Cell Organelles

Grade: First year – Ashur Medical college

Module: HDTD lecture 4

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DATE: 31 JANUARY 2024

Objectives:

- List 2 major types of organelles.
- Define membrane bound and non membrane organelles .
- Define and determine functions of organelles.

A-Membranous

- A-Membranous (membrane-bounded or enclosed) :
- A.1.Nucleus
- A.2. Endoplasmic reticulum (ER) A.2.1Rough ER A.2.2 Smooth ER
- A.3.Golgi apparatus
- A.4.Vacuoles and vesicles: A.4.1 Lysosomes A.4.2 Peroxisomes A.4.3.-Endosomes
- A.4.4.Proteasomes A.4.5.Transport vesicles
- A.5-Mitochondria

Cell organelles

- The suffix - elle mean tiny . So the word (organelle) means a tiny organ.
- Membrane-bounded organelles are found in eukaryotic cells exclusively. Nucleus and mitochondria are bound by double membrane. Other membrane-bounded organelles are bounded by single lipid bilayer membrane.
- Non-Membranous organelles may be found in eukaryotic and prokaryotic cells or found in one type of cells.

The cellular activity

- Cellular activities includes:
- 1- Growth & Development.
- 2- Cell division.
- 3-Synthesis.
- 4- Release of secretions.
- 5- Contractions of muscles (neuromuscular junction).
- 6-Transport of molecules.

A.1. The Nucleus

- Is the largest structure and the most prominent organelle. The nucleus stores genetic that determines the cell characteristics , control cell growth , multiplication and reproduction .
- Number :multinucleated : skeletal muscle fiber , columnar epithelium. RBCs: lose their nuclei when they mature.
- Shape : lobular nuclei (hyper-segmented): granular white blood cells (WBCs),

Spindle: Smooth muscle cells

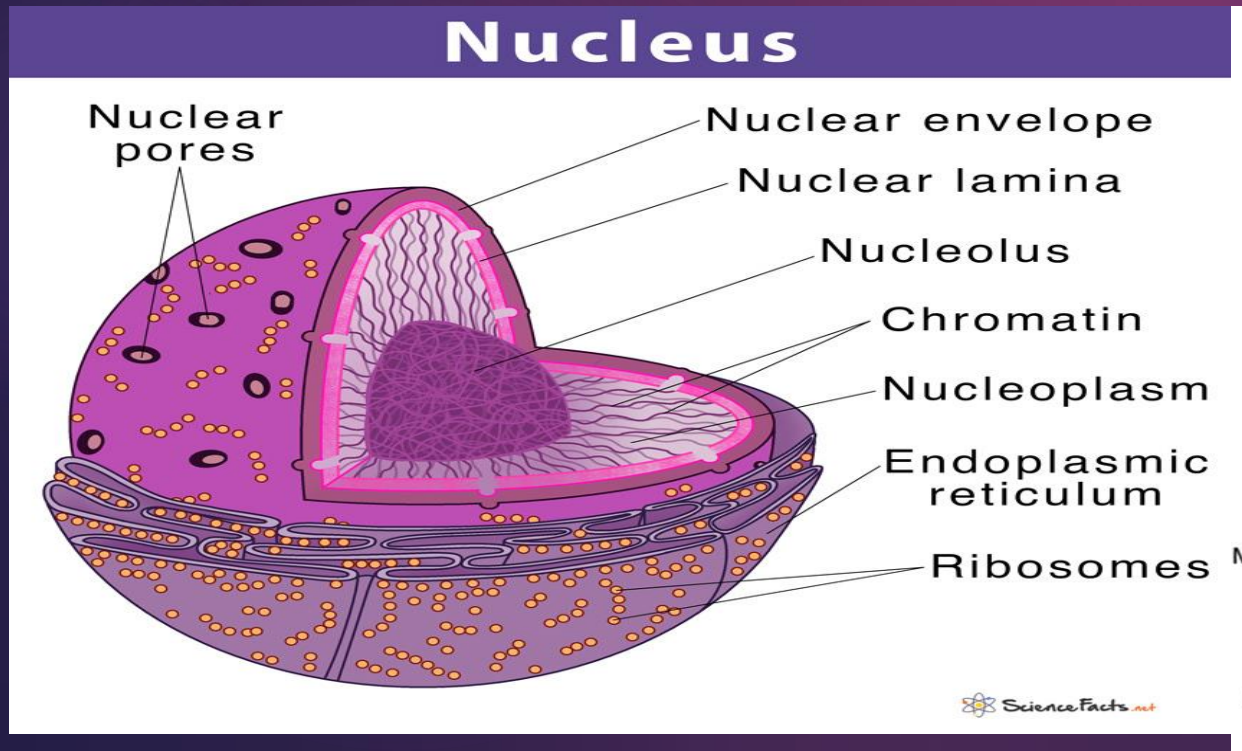
A.1. The Nucleus[2]

