CELL STRUCTUR & FUNCTION:

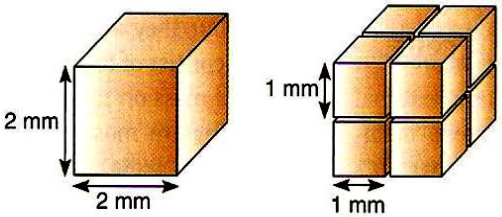
- **All** organisms are composed of cells, the smallest units of living matter.

Cells are capable of self – reproduction, and existing cells come only from preexisting cells **(CELLS THEORY).**

- In 1838-1839 **Matthiais Schleiden & Theodor Schwann** were the first to point out the plants & animals are composed of cells.
- **1855 Virchow** proposed that the new cells are formed only by the division of previously existing cells.
- In **1880 August Weisman**, was pointed that the ancestry of all the cells alive today can be traced back to ancient times.

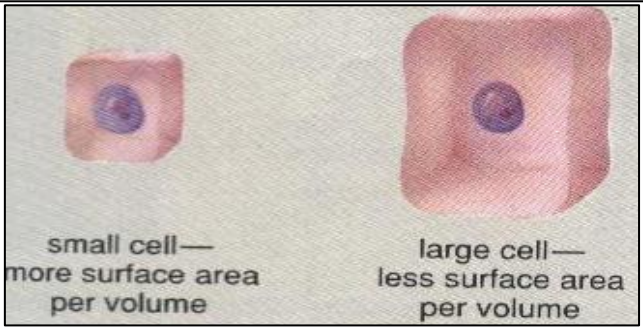
CELLS ARE SMALL:

- A cell needs a surface area that can adequately exchange materials with the environment.
- Surface – area to volume considerations require that cells stage small.
- A small cube that is 1mm. tall has a surface area of 6 mm^2& a volume of $1mm^3$ .This is a ratio of surface area to volume 6:1.But a cube that is 2mm tall has a surface area of 24 mm^2 and a volume of 8 mm^3. This is a ratio of only 3:1.



Surface Area (mm)	Surface Area = height x width x number of sides x number of cubes	24 (2 x 2 x 6 x 1)	48 (1 x 1 x 6 x 8)
Volume (mm)	Volume = height x width x length x number of cubes	8 (2 x 2 x 2 x 1)	8 (1 x 1 x 1 x 8)
Surface Area: Volume Ratio	Surface area/ Volume	3 (24/8)	6 (48/8)

Figure 4–2 Surface area–to–volume ratio. The surface area of a cell must be large enough relative to its volume to permit adequate exchange of materials with the environment. Although their volumes are the same, eight small cells have a much greater surface area (plasma membrane) in relation to their total volume than does one large cell. In the example shown, the ratio of the total surface area to total volume of eight 1-mm cubes is double the surface-to-volume ratio of the single large cube.



There are two major groups of cells:

Prokaryotic & Eukaryotic .Both have a plasma membrane & cytoplasm.

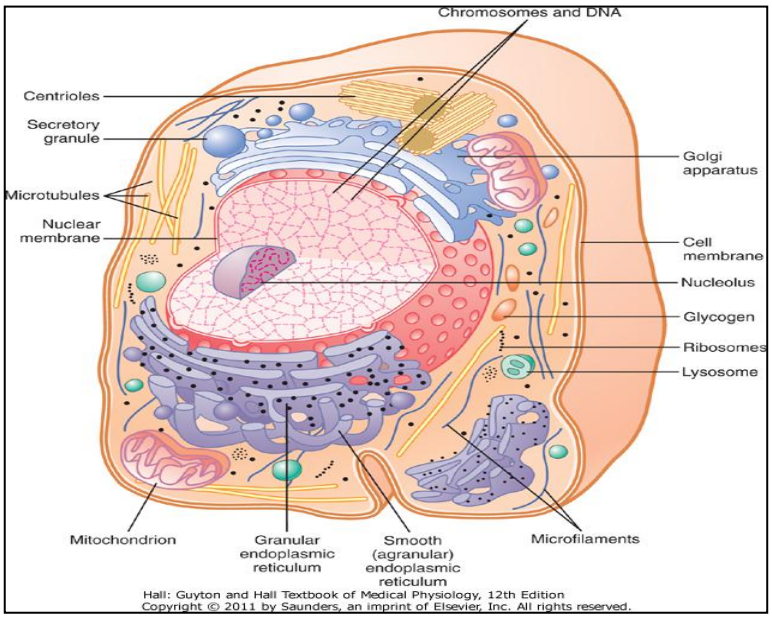
- Eukar.cells have a nucleus & various organelles.
- Proka .cells have anucleotide that is not bounded by nuclear envelope . They also lack most of the other organelles that compartmentalize euka .cells

ORGANIZATION OF THE CELL:

- Every cell is surrounded by plasma membrane which serves as a selective barrier between the cell & its surrounding environment.
- Cells have genetic instructions coded in DNA.
- Cells have internal structures called ORGANELLES have specific function .
- Cell size & Shape are related to function.
- Cells are quit small ex. a frog's egg, at about 1mm .others cell are measured in nanometer nm. .

Eukaryotic cell:

- Have a true nucleus : which is a membrane bounded structure where DNA is housed within thread like structure called chromatin
- In eukaryote, organelles are small membranous bodies each with a specific structure & function.
- The cytosol which is a semi fluid medium outside the nucleus, is divided up & compartmetalizated by organelles.
- Compartmentalization keeps the cell organized & keeps it various functions separate from one another.
- The cytosol in eu. Cell has organized lattice protein filaments (cytoskeleton).



