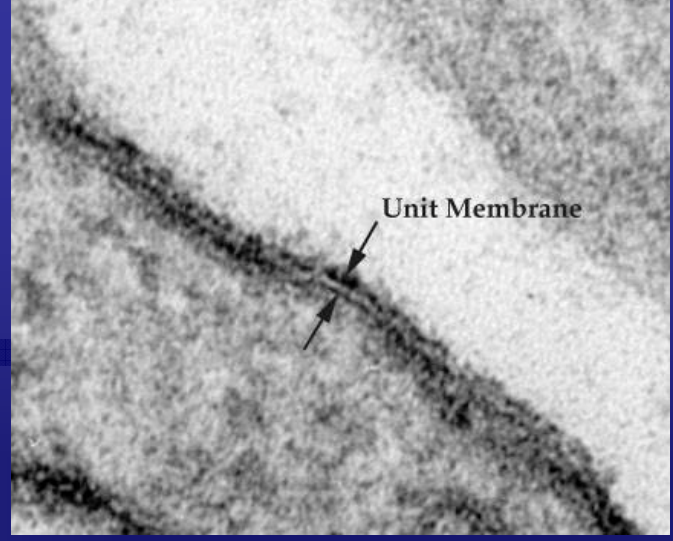
The cell membrane is formed of phospholipids, proteins, and carbohydrates.

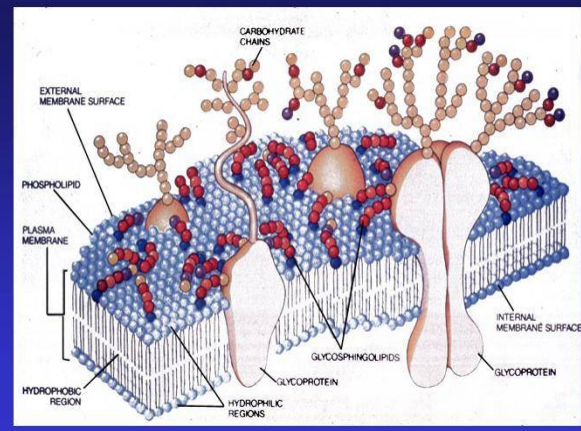
The phospholipids molecules form a bimolecular layer.

Each molecule is formed of two ends; polar or hydrophilic (has affinity with water) end, and non-polar or hydrophobic (has no affinity with water) tail.

Cell membrane







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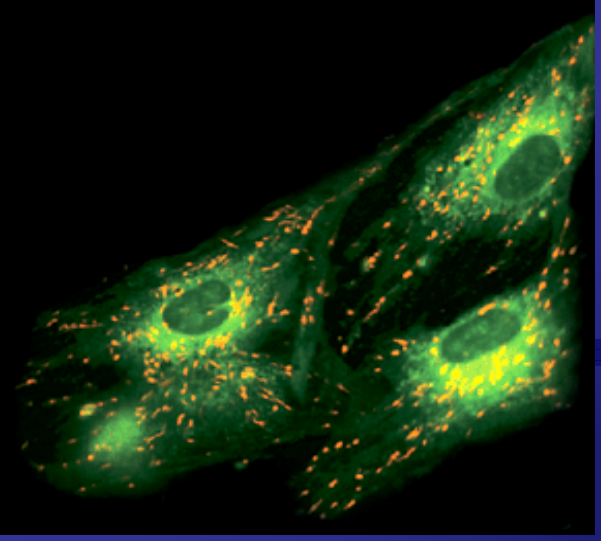
Cell membrane

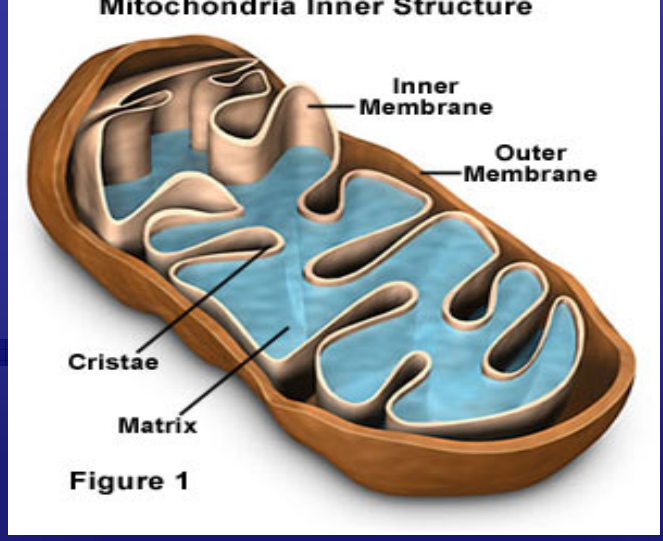
With electron microscope (EM):
It appears as a trilaminar structure.

Consisting of outer and inner <u>electron-dense layers</u> separated by an <u>intermediate electron-lucent layer</u>.

Hydrophilic ends are directed outward.
Hydrophobic tails are directed inward toward the center of the membrane.
The protein are arranged as globules moving freely within the lipid layer (intrinsic and extrinsic.
The carbohydrate is conjugated with the protein (glycoprotein) and lipid (glycolipid) molecules of the cell membrane (cell coat or glycocalyx).

<u>Functions of the cell membrane:</u>
Passive Diffusion
Facilitated diffusion
Active Transport
Selective transport





Mitochondria are membranous organelles.
Involved primarily in cell respiration and energy production.

