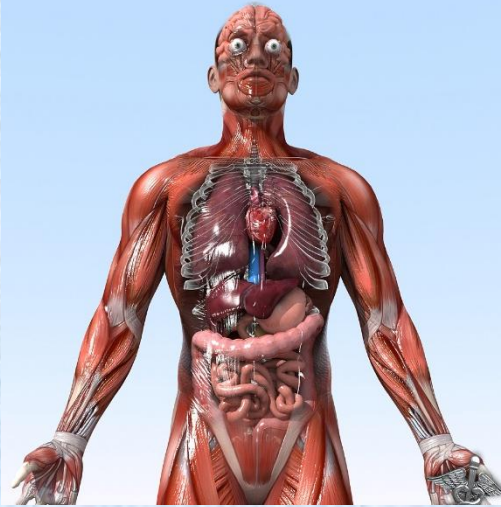


General Animal Biology

Zoo-109

علم الأحياء

109- حين



For Pre-Medical Students



Common First Year

السنة الأولى المشتركة - المسار الصحي

1447-H - 2025

Reference: Campbell, N. A. and Reece, J. B. (2014). *Biology (10th edition)*. Pearson Education. Inc. USA.

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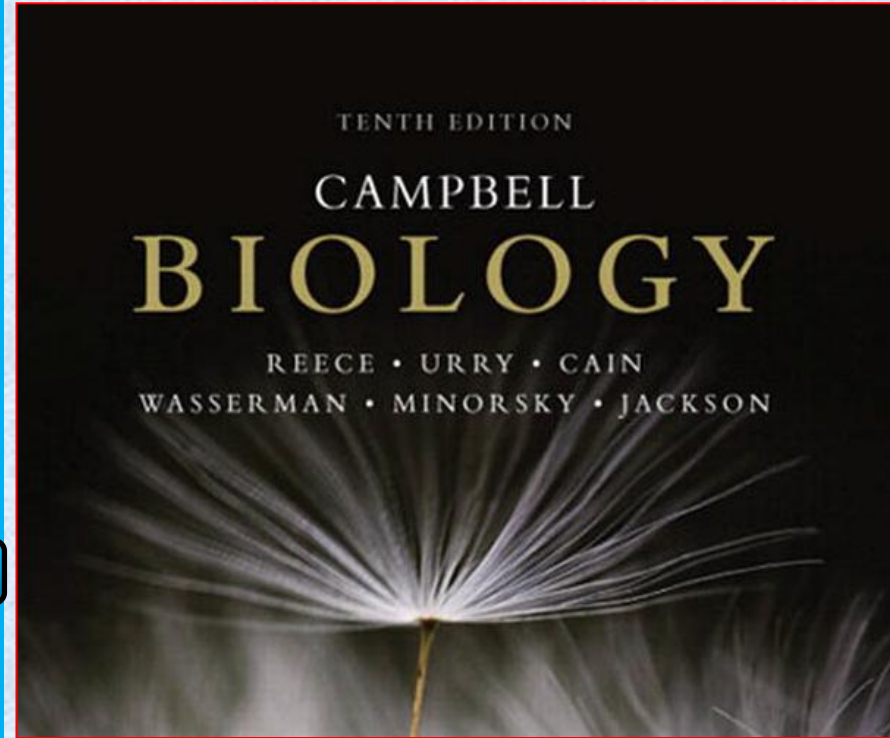
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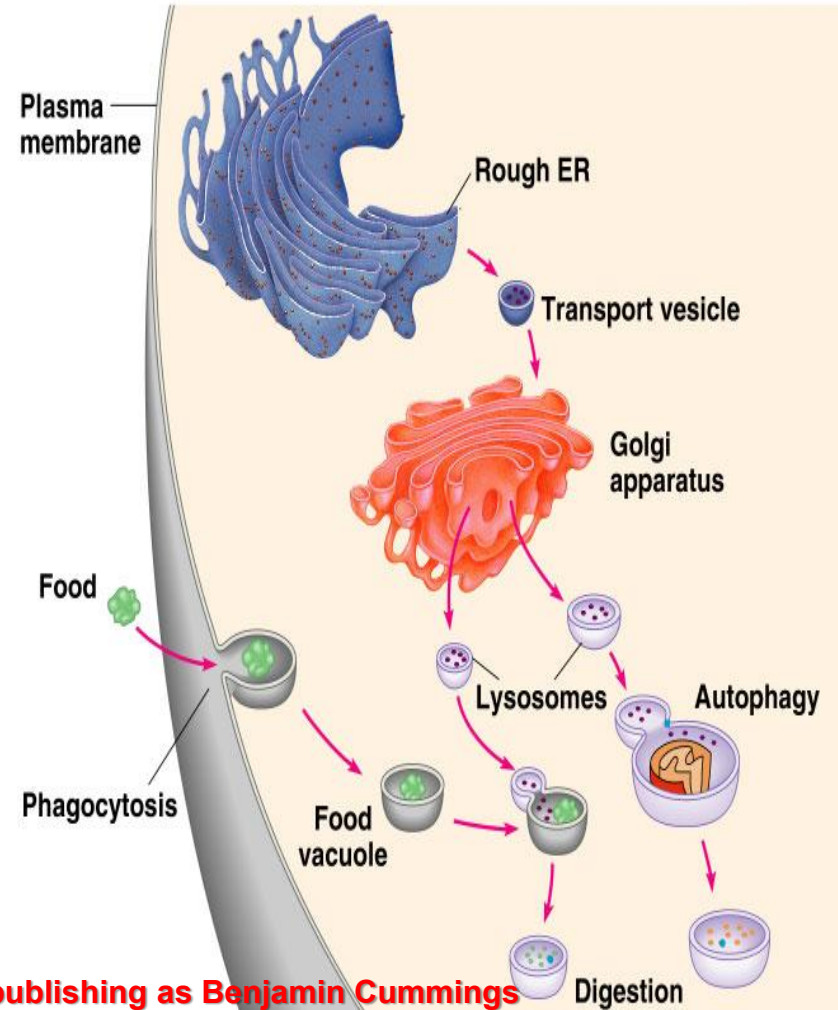
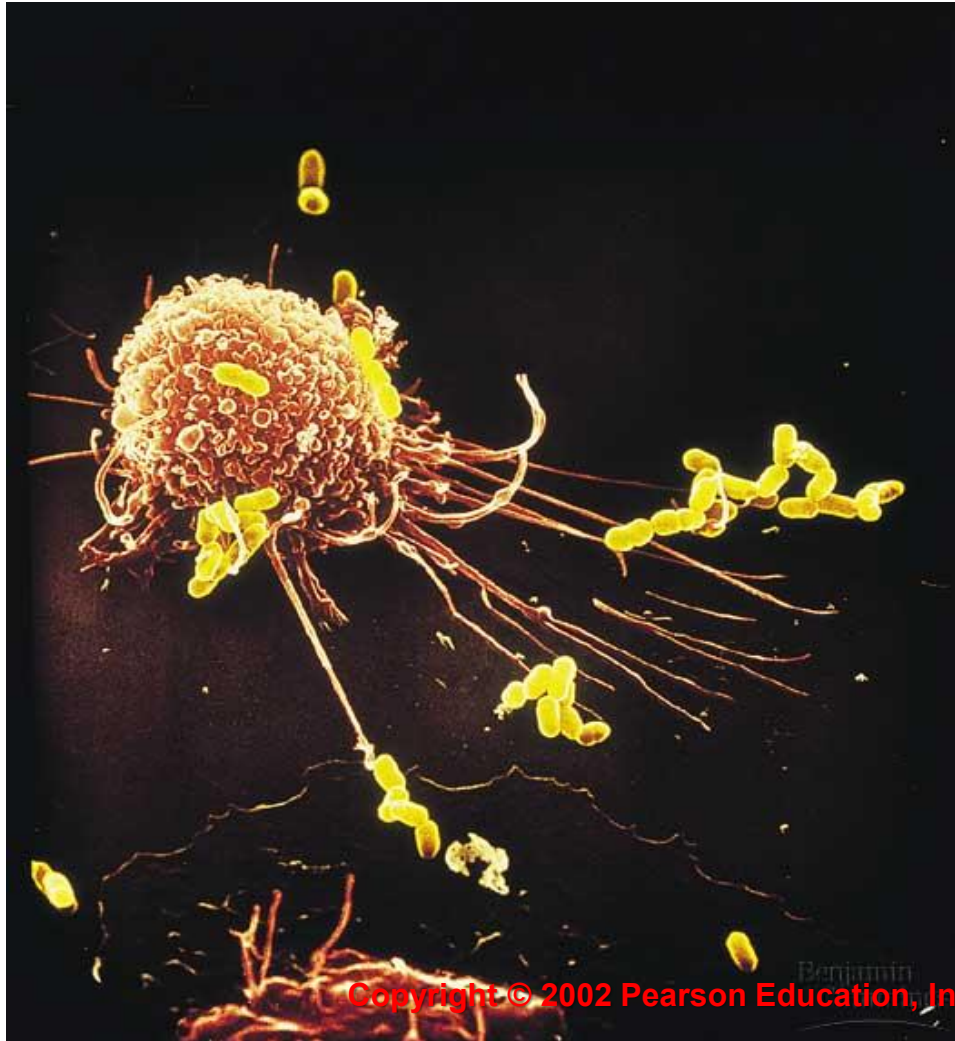
College of Science,
Zoology Department

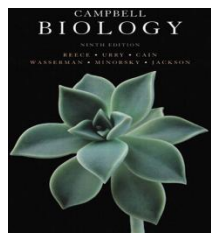
TENTH EDITION
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B- Eukaryotic Cell

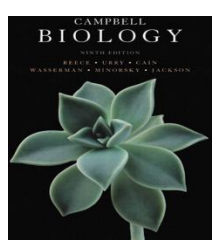




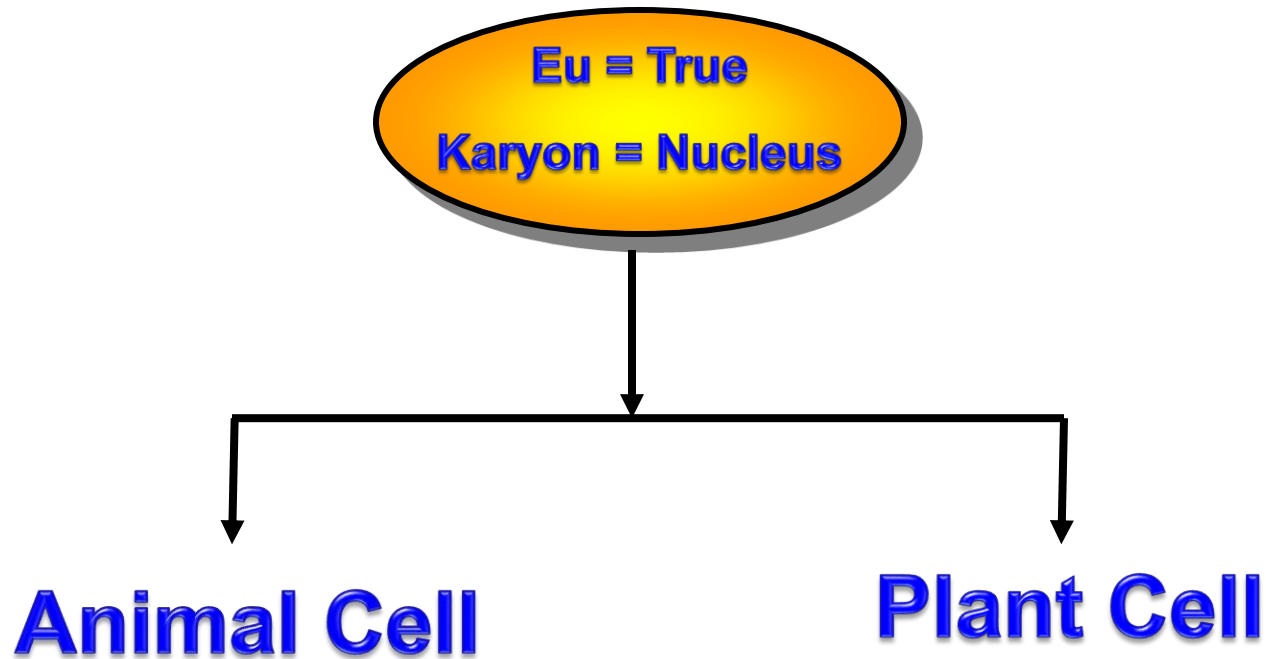
Objectives



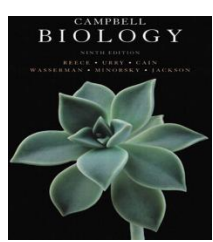
- **Eukaryotic Cell Organization.**
- **Introduction:** Internal membranes compartmentalize the eukaryotic cell.
- **Plant & Animal Cells:** Similarities and Differences.
- **The Cell Organelles:**
 1. The nucleus.
 - Nucleolus.
 2. Ribosomes
 - Types of Ribosomes



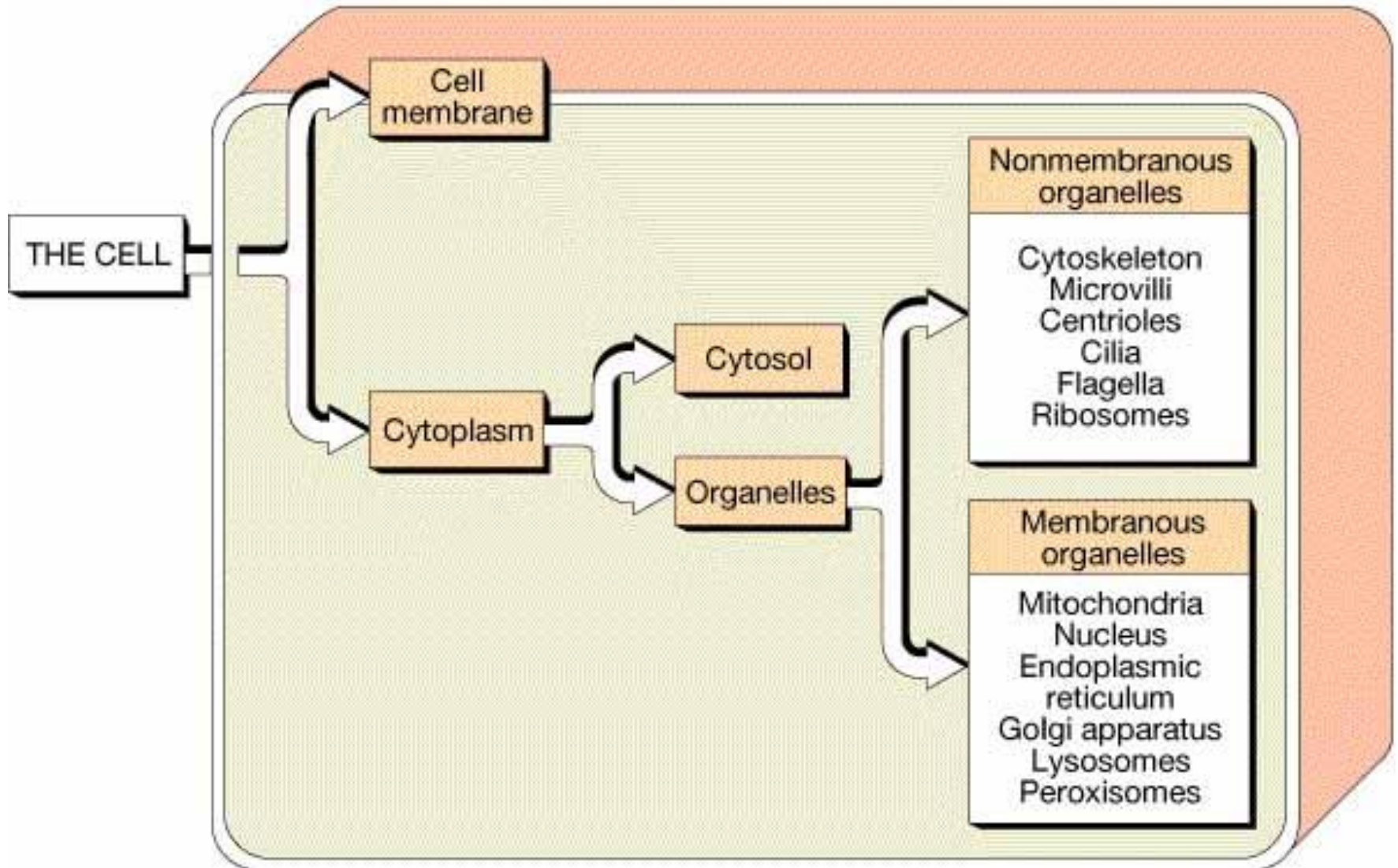
B- The Eukaryotic Cell

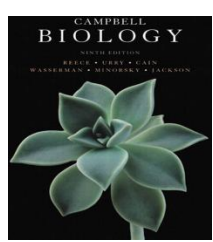


Compare Animal and Plant cell
What are the functions of cell organelles ?



