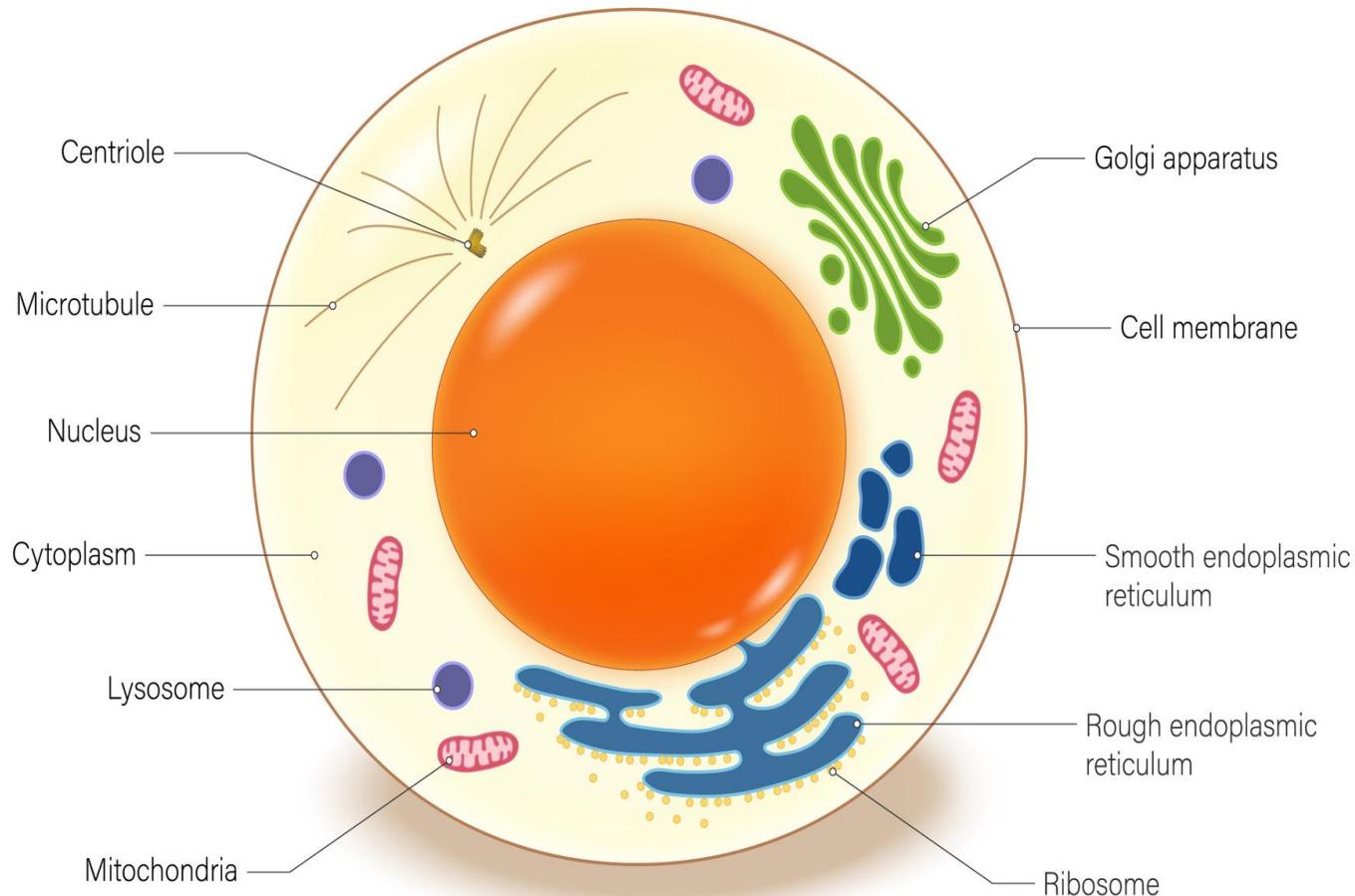

The Cell: Structure, Functions & Organelles

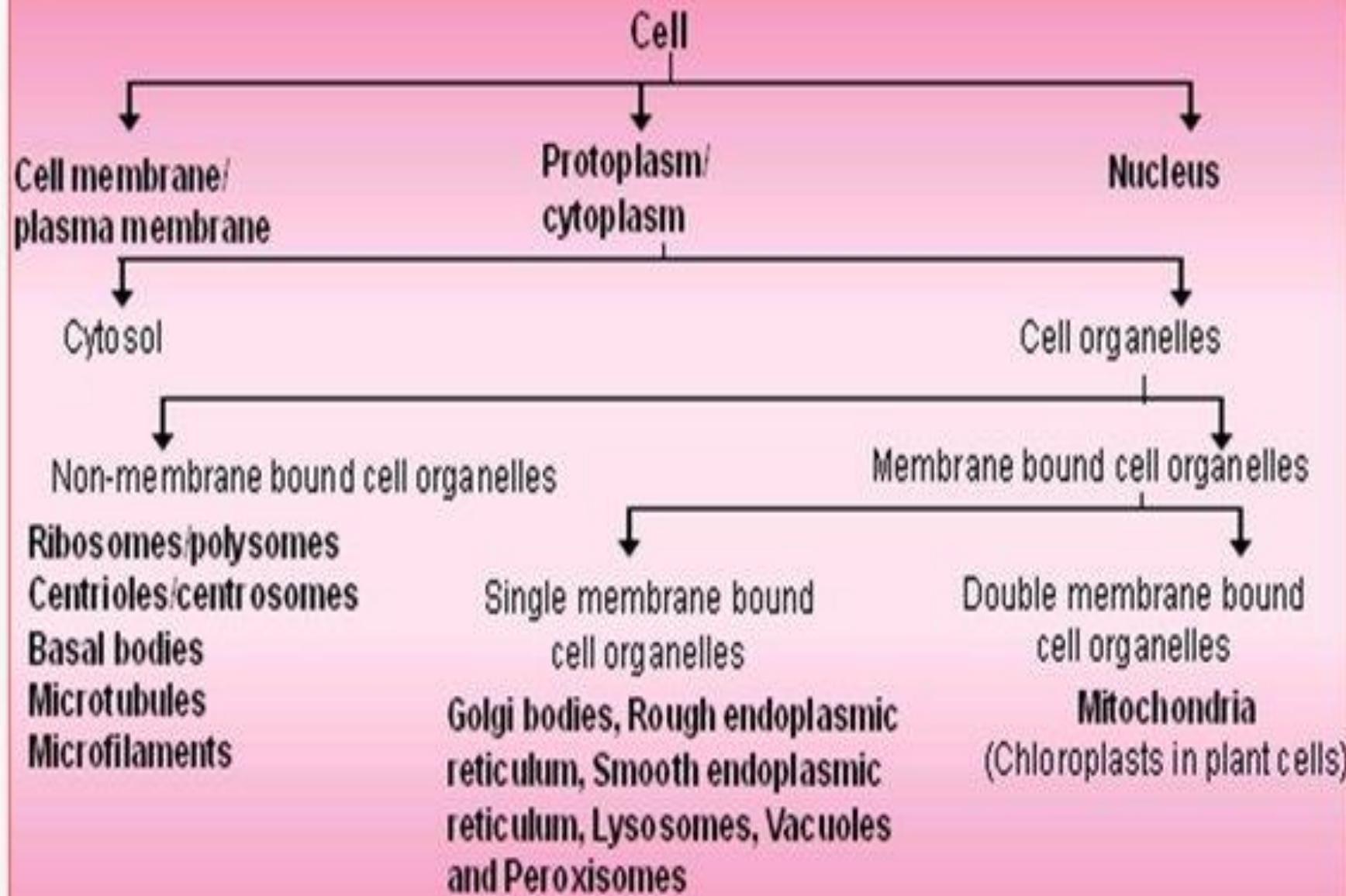
Dr. Bushra Zulfiqar

Introduction to Cell

- Basic structural and functional unit of life
- ~37 trillion cells in human body
- All cells arise from pre-existing cells

Animal cell





Cytoplasm

It acts as the store of important chemicals. It is a physical basis of all metabolic activities. It keeps the cell fully expanded and provides turgidity.

All the cell organelles resides in cytoplasm.

Organelle:

An organelle is a membrane bound structure that carries out specific activities for the cell

Functions of Cell

- Metabolism
- Growth
- Reproduction
- Irritability
- Conductivity
- Secretion & Excretion

Metabolism

- Sum of all chemical reactions in the cell
- Divided into:
 - **Anabolism** → synthesis of proteins, lipids, nucleic acids
 - **Catabolism** → breakdown of substances to release energy
-  *Example:*
Glucose → ATP via glycolysis & oxidative phosphorylation

Growth

- Increase in cell size due to increased synthesis of:
 - Proteins
 - Cytoplasmic organelles
- Requires adequate nutrition & oxygen
-  *Clinical note:*
Growth failure occurs in chronic malnutrition and hypoxia.

Reproduction

- Formation of new cells
- **Mitosis** → somatic cells
- **Meiosis** → germ cells (sperms & ova)
- ✅ Controlled by:
 - Cell cycle regulators
 - DNA integrity checkpoint

Irritability (Responsiveness)

- Ability of cell to respond to stimuli
- Stimuli may be:
 - Chemical
 - Electrical
 - Mechanical
-  *Example:*
 - Neuron responds to electrical stimulus
 - Muscle responds to acetylcholine

Conductivity

- Transmission of impulses
- Highly developed in:
 - Nerve cells
 - Muscle cells

Secretion

- Synthesis and release of substances such as:
 - Hormones
 - Enzymes
 - Neurotransmitters
- Requires **RER → Golgi → vesicles**