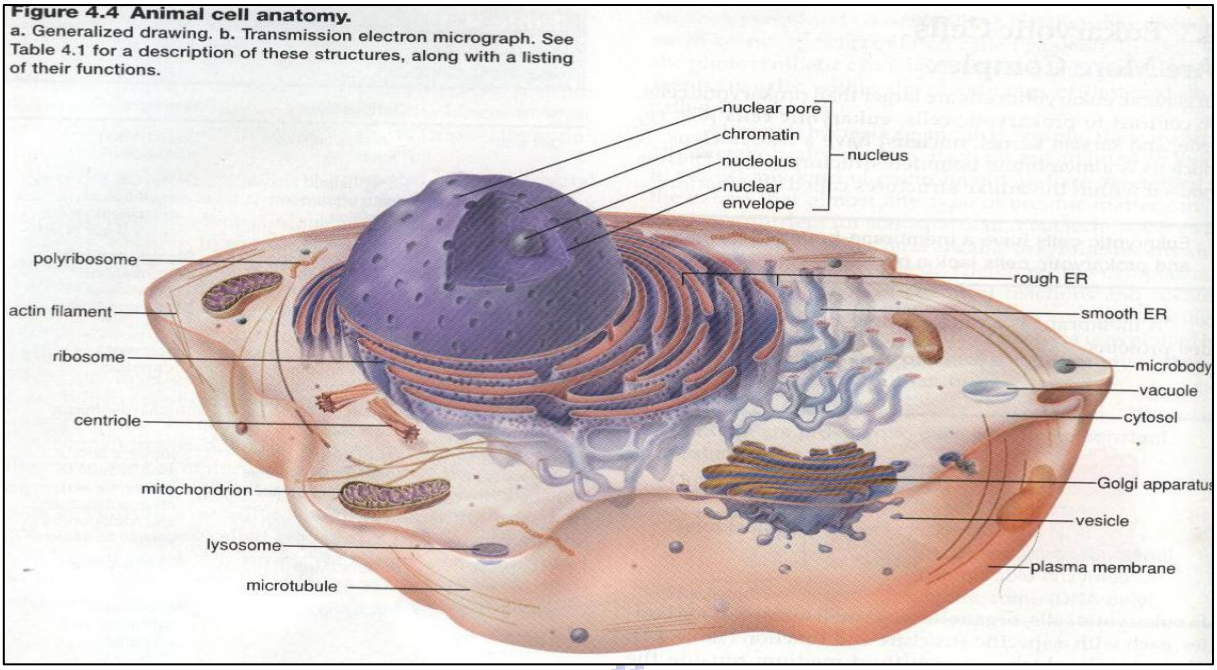
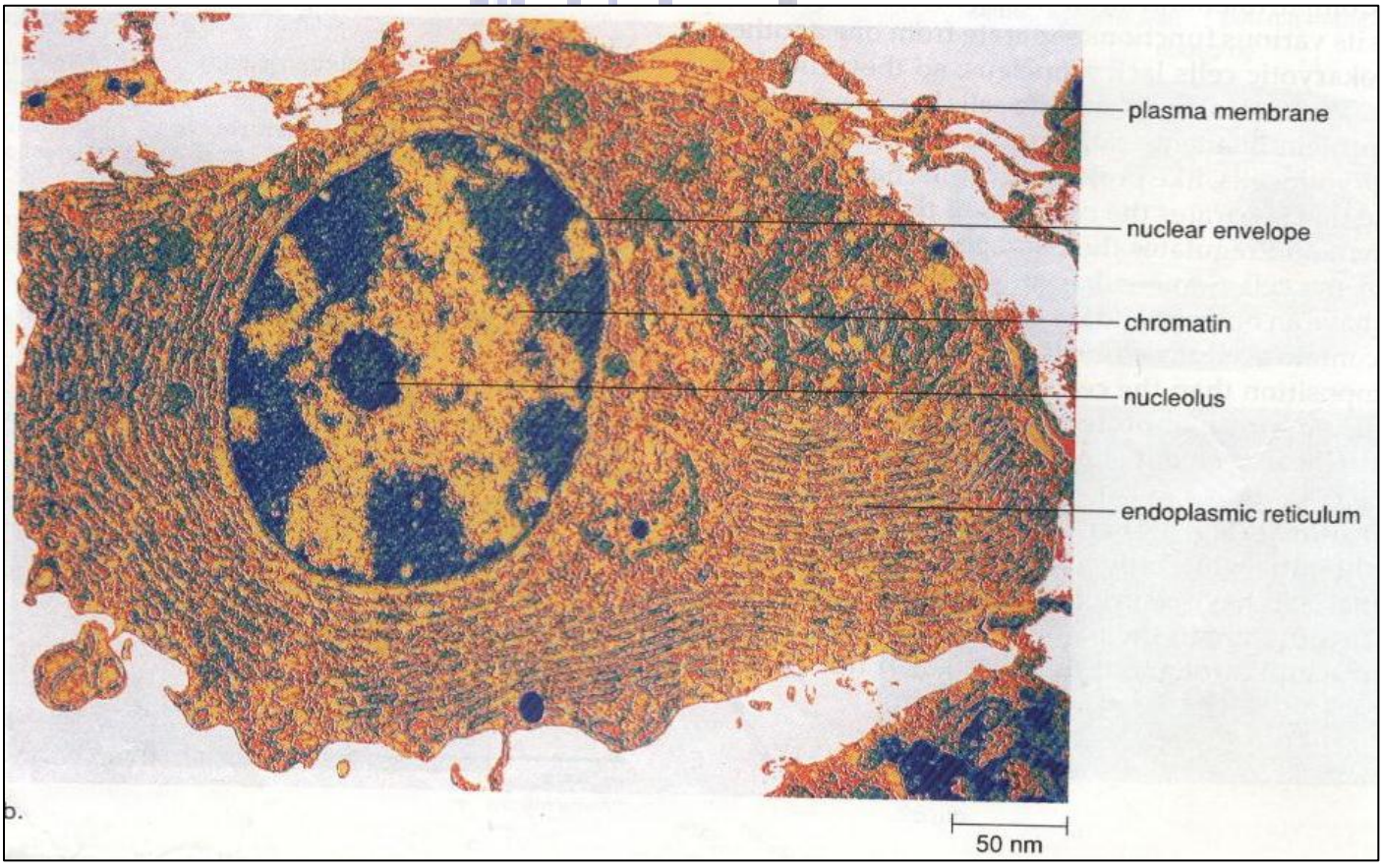


Figure 4.4 Animal cell anatomy.
a. Generalized drawing. b. Transmission electron micrograph. See Table 4.1 for a description of these structures, along with a listing of their functions.

1-Nucleus: Diameter of about 5µm, 1t stores genetic information that determines the characteristic of the body's cells &their metabolic function.

- Every cell contains a complex copy of genetic information, but each cell type has certain gene. DNA chromatin (chromosome) contains DNA & much protein.
- Chromatin is immersed in a semi fluid (Nucleoplasm). it is a threadlike material that undergoes coiling into rod like structures called chromosomes



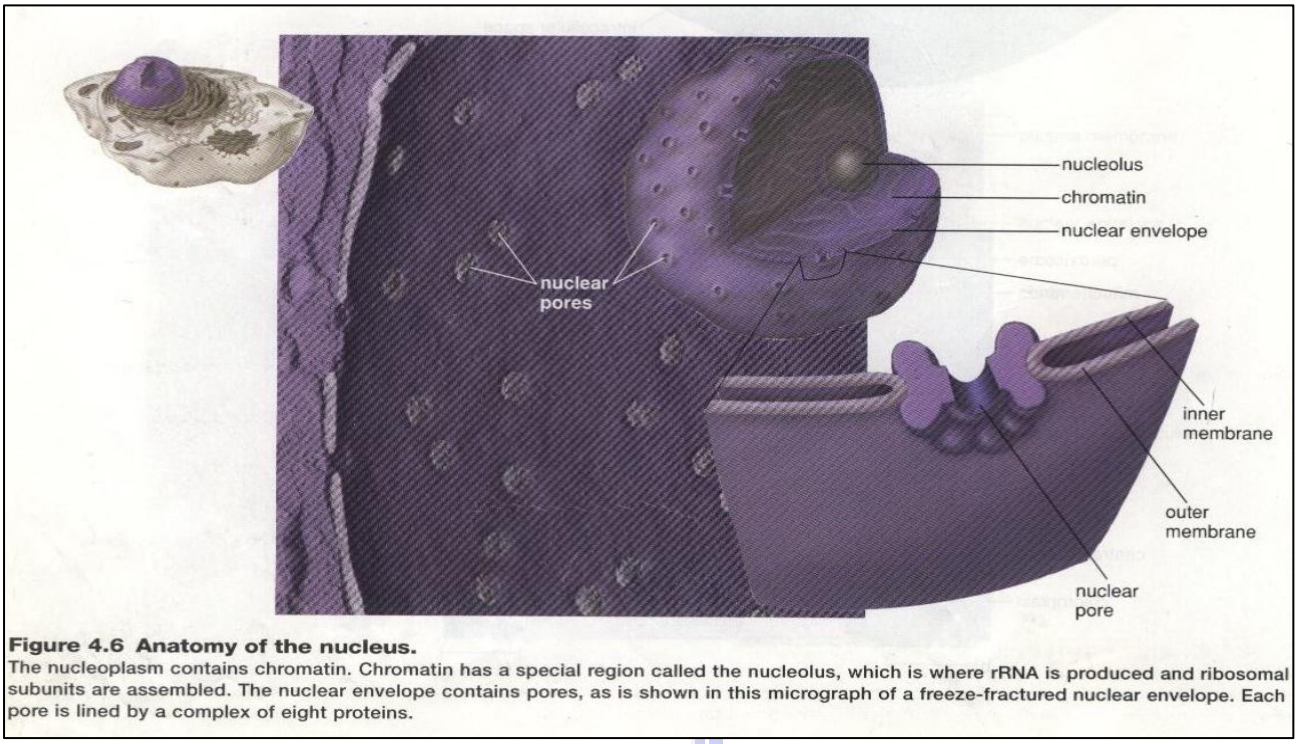
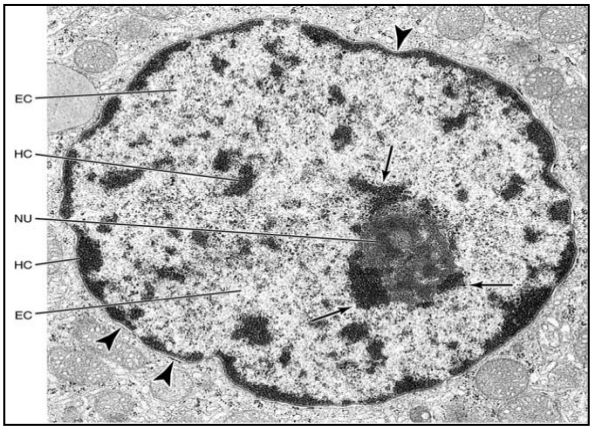


