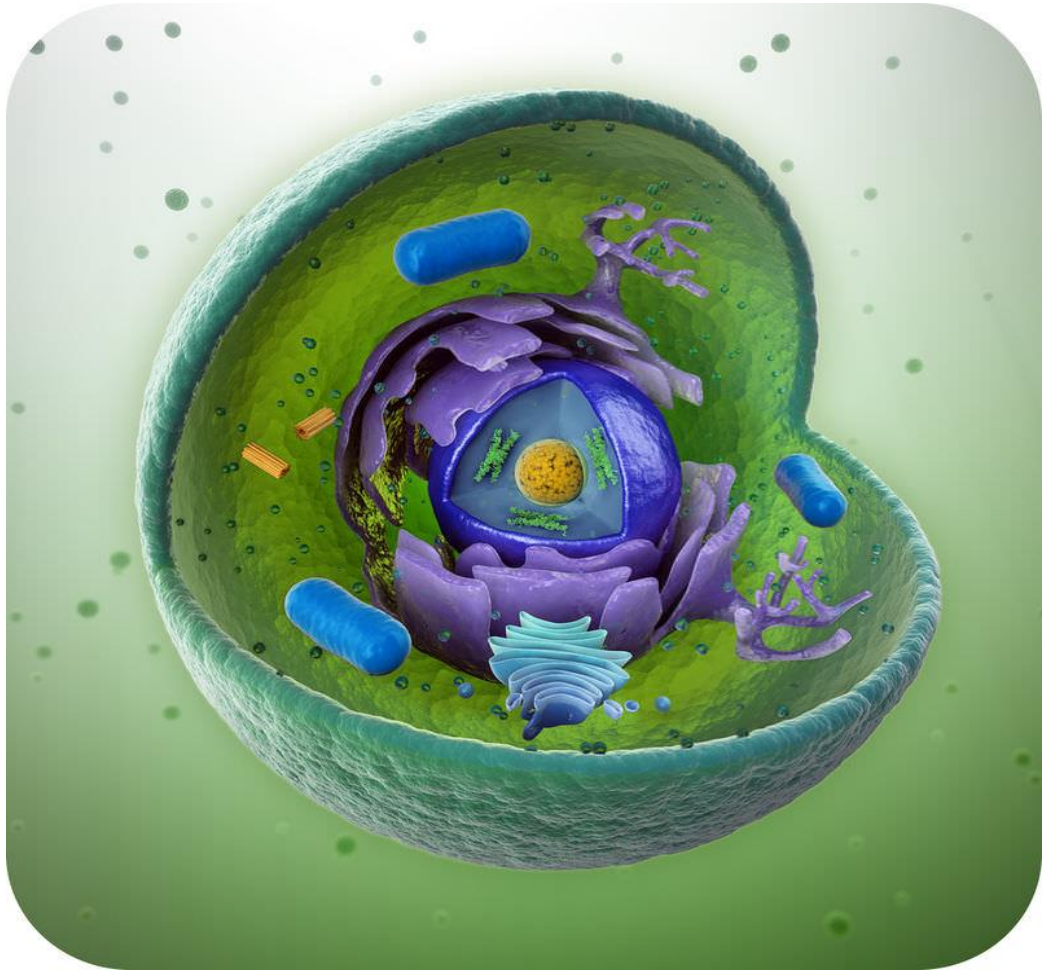
Medical Biology – Year 1



Chapter 1: The Cytoplasm and Cytoplasmic Organelles

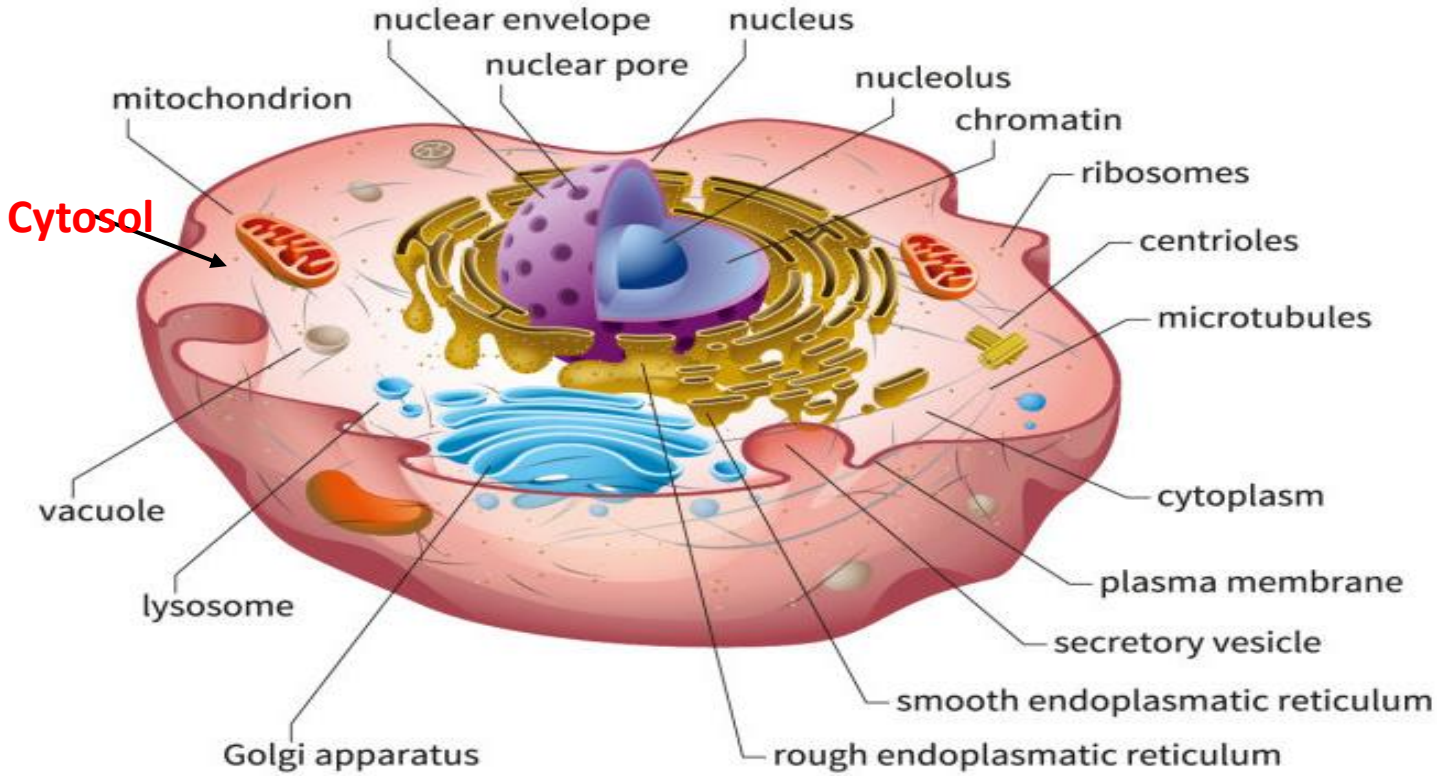
By **Lecturer: Dr. Hanaa Ali Hussein**
Department: Basic Sciences
College of Dentistry
University of Basrah

