تَنوير

BIOLOGY

Lec no : 7

File Title : Chapter 7

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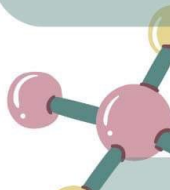


وَقُل رَّبِّ زِدْنِي عِلْمًا

Concept 6.5: Mitochondria and chloroplasts change energy from one form to another

general function

transformers

main function

- **Mitochondria** are the sites of cellular respiration, a metabolic process that uses oxygen to generate ATP

- **Chloroplasts**, found in plants and algae, are the sites of photosynthesis

main function

- Peroxisomes are oxidative organelles

The Evolutionary Origins of Mitochondria and Chloroplasts

- Mitochondria and chloroplasts have similarities with bacteria
  - Enveloped by a double membrane
  - Contain free ribosomes and circular DNA molecules
  - Grow and reproduce somewhat independently in cells

قال علماء التطور ان اصل الكلوروبلاست و الميتوكندريا هو البكتريا

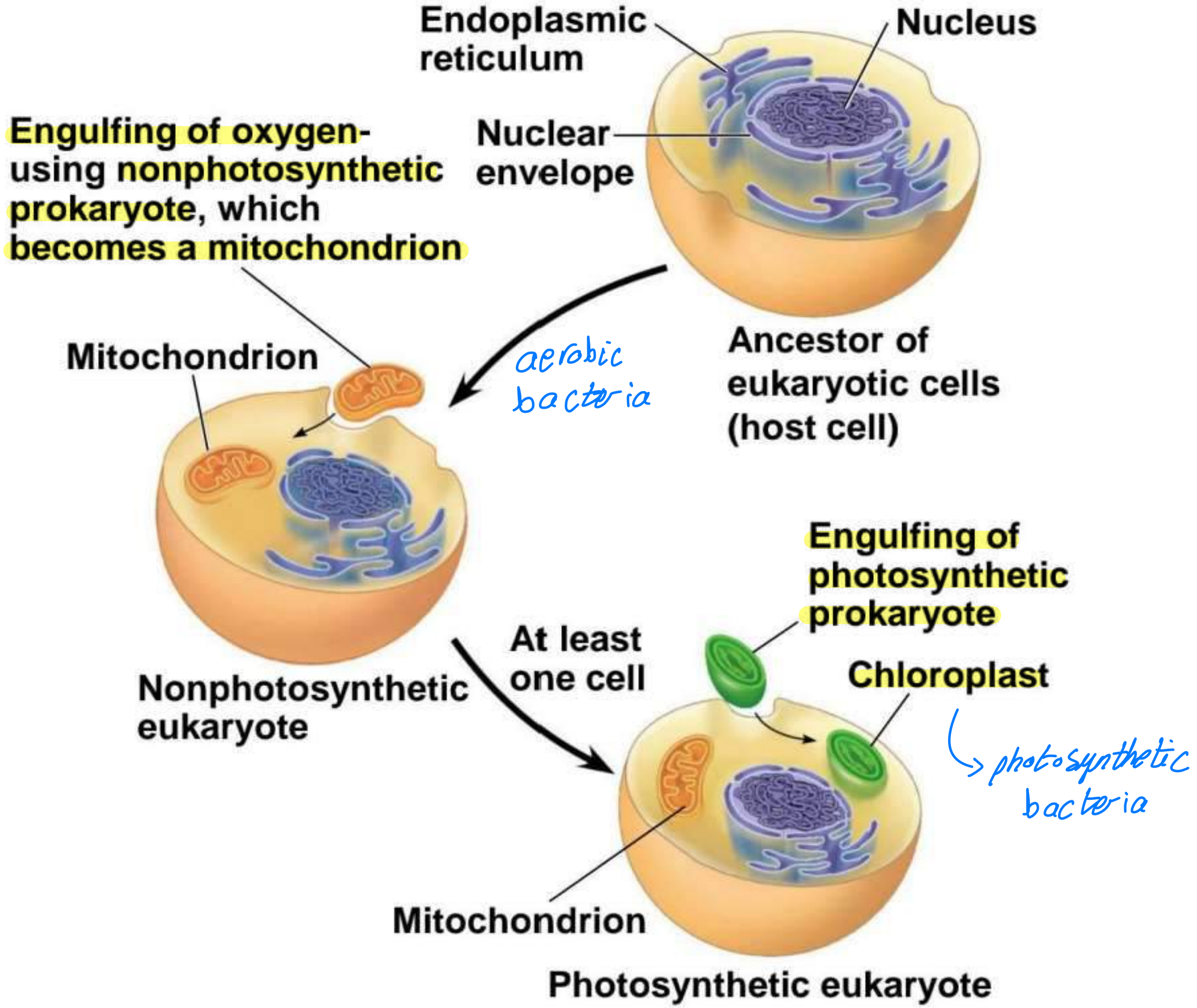
They can synthesis their own proteins and they can replicate but must be in the cell

داخلي تكافل

- The **Endosymbiont theory**
  - An early ancestor of eukaryotic cells engulfed a nonphotosynthetic prokaryotic cell, which formed an endosymbiont relationship with its host
  - The host cell and endosymbiont merged into a single organism, a eukaryotic cell with a mitochondrion
  - At least one of these cells may have taken up a photosynthetic prokaryote, becoming the ancestor of cells that contain chloroplasts

doesn't have a mitochondria or a chloroplast

Figure 6.16



non photosynthetic prokaryote

Aerobic bacteria

becomes a mitochondrion in the cell

non photosynthetic eukaryote

Engulfed by ancestor eucaryotic cell (Host cell)

photosynthetic prokaryote

photosynthetic bacteria

becomes a chloroplast in the cell

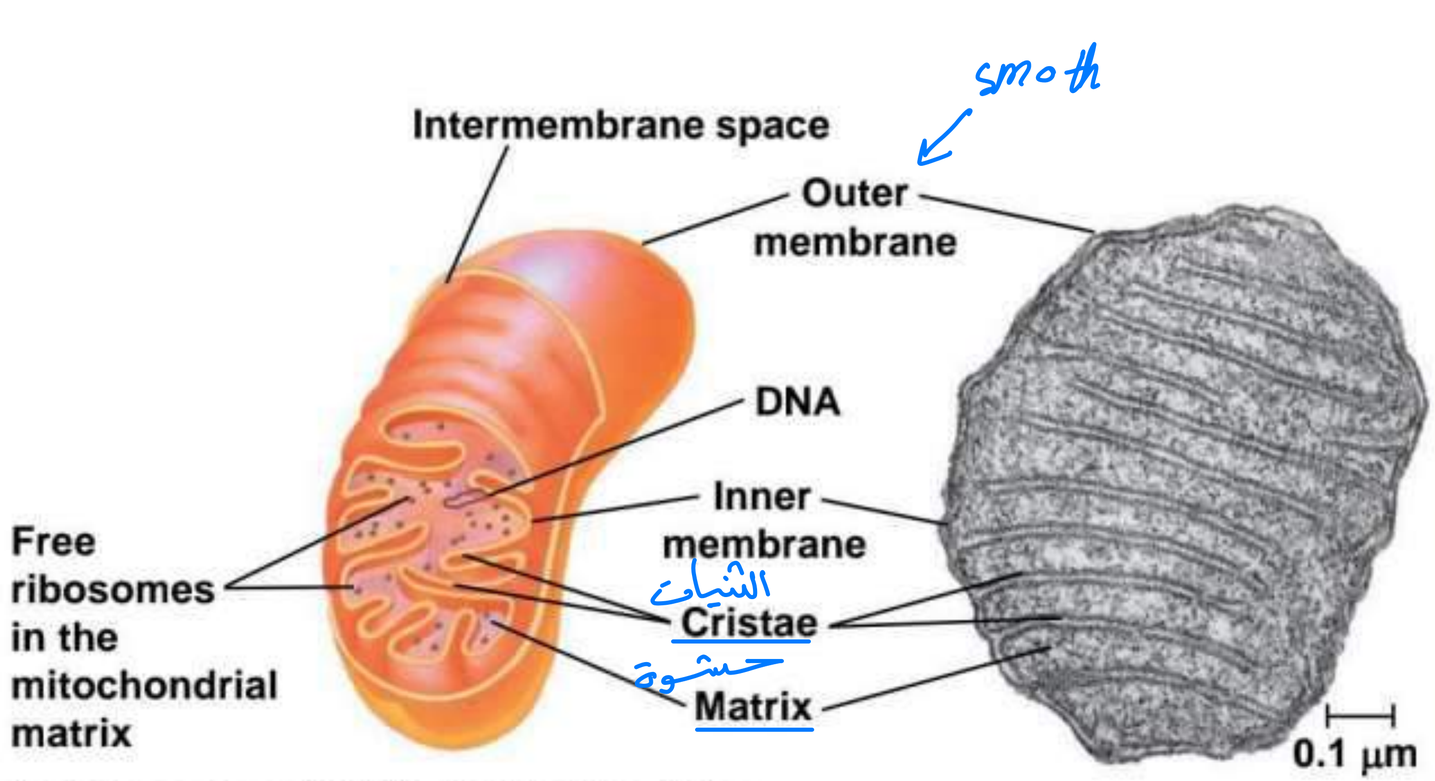
photosynthetic eukaryote

Mitochondria: Chemical Energy Conversion

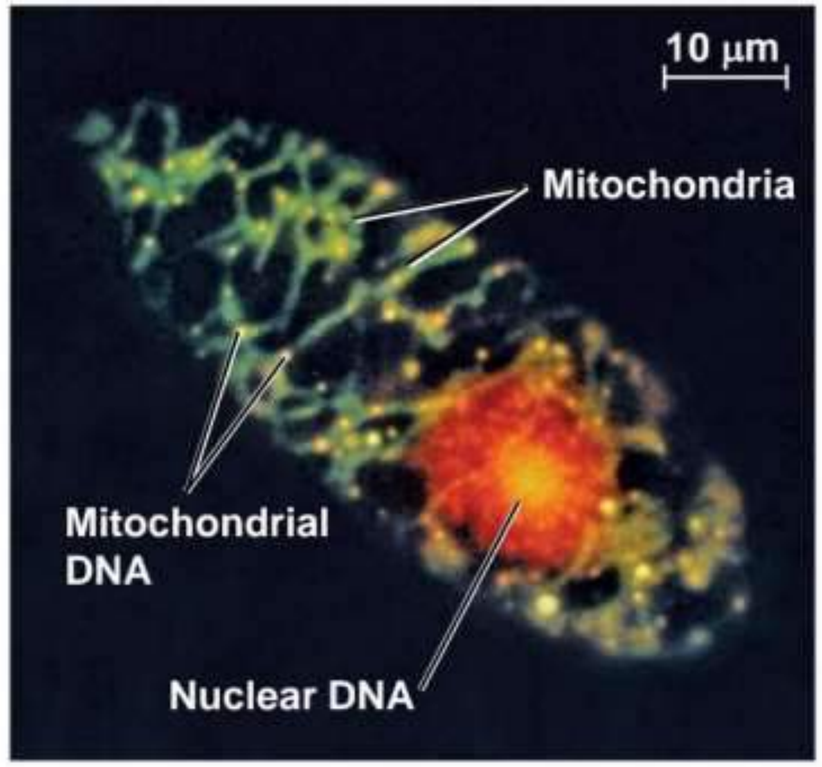
- Mitochondria are in nearly all eukaryotic cells
- They have a smooth outer membrane and an inner membrane folded into **cristae**
- The inner membrane creates two compartments: intermembrane space and **mitochondrial matrix**
- Some metabolic steps of cellular respiration are catalyzed in the mitochondrial matrix
- Cristae present a large surface area for enzymes that synthesize ATP

respiration: transfer energy from chemical energy stored in food to chemical energy stored in ATP molecules

Figure 6.17

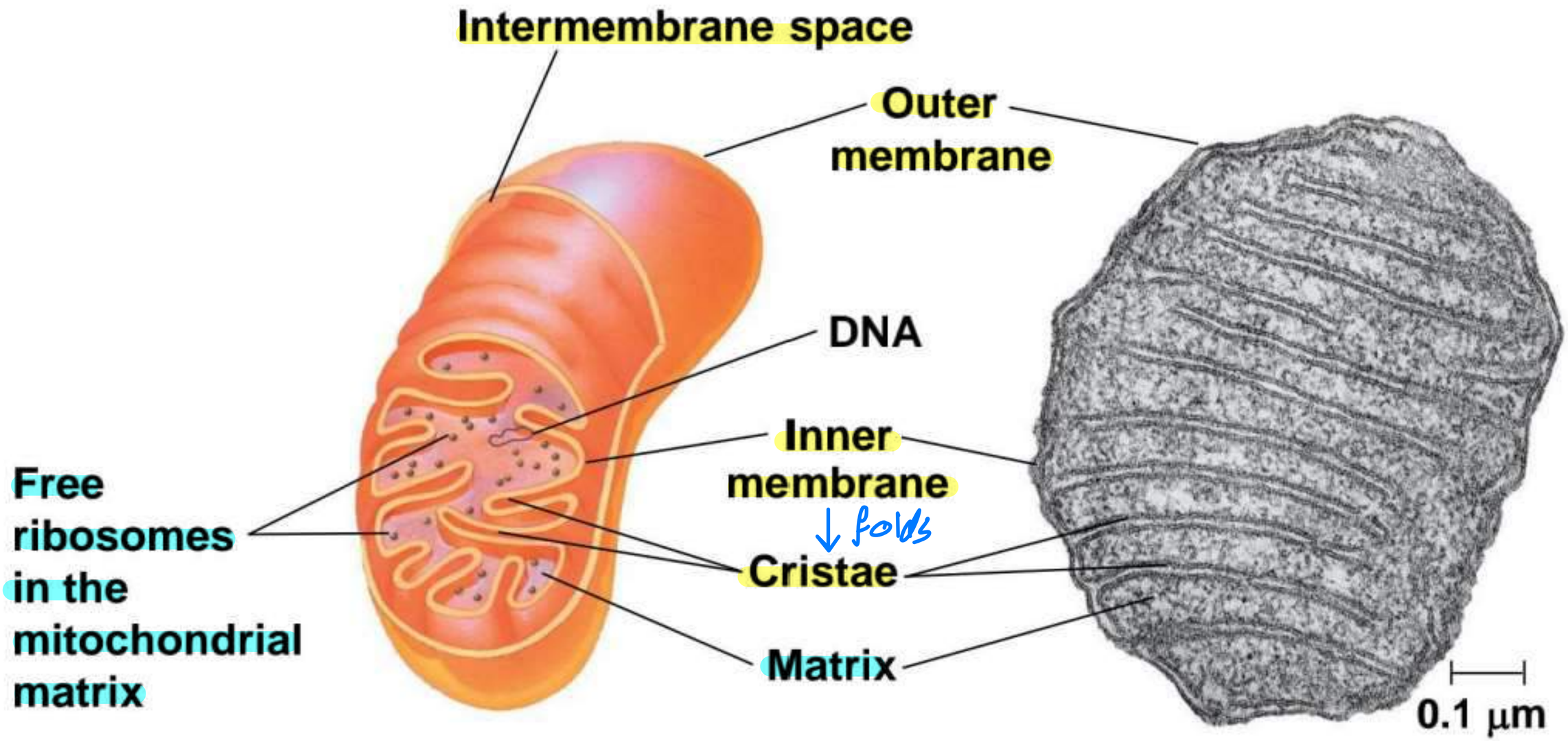


(a) Diagram and TEM of mitochondrion



(b) Network of mitochondria in a protist cell (LM)