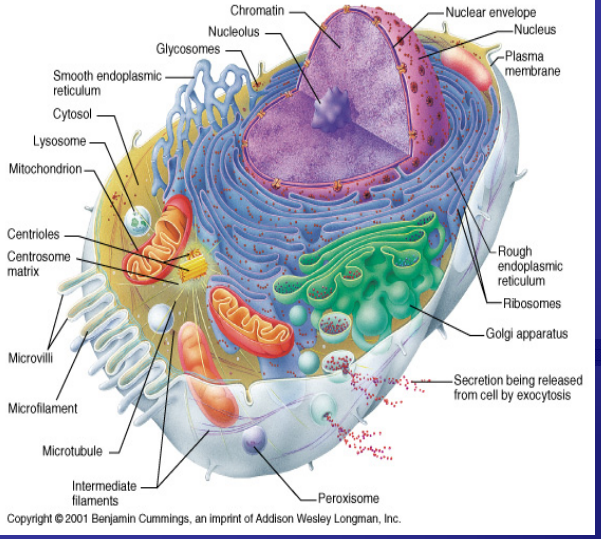
With LM:
Granules
Rod-like
Thread-like

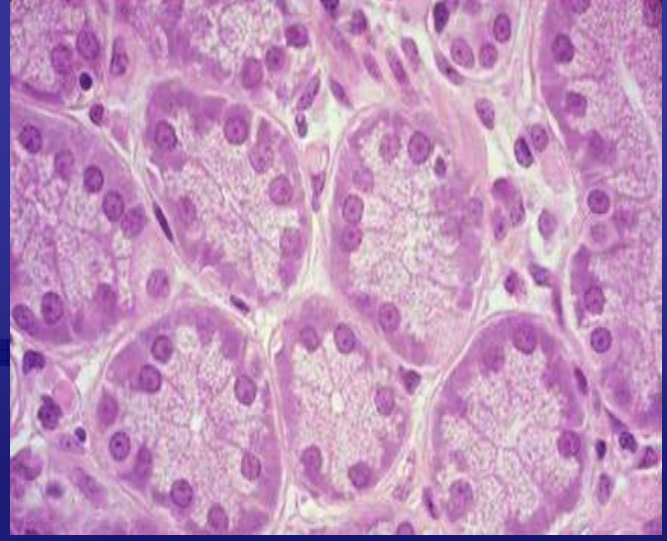
Mitochondria

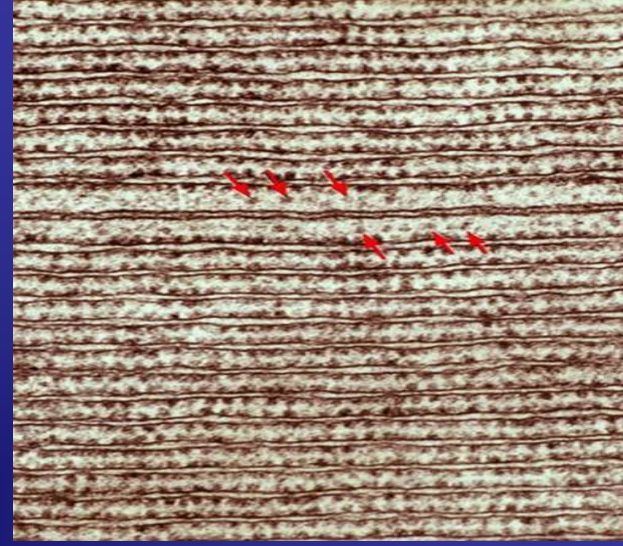
With electron microscope (EM):
It appears as an **ovoid** or elongated **structures bounded by two membranes. The outer membrane is smooth.**
The inner membrane is thrown into folds called **cristae** projecting into the inner cavity that is filled with an

Functions:
- **They house the chains of enzymes** that catalyze reactions **that provide the cells with most of its ATP (adenosine triphosphate).**

The **matrix** contains **enzymes of Krebs cycle** and **fatty acid oxidation.**
The **inner membrane** contains the **cytochromes** and the **enzymes involved in**







Endo=inside;
plasma=cytoplasm;
Reticulum = network.
The endoplasmic reticulum is
irregular network
branching and anastomosing
tubules
Cisternae
vesicles.
There are 2 types: rough ER and

Rough ER

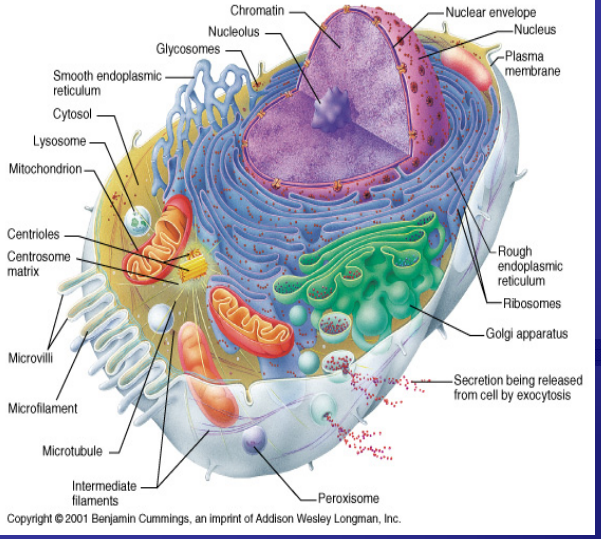
The rough endoplasmic reticulum is a membranous organelle concerned principally with synthesis and secretion of proteins.

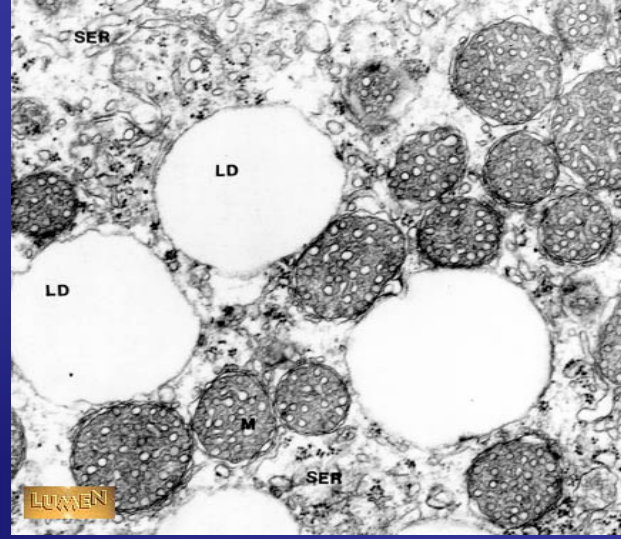
It is called rough due to the presence of large number of ribosomes attached to its limiting membrane.