Objectives

- Identify the cytoplasm, and name its contents.
- Describe the composition of the cytosol.
- Define the cytoplasmic inclusions.
- Describe different types of cytoplasmic organelles.
- Discusses the function (s) of the organelles.
- Describe and give the role of the cytoskeletal elements.

The Cytoplasm

- **The Cytoplasm** is a gel cellular material found between the plasma membrane and the nuclear envelope of the nucleus, consists of three major components including cytosol, organelles, and cytoplasmic inclusions.
- Cytoplasm without Cell organelles are called **Cytosol**.
- **Cytosol** is the jelly-like mixture in which the other organelles are suspended, so **cytosol + organelles = cytoplasm.**



The Cytoplasm

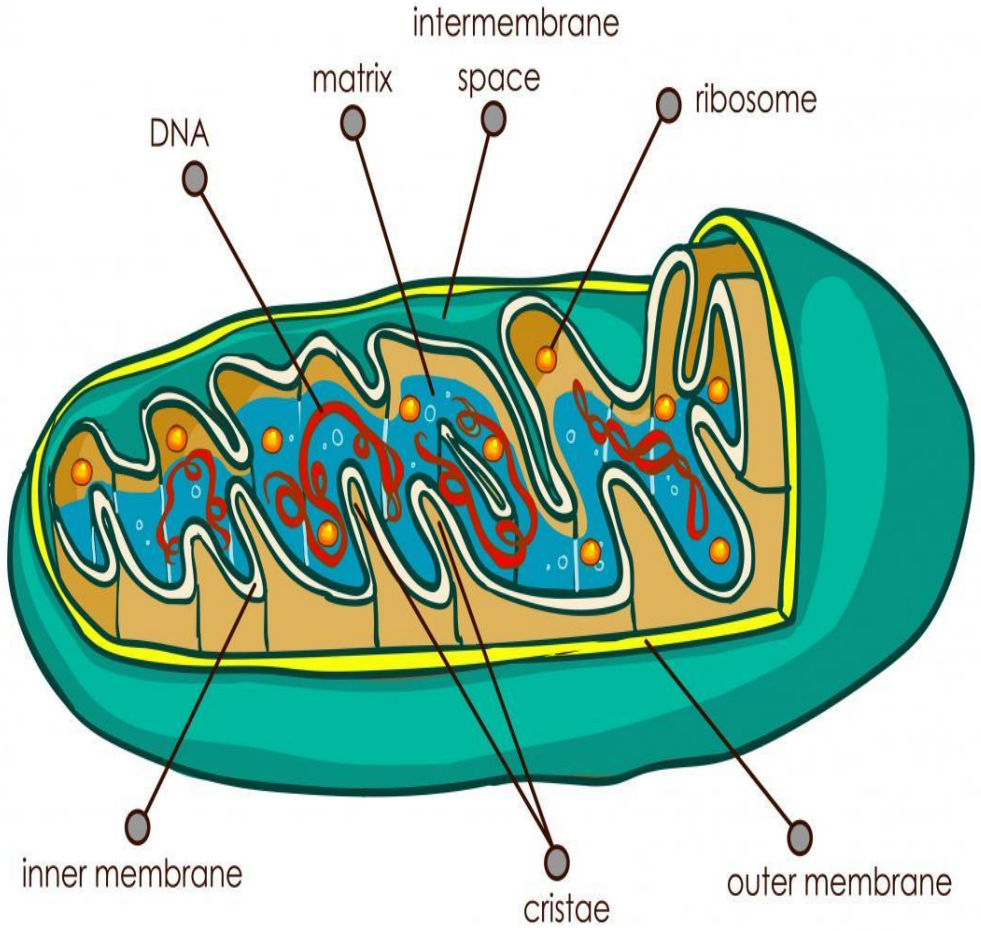
- **Cytoplasm** has many membranes bound organelles like **Endoplasmic reticulum, Golgi Bodies, Mitochondria, Plastids and vacuoles**.

They also have non membrane bound structures called ribosomes, microtubules, microfilaments, and centrioles

- In **Eukaryotic cells**, most organelles are surrounded by a membrane, but in Prokaryotic cells there are no membrane-bound organelles.
- The **cytoplasmic inclusions** are chemical substances differ in nature in different types of human cells