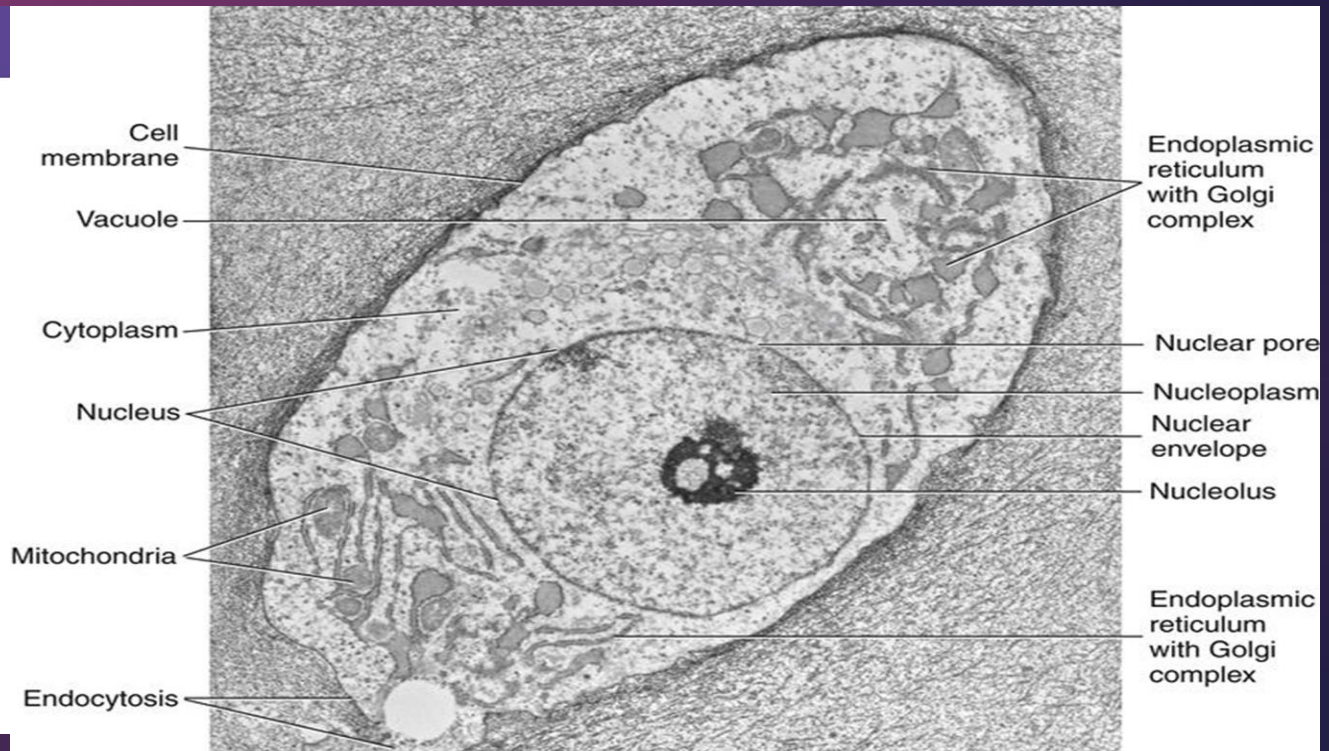
The structure of nucleus

- **A.1.1. Nuclear envelope: Double membrane, which is separated the nucleus from the cytoplasm and continuous with the endoplasmic reticulum .**
- **A.1.2. Nuclear pores: the pores are sufficient size (100 nm), are rings of proteins that allow certain biochemical to exit or enter the nucleus.**

A.1. The Nucleus -3

- **A.1.3.Nucleolus : non-membrane bound organelle ,may be one or more , appears darkened regions under microscope, and is the site of ribosome production.**
- **A.1.4. Chromatin: is a combination of DNA molecules and proteins that make up chromosomes.**
- **A.1.5.Nucleoplasm: Semi-fluid medium has a different composition from cytoplasm and different pH.**





A.2. Endoplasmic reticulum (ER)

- The ER occurs as an interconnected network of flattened sacs or tubules .
- The membranes of the ER are connected to the outer nuclear envelope, and they may also extend into the cell membrane.
- They are of two types : 1) The smooth (SER) with no ribosomes on its cytoplasmic surface.

2) The rough (RER) when there is a presence of ribosomes.

Functions :

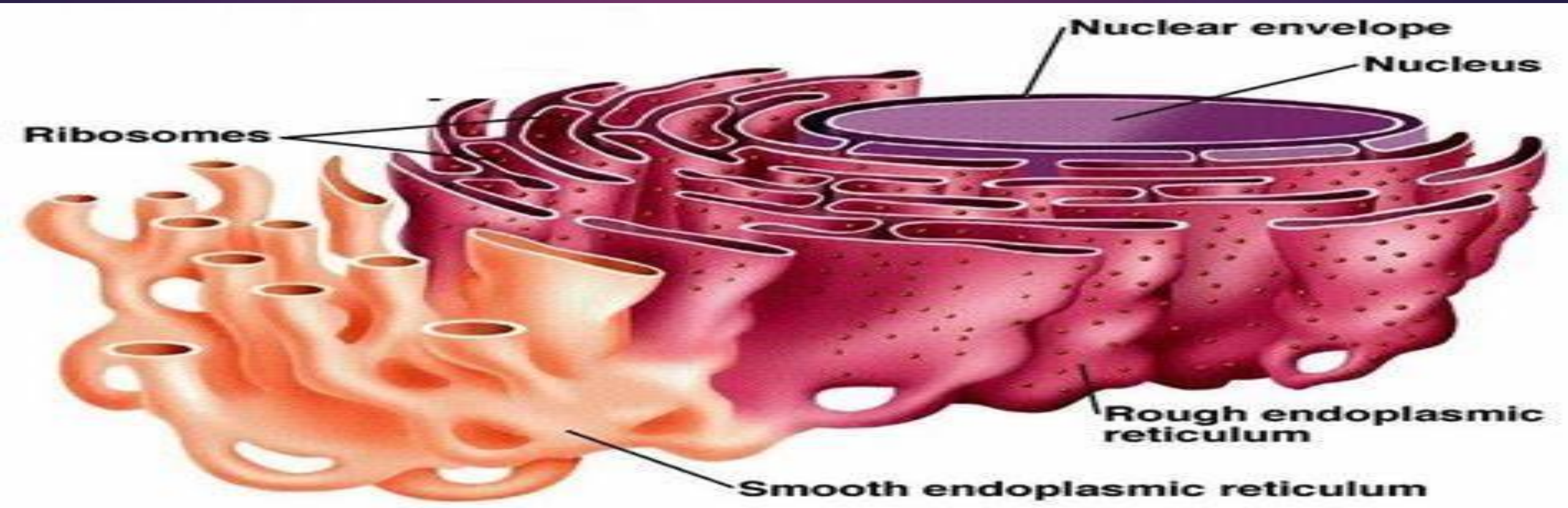
1- RER : produces proteins. (pancreatic cells, liver cells, goblet cells, and plasma cells).

