

# 2- Cell Biology

## Cell compartments



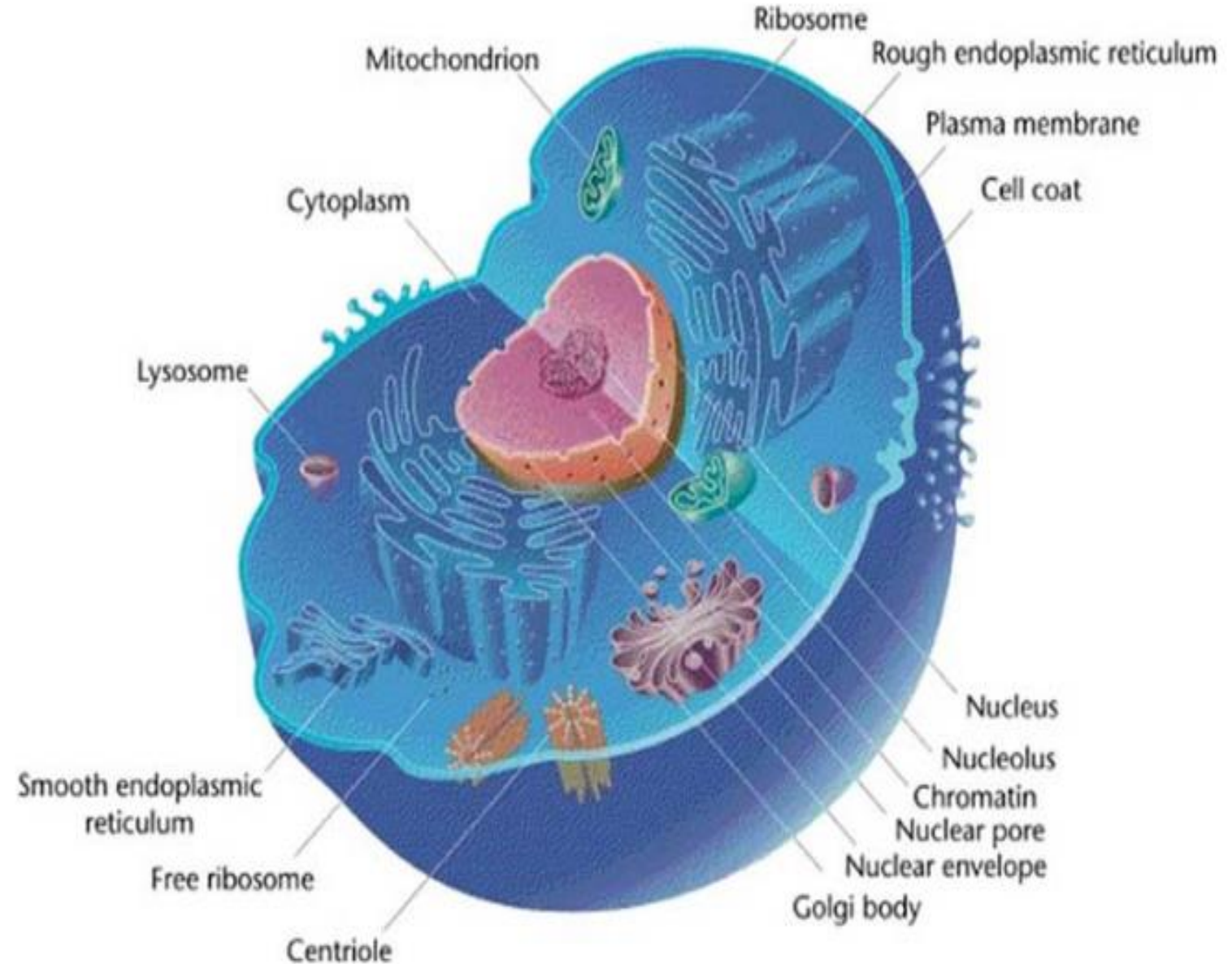
THE UNIVERSITY *of* DUHOK



COLLEGE *of*  
VETERINARY MEDICINE

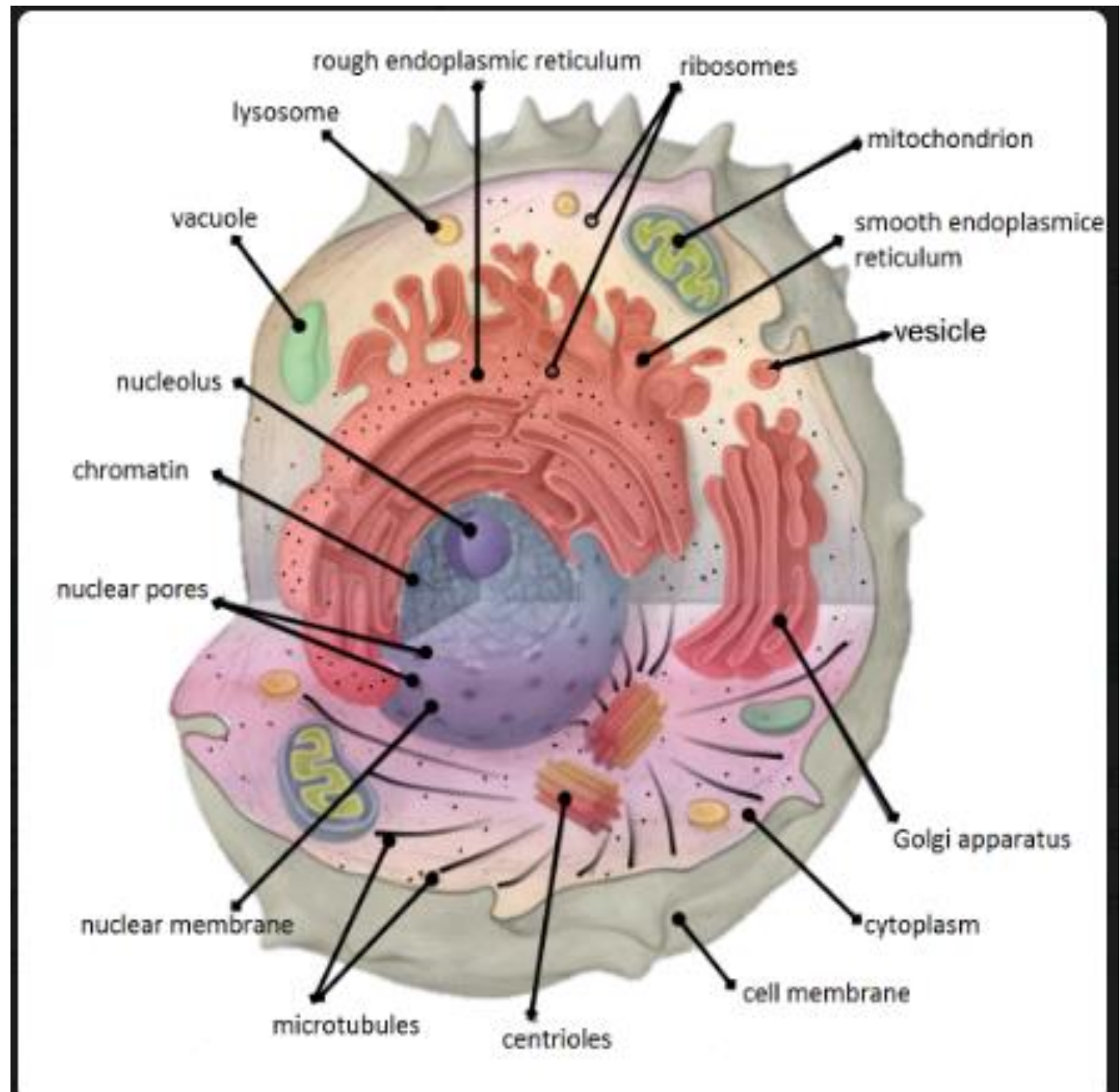
# Cell biology

Cell biology is a branch of biology focused on the study of cell structure and function, on how cells form and divide, and how they differentiate and specialize



# Cellular components

- Cellular compartments in eukaryotic cells are closed, membrane-bound regions within the cytosol that are specialized for specific biological processes
- Each eukaryotic cell has a Nucleus, Cytoplasm and cell membranes