With LM:
it appears as
basophilic
Cytoplasmic areas
that are referred to as the ergastoplasm or chromidial substances.

With EM:
it consists of an anastomosing network of:
tubules
vesicles and flattened cisternae that ramifies throughout the cytoplasm.

Functions:
Synthesis of proteins for extracellular use (secretory proteins, lysosomal proteins and membrane proteins).
Glycosylation of proteins to form





The smooth endoplasmic reticulum is membranous organelle.

It differs from the rER in that its limiting membrane is smooth and devoid of ribosomes.

With LM, it does not appear.

The cytoplasm of the cells contained abundant sER usually appears acidophilic.

Smooth ER

With EM, it appears as irregular network of membranous tubules and vesicles devoid of ribosomes in contrast to the flattened ribosome-studded cisternae of rER.

Functions:

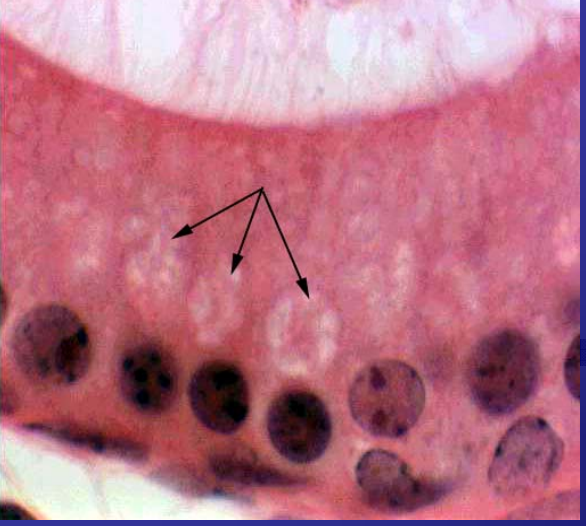
1. Steroid hormone synthesis in the testicular interstitial cells, the cells of the corpus luteum and adrenal cortex cell.

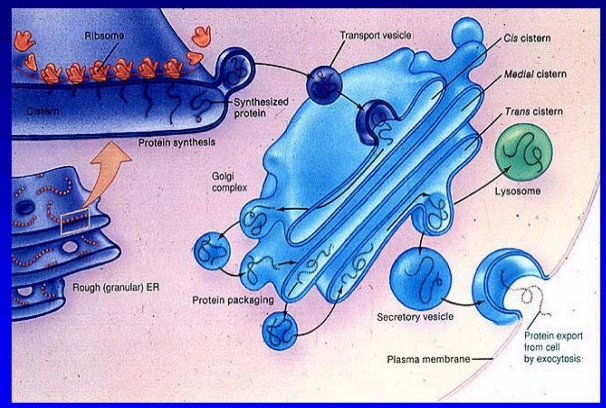
2. Drug detoxification in liver cells.

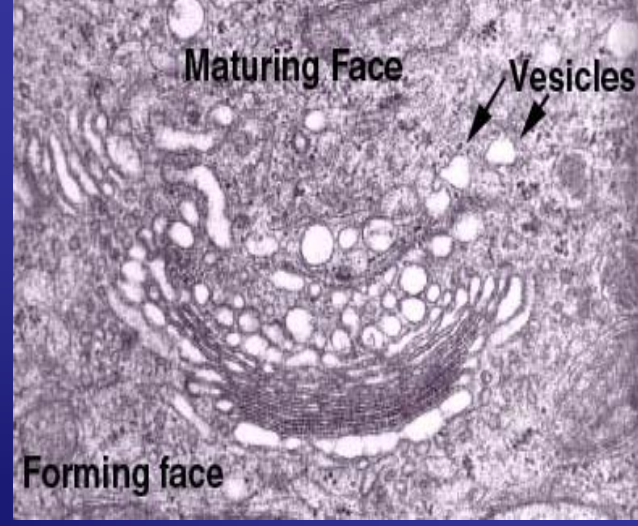
3. Lipid synthesis in the intestinal absorptive cells.

4. Release and storage of Ca++ ions in striated muscle cells.

5. Production of H CL in gasric parietal cells.







Golgi Apparatus

The Golgi apparatus is a membranous organelle concerned principally with synthesis, concentration, packaging and release of the secretory products.

With LM, it can be selectively stain with silver salts or osmium where it [illegible]

With LM, In H&E sections, it may be visible as a lighter-stained region called negative Golgi image.

It is seen to great advantage in secretory cells such as osteoblasts.

With EM, the main structure unit of the Golgi apparatus is a flattened membranous vesicle called Golgi saccule.

The Golgi saccules are arranged in Golgi

Each stack of saccules has:

1) A forming face or Cis face that is convex in shape.

2) A maturing face or trance face that is concave.

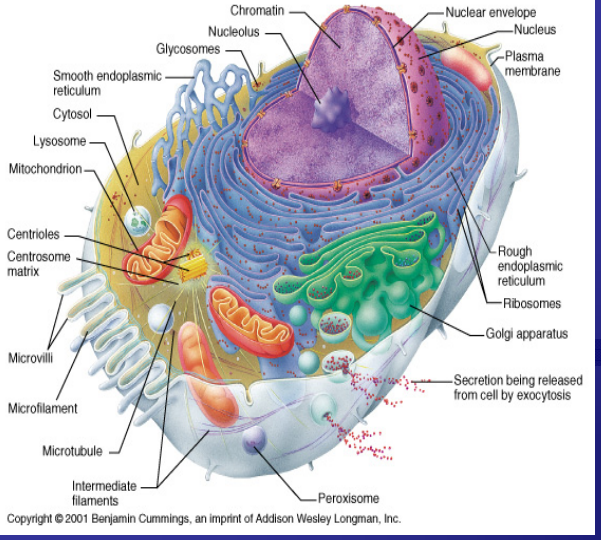
The Cis face is usually associated with a number of small transfer vesicles, and the trance face has much larger secretory granules.