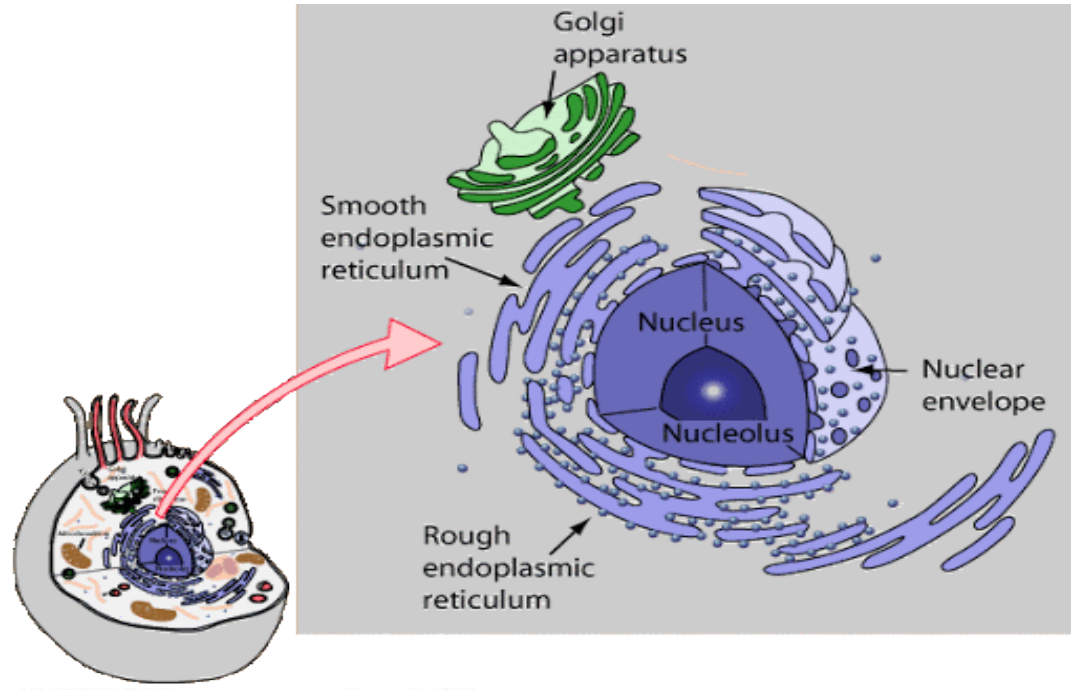
The Mitochondria

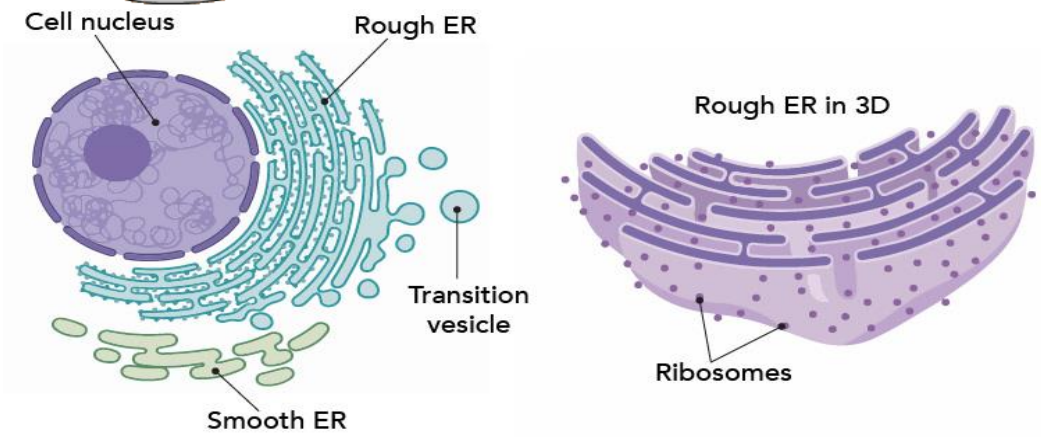
- **The Mitochondria** are found scattered throughout the cytosol, and are relatively large organelles (second only to the nucleus and chloroplasts).
- Mitochondria are surrounded by two membranes, between the two membranes filled with **mitochondrial matrix** (ribosomes, circular DNA to manufacture their own RNAs and proteins).
- A. The smooth **outer membrane** serves as a boundary between the mitochondria and the cytosol.
- B. The **inner membrane** has many long folds, known as **cristae**, which greatly increase the surface area of the inner membrane, providing more space for ATP synthesis to occur.
- **Inermembranous space** of 6-8 nm is found between the two membranes filled with the amorphous mitochondria matrix.



Endoplasmic Reticulum (ER)