Eukaryotic Cell Organization



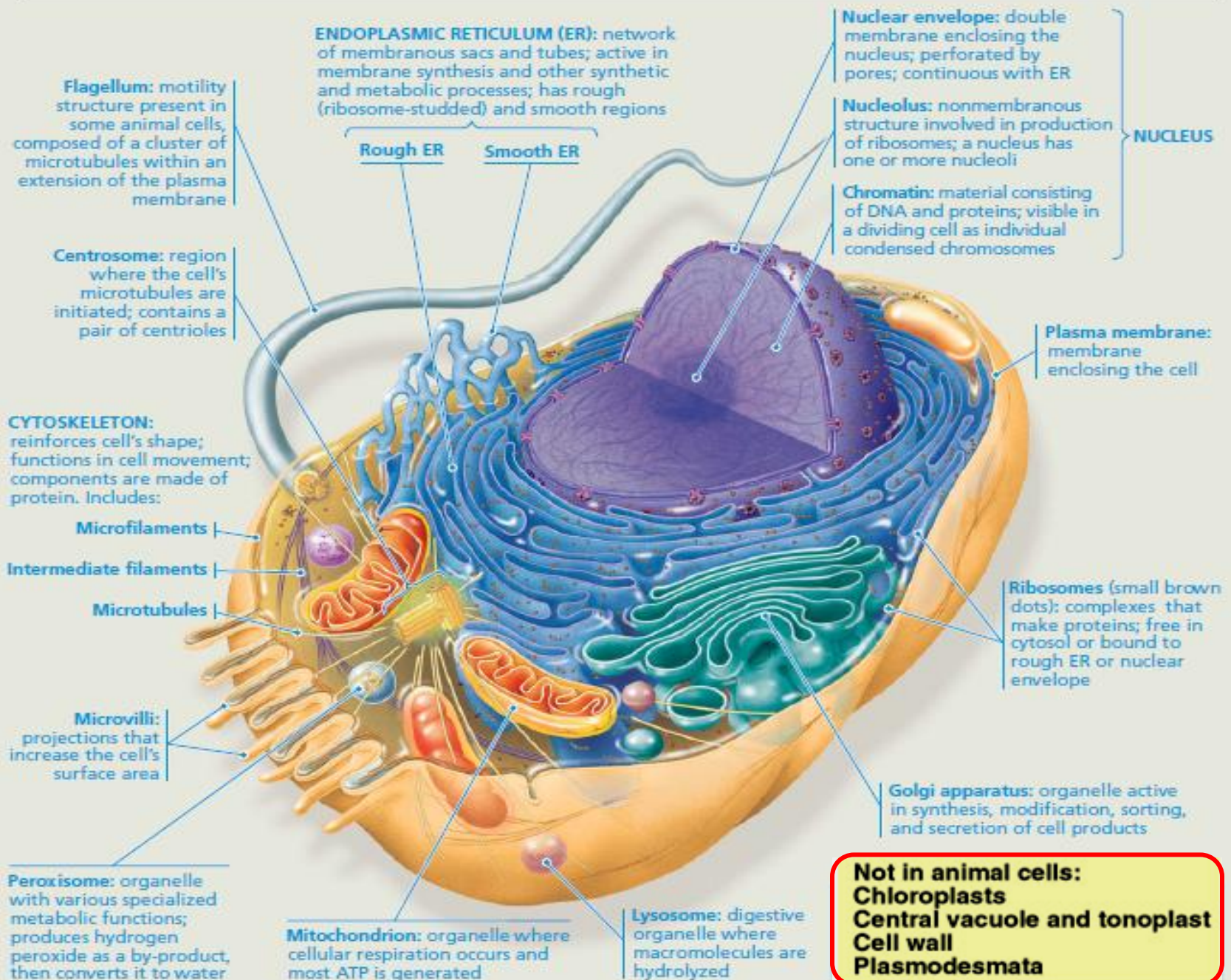


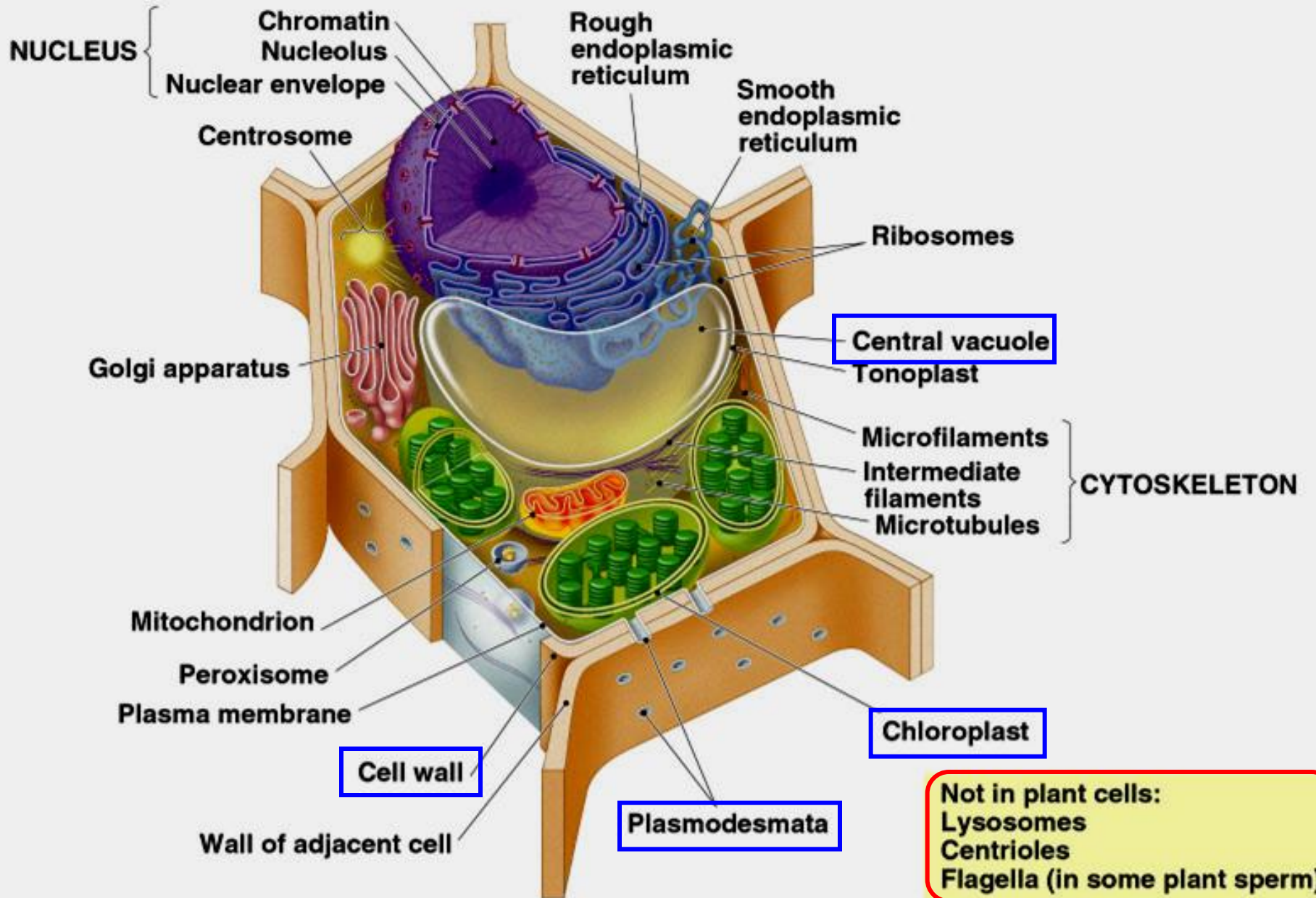
Introduction

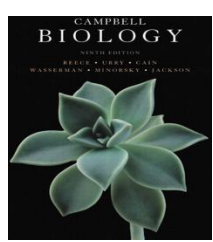


- An eukaryotic cell has **internal membranes**, which partition the cell into compartments.
- These membranes also participate in metabolism as many enzymes are built into membranes.
- The general structure of a cell membrane is a **double layer** of **phospholipids** and **diverse proteins**.
- Each type of membrane has a unique combination of **lipids** and **proteins** for its specific functions.
 - For example, those in the membranes of mitochondria function in cellular respiration.

Animal Cell (cutaway view of generalized cell)





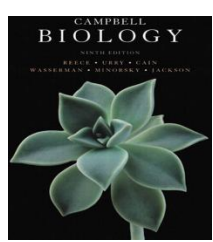


Comparison: Plant & Animal Cells



- **Similarities**

- Both are eukaryotic cells
- Both contain similar organelles
- Both are surrounded by cell membrane



Comparison: Plant & Animal Cells



- **Differences**

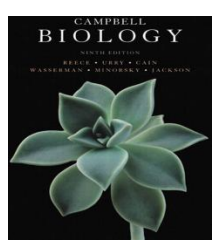
- **Plants have**

- **Cell wall**: that is not found in animal cells.
- **Chloroplasts**: that is photosynthetic and are not found in animal cells.
- **Central vacuole**: that is not found in animal cells
- **Plasmodesmata**: that is not found in animal cells

- **Animals have**

- Lysosomes, centrioles and flagella are not found in plants. Centrioles have important role in cell division.

The Cell Organelles



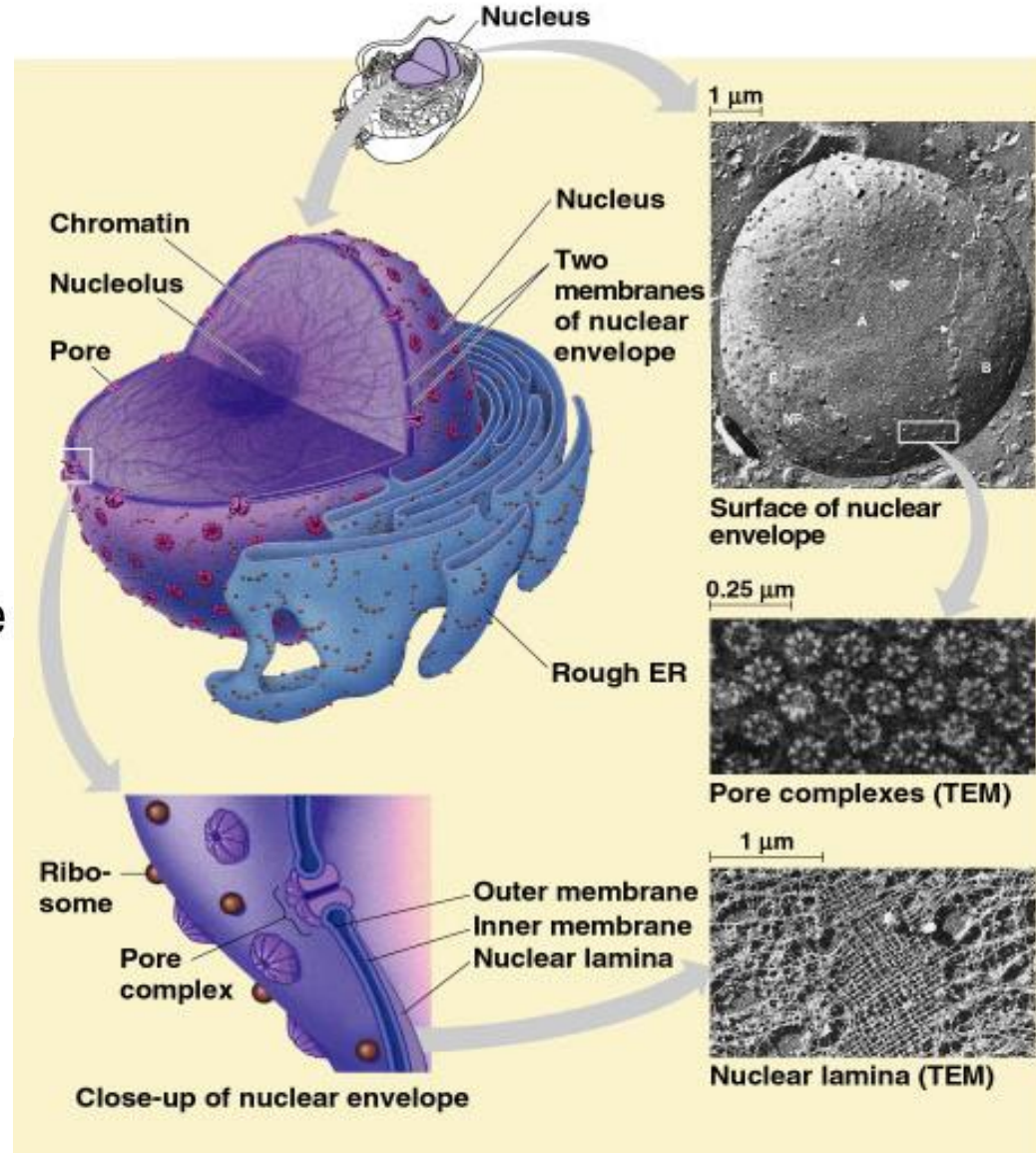
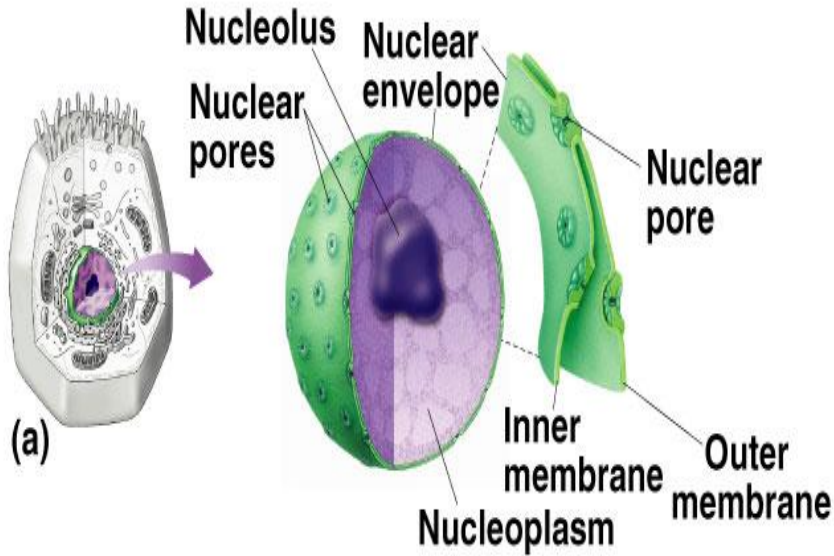
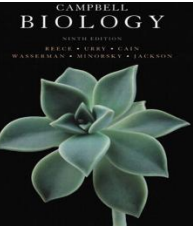
1)- The nucleus:

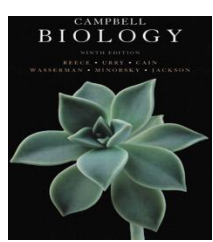
Contains the cell's genetic library



- The nucleus contains most of the genes in an eukaryotic cell as it is the repository for genetic material.
- The nucleus is separated from the cytoplasm by a double membrane called nuclear envelope.
- It directs activities of the cell.
- The nuclear membrane contains **pores** that allow macromolecules and particles to pass through.
- The nuclear membrane is maintaining the shape of the nucleus.