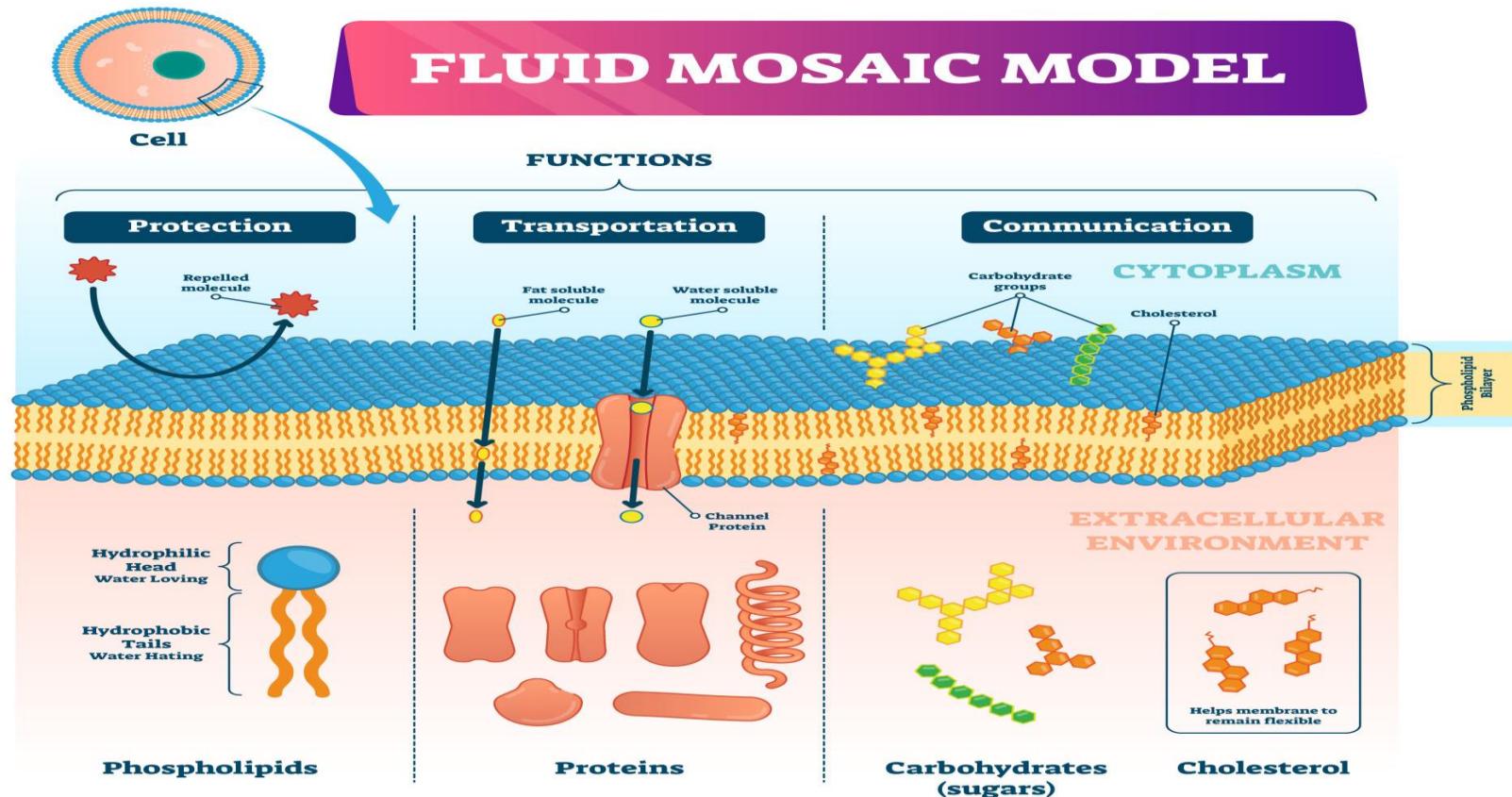
Excretion

- Removal of waste products:
 - CO_2
 - Urea
 - Reactive oxygen species

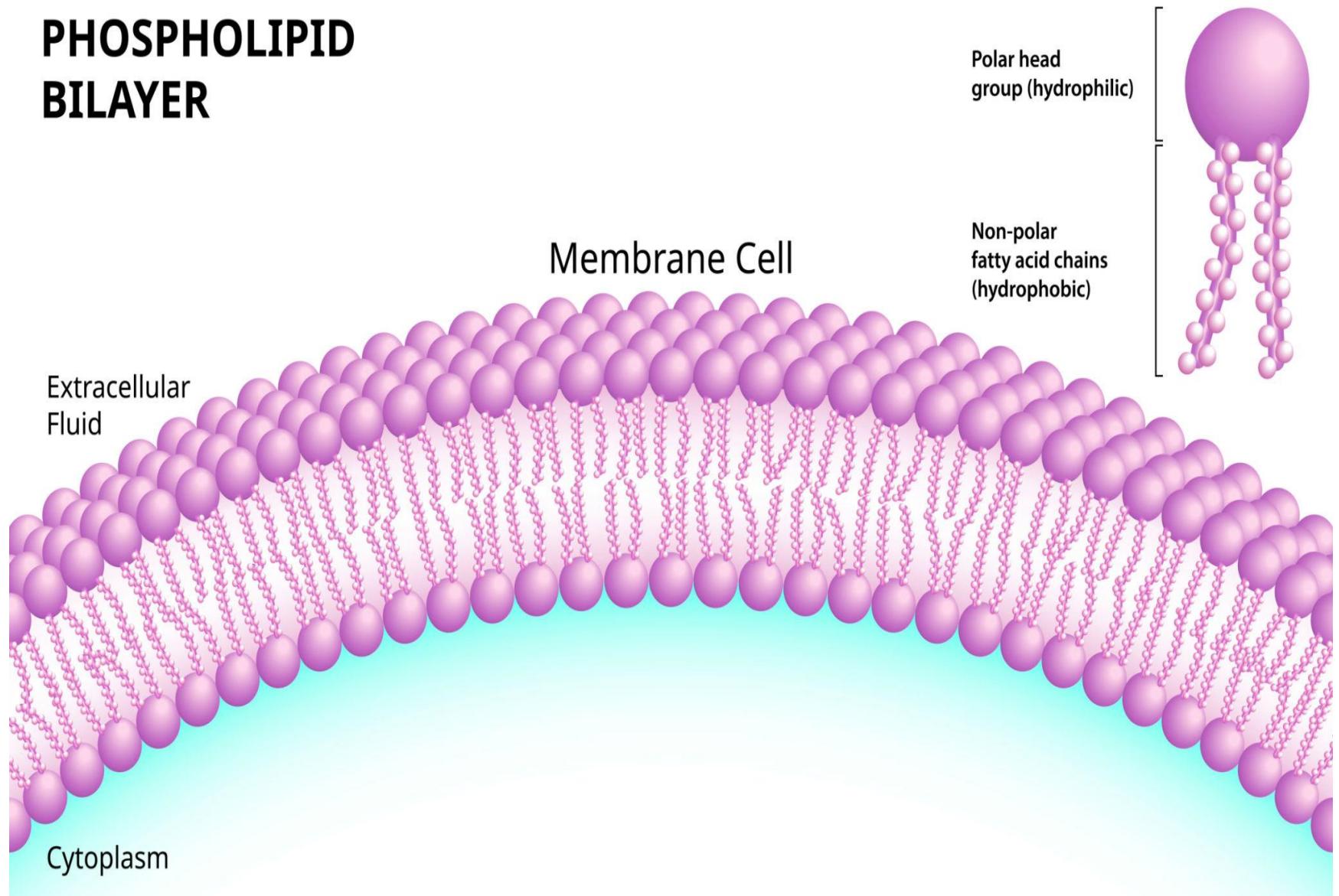
Basic Cell Structure

- Cell membrane
- Cytoplasm
- Nucleus

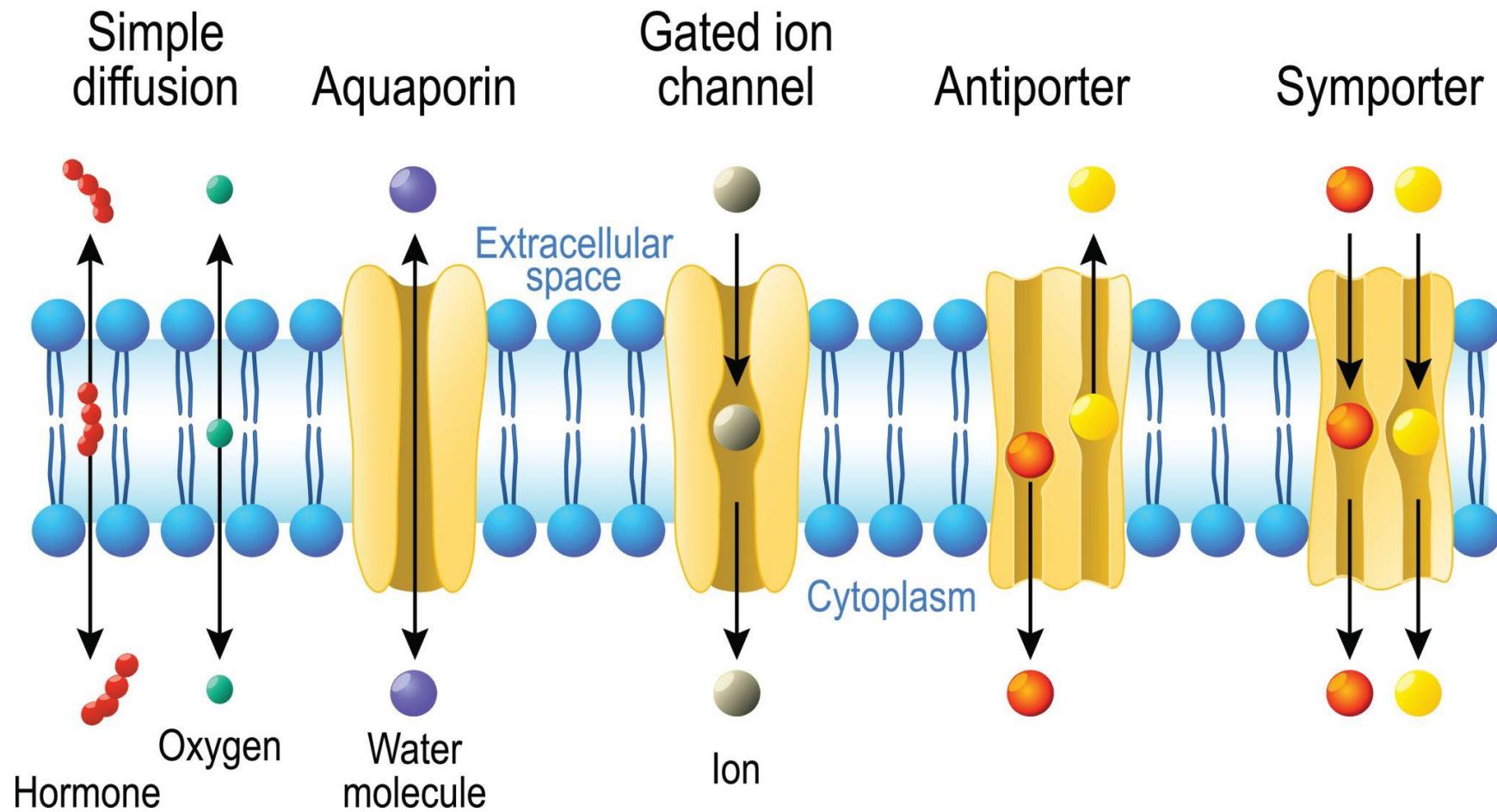
1. CELL MEMBRANE (PLASMA MEMBRANE):