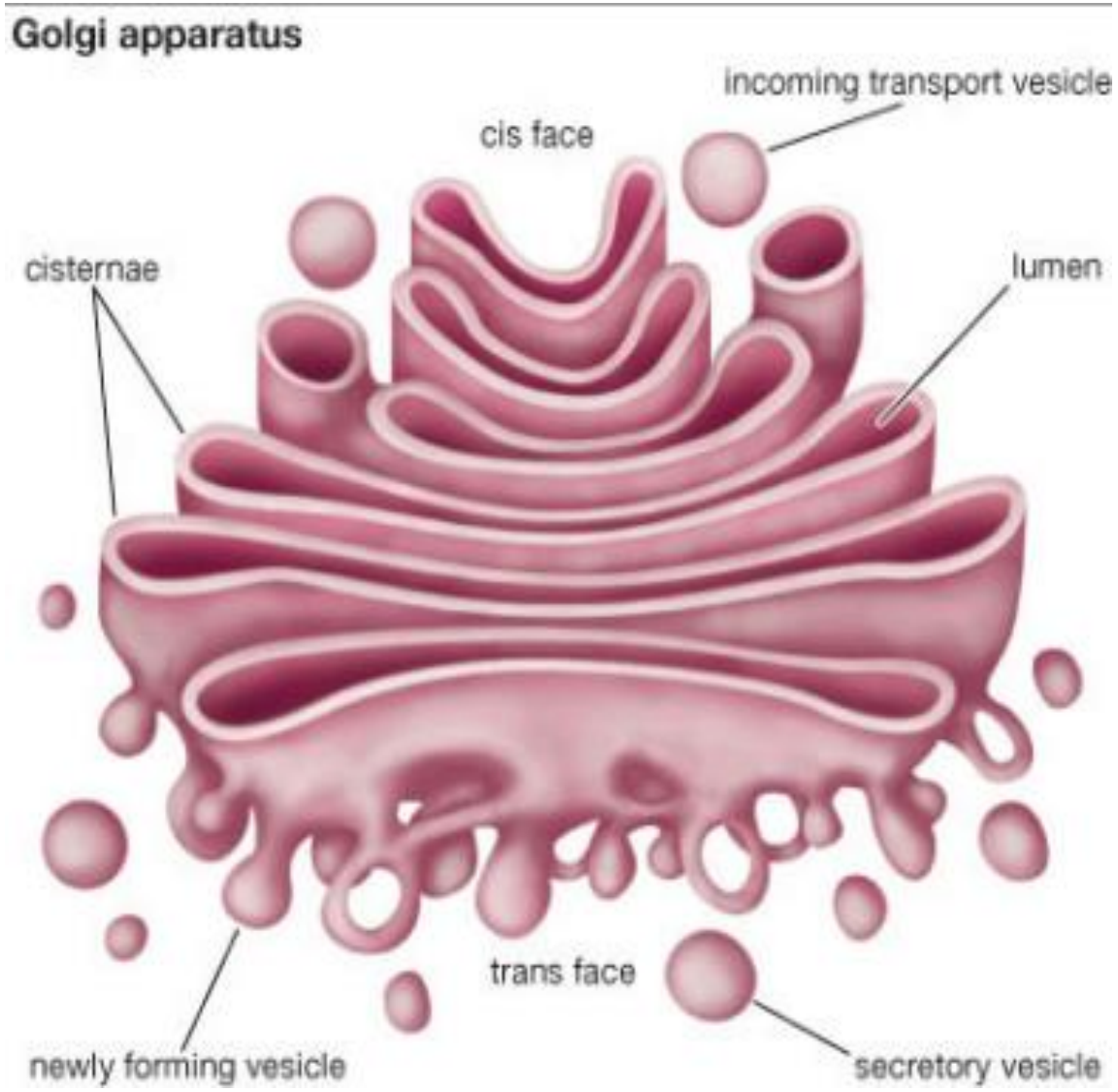
- **The ER** is a large organelle made of membranous sheets and tubules
- It extends from cell membrane to nuclear membrane
- The primary function of the ER is to act as an internal transport system, allowing molecules to move from one part of the cell to another.
- There are two types of ER, **Rough** and **Smooth** ER.
- The **rough ER** is studded with 80s ribosomes and is the site of protein synthesis. It is an extension of the outer membrane of the nuclear envelope, so allowing mRNA to be transported swiftly to the 80s ribosomes, where they are translated in protein synthesis.
- The **smooth ER** is where polypeptides are converted into functional proteins and where proteins are prepared for secretion. It is also the site of lipid and steroid synthesis, and is associated with the Golgi apparatus. Smooth ER has no 80s ribosomes and is also involved in the regulation of calcium levels in muscle cells, and the breakdown of toxins by liver cells.





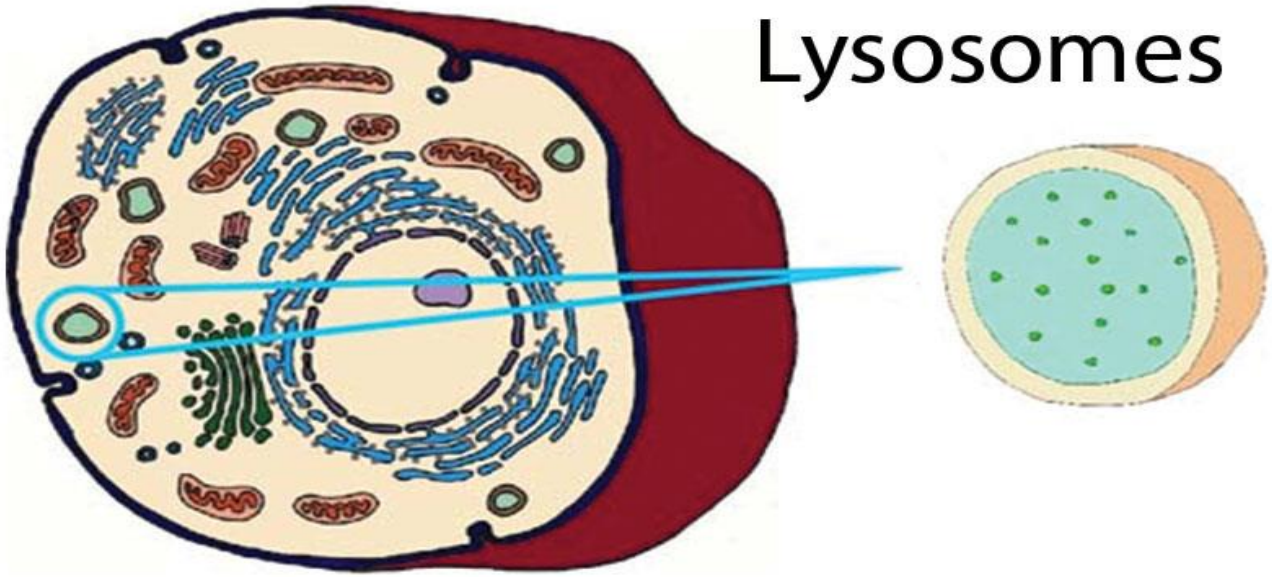
Golgi Apparatus (complex)

- The **Golgi apparatus** is the processing, packaging and secreting organelle of the cell, so it is much more common in glandular cells.
- Commonly called **packaging centres of the cell**.
- The Golgi apparatus is a system of membranes, made of flattened sac-like structures called **cisternae**.
- Two functional faces are described in the structure of the Golgi apparatus, **entry immature face (cis face)**, facing the endoplasmic reticulum, and **exit mature concave face (trans face)**, facing the plasma membrane.
- The primary function of the Golgi apparatus is to store the product of ER by modify proteins for export by the cell, produce Lysosomes, and secrete various Enzymes, hormones and cell wall material.



Lysosome

- **Lysosome** are small spherical organelles that enclose hydrolytic enzymes within a single membrane, packed inside a Golgi complex.
- Lysosomes are common in the cells of Animals, Protoctista and even Fungi, but rare in plants
- Four types- Primary, secondary, residual & auto lysosomes.