2-SER : a- Produces lipids and steroid hormones (adipose cells, interstitial cells, glycogen-storing cells of the liver, conduction fibers of the heart, spermatocytes, and leucocytes).

b- Detoxify compounds (such as drugs) in the liver. C- Conjugation of bilirubin

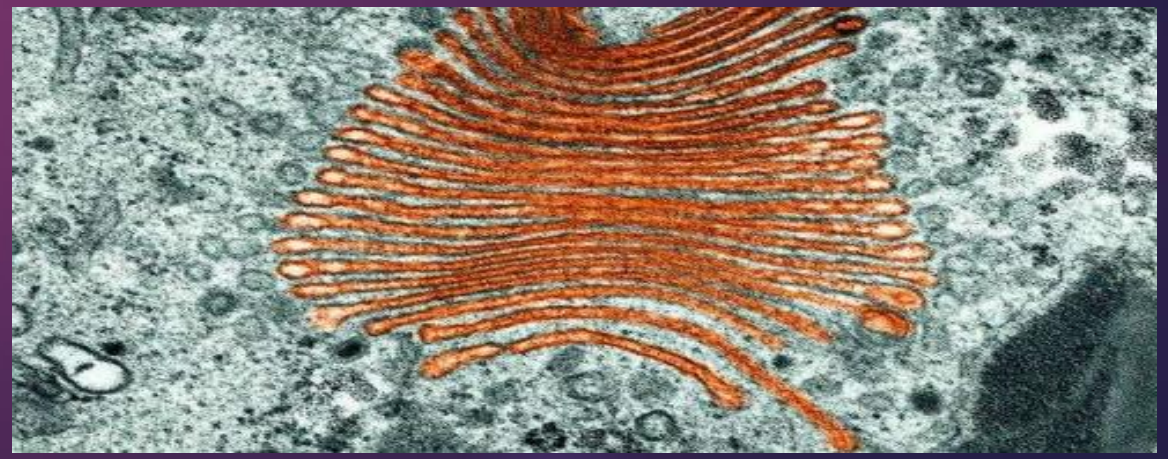
A.2 Endoplasmic reticulum (ER)[2]

The ER forms transport vesicles in which large molecules are transported to other parts of the cell. Often, these vesicles (Cisternae) are on their way to the plasma membrane or the Golgi apparatus.



A.3 Golgi apparatus

- The Golgi apparatus is made up of membranous saccules (cisternae). These cisternae originate from the vesicles that bud off from the endoplasmic reticulum. The Golgi receives synthetic products from the ER.
- Functions :
- 1-Modify and process proteins and lipides. For example, a chain of sugars (carbohydrates) may be added to them, forming glycoproteins and glycolipids.



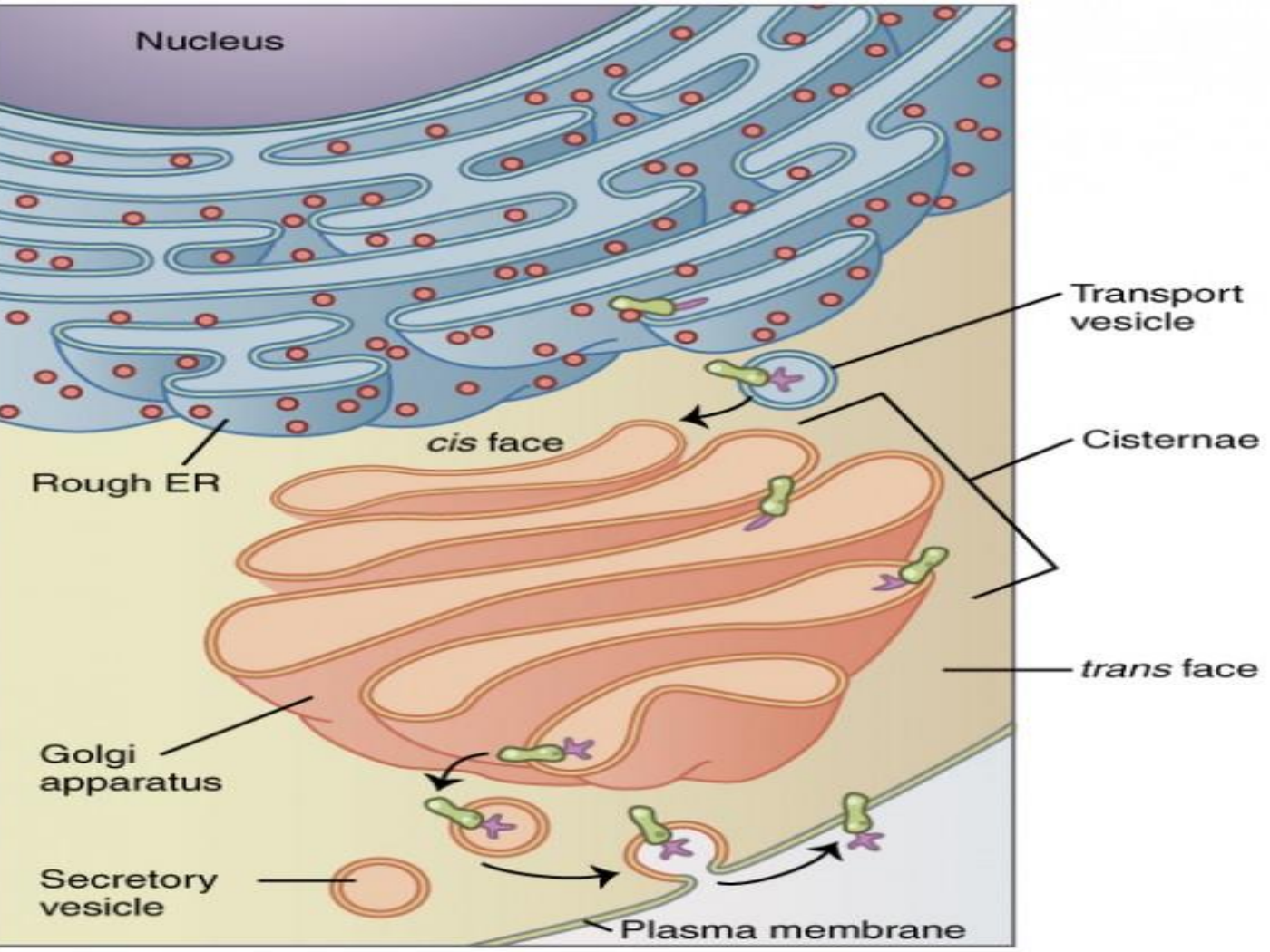
Golgi apparatus: Colored transmission electron micrograph (TEM) of a Golgi apparatus (orange).