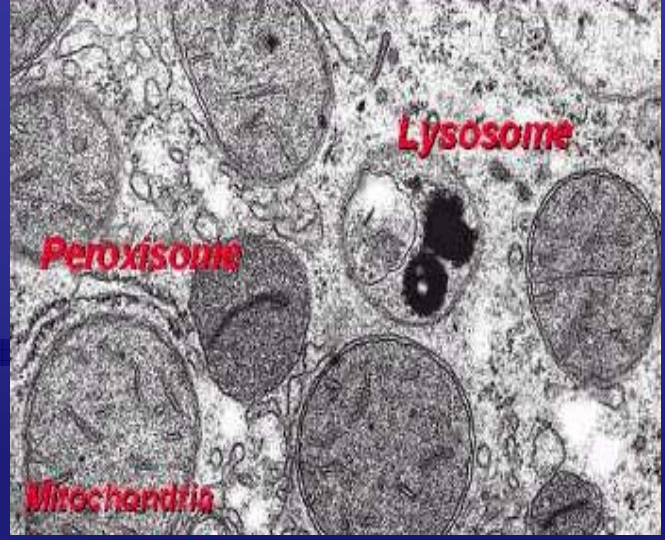
Functions:

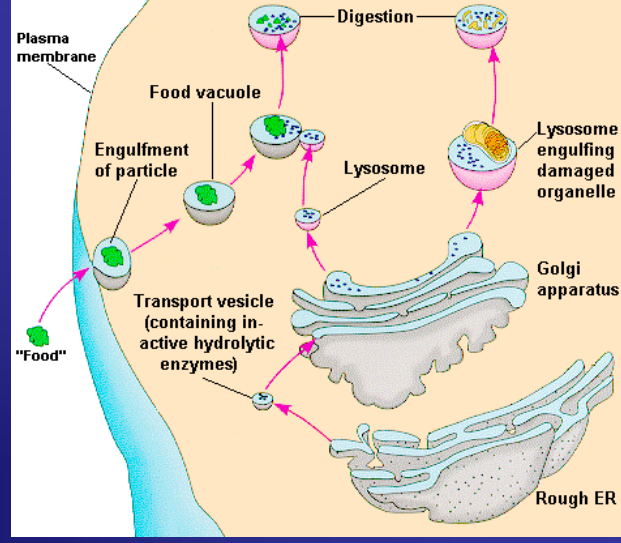
Packaging and concentration of secretions.

Modification of the secretory products such as glycosylation and sulfation of proteins to for glycoproteins and sulfated glycoproteins (mucus).

Production of primary lysosomes.







Lysosomes

They are membrane-bounded vesicles (0.2-0.4 μm) containing a number (more than 40) of hydrolytic enzymes that are active at acid pH (acid hydrolases) maintained within their interior.

This group of enzymes is capable of destroying all the major macromolecules (e.g., proteins and lipids) of

LM provides no direct evidence for the existence of lysosomes.

The lysosomes are resolved at the LM level when their enzyme contents (e.g., acid phosphatase) are stained by histochemical methods.

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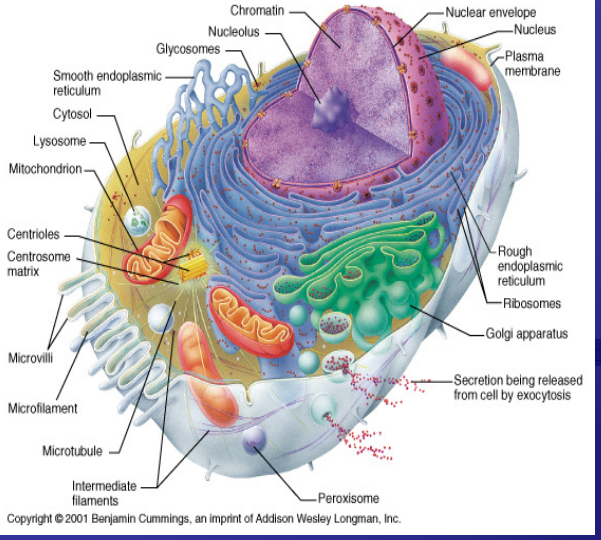
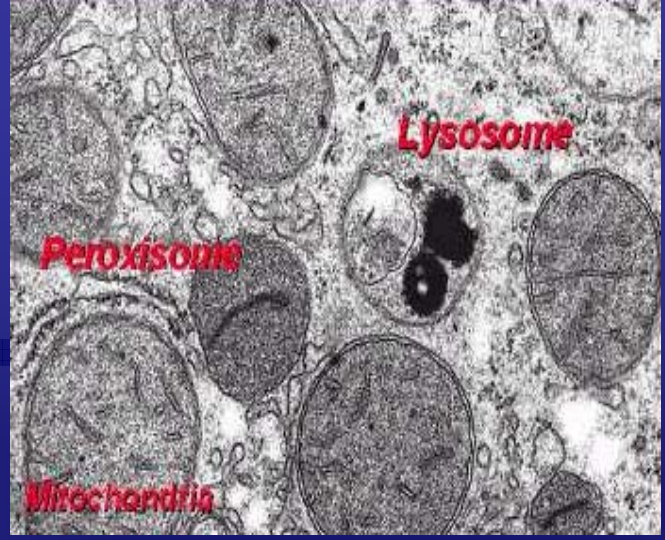
EM: The lysosomes appear

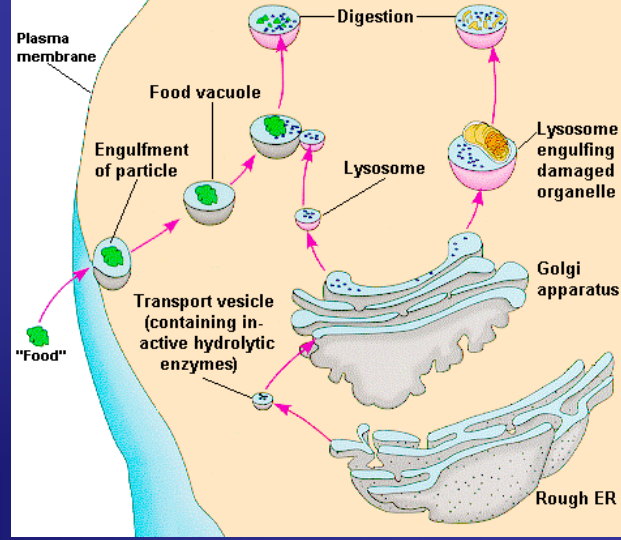
Types: Primary lysosomes, They are lysosomes freshly formed from the Golgi or sER.