- **Function**:

1. Lysosomes are the site of protein digestion – thus allowing enzymes to be re-cycled when they are no longer required.
2. They are also the site of food digestion in the cell, and of bacterial digestion in phagocytes.
3. Metabolic function by breaking down of glycogen and releasing energy.

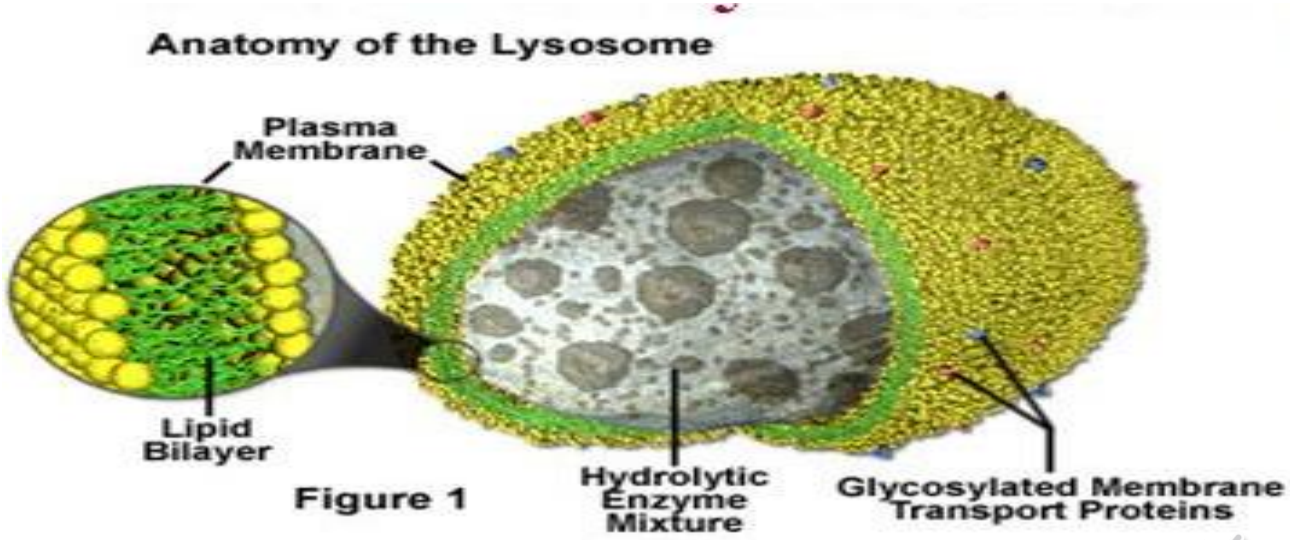


Figure 1

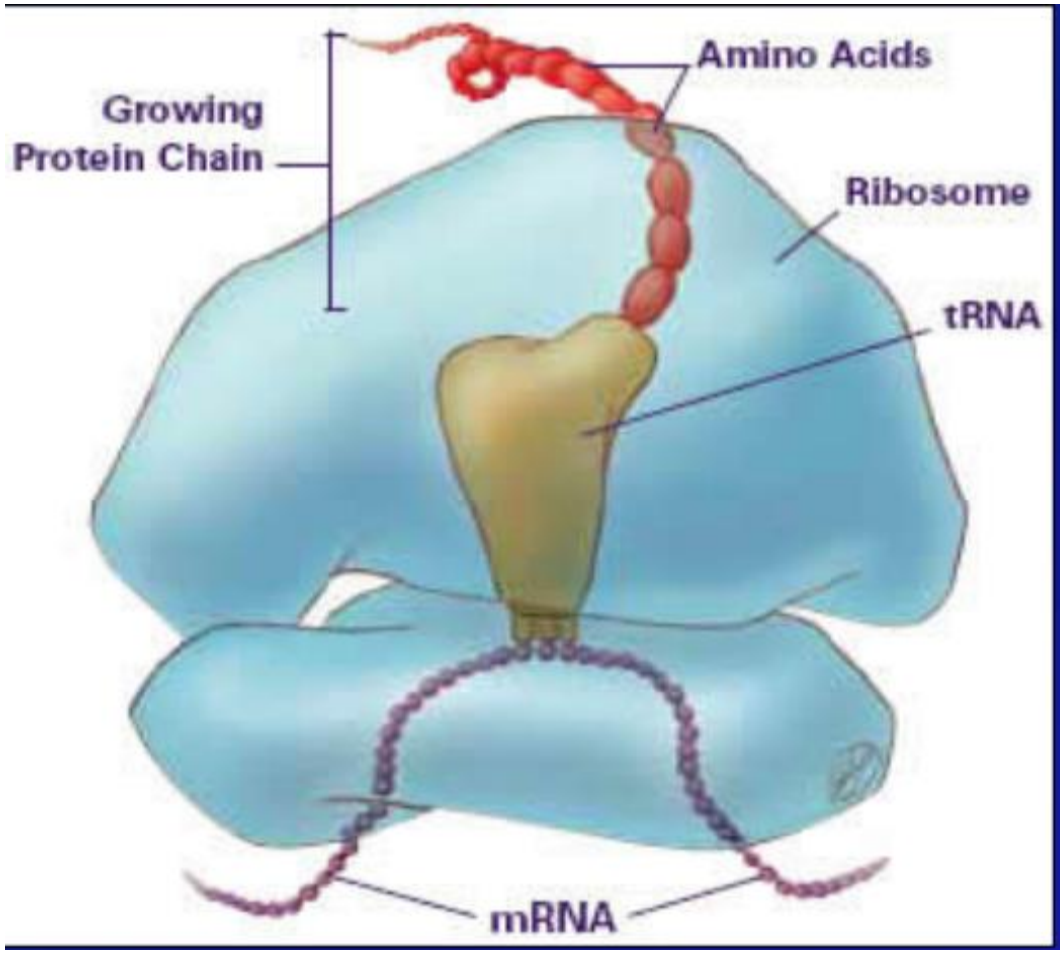
Non membranous organelles

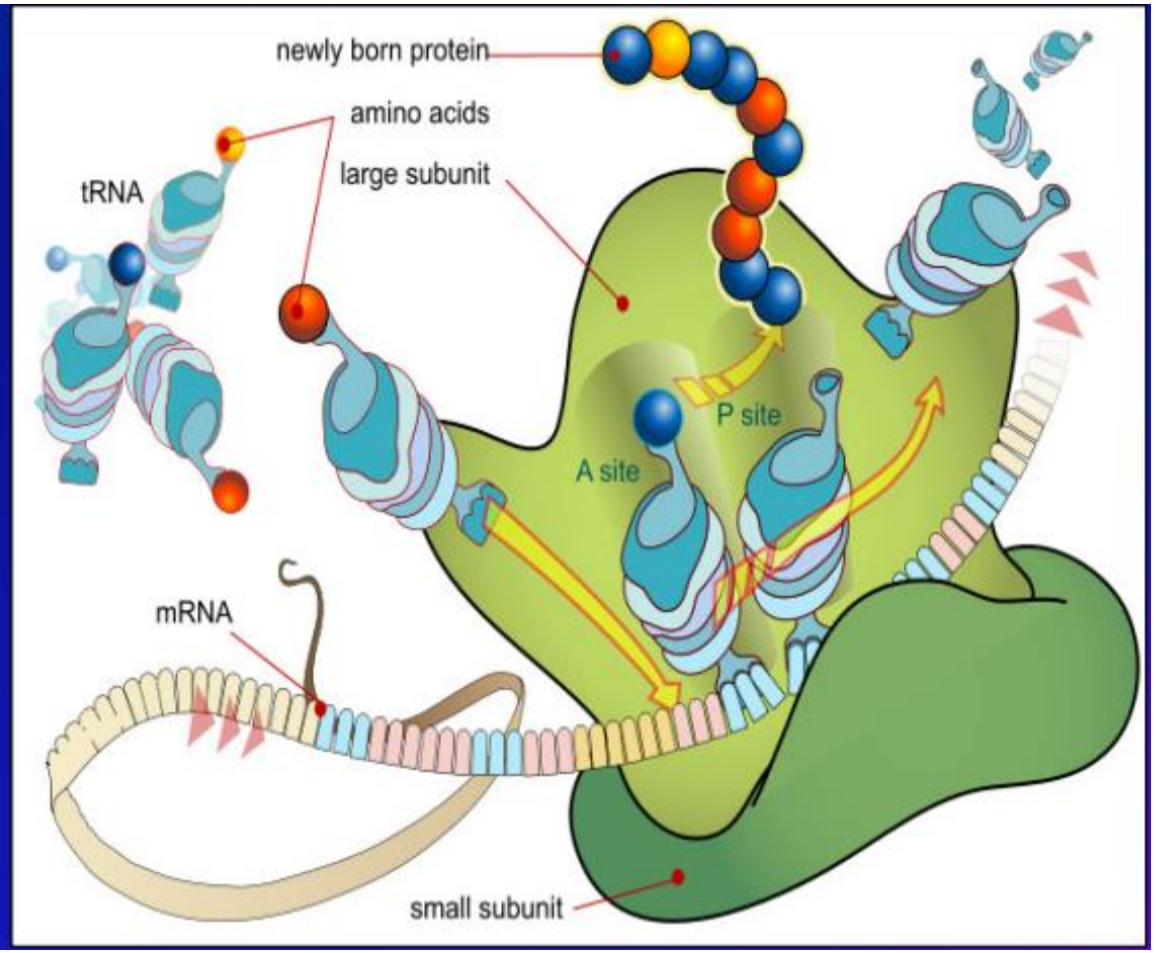
- **The non membranous organelles are cytoplasmic organelles lacking of a membrane a round their internal structure, such as the ribosome, centrioles, microtubules, and microfilaments.**

The Ribosome

1. The ribosomes are small (20-30 nm) non-membranous particles assembled in the nucleus by association of ribosomal ribonucleic acid (rRNA) synthesize in the nucleus and proteins synthesize in the cytoplasm.
2. The ribosome particles are transported out the nucleus through nuclear pores of the nuclear envelope to be in many types.
3. Present in cytoplasm, mitochondria, chloroplast & also found attached to rough ER & nuclear membrane.
4. They exist in two sizes: 70s are found in all Prokaryotes, chloroplasts and mitochondria.
5. 80s found in all eukaryotic cells – attached to the rough ER.
6. Ribosome particles found as either free single granules, cluster polysomes of granules, or attached granules to the cisterna of rER.
7. Ribosome particles are the sites where amino acid molecules are incorporated into protein molecules, either to be used by the cells or secreted out the plasma membrane of the secretory cell, as that of the granular tissue (salivary glands).