The nucleus: Contains the cell's genetic library



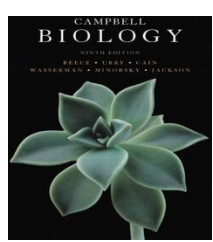


The nucleus:

Contains the cell's genetic library



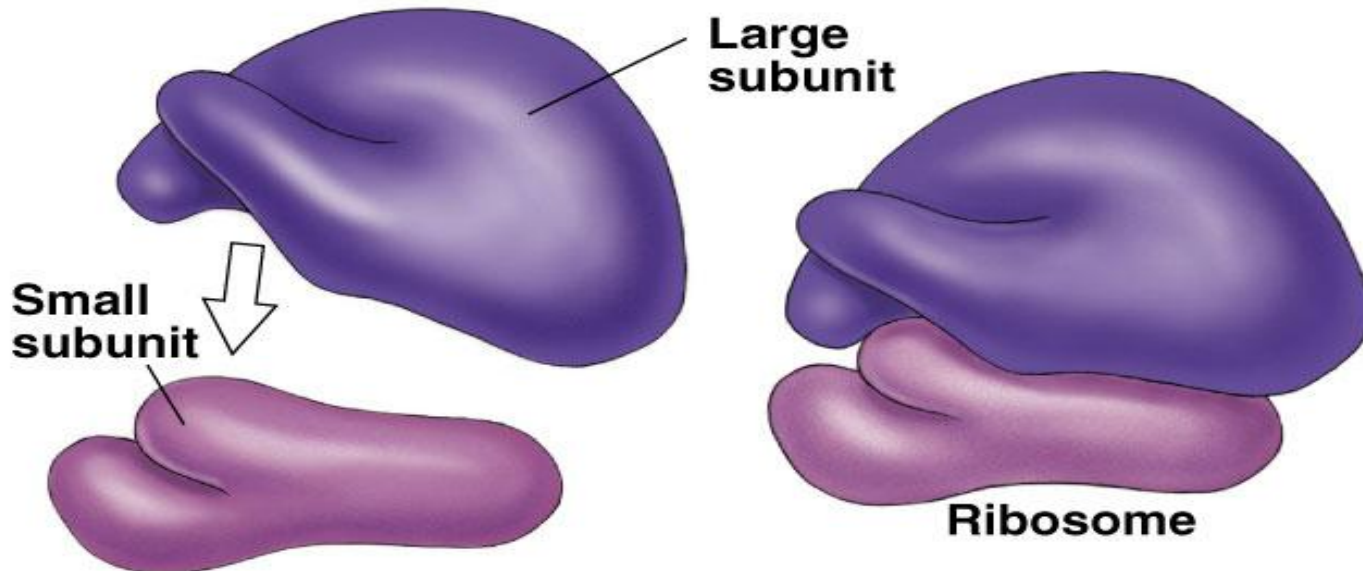
- The nucleus contains the **“chromatin fibers”** which are made up of **DNA** and **proteins**.
- When the cell prepares to divide, the chromatin fibers coil up and **condensed** to be seen as **“chromosomes”**.
- Each eukaryotic species has a characteristic number of **chromosomes**.
 - A typical human cell has **46 chromosomes**, but sex cells or gametes (eggs and sperms) have only **23 chromosomes**.
- The nucleus directs protein synthesis by synthesizing messenger RNA (**mRNA**).
 - The mRNA travels to the cytoplasm and combines with ribosomes to translate its genetic message into the primary structure of a specific protein.
- **Nucleolus** is a dark region and produces ribosomes.



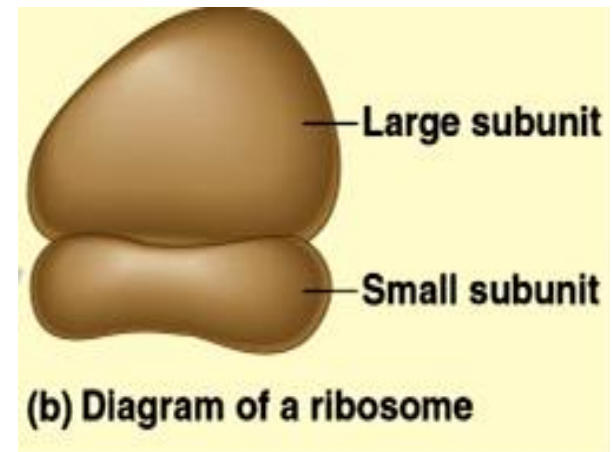
2)- Ribosomes: The protein-making machine



- **Ribosomes:** are **RNA-protein complexes**, and composed of **two subunits** (**large** and **small**) that join and attach to mRNA to carry out protein synthesis.
- So, it is the site of **protein synthesis**.
- Ribosome assembly begins in the **nucleolus** and is completed in the cytoplasm.



- In the nucleus, **rRNA** is transcribed, then binds to special proteins to form the **ribosomal** subunits inside the **nucleolus**.
- The **subunits** pass out through the nuclear pores to the cytoplasm where they combine to form **Functional Ribosomes** when they attach to an mRNA molecule.
- **Cells that synthesize large quantities of proteins (e.g., pancreas) have large numbers of ribosomes.**



- **Types of Ribosomes:-**

- 1) **Free ribosomes** are suspended in the cytosol and synthesize proteins that function **within the cytosol**.
- 2) **Bound ribosomes** are attached to the outside of the endoplasmic reticulum.
 - These synthesize proteins that are either included into membranes or for **secretion outside the cell**.

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جامعة الملك سعود

**College of Science,
Zoology Department**

**General Animal Biology
(Zoo-109)**

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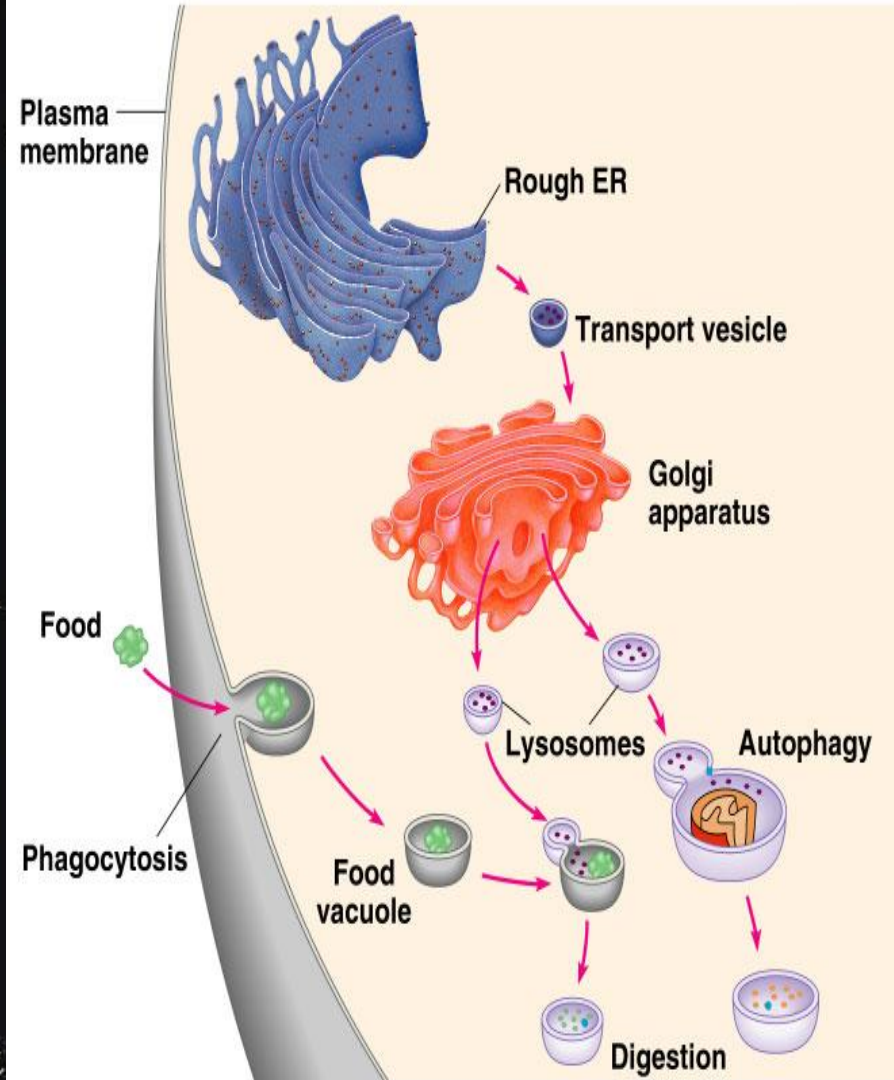
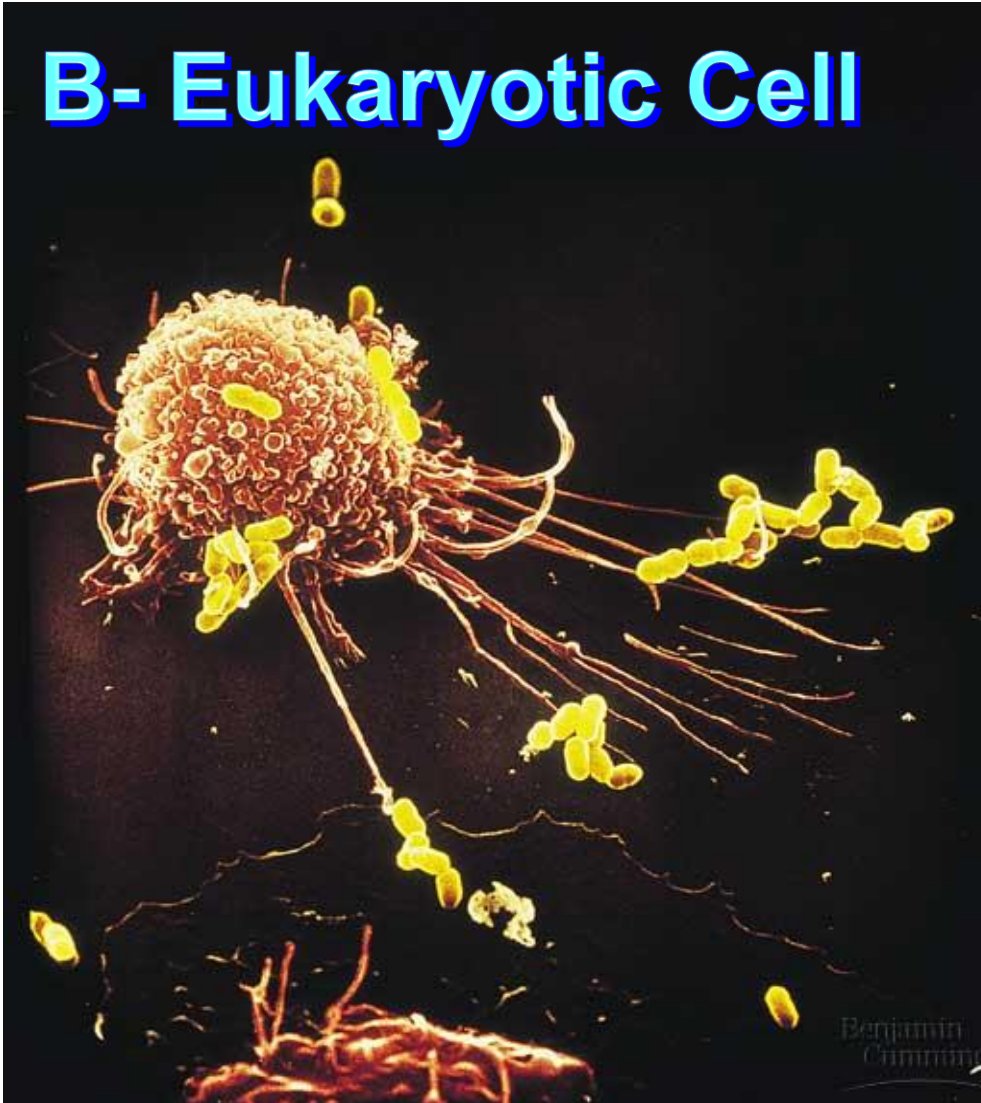


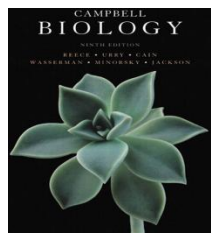
Thank you very much

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B- Eukaryotic Cell





Objectives

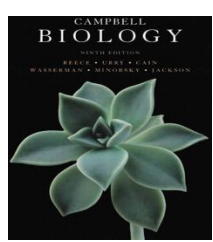


3)- The Endomembrane System

- a. The endoplasmic reticulum (ER)
 - Smooth ER.
 - Rough ER .
- b. Golgi apparatus.
- c. Lysosomes.
- d. Vacuoles.

4)- Other membranous organelles

- a. Peroxisome.
- b. Mitochondria.



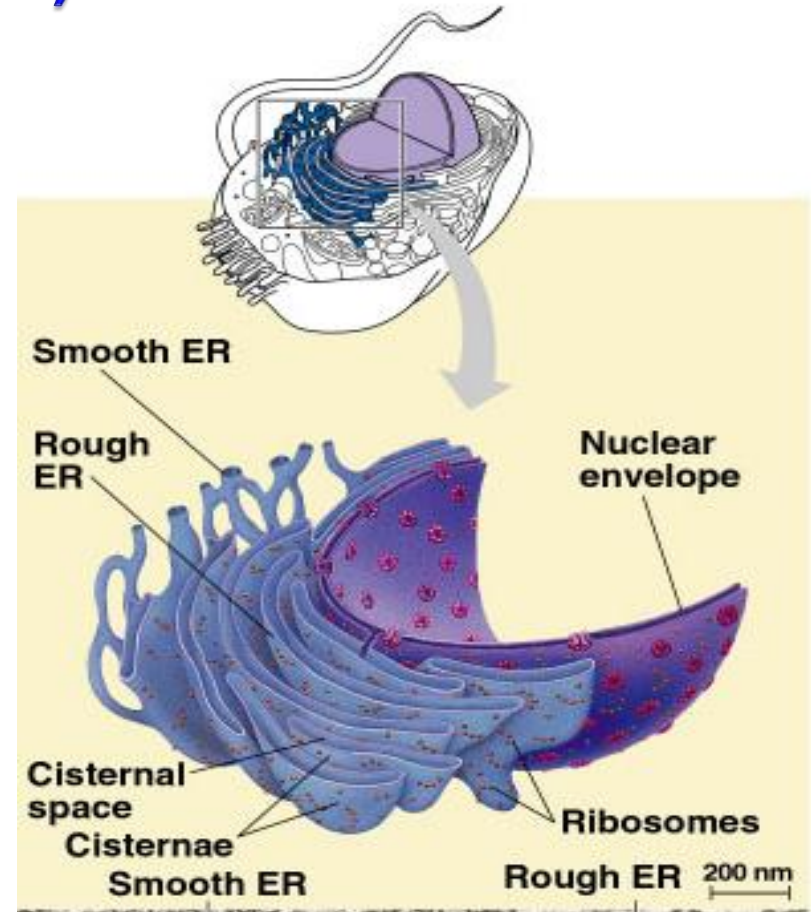
3- The Endomembrane System

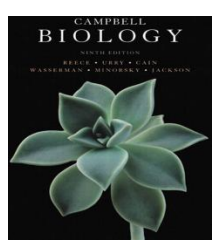


A)- The endoplasmic reticulum (ER)

(The intracellular highway)

- It is the largest internal membrane, composed of lipid bilayer
- It serves as a system of channels from the nucleus.
- It functions in **storage** and **secretion** of cell products

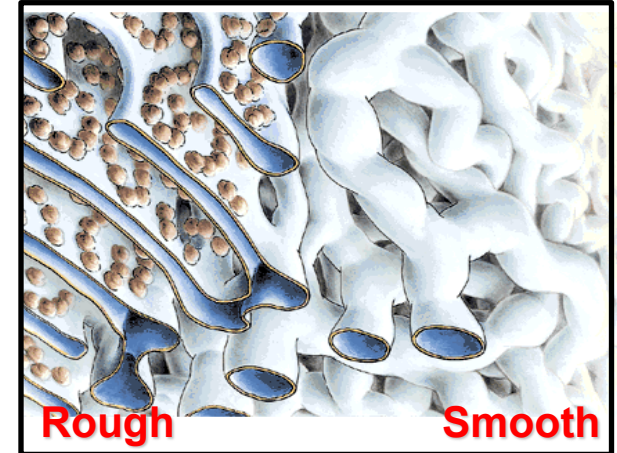




3- The Endomembrane System



Types of endoplasmic reticula

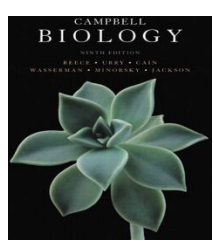


The rough ER:

- It is “rough” because of the associated ribosomes (bound ribosomes)
- It is abundant in those cells that secrete proteins such as **digestive glands** and **antibody-producing cells**.