A.3 Golgi apparatus 2

- 2. Packaging of macromolecules like proteins and lipids before they are sent to their destination.
- 3-Transport and secretion :Act as the ‘post office’ of the cell. Secretory/transport vesicles leave the Golgi apparatus move to other parts of the cell. Some vesicles proceed to the plasma membrane where they discharge their contents (exocytosed).
- 4. Creation of lysosomes.

A.3 Golgi apparatus [3]

- It has 2 'faces' - the cis (receiving or forming or entry) face, and the trans (or maturing or exit) face.



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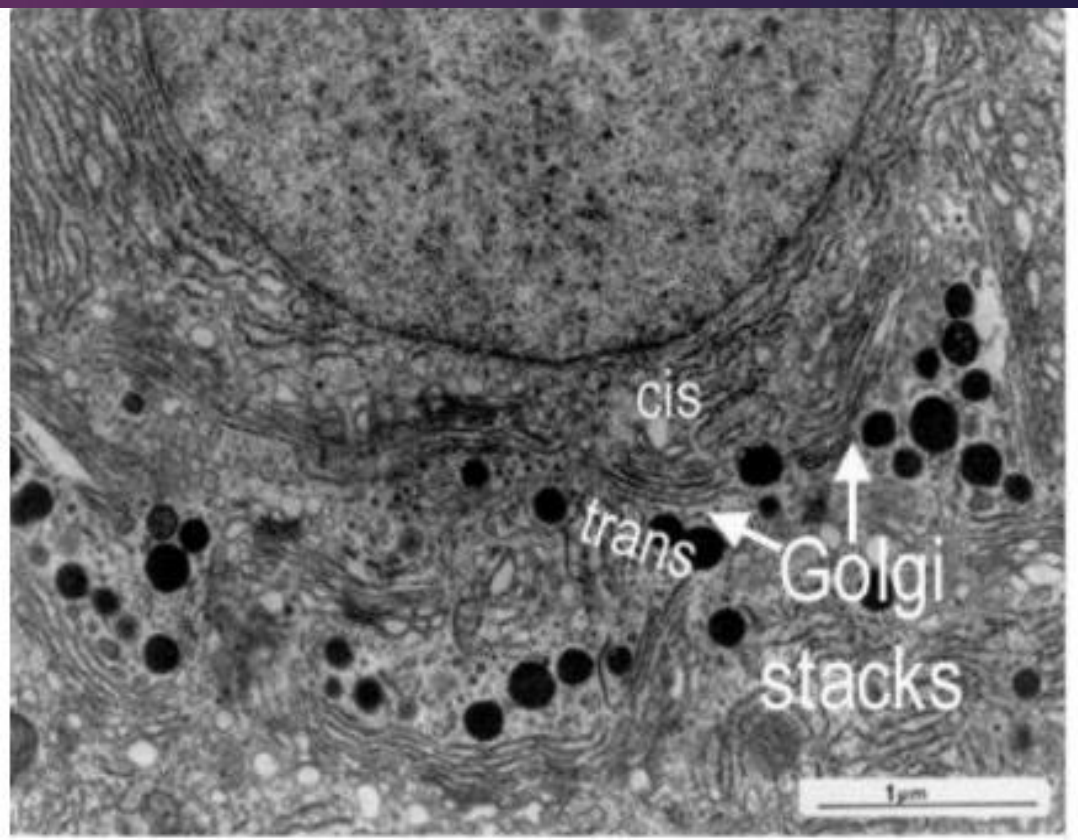


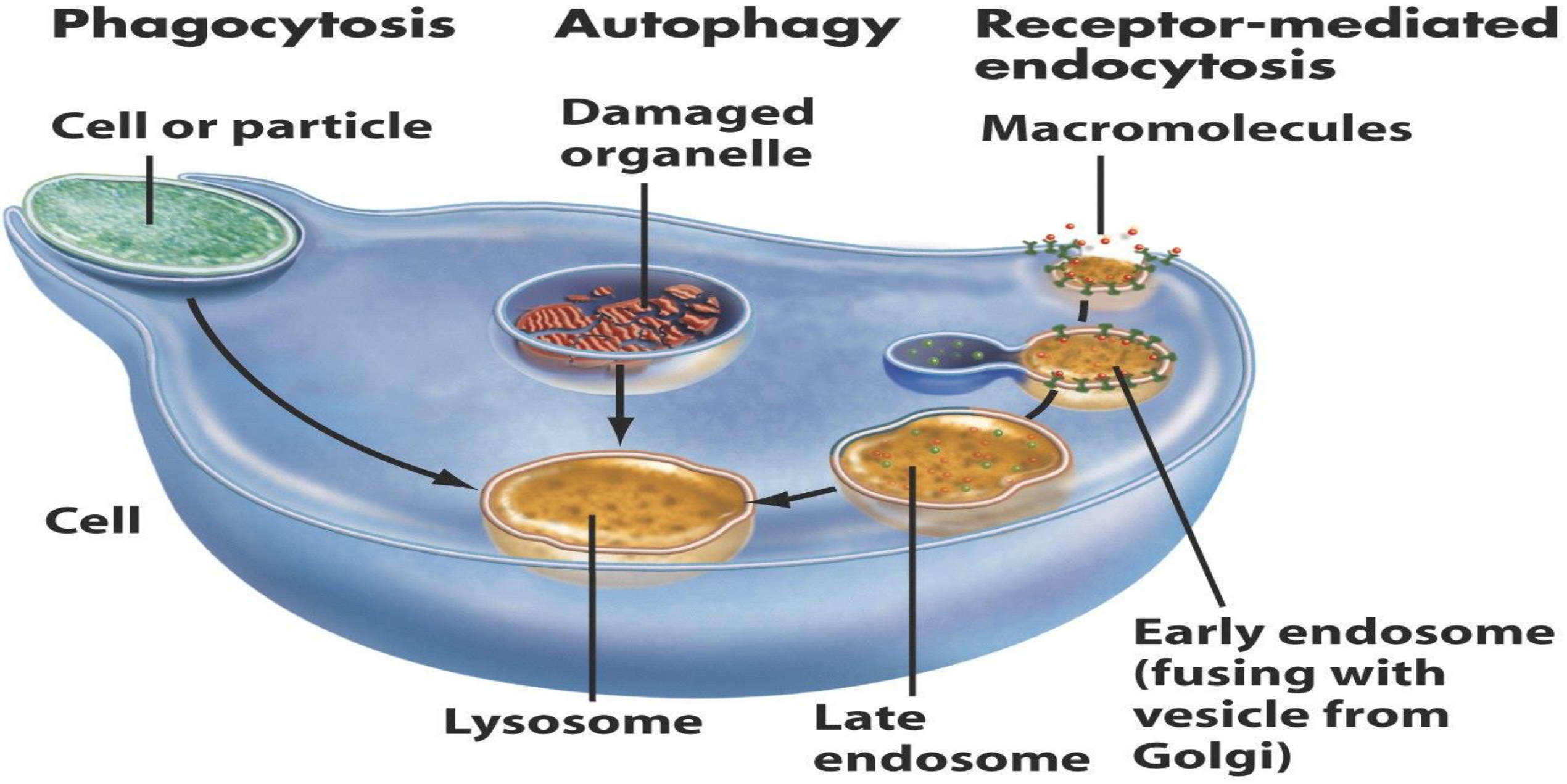
An electron micrograph showing Golgi stacks