The Ribosome





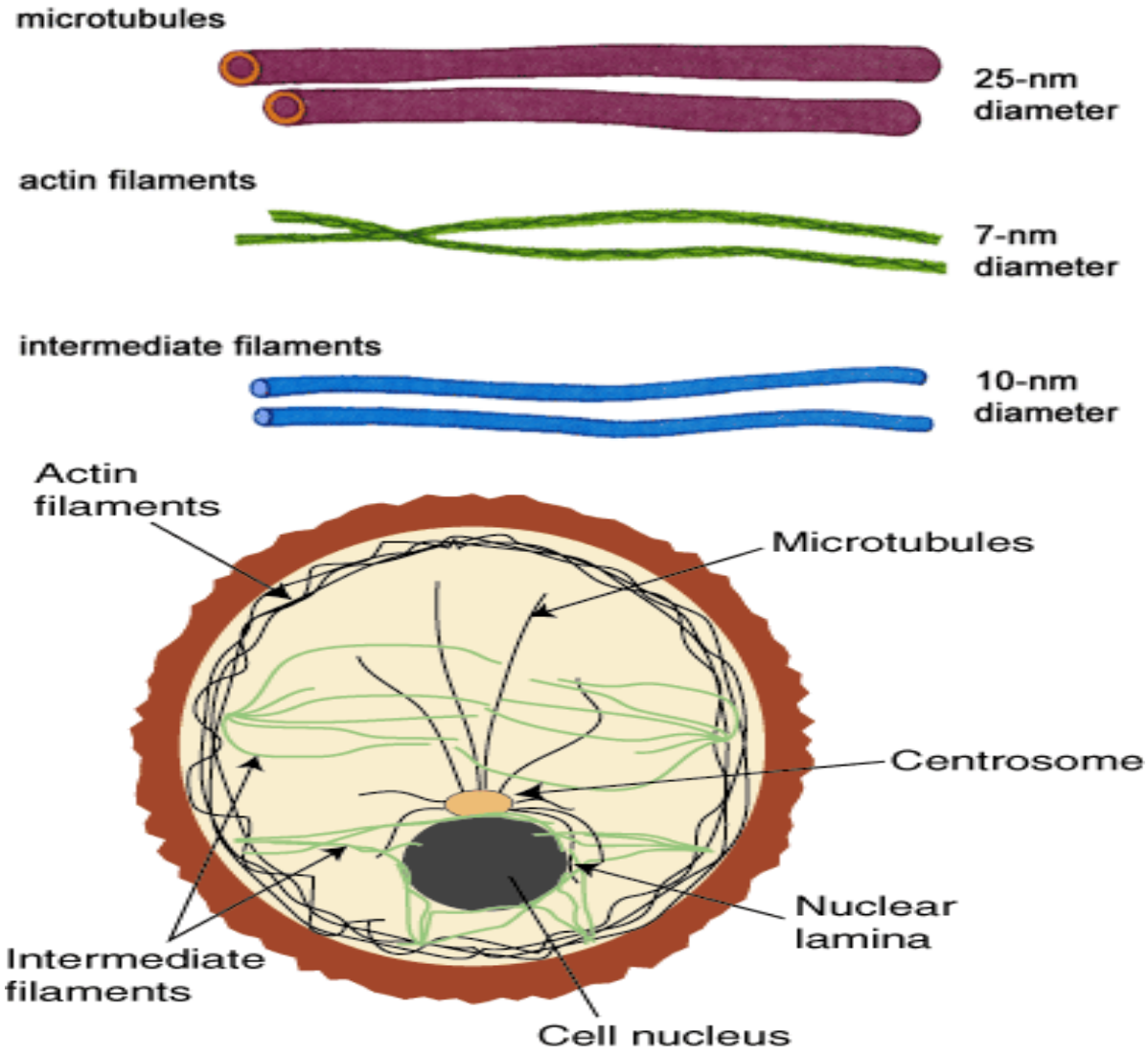
The Cytoskeleton (Cell skeleton)

- The cytoskeleton is a series of rod-like non-membranous structures run in the cytosol of prokaryotic and eukryotic cells, forming a network to maintain the morphology of the cell
- The cytoskeleton consists of two structures:

a) microfilaments (contractile). They are made of actin, and are common in motile cells.
b) microtubules (rigid, hollow tubes – made of tubulin).

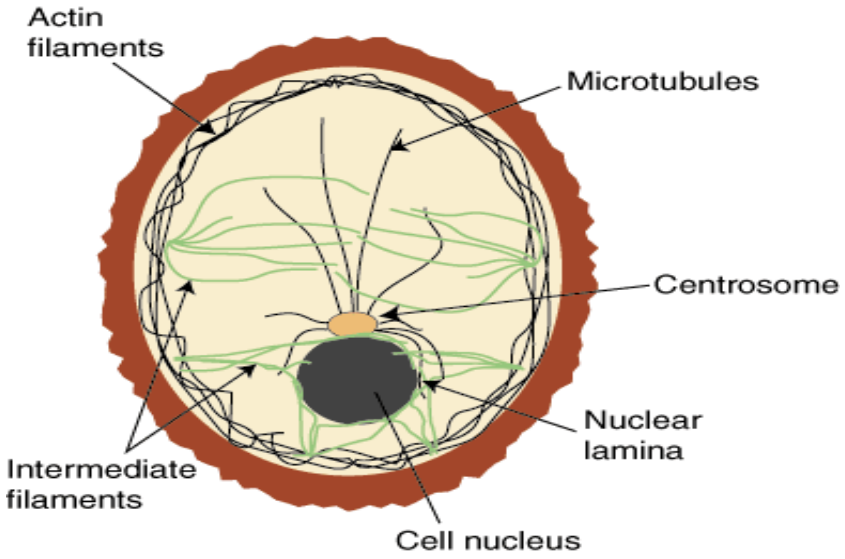
- Microtubules have three functions:

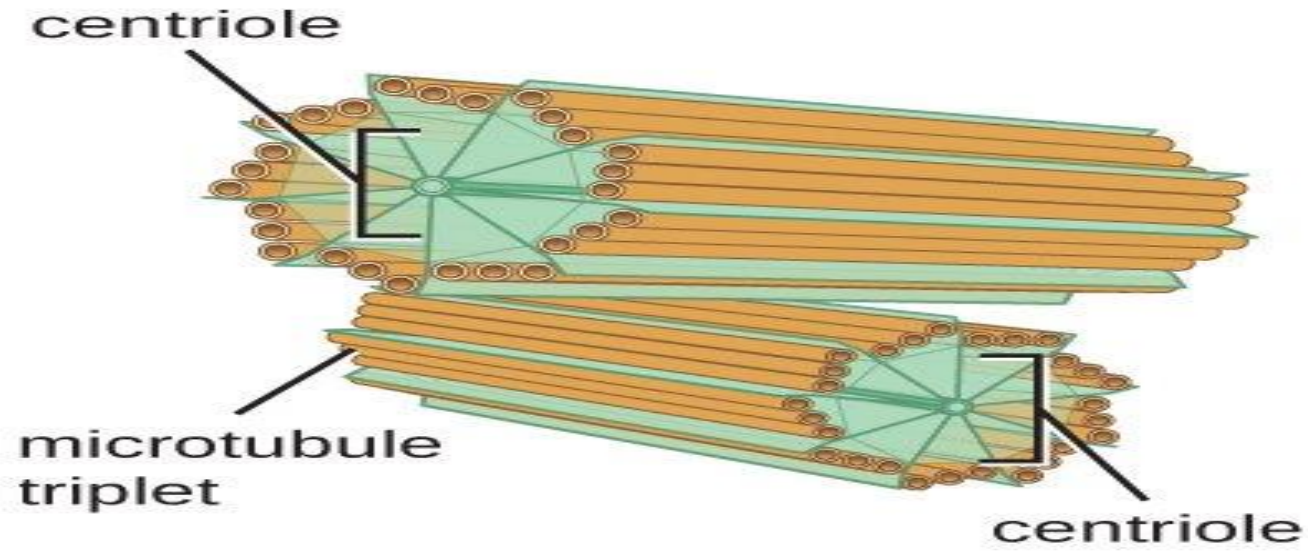
a) To maintain the shape of the cell.
b) To serve as tracks for organelles to move along within the cell.
c) Building up other organelles such as **cilia and flagella**, **centrioles, and spindle fibers**.