The smooth ER:

- It is smooth as it lacks the associated ribosomes.
- It is rich in enzymes and plays a role in metabolism.
- Its enzymes synthesize **lipids** (oils, phospholipids and steroids), including the (sex hormones).
- It helps in **detoxifying drugs and poisons**, thus, it exists extensively in the liver cells.

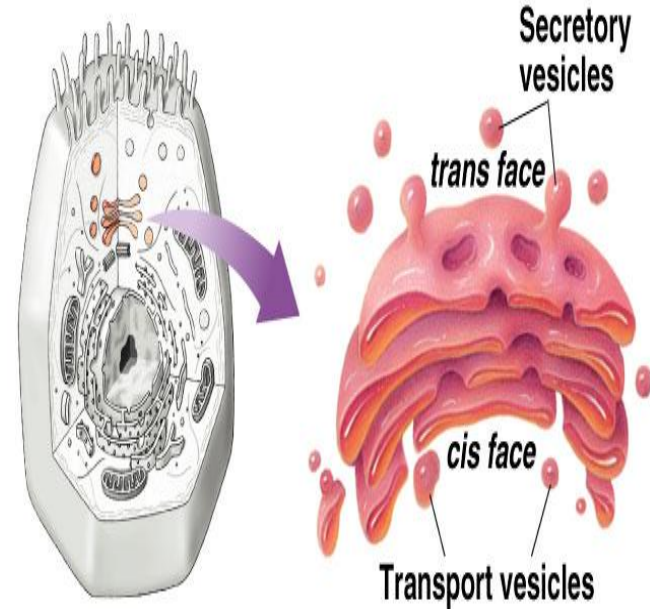


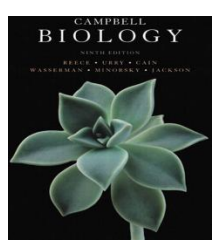
3- The Endomembrane System



B)- Golgi apparatus: (finishes, sorts, packages and ships cell products)

- Many transport products from the ER travel to the Golgi apparatus for **modification of their contents**.
- Thus, Golgi body's function is **manufacturing, warehousing, sorting (Packaging), and shipping materials to outside the cell**.
- The Golgi also **manufactures polysaccharides**.
- It correctly **send proteins** to their respective addresses.
- If the Golgi makes a mistake in shipping the proteins to the right address, certain functions in the cell may stop.
- **The Golgi apparatus is more abundant in secretory cells.**



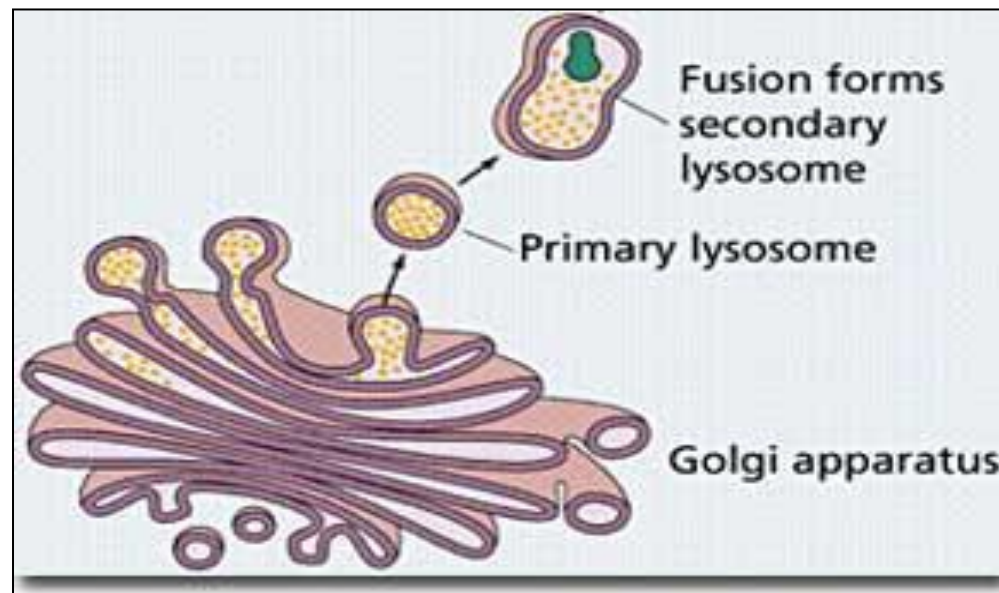


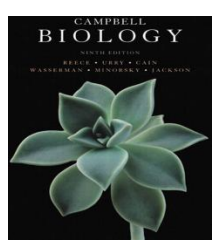
3- The Endomembrane System



C)- Lysosomes: They are digestive components

- Lysosome is a membrane-bounded sac contains enzymes that digest macromolecules.
- **Lysosomal enzymes** work best at pH = 5 (acidic).
- **Lysosomal enzymes** are synthesized by rough ER and then transferred to the Golgi then to lysosomes.



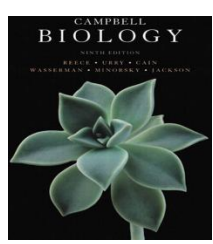


3- The Endomembrane System



Functions of Lysosomes

- 1) They have enzymes that **hydrolyze** the macromolecules (proteins, fats, polysaccharides, and nucleic acids).
- 2) Can destroy the cell by auto-digestion (**autophagy**).
- 3) Can also fuse with and digest another organelle or part of the cytosol. This process is called **recycling** which **renews the organelle** and/or the cell.
- 4) Can fuse with food vacuoles to **digest food**, (*when a food item is brought into the cell by Phagocytosis*).
5. They **digest** unwanted particles.
6. They help white blood cells to **destroy bacteria**.

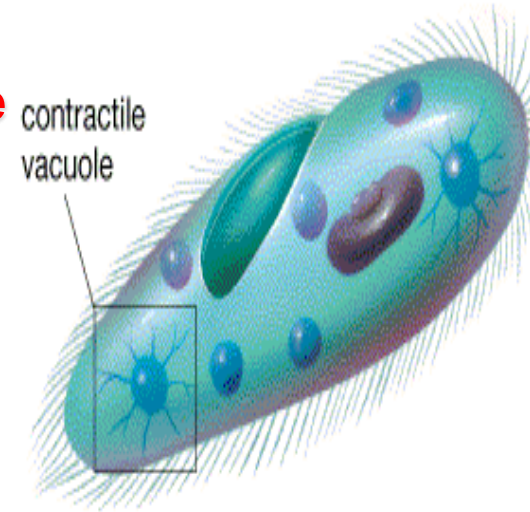


3- The Endomembrane System



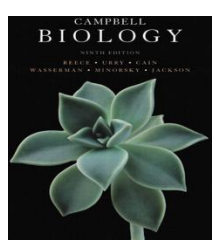
D)- Vacuoles: They have diverse functions in cell maintenance

- They are membrane-bound sacs with varied functions such as **storage, digestion, and waste removal**.
- Contain water solution and help plants maintain shape.



There are different types of vacuoles including:

1. **Food vacuoles:** from phagocytosis, fuse with lysosomes for digestion.
2. **Contractile vacuoles**, فجوة متقبضة: found in freshwater protists (e.g. *Paramecium*) to maintain **osmoregulation** (water balance) by pumping excess water out of the cell.
3. **Central vacuoles:** in mature plants; store wastes, maintain the cell shape.

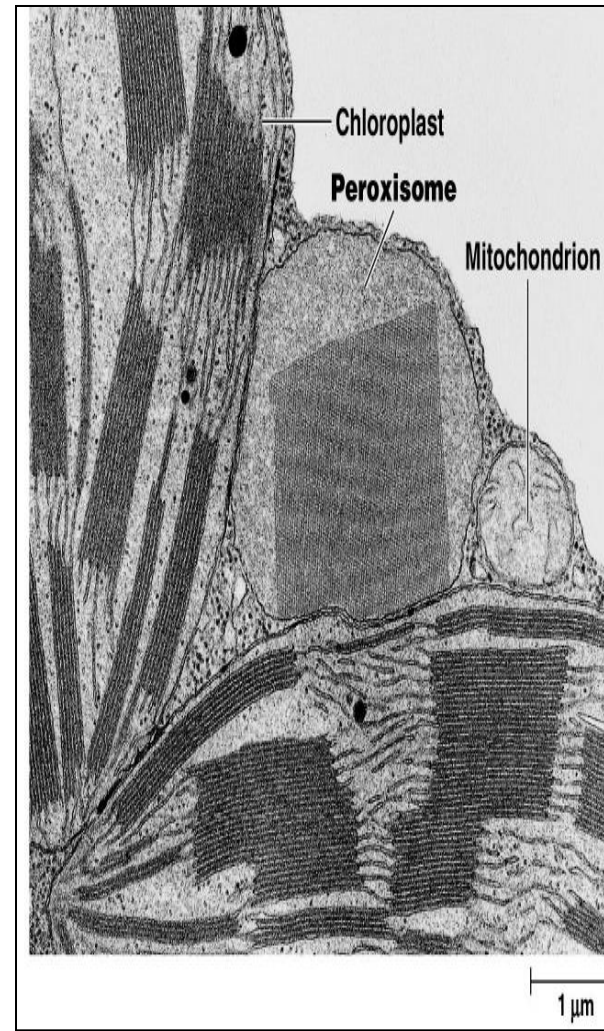


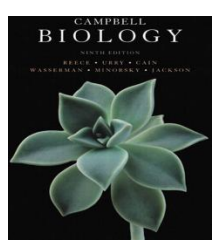
4- Other Membranous Organelles



1)- Peroxisomes

- Are similar in appearance to lysosomes, but the two have different origins:
 - *Lysosomes are generally formed in the Golgi complex,*
 - *Whereas peroxisomes are self-replicating themselves.*
- Contain enzymes for **degrading amino acids and fatty acids**, resulting in production of the **toxic hydrogen peroxide (H_2O_2)**; as a byproduct of cellular metabolism.



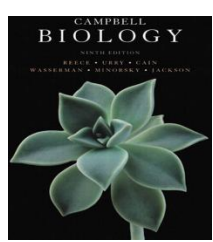


Other Membranous Organelles



Functions of peroxisomes:

- 1- They have enzymes that converts the toxic H_2O_2 to water (H_2O).
- 2- They **break fatty acids** down to smaller molecules that are transported to mitochondria as fuel (for cellular respiration).
- 3- They detoxify alcohols and other **harmful compounds**. Thus, it exists extensively in the **liver cells.**
- 4- They initiate the production of **phospholipids**, which are the major component of cellular membranes.



Other Membranous Organelles



2)- Mitochondria:

They are rod-shaped organelles that convert oxygen and nutrients into **ATP** (adenosine triphosphate) during **aerobic respiration**.

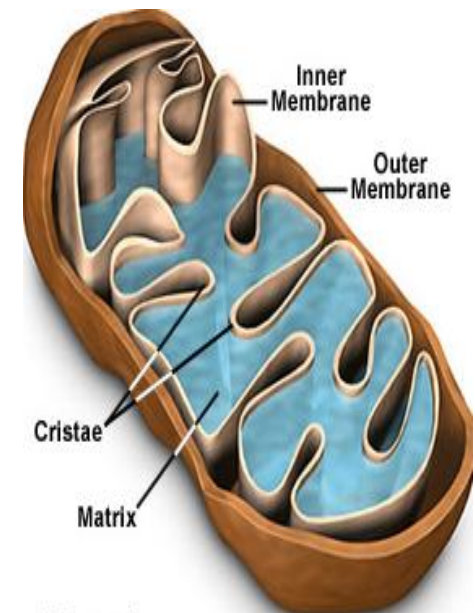
- **Mitochondria are the sites of cellular respiration,**

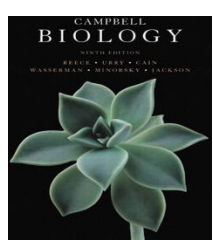
- Generating **ATP** from the catabolism (هدم/احرق) of sugars, fats, and other fuels in the presence of oxygen.

- Almost all eukaryotic cells have mitochondria except red blood cells.

- Mitochondria **are mobile** and moving around inside the cell along tracks in the cytoskeleton.

- The **number of mitochondria** present in a cell depends upon the metabolic requirements of that cell, and may range from **a single large mitochondrion to thousands**.





Other Membranous Organelles

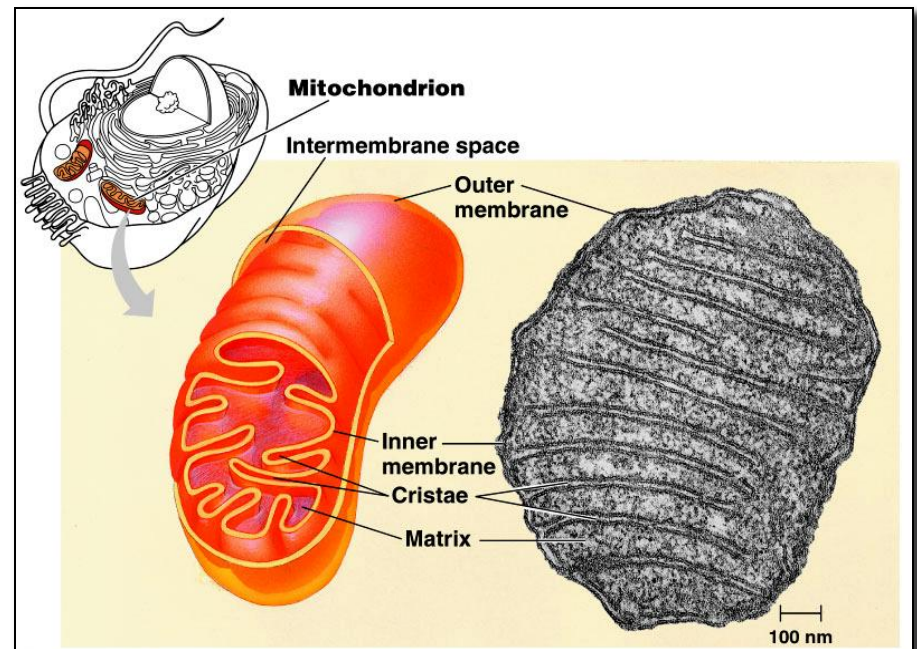


Structure of mitochondrion:

- Mitochondria have a smooth outer membrane and a highly folded inner membrane forming the **cristae**.
- The inner membrane encloses the **mitochondrial matrix**, a fluid-filled space with the mitochondrial **DNA, ribosomes, and enzymes**.