PHOSPHOLIPID BILAYER



Membrane transporters

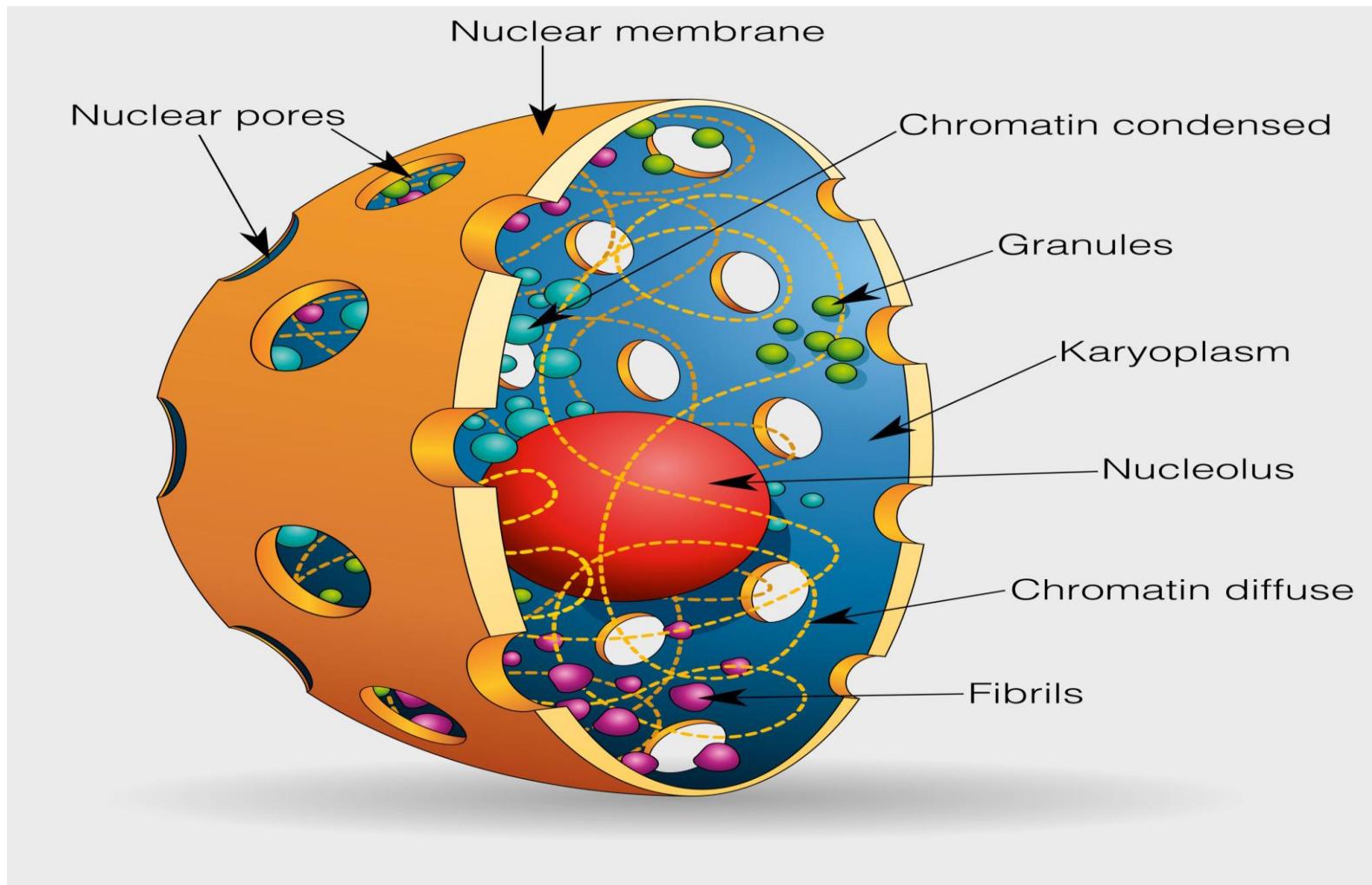


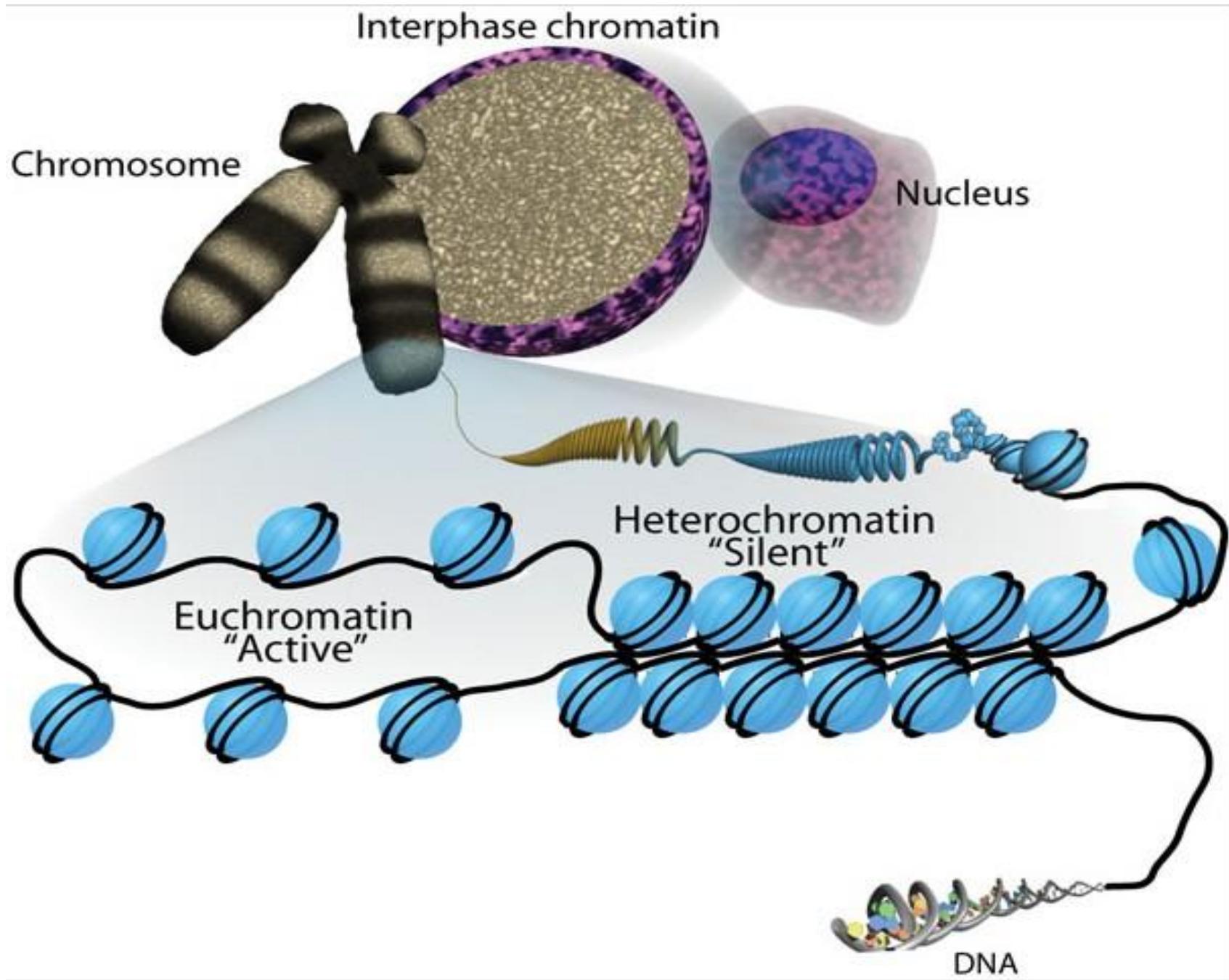
- **Structure**
- Thickness: **7–10 nm**
- Components:
 - Phospholipid bilayer
 - Proteins
 - Carbohydrates
- **Functions**
- Selective permeability
- Cell recognition (antigens)
- Signal reception (receptors)
- Transport of ions & molecules

CYTOPLASM

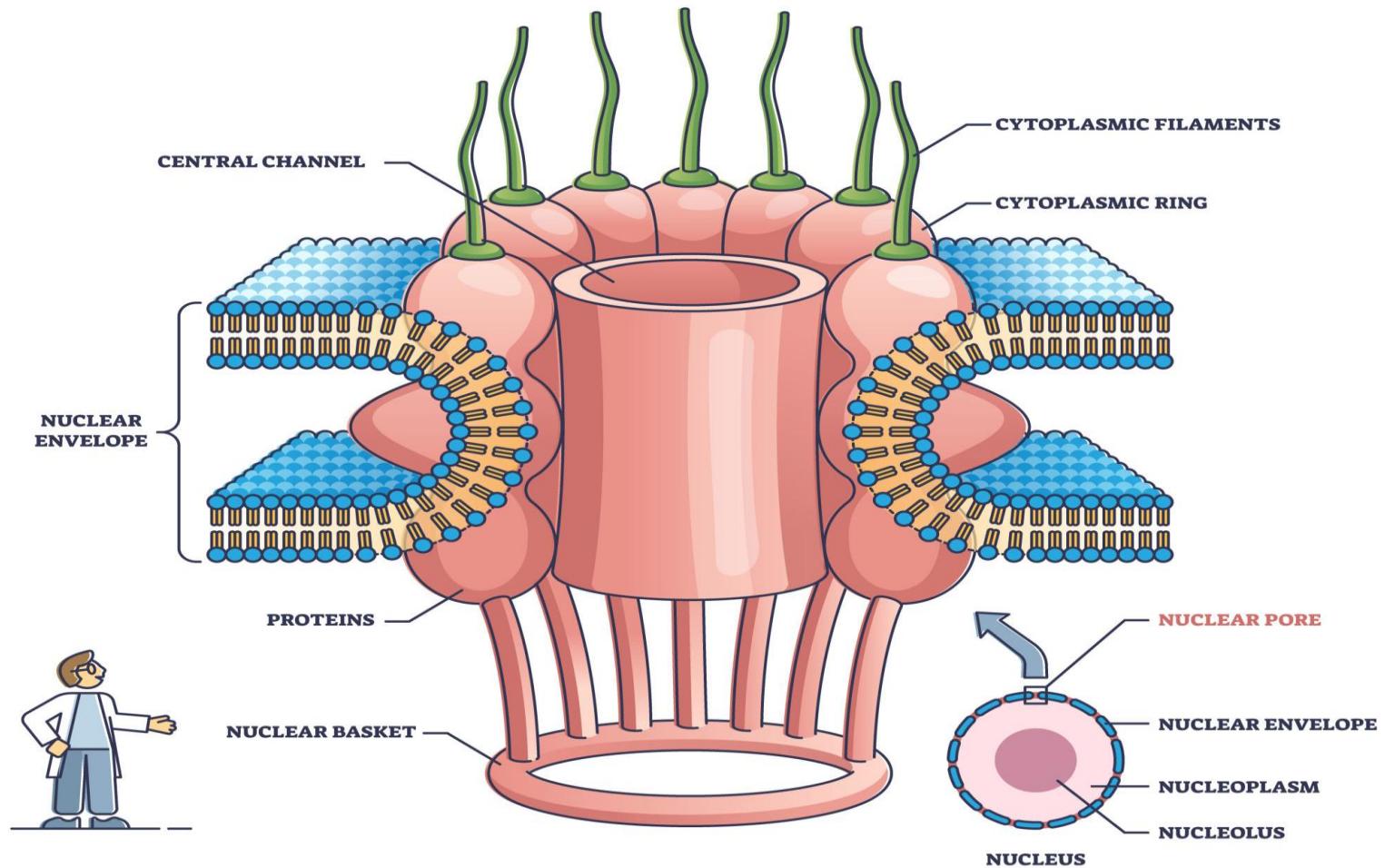
- Semi-fluid intracellular matrix
- Contains:
 - Cytosol
 - Organelles
 - Cytoskeleton
- **Functions**
- Site of metabolic reactions
- Intracellular transport
- Maintains cell shape