A.4. Vesicles and vacuoles:

- Are membrane-bound sacs involved in transportation and storage. Vacuoles are larger than vesicles.

A.4.1 Lysosomes

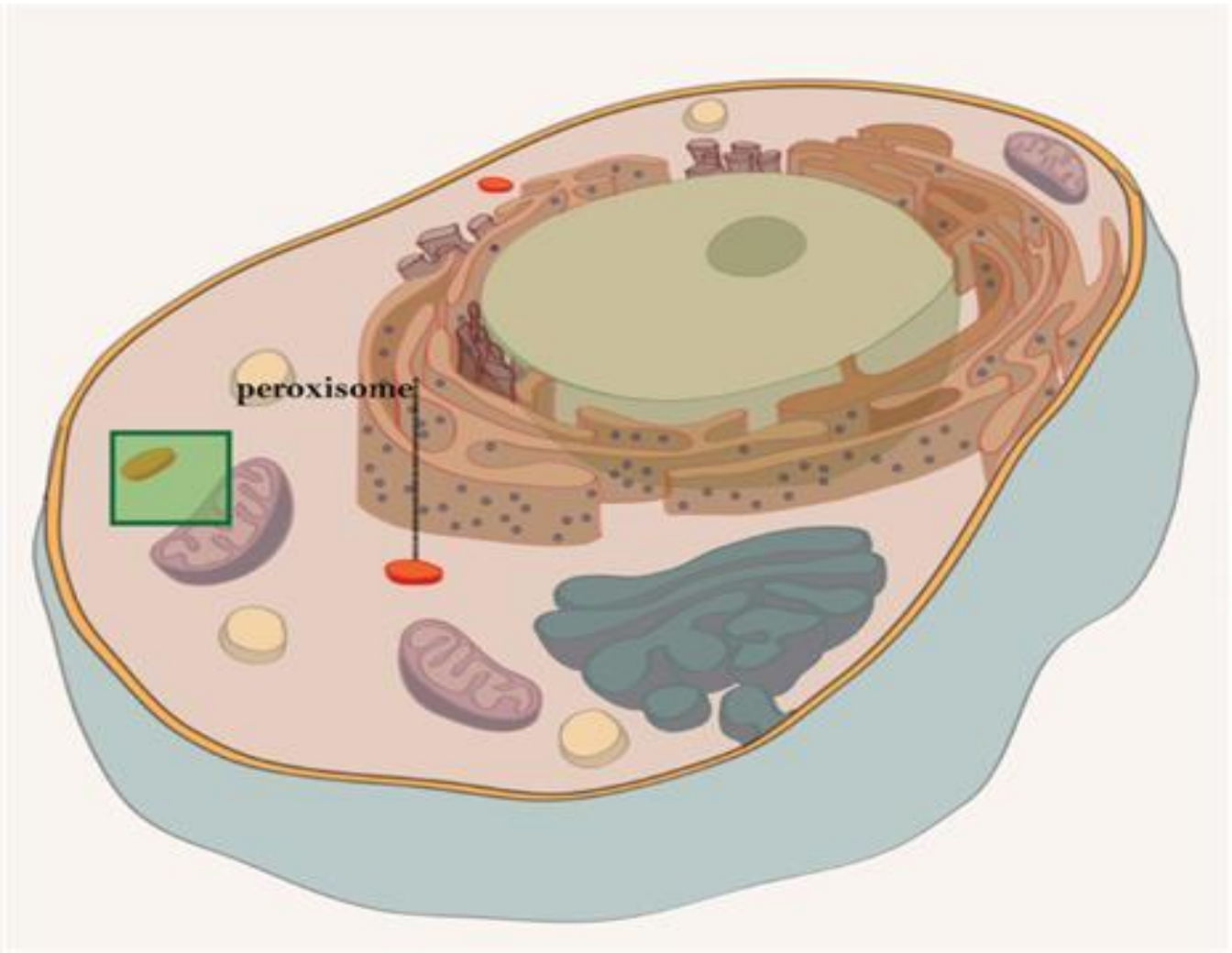
- Also known as cell vesicles are membrane-bound vesicle that contain hydrolytic enzymes for digesting macromolecules.
- They are round subcellular organelles found in almost all eukaryotic cells .
- Ways to enter a lysosome –are 1-phagocytosis, 2- autophagy, and 3-receptor-mediated endocytosis.
- They contain around 40 different types of hydrolytic enzymes, including proteases, nucleases and lipases (they are all acid hydrolases, which need an acid pH to work optimally).
- In a process called autodigestion, parts of a cell may be broken down by the lysosomes.