They contain nothing but hydrolytic enzymes.

Secondary lysosomes are formed as the result of fusion of primary lysosomes with phagosomes. A phagosome is a membrane-bounded vesicle containing either exogenous material (e.g., bacteria) and it is called heterophagosome or endogenous material (e.g., damaged organelle) and it is called autophagosome.







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EM: The lysosomes appear

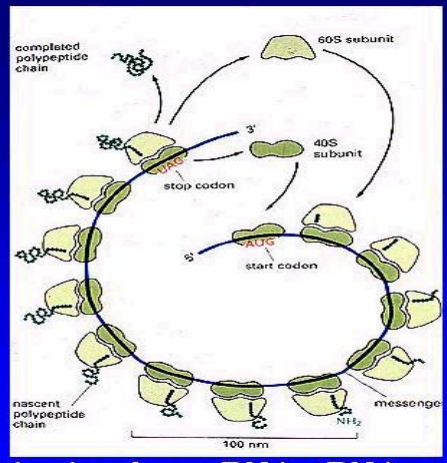
Multivesicular bodies are spherical forms of heterophagosomes.

They are membrane-bounded vesicles containing a number of smaller vesicles.

Functions:

Degradation of any exogenous macromolecules (phagocytosis and pinocytosis).

Disposition of any organelles or cell constituents that are no longer useful to the cell (autophagy).



Protein translation involves mRNA, tRNA and rRNA

Ribosomes

They are rounded ribonucleoprotein particles, 20-30 nm in diameter that provide the intracellular sites where amino acids are linked together to form polypeptide chains (proteins).

With LM:

They are too small to be seen.

Cell containing abundant ribosomes usually has basophilic cytoplasm.

With EM, the ribosomes are seen free in the cytoplasm either as separate entities or attached to messenger RNA molecules in small aggregation called polyribosomes or polysomes.

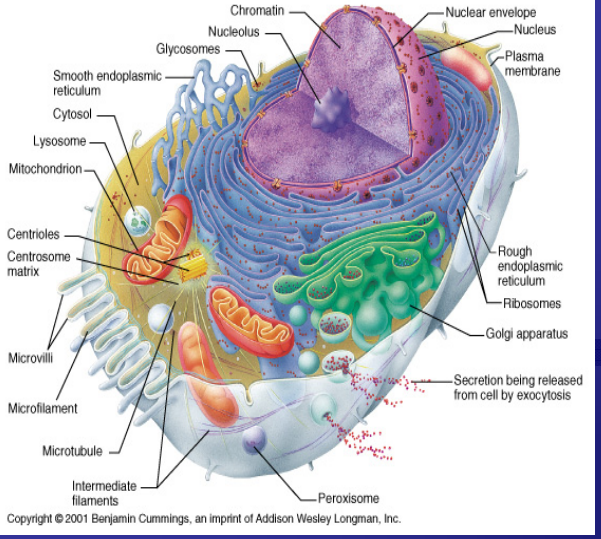
Polyribosomes may also be attached to the surface of rER.

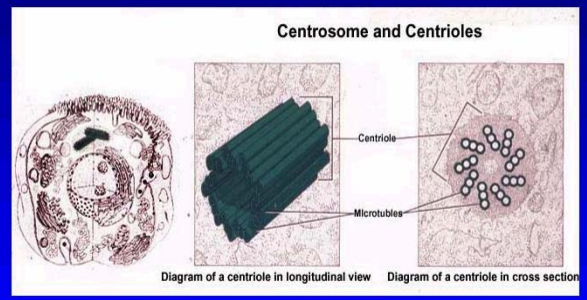
Each ribosome composed of a large and a small subunit that are made of rRNA and different types of proteins.

Functions:

Free ribosomes are responsible for synthesis of proteins for internal use (cytoplasmic proteins and enzymes).

Attached ribosomes are responsible for synthesis of proteins for external use (secretory or lysosomal enzymes





_-tubulin: mitosis, meiosis, flagella, basal bodies and cilia,

The centrosome is a specialized zone of cytoplasm contains a pair of centrioles that function as microtubular organization center (MOC).

In some epithelial cells, centrioles are located in the apical cytoplasm immediately beneath the ciliated surface. Such apical centrioles are called basal bodies.

With EM, each centriole is a hollow cylinder, closed at one end.

The two centrioles of each diplosome are arranged with their long axes at right angles to each other.

The wall of each centriole is made up of nine triplet of parallel microtubules connected to each other by a fine filaments, the protein link.