The mitochondrion is different from the most other organelles because:

1. It has its own **DNA, ribosomes, and enzymes**.
2. It reproduces independently of the cell.



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**General Animal Biology
(Zoo-109)**

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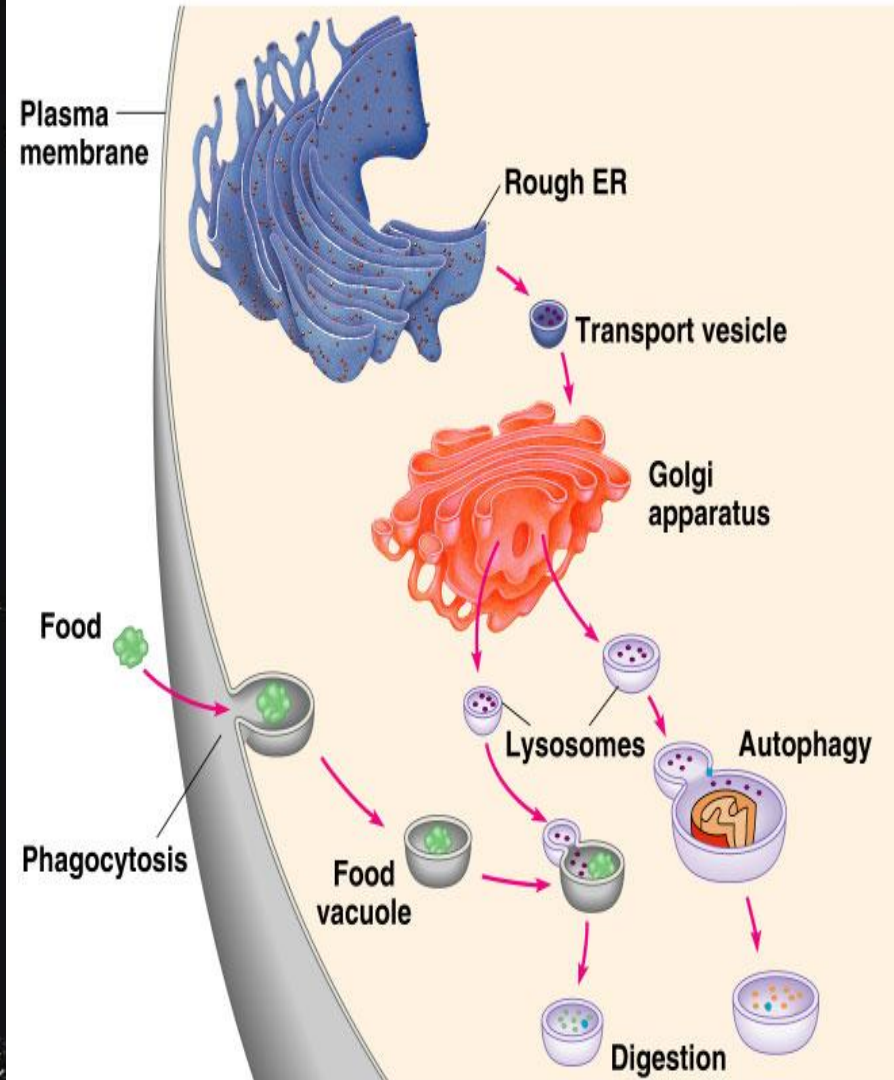
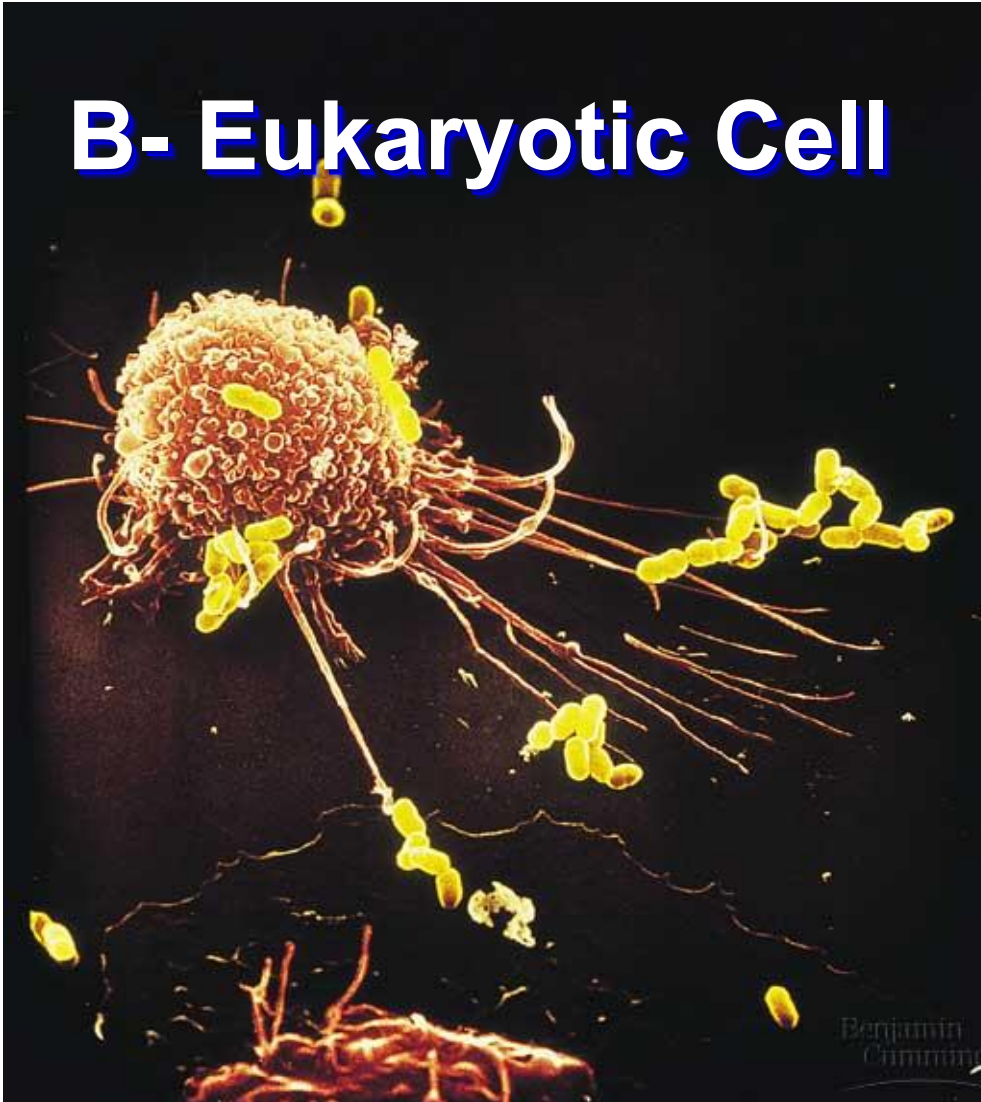


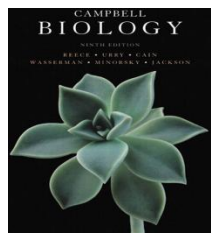
Thank you very much

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B- Eukaryotic Cell





Objectives



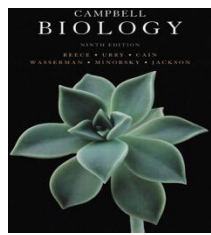
5)- The Cytoskeleton (الهيكل الخلوي): structure and function.

- ✓ Microtubules الأنيبيبات الدقيقة
- ✓ Microfilaments اللييفات الدقيقة
- ✓ Intermediate filaments اللييفات المتوسطة

Centrosome الجسم المركزي

Cilia and Flagella الأهداب والأسواط

6)- Cell membrane الغشاء الخلوي

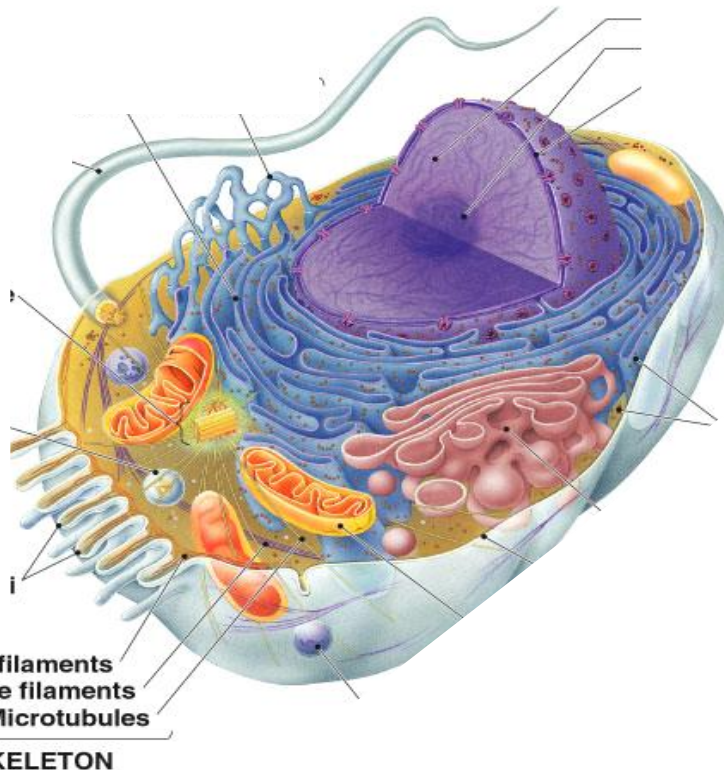


The Cytoskeleton الهيكل الخلوي

Microtubules and filaments



A network of fibres شبكة من الالياف that provides **structural support** تدعيم to the cell. The cytoskeleton also functions in **cell motility** تحرك الخلية and regulation.

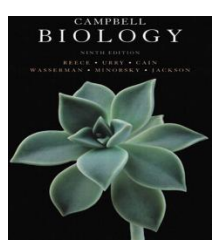


It is made up of 3 types of fibers

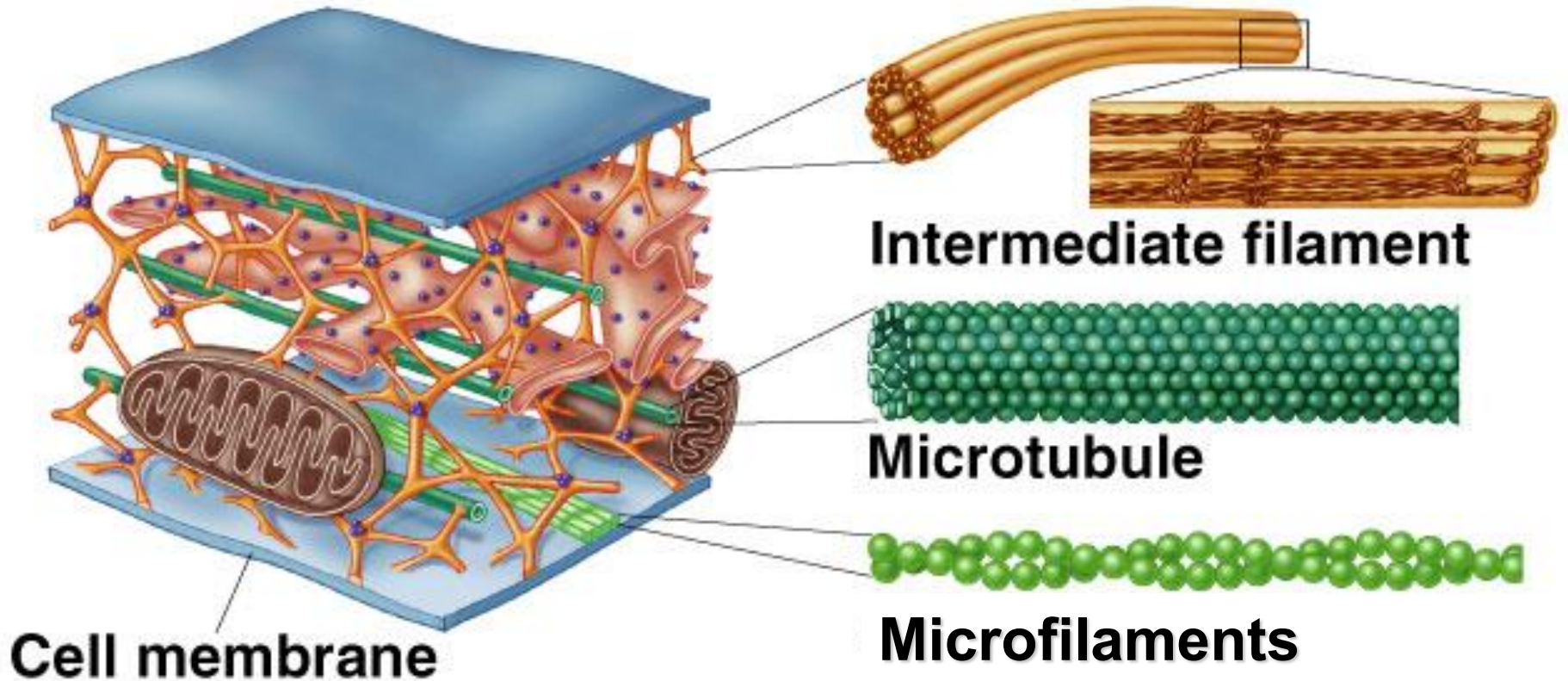
1. Microfilaments.
2. Microtubules.
3. Intermediate filaments.

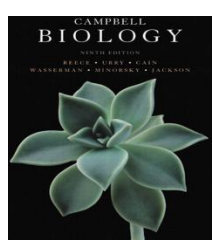
It has 3 main functions:

1. Provides mechanical support of the cell and keeps organelles in their fixed locations.
2. Helps moving materials within the cell.
3. Plays a major role in cell motility.