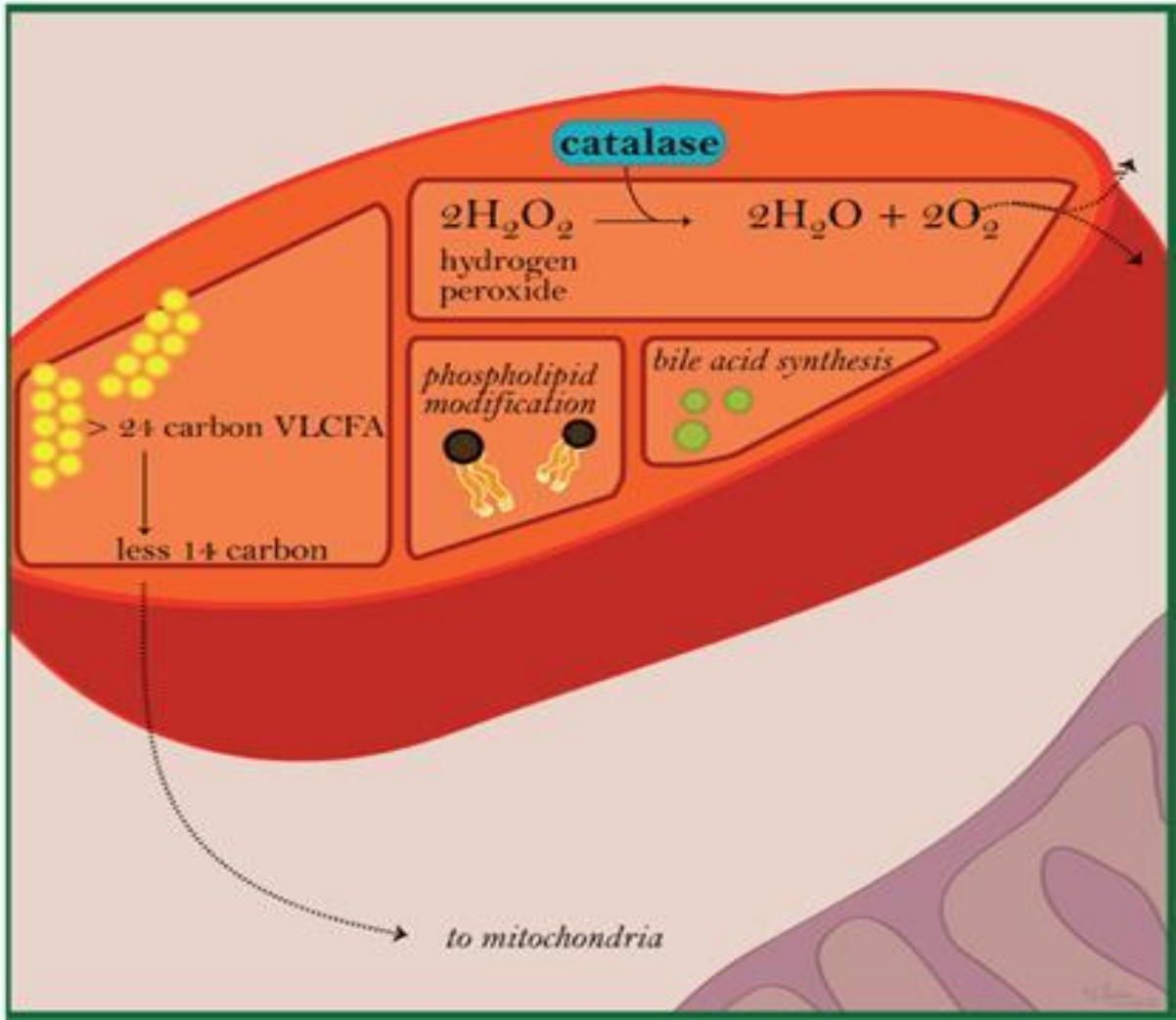

Phagocytosis
Autophagy
Receptor-mediated endocytosis
Cell or particle
Damaged organelle
Macromolecules
Cell
Lysosome
Late endosome
Early endosome (fusing with vesicle from Golgi)

A.4.2. Peroxisome

- The peroxisome is an oxidative organelle that is present in most eukaryotic cells.
- The peroxisome is surrounded by a lipid bilayer membrane.
- It may also contain a crystalloid core. The core contains all the enzymes necessary for its function.
- Peroxisomes contain enzymes that produce hydrogen peroxide as a by-product while performing various functions, such as breakdown of fatty acids and detoxification of chemicals and drugs in the liver.
- Also contain an enzyme that converts the toxic hydrogen peroxide by-product of these reactions into H2O.

A.4.2. Peroxisome[2]





- A.4.3. Endosomes : The endosomes function is relates to The transportation of extracellular material into the intracellular domain.
- A.4.4. Proteasomes : Deal primarily with endogenous proteins.
- A.4.5. Transport vesicles: Transport vesicles help move materials, such as proteins and other molecules, from one part of a cell to another.

