تنوير

BIOLOGY

Lec no :

File Title : Chapter 12

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Biology : Chapter 12

cell cycle + mytosis

Done by: Leen AlAshram

Overview: The Key Roles of Cell Division

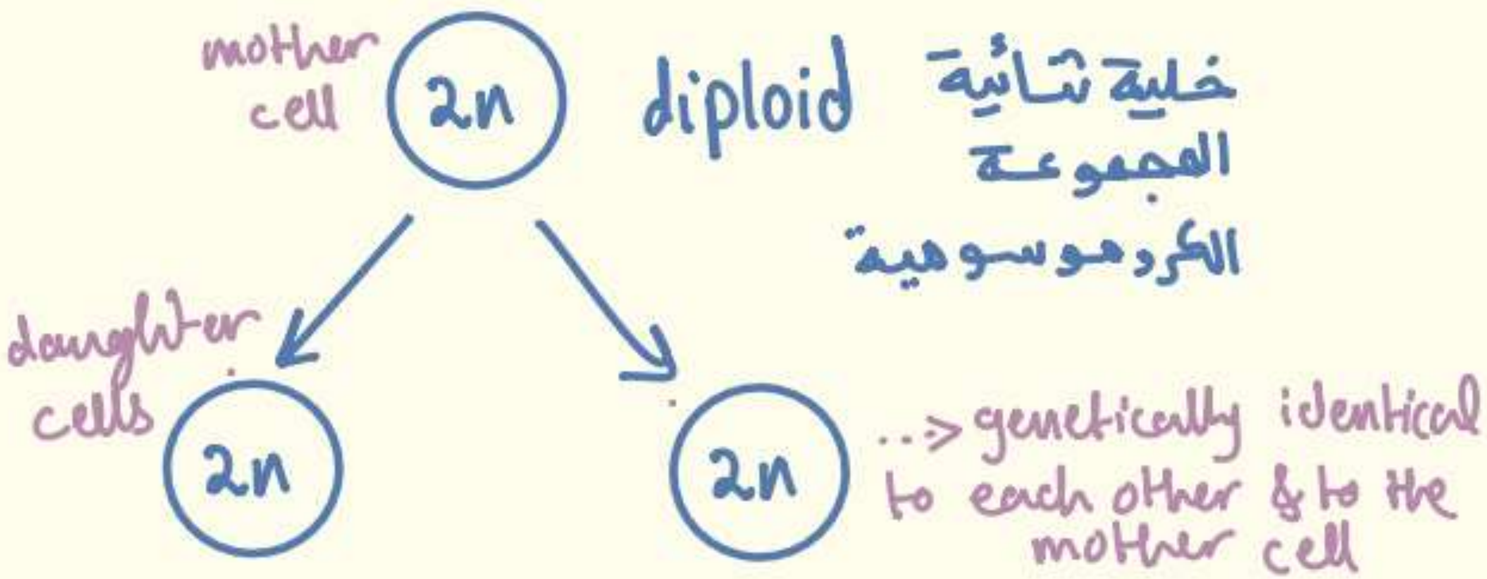
- The ability of organisms to produce more of their own kind best distinguishes living things from nonliving matter
- The continuity of life is based on the reproduction of cells, or **cell division**

cell division - for continuity of life.

chapter 12

Mitotic division
Mitosis

- growth
- repair stein
- development of zygote
- asexual reproduction (Bacteria)



* not reproductive cells [somatic cell]
... / الجلد / العين في خلية / خلية جسمية
* increase number of cells without changes

chapter 13

- sexual reproduction
- genetic variation
- large number of gametes

miotic division
meiosois

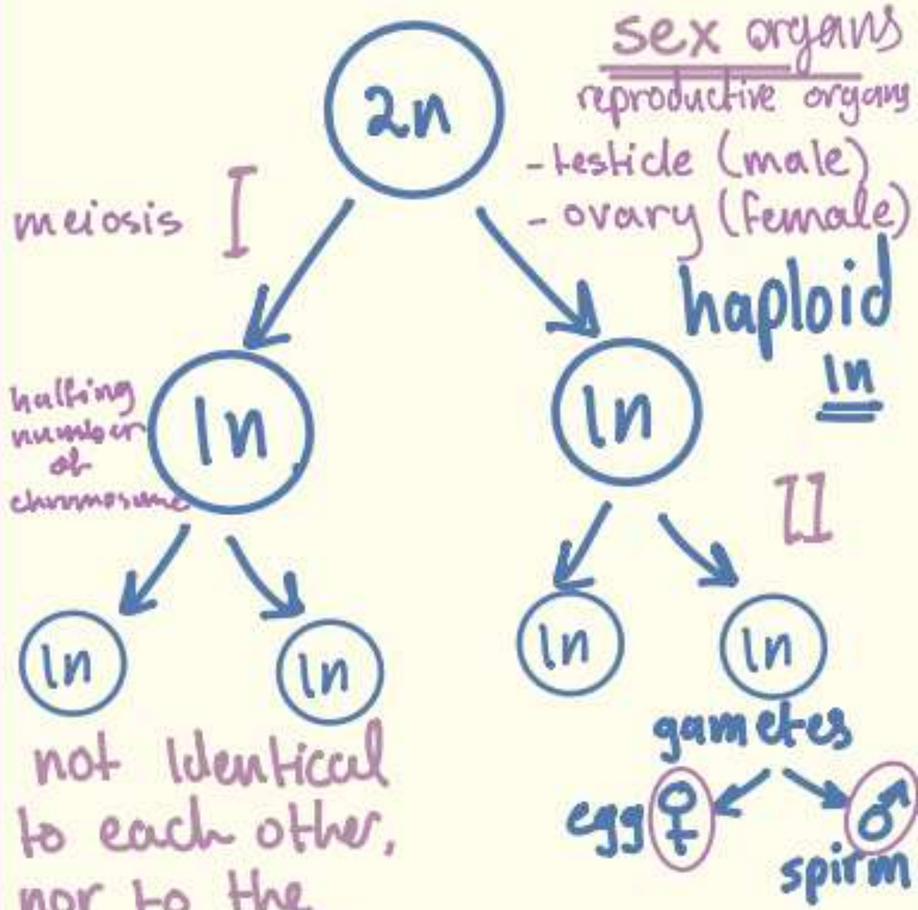
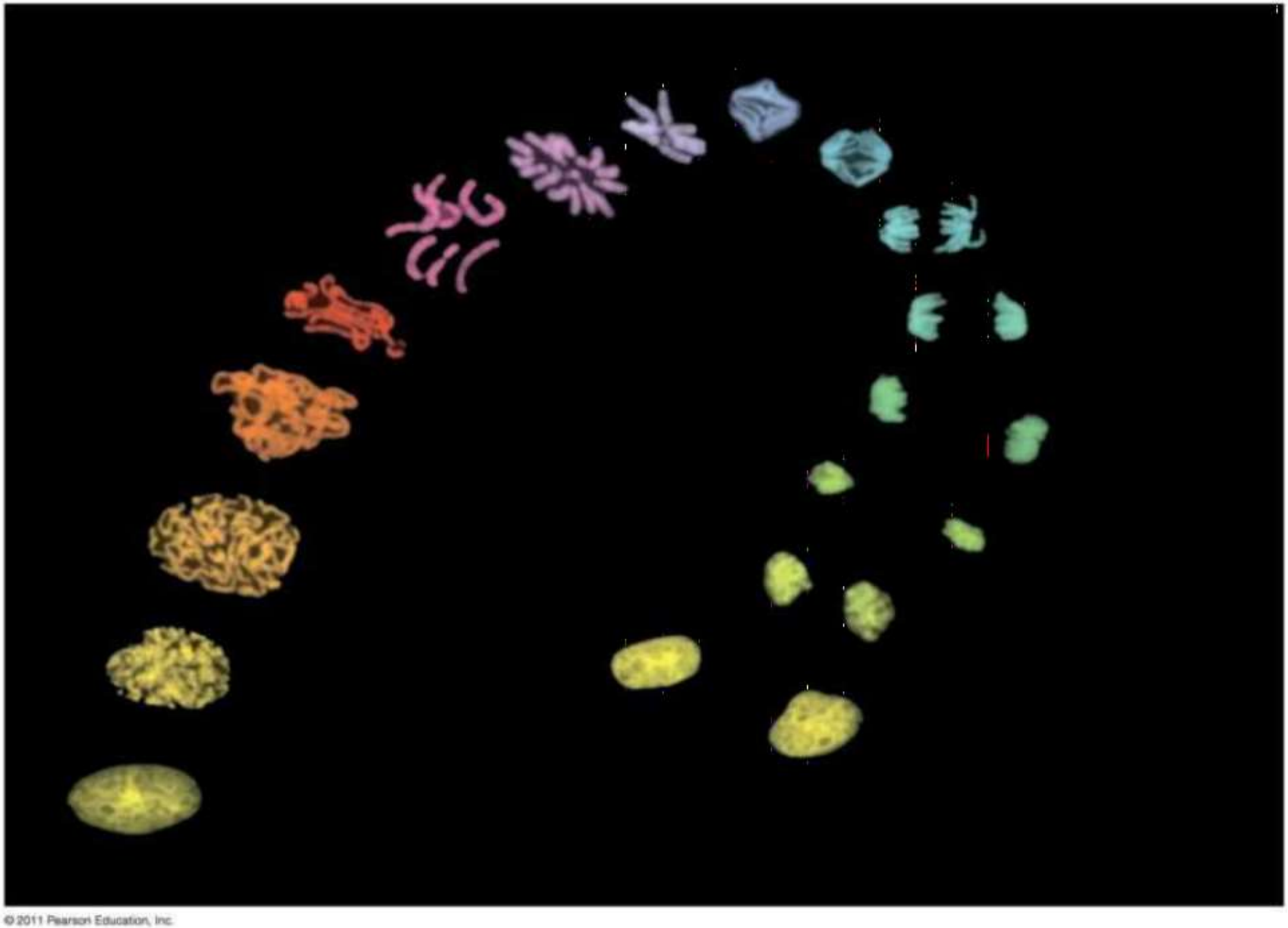
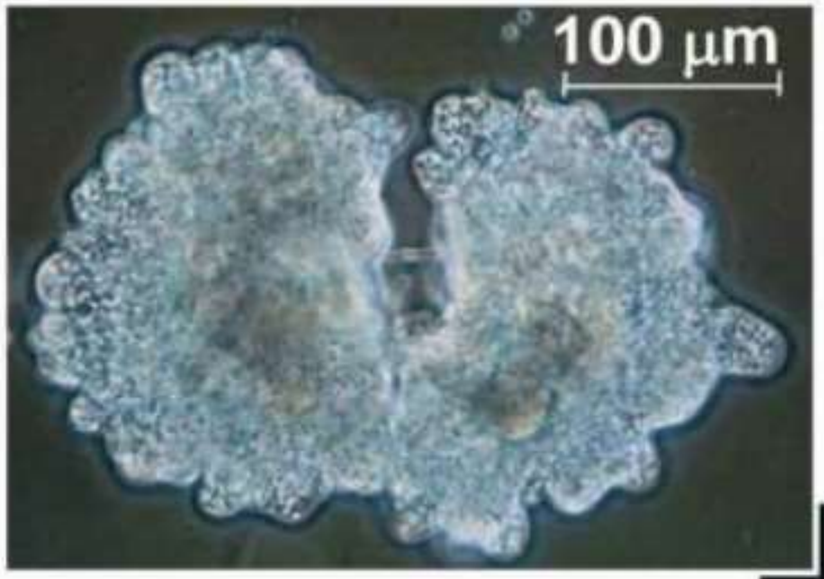


Figure 12.1



- In unicellular organisms, division of one cell reproduces the entire organism
- Multicellular organisms depend on cell division for
  - Development from a fertilized cell (zygote)
  - Growth
  - Repair
- Cell division is an integral part of the **cell cycle**, the life of a cell from formation to its own division

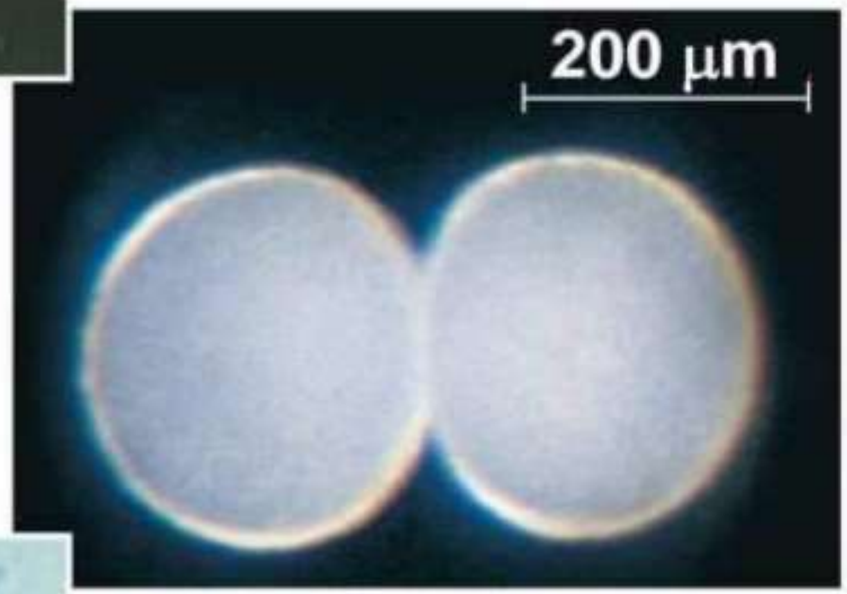
Figure 12.2

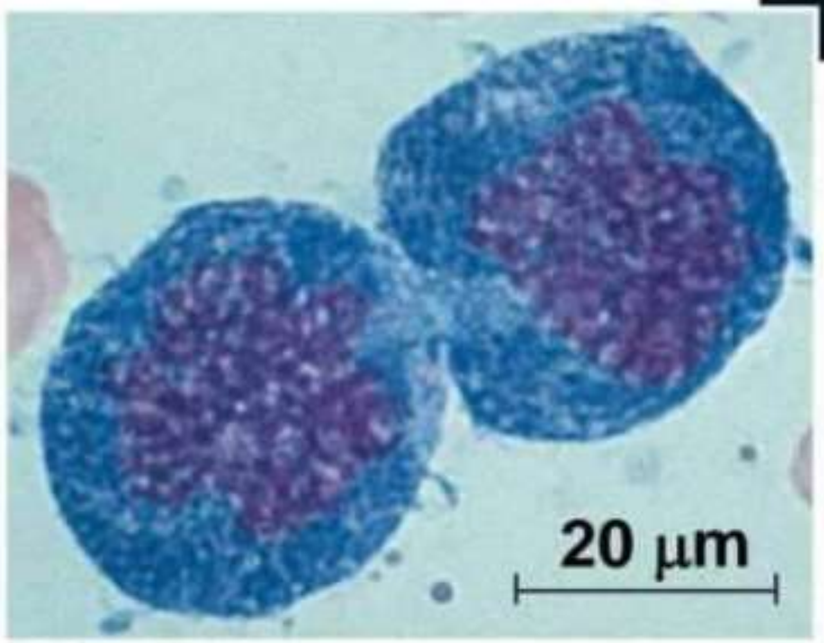


(a) Reproduction

mitosis → asexual production
=
not

(b) Growth and development

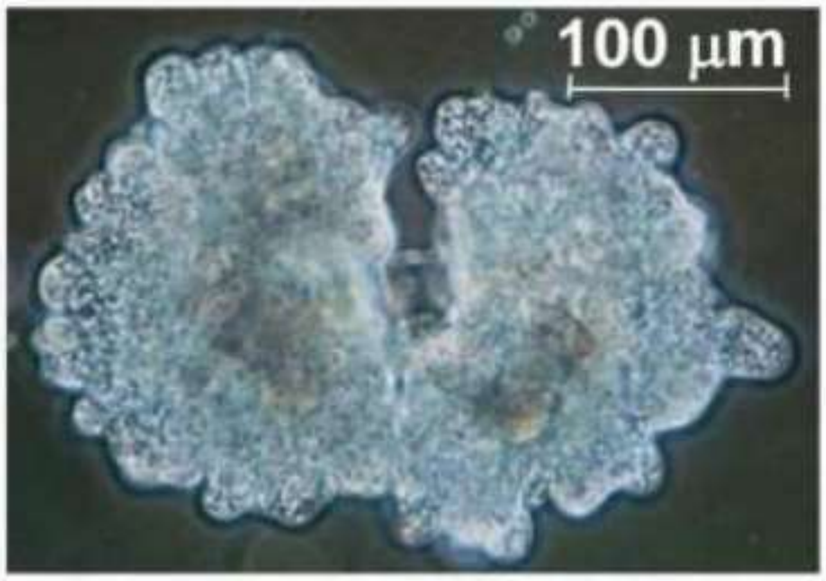




repair

(c) Tissue renewal

Figure 12.2a



(a) Reproduction

Figure 12.2b

- **(b) Growth and development**

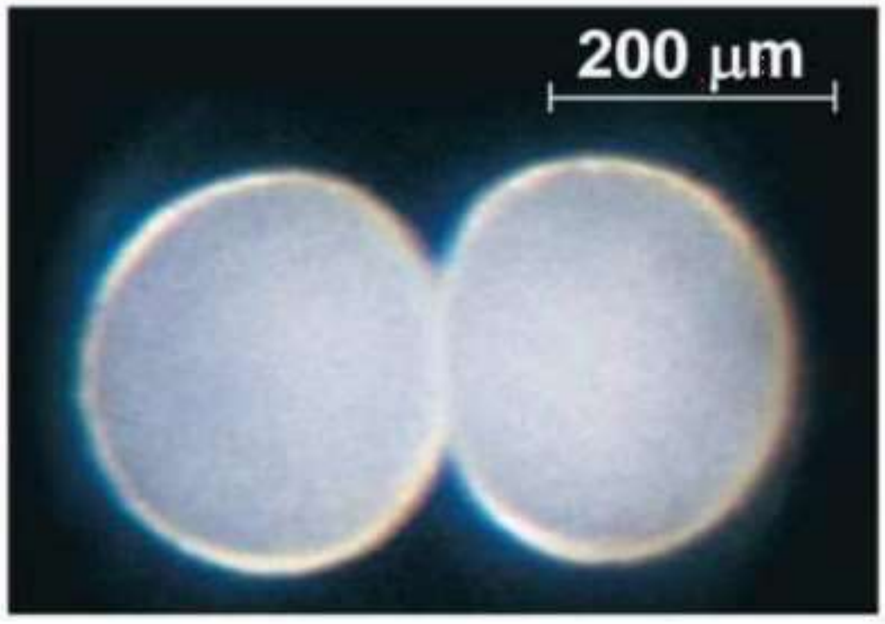
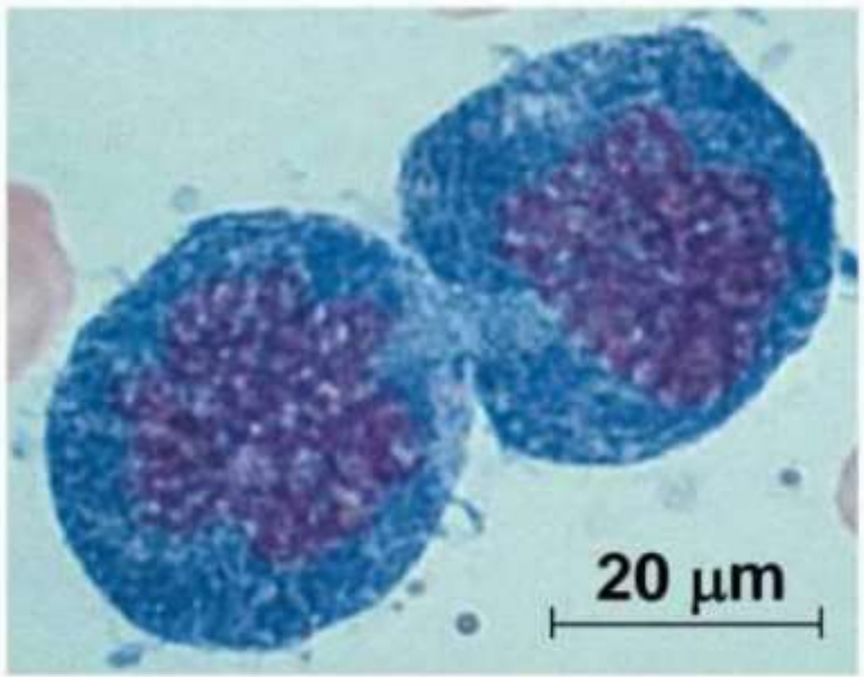