# Cellular components

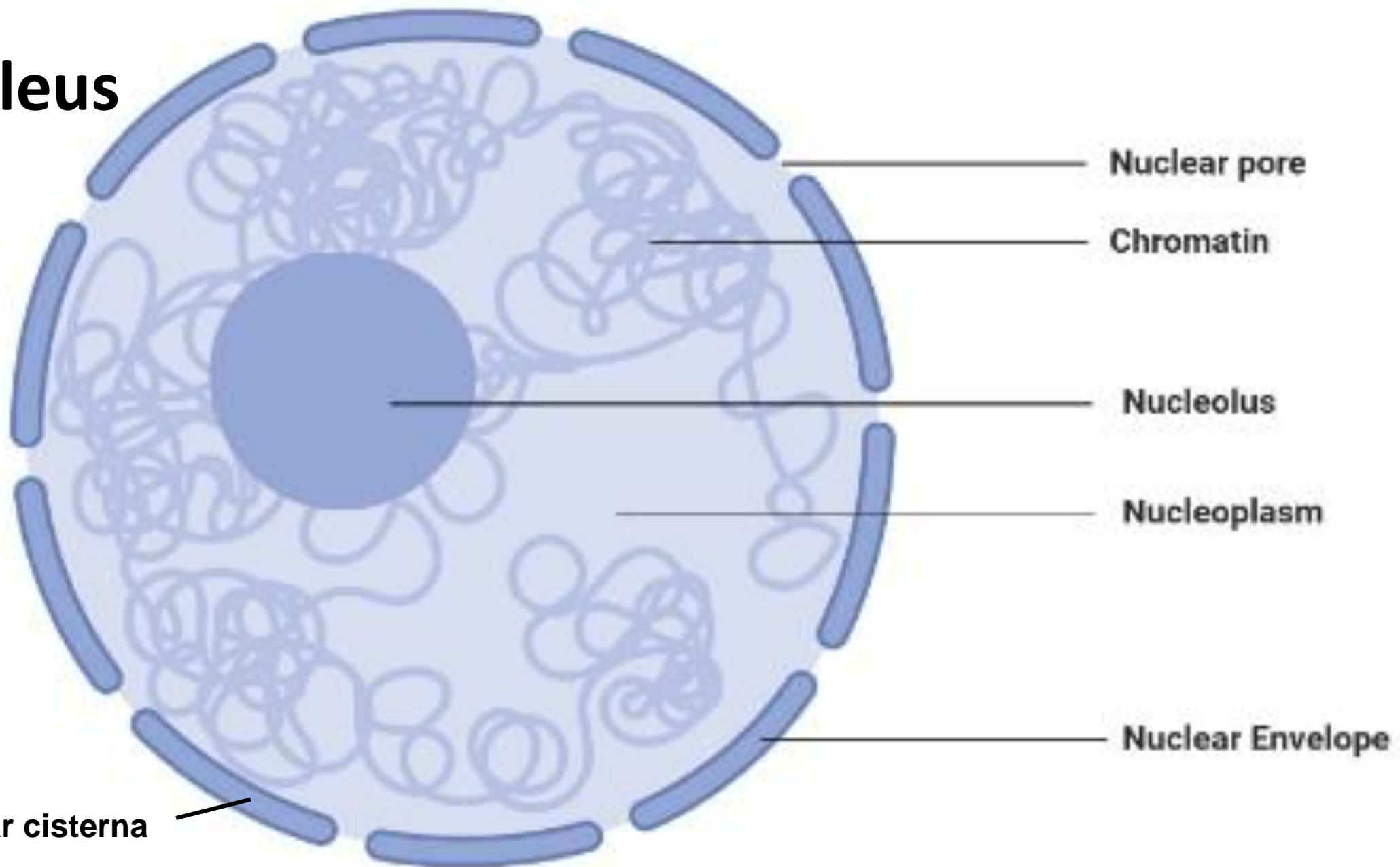
## I- Nucleus

- The nucleus is a spherical or elongated structure covered with membrane, about 5-10 microns in diameter. Within the nucleus, the DNA is organized into discrete units called chromosomes, structures that carry the genetic information. Each chromosome contains one long DNA molecule associated with many proteins, including histones.
- All eukaryotic cells contain a nucleus (plural = nuclei) except mature erythrocytes (red blood cells)
- Each nucleus consists of a **nuclear envelope, chromatin, nucleoli and nucleoplasm**