Figure 4.6 Anatomy of the nucleus.
The nucleoplasm contains chromatin. Chromatin has a special region called the nucleolus, which is where rRNA is produced and ribosomal subunits are assembled. The nuclear envelope contains pores, as is shown in this micrograph of a freeze-fractured nuclear envelope. Each pore is lined by a complex of eight proteins.

- The nucleus is separated from the cytoplasm by a double membrane known (Nuclear envelope) the inner membrane of N.E. composed of protein& fiber called (nuclear lamina) which keeps :

1- The shape of the nucleus.
2- Organize chromatin.
3- May funnel substances toward or away from the nuclear pores.



2- Ribosomes: Are sites of protein synthesis it **is found in both pro &euk**. are slightly smaller in prok. They are composed of 2-subunits, large & small. *Ribosome occurs: 1-free within the cytosol. Either single or in groups called polyribosome .They are often, attached to the endoplasmic reticulum ER→RER.

SER= smooth ER, without attached ribosome

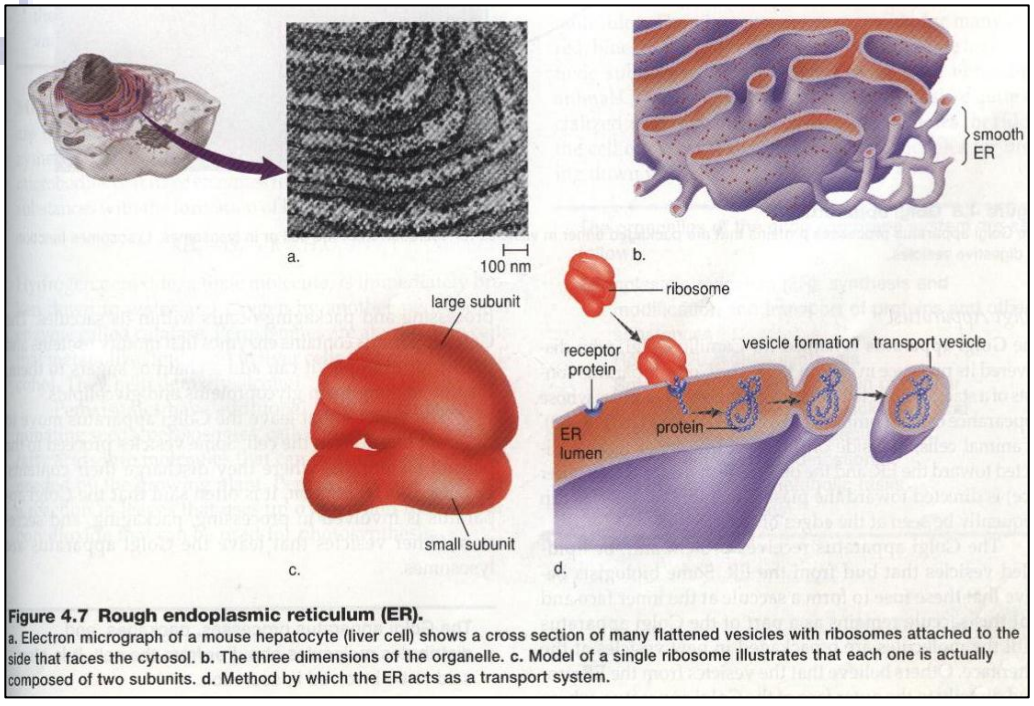


Figure 4.7 Rough endoplasmic reticulum (ER).
a. Electron micrograph of a mouse hepatocyte (liver cell) shows a cross section of many flattened vesicles with ribosomes attached to the side that faces the cytosol. b. The three dimensions of the organelle. c. Model of a single ribosome illustrates that each one is actually composed of two subunits. d. Method by which the ER acts as a transport system.

3- Endomembrane System

- It consists of

a. Nuclear envelope b. Endoplasmic reticulum c. Golgi apparatus d. Vesicles

- This system compartmentalizes the cell so that particular enzymatic reactions are restricted to specific regions.
- It is a complicated system of membranous channels & saccules (flattened vesicles) is physically continuous with the outer membrane of the nuclear envelop

A- ***Rough E.R*** **is** studded with ribosome on the side of the membrane that faces the cytoplasm (protein syn.).

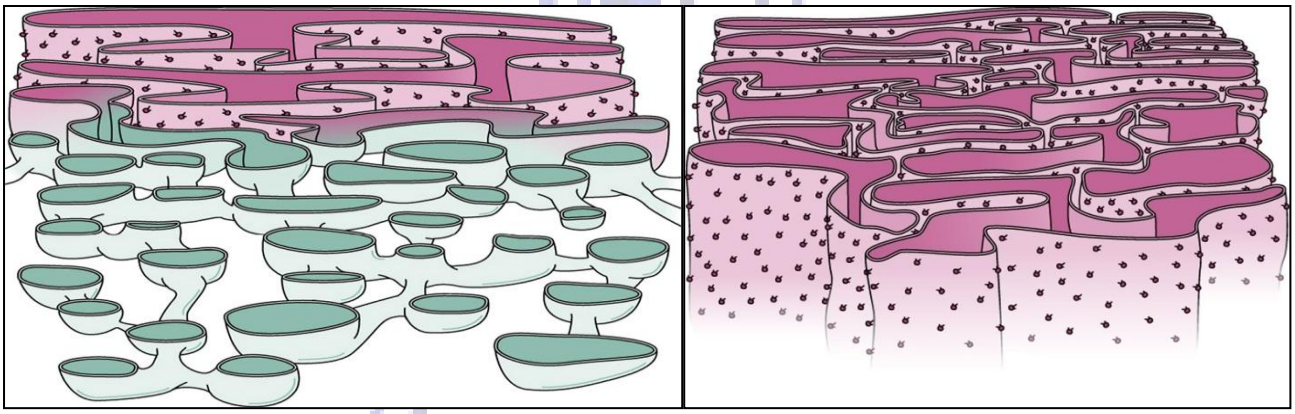
B- ***Smooth E.R*** continuous with RER**. It**