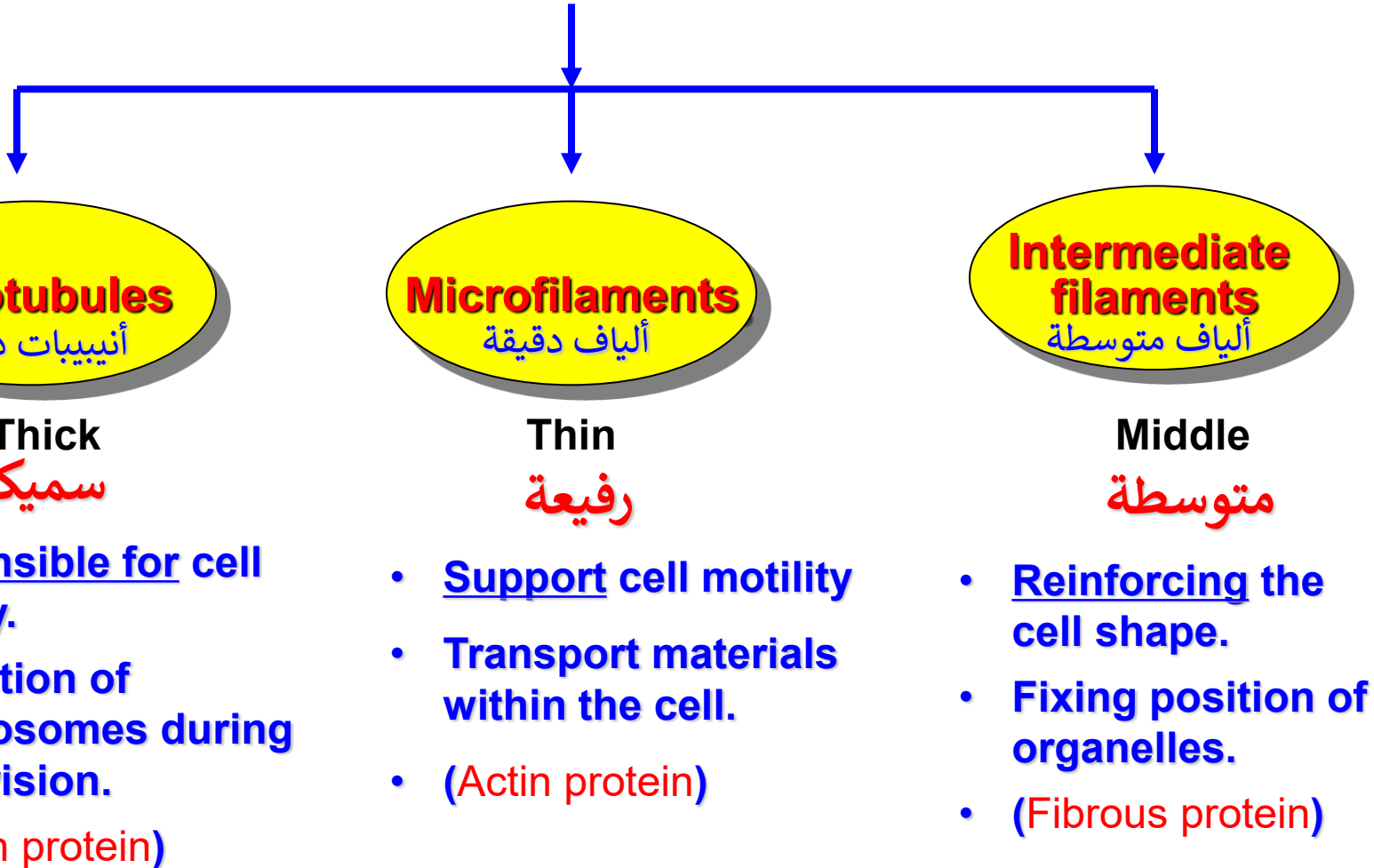
Cytoskeleton

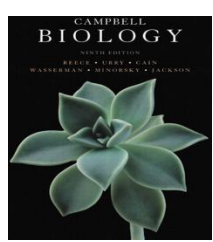




Cytoskeleton

Cytoskeleton





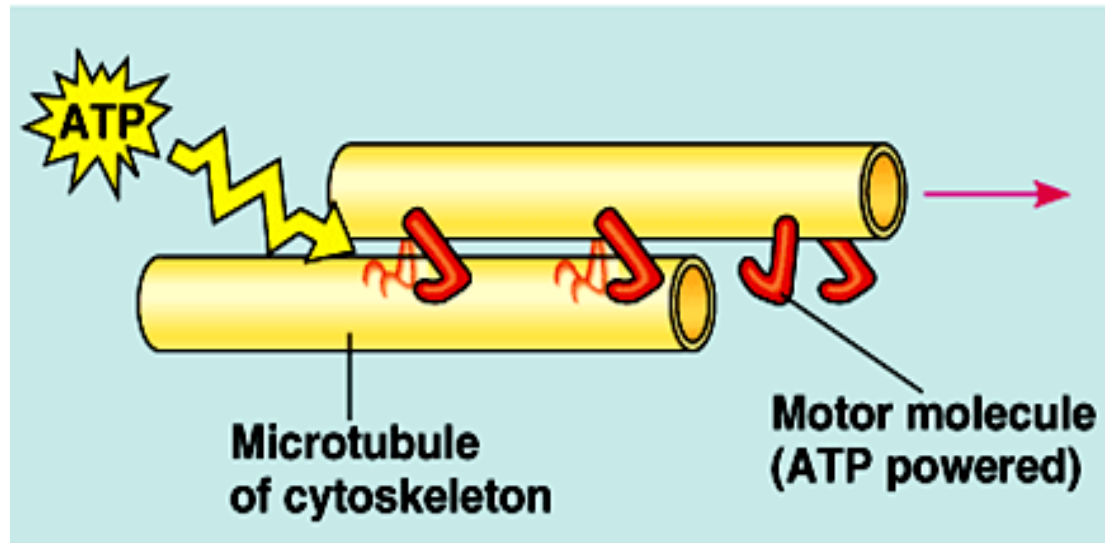
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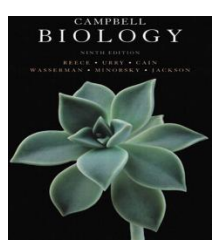


- The cytoskeleton is dynamic, dismantling **يتفكك** in one part and reassembling **يتجمع** in another to change cell shape.
- The cytoskeleton plays a major role in cell motility **حركة الخلية** by interacting with **motor proteins**. **البروتين الحركي**.
- Motor proteins are able to move along the surface of a suitable substrate (powered by **ATP**).
- Motor proteins are the driving force behind most active transport of proteins and vesicles in the cytoplasm.

Cell Movement

- In **cilia** and **flagella** motor proteins pull components of the cytoskeleton past each other **عكس بعضهم البعض**.
- This is also true in **muscle cells**.



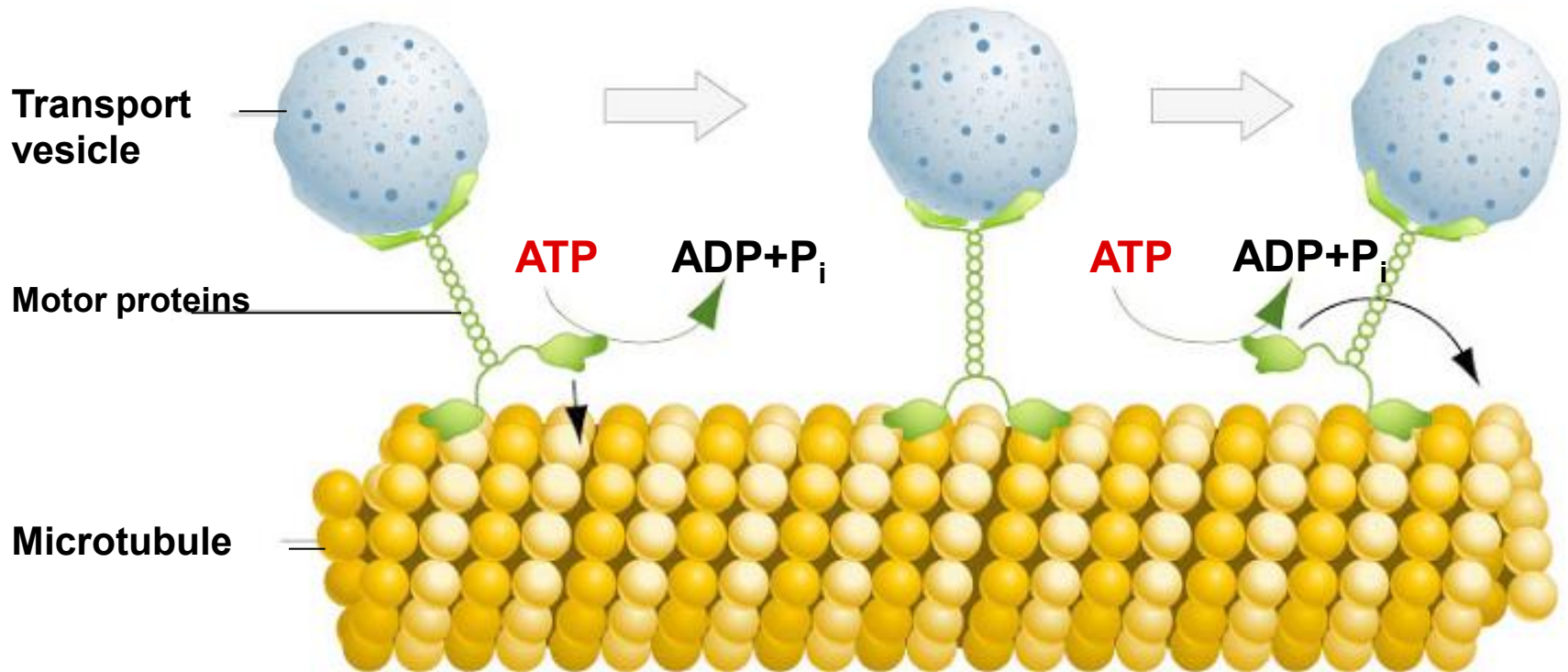


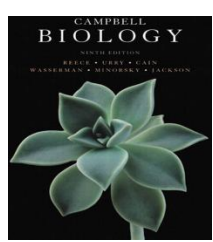
Motor proteins



Motor proteins are a class of molecular motors that are able to move along the surface of a suitable substrate. They are powered by the hydrolysis of **ATP** and convert chemical energy into mechanical work.

MOTOR PROTEINS "WALKS" ALONG A MICROTUBULE TRACK

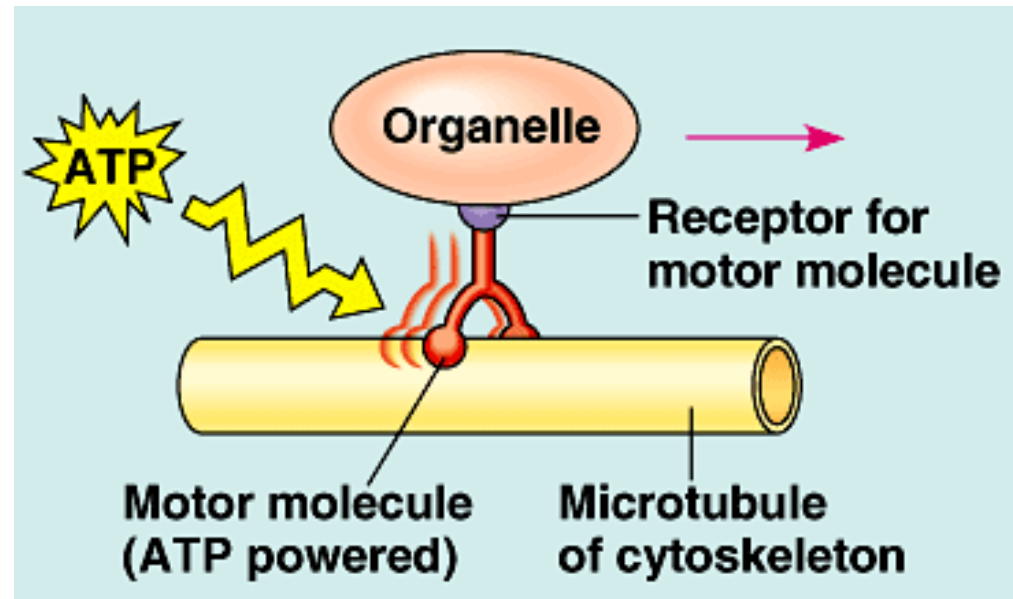




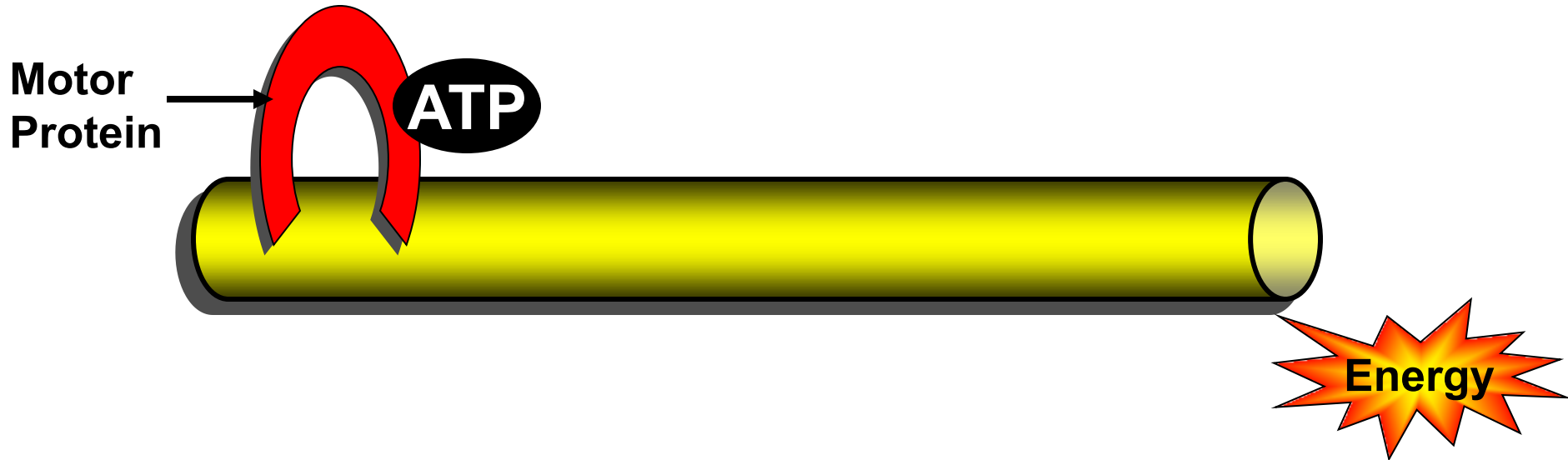
Motor proteins



- Interactions of motor proteins and the cytoskeleton circulates materials within the cell.
- The cytoskeleton may transmit mechanical signals that rearrange the nucleoli and other structures.
- Motor molecules also carry **vesicles** or **organelles** to various destinations **إلى أماكن مختلفة** provided by the cytoskeleton.

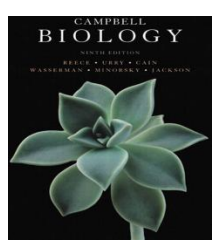


Organelle



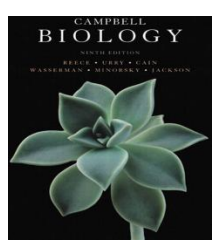
Microtubules functions as tracks قضييب that guide motor proteins carrying organelles to their destination المكان المستهدف.

They move chromosomes during cell division



Motor proteins and movement of organelles





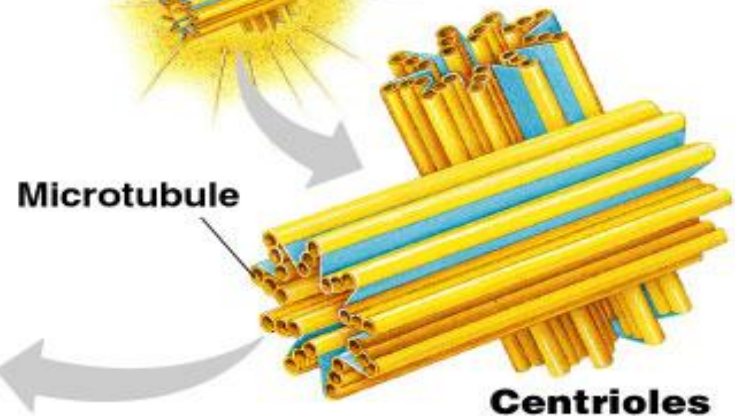
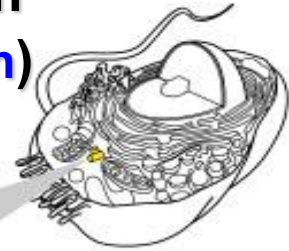
Centrosome



- In many cells, microtubules grow out from a **centrosome** الجسم المركزي near the nucleus.

Centrosome

- In animal cells, the centrosome has a pair of **centrioles**, each with **9 triplets** of microtubules تسعة مجموعات ثلاثية الأنابيبات (9 + 0 pattern) arranged in a ring مُرتبة دائريا.
- During cell division the centrioles replicate تتضاعف.