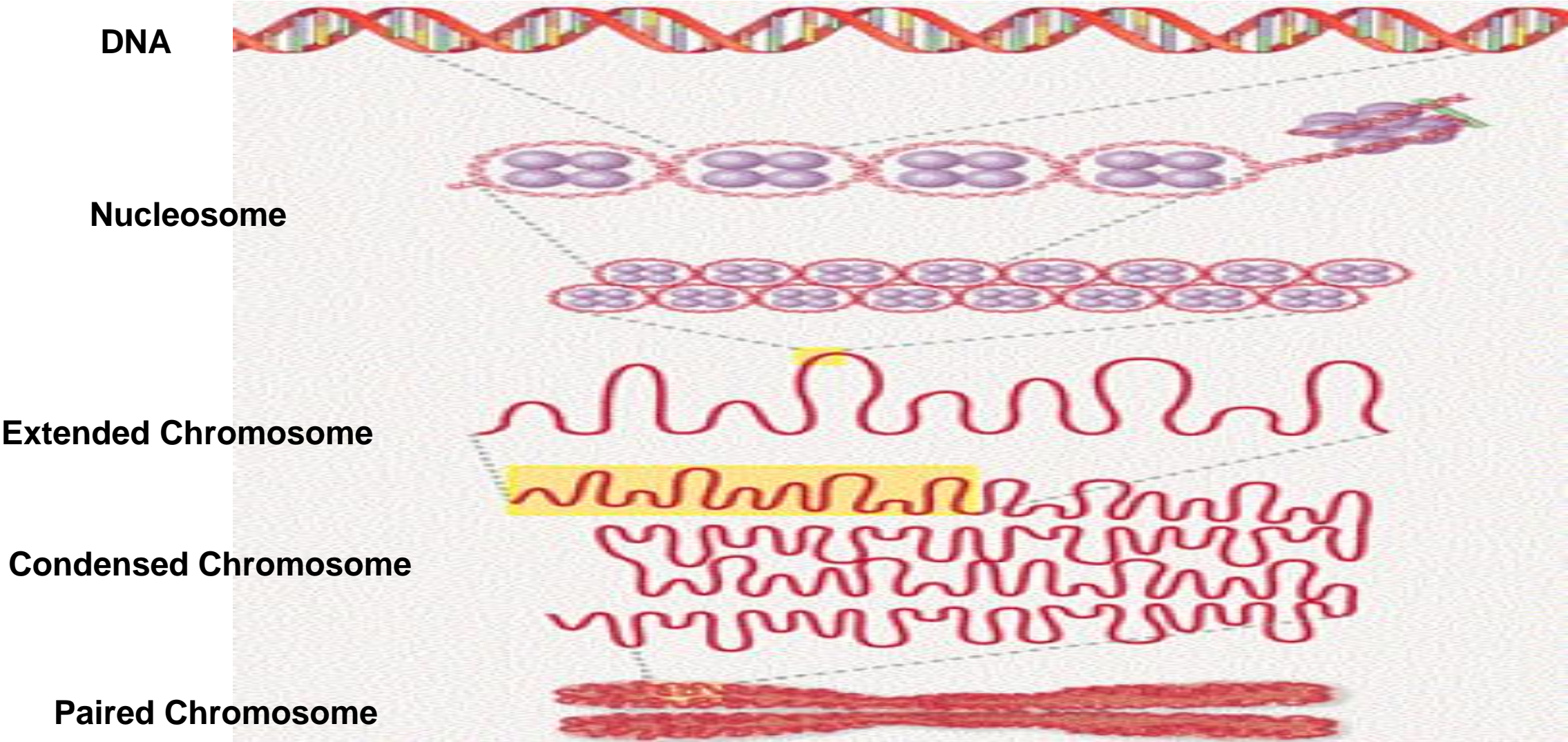
# I- Nuclear components

1. **Nuclear envelope:** The nucleus is surrounded by a nuclear envelope, which consists of two lipid bilayers. The space between the two layers called the perinuclear space. The envelope is perforated by nuclear pores that regulate the passage of substances into and out of nucleus.
  2. **Chromatin:** it consists of DNA and proteins (histone), the DNA wrap around histone to make nucleosome. Nucleosome coils and condenses to form chromosomes during cell division.
- **The main function of chromatin** is package DNA into a small volume; to fit into the nucleus, strength the DNA during mitosis and prevents chromosome breakage.

# Nucleus



# The process of DNA packaging



# Types of Chromatin

Chromatin in the nucleus exists as **euchromatin** or **heterochromatin**.

- **Heterochromatin** is tightly packed DNA that darkly stained with basic dyes. It present in inactive cells where the transcription cannot occur.
- **Euchromatin** is extended DNA that poorly stained and is difficult to distinguish even by electron microscopy. Euchromatin presents in active cells that have more transcriptional activity and cell division.

**3- Nucleoli:** are one or two round basophilic bodies located within the nucleus. It consists of proteins and DNA that responsible for synthesis of ribosomal RNA (rRNA). They are present in embryonic cells, in cell that synthesize protein and tumour cells.

**4- Nucleoplasm:** is the fluid in which the nuclear components are embedded. It is composed of protein, metabolites, ions and water.

## II. Cytoplasm

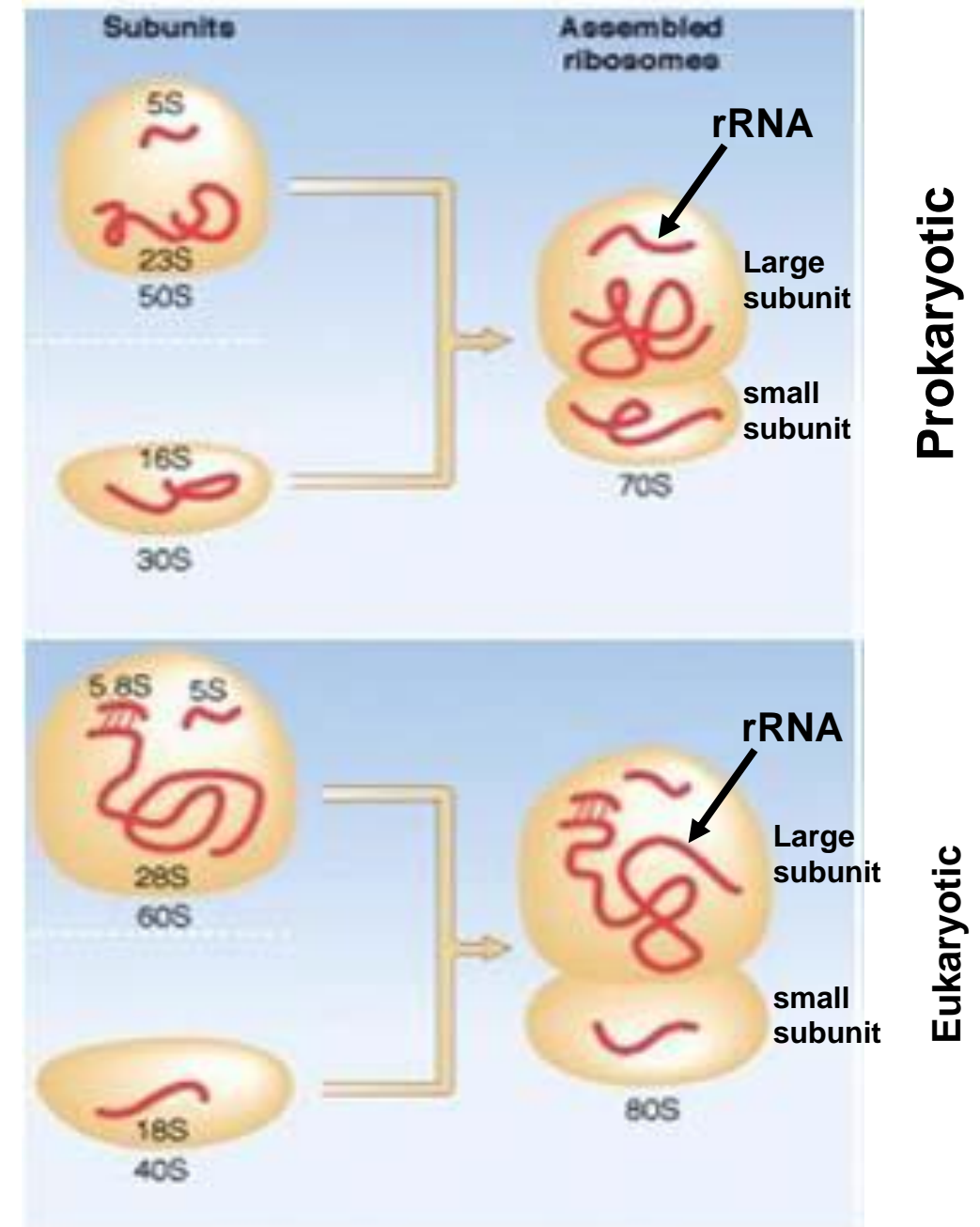
- Cytoplasm is composed of **organelles** and **cytosol** (jelly like material consisting of mainly water and proteins).
- Cytoplasm contains non membranous organelles such as ribosomes and centrosome as well as membranous organelles, such as endoplasmic reticulum, Golgi apparatus, mitochondria, lysosomes, vacuoles.