3. NUCLEUS





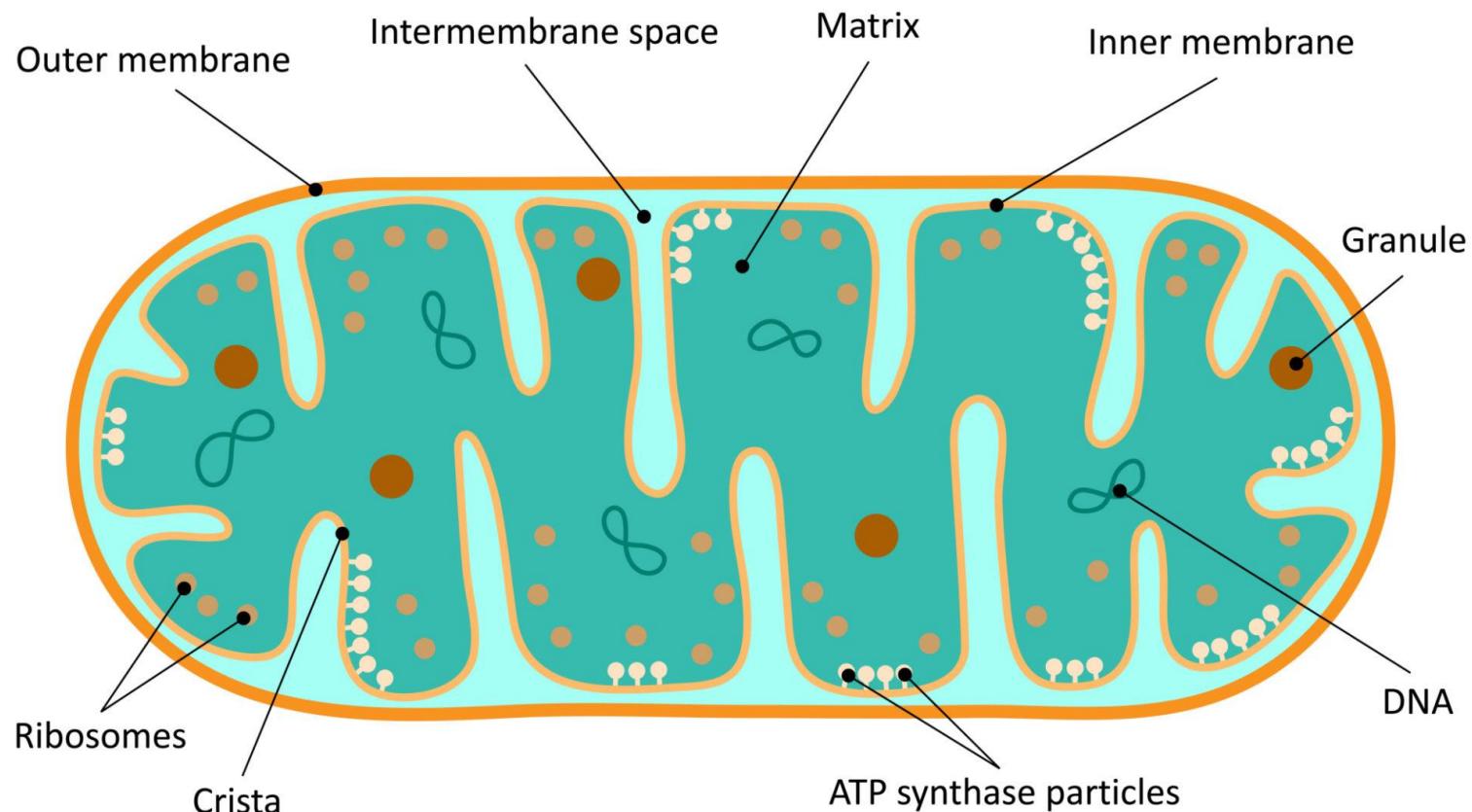
NUCLEAR MEMBRANE PORE



- **Structure**
- Double membrane nuclear envelope
- Nuclear pores
- Chromatin
- Nucleolus
- **Functions**
- Genetic control of cell
- DNA replication
- RNA transcription
- Cell division regulation
- ➔ *Chromatin types:*
- **Euchromatin** → active
- **Heterochromatin** → inactive