1-synthesizes the phospholipids that occur in membranes, in addition to other function:

2. In testes, it produces testosterone.

3. In liver, it helps detoxify drugs.

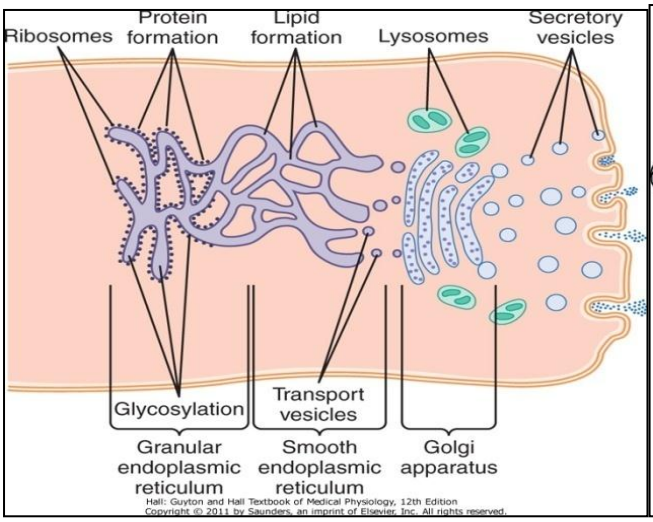
4. It also forms vesicles in which large molecules are transported to other parts of the cell often these vesicles are on their way to the plasma or golgi apparatus

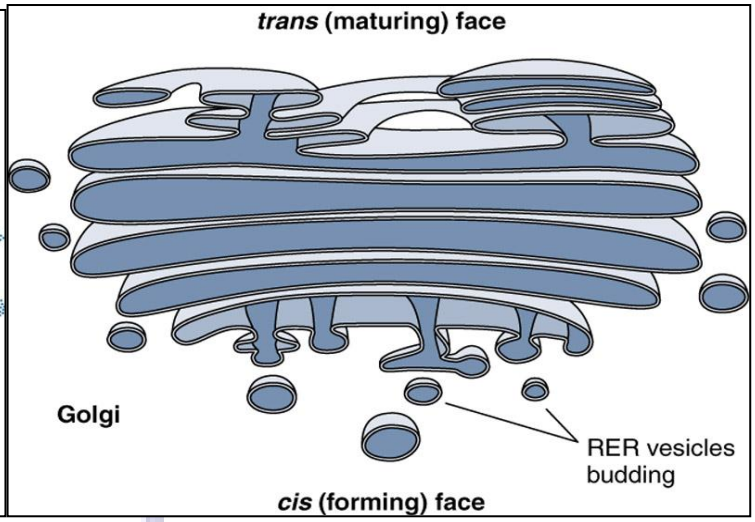


GOLGI APPARATUS:

- Is named for camill Golgi , consists of stack of 3-20 saccules the inner face is directed toward the ER and the outer face is directed toward the plasma membrane
- **Its functions processing, packaging & secretion.**
- It receives vesicles containing protein & lipid which bud from ER ,so called ER vesicles continually pinch off from ER& fuse with the golgi App to process and form Lysosomes, & secretory vesicles .

  2- Proteins & Lipids may be modified by enzymes from Golgi. app. & a sugar chain may be added to them to become Glycoprotein & Glycoliped.





- The vesicles that leave Golgi .app. Called secretory vesicles‘ or secretory granules may proceed to the plasma memb . Where they discharge their contents. Because this is secretion, it is often said that the Golgi app. is involved in processing, pack., secretory.
- Ex. the transport of mucous, insulin & digestive enzymes.
- Other vesicles that leave the Golgi apparatus are lysosomes

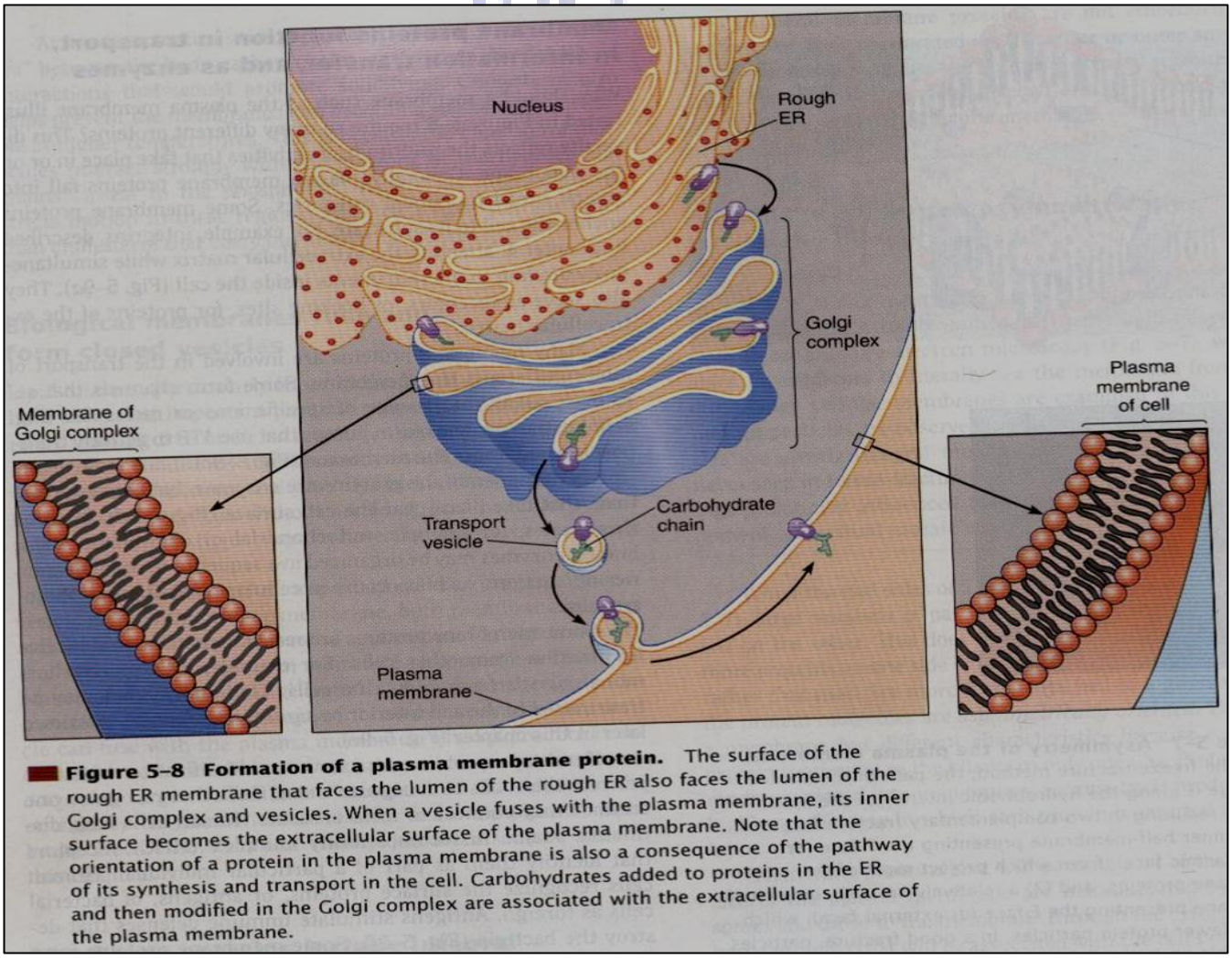
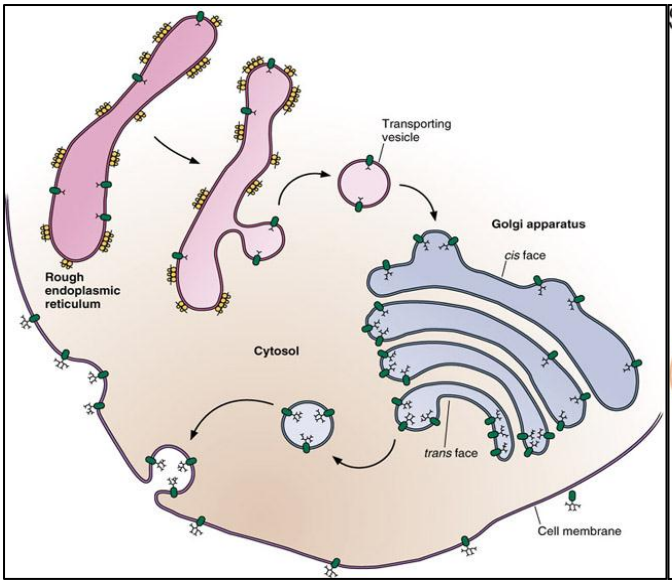
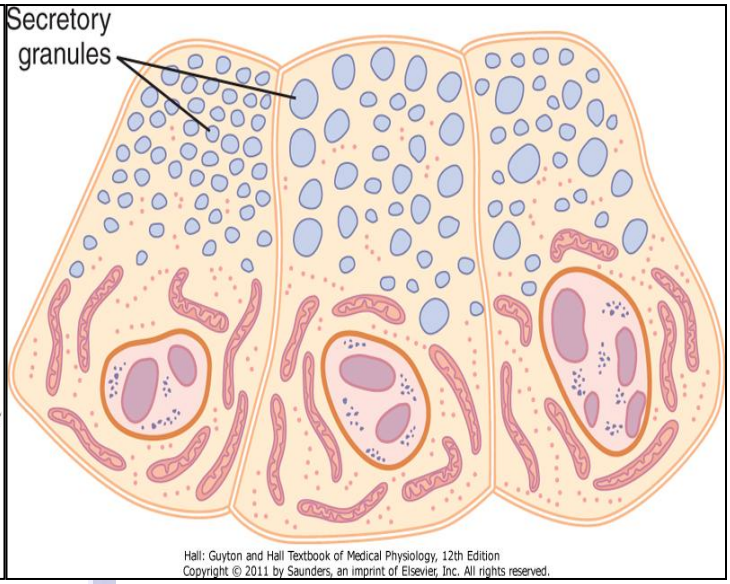