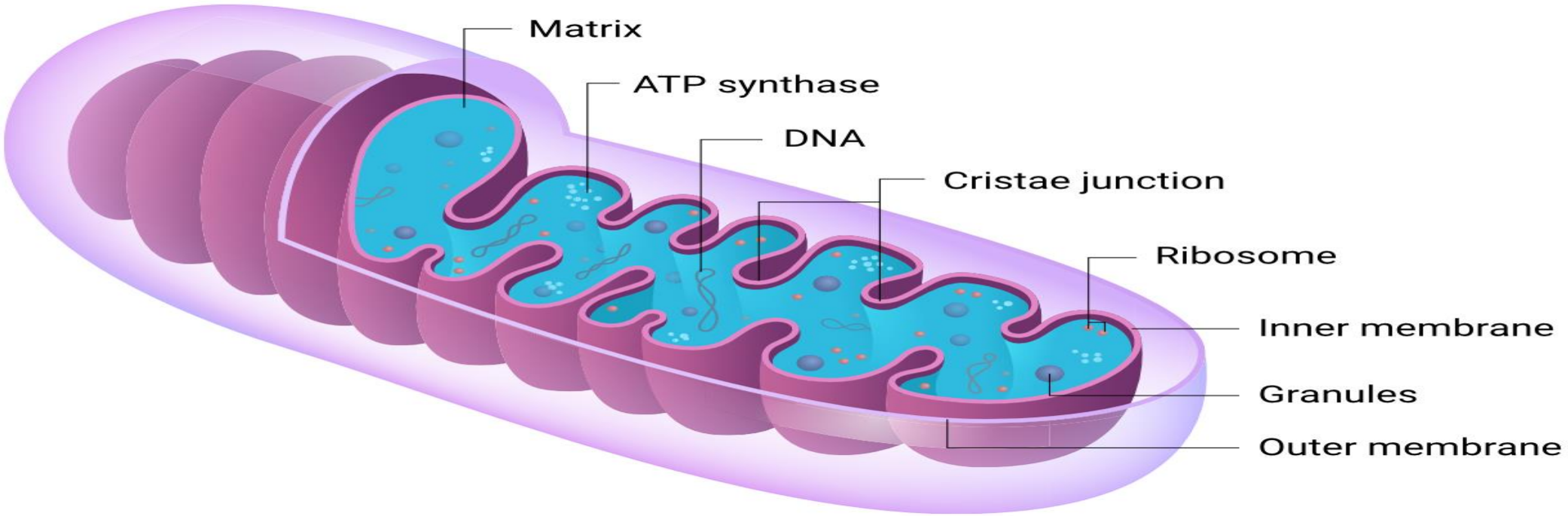
A.5.Mitochondria

- Mitochondria are rod-shaped or oval or spherically shaped, with a size of 0.5 to 10 µm.
- They have a mitochondrial gel-matric in the central mass.
- • Mitochondria have two special membranes – outer and inner membranes:
- 1. The Inner Membrane bend into folds and forms the cristae, the site of energy generation (houses of energy).
- 2. The matrix is the soluble portion of the mitochondria:
- a) Site of carbon metabolism.
- b) Location of mt-DNA.
- c) Site of mitochondrial protein synthesis.

A.5. Mitochondria[2]

- The functions of Mitochondria include:
- 1. Their primary function is the site of aerobic respiration of cells through which energy is generated in the form of Adenosine Tri-phosphate (ATP), so it is called “the powerhouse of the cell” .
- Sugars + O2 - - > ATP + CO2 + H2O.
- 2. Mitochondria also store calcium which assists in cell signaling activity.
- 3. Mitochondria play a major role in programmed cell death (apoptosis) and mutations in the mtDNA can inhibit apoptosis causing the development of malignant tumor.

A.5.Mitochondria[3]



Non-Membranous structures

- Structures found in eukaryotic cell
- **B.1. Nucleolus** (A.1.3.)
- **B.2.:Filaments:**
- **B. 2.1. Microfilaments**
- **B. 2.2Intermediate filaments**
- **B.2.3. Microtubules**
- **B.3.Centrioles**
- **B.4.Cilia**
- Structures found in both of eukaryotic &prokaryotic cells
- **B.5._Flagella**
- **B.6.Ribosomes**

Cytoskeleton of eukaryotic cells

- **The cytoskeleton is a network of different protein fibers that provides many functions:**
- **It maintains or changes the shape of the cell;**
- **secures organelles in specific positions;**
- **enables cytoplasm , vesicles; and the whole cell to move in response to stimuli.**

Cytoskeleton of eukaryotic cells[2]

- Cytoskeleton is made up of 3 types of tiny filaments: Microfilaments, Intermediate filaments , and microtubules .

B.2.1. Microfilaments

Are the thinnest and most abundant of the cytoskeleton proteins.

They are composed of actin, a contractile protein, and can be assembled (collected) quickly according to the need of the cell or organelle structure. They are solid and narrower, provide strength for cells. They help to anchor one cell to another

There is a high concentration of microfilaments in muscle cells, where they form myofibrils, the basic unit of the muscle cell.

B.2.2. Intermediate filaments

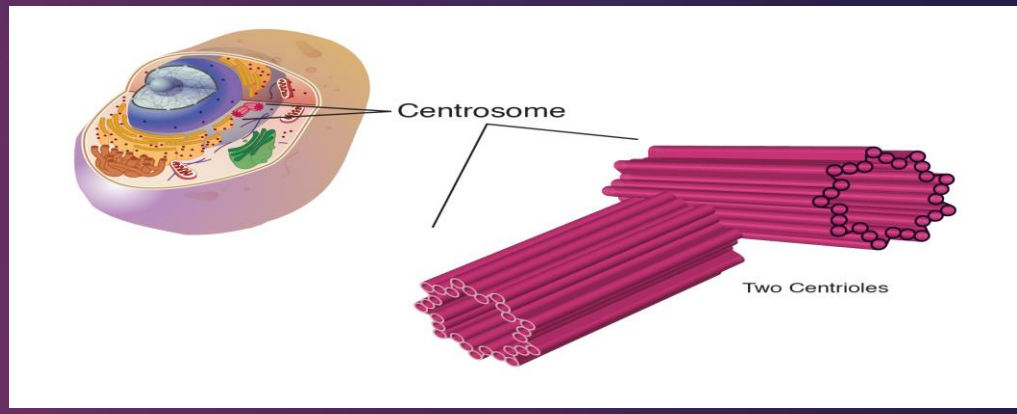
- Intermediate filaments are slightly larger in diameter and are found most extensively in regions of cells that are going to be subjected to stress. Their average diameter of (10 nm) is between those of narrower microfilaments (7 nm) and wider microtubules (25 nm).
- Intermediate filaments proteins represent a variety of proteins eg keratins.
- Desmosomes contain intermediate filaments. Desmosomes are one of the stronger cell-to-cell adhesion types thus function to resist mechanical stress.