Figure 12.2c



◀ (c) Tissue renewal

Concept 12.1: Most cell division results in genetically identical daughter cells

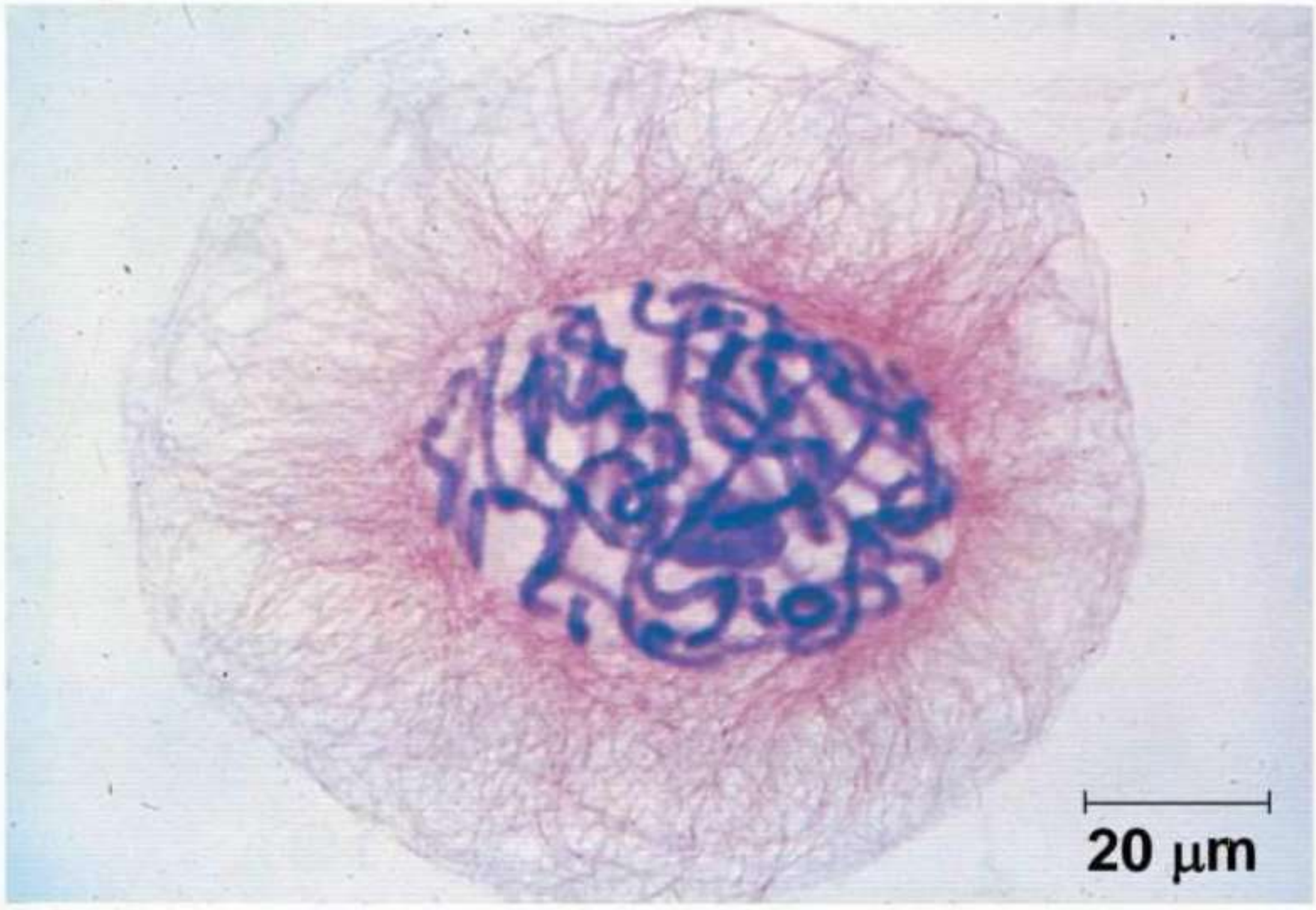
- Most cell division results in daughter cells with identical genetic information, DNA
- The exception is meiosis, a special type of division that can produce sperm and egg cells

Cellular Organization of the Genetic Material

23 pair of chromosome
"genetic makeup" ← المحتوى الجيني

- All the DNA in a cell constitutes the cell's **genome**
- A genome can consist of a single DNA molecule (common in prokaryotic cells) or a number of DNA molecules (common in eukaryotic cells)
- DNA molecules in a cell are packaged into **chromosomes**

Figure 12.3



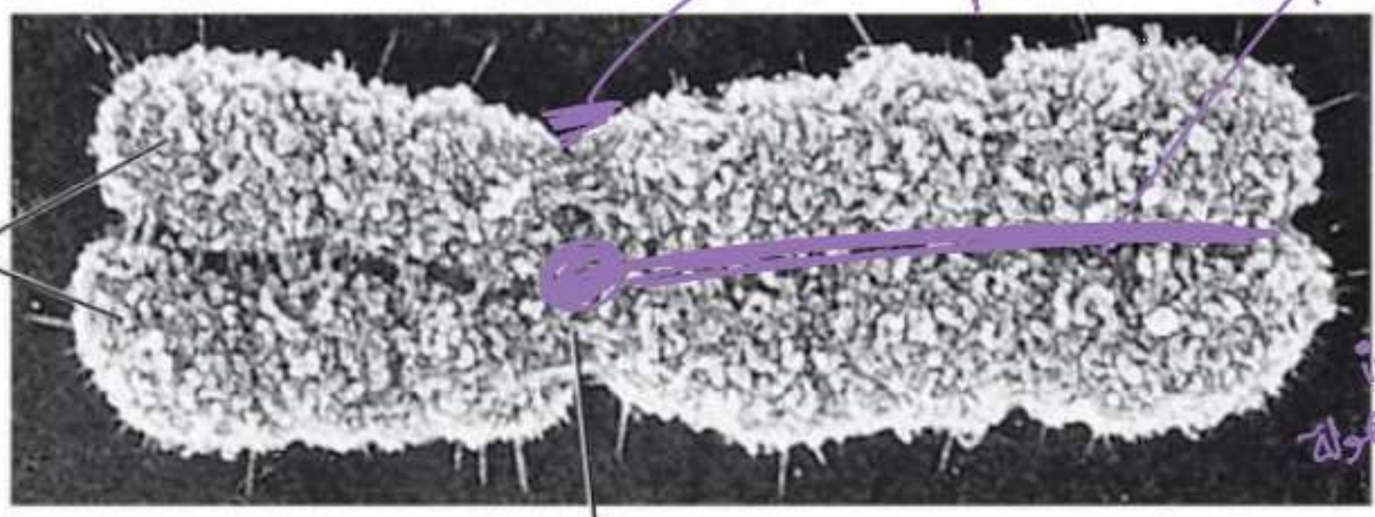
- Eukaryotic chromosomes consist of **chromatin**, a complex of DNA and protein that condenses during cell division
- Every eukaryotic species has a characteristic number of chromosomes in each cell nucleus
- **Somatic cells** (nonreproductive cells) have two sets of chromosomes
- **Gametes** (reproductive cells: sperm and eggs) have half as many chromosomes as somatic cells

Distribution of Chromosomes During Eukaryotic Cell Division

- In preparation for cell division, DNA is replicated and the chromosomes condense
- Each duplicated chromosome has two **sister chromatids** (joined copies of the original chromosome), which separate during cell division
- The **centromere** is the narrow "waist" of the duplicated chromosome, where the two chromatids are most closely attached

Figure 12.4

*chromosomes are thicker & shorter ch chromatine



centromere المنطقة اللي بوسطي
kinetochore protein
② cohesin protein (gluing 2 sister cromatide) once it is active بتربط once it isn't inactive بتفكوا بسهولة
له دور في mitosis
عوامل تباتع مع بعض ① + ②
① منطقة التقاء ≤ sister cromatide region / waste "التخصر" constriction

- During cell division, the two sister chromatids of each duplicated chromosome separate and move into two nuclei
- Once separate, the chromatids are called chromosomes

cell cycle → stage make DNA replication occurs before both miosis & mitosis

Figure 12.5-1

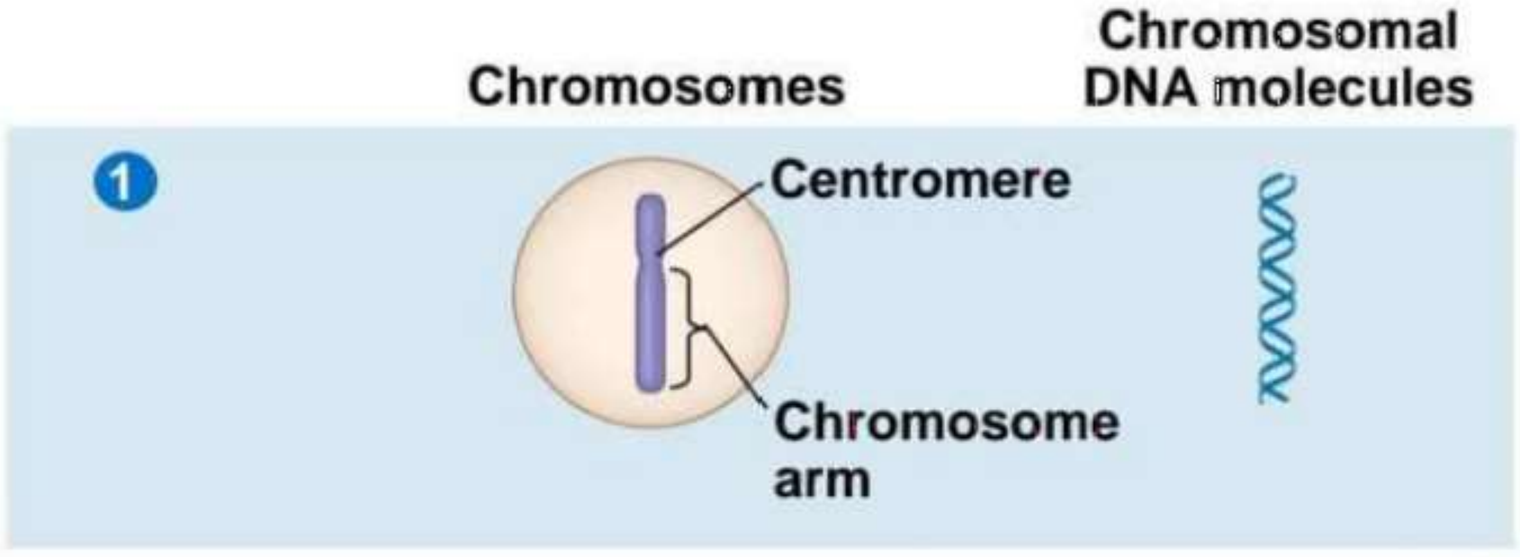


Figure 12.5-2

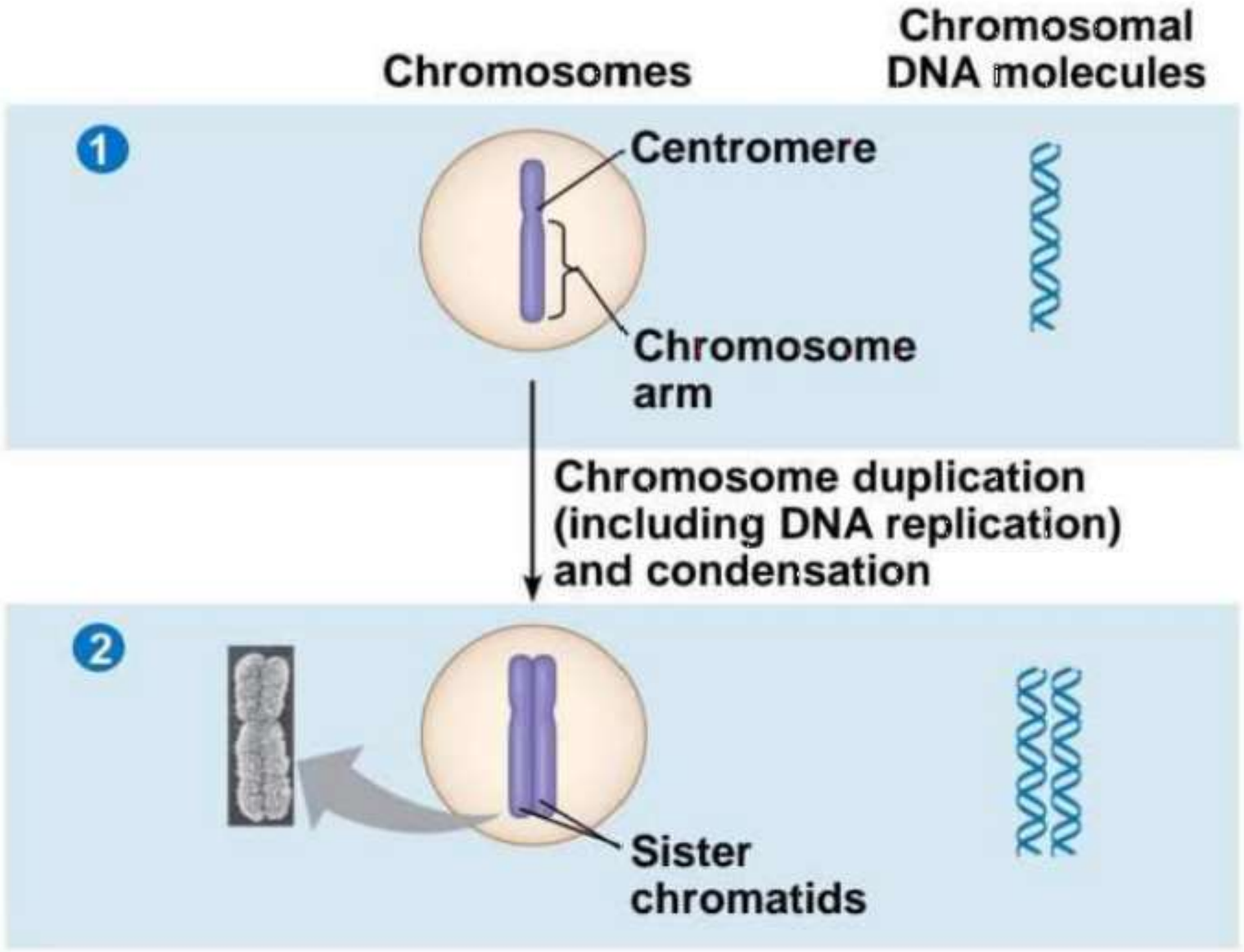
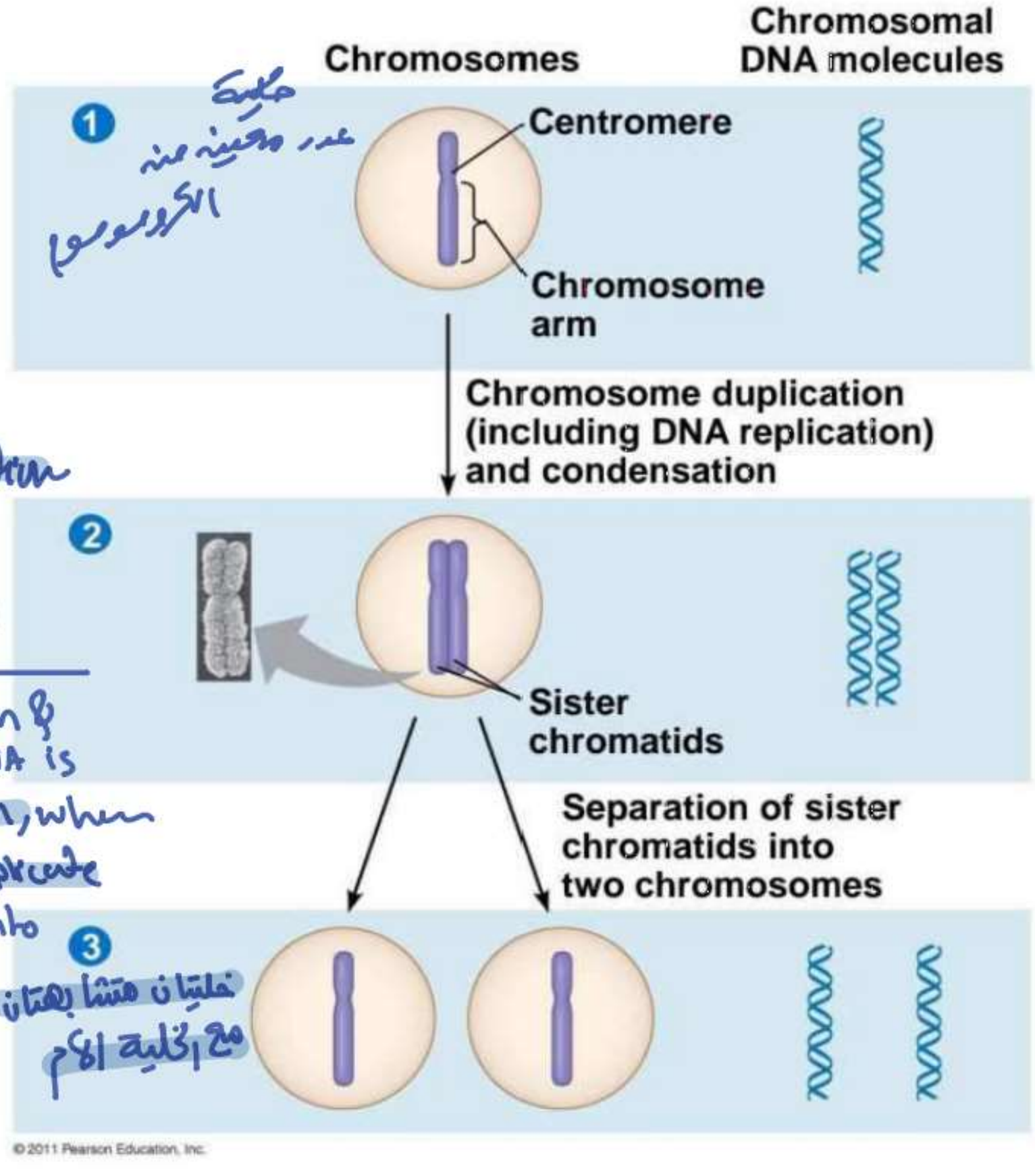