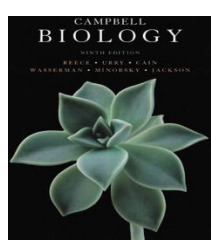


Longitudinal section of centriole

Microtubules

Cross section of centriole

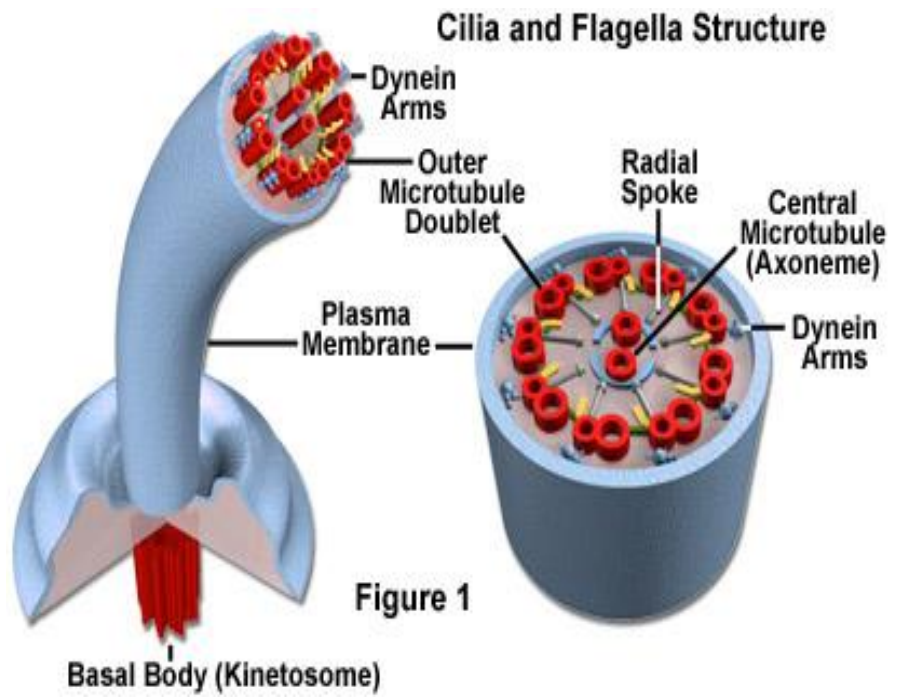
Centrioles



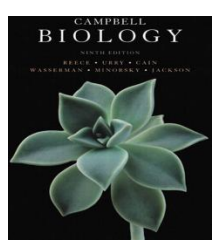
Cilia and Flagella



- ❖ Both **cilia** and **flagella** have the same ultrastructure *التركيب الدقيق*.
- ❖ Both have a core *مركز* of **microtubules** sheathed by the plasma membrane.
- ❖ **9-doublets** (**9 + 2 pattern**) *تسعة مجموعات ثنائية الأنابيبتان* of microtubules arranged around a pair at the center.
- ❖ Flexible “wheels” of proteins connect outer doublets to each other and to the core.
- ❖ The outer doublets are also connected by motor proteins.



❖ Thus, the structure of the cilium and flagellum is different from that of the centriole.

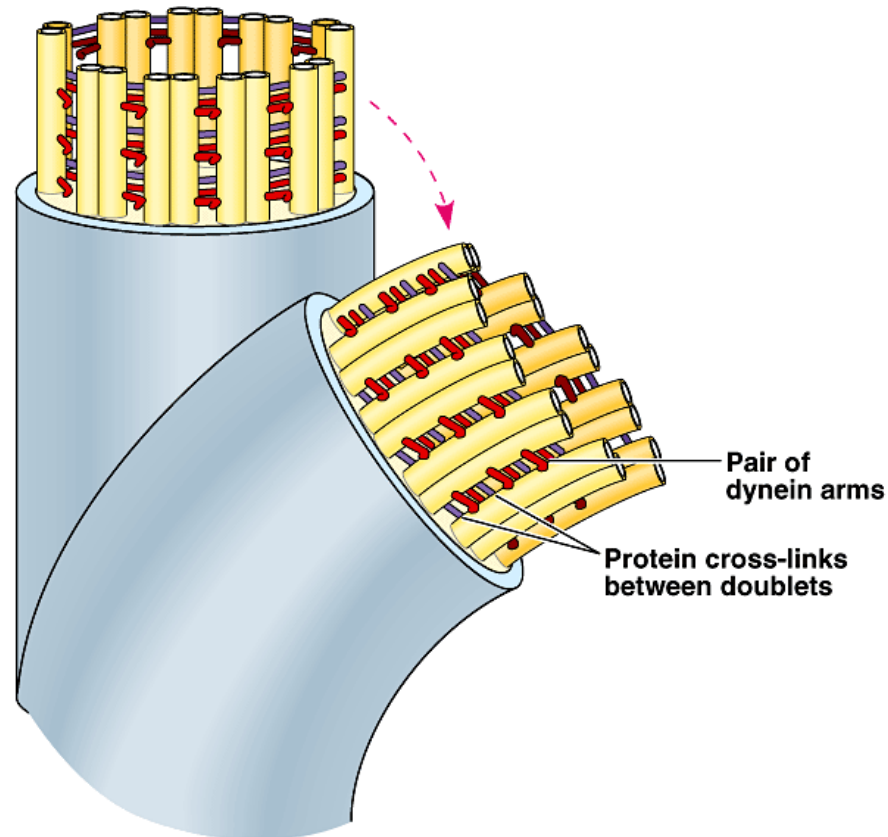


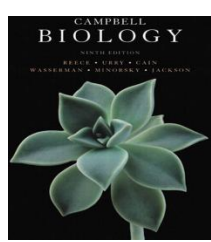
Movement of Cilia and Flagella



- **Cilia** and **flagella** have arms of a motor protein (**dynein** بروتين الداينين).

- Dynein arms alternately grab, move, and release the outer microtubules.
- Protein cross-links limit sliding and the force is expressed as bending إلتواء.





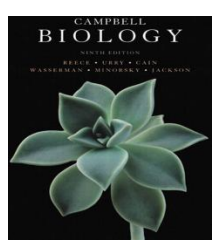
Movement of Cilia and Flagella



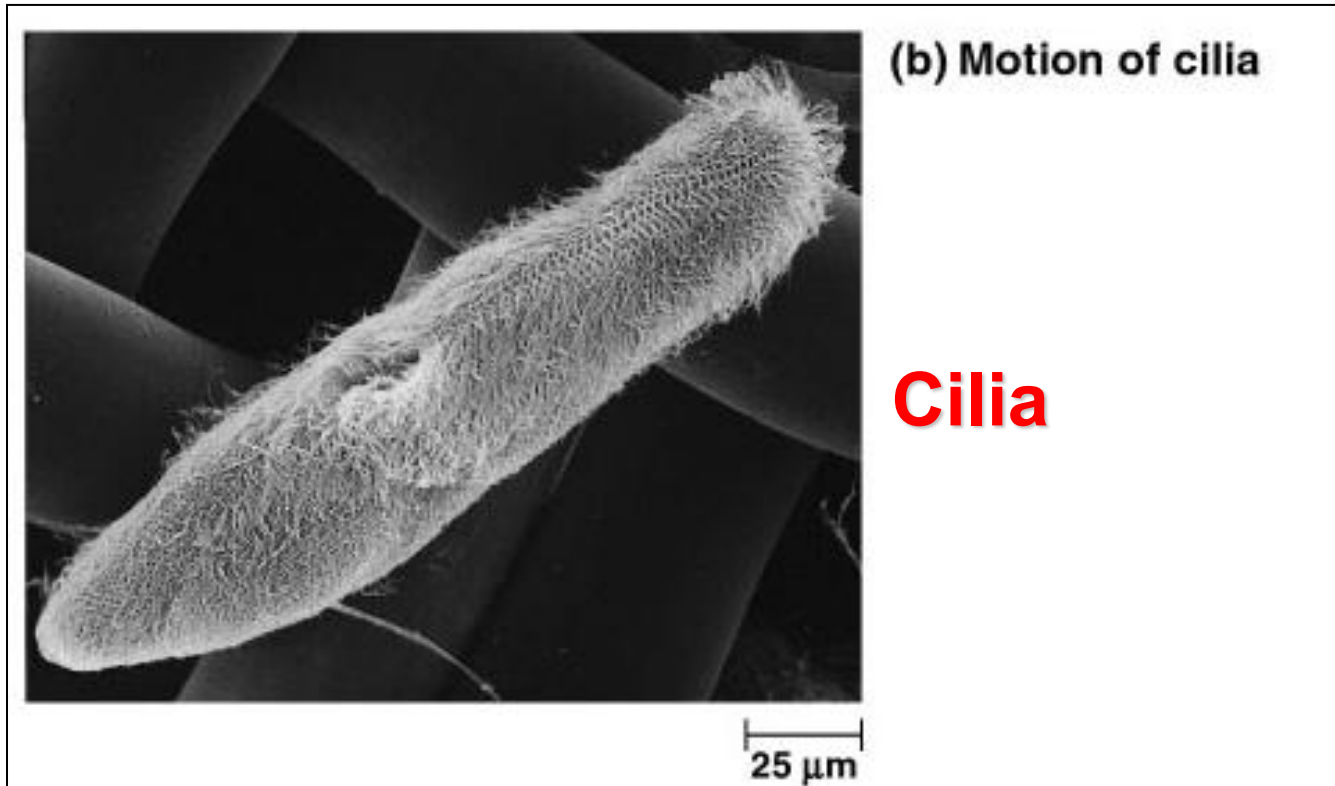
- **Microtubules** are the central structural supporting both **cilia** الأهداب and **flagella** الأسواط.
 - Both can move unicellular and small multicellular organisms by propelling دفع water outside the organism.

Movement of cilia & flagella

- **Cilia** usually occur in large numbers on the cell surface.
- **Flagella** usually occur in just one or a few per cell.
- **Cilia** move more like oars مجاديف with alternating power and recovery strokes.
- **Flagella** have an undulatory movement حركة تموجية.
- **So, cilia and flagella differ in their beating pattern** أسلوب الحركة.

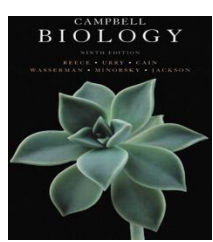


Cilia of *Paramecium*





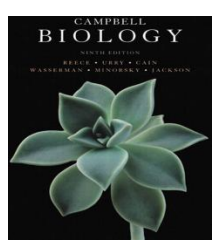
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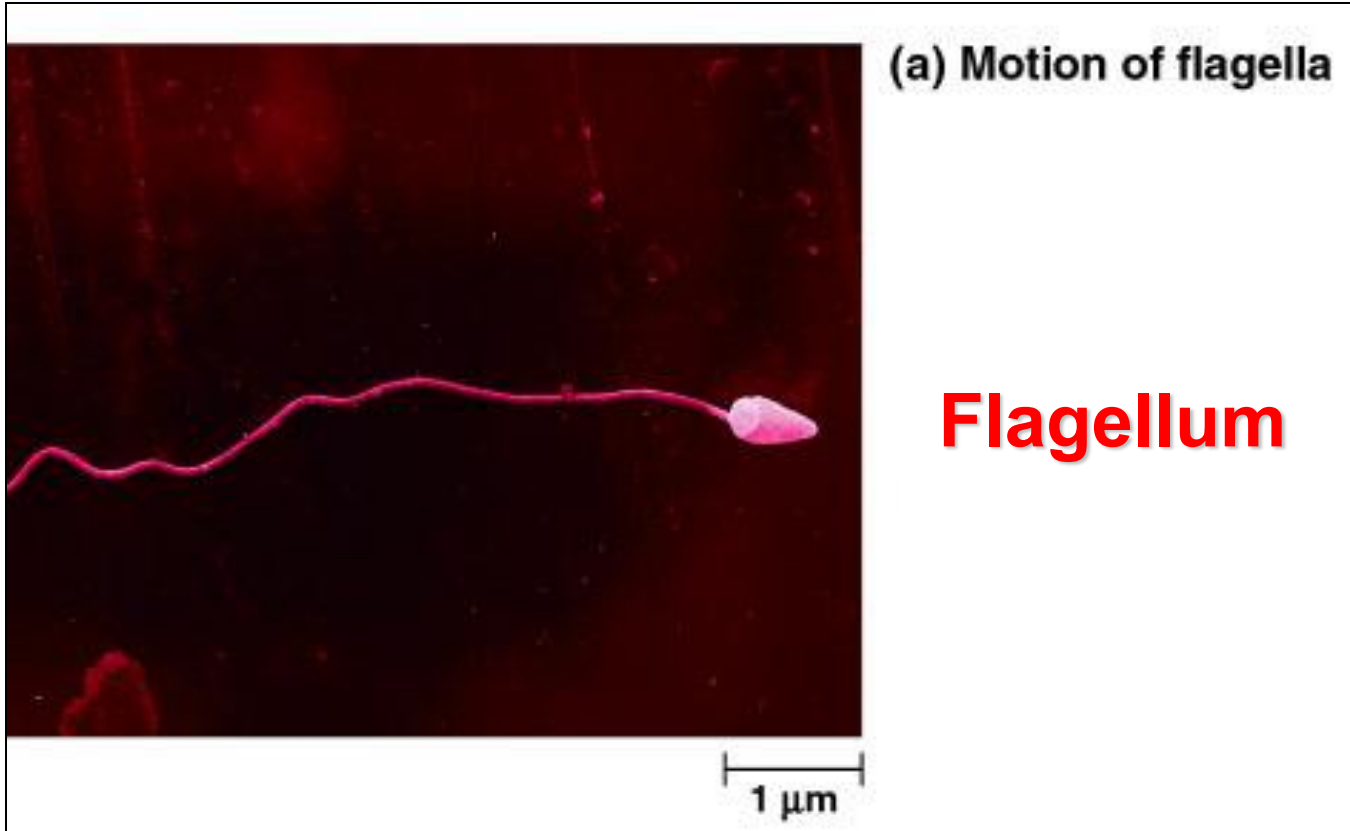
Cilia of *Paramecium*