. B.2.3.Microtubules

- Ae hollow tubes composed of a protein called tubulin. They are the thickest and most rigid of filaments.
- Microtubules width is as wide as 23 to 27 nm. They are capable of rapid assembly and disassembly according to need. They provide platforms for intracellular transport and are involved in the movement of secretory vesicles ,organelles , and in cell division .
- Microtubules have a major structural role in cilia and flagella.
- The regulation of microtubule assembly is under the control of a microtubule organizing center called the centrosome.

B.3. Centrosomes

- **Centrosomes are organelles that organize microtubules and control cell division in animal cells.**
- **Each cell has a pair of centrioles in the centrosome the members of each pair at right angles to one another.**
- **Functions :**
- **1-The centrosomes help in cell division.**
- **2-They maintain the chromosome number during cell division.**



- **3-In mitosis, they help in organizing the microtubules ensuring that the centrosomes are distributed to each daughter cell.**
- **4-They regulate the movement of microtubules and cytoskeletal structures, thereby, facilitating changes in the shape of the cell.**
- **5- They are essential for the formation of centrosomes, cilia, and flagella.**

B.4. & B.5. Cilia and Flagella

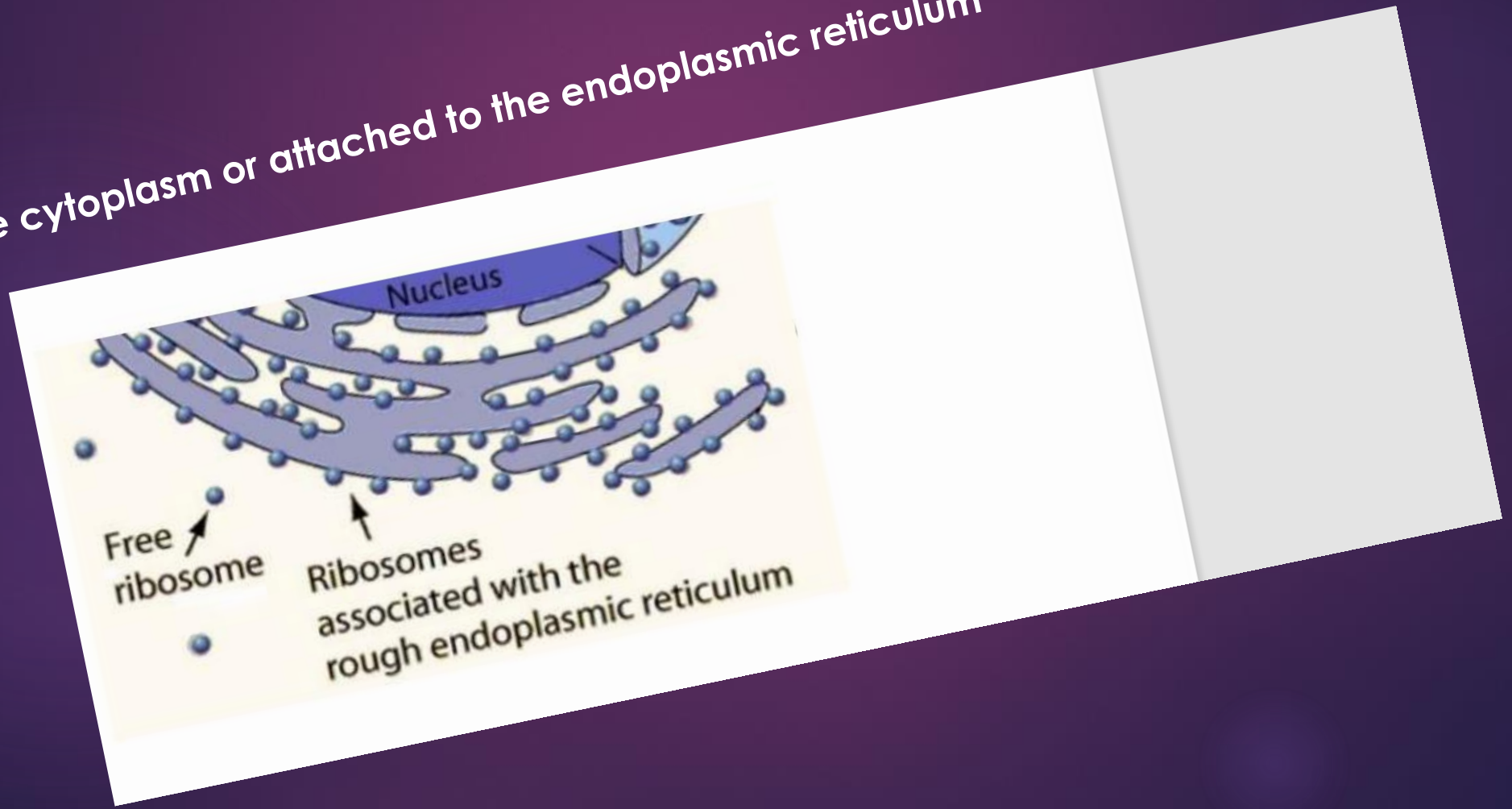
- Cilia and flagella are finger-like projections that extend from some cells.
- They aid in cell movement and help to move substances around cells.
- Examples
- 1. Salmonella species and sperm cells have flagella which enables them to move.
- 2. Cilia : On the epithelial lining of the nostrils and bronchus help propel surface particles.
- Paramecia cilia beat rhythmically to move them and to direct food particles into their mouths.

B.6.: Ribosomes

- Are small organelles responsible for protein synthesis. protein synthesis occurs in ribosomes, composed of proteins and rRNA.
- • Are not bound by a membrane.
- • Eukaryotic ribosomes are built in a structure called the nucleolus.
- • May be free in the cytoplasm, or bound to the ER
- • Are found in prokaryotes, plants, and animals.

B.6.Ribosomes

Found in the cytoplasm or attached to the endoplasmic reticulum




Thank you