Figure 12.5-3



عشان تبلت 2n وتتضاعف DNA لازم يتضاعف بالأول

DNA replication → one step on cell cycle

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before division & replication, DNA is a cromatin, when it wants to replicate it turns into chromosomes

- Eukaryotic cell division consists of

1st – **Mitosis**, the division of the genetic material in the nucleus

2nd – **Cytokinesis**, the division of the cytoplasm

- Gametes are produced by a variation of cell division called **meiosis**
- Meiosis yields nonidentical daughter cells that have only one set of chromosomes, half as many as the parent cell

Concept 12.2: The mitotic phase alternates with interphase in the cell cycle

- In 1882, the German anatomist Walther Flemming developed dyes to observe chromosomes during mitosis and cytokinesis

Phases of the Cell Cycle

in every eukaryotic cell

same steps. But the length of the cycle differs, in humans (24 h)

interphase + M phase

- The cell cycle consists of
  - **Mitotic (M) phase** (mitosis and cytokinesis)
  - **Interphase** (cell growth and copying of chromosomes in preparation for cell division)

بالتحضير عشان لما تدخل M phase تكون خالية من الأخطاء

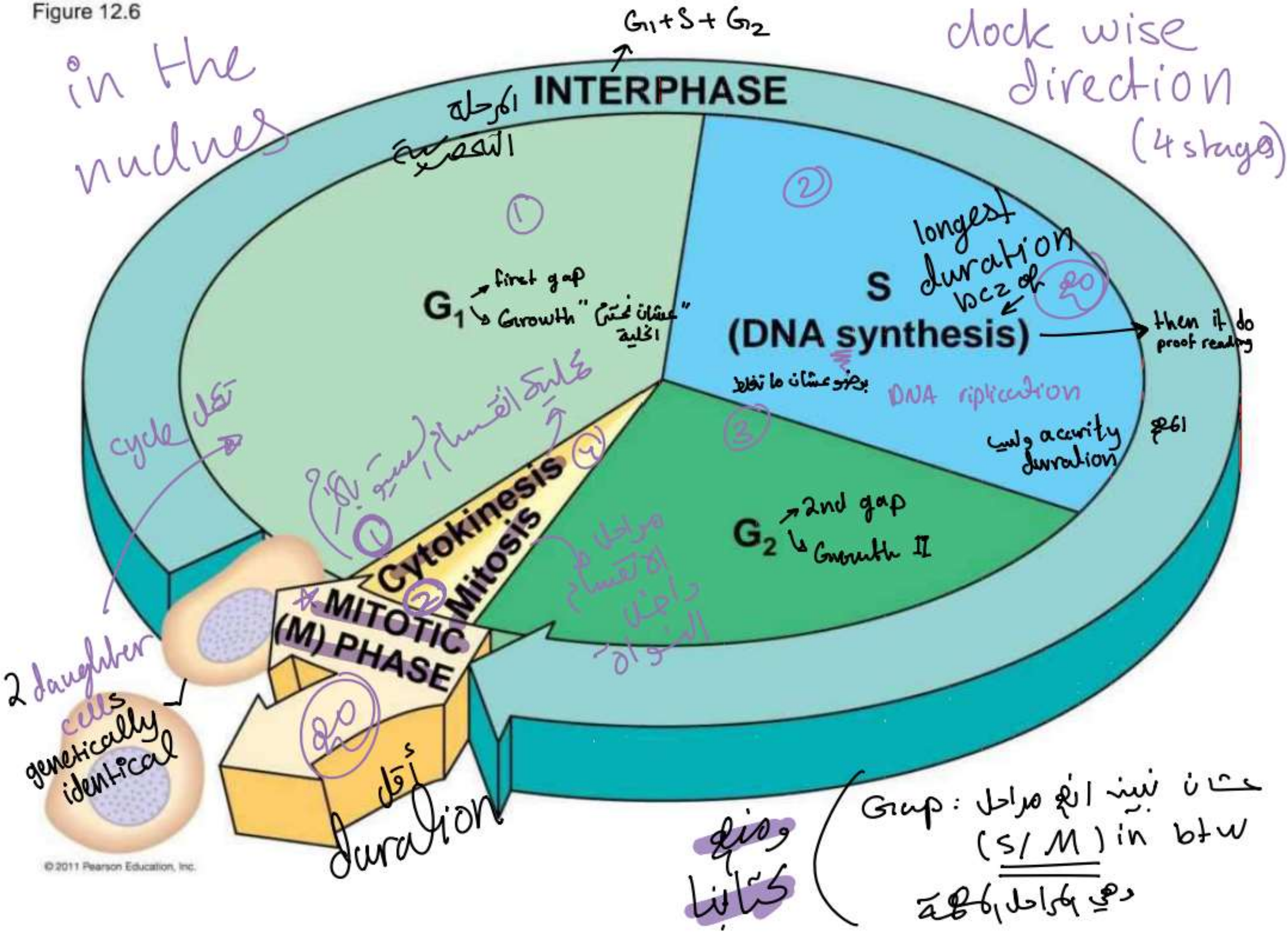
- Interphase (about 90% of the cell cycle) can be divided into subphases
  - **G_1 phase** ("first gap")
  - **S phase** ("synthesis")
  - **G_2 phase** ("second gap")

cell is bigger
cell organils ×2 / except DNA + centrosome
prepares proteins & everything needed for S phase
at end: 2 identical copies of DNA
checking up on having everything needed for (M phase
اي شي ناقص وبحتاجه في M phase ترجع تصنعه

everything needed for replication is already prepared in G1

- The cell grows during all three phases, but chromosomes are duplicated only during the S phase

Figure 12.6



Gap: عشان نبين انهو مراحل (S/M) in btw
وهي مراحل

M phase

1

- Mitosis is conventionally divided into five phases
  - a **Prophase** beginning
  - b **Prometaphase** in btw of a + c
  - c **Metaphase** الاستوائية
  - d **Anaphase** الانفصالية
  - e **Telophase** النهائية

2

- Cytokinesis overlaps the latter stages of mitosis

PLAY BioFlix: Mitosis

Figure 12.7

Mitosis stages in Animal cells

almost same in plant cell

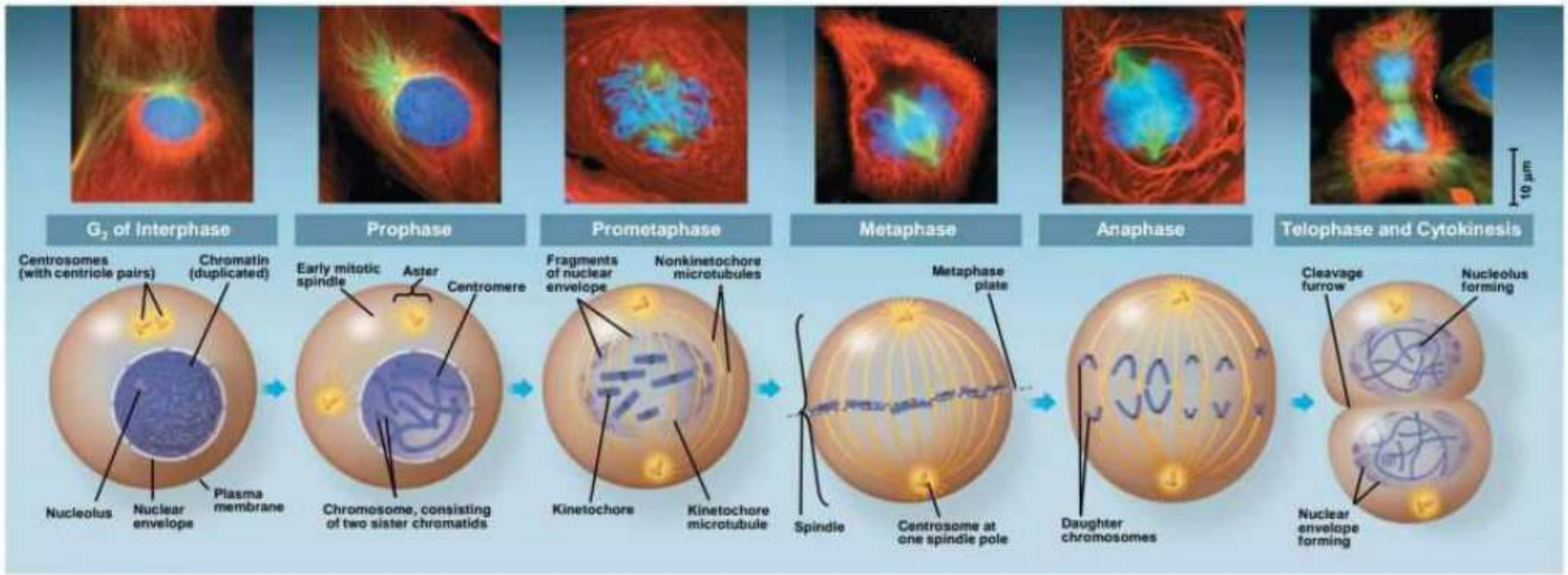


Figure 12.7a

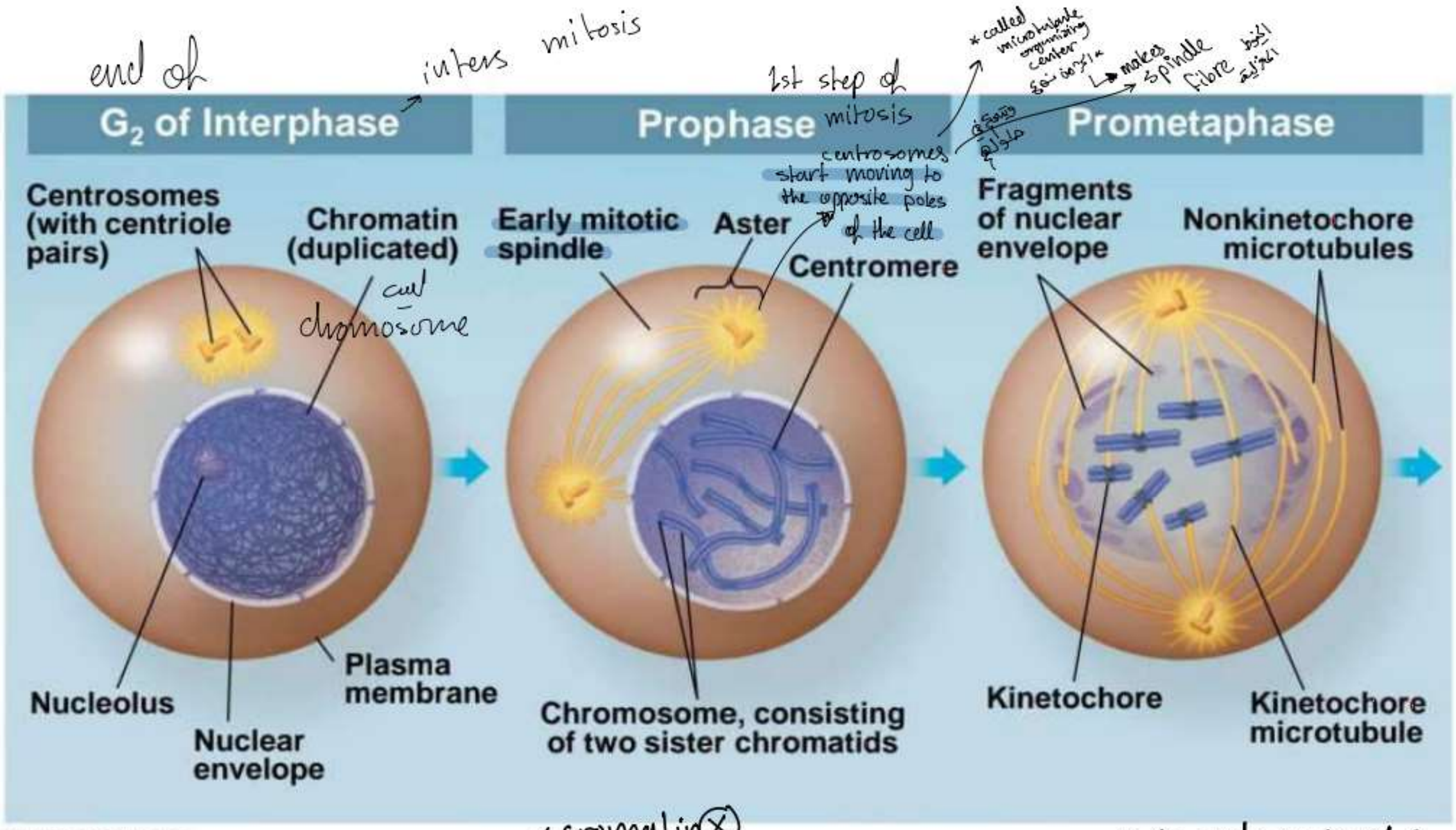
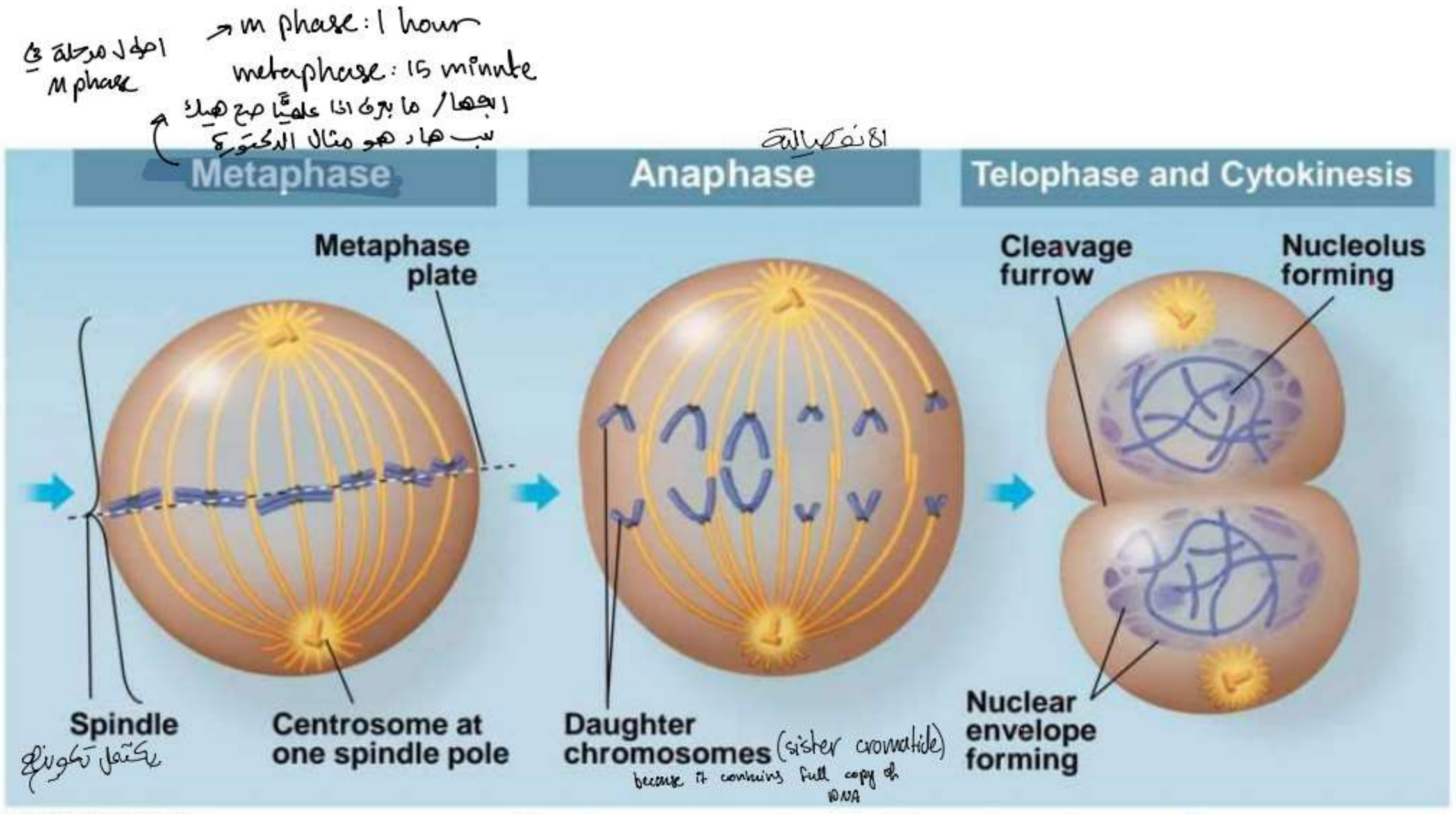


Figure 12.7b



* spindle → [two centrosomes found on opposite poles, + 3 types of spindle microtubules]

* chromosomes will be lined at Metaphase plate

* 2 sister chromatide seperates
1. inactivation of cohesin protein
2 shorting & contraction of kinetocore microtubule
3. [centromeric division] / elogated / overlapping / non-kinetochore

* nucleolus
- nucleolus
- nuclear envelop
- one cell / two nucleos each one of them has same number of chromosome
- sister chromatide → chromosome