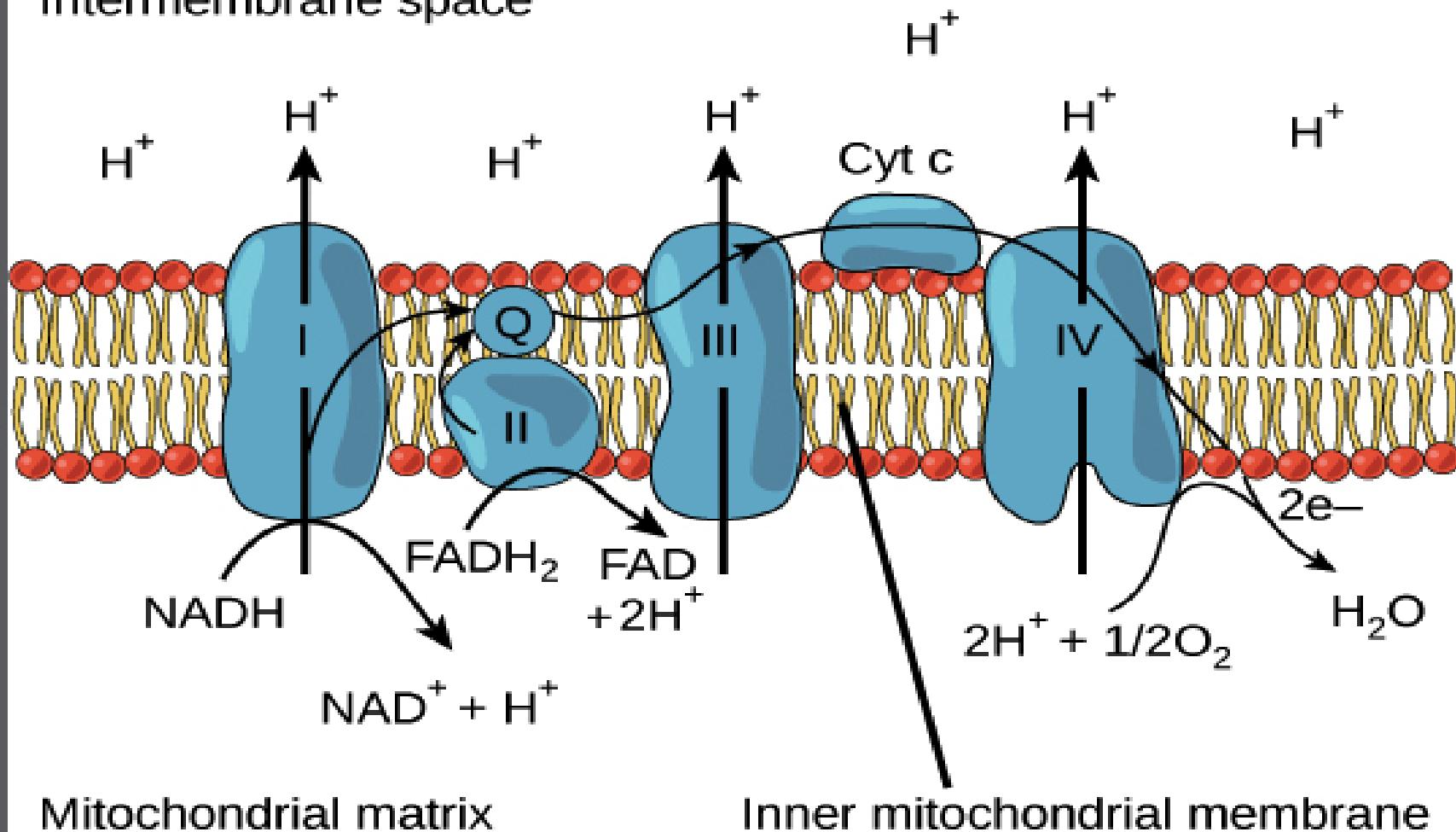
MITOCHONDRIA

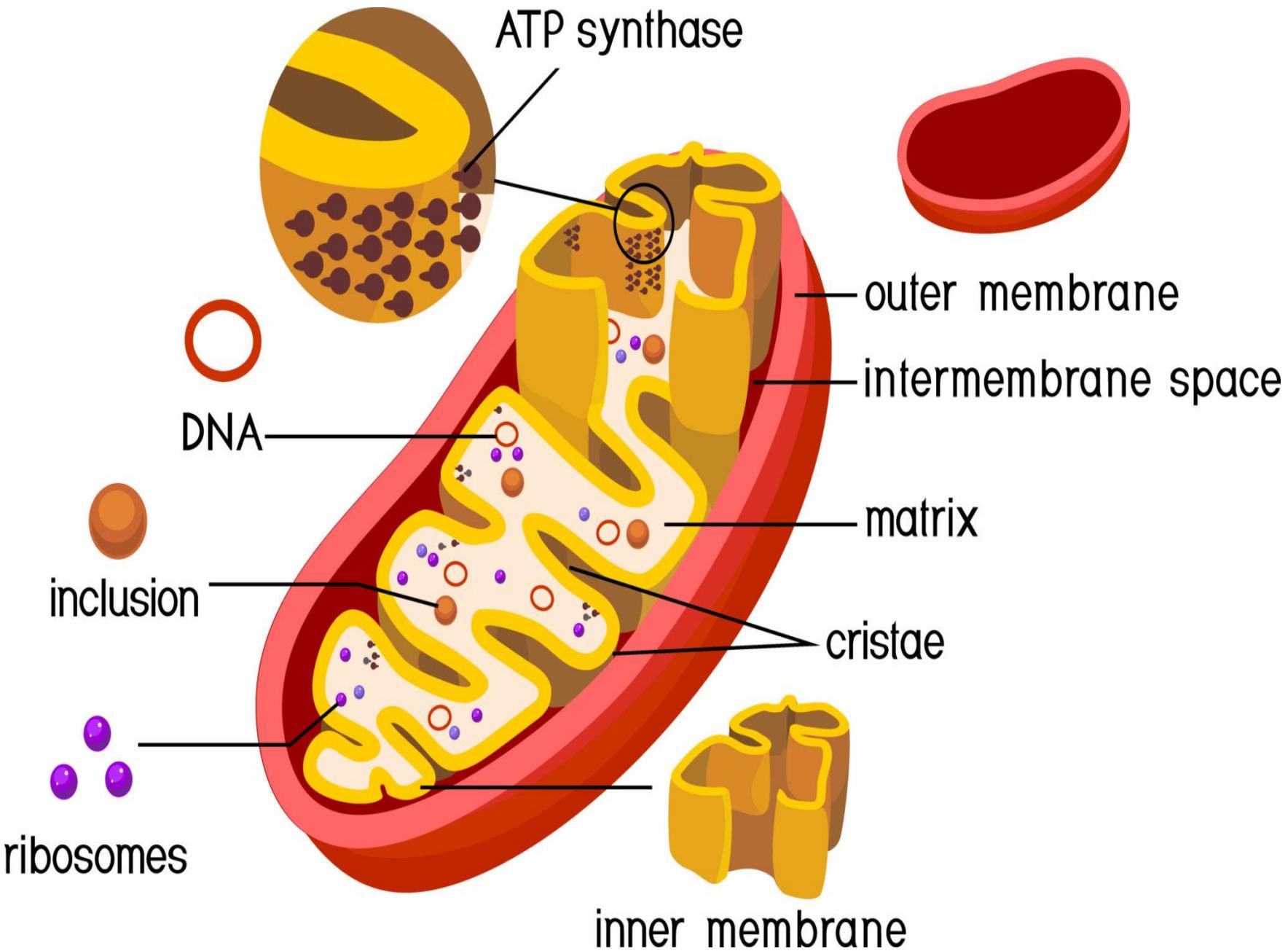
MITOCHONDRION



Electron Transport Chain

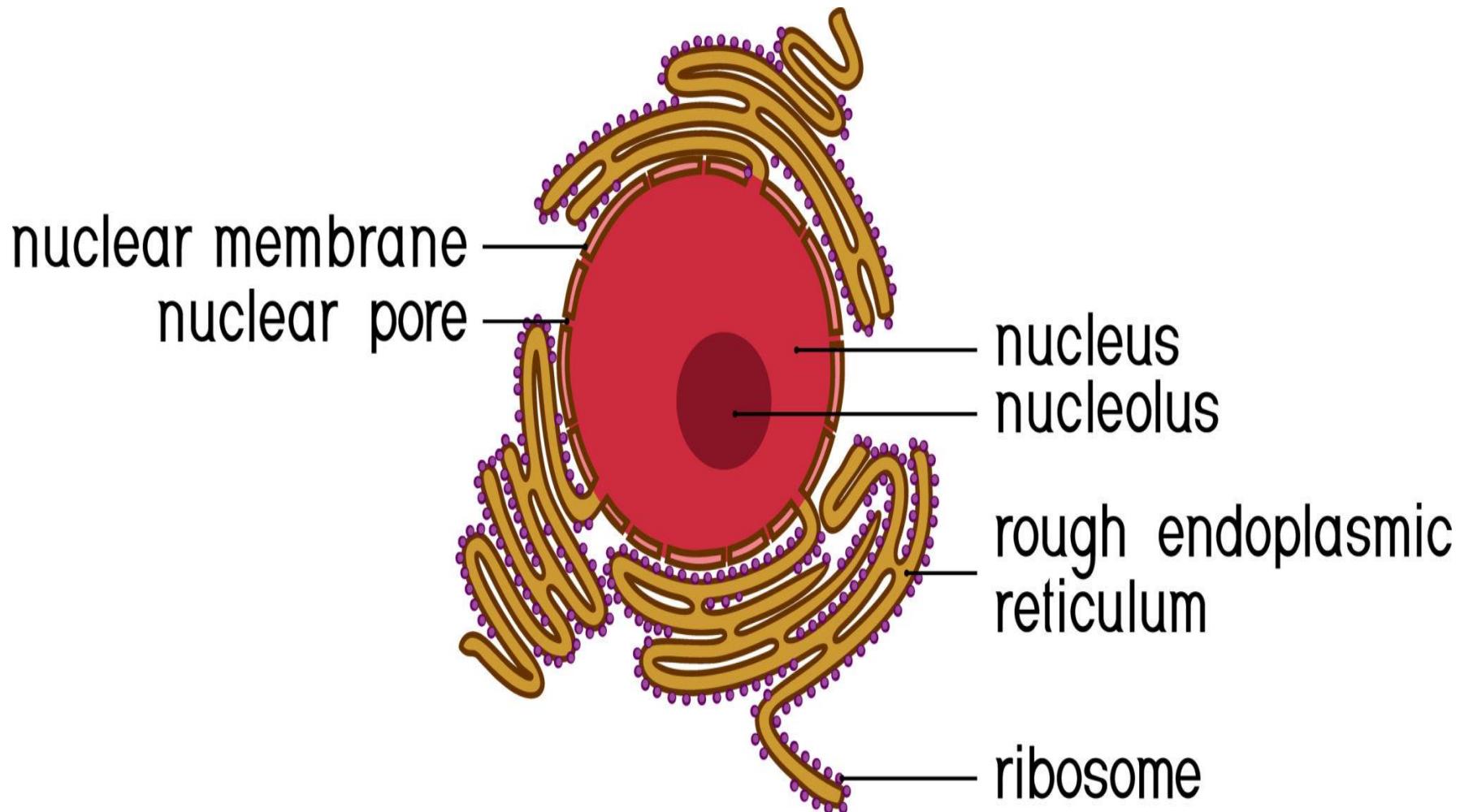
Intermembrane space





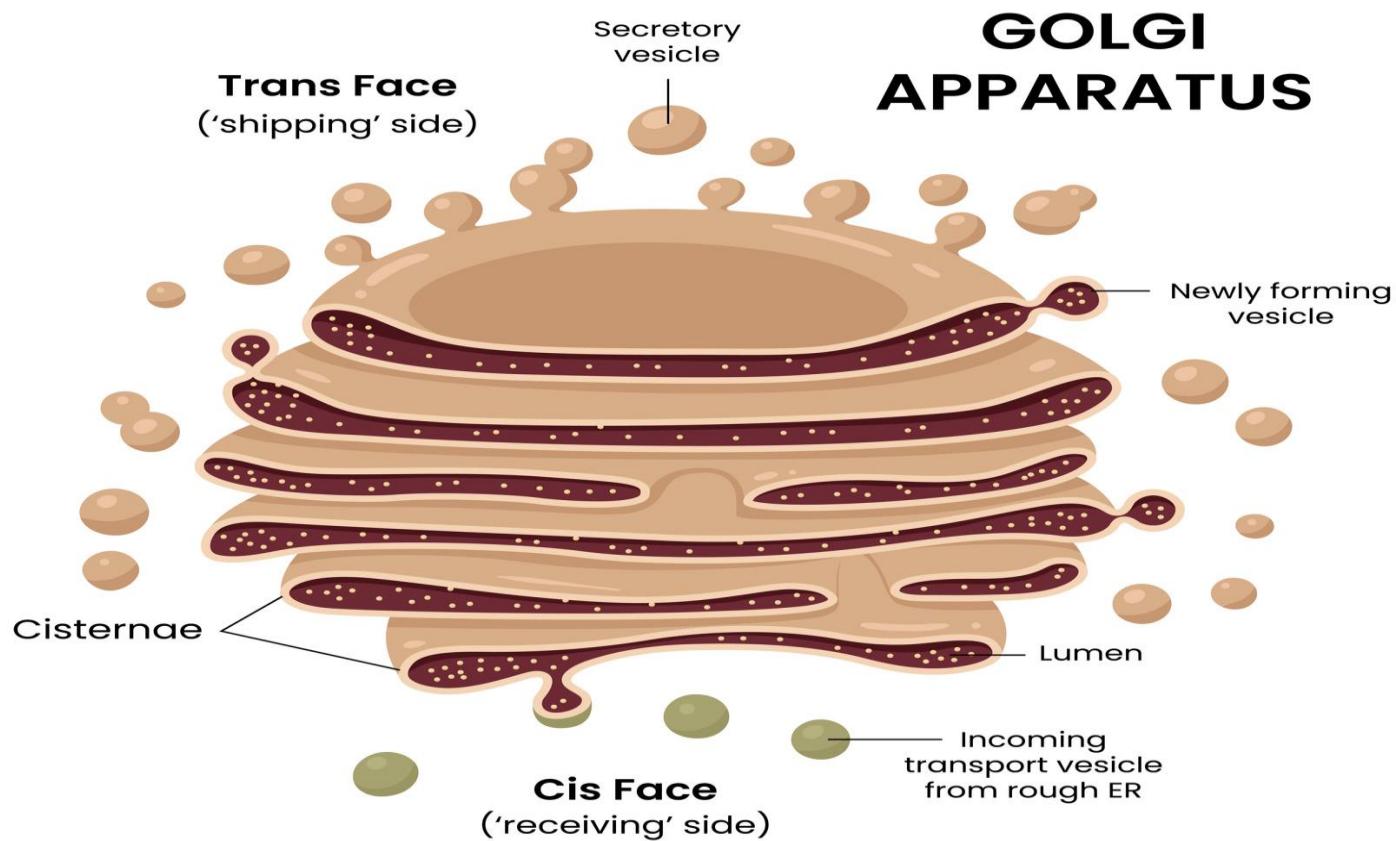
- **Structure**
- Outer membrane
- Inner membrane → cristae
- Matrix with enzymes & mtDNA
- **Functions**
- ATP production
- Apoptosis regulation
- Heat production
- Calcium storage
-  *Exam pearl:*
Cells with high energy demand have more mitochondria

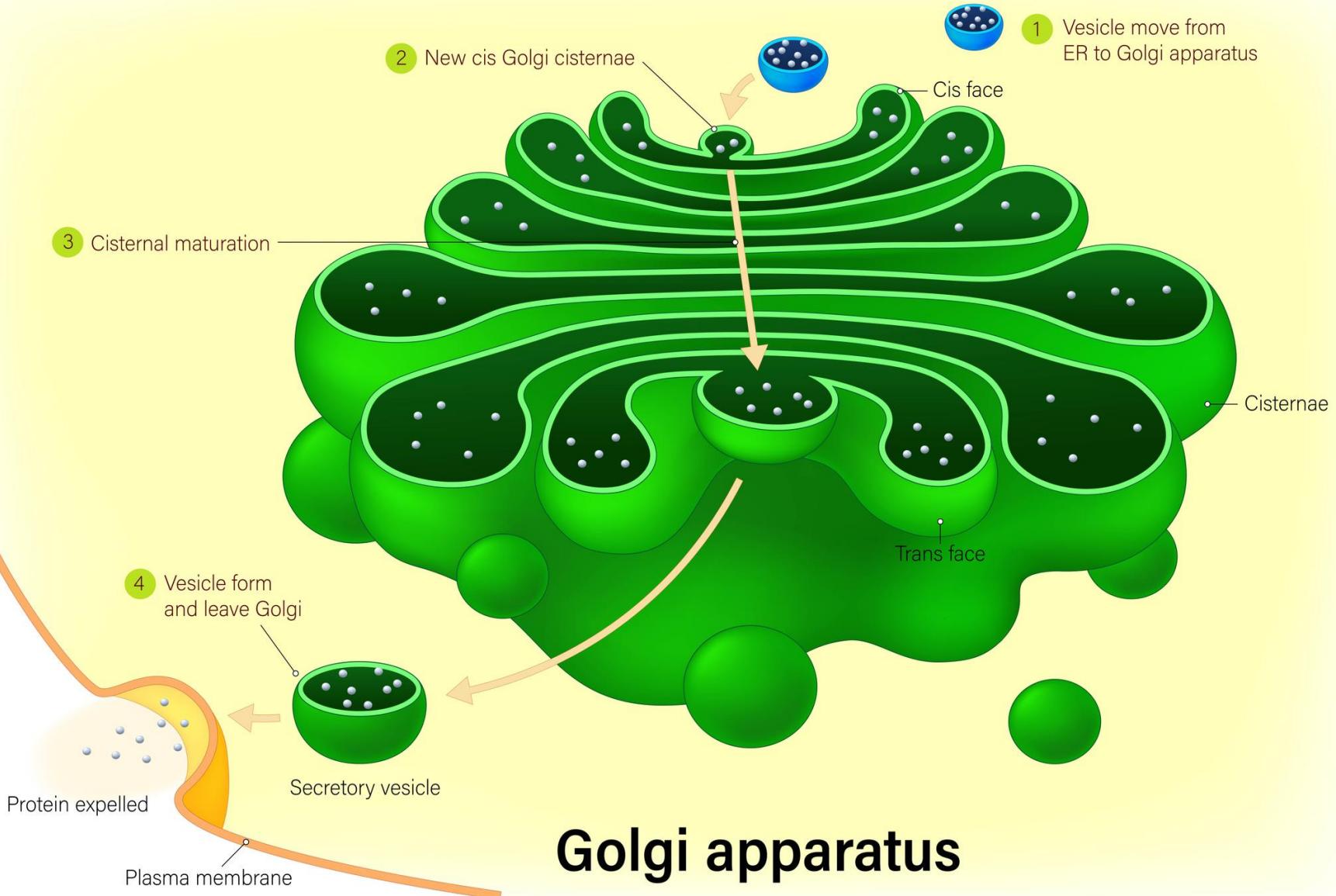
ENDOPLASMIC RETICULUM (ER)



- **Rough ER (RER)**
- Ribosome attached
- Protein synthesis
- Antibody formation
- ♦ **Smooth ER (SER)**
- Lipid & steroid synthesis
- Detoxification (liver)
- Calcium storage (muscle)
- ✅ *Clinical:*
SER hypertrophy in chronic drug users