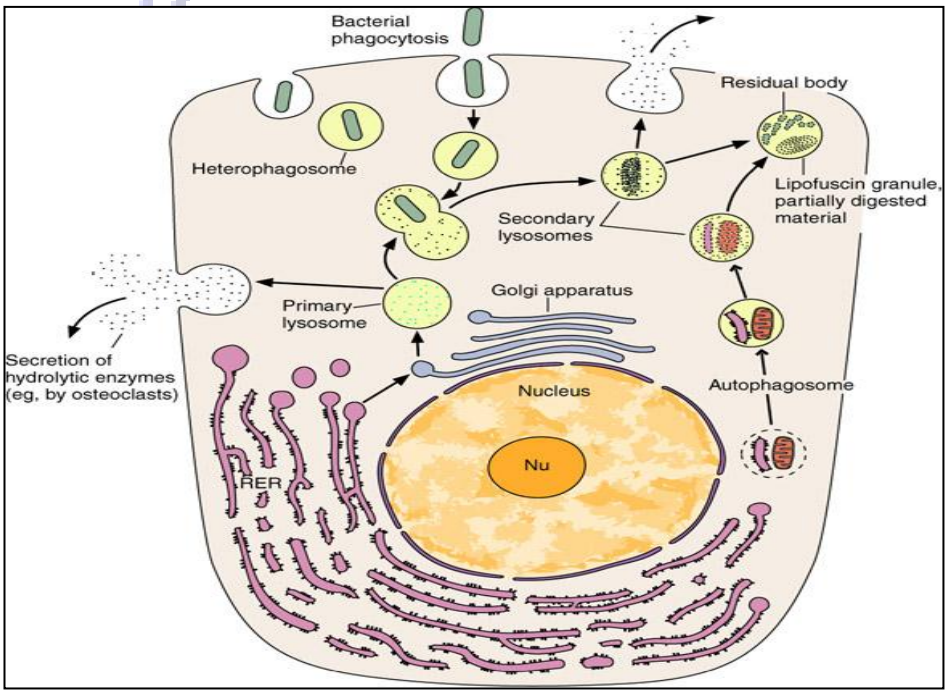
Figure 5–8 Formation of a plasma membrane protein. The surface of the rough ER membrane that faces the lumen of the rough ER also faces the lumen of the Golgi complex and vesicles. When a vesicle fuses with the plasma membrane, its inner surface becomes the extracellular surface of the plasma membrane. Note that the orientation of a protein in the plasma membrane is also a consequence of the pathway of its synthesis and transport in the cell. Carbohydrates added to proteins in the ER and then modified in the Golgi complex are associated with the extracellular surface of the plasma membrane.





LYSOSOME:

- Membrane bounded vesicles produced by the Golgi app. Lysosomes provide an intracellular digestive system, ' which contain hydrolytic digestive enzymes ,that allows the cell to break down complex molecules –lipids ,proteins , carbohydrates ,and nucleic acid . About 40 different digestive enzymes have been identified.
- Macromolecules are brought into a cell by vesicle formation at the plasma memb. When lysosome fuses with such a vesicle, its contents are digested by lysosomes enzymes.
- Break down the contents of damaged cell ex. W.B.C. with bacteria in vesicles fuse with lyso. are digested.
- Even part of a cell are digested by its own lysosomes called (out digestion) which is important during development ex: the fingers of a human embryo are at first webbed , but they are freed from one another as a result of lysosomal action