Figure 6.17a



(a) Diagram and TEM of mitochondrion

Chloroplasts: Capture of Light Energy

- Chloroplasts contain the green pigment chlorophyll, as well as enzymes and other molecules that function in photosynthesis
- Chloroplasts are found in leaves and other green organs of plants and in algae

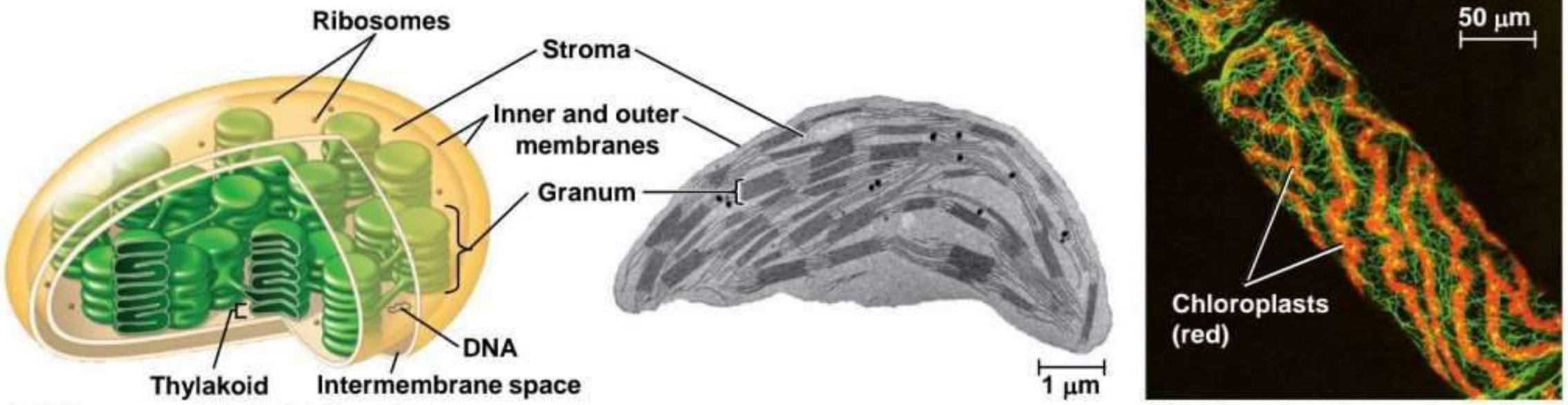
Kinds of plastids:

1) Chloroplasts: green color because of chlorophyll
   function: photosynthesis
2) chromoplasts: to attract insects for pollination (colored)
3) leucoplasts (Amyloplasts). storage

photosynthesis: transfer the energy from light energy to chemical energy stored in food

- Chloroplast structure includes
  - **Thylakoids**, membranous sacs, stacked to form a **granum**
  - **Stroma**, the internal fluid
- The chloroplast is one of a group of plant organelles, called **plastids**

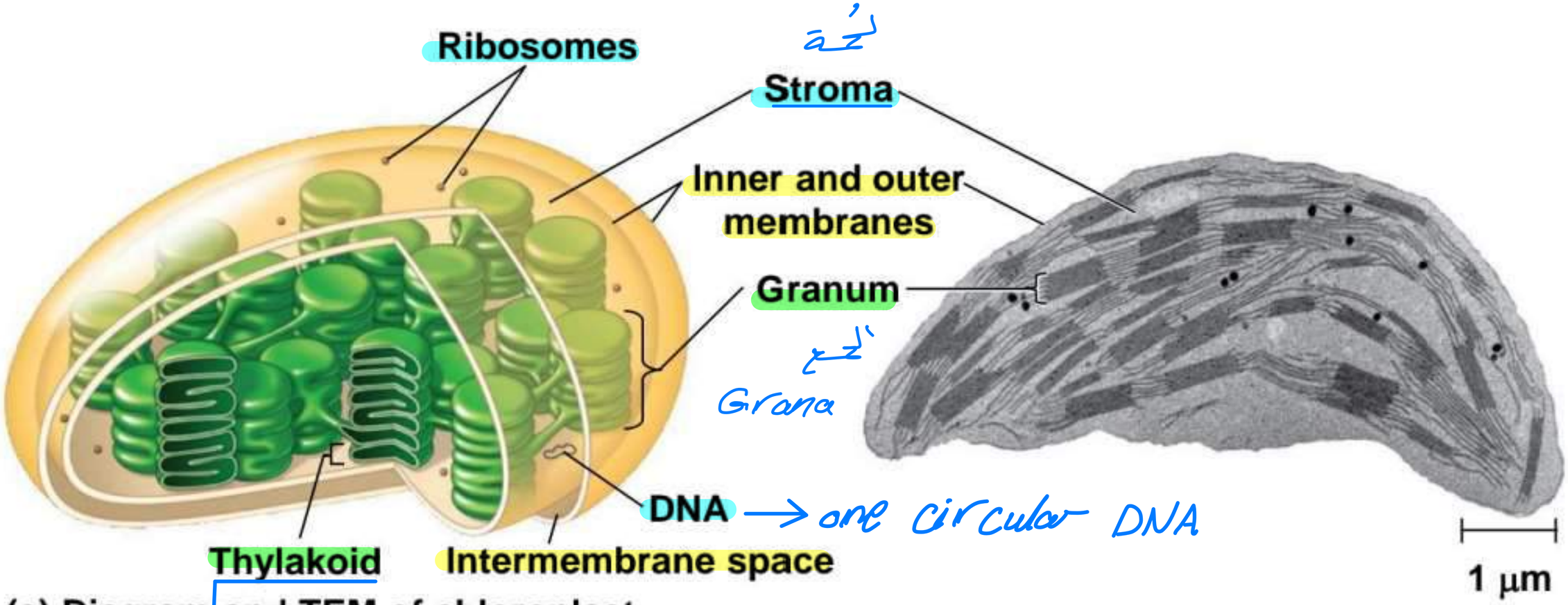
Figure 6.18



(a) Diagram and TEM of chloroplast

(b) Chloroplasts in an algal cell

Figure 6.18a



(a) Diagram and TEM of chloroplast

اعتبره غشاء ثالث
وهو اللي لونه اخضر
في البلاستيدة

The chlorophyll pigment is on the thylakoid membrane

Peroxisomes: Oxidation

contains hydrolytic enzymes

the difference between it and the Lysosomes

- **Peroxisomes** are specialized metabolic compartments bounded by a single membrane
- Peroxisomes produce hydrogen peroxide and convert it to water

H_2O_2 يسبب الحروق — موجود في صبغات الشعر (ما يسمى الاكسجين)

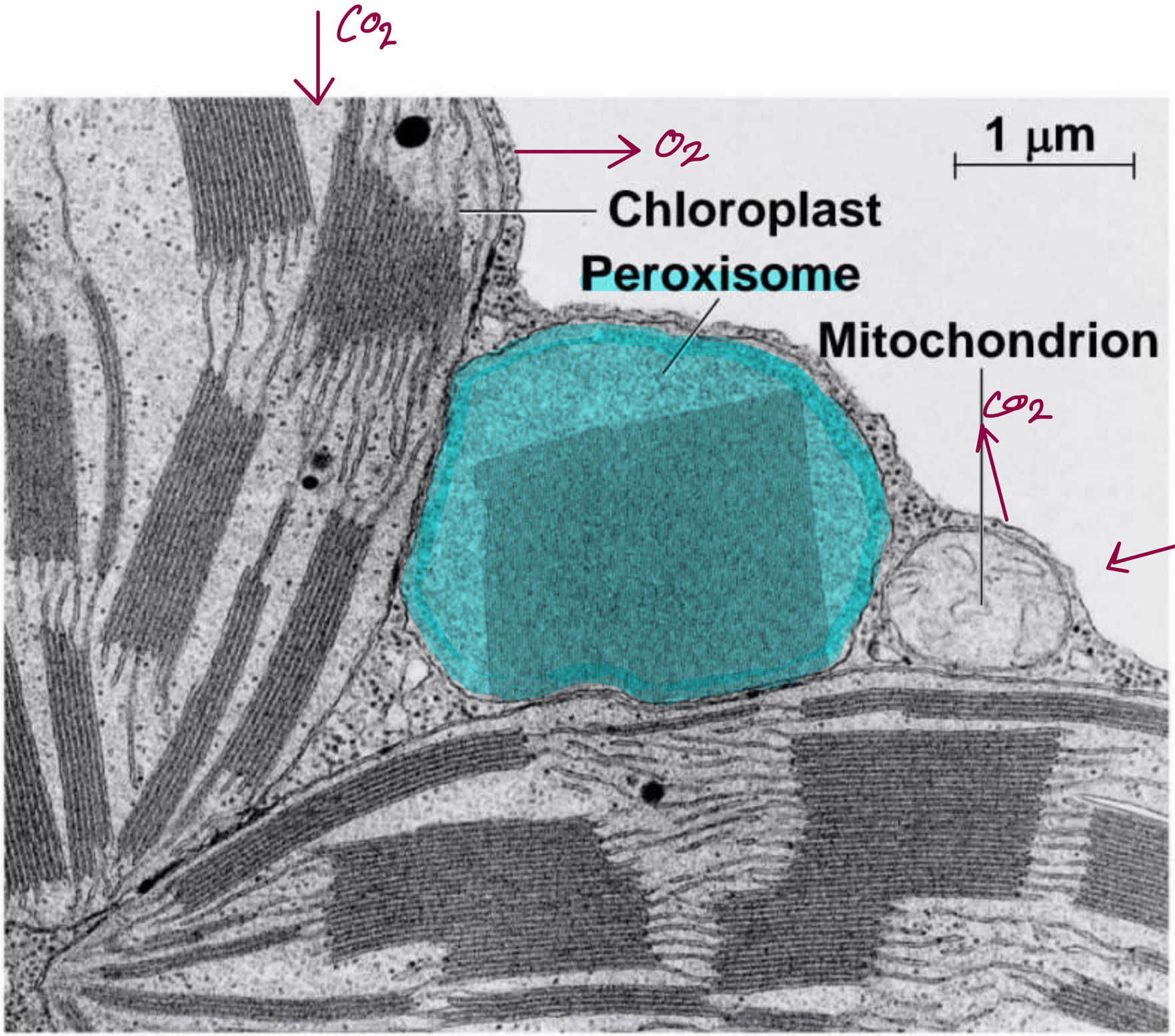
- Peroxisomes perform reactions with many different functions
- How peroxisomes are related to other organelles is still unknown

يخرب ضار

$$H_2O_2 \xrightarrow{\text{catalase}} H_2O + O_2$$

H_2O_2: byproduct from oxygen.

Figure 6.19



functions of Peroxisome:

1) Catalyses hydrogen peroxide (H_2O_2)

$$H_2O_2 \longrightarrow H_2O + O_2$$

---

2) Transfer lipids to carbohydrates for a fast source of energy

lipids	carbs
high source of energy but slow	lower source of energy but fast

---

3) Glyoxysomes: found in plants seedlings

بذرة النبات تحتوي على الجنين (embryo) بحيث ينمو مع الماء و تحتوي ايضا على دهون مخزنة داخلها و يقوم ال glyoxysomes بتحويل الدهون الى كربوهيدرات لانها مصدر طاقة سريع

Concept 6.6: The cytoskeleton is a network of fibers that organizes structures and activities in the cell

proteins

- The **cytoskeleton** is a network of fibers extending throughout the cytoplasm
- It organizes the cell's structures and activities, anchoring many organelles

تثبيت

- It is composed of three types of molecular structures
  - Microtubules
  - Microfilaments
  - Intermediate filaments

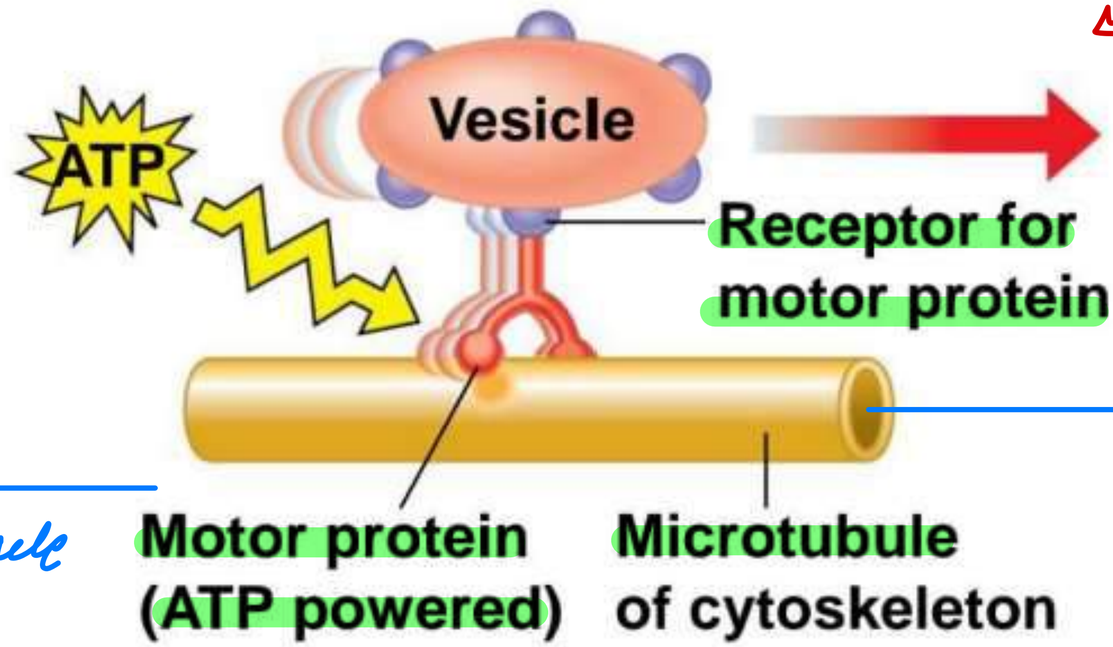
All are proteins but differ in:
1) diameter of the fiber
2) kind of protein