Figure 12.7c

this permits elogation of the cell

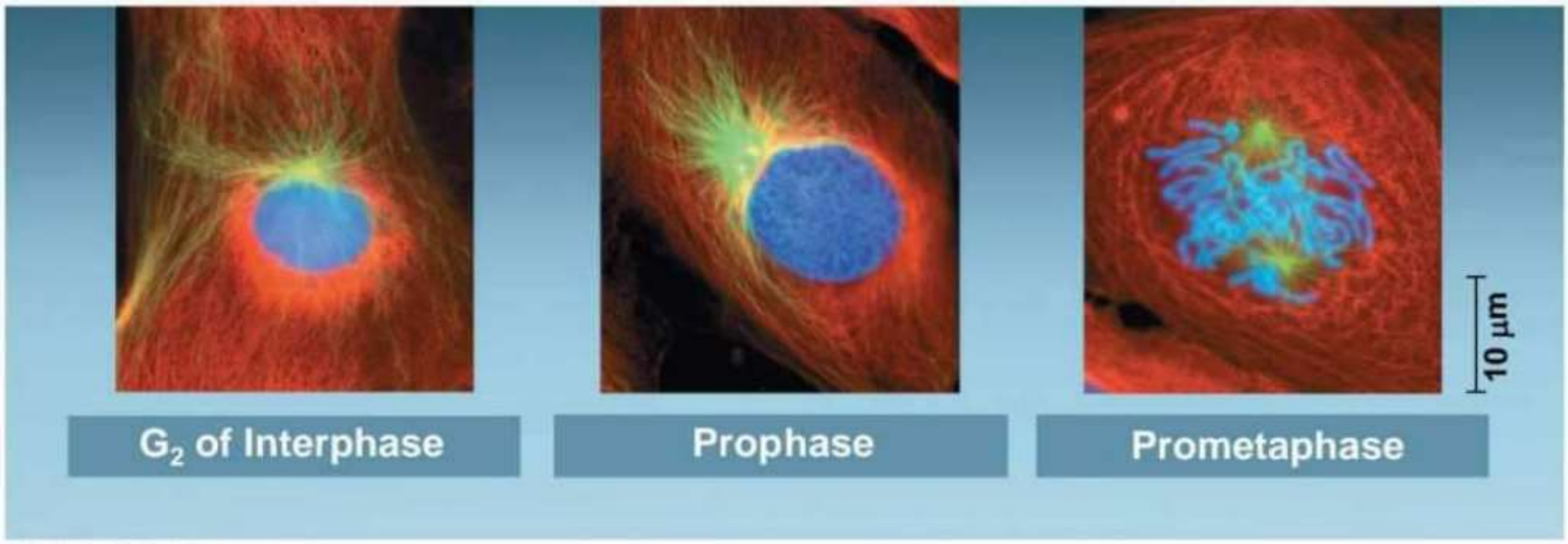


Figure 12.7d

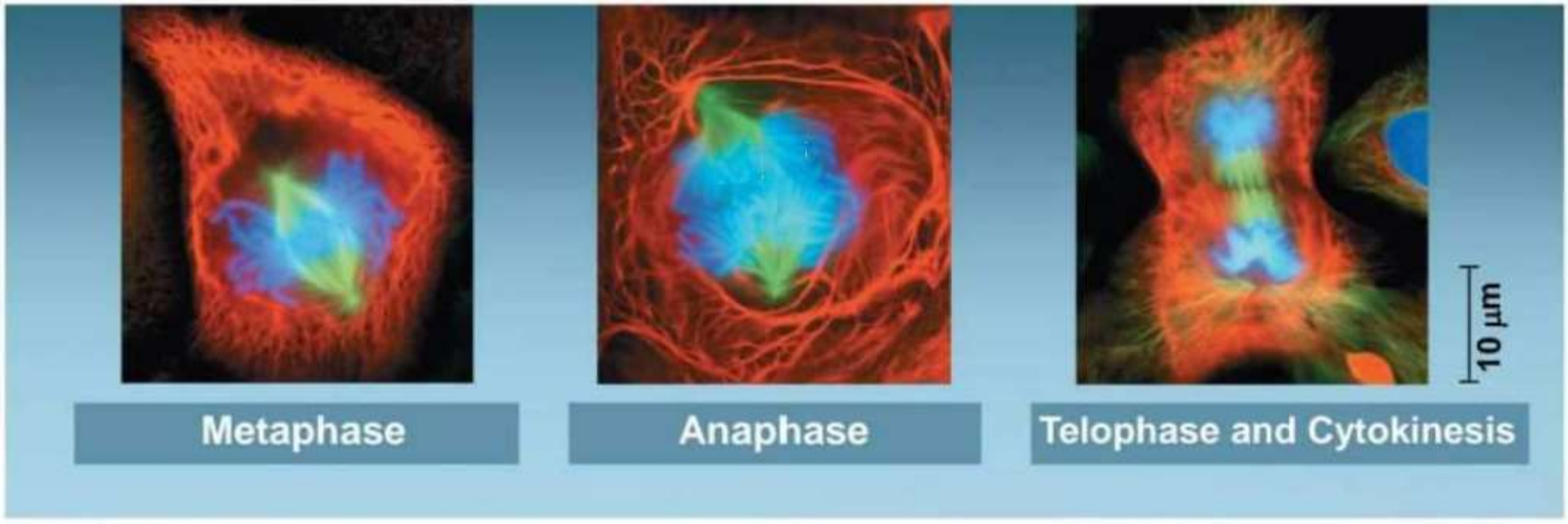


Figure 12.7e

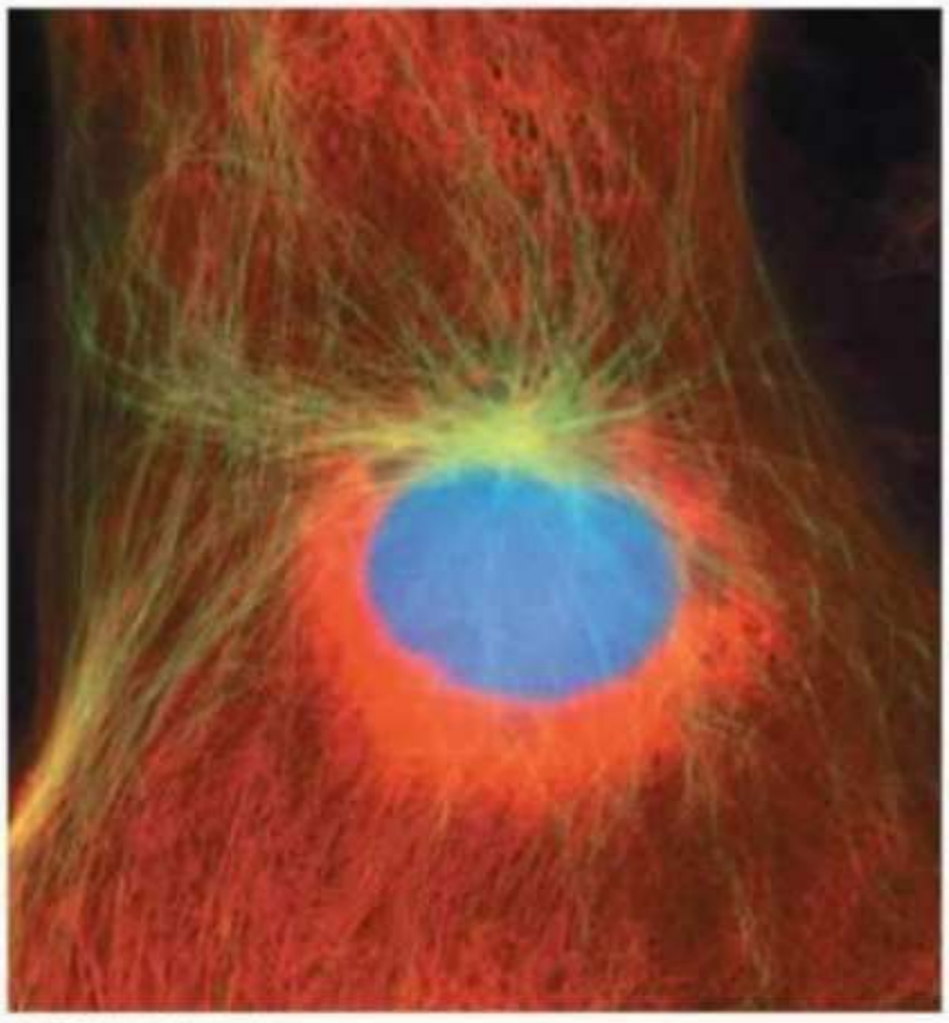


Figure 12.7f

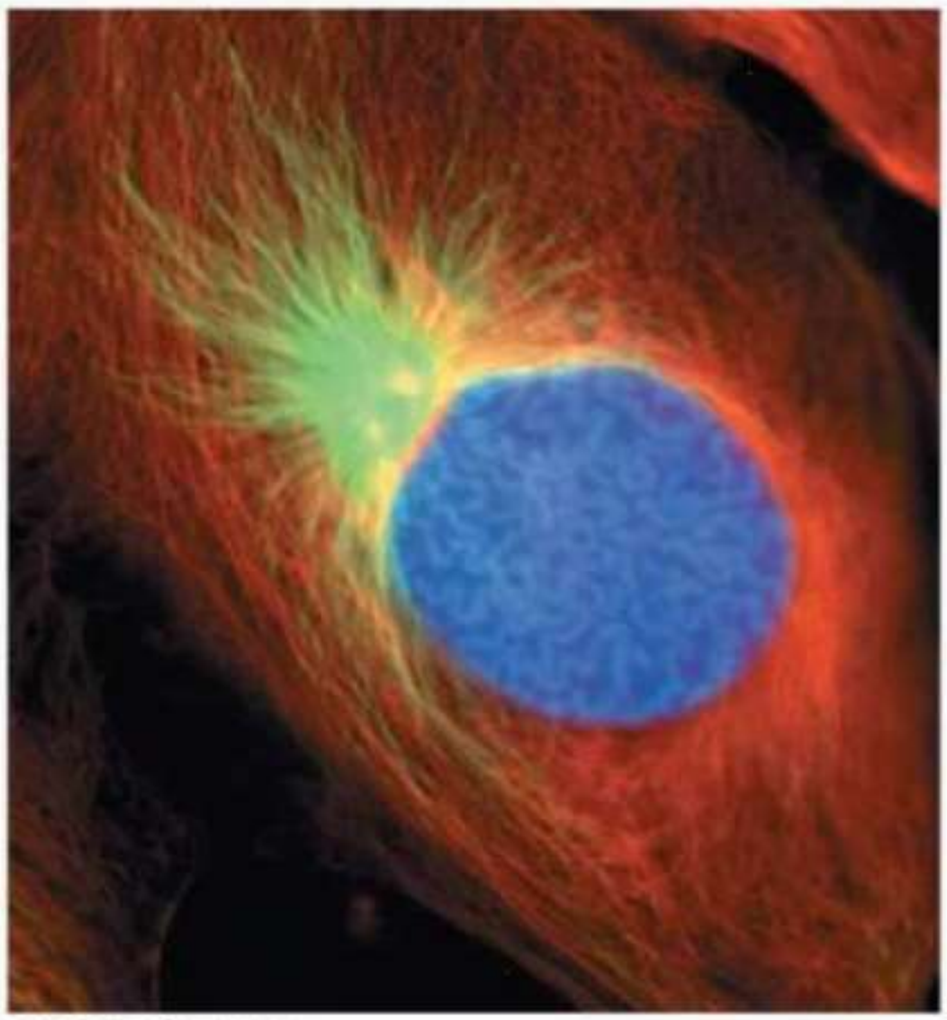


Figure 12.7g

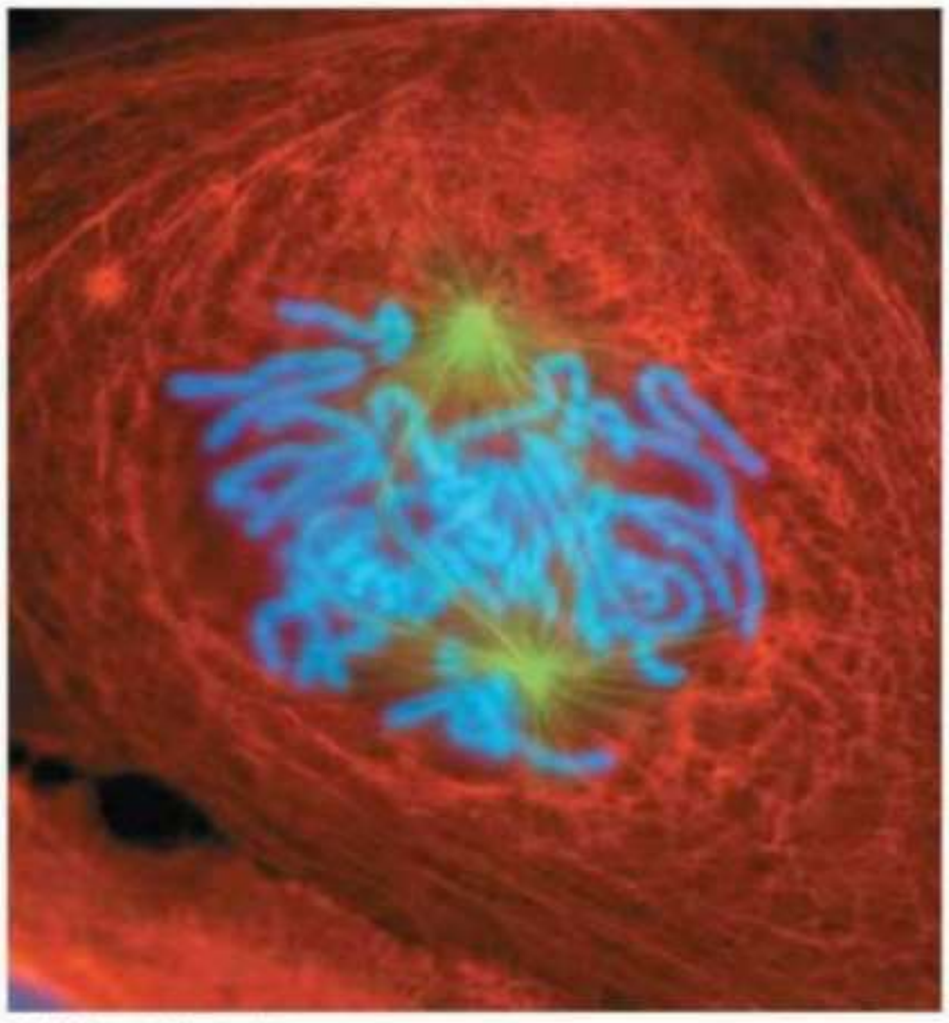


Figure 12.7h

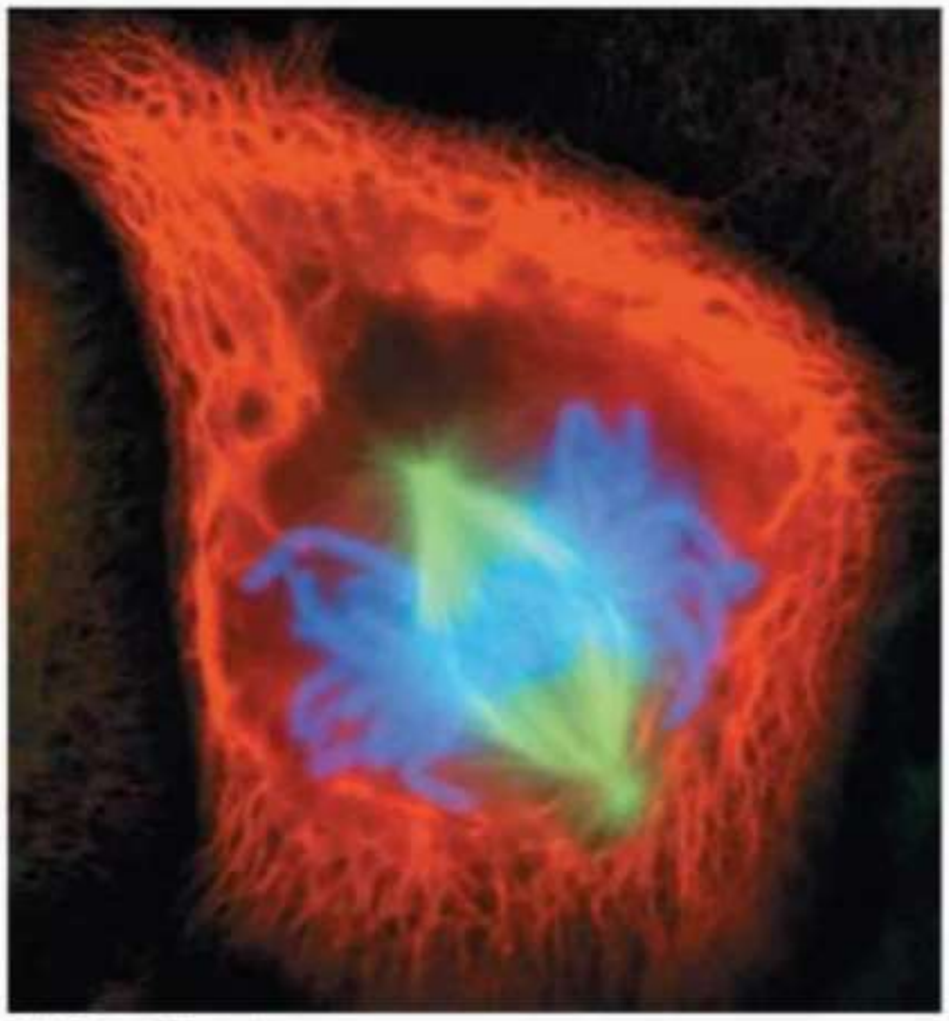
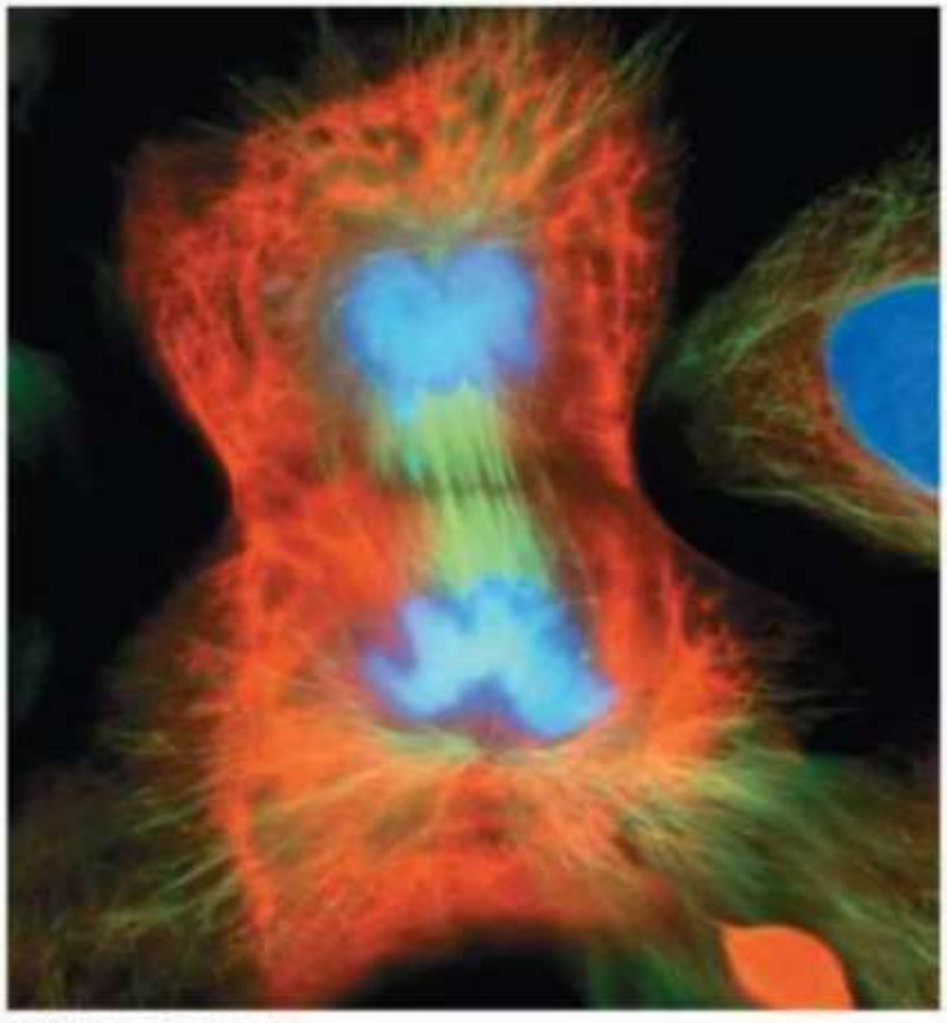


Figure 12.7i

Figure 12.7j



The Mitotic Spindle: *A Closer Look*

- The **mitotic spindle** is a structure made of microtubules that controls chromosome movement during mitosis
- In animal cells, assembly of spindle microtubules begins in the **centrosome**, the microtubule organizing center
- The centrosome replicates during interphase, forming two centrosomes that migrate to opposite ends of the cell during prophase and prometaphase

- An **aster** (a radial array of short microtubules) extends from each centrosome
- The spindle includes the centrosomes, the spindle microtubules, and the asters

- During prometaphase, some spindle microtubules attach to the kinetochores of chromosomes and begin to move the chromosomes
- **Kinetochores** are protein complexes associated with centromeres
- At metaphase, the chromosomes are all lined up at the **metaphase plate**, an imaginary structure at the midway point between the spindle's two poles

Figure 12.8

3 types of spindle microtubules:

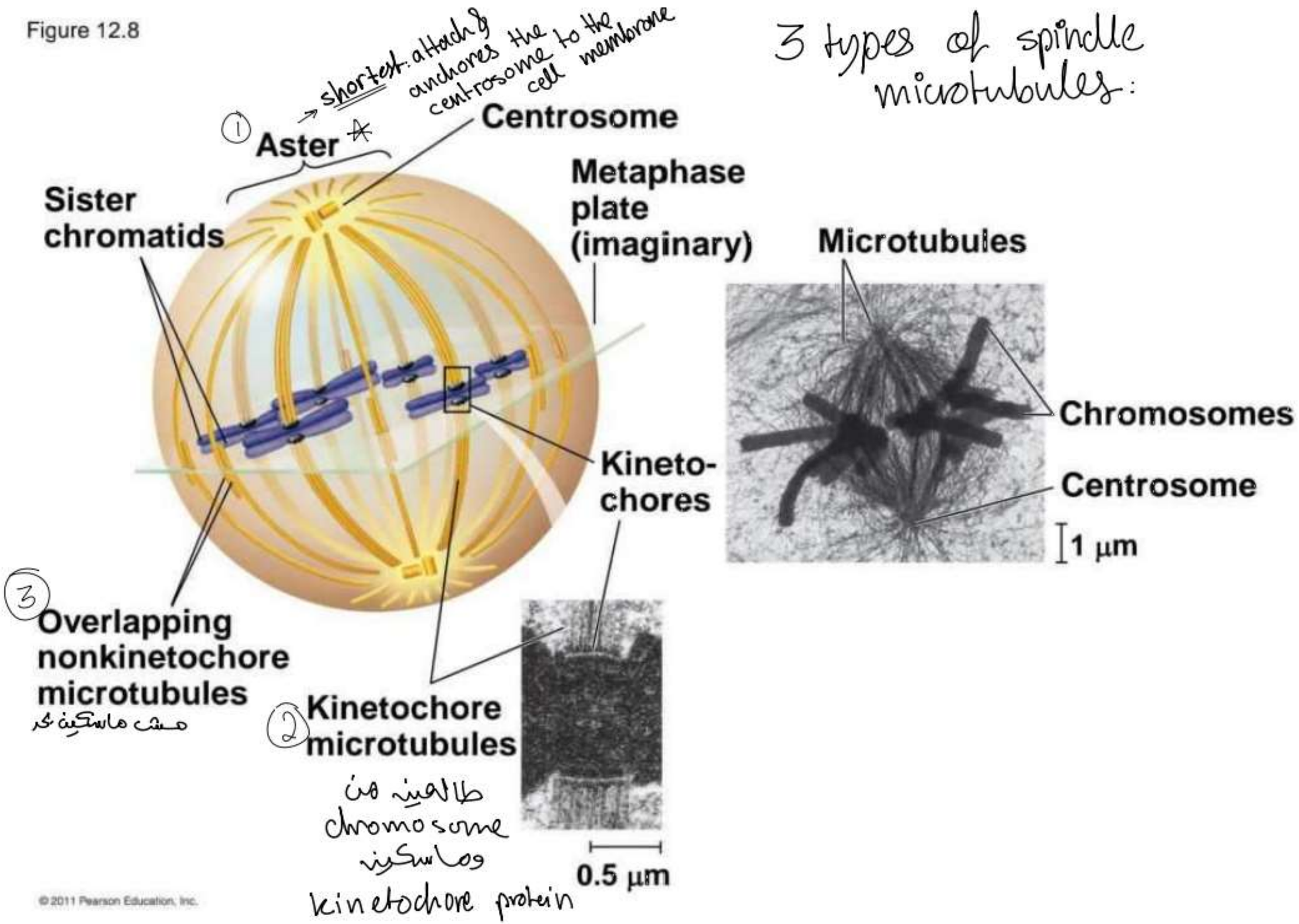


Figure 12.8a

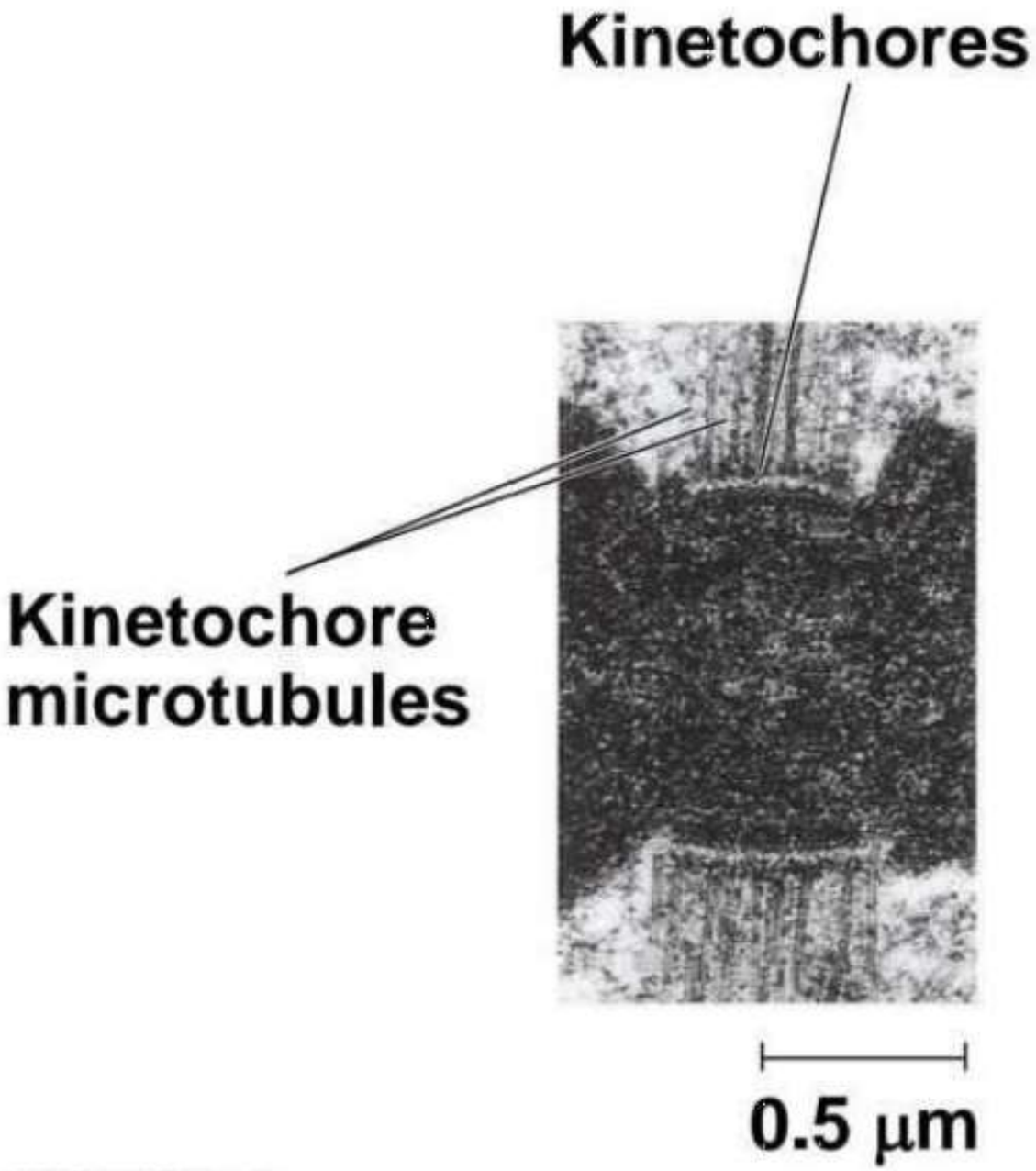
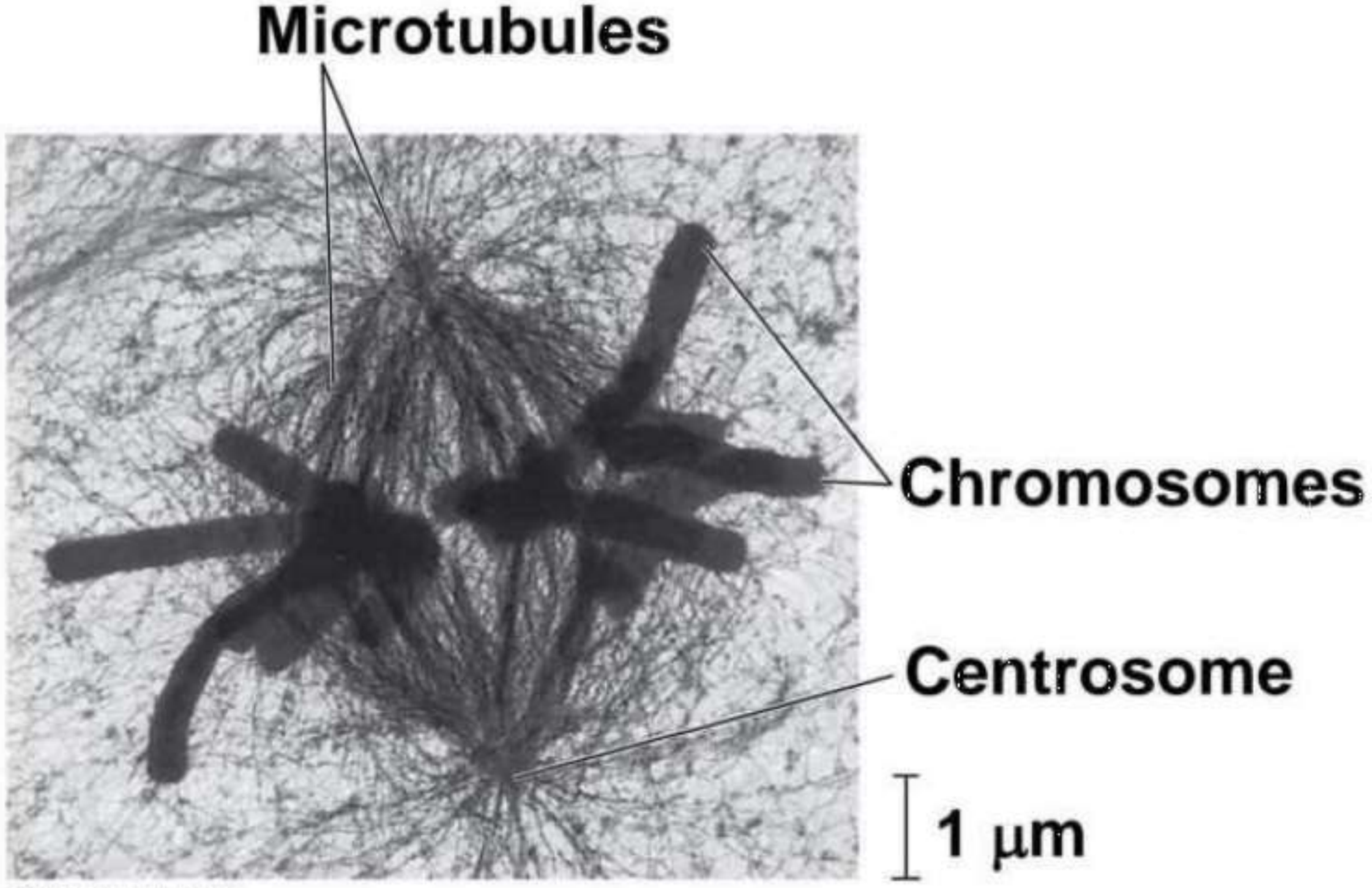


Figure 12.8b



- In anaphase, sister chromatids separate and move along the kinetochore microtubules toward opposite ends of the cell
- The microtubules shorten by depolymerizing at their kinetochore ends

Figure 12.9

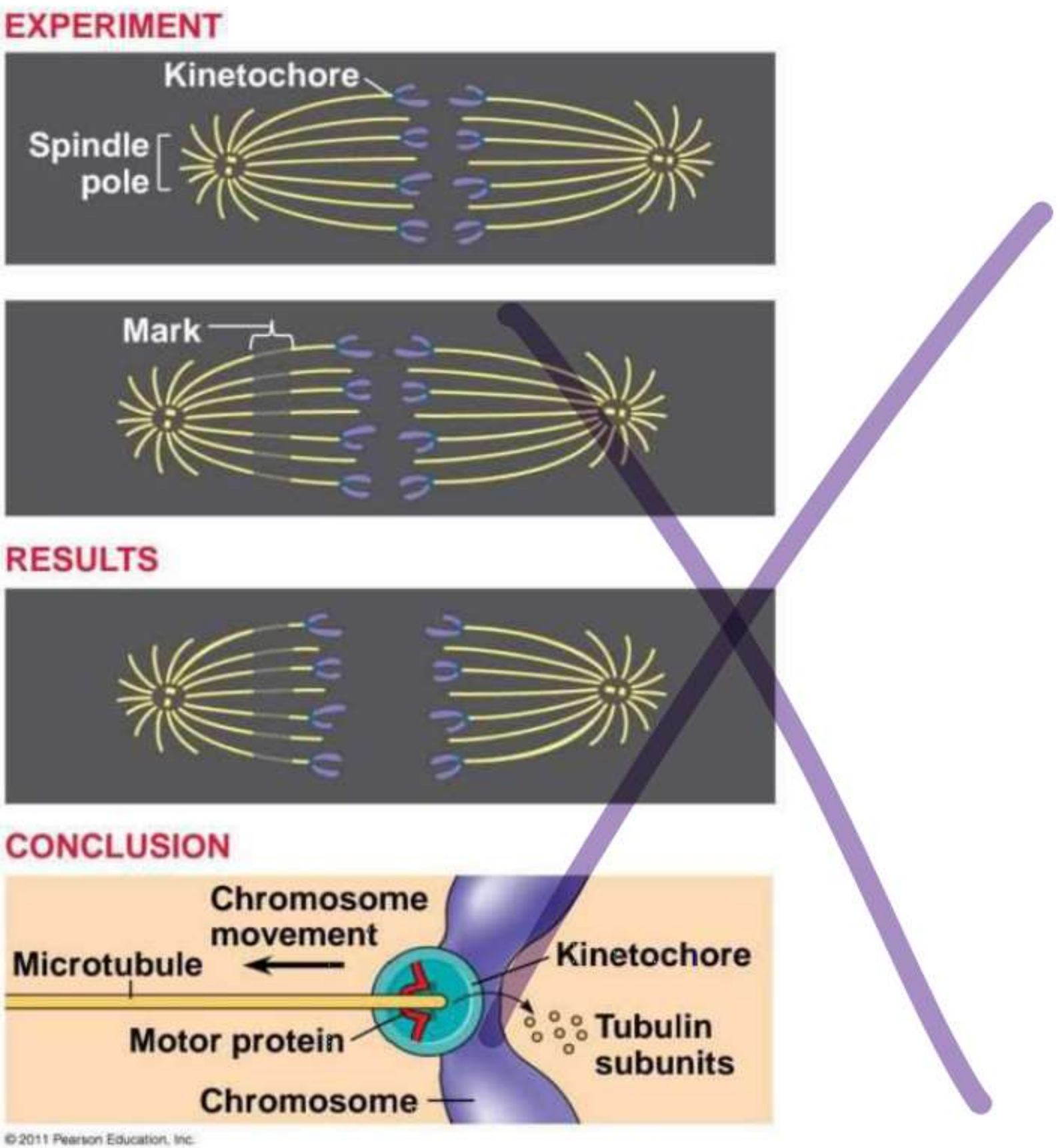
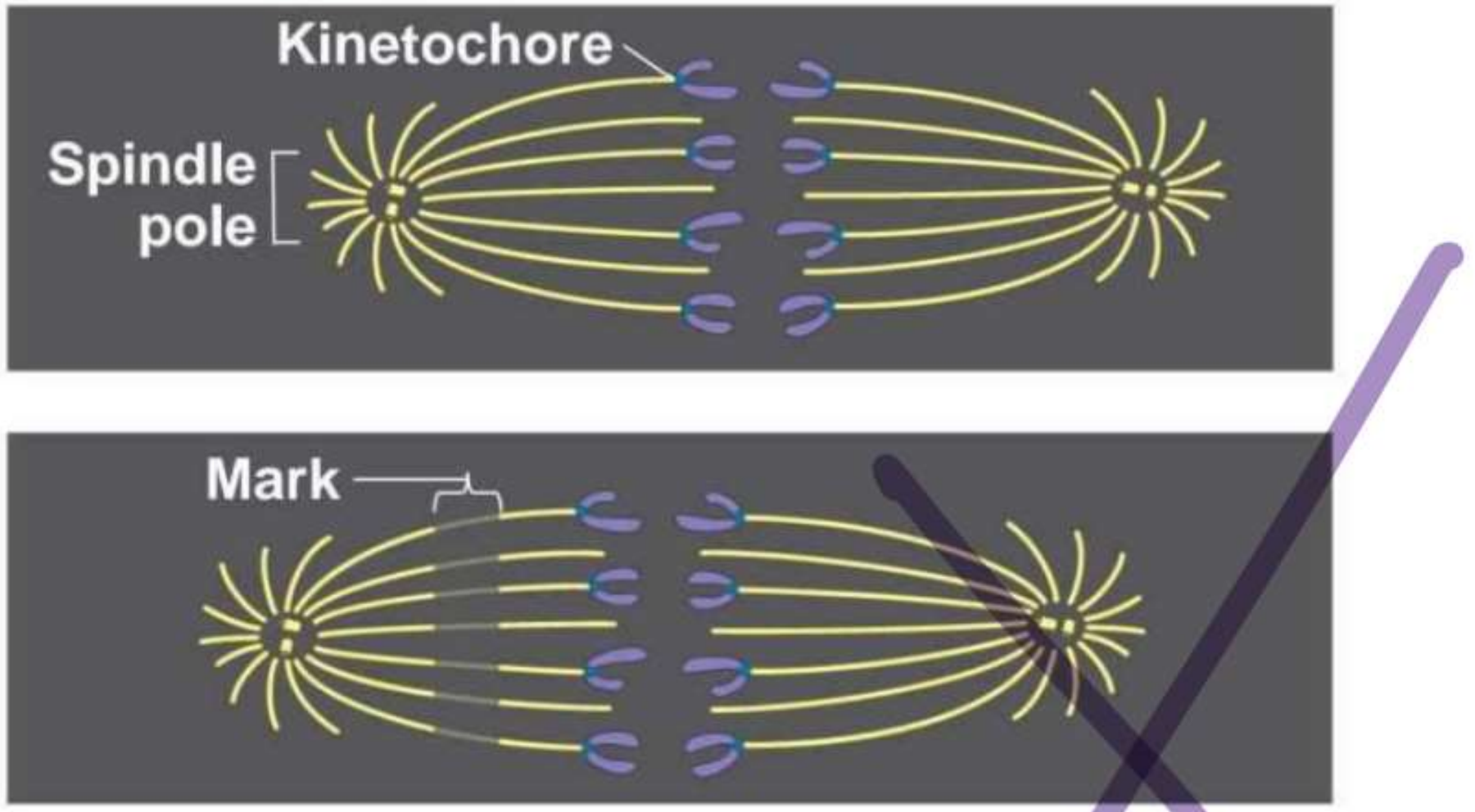