## II- Cytoplasmic organelles

### Non membranous cytoplasmic organelles

#### 1- Ribosome

- Ribosomes are round shaped organelles that synthesize protein in the cell. Ribosomes are complexes made of ribosomal RNAs and protein subunits (large and small).
- Ribosomes are found within the cytoplasm either free or attached to the Endoplasmic reticulum (ER).



## 2- Centrosome

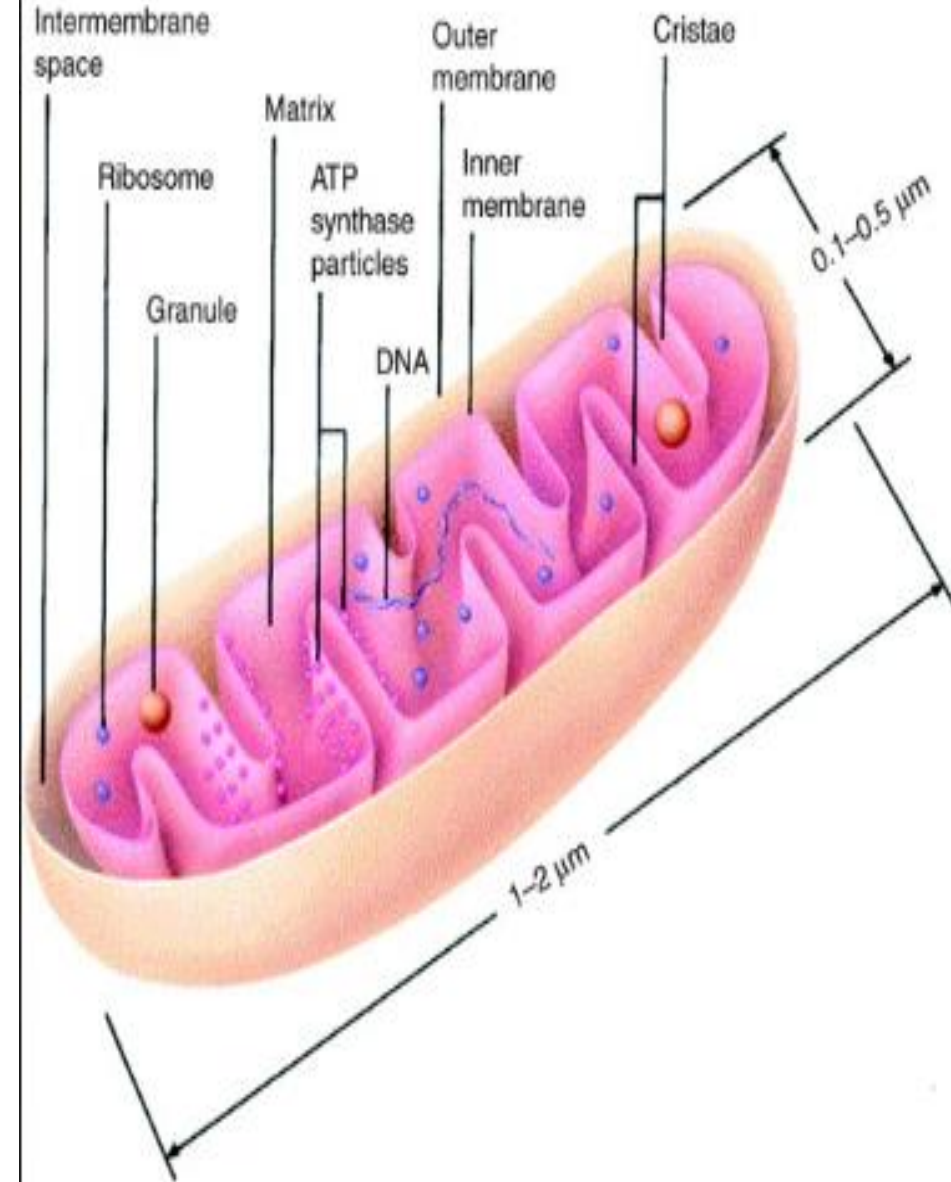
- Centrosome is a small body, located near the nucleus, it is composed of two centrioles arranged at right angles to each other .
- The centrosome plays an important role during cell division where the spindle filaments extend between the centrioles present at each pole of the cell.



# Membranous cytoplasmic organelles

## 1- Mitochondria

- **Mitochondria** are sac-like structure, bounded by two layered membrane (inner and outer).
- **Cristae** is folds that extends from The inner mitochondrial membrane into the matrix.
- **Mitochondrial matrix** contains circular DNA and ribosome allowing it to self replicate and produce protein. They are abundant in metabolically active cells (muscle, brown adipose tissue)
- They are the sites of cellular respiration (ATP)



## 2- Endoplasmic Reticulum (ER)

**Endoplasmic reticulum:** The ER is a complex network of flattened sacs and tubules that extends throughout the cytoplasm of the cell. They are the sites of protein and lipid production.