Roles of the Cytoskeleton: Support and Motility

- The cytoskeleton helps to support the cell and maintain its shape
- It interacts with **motor proteins** to produce motility
- Inside the cell, vesicles can travel along "monorails" provided by the cytoskeleton
- Recent evidence suggests that the cytoskeleton may help regulate biochemical activities

Figure 6.21

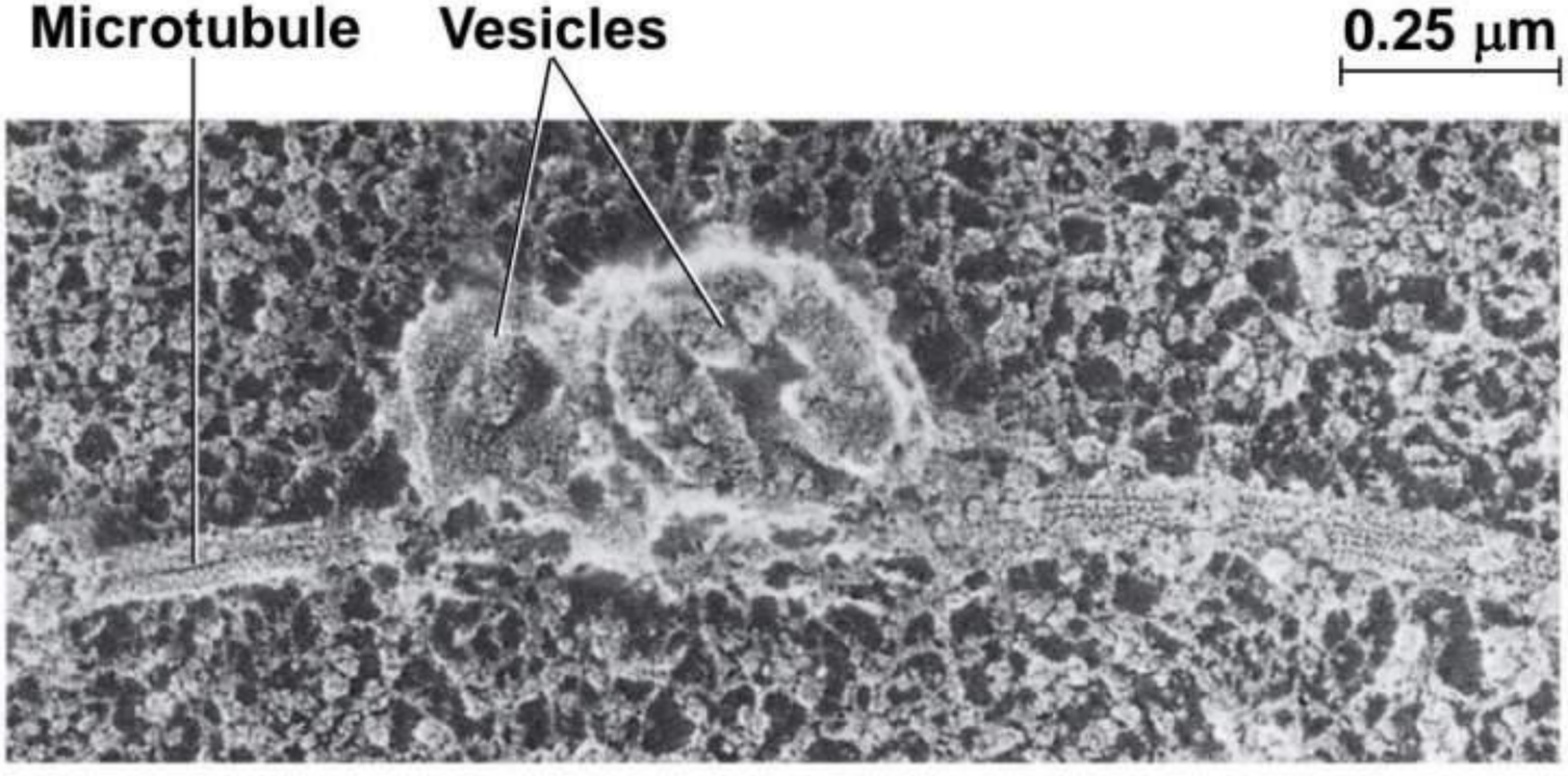
organelle movement in microtubules



يثبت حاله على ال microtubule وعليه مستقبلات للـ vesicle

يتحرك الشارع

(a)



(b)

Components of the Cytoskeleton

- Three main types of fibers make up the cytoskeleton
  - *Microtubules* are the thickest of the three components of the cytoskeleton
  - *Microfilaments*, also called actin filaments, are the thinnest components
  - *Intermediate filaments* are fibers with diameters in a middle range

Table 6.1

Table 6.1 The Structure and Function of the Cytoskeleton

Property	Microtubules (Tubulin Polymers)	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin, each a polymer of actin subunits	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, a dimer consisting of α-tubulin and β-tubulin	Actin	One of several different proteins (such as keratins), depending on cell type
Main functions	Maintenance of cell shape (compression-resisting "girders") Cell motility (as in cilia or flagella) Chromosome movements in cell division Organelle movements	Maintenance of cell shape (tension-bearing elements) Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility (as in pseudopodia) Cell division (cleavage furrow formation)	Maintenance of cell shape (tension-bearing elements) Anchorage of nucleus and certain other organelles Formation of nuclear lamina

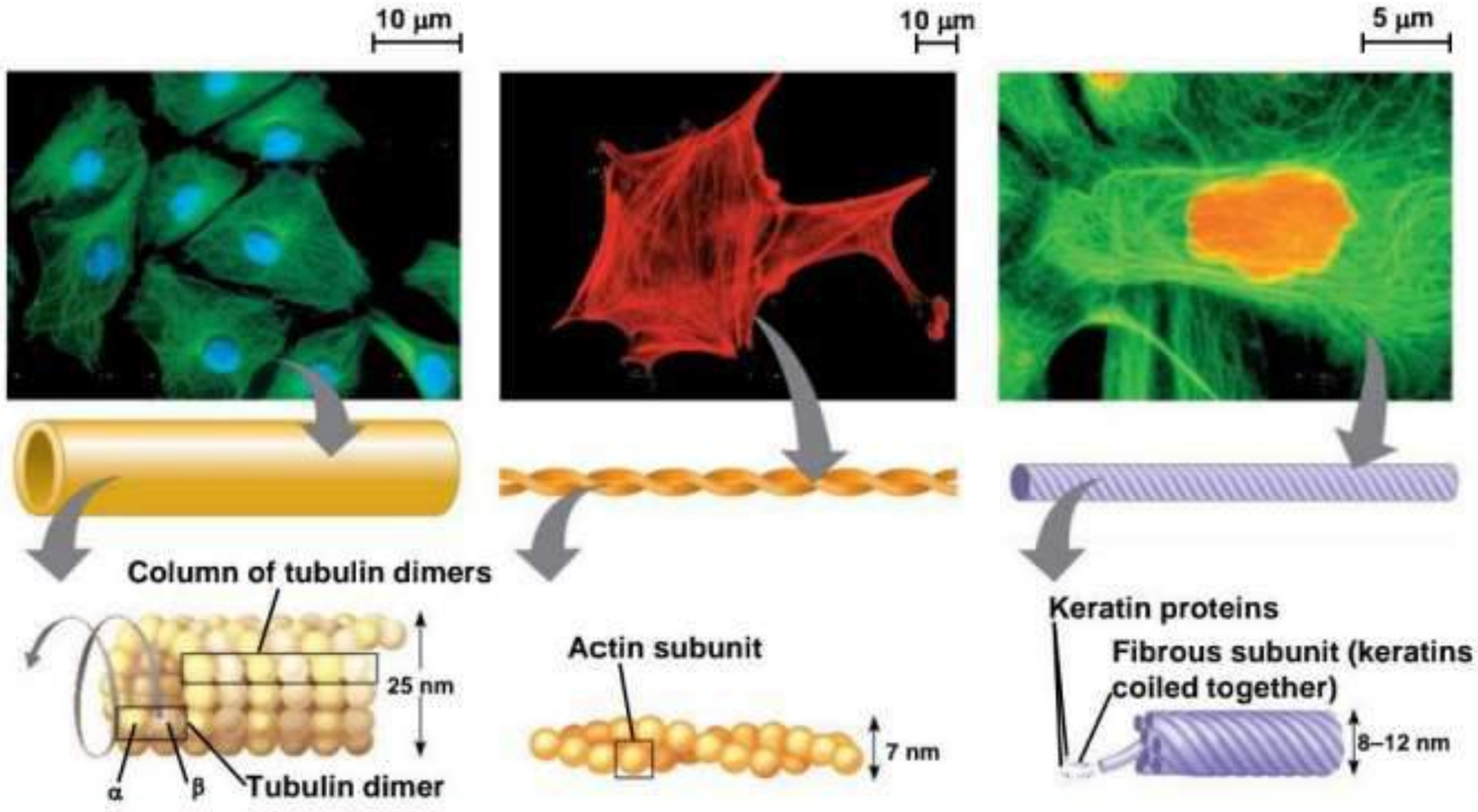


Table 6.1a

Property	Microtubules (Tubulin Polymers)
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules
Diameter	25 nm with 15-nm lumen
Protein subunits	Tubulin, a dimer consisting of α-tubulin and β-tubulin
Main functions	Maintenance of cell shape (compression-resisting "girders")
	Cell motility (as in cilia or flagella)
	Chromosome movements in cell division
	Organelle movements

فارغ / أجوف

حامل ← التجويف

centrosomes

vesicle movement

made of 2 polypeptides
α-tublin and β-tublin
Quaternary structure

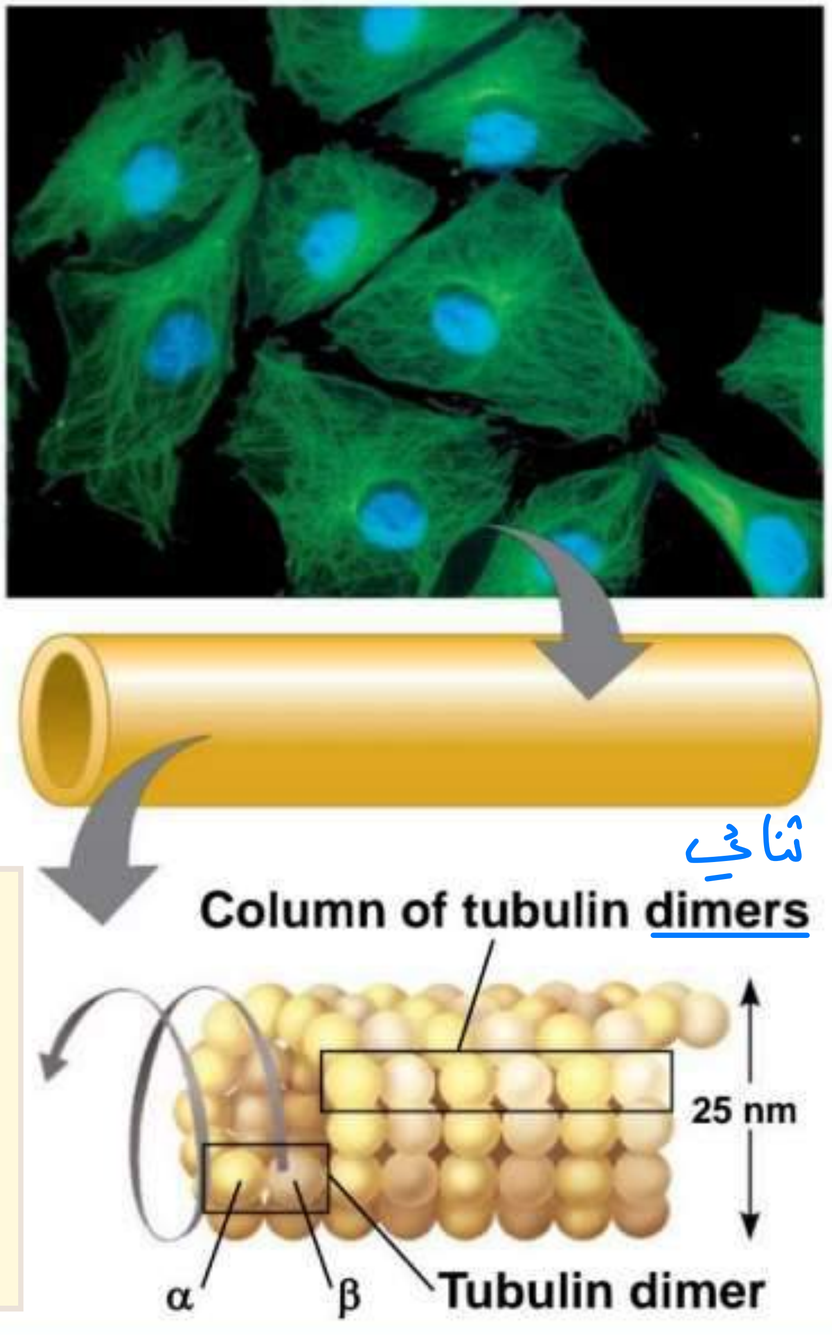
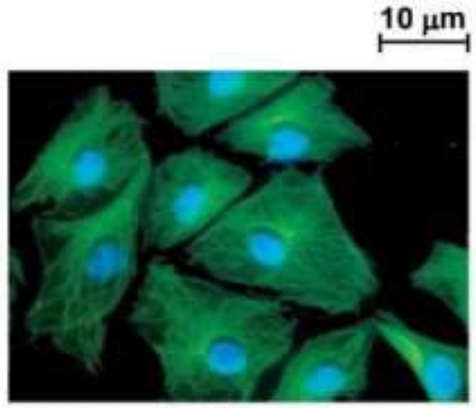


Table 6.1aa

عند عملية انفصال الخلية يتم فصل الكروموسومات الى كروماتيدين و ينتج (كروماتيدات ابنة)
بحيث كل واحدة منها تحتوي على نسخة من ال DNA و تتجه كل منها الى قطب من اقطاب الخلية
حيث يتواجد الجسمان المركزيان (كل جسم مركزي يتكون من مريكزان) عند طريق امتداد خيوط
مغزلية تتكون من (Microtubules) ترتبط بالكروماتيدات و تسحبها