GOLGI APPARATUS

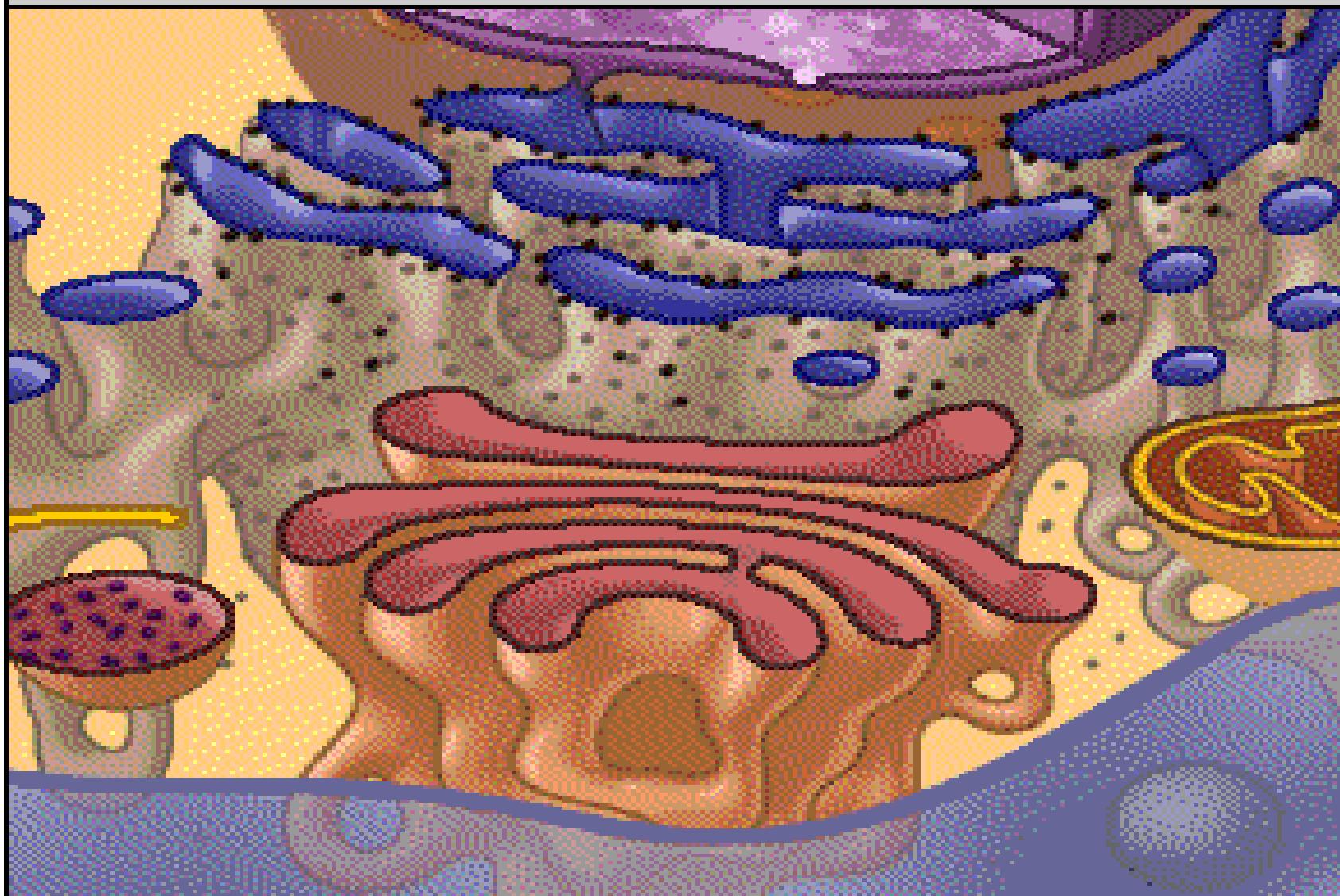




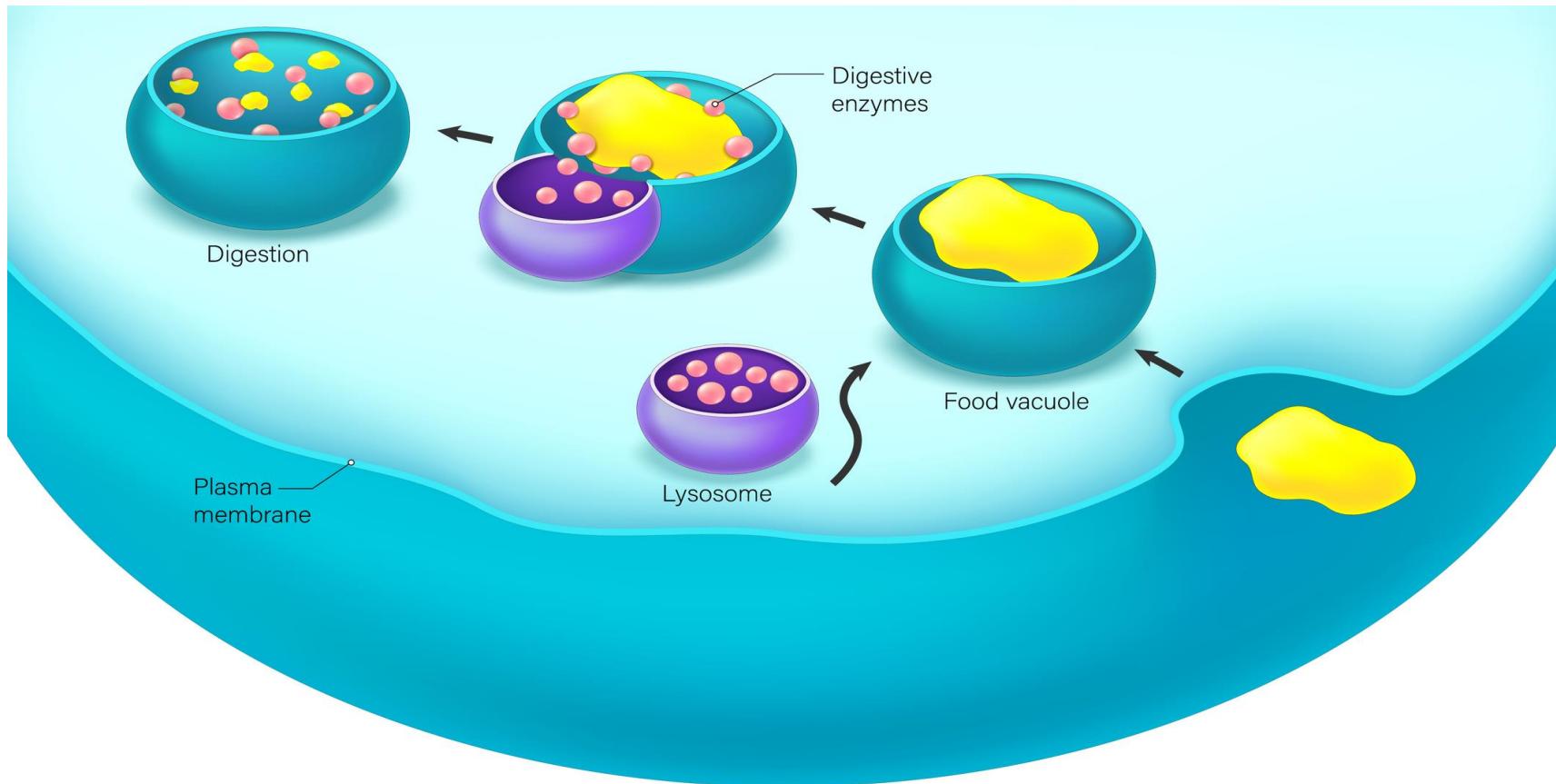
Golgi apparatus

- **Functions**
- Protein modification (glycosylation)
- Packaging & sorting
- Lysosome formation
- Secretion
-  **Faces:**
- **Cis** → receiving
- **Trans** → shipping

Step 1. A secretory protein is synthesized inside the rough endoplasmic reticulum, migrates through it, and exits inside a vesicle.



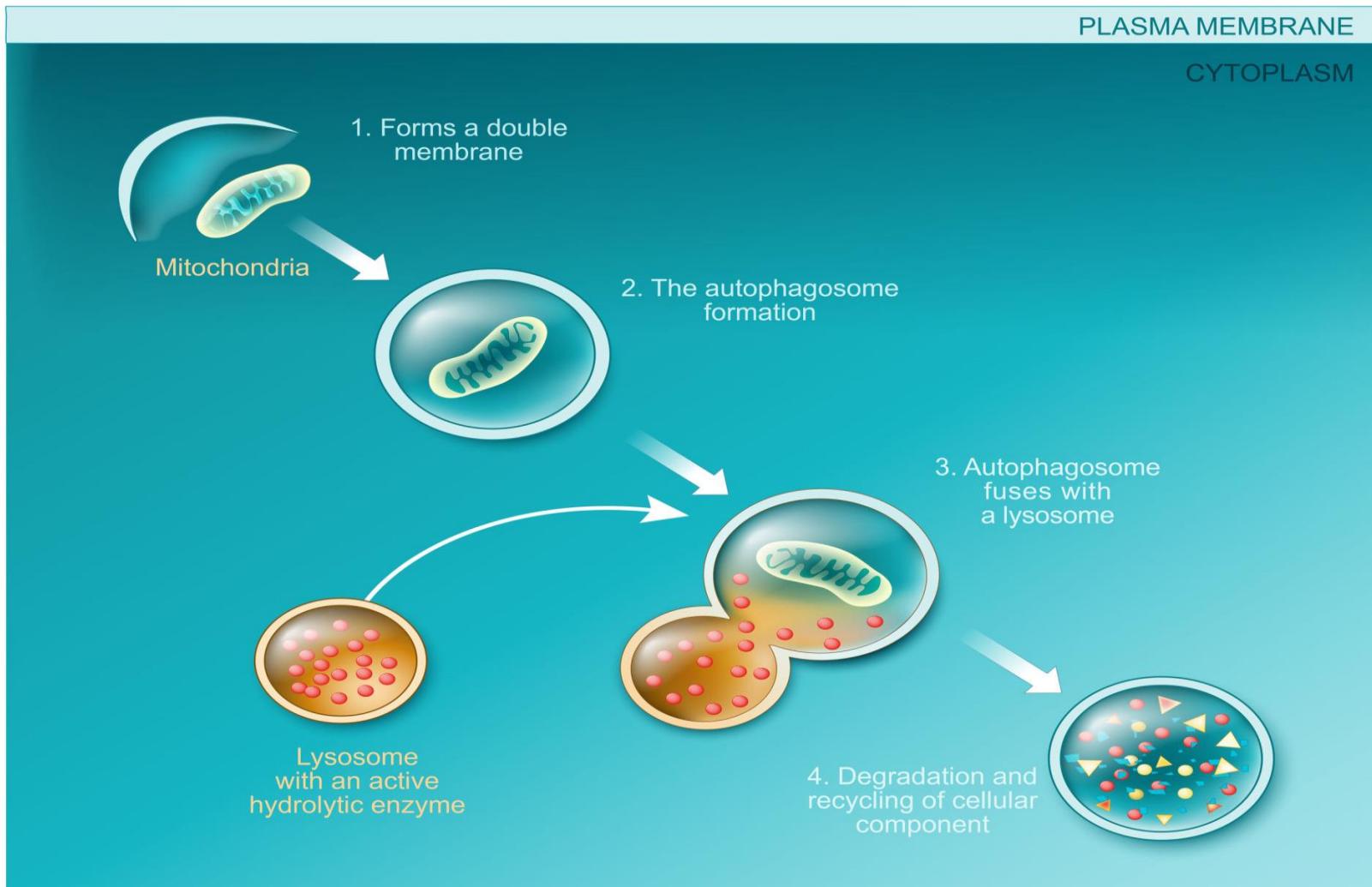
LYSOSOMES



Lysosome digestion food

Phagocytosis

AUTOPHAGY



- Functions
- Intracellular digestion
- Autophagy
- Autolysis
- ✅ *Exam line:*
“Lysosomes are suicide bags of the cell.”
- ✅ *Clinical:*
Lysosomal storage diseases