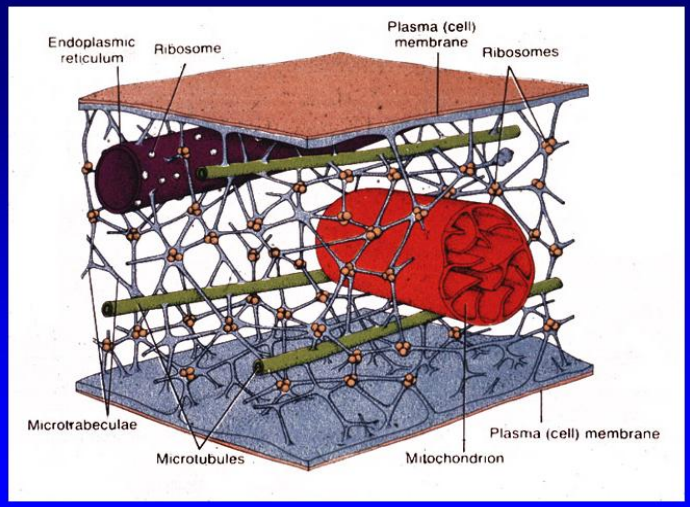
Functions:

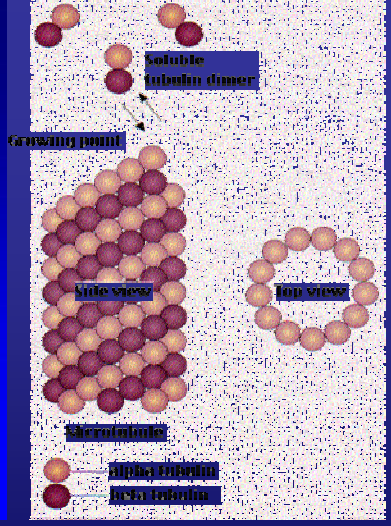
Formation of mitotic spindle during cell division.

Microtubular organization center (MOC)

Ciliogenesis

Centrioles





The Cytoskeleton is a complex network of minute filaments and tubules located within every cell, that maintain cell shape and stability and are responsible for some cell functions. It includes cytofilaments and microtubules.

Cytoskeleton

Cytofilaments:

Cytofilaments are minute thread-like structures of three types:

Actin (thin filaments)
Myosin (thick filaments)
Intermediate filaments.

Microtubules:

They are hollow tubular structures of variable length with a constant diameter of 25nm.

Microtubules are stable permanent structures in cilia, flagella, centrioles and basal

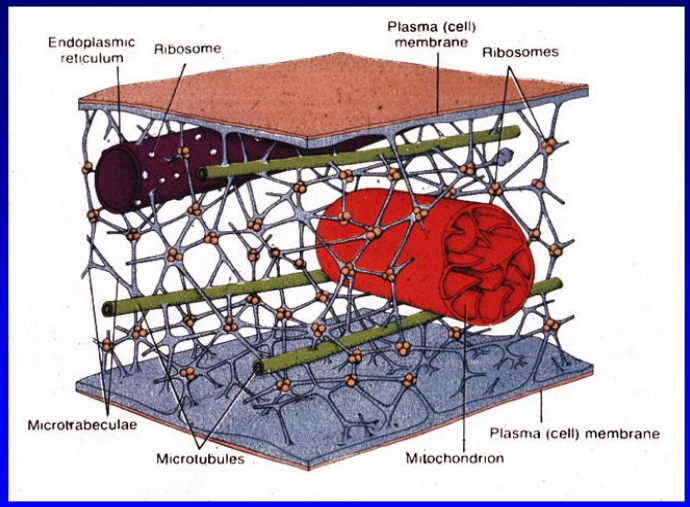
Functions:

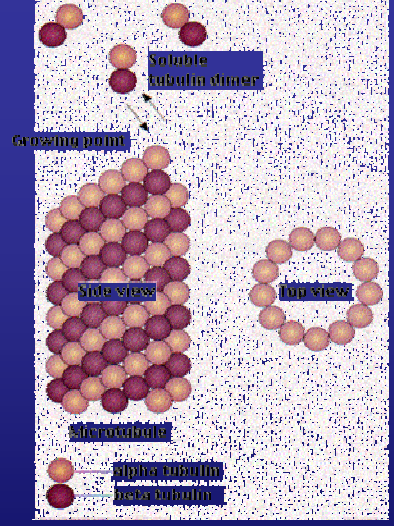
It provides the structural support for plasmalemma cellular organelles and some cytosol enzyme system.

It provides the means for the movement of intracellular organelles within the cytoplasm.

It plays an essential role in cell motility as well as provides the framework of motile structures such as cilia and flagella.

It is responsible for





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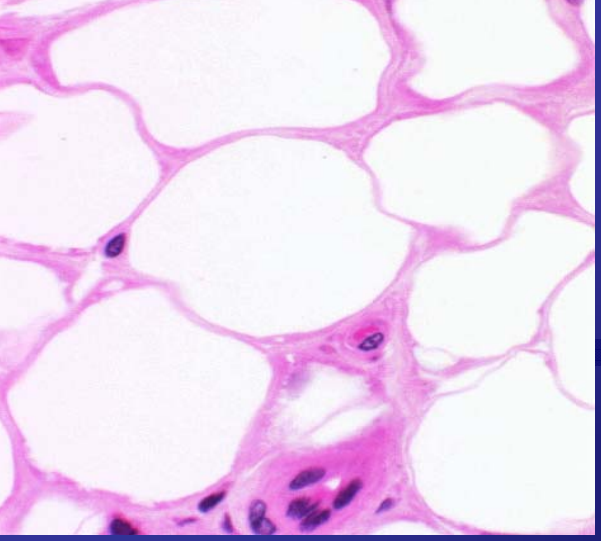
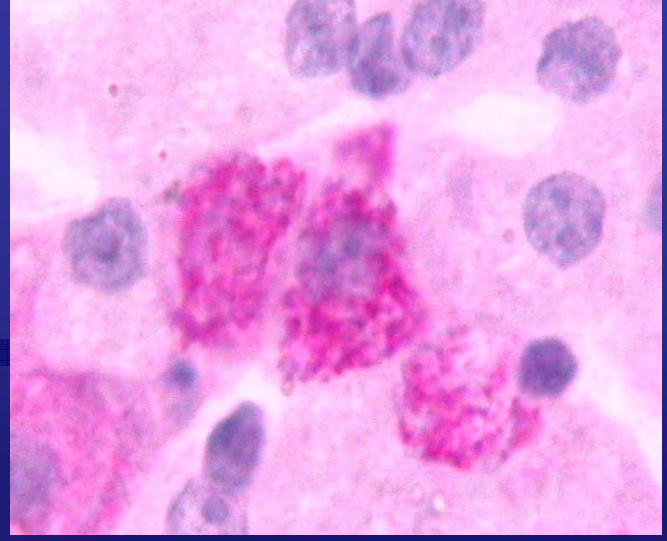
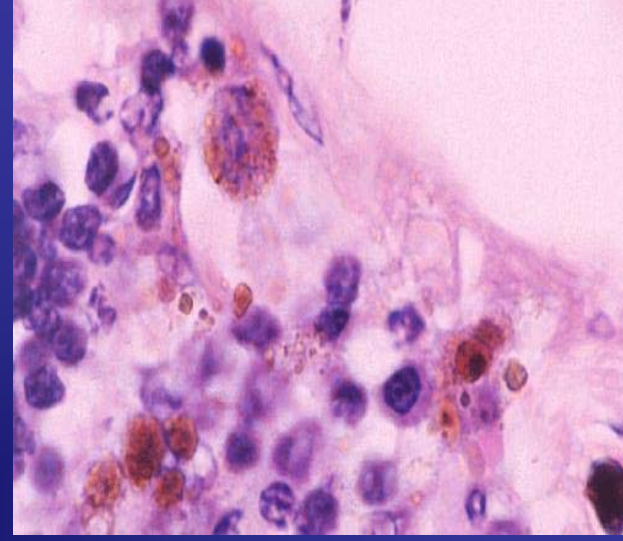