زمن المخ بشد و بسحب



Microtubules

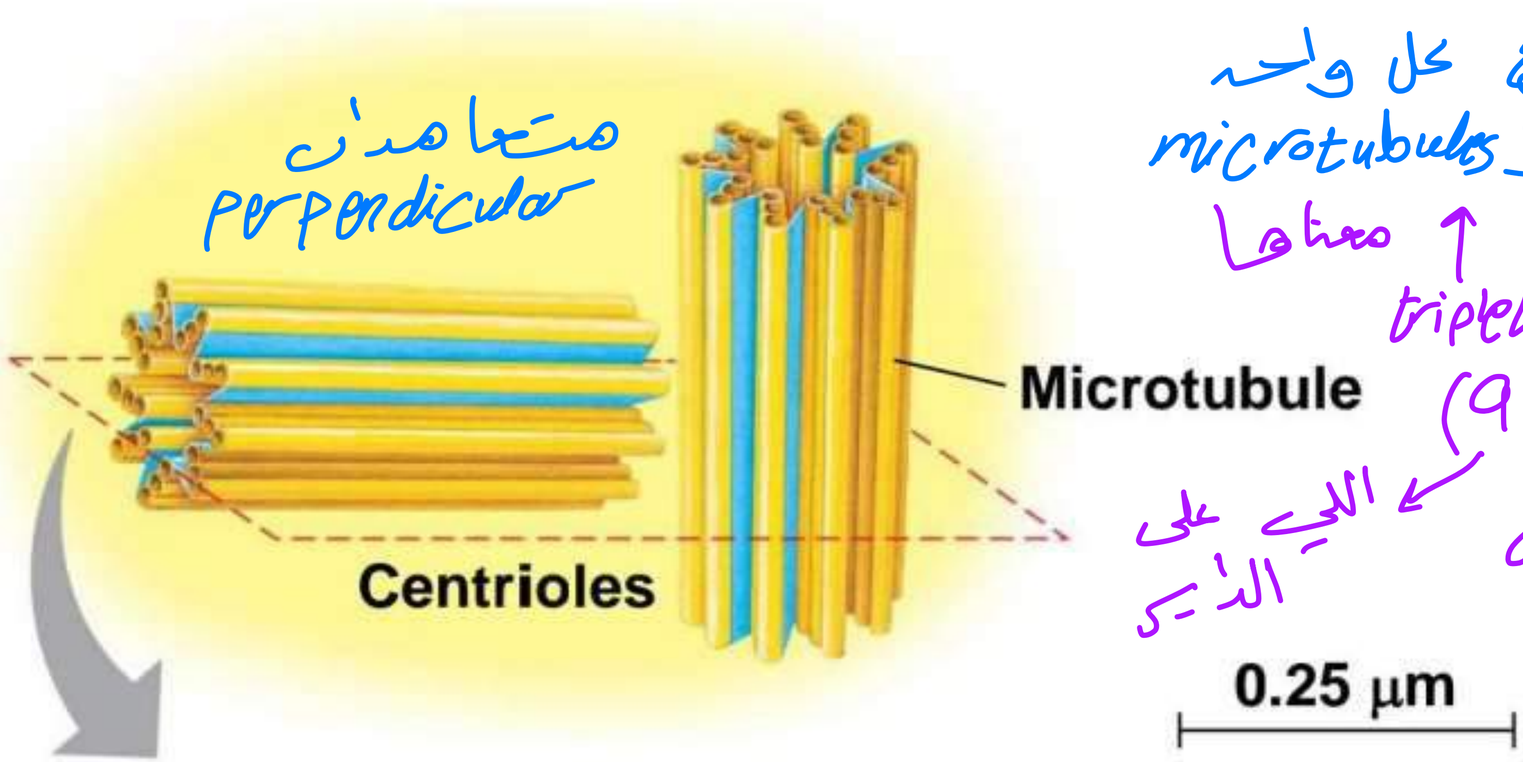
- **Microtubules** are hollow rods about 25 nm in diameter and about 200 nm to 25 microns long
- Functions of microtubules
  - Shaping the cell
  - Guiding movement of organelles
  - Separating chromosomes during cell division

has 2

Centrosomes and Centrioles

- In many cells, microtubules grow out from a **centrosome** near the nucleus
- The centrosome is a "microtubule-organizing center"
- In animal cells, the centrosome has a pair of **centrioles**, each with nine triplets of microtubules arranged in a ring

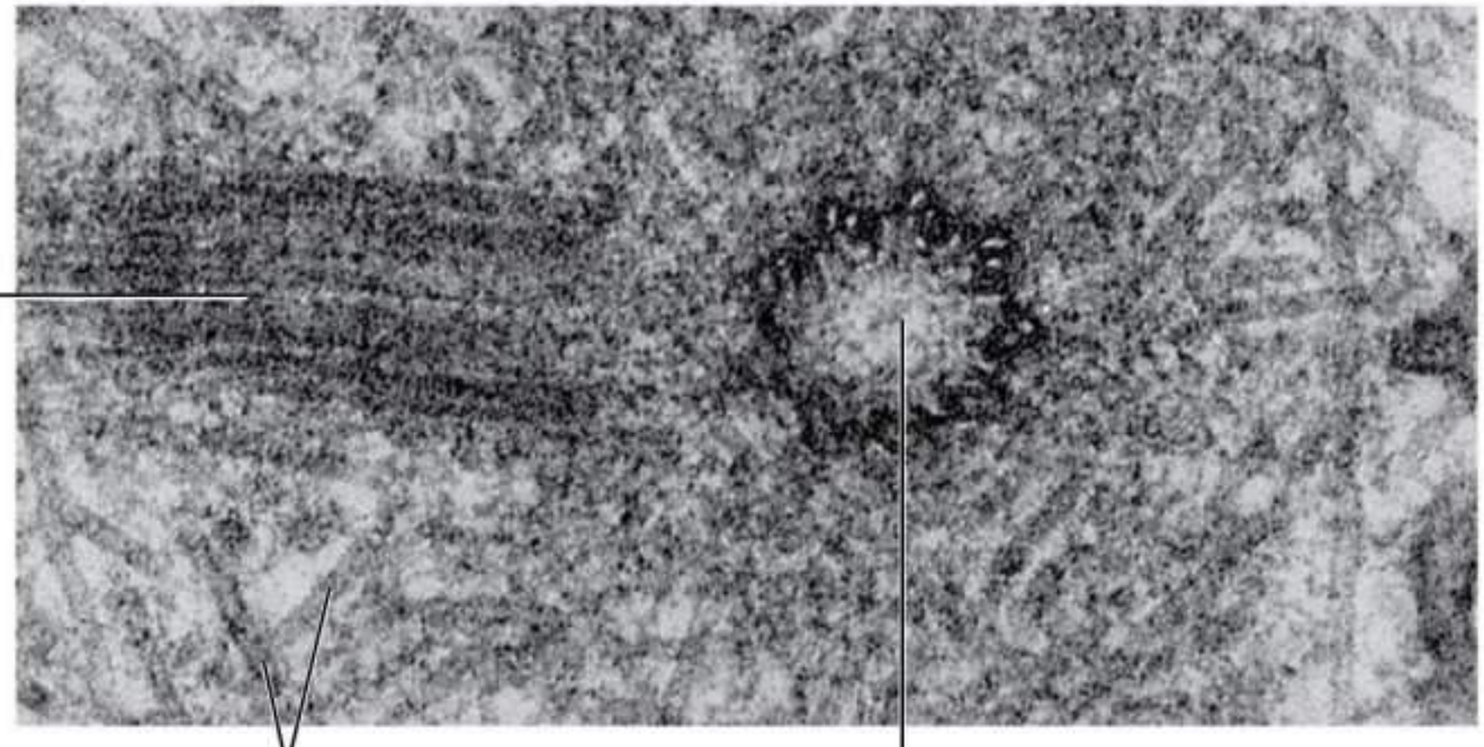
Figure 6.22



متعامدان
perpendicular

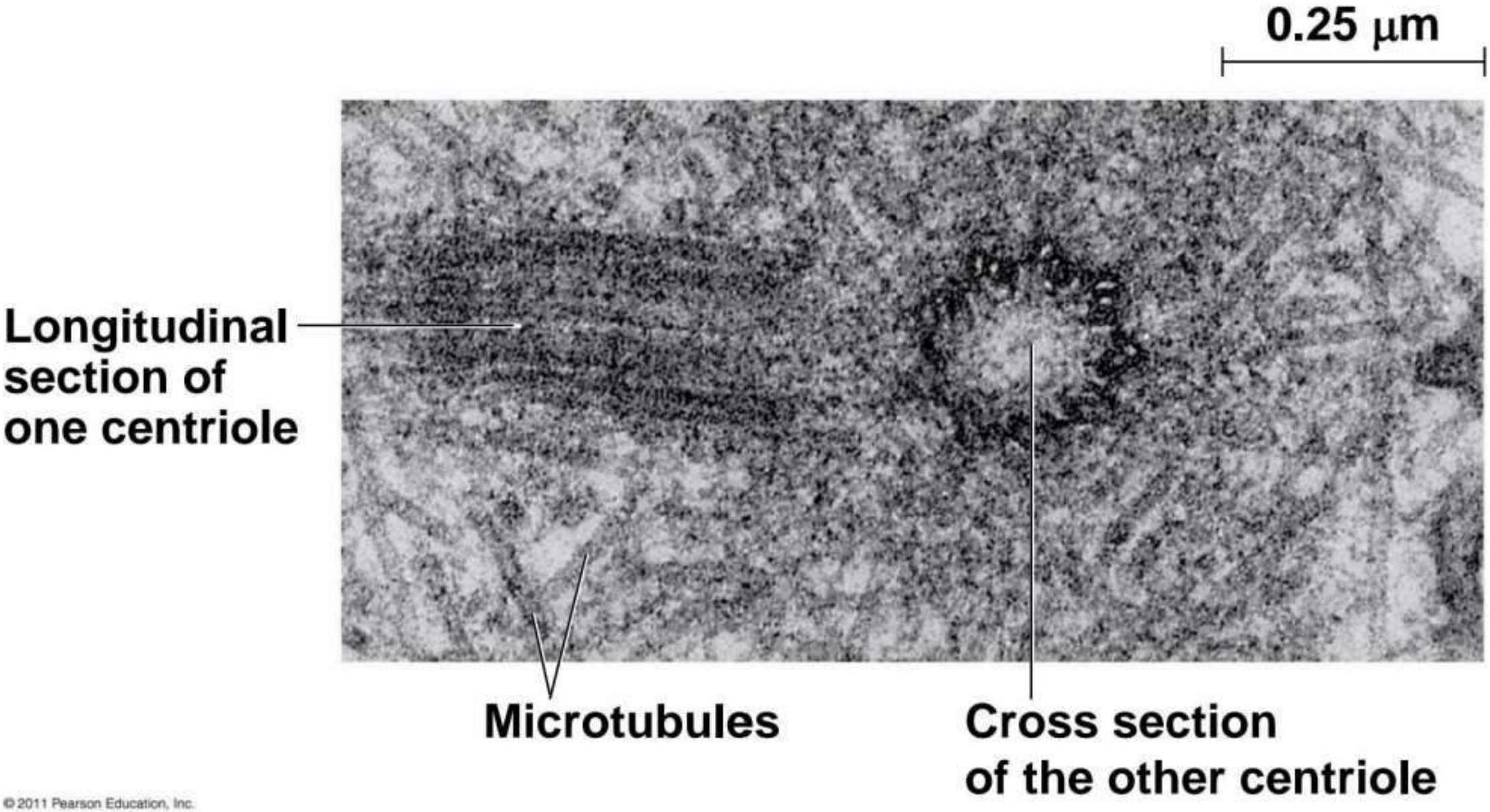
9 أذرع كل واحد
من 3 microtubules
معاها
triplets
(9+0)
اللي على الذيل
اللي بالنص

centrioles are only found in animal cells



centrosomes are found in both plant and animal cells but plant cells have a similar organelle to centrioles

Figure 6.22a



same structure

Cell motility in microtubules

Cilia and Flagella

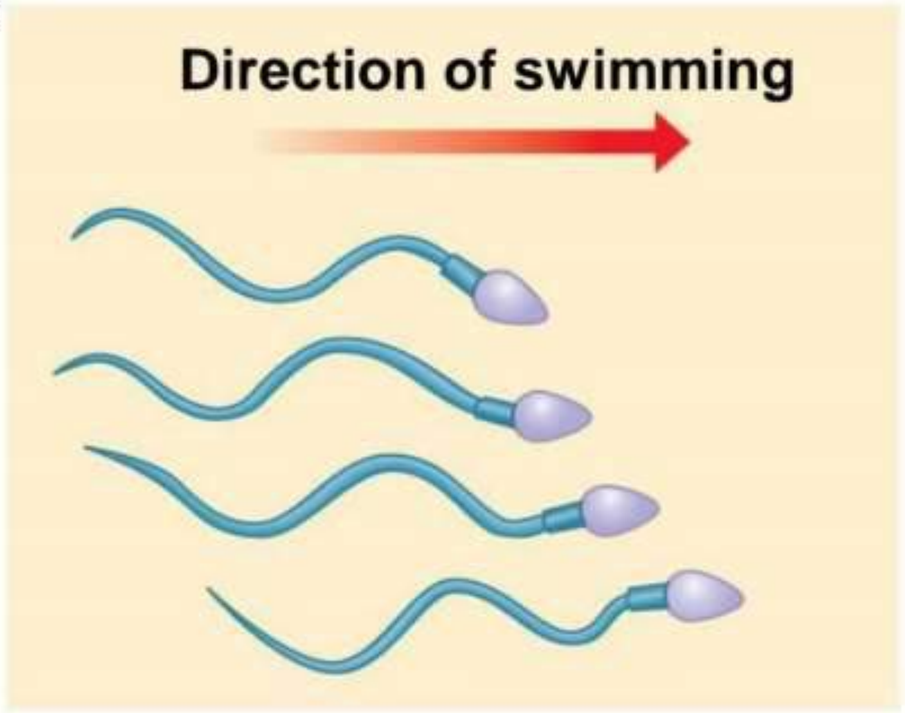
- Microtubules control the beating of **cilia** and **flagella**, locomotor appendages of some cells
- Cilia and flagella differ in their beating patterns

العدد	الكثر	أقل
الطول	أقصر	أطول
الحركة	عكس اتجاه حركة الخلية زي القارب	نفس اتجاه الحركة سباحة عادية