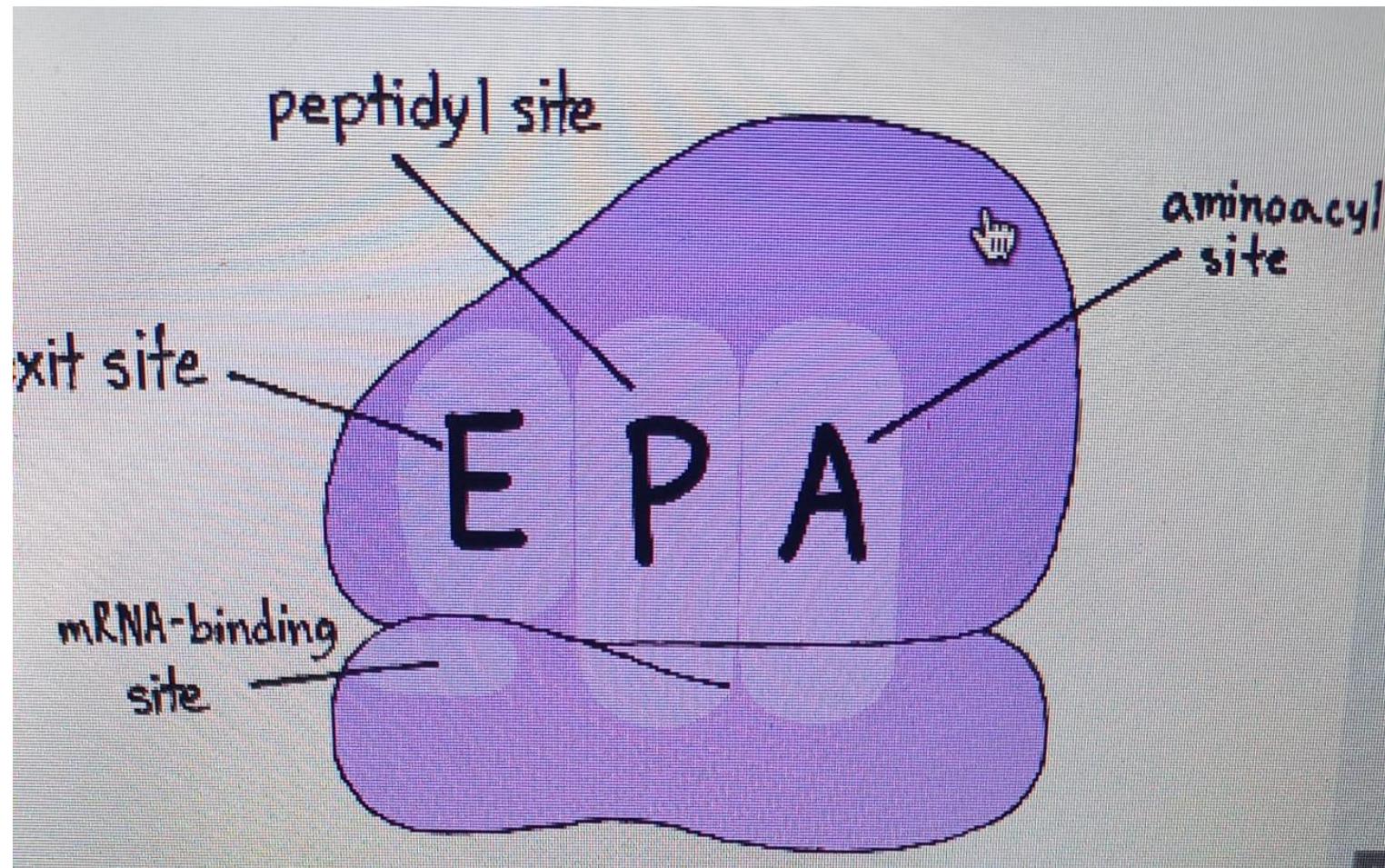
PEROXISOMES

- Functions
- Detoxification
- Breakdown of H₂O₂
- Fatty acid oxidation
- ✨ *Enzyme*: Catalase

RIBOSOMES

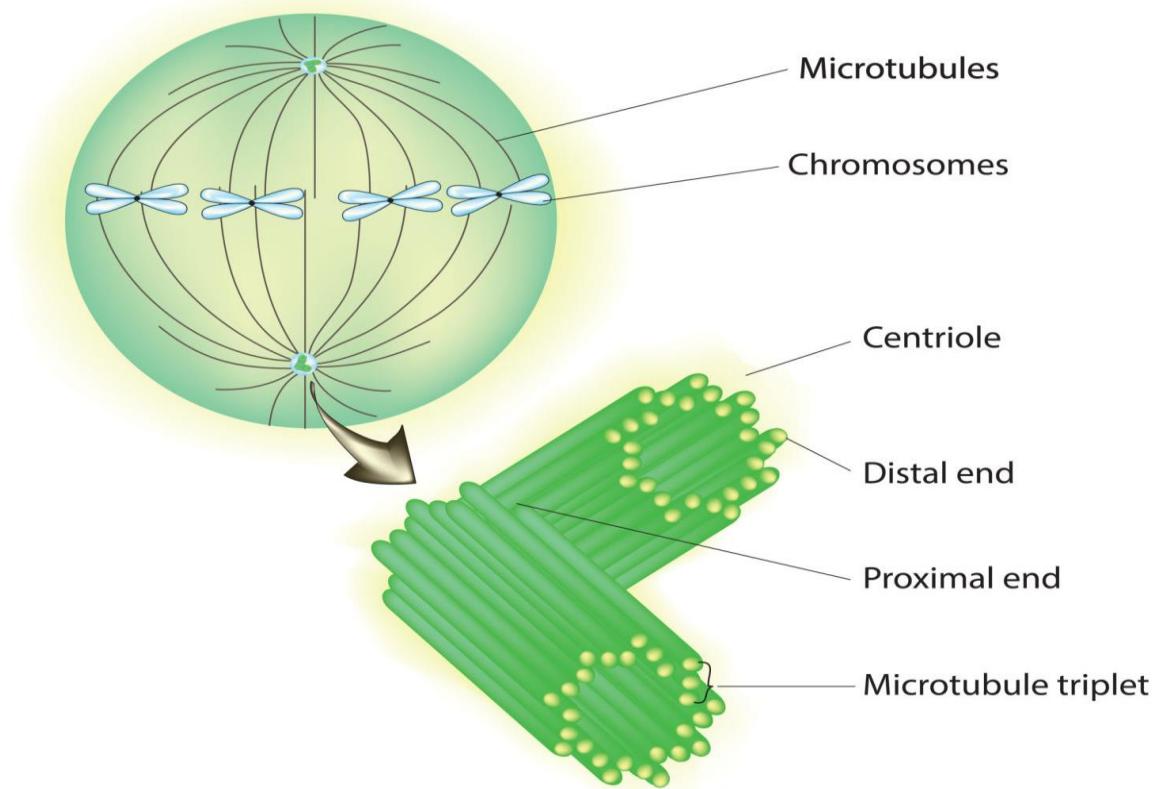
- Functions
- Protein synthesis
- ⚡ Types:
- Free ribosomes → intracellular proteins
- Bound ribosomes → secretory proteins

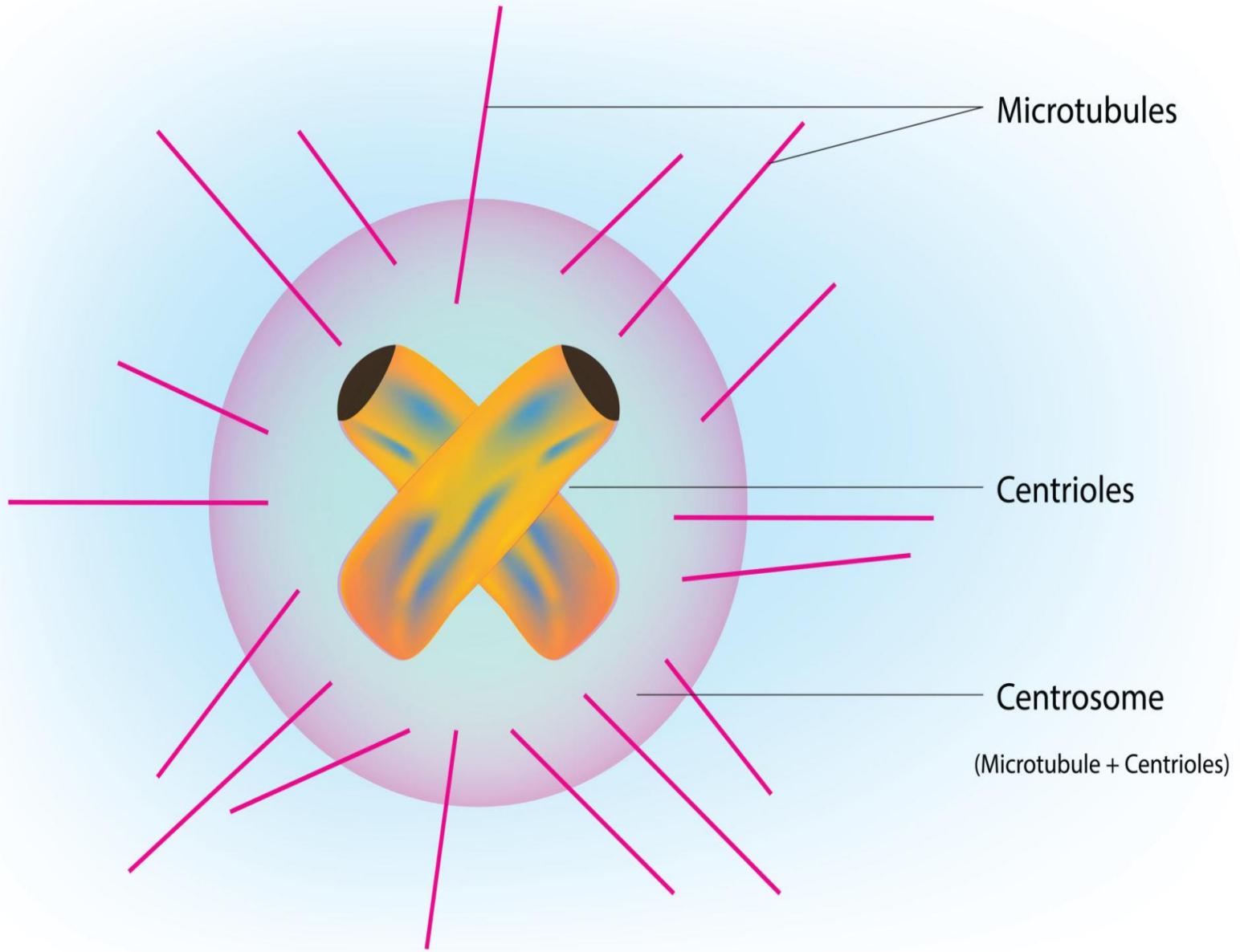
- They consist of two subunits:
 1. Larger 60s
 2. Smaller 40s
- It has 3 sites for mrna translation
 1. E exit site
 2. P peptidyl site
 3. A aminoacyl site