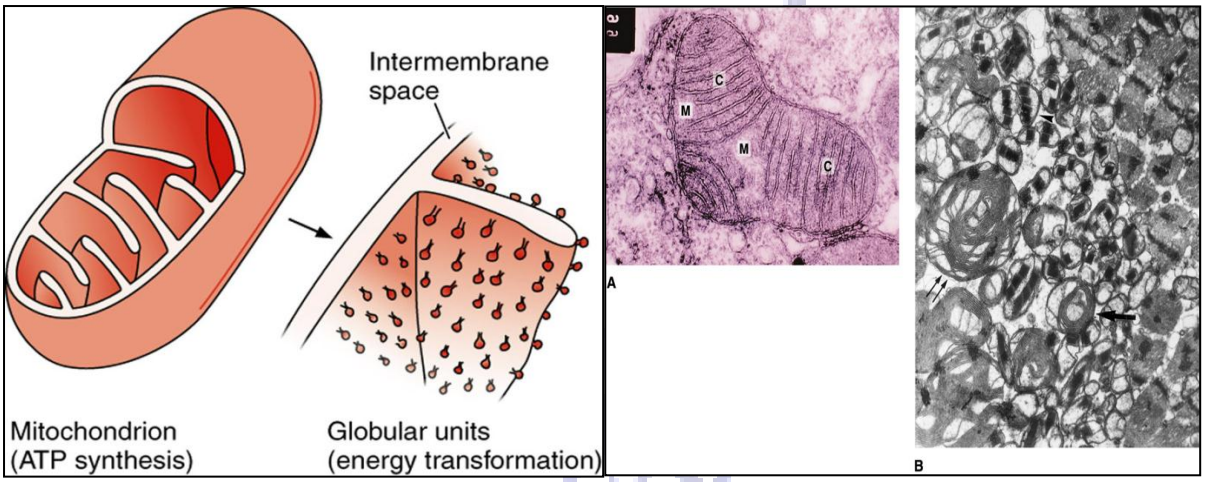


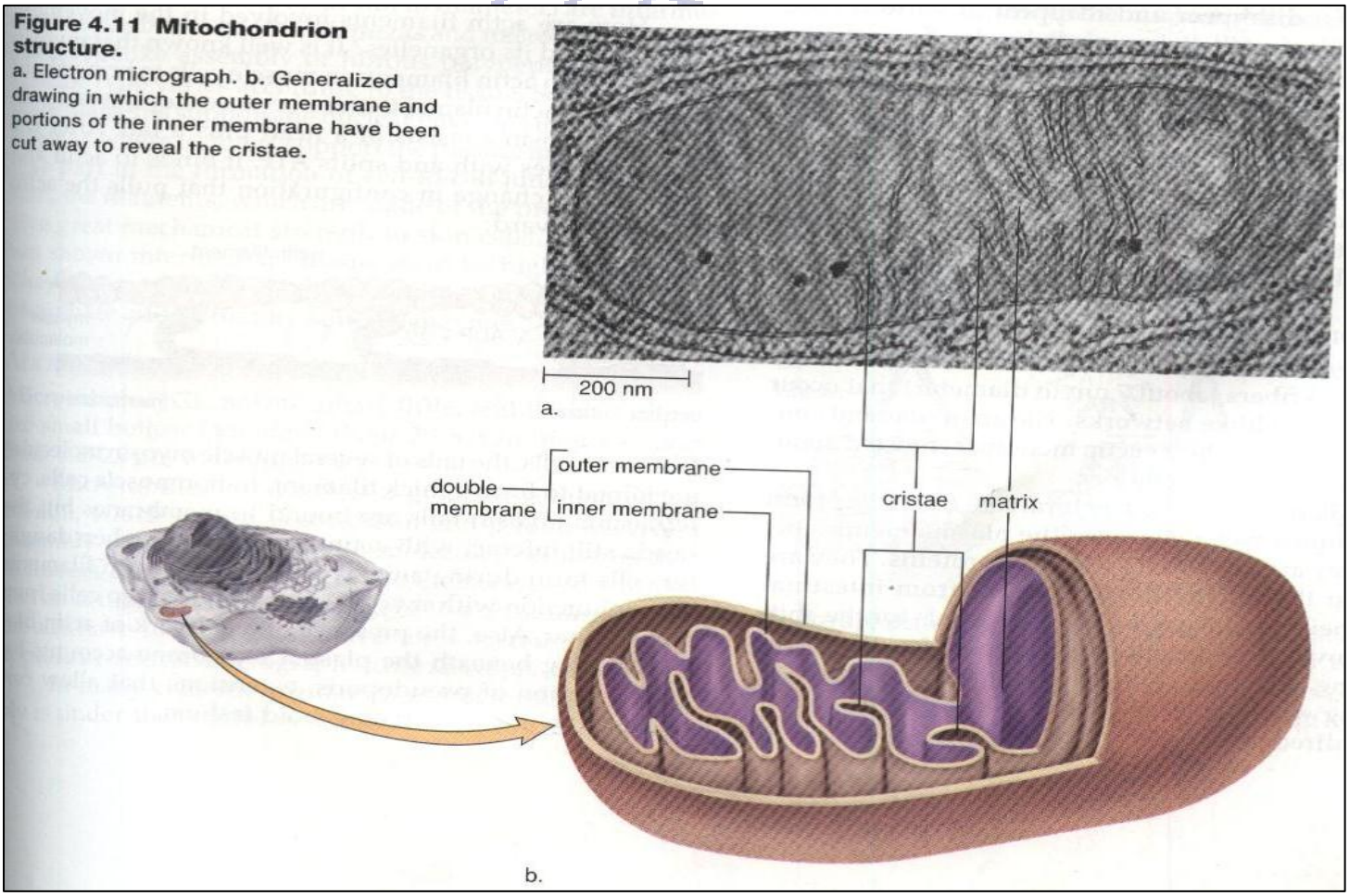
- **Primary lysosome: -** Formed by Golgi app., their hydrolytic enzymes synth. in RER . One or more primary lysosomes fuse with the vesicle containing the ingested material , forming a large vesicle a **secondary lysosome** .under some conditions lysosome break down organelles so that their components can be recycled or used as an energy source
- **In certain genetic diseases of humans, known as lysosomal storage diseases, one of the normally present digestive enzymes is lacking, its substrate substance that the enzyme would normally break down accumulates in the lysosome, ultimately interfering with cellular activities. ex. Tay-sachs disease, in which normal lipid cannot be broken down in brain cells , the lipid accumulates in the cells, resulting in mental retardation & death**
- **Microbodies :** Are membrane –bounded vesicles that contain specific enzymes imported from cytocol.
- **Peroxisomes** : Are micro bodies that have enzymes for oxidizing certain organic substances with the formation of hydrogen peroxide (H_2O_2)
- $RH_2 + O_2$ $R + H_2O_2$, toxic molecule , is a highly oxidizing substance, is broken down to $H_2O + O_2$ with other peroxisomal enzyme (**catalase**)another oxidase enzyme present in large quantities in peroxisomes, to oxidize many substances that might otherwise be poisonous to the cell..
- Peroxisomes are abundant in cells that metabolize lipids & in liver cells that metabolize alcohol. They help detoxify alcohol.
- They are formed by self- replication' and contain oxidizes rather than hydrolyses
- **Vacuoles: -** are large membranous Sacs . vesicles in the protozoans are quite specialized , & they include
  1. contractile vacuoles for ridding the cell of excess water
  2. Digestive vacuoles (food vacuoles) vacuoles play a significant for breaking down nutrients. Vacuoles play a significant role in plant growth and development**.**

Energy related organelles:

- The cell obtains energy in the form of chemical energy in food molecules (such as glucose) or from light energy.
- Energy take place in
  1. Cytosol.
  2. mitochondria & chloroplasts
- Chemical energy stored in ATP_ drive chemical reaction in the cell.
- Mitochondria & chloroplasts contain small amount of DNA that code for some of their proteins. These interesting organelles grow & produce themselves
- Mitochondria It called "powerhouses" of the cell**.**

- (0.5 _ 1.0) µm in diameter & 2.5µm in length. Are bounded by double membrane
- The outer mitochondria memb. is smooth & allows many small molecules to pass through it.
- The inner mito. Memb., form shelves or cisternia with oxidative enzymes are attached
- In addition, the inner cavityis filled with a matrix that contains dissolved enzymes which operate in association with the oxidative enzymes on the shelves to cause of oxidation of the nutrients , and forming carbon dioxide and water with releasing energy. Energy is used to synthesize ATP which transported out of the mitochondria ,wherever it is needed for performing cellular functions