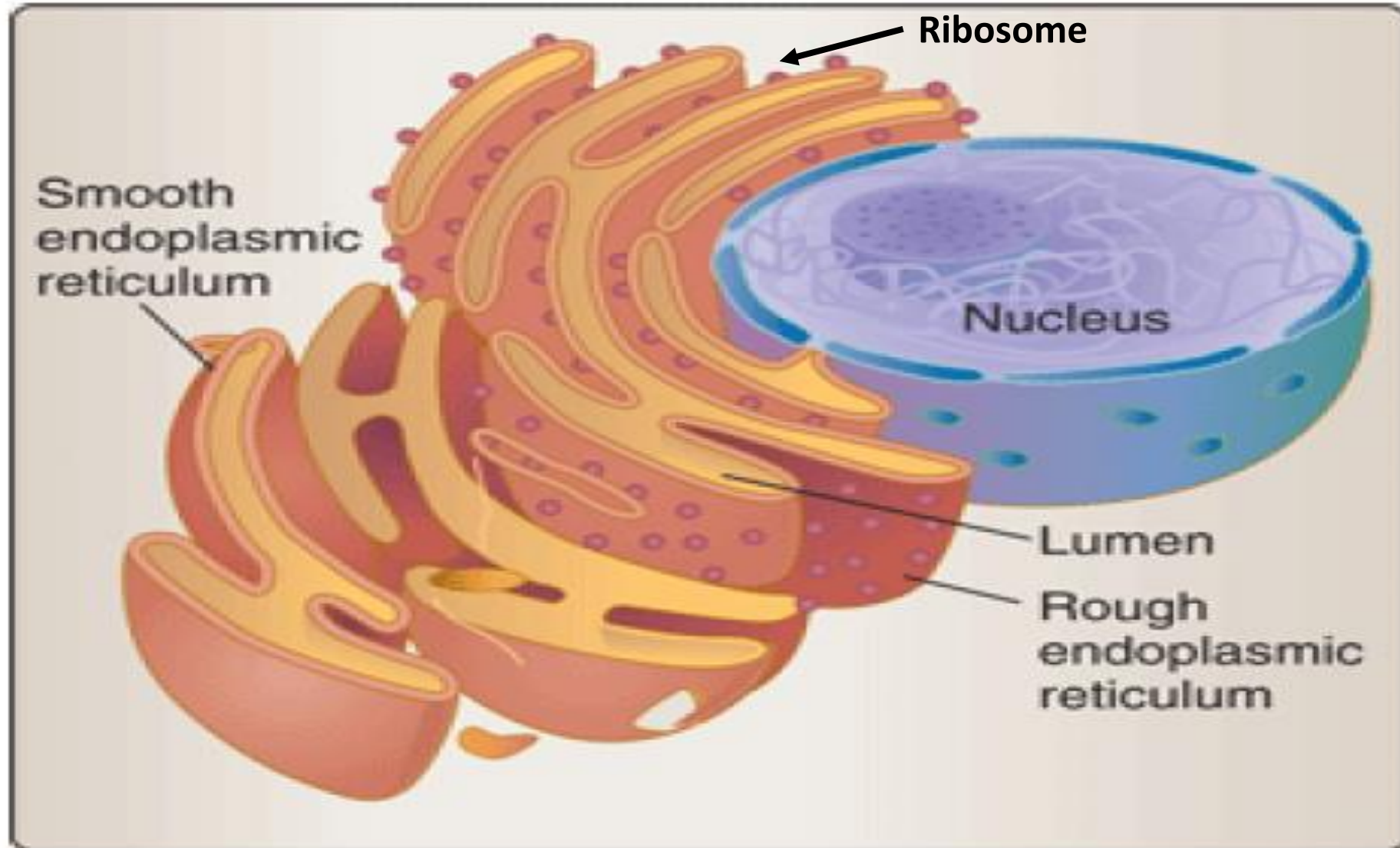
### Types of Endoplasmic reticulum (ER)

It can be divided into the following types:

**A. Rough endoplasmic reticulum:** it is covered with ribosomes which gives it a rough appearance and is continuous with the outer nuclear membrane. Rough ER transport materials through the cell and produces proteins in cisternae.

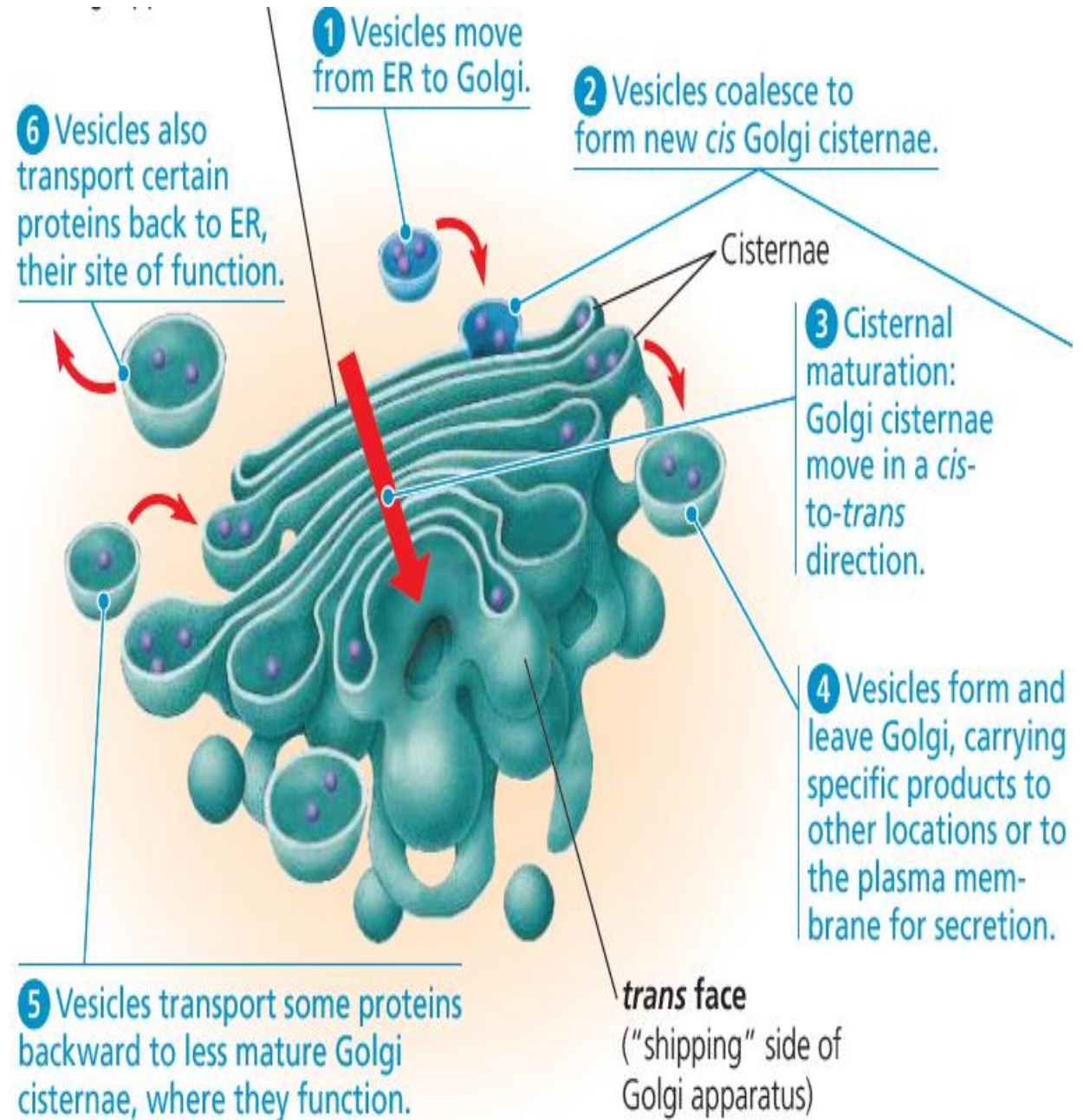
**B. Smooth endoplasmic reticulum:** it lacks ribosomes and contains enzymes that are important in lipids (fats) metabolism and steroid hormones production.