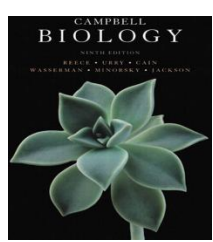




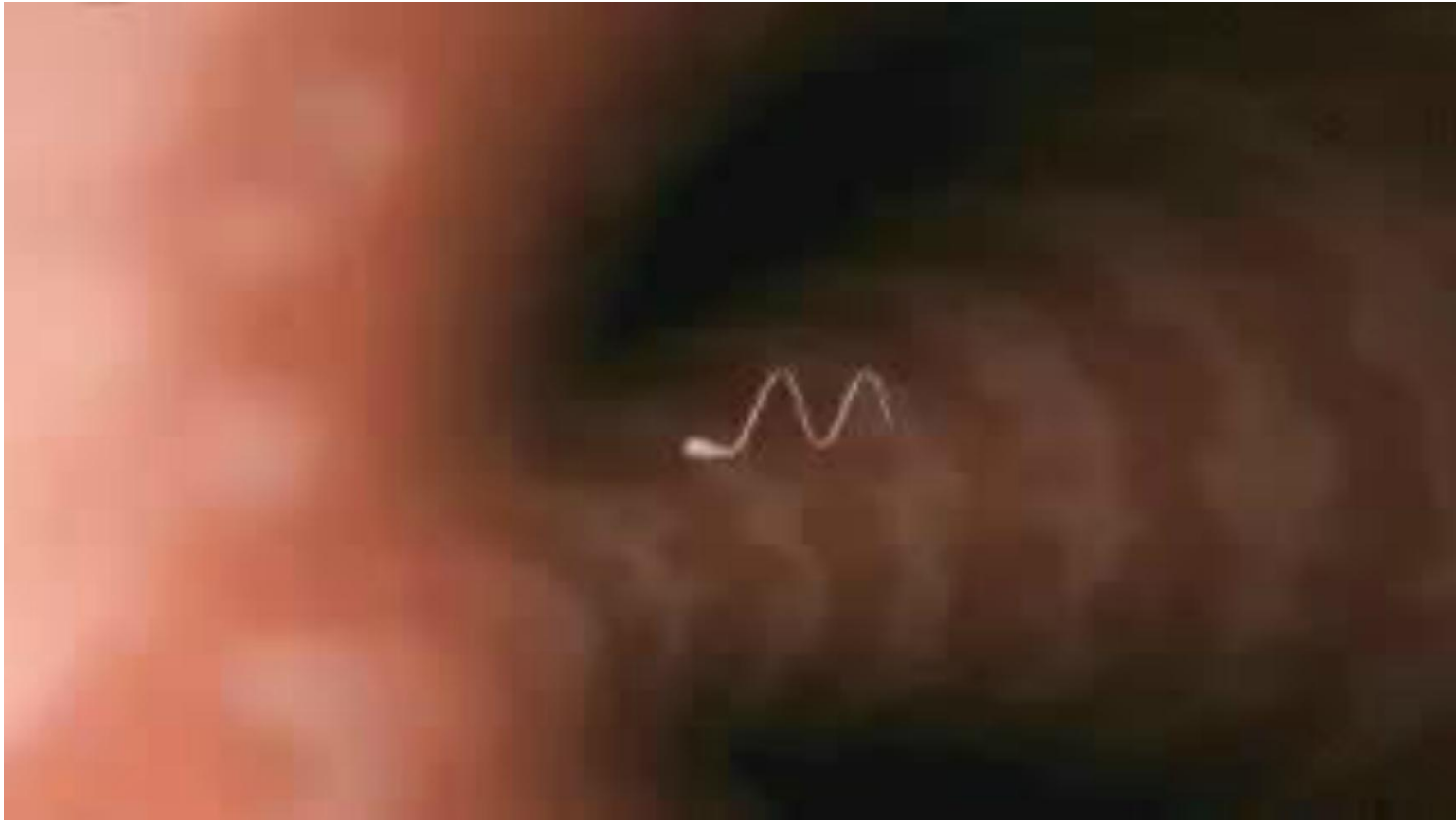


Flagellum of sperm





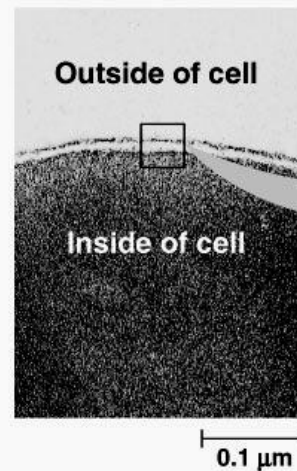
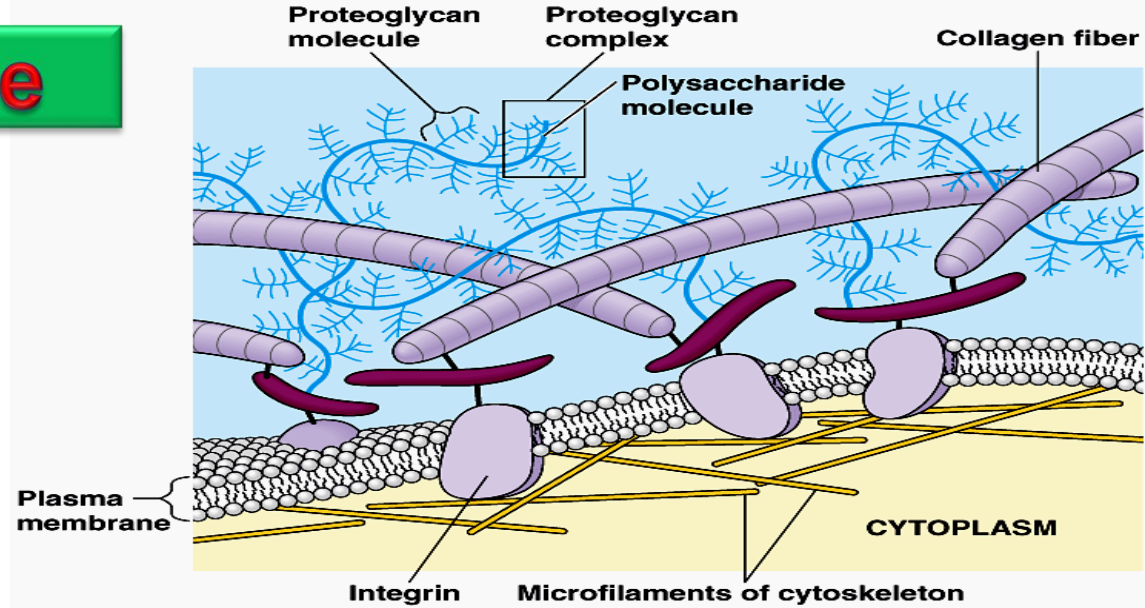
Flagellum of sperm



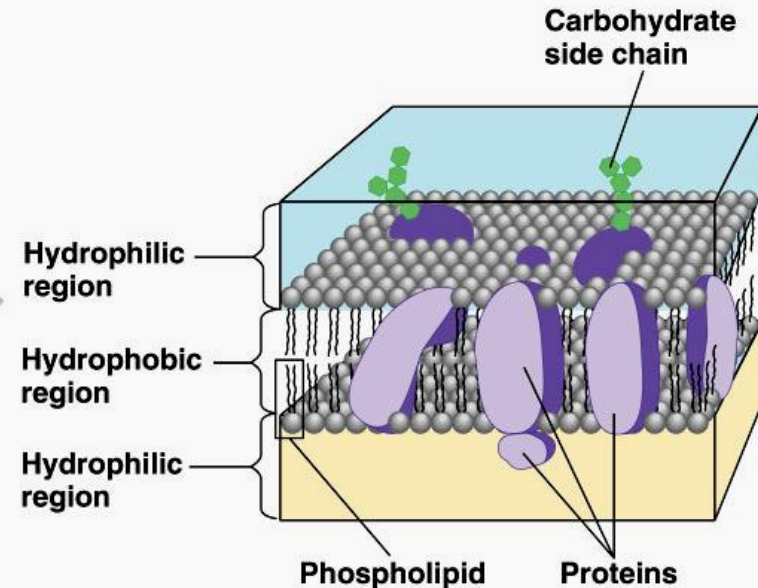
6- Cell membrane

- The plasma membrane functions as a **selective barrier**

that حاجز إختیاری allows passage of **oxygen**, **nutrients**, and **wastes** for the whole volume of the cell.

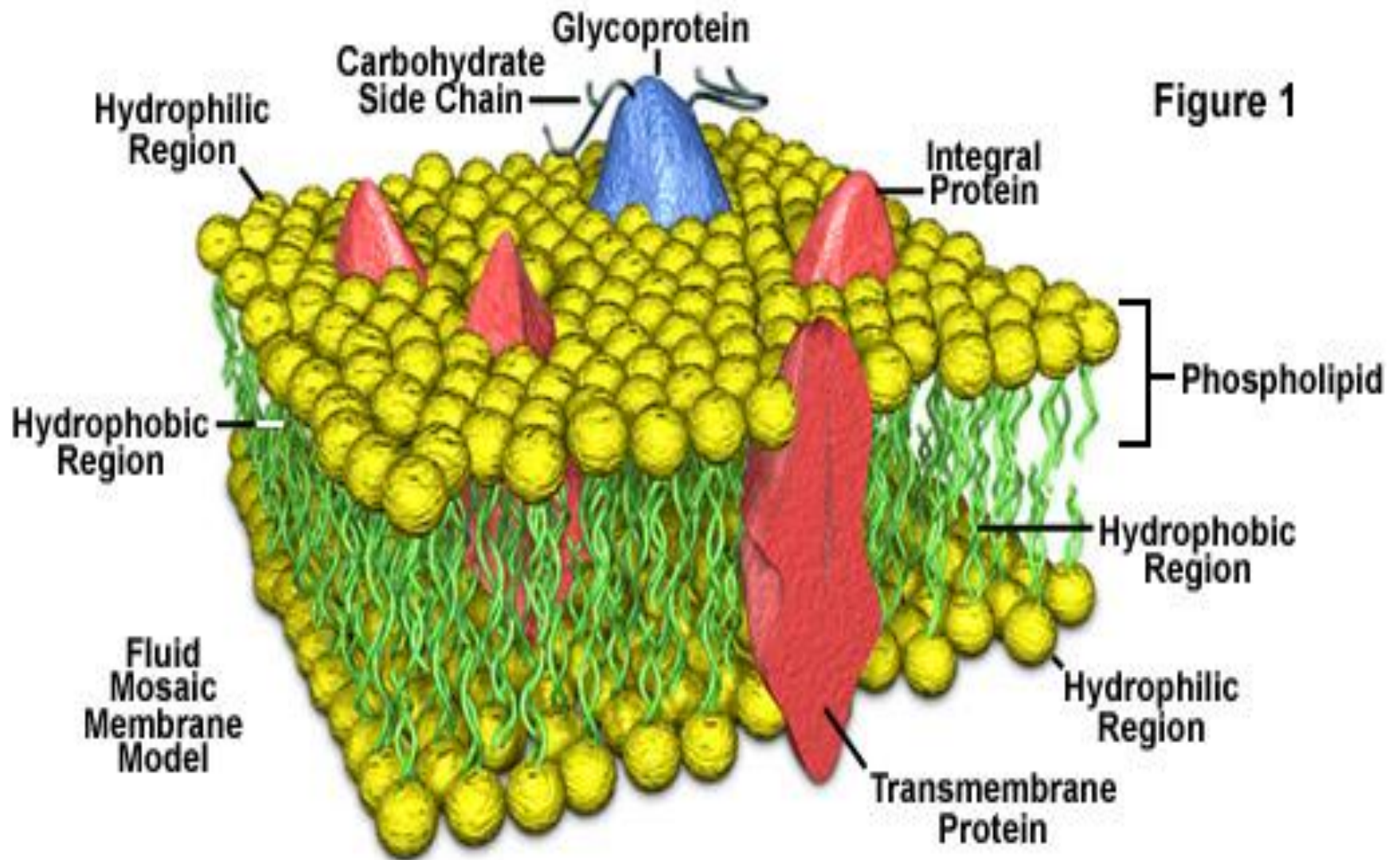


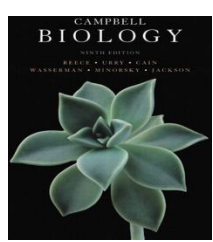
(a) TEM of a red blood cell



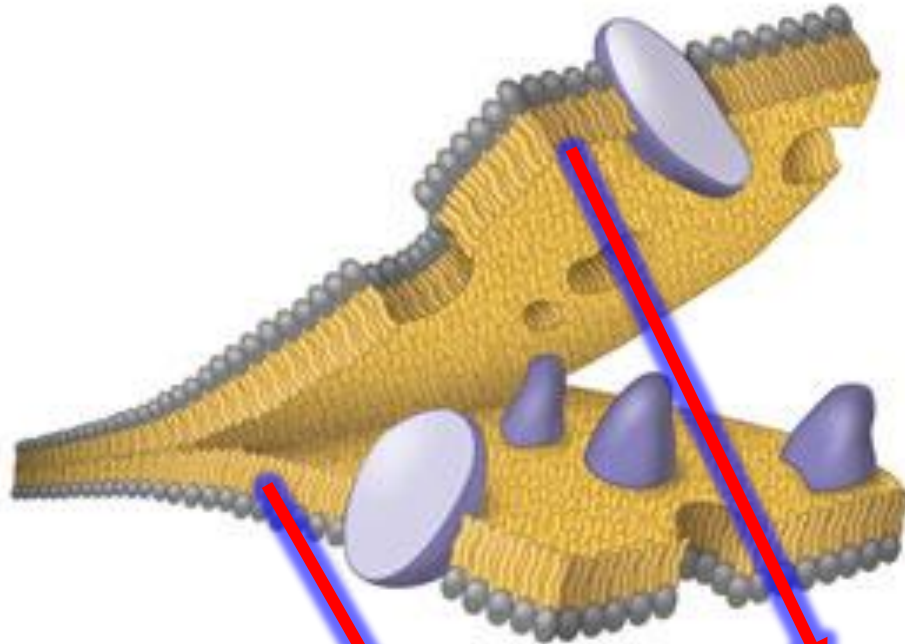
(b) Structure of the plasma membrane

Plasma Membrane Structural Components



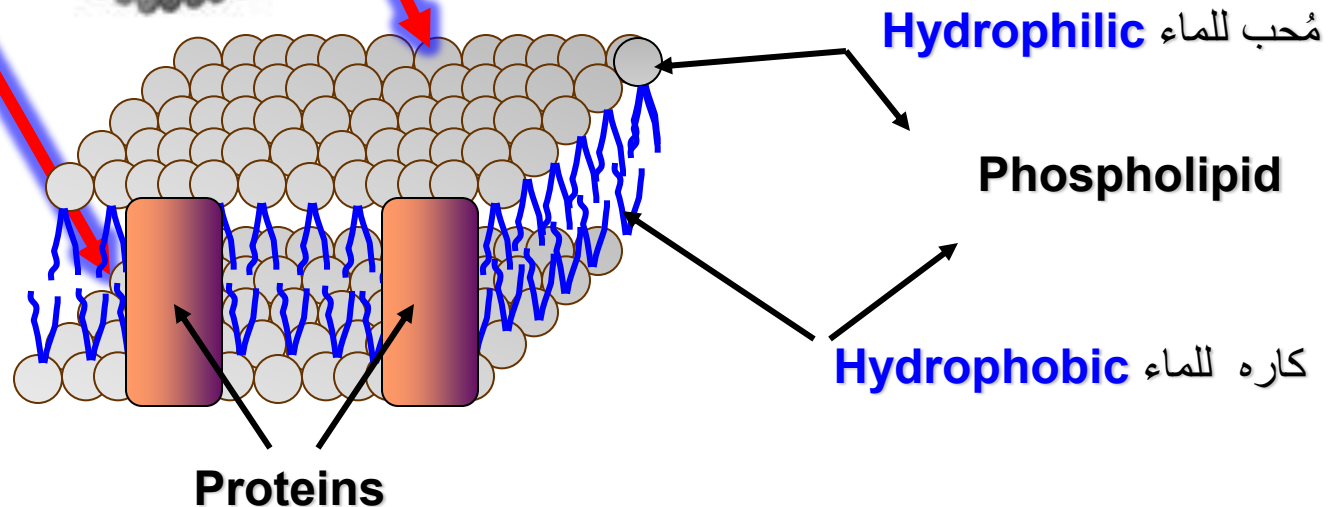


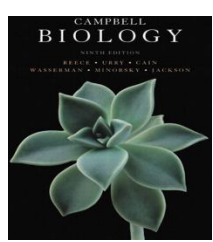
Cell membrane



Composed of a kind of lipids (phospholipids) and proteins

Lipid layer contains **hydrophilic** and **hydrophobic** regions





Comparison between Prokaryotic and Eukaryotic cells



Term	Prokaryotic cell	Eukaryotic cell
Size	1-10 μm in diameter	10-100 μm in diameter
Cell wall	Existed	In plant cell (not animal cell)
nucleus	No nuclear envelope but Nucleoid	True nucleus exists with nuclear envelope
DNA	As fibre in the nucleoid region (plasmids in some cases)	As Chromatin (DNA and protein)
Specialized Organells	Most of them are absent	All are existed
Cell division	By Binary Fission	Meiotic and/or Mitotic

TENTH EDITION
CAMPBELL
BIOLOGY

REECE • URRY • CAIN
WASSERMAN • MINORSKY • JACKSON

عمادة التعليم الإلكتروني والتعلم عن بعد
E-learning Deanship



King Saud University
جامعة الملك سعود

**College of Science,
Zoology Department**

**General Animal Biology
(Zoo-109)**

جامعة
الملك سعود
King Saud University



Thank you very much

شكرا جزيلاً

Zoology Department