CENTROSOME & CENTRIOLES

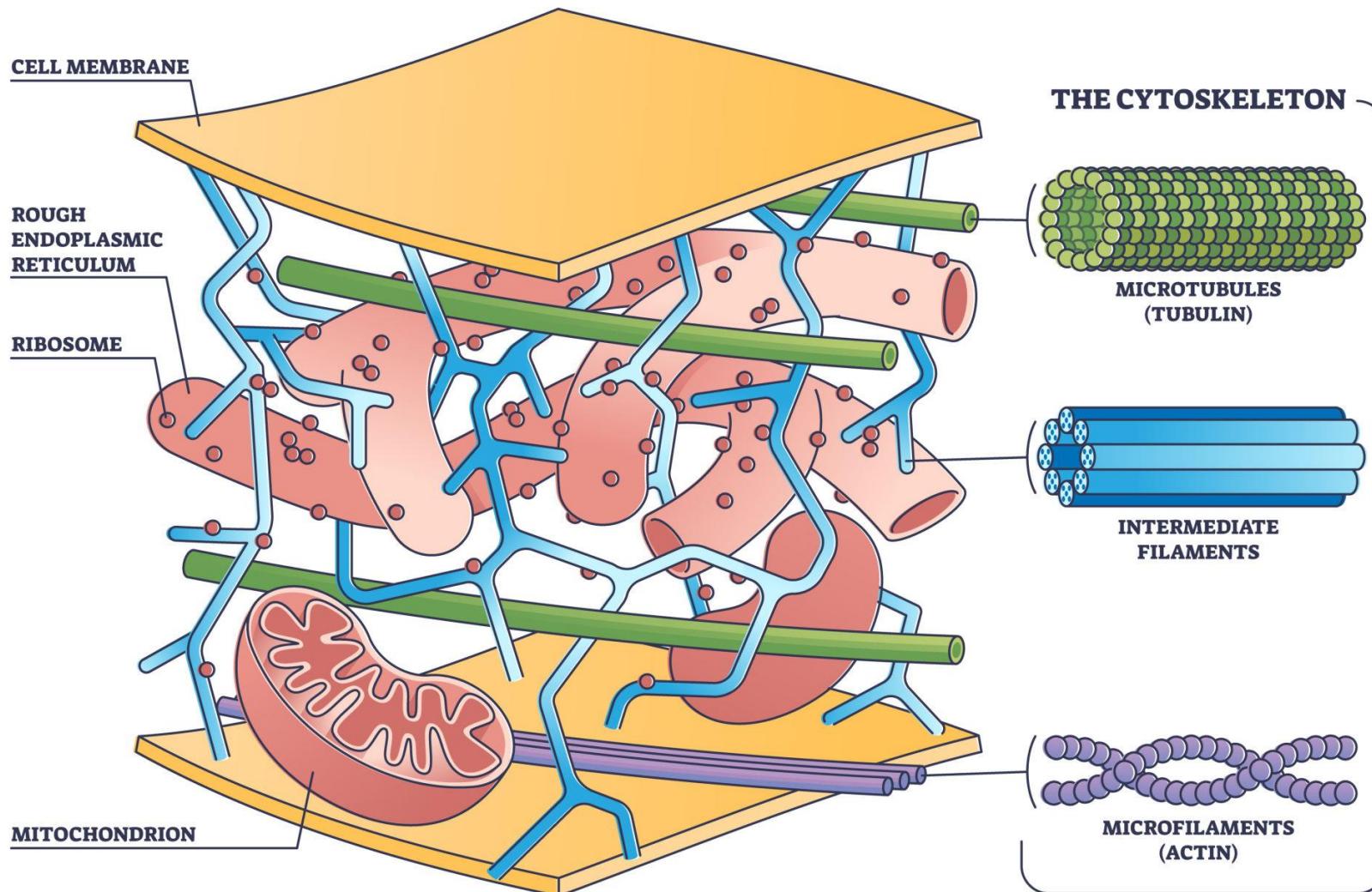
Centrioles

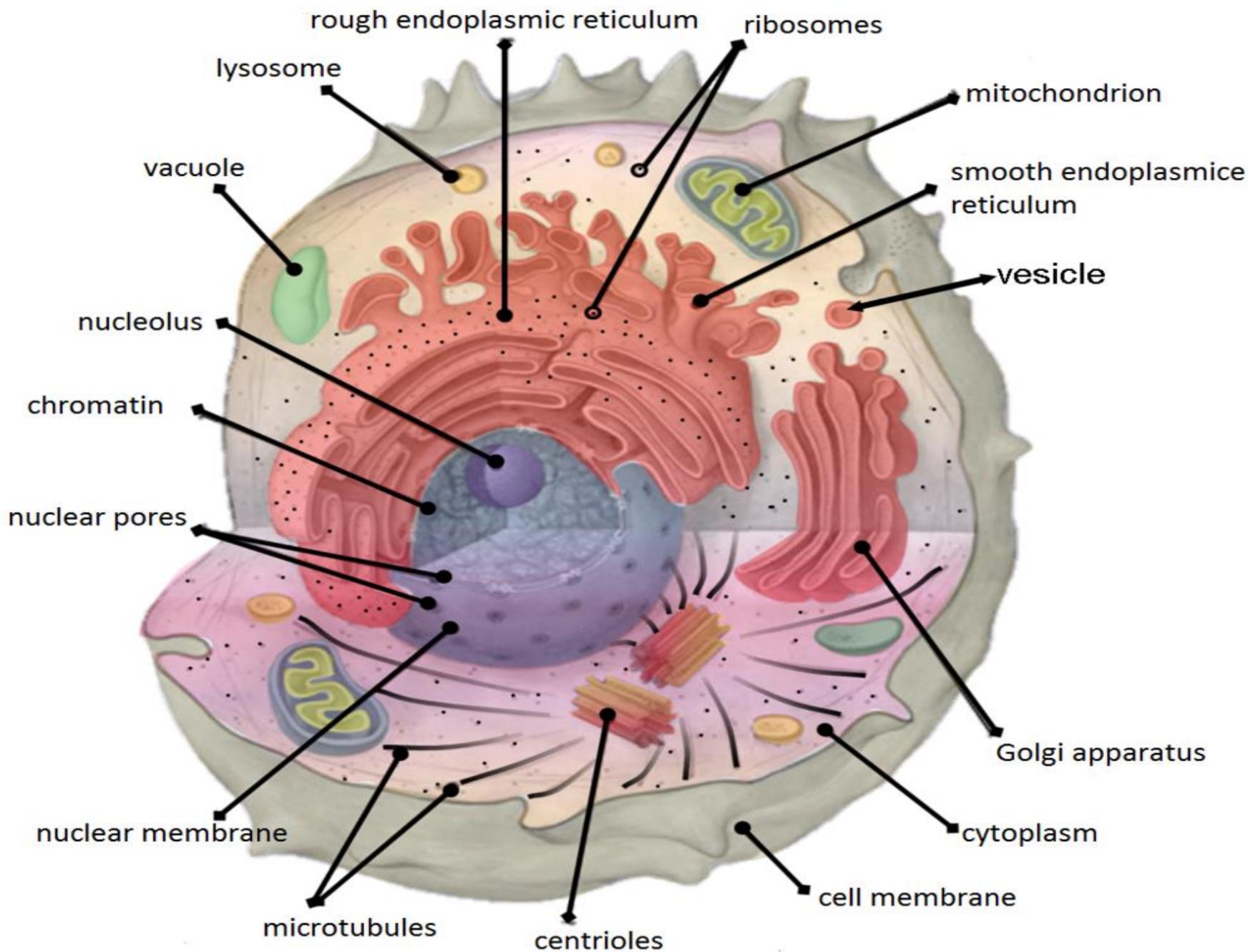




- **Functions**
- Spindle formation
- Cell division

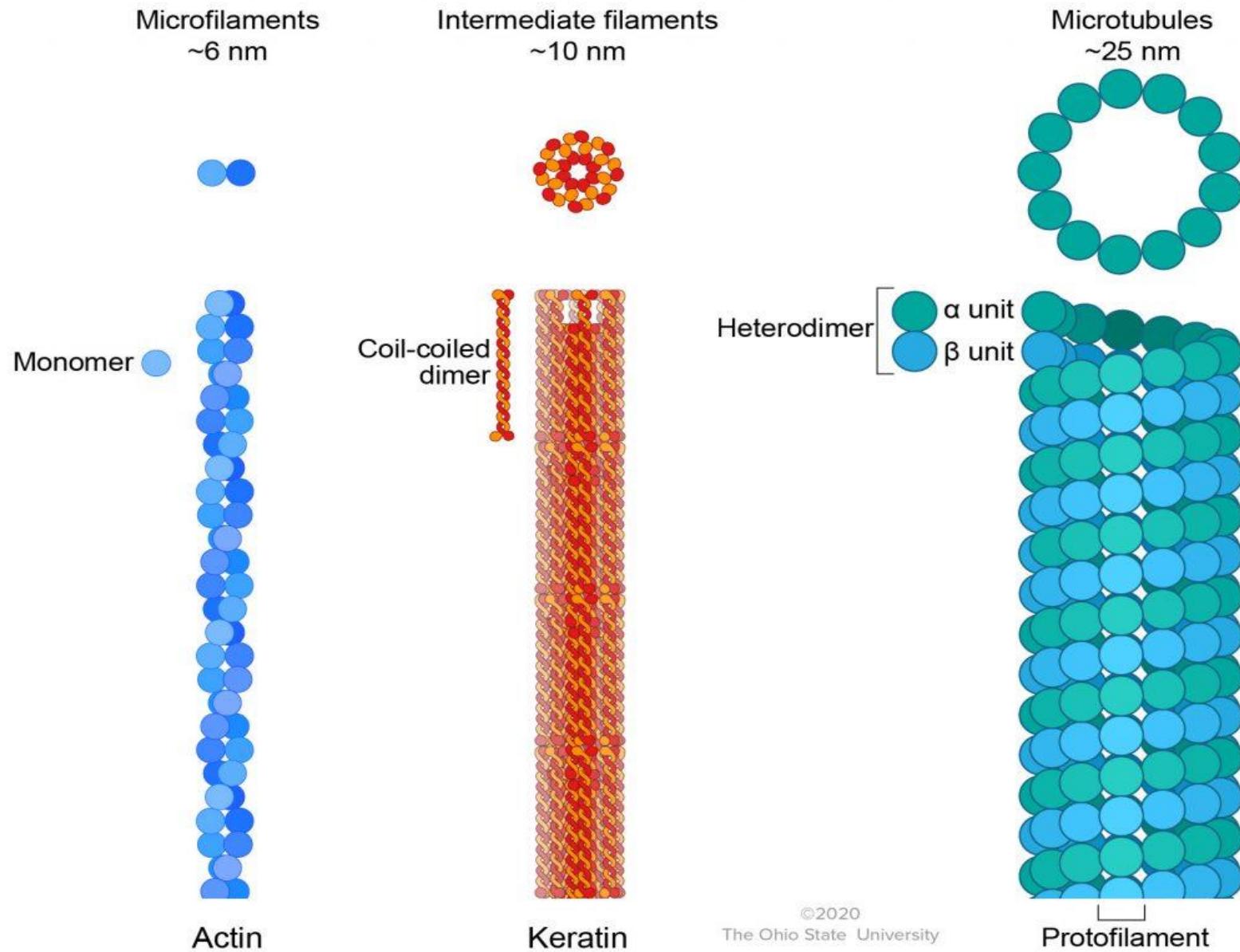
CYTOSKELETON





Cytoskeleton

- A network of **protein filaments** present in the cytoplasm
- Maintains **cell shape, organization, and movement**
- Provides **structural support** to the cell
- **Main Functions**
 - Maintains cell shape
 - Anchors organelles
 - Enables intracellular transport
 - Essential for cell division and motility
- **Major Components**
 1. Microfilaments
 2. Intermediate filaments
 3. Microtubules



Microfilaments

- Protein: **Actin**
- Thinnest filaments
- Located beneath cell membrane
- **Functions**
- Cell shape
- Muscle contraction
- Cell motility

Intermediate Filaments

- Proteins: **Keratin, vimentin, desmin**
- Strong & stable
- **Functions**
- Provide tensile strength
- Resist mechanical stress
- ✖ *Clinical:* Defects → fragile cells

Microtubules

- Protein: **Tubulin**
- Largest filaments
- Form spindle fibers, cilia, flagella
- **Functions**
- Chromosome movement
- Vesicle transport
- Cell division

- **Actin → movement**
- **Keratin → strength**
- **Tubulin → division & transport**

SPECIALIZED CELL STRUCTURES

- **Microvilli**
- Increase surface area
- Intestine
- **Cilia**
- Movement of mucus
- Respiratory tract
- **Flagella**
- Sperm motility

Best Choice Questions (BCQs)

- 1. Powerhouse of cell? → Mitochondria
- 2. Organelle for protein modification? → Golgi apparatus
- 3. Calcium storage in muscle? → SER
- 4. Site of oxidative phosphorylation? → Inner mitochondrial membrane
- 5. Suicide bags of cell? → Lysosomes