## 2- Endoplasmic reticulum



### 3- Golgi body(apparatus):

- The Golgi apparatus consists of a group of flattened membranous sacs- cisternae
- Golgi apparatus is responsible for receiving substances at the cis face, materials that secreted by the endoplasmic reticulum, modified, and packaged into vesicles at the trans face for delivery to extracellular space



## **4- Lysosome**

- Lysosomes are a membranous sac of hydrolytic enzymes with acidic (PH 5.0) that facilitate the digestion of proteins, organelles, and extracellular debris through the action of acid hydrolases. therefore, they described as stomach of the eukaryotic cell.

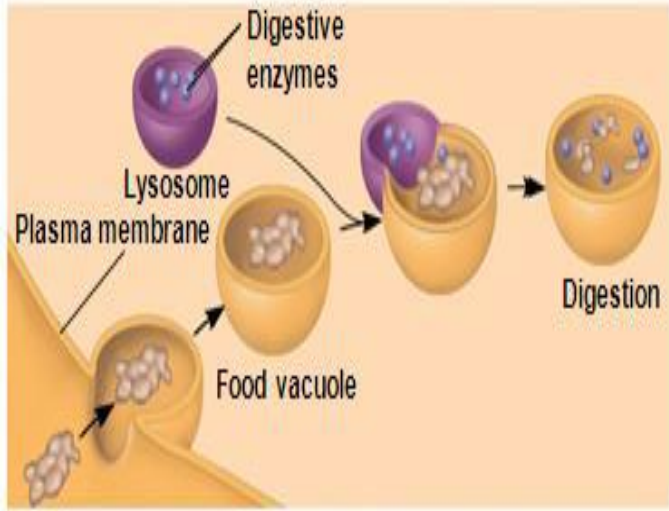
## **5- Endosomes**

Endosomes are internal membrane-bound structures, formed by endocytosis process, and found in the cytoplasm.

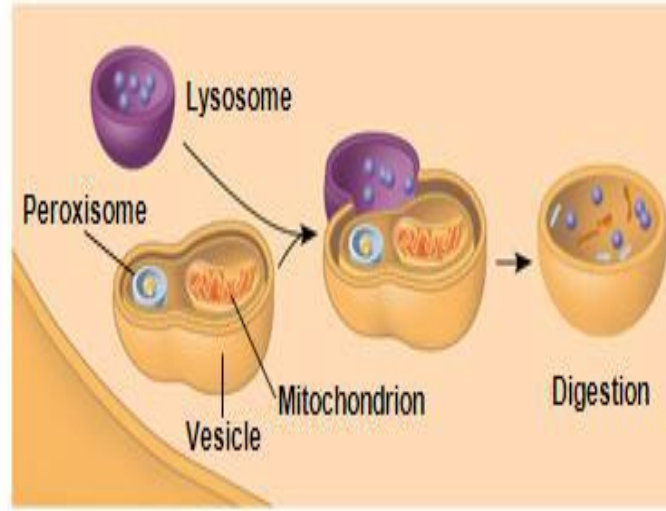
## **6- Phagosomes**

- Phagosomes are membranous vesicles that contain materials such as damaged organelles. Phagosomes fuse with lysosomes to digest these contents