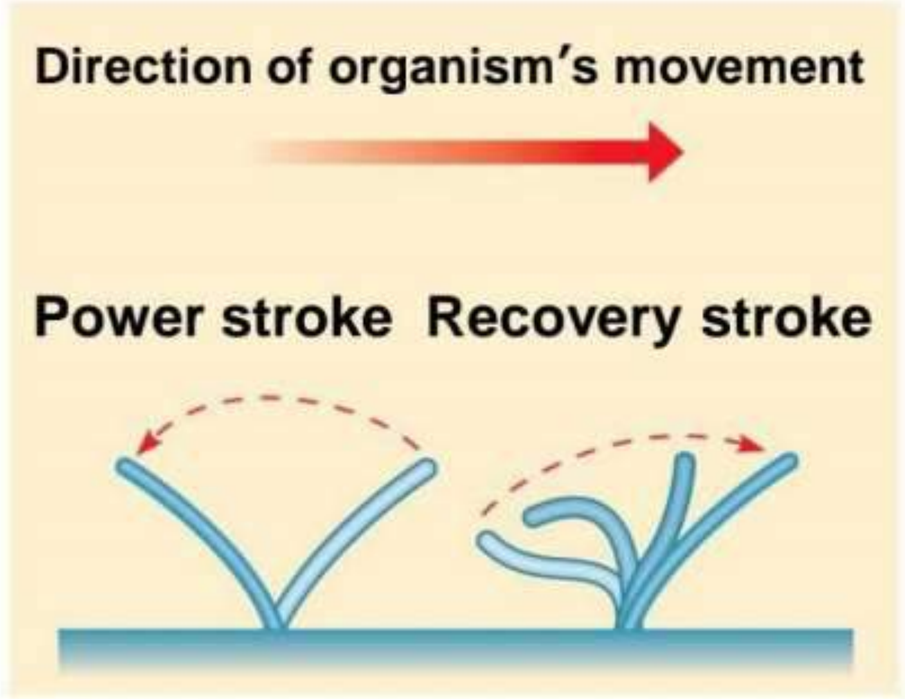
PLAY Video: *Chlamydomonas*

PLAY Video: *Paramecium* Cilia

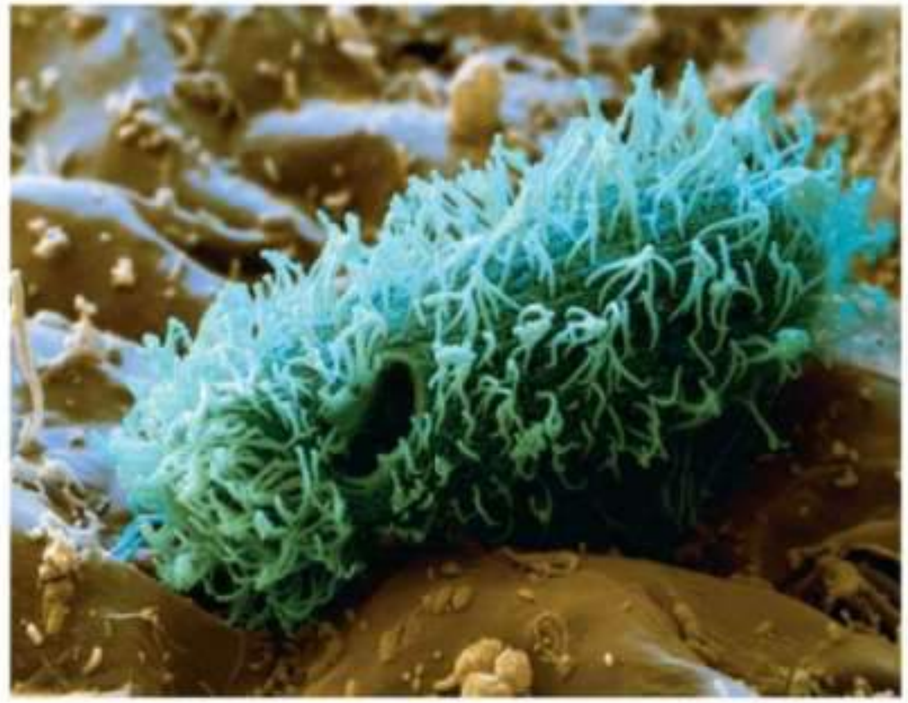
Figure 6.23



(a) Motion of flagella



(b) Motion of cilia



- Cilia and flagella share a common structure
  - A core of microtubules sheathed by the plasma membrane → الجزء الحر
  - A **basal body** that anchors the cilium or flagellum → الجزء المثبت في الخلية
  - A motor protein called **dynein**, which drives the bending movements of a cilium or flagellum

PLAY Animation: Cilia and Flagella

- How dynein "walking" moves flagella and cilia
  - Dynein arms alternately grab, move, and release the outer microtubules
  - Protein cross-links limit sliding
  - Forces exerted by dynein arms cause doublets to curve, bending the cilium or flagellum

Figure 6.24

Microtubules

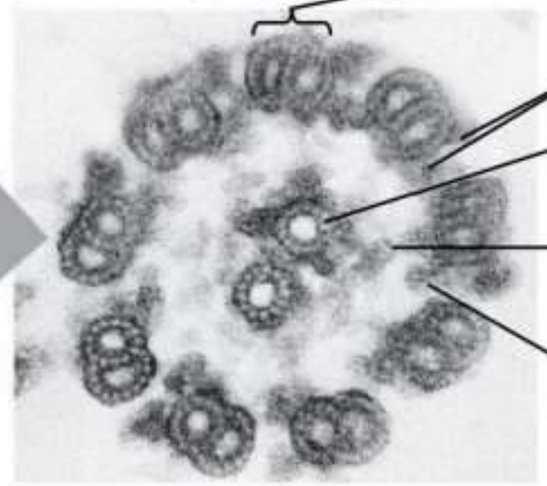
Plasma membrane

Basal body

0.5 μm

(a) Longitudinal section of motile cilium

0.1 μm



(b) Cross section of motile cilium

Outer microtubule doublet

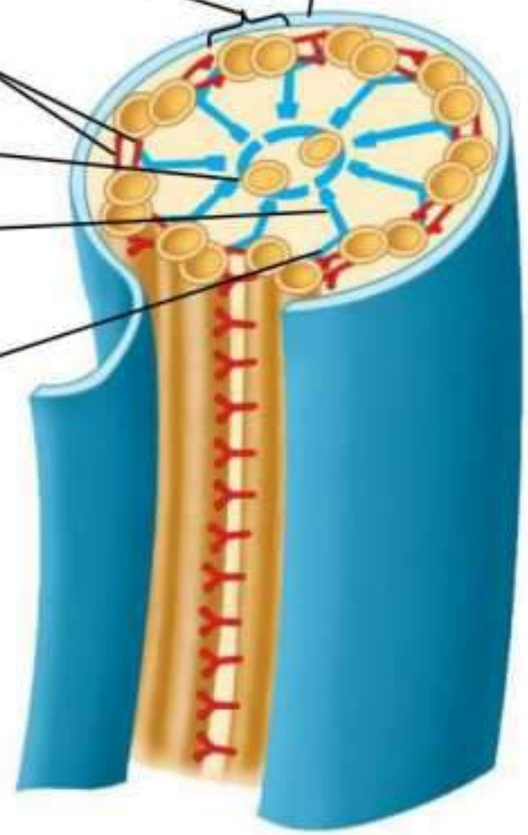
Dynein proteins

Central microtubule

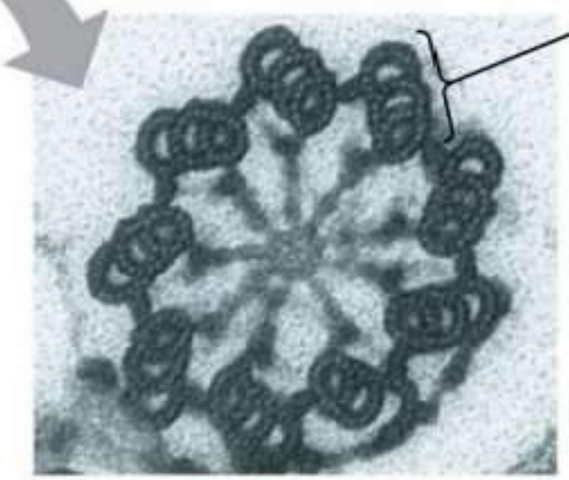
Radial spoke

Cross-linking proteins between outer doublets

Plasma membrane



0.1 μm



(c) Cross section of basal body

Triplet

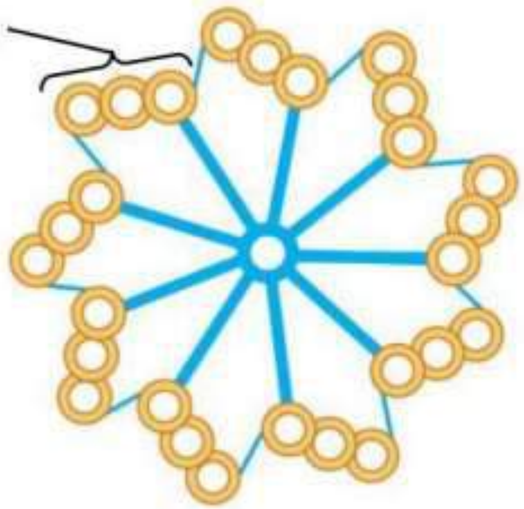
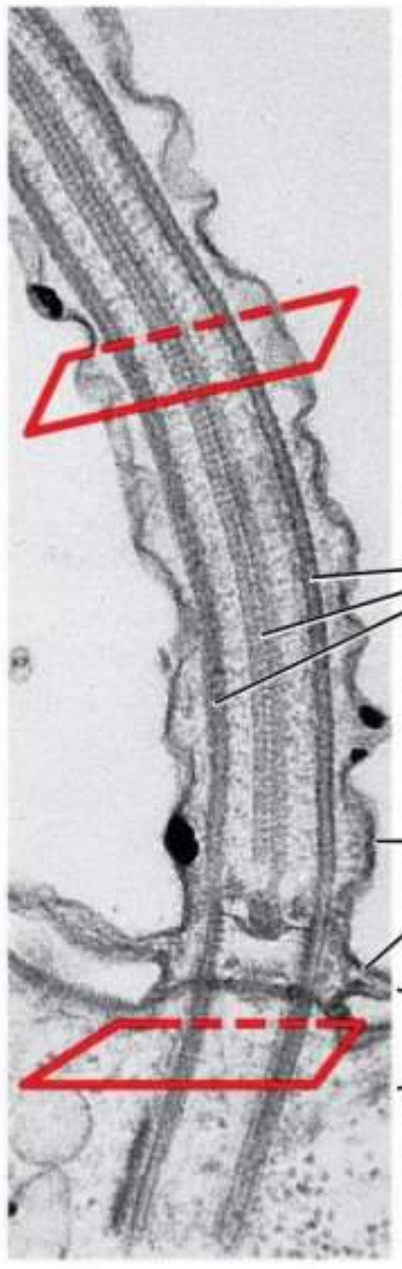


Figure 6.24a



Microtubules

Plasma membrane

جسم قاعدي

Basal body

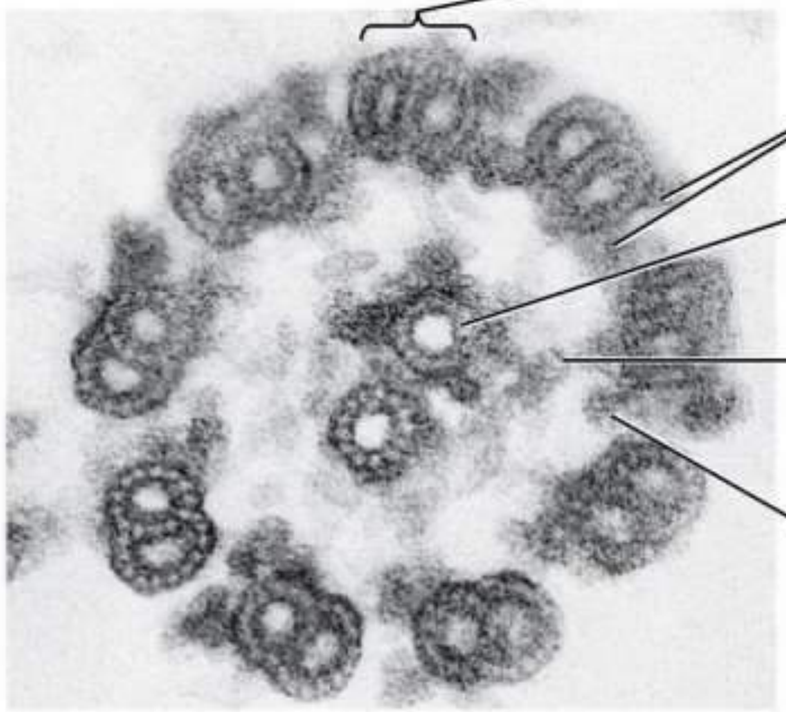
يشبتها بالخلية

attached to the plasma membrane

0.5 μm

(a) Longitudinal section of motile cilium

Figure 6.24b



(b) Cross section of motile cilium

The free part

Outer microtubule doublet

motor protein

Dynein proteins

Central microtubule

Radial spoke

Cross-linking proteins between outer doublets

doublets (9+2)