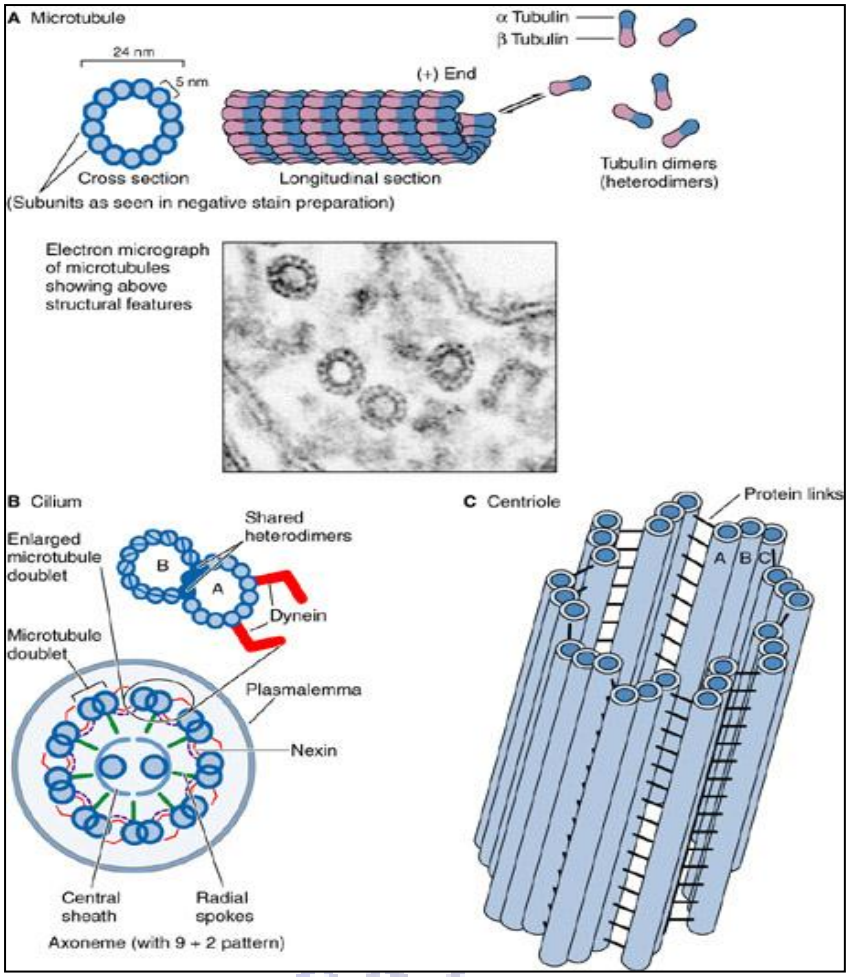




- Mitoch. Are most numerous in cells that are very active (more than 1000 mitoch.,(in a single liver cell)
  In mammalian cell each mitoch, has 5_10 identical circular DNA links with genetic diseases, including a form ;
- **1- of young adult blindness & progressive muscle degeneration.**
  2_ Mitoch. Also affect health & aging by leaking electron_ <u>from free radicals toxic, these</u> electrons bond with other compound in cell, interfering with normal function.
- **3_ Mitoch. Play role in programmed cell death or apoptosis (is a normal part of an organism's development & maintains) ex. Cells in the intestinal wall are continuously destroyed & replaced by new cells.**
  Inhibition of apoptosis is may contribute to a variety of diseases including cancer, acquired immunodeficiency syndrome (AIDs) & Alzheimer's disease.

<u>CYTOSKELETON</u>

- 1-The shape of cells & their ability to move are determined in large part by the cytoskeleton, a dense of network of protein fibers.
  2- Transport of materials & 3_ in cell division. It is made of 3 types of protein filaments:
- 1-Microtubules 2- microfilaments- Are fiber formed from beadlike, globular protein subunits, which can rapidly assembled & disassembled.
- (also known as actins filaments)
- 3-Intermediat filaments: Made from fibrous protein subunits & are more stable than microt. &microfila.
- **1-Microtubules**: are hollow cylinder:
- Are the thickest filaments of cytoskeleton. They are 1- involved in the movement of chromosomes during cell division.
- 2- They are the major structural components of cilia & flagella.
- 3- They made of alpha – tubulin & beta tubulin. Microtubules have 13 rows of tubulin dimmers.
- The regulation of microtubule assembly is under the control of microtubule organizing center, MTOCs. Centrosome a structure that is important in cell division.
- The centrosome contain two centrioles. These structures which are oriented within the Centro some at right angles to each other are known as 9 × 3 structures, The centrioles are duplicated before cell division



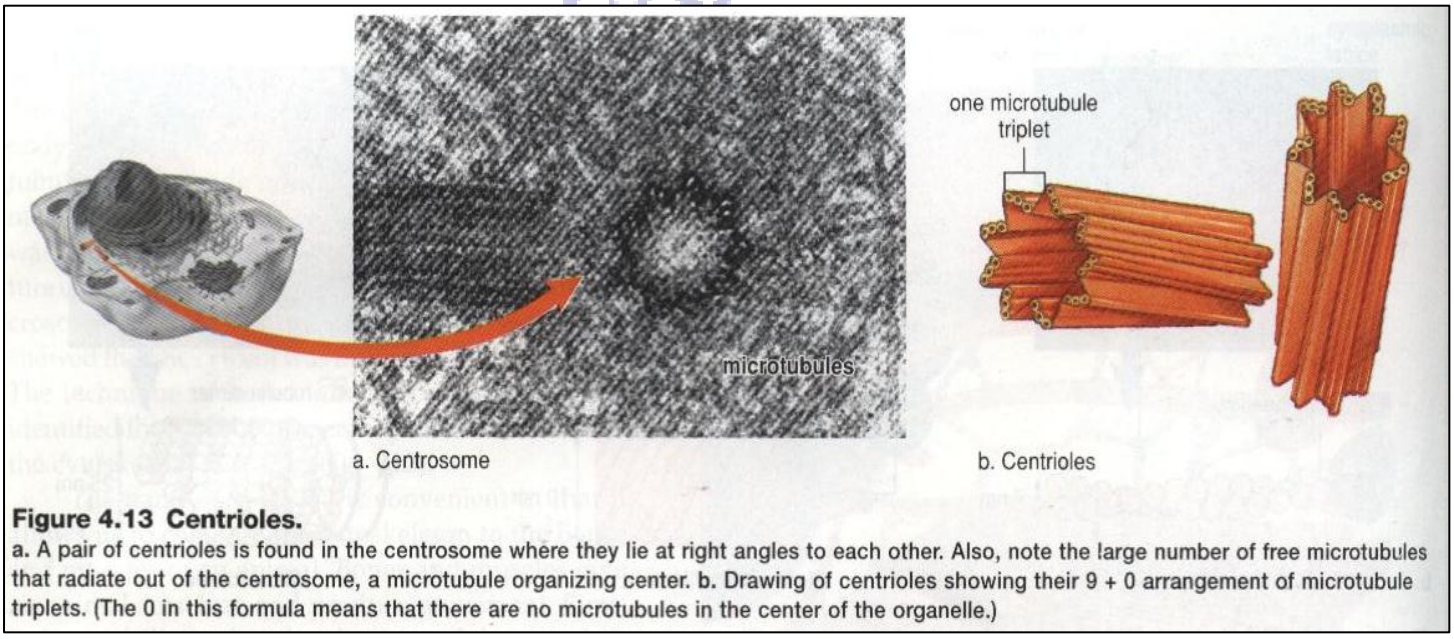


Figure 4.13 Centrioles.
a. A pair of centrioles is found in the centrosome where they lie at right angles to each other. Also, note the large number of free microtubules that radiate out of the centrosome, a microtubule organizing center. b. Drawing of centrioles showing their 9 + 0 arrangement of microtubule triplets. (The 0 in this formula means that there are no microtubules in the center of the organelle.)