Figure 12.9a

EXPERIMENT



RESULTS

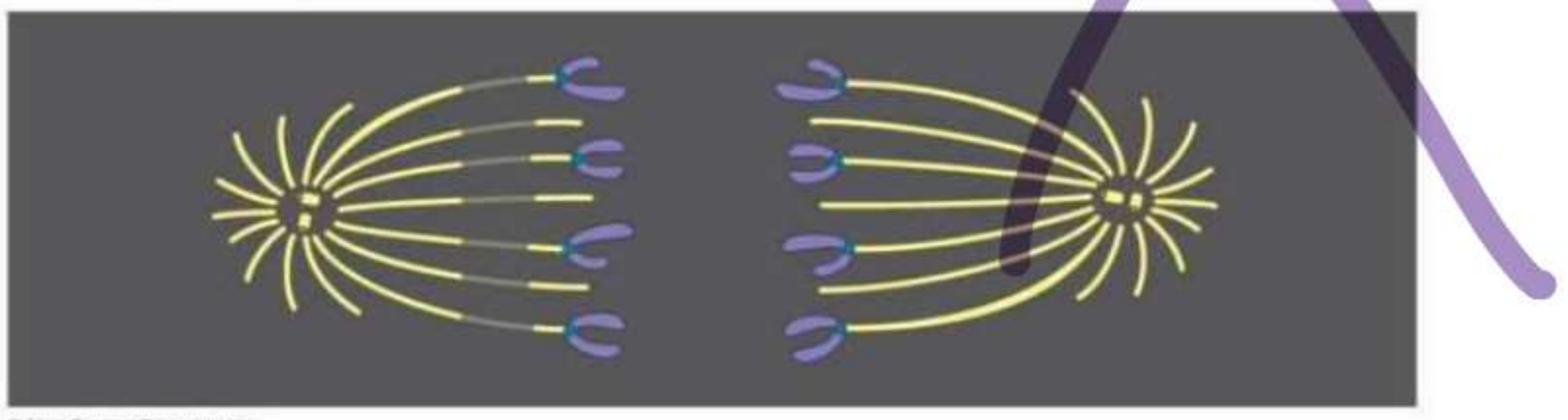
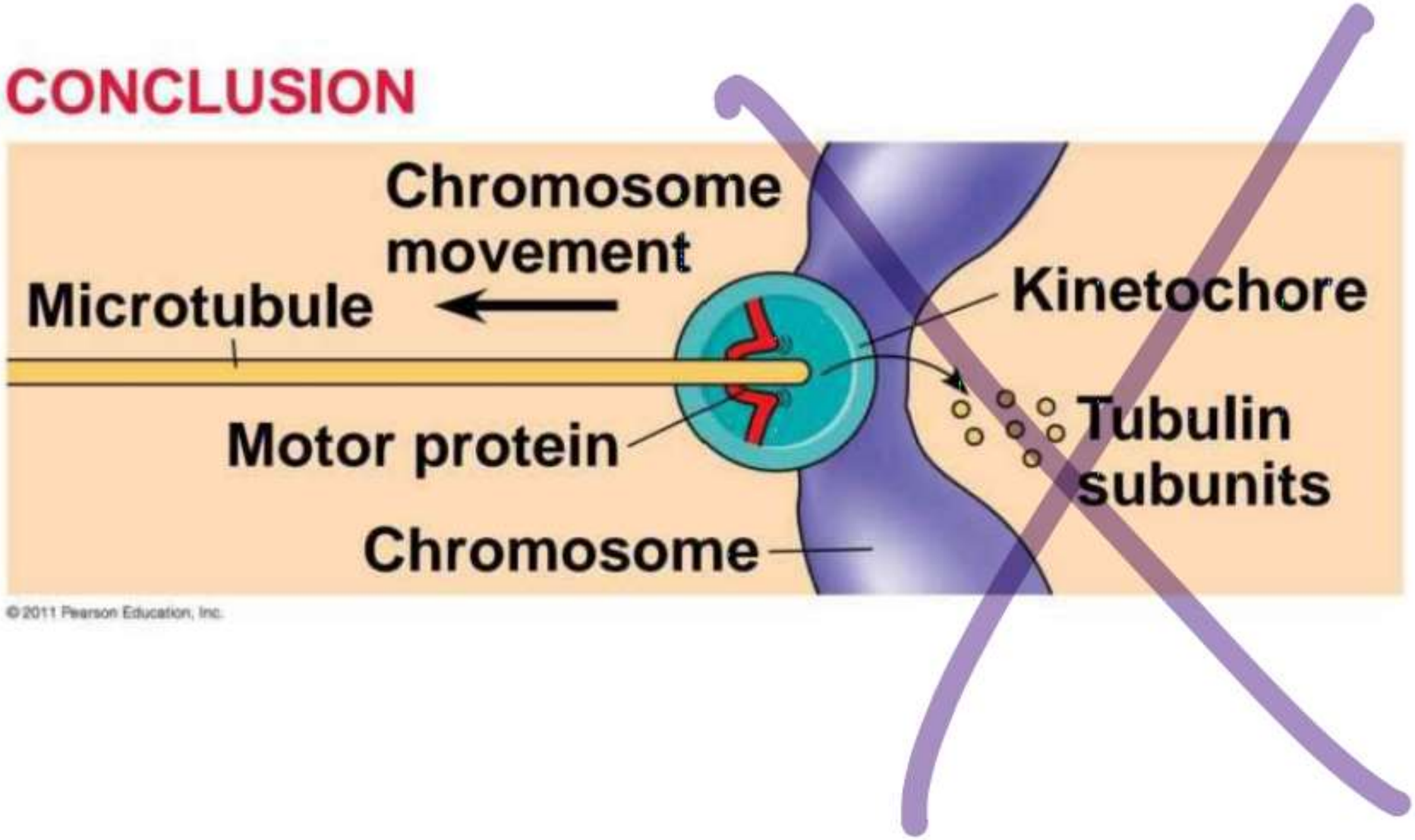


Figure 12.9b



- Nonkinetochore microtubules from opposite poles overlap and push against each other, elongating the cell
- In telophase, genetically identical daughter nuclei form at opposite ends of the cell
- Cytokinesis begins during anaphase or telophase and the spindle eventually disassembles

Cytokinesis: *A Closer Look*

- In animal cells, cytokinesis occurs by a process known as **cleavage**, forming a **cleavage furrow**
- In plant cells, a **cell plate** forms during cytokinesis

PLAY Video: Animal Mitosis

PLAY Video: Sea Urchin (Time Lapse)

Figure 12.10

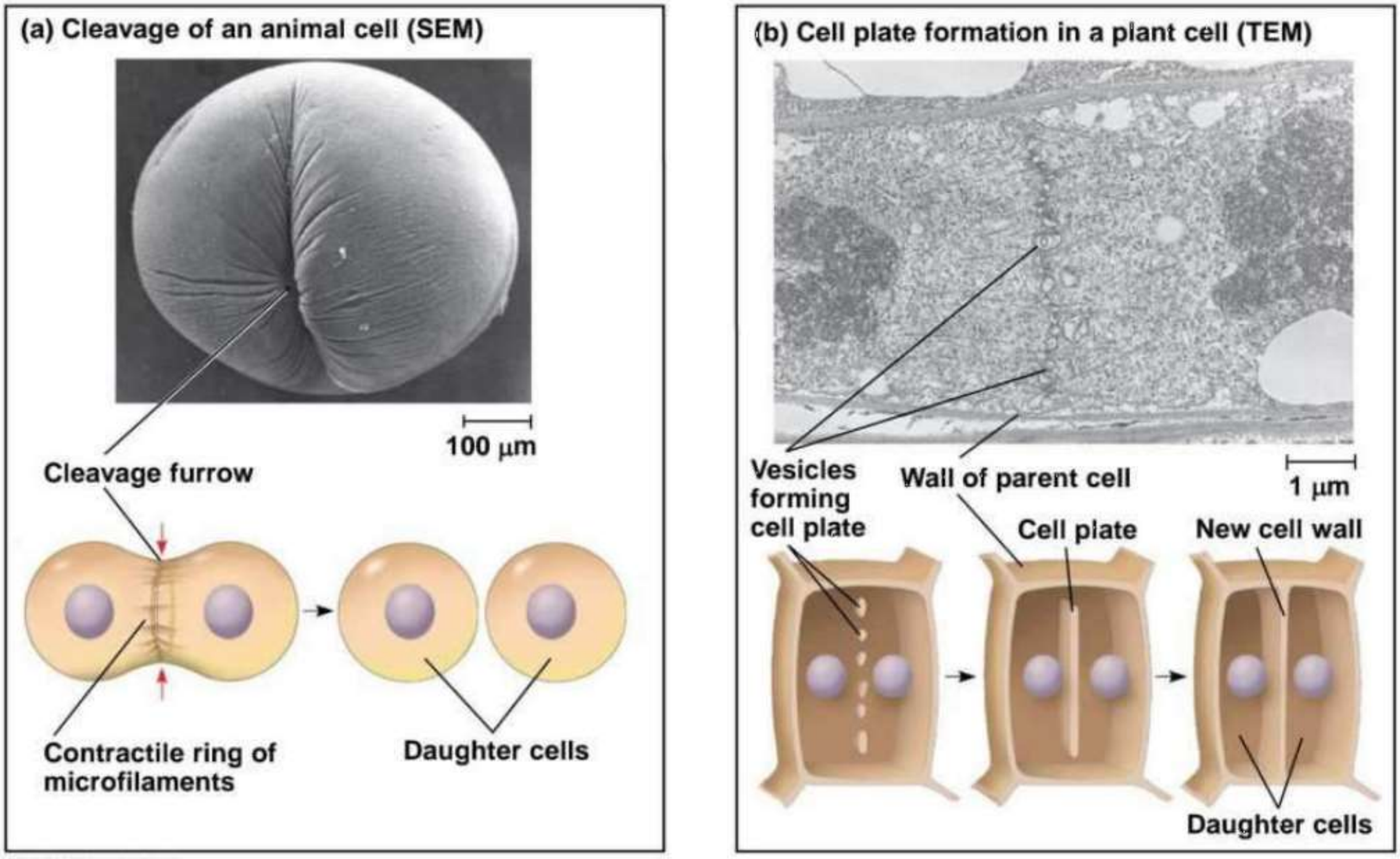
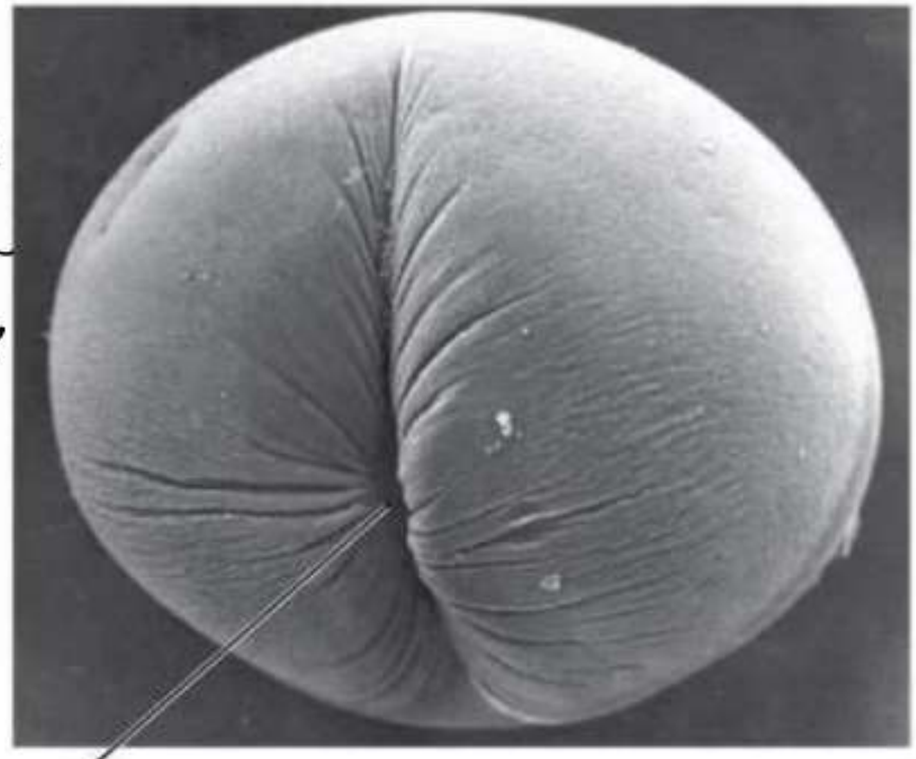


Figure 12.10a

(a) Cleavage of an animal cell (SEM)

cytokinesis in Animal cells: occurs by formation of cleavage furrow with help of microfilaments



no hard protection (cell wall)

– microfilaments: contractile ring of actin

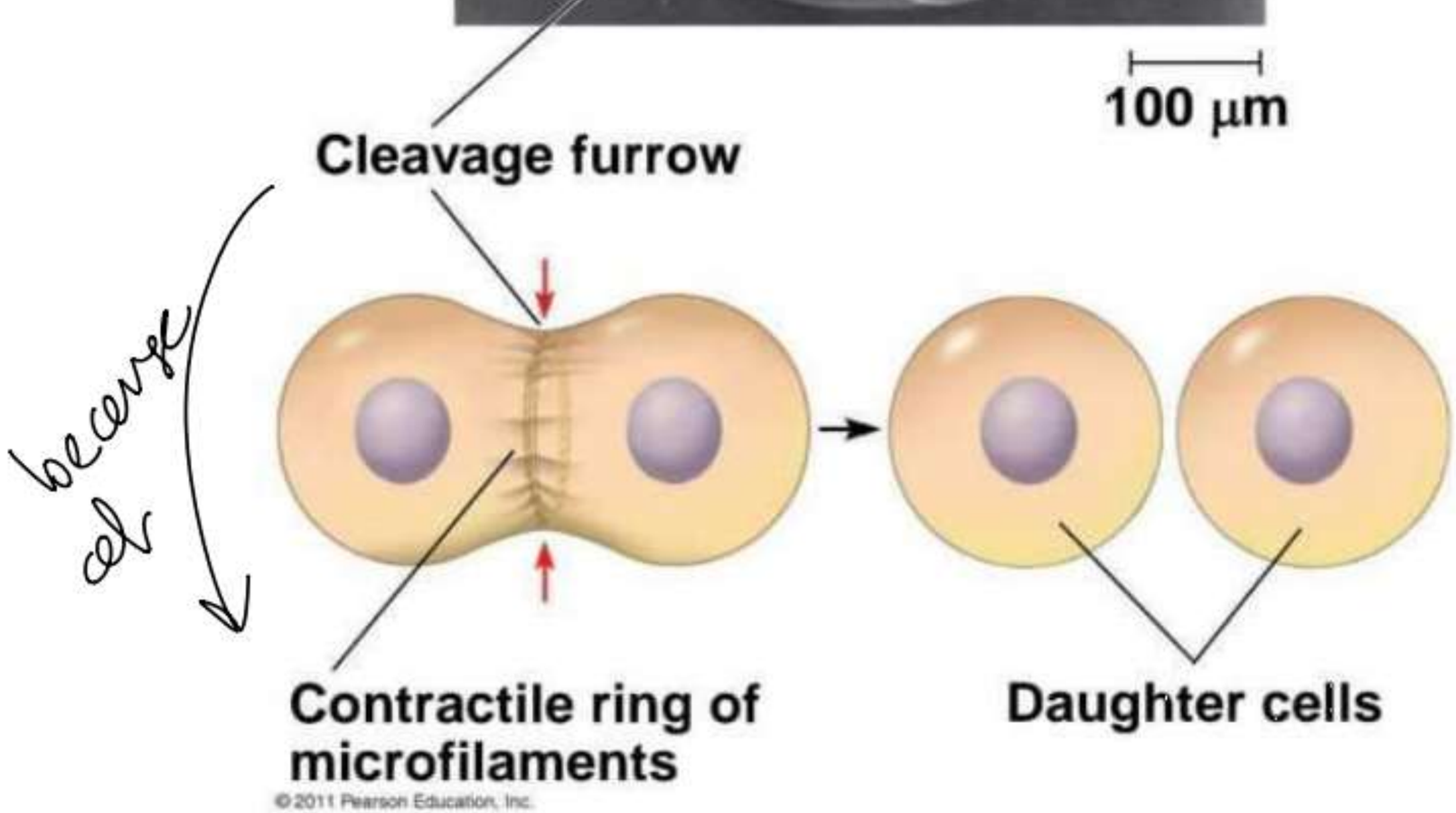
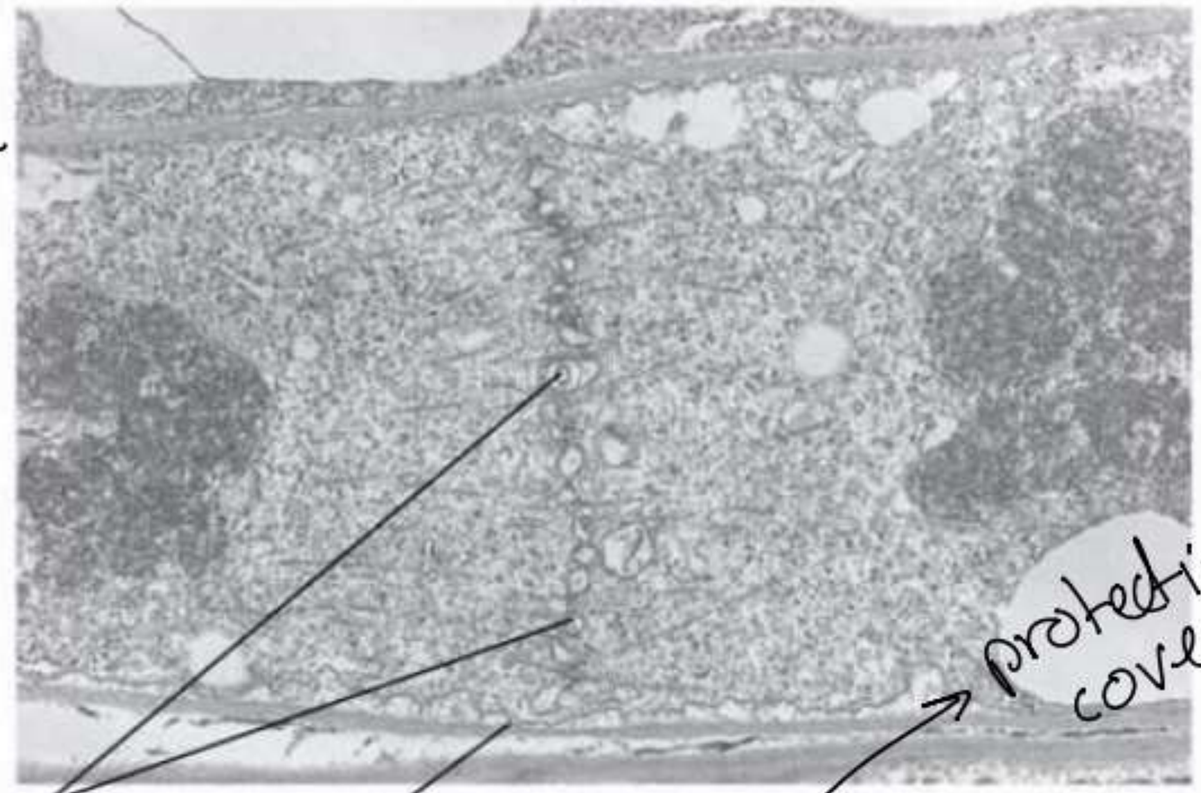
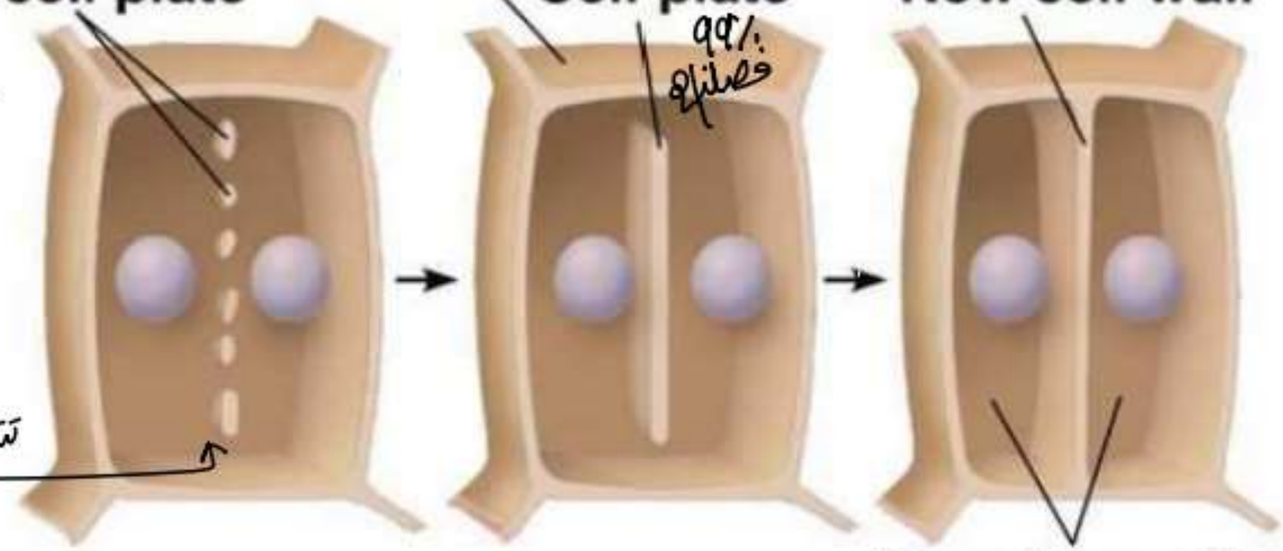