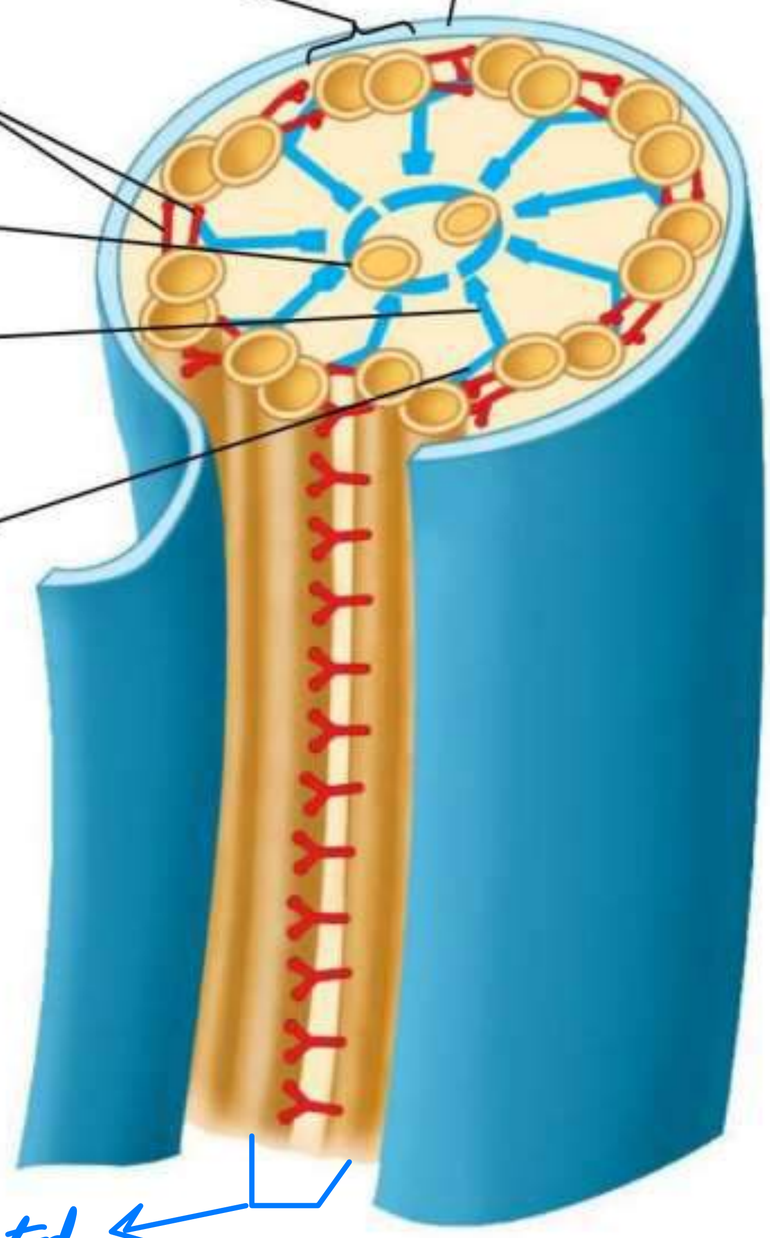
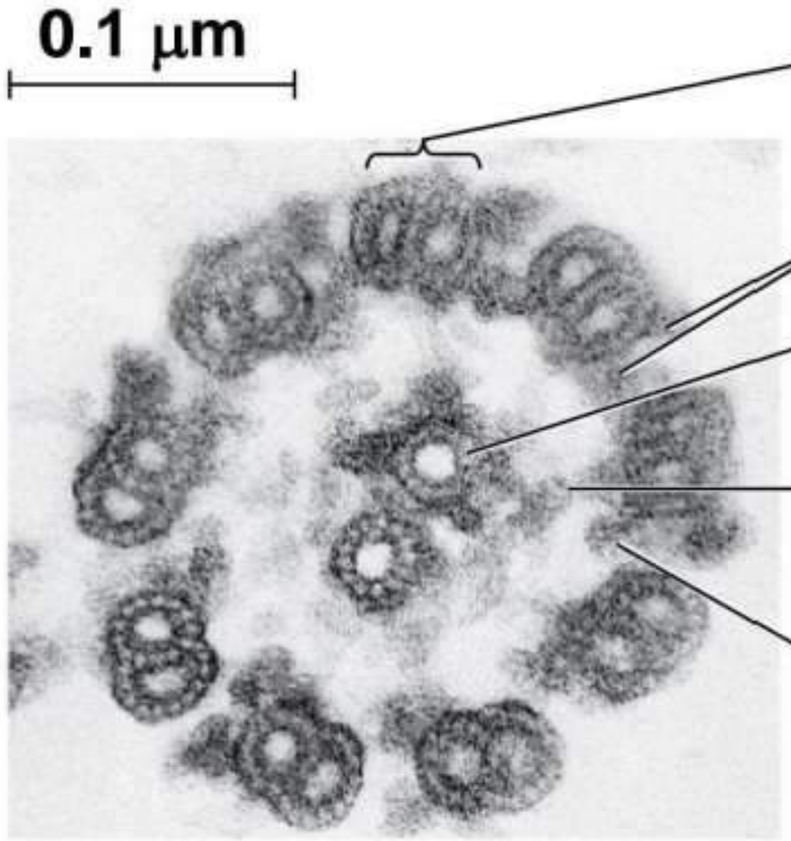
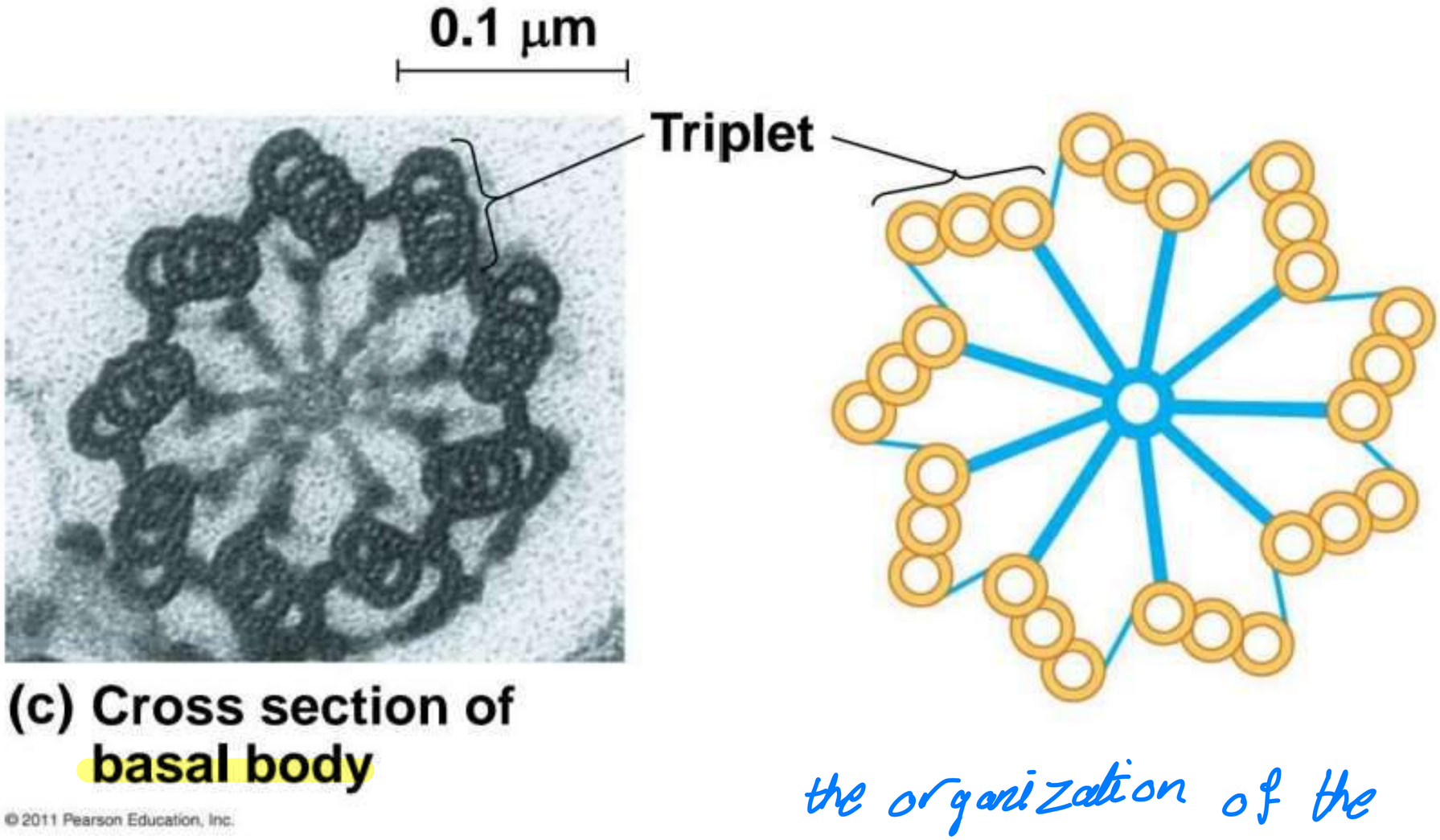


Figure 6.24ba



(b) Cross section of motile cilium

Figure 6.24c



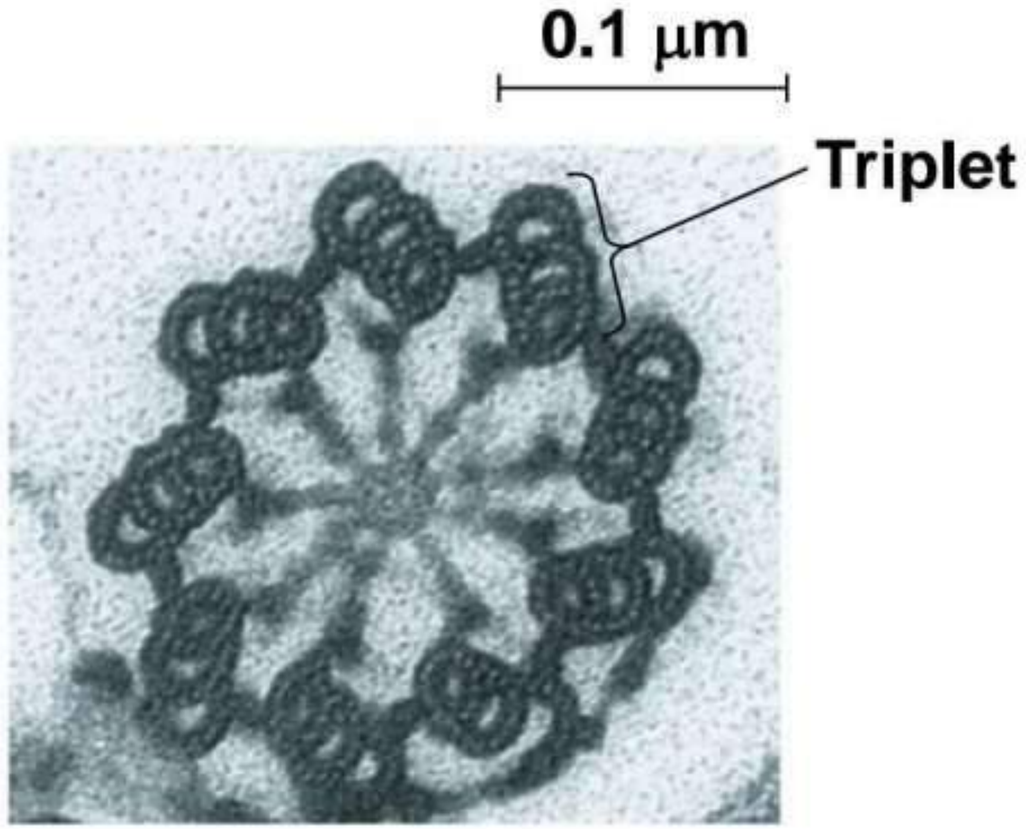
(c) Cross section of basal body

triplets
(9+0)

the organization of the microtubules in the basal body is the same in the centrioles