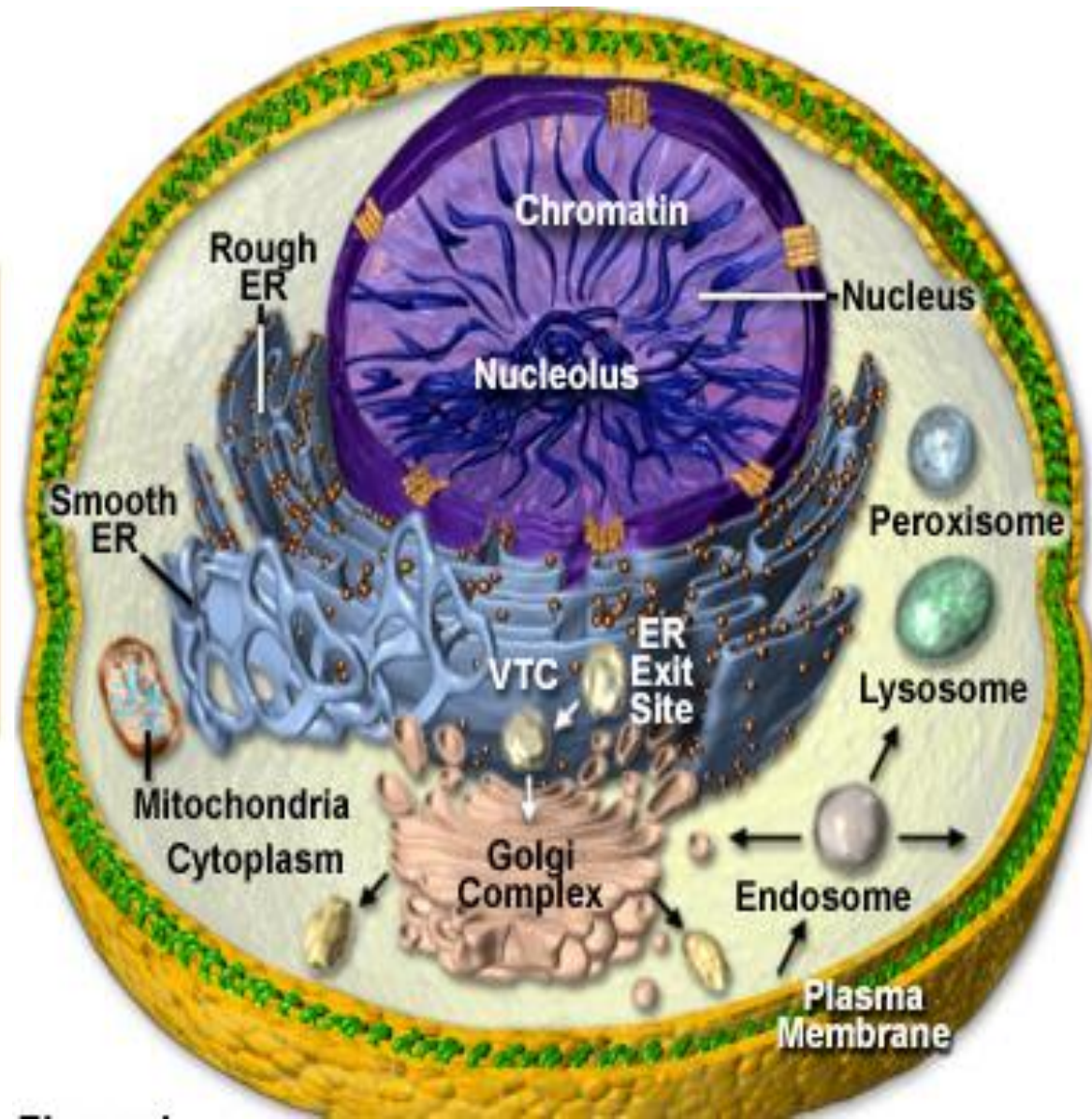
# Cell digestion



(a) Phagocytosis



(b) Autophagy



## 7- Peroxisome

is a specialized metabolic compartment bounded by a single membrane. It produces hydrogen peroxide as a product and then converts it to water.

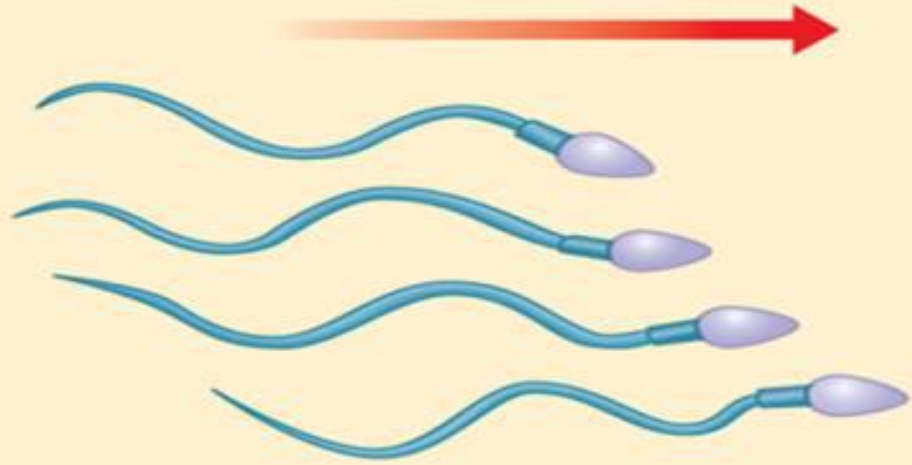
## 8- Cilia and Flagella

Cilia and flagella are projection from the cell motile, they move the cell or materials around the cells. Sperm has flagellum and cells lining the respiratory tract have cilia

## 9- Other cytoplasmic inclusions:

- **Lipid droplet**
- **Glycogen granules**
- **Melanin:** is a brown pigment present in epidermis, retina and brain