Figure 12.10b

cytokinesis by formation of cell plate then cell wall

(b) Cell plate formation in a plant cell (TEM)





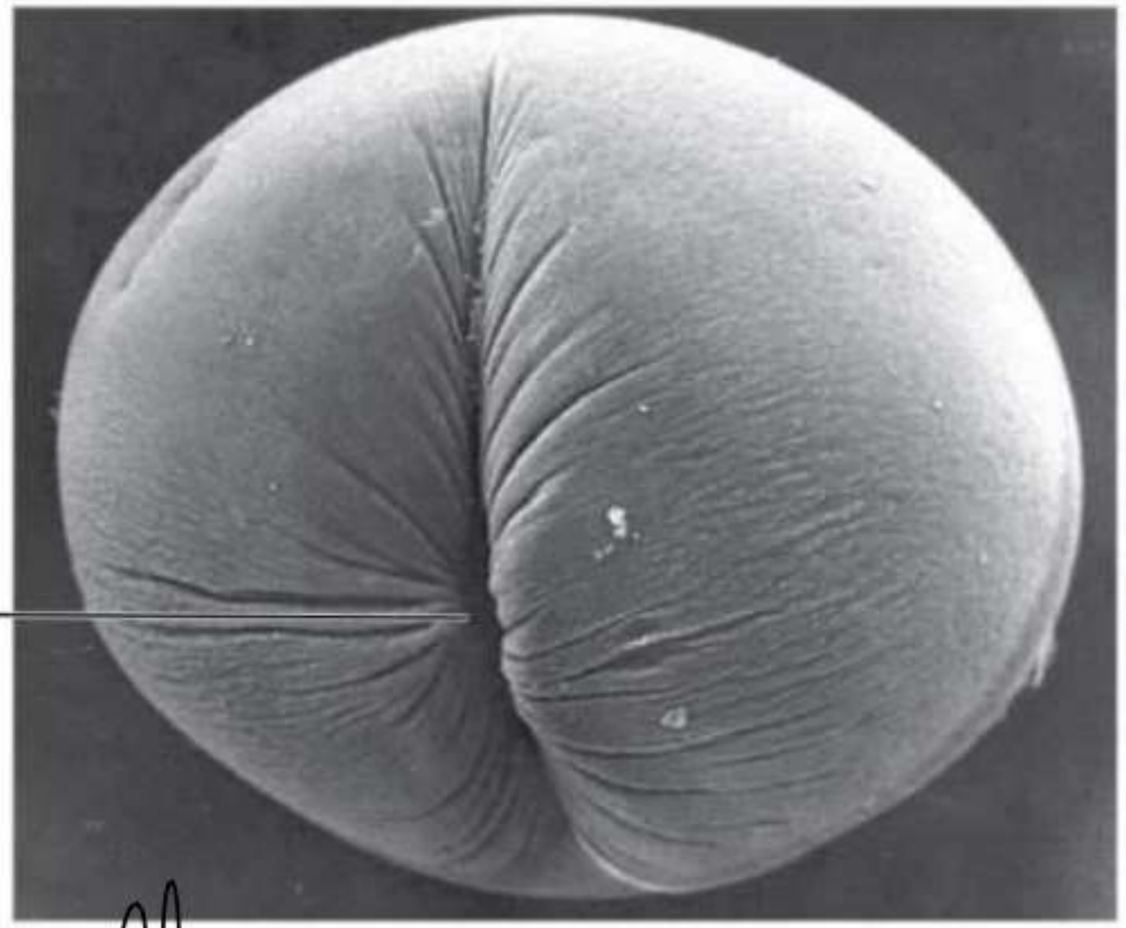
*golgi apparatus manifactures type of carbohydrates that helps in cell wall synthesis

cellulose ... vesicle containing carb.

forming cell plate

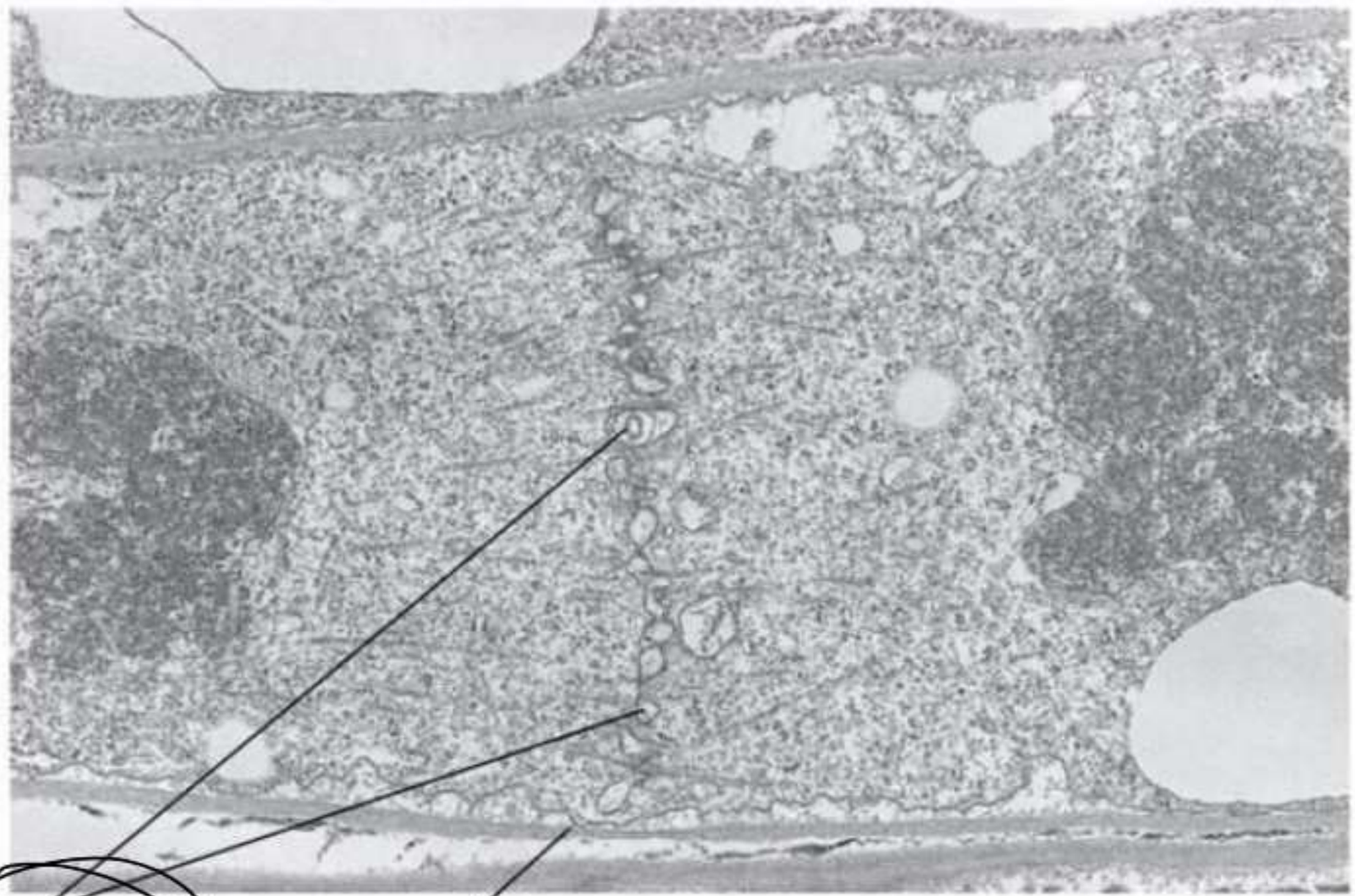
membrane of visicle is the membrane of cell wall of new cell

Figure 12.10c



in animal cell

Figure 12.10d



Vesicles forming cell plate

Wall of parent cell

1 μm

Figure 12.11

مراحل الانقسام في الخلية النباتية

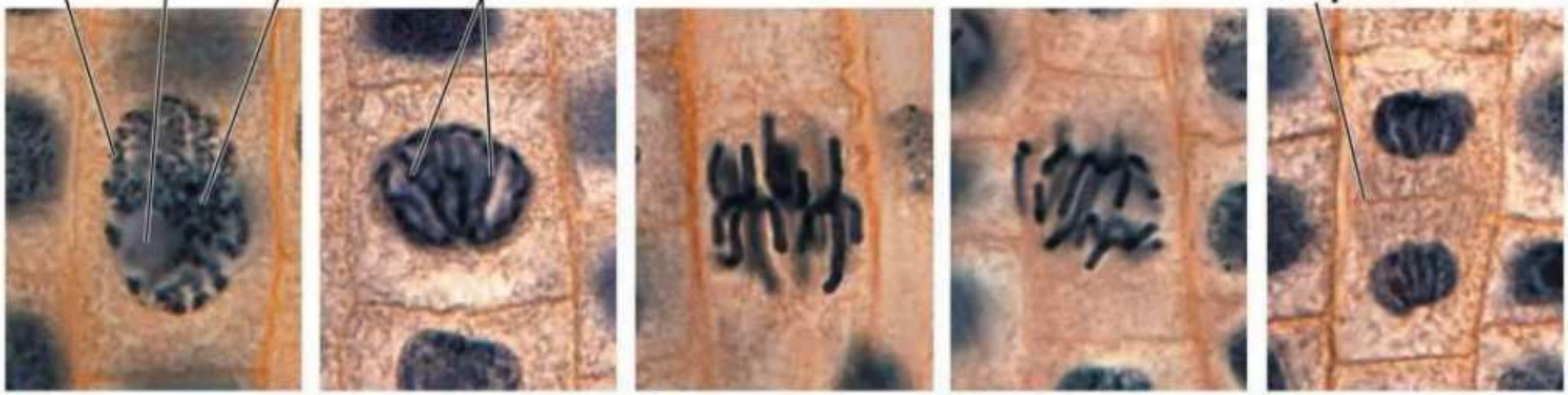
Apical tips in plants

shoot tip
خوصة الارضة
(ساقة تاريخية)

احتووا جميع مراحل mitosis

Root tips
قمم نامية تحت الارضة تحضي الجذور

Nucleus
Chromatin condensing
Nucleolus
Chromosomes
10 µm
Cell plate



1 Prophase
2 Prometaphase
3 Metaphase
4 Anaphase
5 Telophase

Figure 12.11a

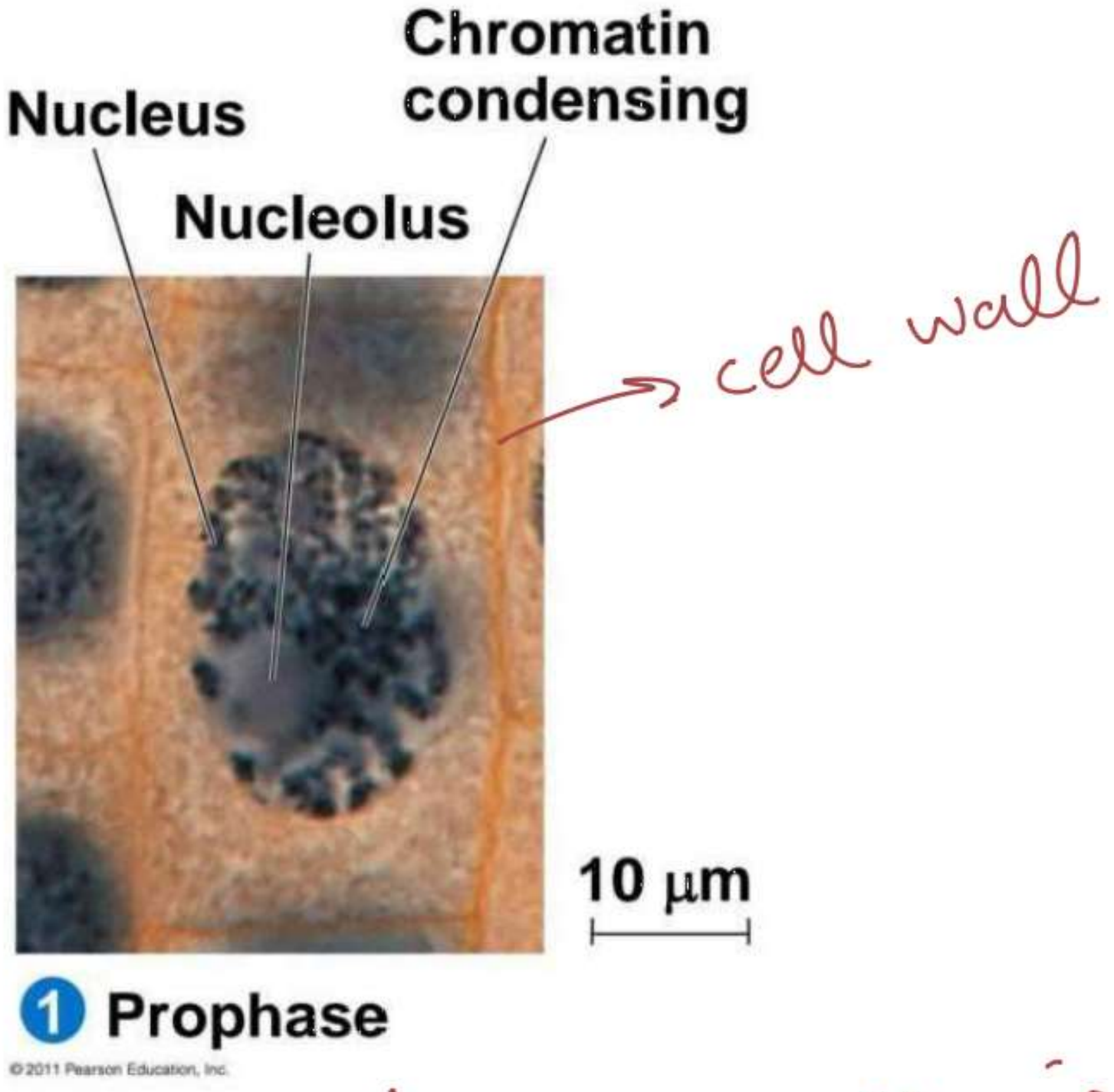


Figure 12.11b

no nuclear envelope

no nucleolus

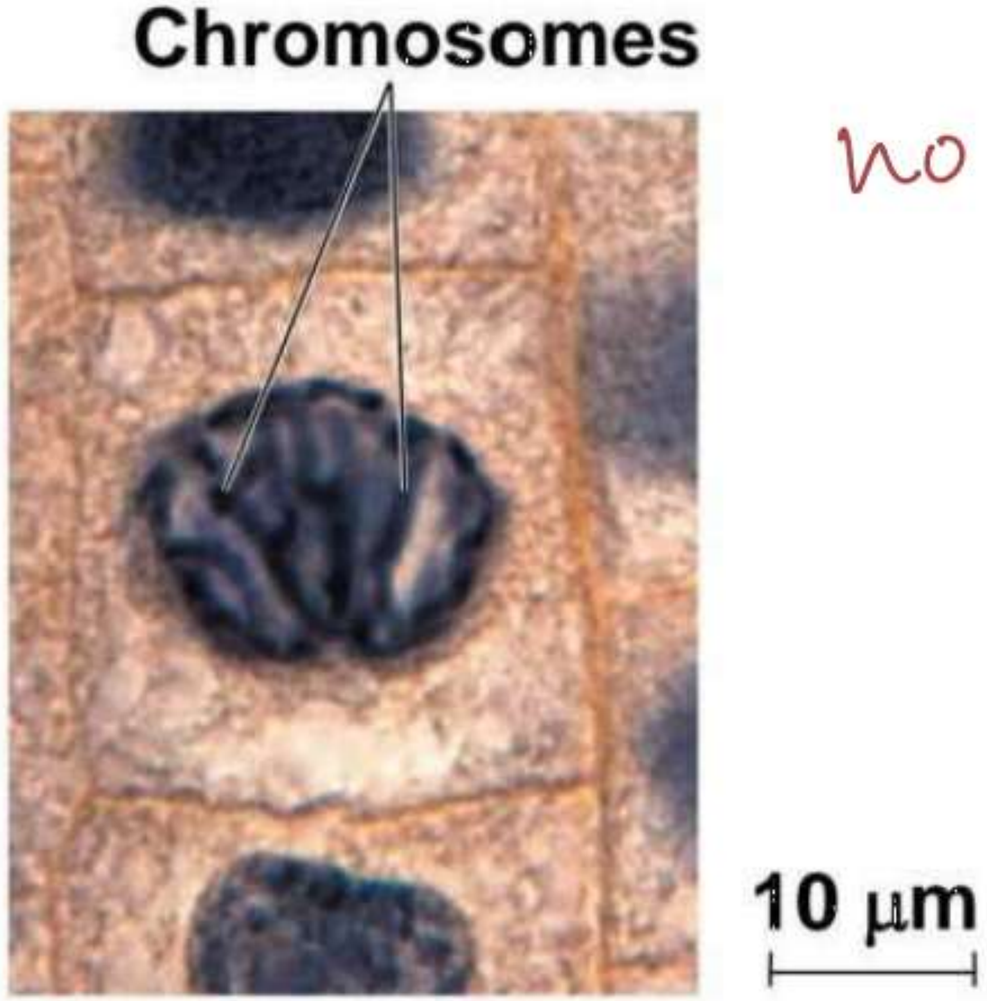


Figure 12.11c

مرتب
ك
metaphase
plate

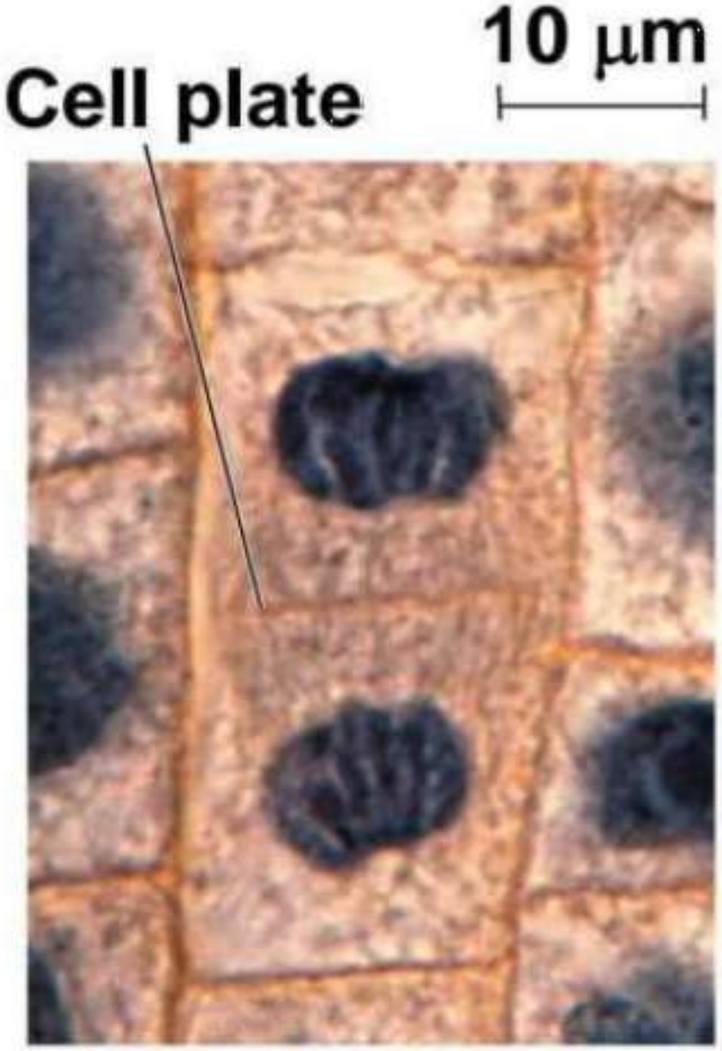
Figure 12.11d

separation of sister chromatids

Figure 12.11e

rate of mitosis in young age is more

growth



Role of mitosis in cells: يلي

1. growth
2. development
3. Repair [regeneration]
4. Asexual Rep

Bacteria, Amoeba, بنات البطاطا

Binary Fission in Bacteria

- Prokaryotes (bacteria and archaea) reproduce by a type of cell division called **binary fission**
- In binary fission, the chromosome replicates (beginning at the **origin of replication**), and the two daughter chromosomes actively move apart
- The plasma membrane pinches inward, dividing the cell into two