CILIA & FLAGELLA **:** are composed of Microtubules projecting from surface of many cells, thin , movable structures important in cell movement .

- **Flagella** are long single or only few (200µm) in animals flagella serve as the tail of sperm cells.

- **Cilia** has many short (2-10 µ m) appendages. These structures are found on unicellular & small multicelular organism. In animals cilia occur on the surfaces of cells (e.g. respiratory passage ways).

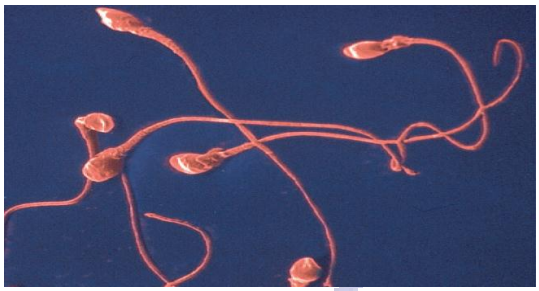
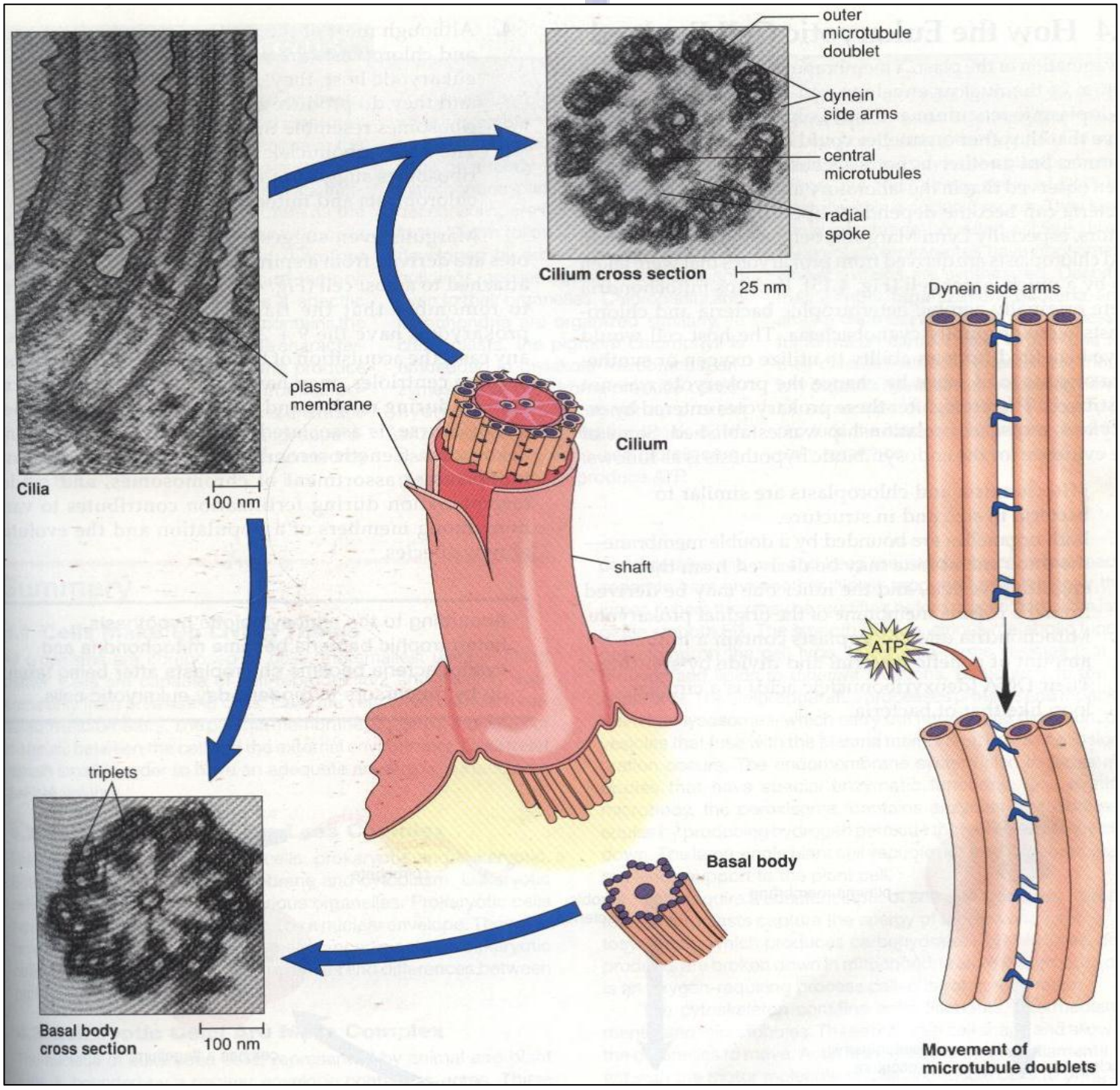


Figure 3.12 Sperm cells. Sperm cells use long, whiplike flagella to move about.



- Eukaryotic cilia & flagella are structurally alike. Each consists of a slender, cylindrical stalk covered by an extension of the plasma membrane. The core of the stalk contains a group of microtubules arranged as 9+2 of microtubules.
- Each cilium or flagellum is anchored in the cell by a basal body, which has a set of three attached microtubules.
- (9x3 structure).
- **2-Microfilaments**: consist of intertwined strings of actin called also actin filaments, flexible solid fiber each one consists of two intertwined polymer chains.
- Some type of cells have microvilli , projection of plasma membrane ,which contain bundles of microfilaments
- **3-Intermediate filaments help stabilize cell shape**
- Are tough fibers .They vary widely in protein composition & size among different cell types. Their function to strengthen the cytoskeleton &stabilized cell shape .They are responsible for formation of a sheath called Nuclear lamina

Inclusions

Inclusions are of two kinds: stored cellular products

such as glycogen granules, pigments, and fat droplets and foreign bodies such as dust particles, viruses, and intracellular bacteria.

Inclusions are never enclosed in a unit membrane, and unlike the organelles and cytoskeleton, they are not essential to cell survival.

Table 3.1 Structures in Animal Cells

Name	Composition	Function
Plasma membrane	Phospholipid bilayer with embedded proteins	Selective passage of molecules into and out of cell
Nucleus	Nuclear envelope surrounding nucleoplasm, chromatin, and nucleolus	Storage of genetic information
Nucleolus	Concentrated area of chromatin, RNA, and proteins	Ribosomal formation
Ribosome	Protein and RNA in two subunits	Protein synthesis
Endoplasmic reticulum (ER)	Membranous saccules and canals	Synthesis and/or modification of proteins and other substances, and transport by vesicle formation
Rough ER	Studded with ribosomes	Protein synthesis
Smooth ER	Having no ribosomes	Various; lipid synthesis in some cells
Golgi apparatus	Stack of membranous saccules	Processing, packaging, and distributing molecules
Vacuole and vesicle	Membranous sacs	Storage and transport of substances
Lysosome	Membranous vesicle containing digestive enzymes	Intracellular digestion
Mitochondrion	Inner membrane (cristae) within outer membrane	Cellular respiration
Cytoskeleton	Microtubules, actin filaments	Shape of cell and movement of its parts
Cilia and flagella	9 + 2 pattern of microtubules	Movement of cell
Centriole	9 + 0 pattern of microtubules	Formation of basal bodies