**Direction of swimming**



**(a) Motion of flagella**

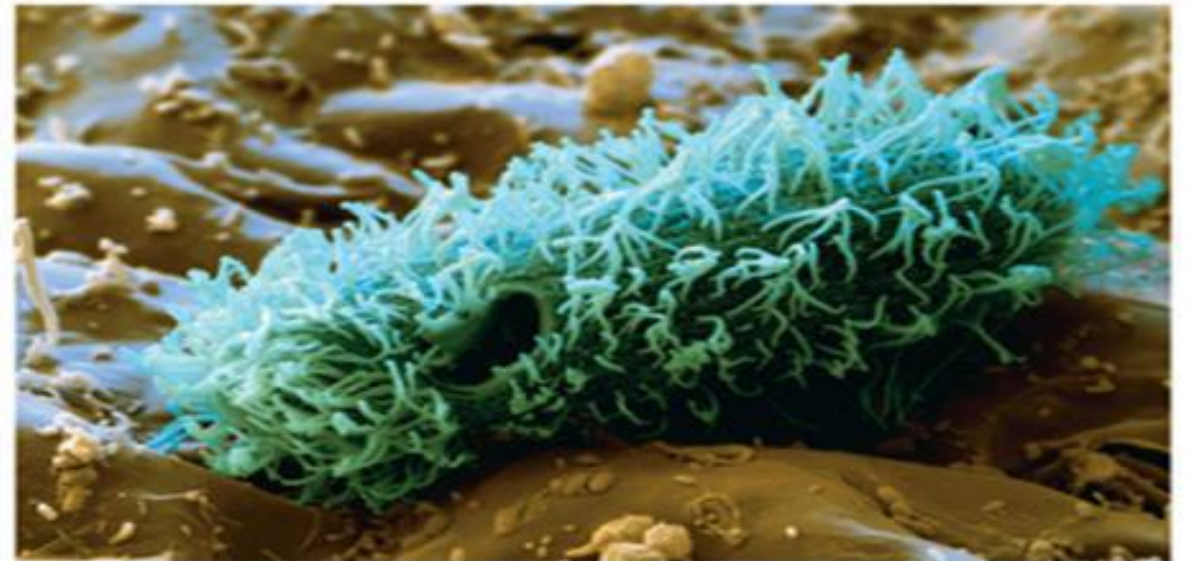


**Direction of organism's movement**

**Power stroke Recovery stroke**



**(b) Motion of cilia**



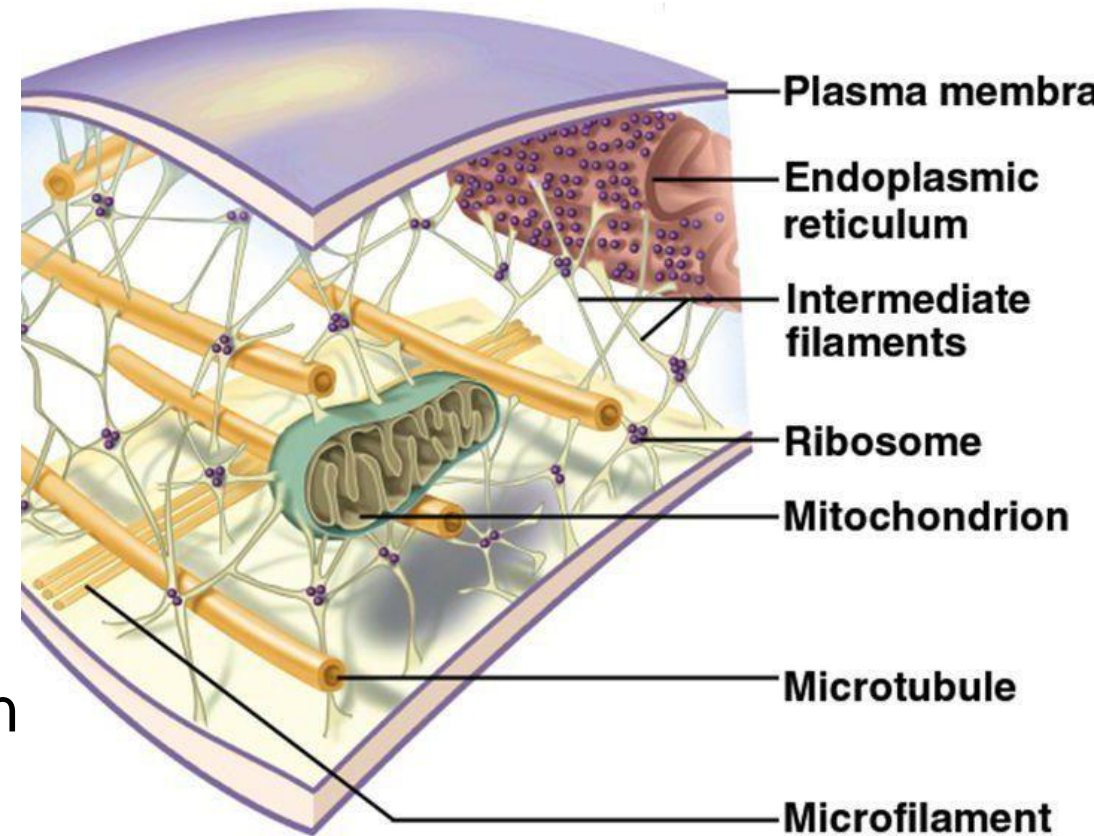
# Cytoskeleton

**Cytoskeleton** The cytoskeleton is a network of protein fibers inside the cell that gives it shape, strength, and support. It also helps the cell move and transport materials.

## Cytoskeleton has three types

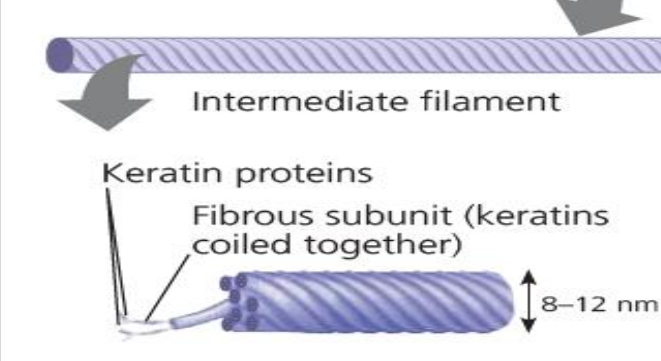
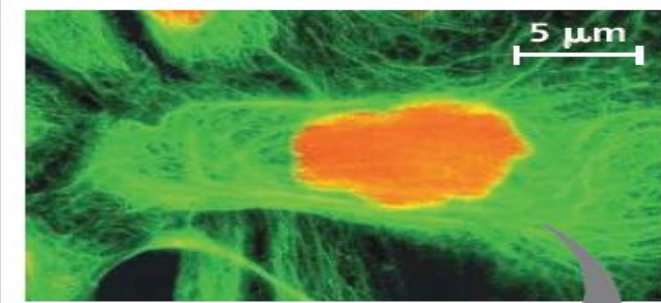
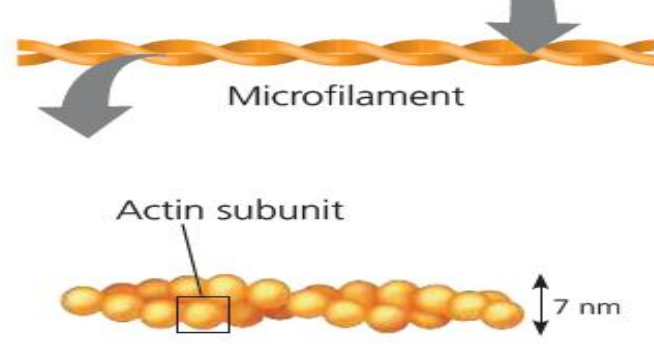
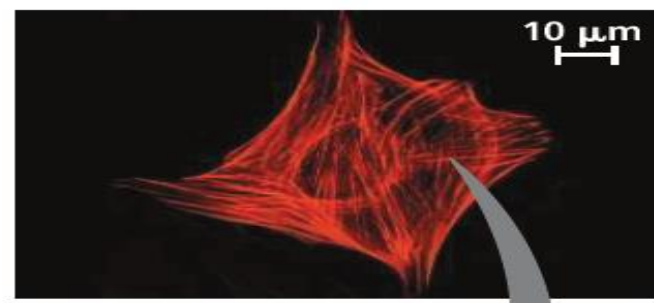
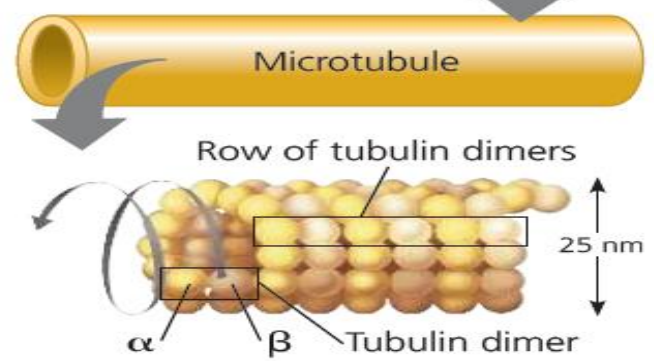
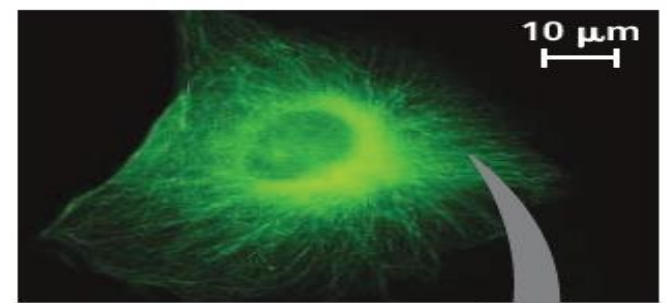
- **Microtubules** are the thickest of the three types; **microfilaments** (also called actin filaments) are the thinnest; and **intermediate filaments** are fibers with diameters in a middle range

## Cytoskeleton Diagram



Property	Microtubules (Tubulin Polymers)	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes	Two intertwined strands of actin	Fibrous proteins coiled into cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, a dimer consisting of an $\alpha$ -tubulin and a $\beta$ -tubulin	Actin	One of several different proteins (including keratins)
Main functions	Maintenance of cell shape; cell motility; chromosome movements in cell division; organelle movements	Maintenance of cell shape; changes in cell shape; muscle contraction; cytoplasmic streaming (plant cells); cell motility; cell division (animal cells)	Maintenance of cell shape; anchorage of nucleus and certain other organelles; formation of nuclear lamina

Fluorescence micrographs of fibroblasts.



# Types of Intermediate filaments

## INTERMEDIATE FILAMENTS