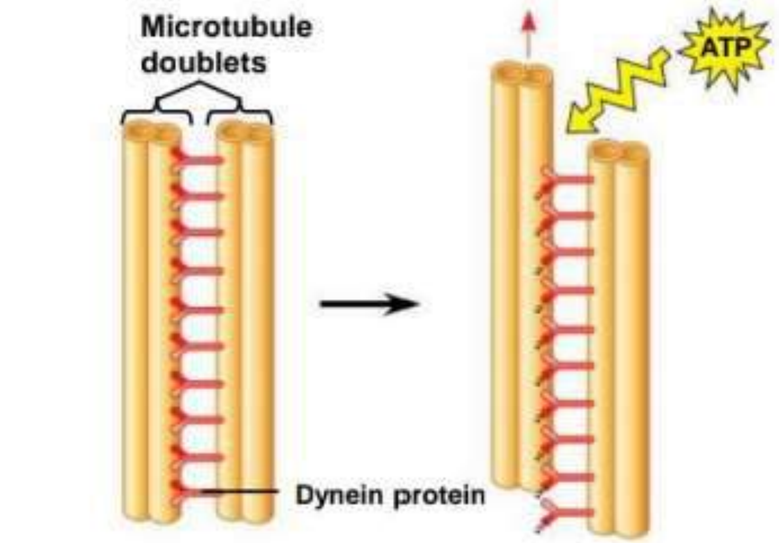
same origin

Figure 6.24ca

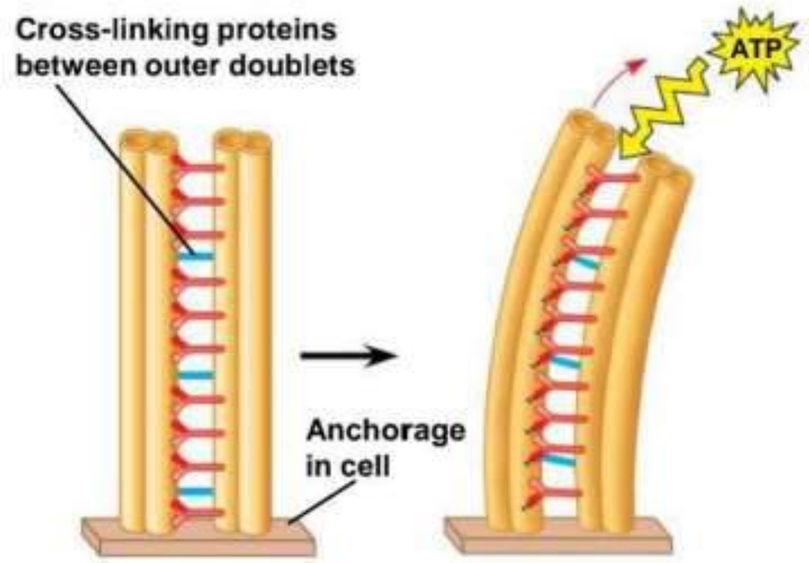


(c) Cross section of basal body

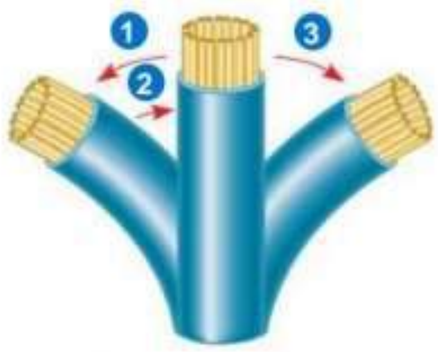
Figure 6.25



(a) Effect of unrestrained dynein movement

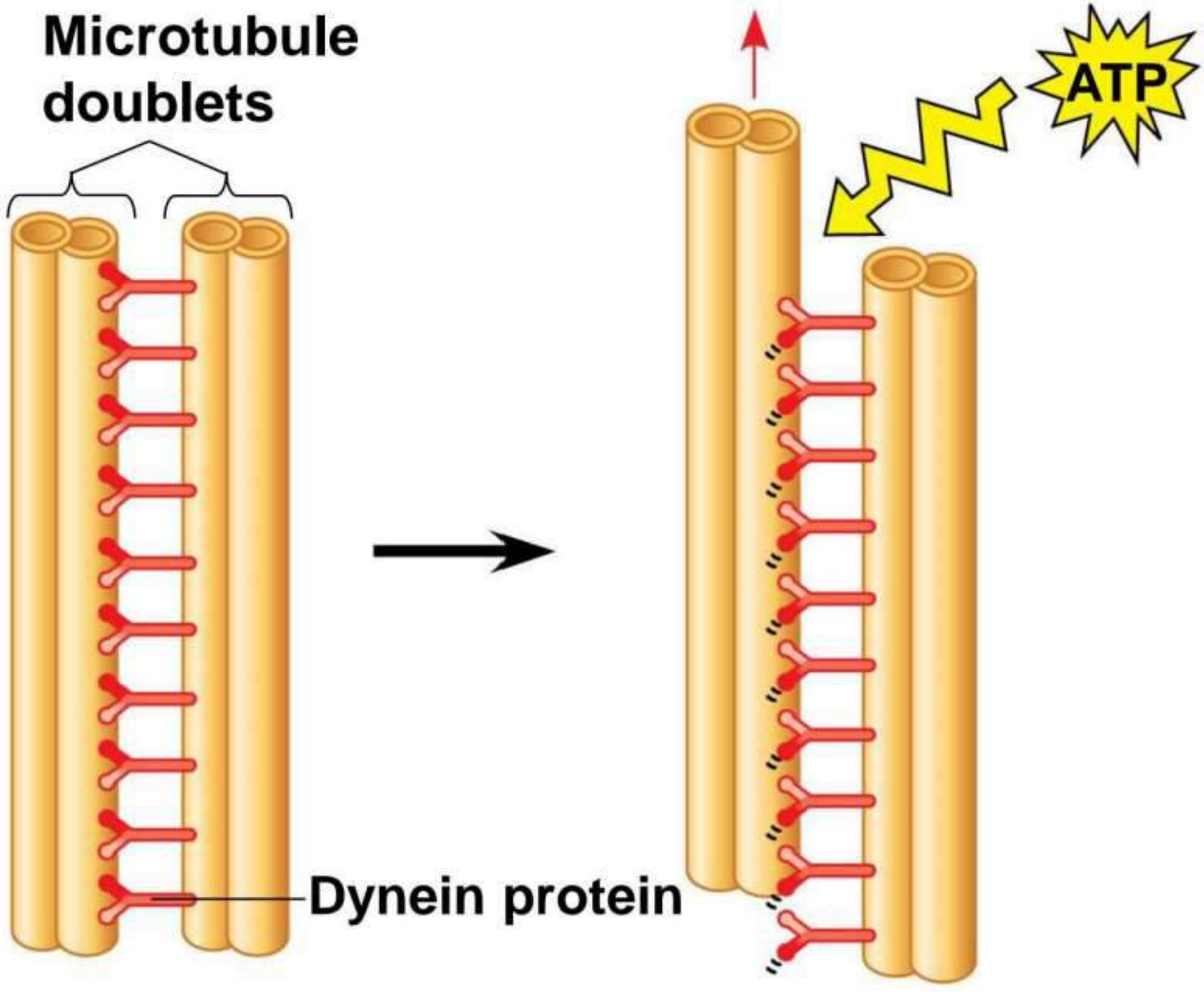


(b) Effect of cross-linking proteins



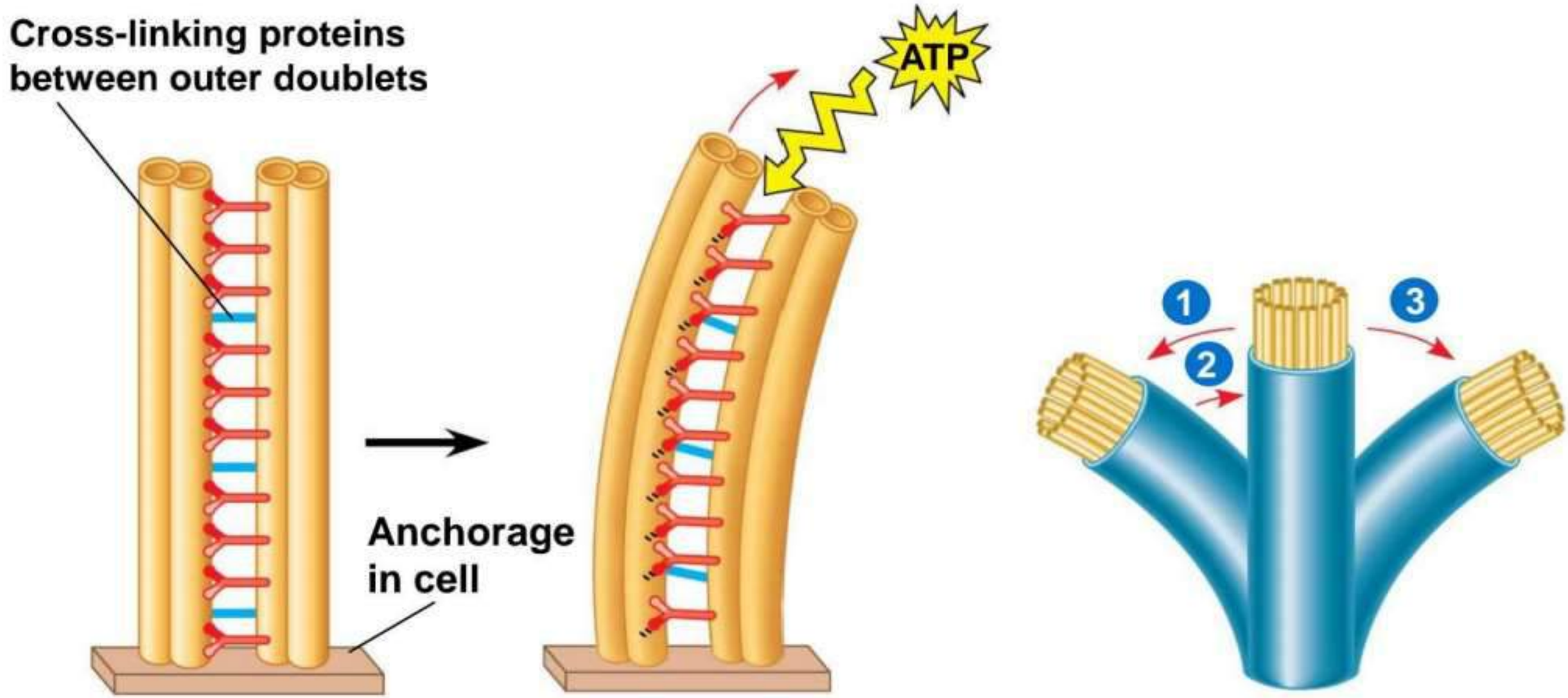
(c) Wavelike motion

Figure 6.25a



(a) Effect of unrestrained dynein movement

Figure 6.25b



(b) Effect of cross-linking proteins

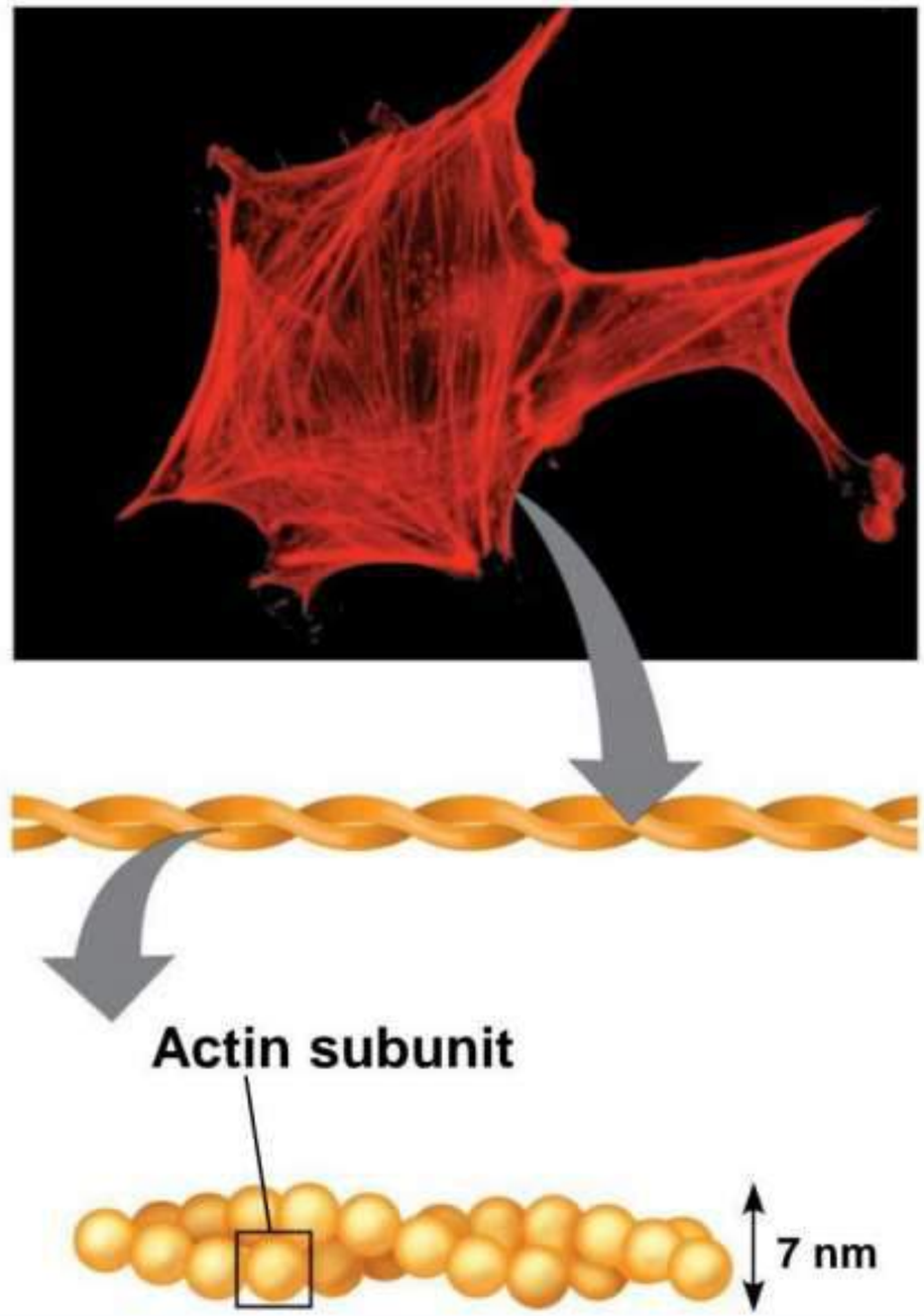
(c) Wavelike motion

Table 6.1b

Property	Microfilaments (Actin Filaments)
Structure	Two intertwined strands of actin, each a polymer of actin subunits
Diameter	7 nm
Protein subunits	Actin
Main functions	Maintenance of cell shape (tension-bearing elements)
	Changes in cell shape
	Muscle contraction
	Cytoplasmic streaming
	Cell motility (as in pseudopodia)
	Cell division (cleavage furrow formation)

same

اقدام كاذبة
يعني كل صورة تتكون
فيها عهة



Microfilaments (Actin Filaments)

- **Microfilaments** are solid rods about 7 nm in diameter, built as a twisted double chain of **actin** subunits
- The structural role of microfilaments is to bear tension, resisting pulling forces within the cell
- They form a 3-D network called the **cortex** just inside the plasma membrane to help support the cell's shape

تحت الغشاء موجودة

- Bundles of microfilaments make up the core of microvilli of intestinal cells

خلايا

Figure 6.26

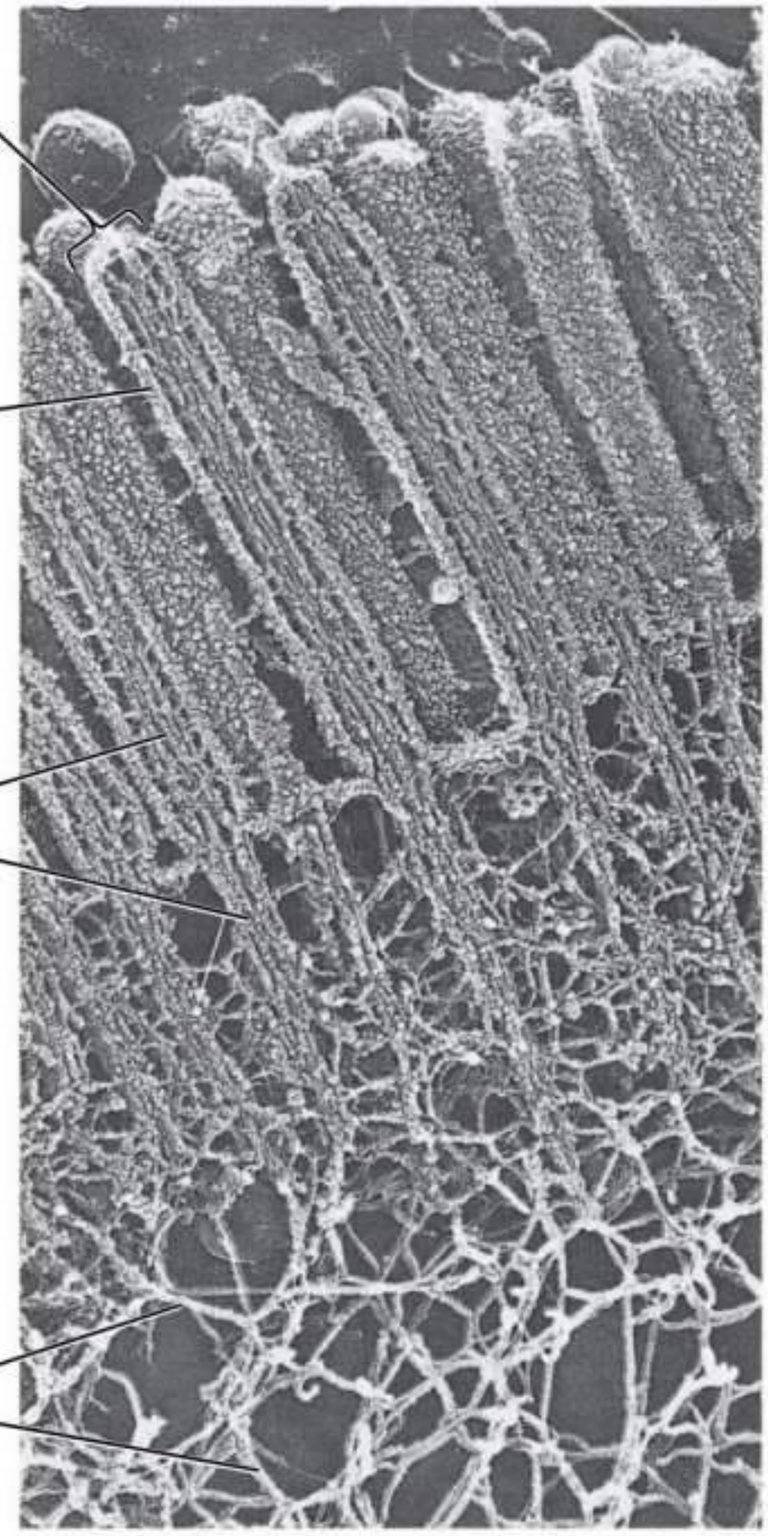
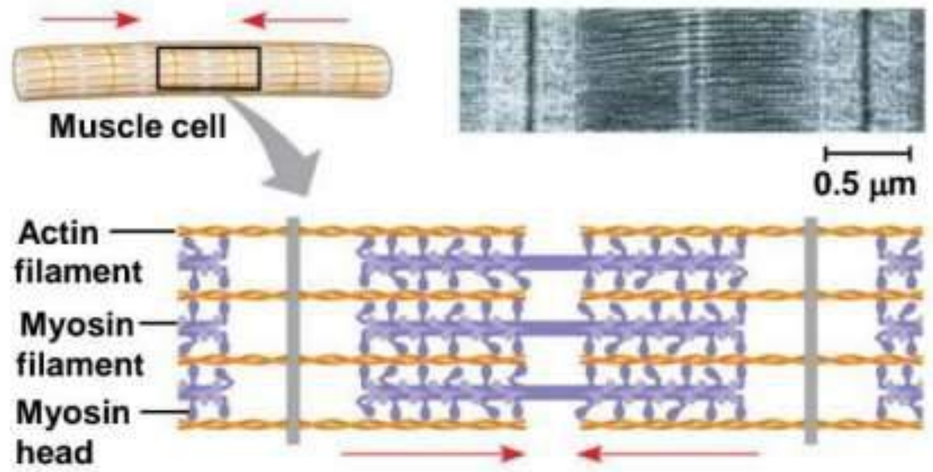
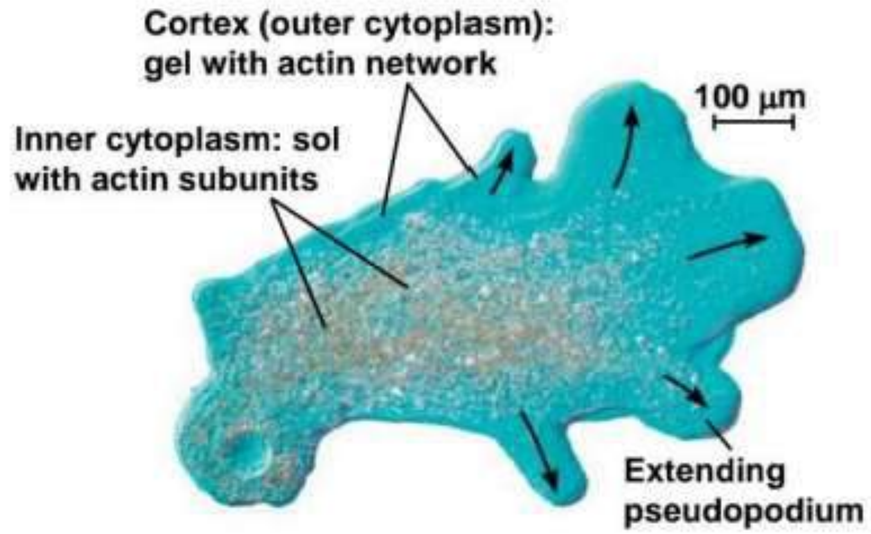