They are temporary lifeless accumulation of metabolites or cell products, such as stored food, pigments and crystals.

Stored food such as glycogen in liver cells, and lipids in fat cells.

Pigments are substances that have their own color in their nature state.

1. Exogenous pigments
2. Endogenous

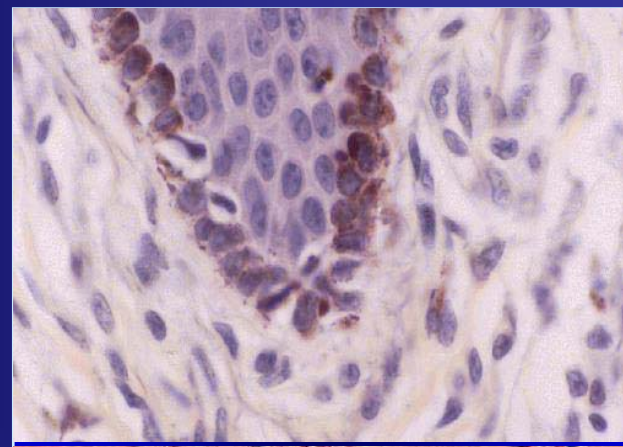
Inclusions

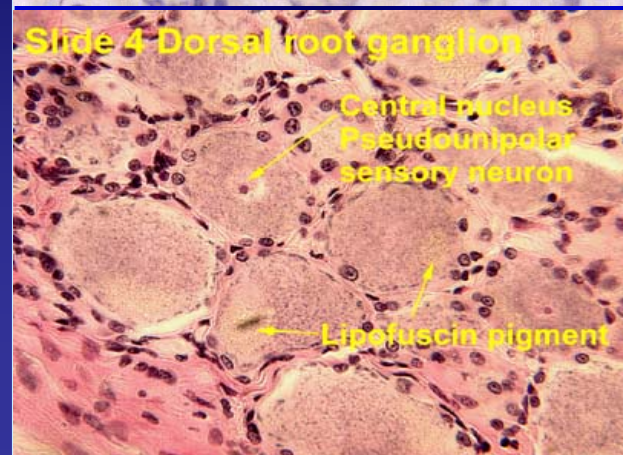
The exogenous pigments are those that have been produced outside the body.

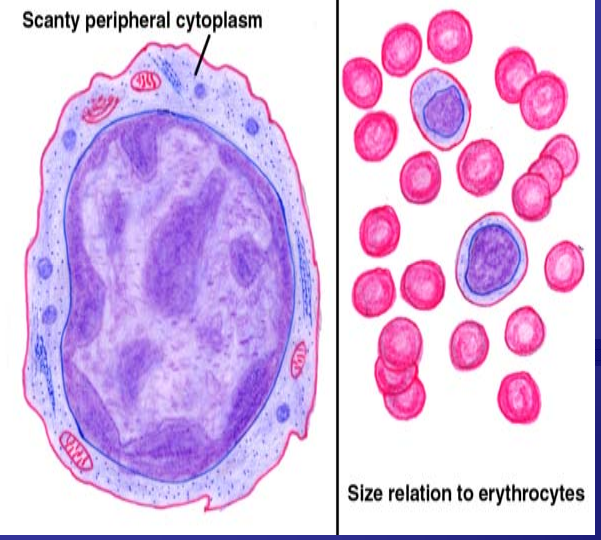
They include carotene, dusts, minerals and tattoo marks.

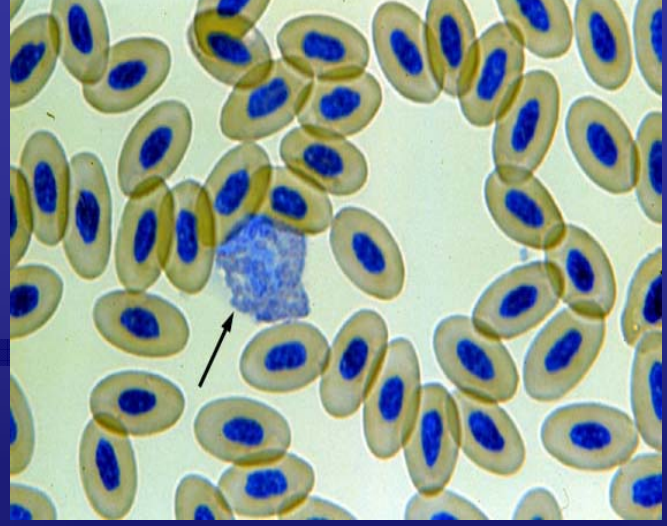
The endogenous pigments include:

Hemoglobin
Hemosiderin
Bilirubin
Melanin
Lipofuscin









The nucleus is the largest component of the cell.