The Centrosome

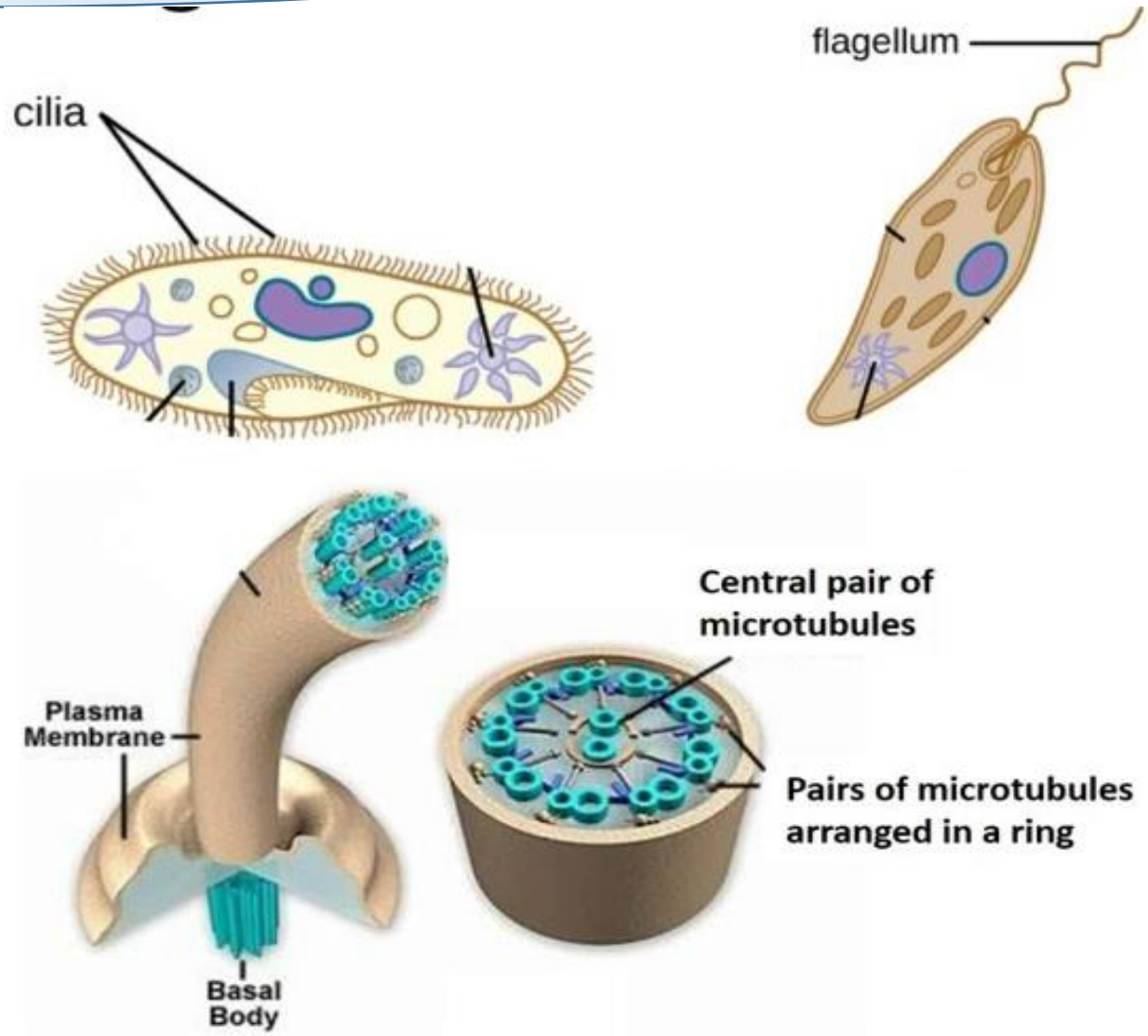
- **Centrosome** is a microtubular center of most of animal cells found close to the nucleus and has two perpendicular structures called **centrioles**.
- Each **centriole** has nine sets of tripled microtubules fused to one another, sharing a common wall.
- One microtubule of each set is with a complete ring of **13 subunits** while the other two are with a **C-shaped structure**. The set of such microtubules is connected to each other by protein bands.





The Cilia and Flagella

- **Cilia and Flagellae** are structures that project from the cell, where they assist in movement.
- Cilia (sing. cilium) are short, and numerous and hair-like.
- Flagellae (sing. flagellum) are much longer, fewer, and are whip-like.
- The cilia and flagellae of all Eukaryotes are always in a '9 + 2' arrangement that is characteristic
- Protoctista commonly use cilia and flagellae to move through water.
- Sperm use flagellae (many, all fused together) to swim to the egg.
- Cilia line our trachea and bronchi, moving dust particles and bacteria away from the lungs.



Recap

- **Cytoplasm.**
- **Cytoplasm organelles.**
- **Function (s) of the organelles.**
- **Mitochondria.**
- **Ribosome, endoplasmic reticulum, and Golgi apparatus.**
- **The role of the cytoskeletal elements.**

Thank you