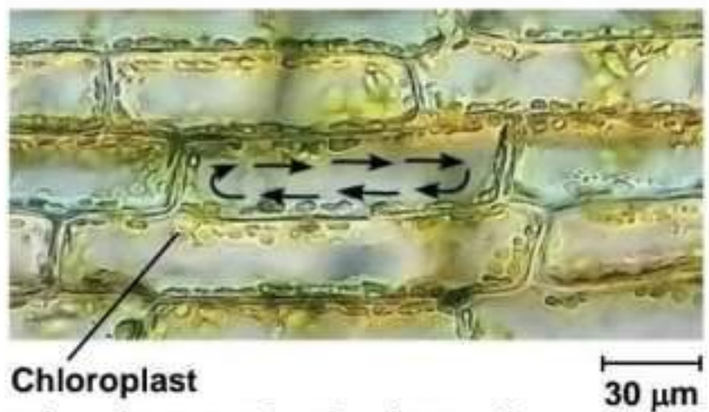
Figure 6.27



(a) Myosin motors in muscle cell contraction



(b) Amoeboid movement

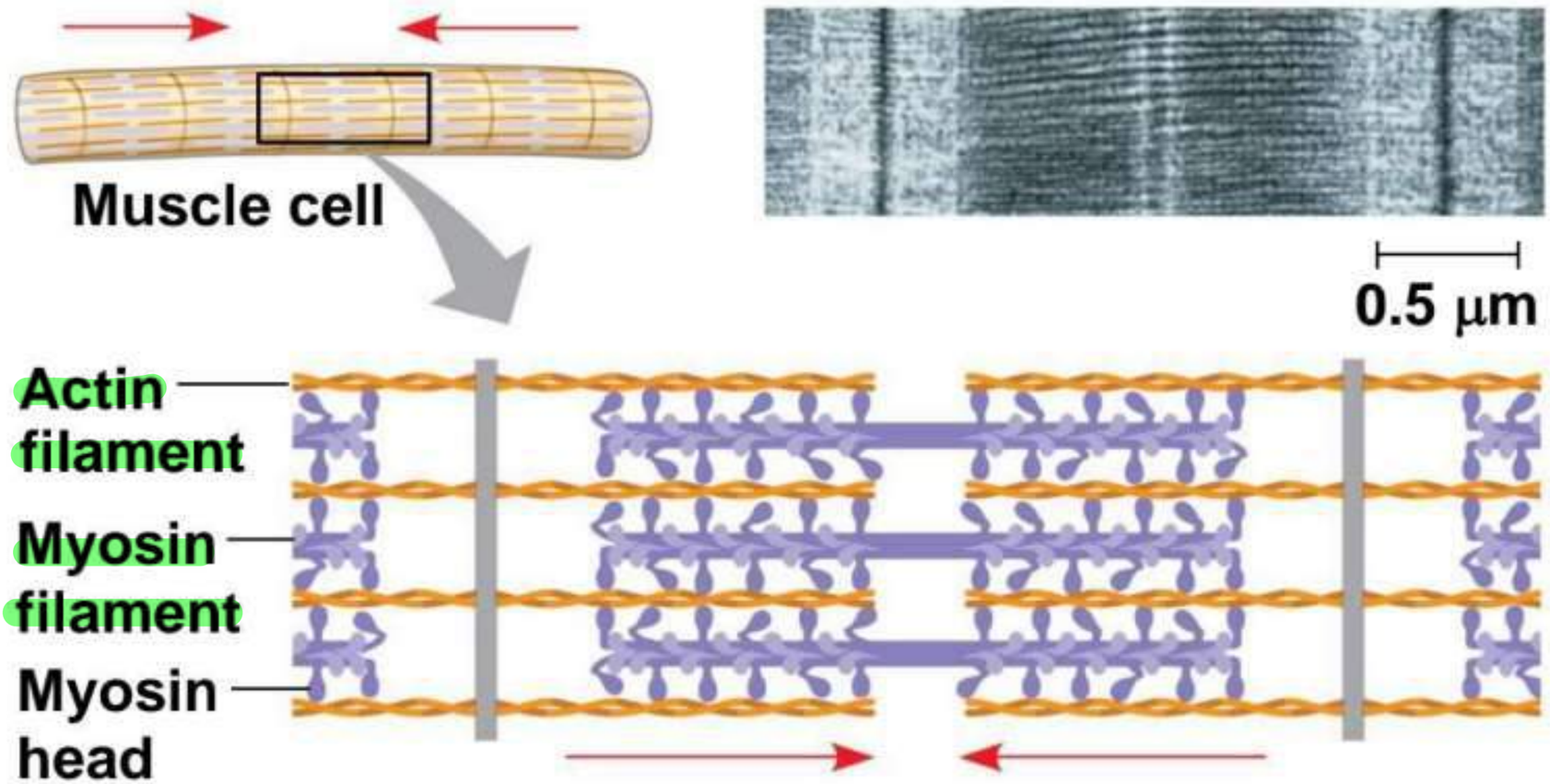


(c) Cytoplasmic streaming in plant cells

- Microfilaments that function in cellular motility contain the protein **myosin** in addition to actin
- In muscle cells, thousands of actin filaments are arranged parallel to one another
- Thicker filaments composed of myosin interdigitate with the thinner actin fibers

Figure 6.27a

muscle contraction



(a) Myosin motors in muscle cell contraction

sliding over each other

Figure 6.27b

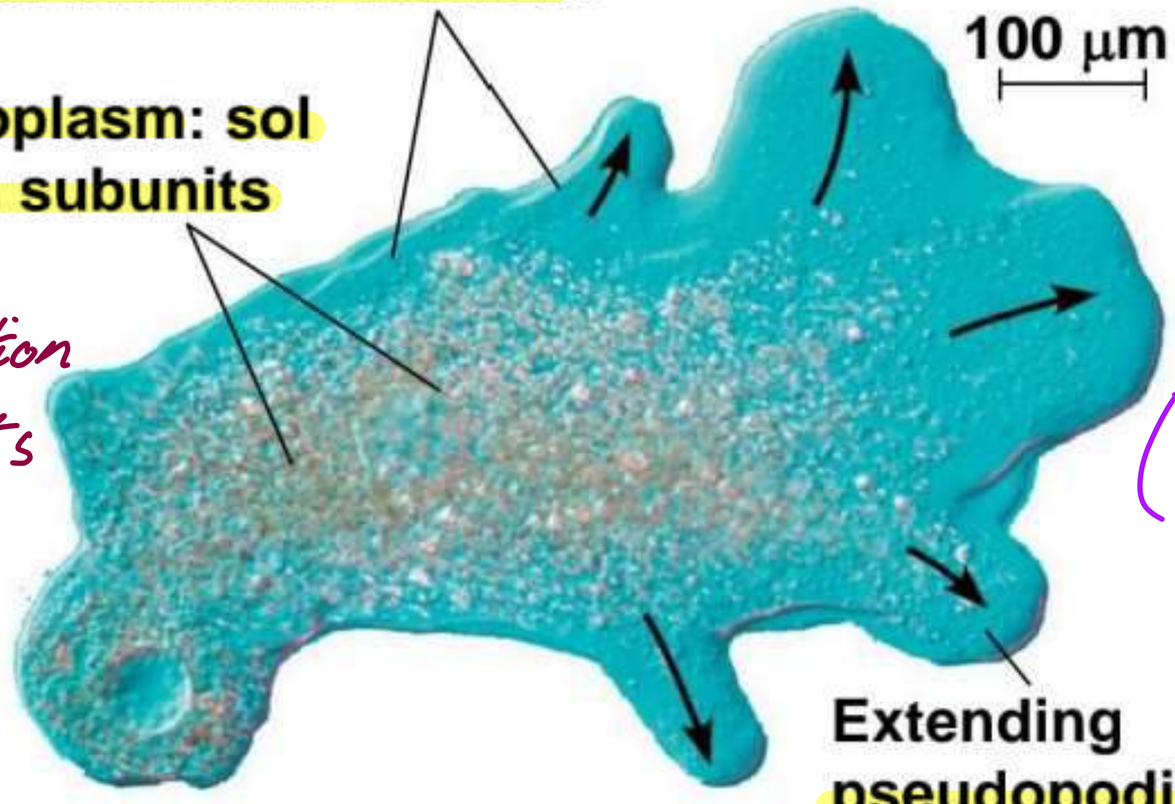
only in animal cells

low microfilaments concentration

Cortex (outer cytoplasm): gel with actin network

Inner cytoplasm: sol with actin subunits

high concentration of microfilaments



The cytosol moves from sol area to gel area (how pseudopodium are made)

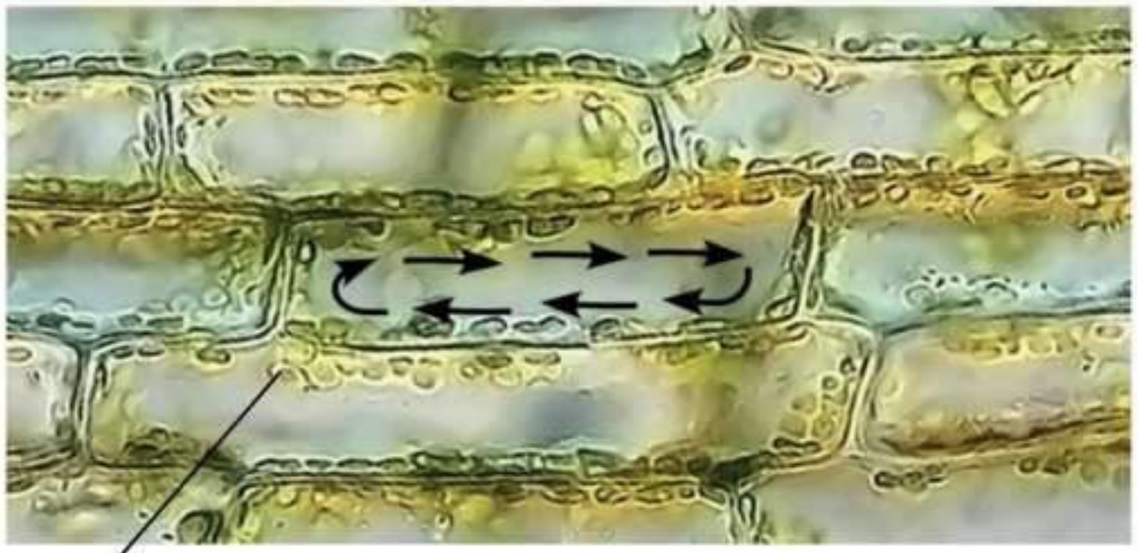
(b) Amoeboid movement

the cytoplasm is filled with actin filaments but with different concentrations, the area that is filled with microfilaments is more solid, areas with less concentration are more like gel

- Localized contraction brought about by actin and myosin also drives amoeboid movement
- **Pseudopodia** (cellular extensions) extend and contract through the reversible assembly and contraction of actin subunits into microfilaments

Figure 6.27c

الهدف منها توزيع الغذاء والماء بين خلايا الخلية النباتية



(c) Cytoplasmic streaming in plant cells

- **Cytoplasmic streaming** is a circular flow of cytoplasm within cells
- This streaming speeds distribution (توزيع) of materials within the cell
- In plant cells, actin-myosin interactions and sol-gel transformations drive cytoplasmic streaming

4) cell division (cleavage furrow formation)

تلتف خيوط الاكتين(Microfilaments/Actin Filaments) حول نصف الخلية و
تحدث تخصر(Cleavage furrow) فيها حتى تنقسم الخلية الى خليتين