It is present in all cells except the red blood cells.

It consists primarily of:

1. DNA (20% of its mass).
2. DNA-binding proteins.
3. Some RNA.

It carries the hereditary material (DNA).

It is responsible for cell division.

It controls all the cellular activities.

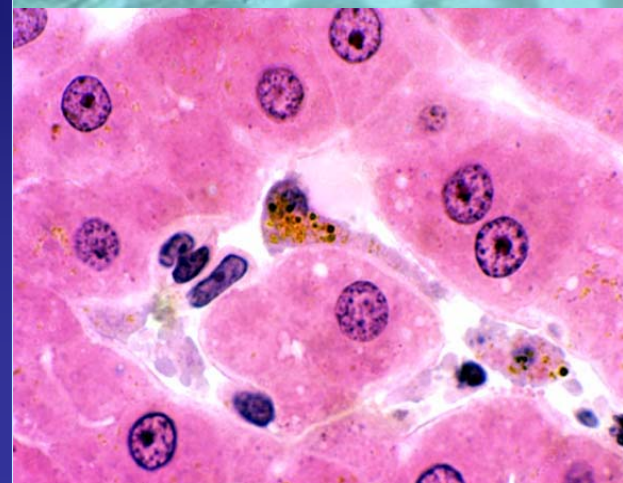
Nucleus

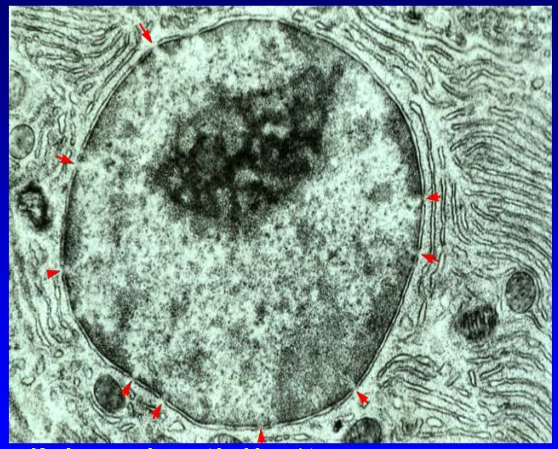
With LM, the nuclei appear as basophilic structure located either centrally, eccentric or in a peripheral position.

Most commonly nuclei are spherical or ovoid but they may be spindle-shaped (smooth muscle), bean or kidney-shaped (monocytes), or multilobulated (neutrophils).

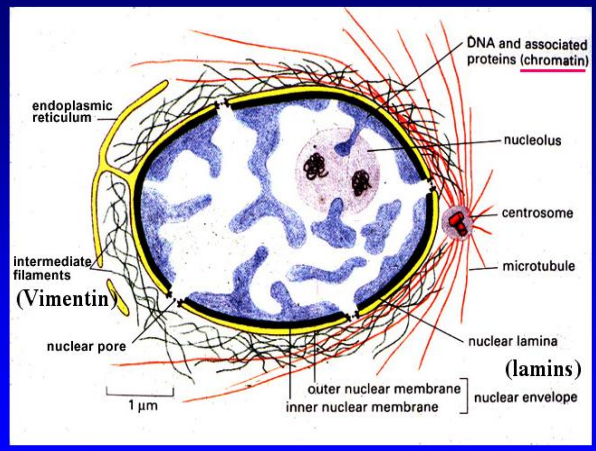
Most often, cells are mononucleated

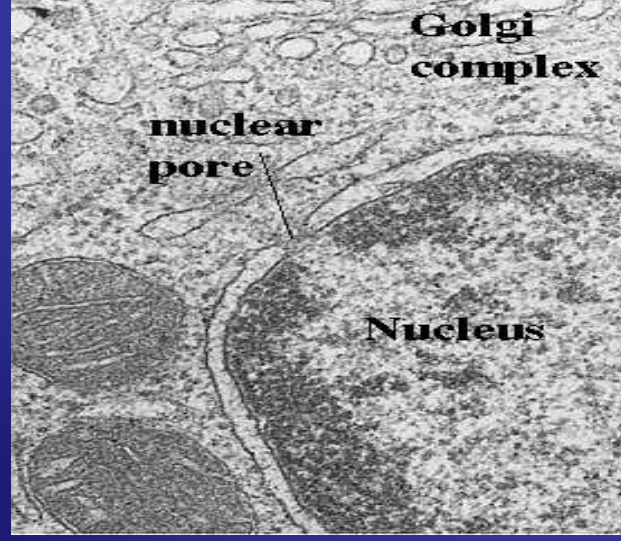
Some however, may be binucleated multinucleated.





Nuclear membrane (double unit), pores





The interphase consists of:

Nuclear envelope.

Chromatin.

Nucleolus.

Nuclear sap (karyolymph).

The NE with LM, it appears as a single basophilic line due to the presence of condensed chromatin adherent to its inner surface (peripheral

Nucleus

•With EM, the nuclear envelope consists of two membranes separated by a perinuclear space 25 nm wide.

▪Numerous pores through which the nucleus communicates with the cytoplasm interrupt the nuclear envelope.

•Two types of chromatin are distinguished:

•1. Heterochromatin

•2. Euchromatin.

•The heterochromatins consist of tightly coiled portions of chromosomes.

•The genes are repressed and transcription does not occur.

•It predominates in inactive cells.

•The euchromatin is the extended, uncoiled portions of chromosomes in which the transcription of DNA is active.

•The nucleolus is a conspicuous, spherical, basophilic structure that is primary concerned with synthesis of ribosomal RNA.

•The nuclear sap is a colloidal solution in which chromatins are suspended.

•It helps in the movement of RNA (rRNA, tRNA, and mRNA) toward the nuclear pores.