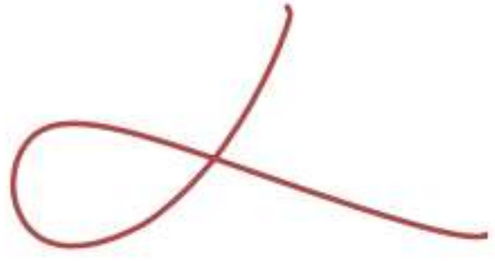
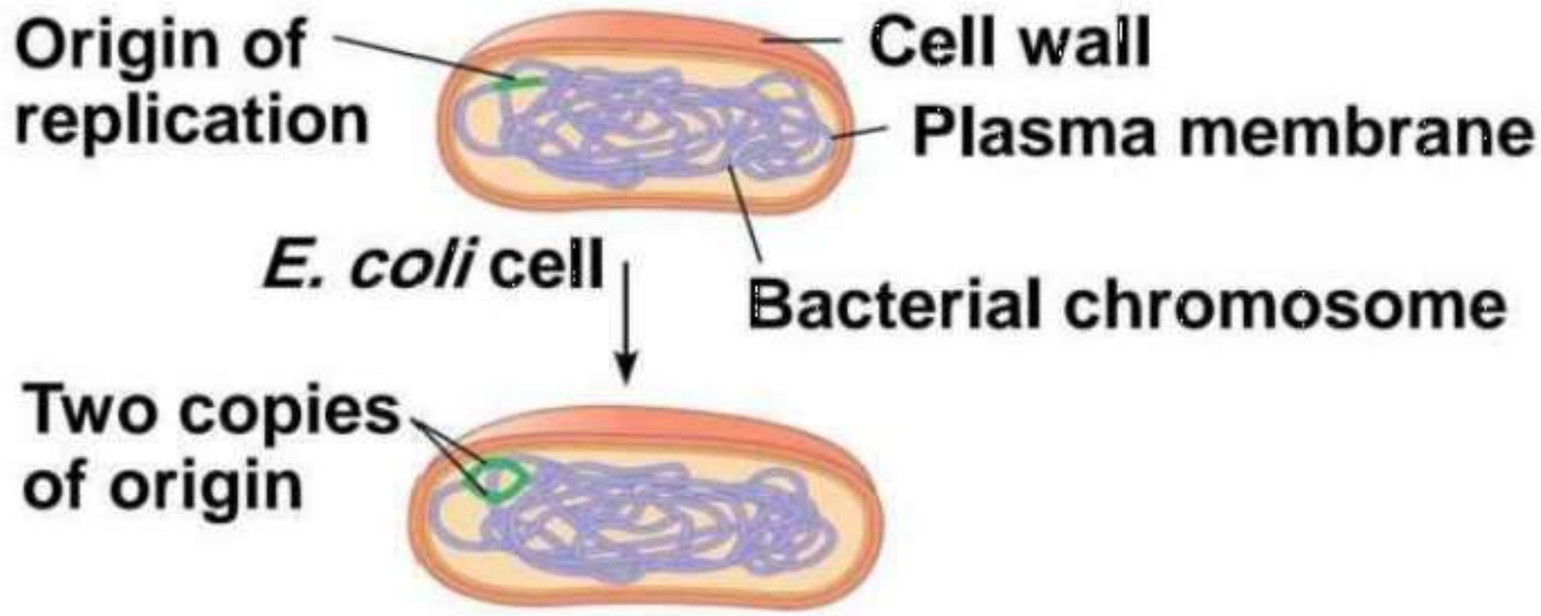


Figure 12.12-1



1 Chromosome replication begins.

Figure 12.12-2

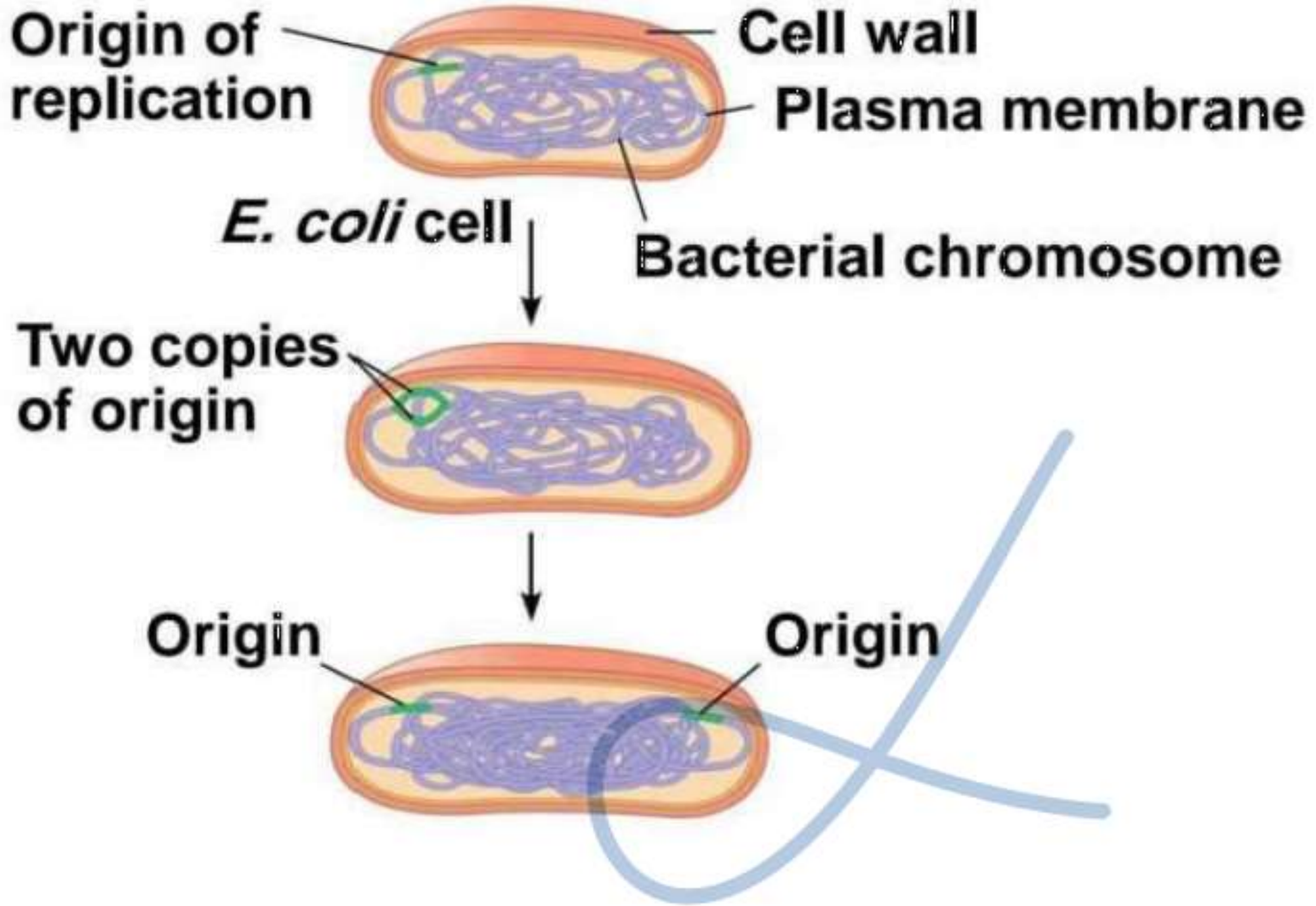


Figure 12.12-3

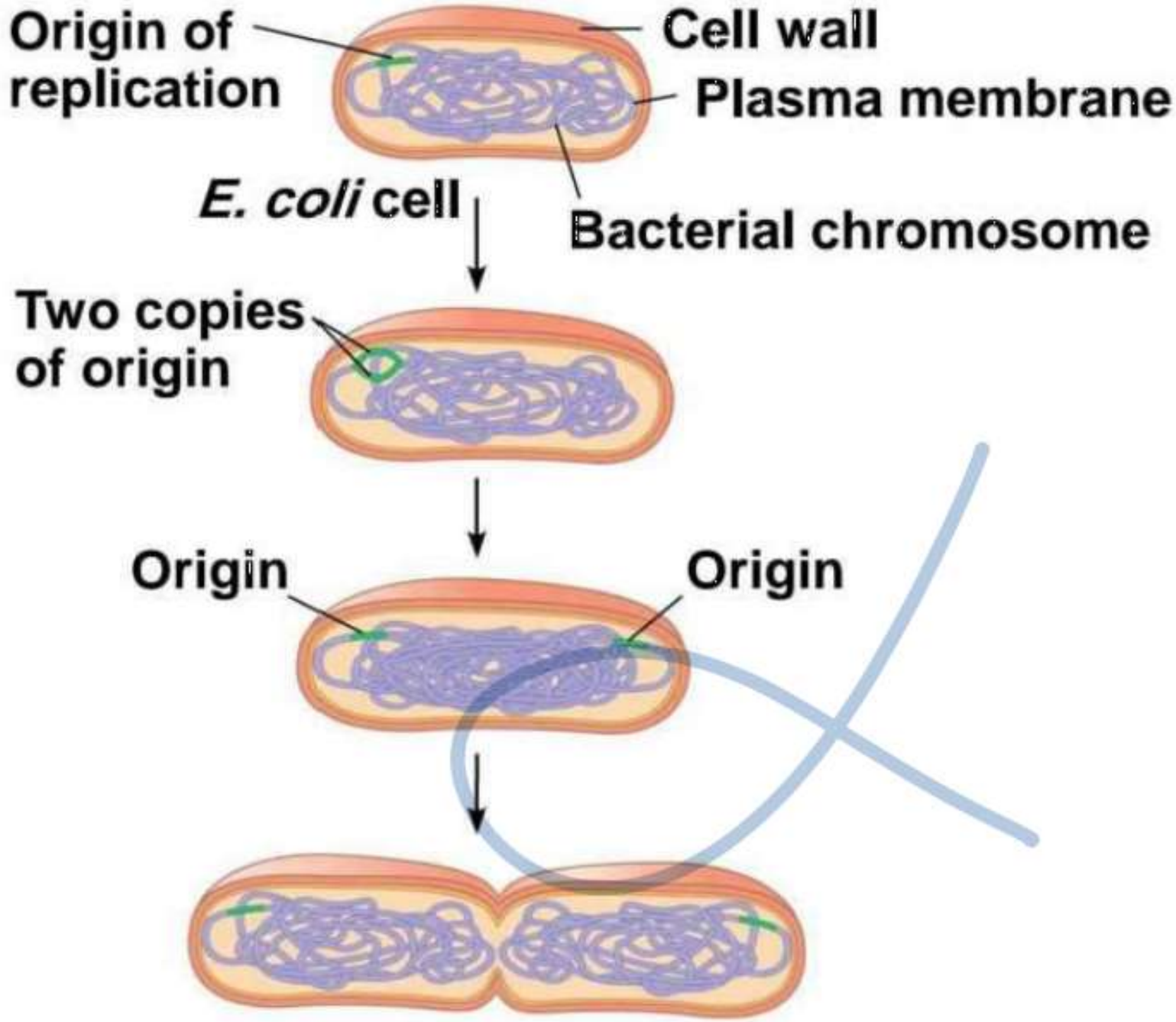
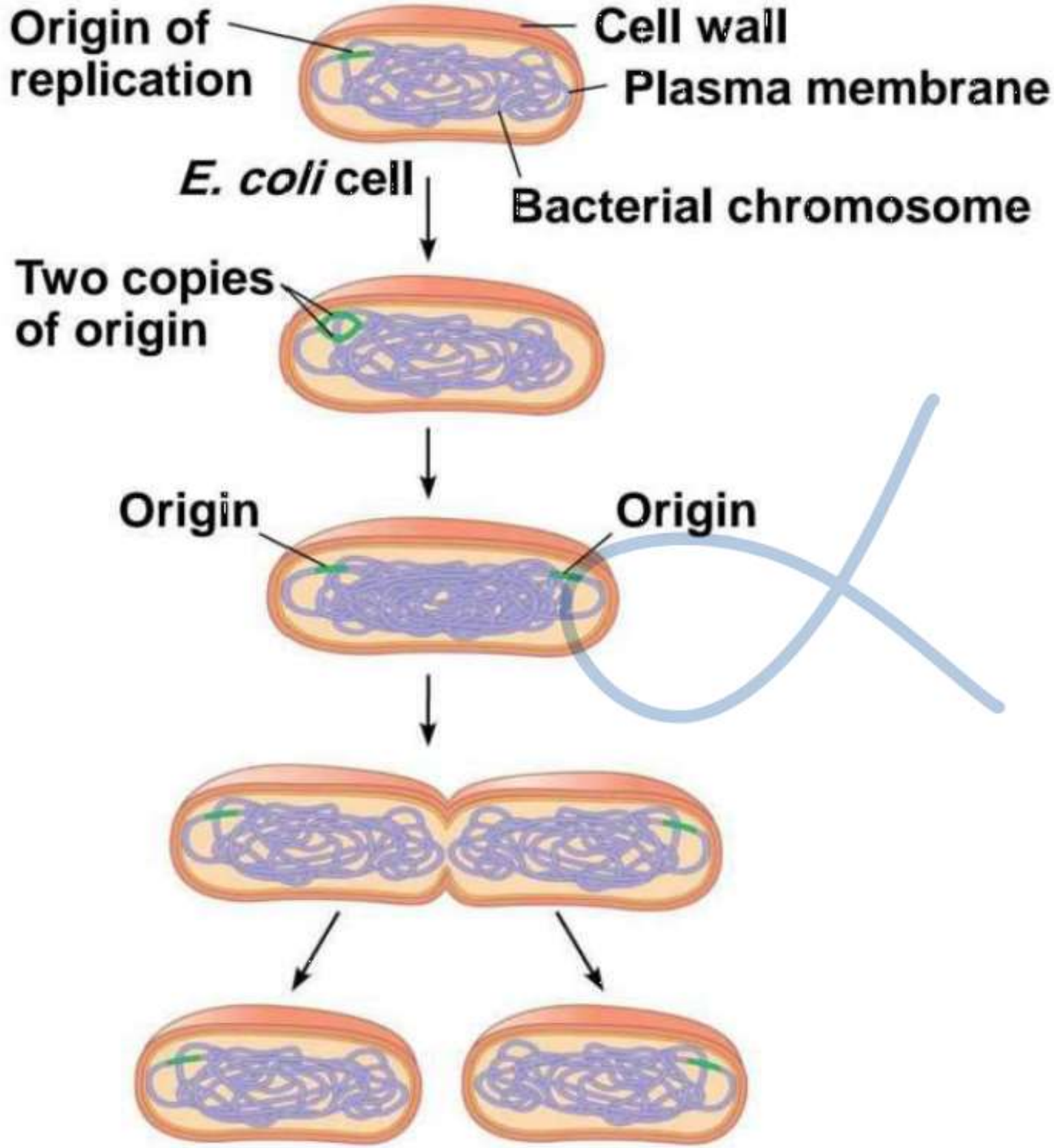


Figure 12.12-4



The Evolution of Mitosis

- Since prokaryotes evolved before eukaryotes, mitosis probably evolved from binary fission
- Certain protists exhibit types of cell division that seem intermediate between binary fission and mitosis

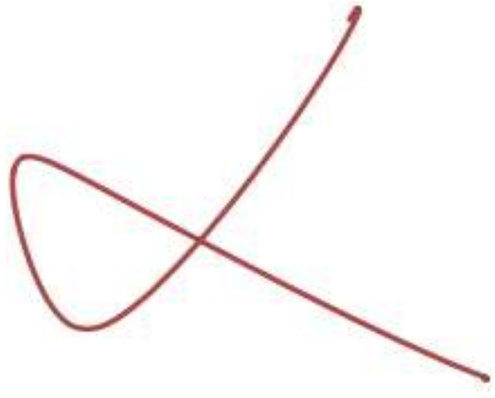
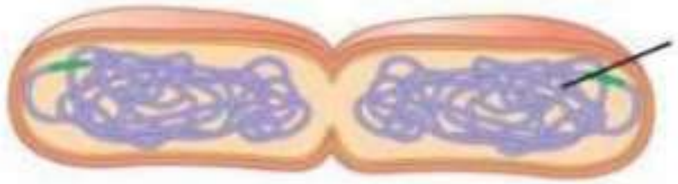
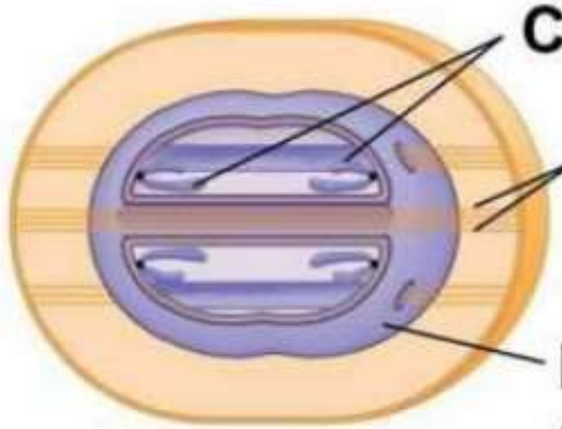


Figure 12.13

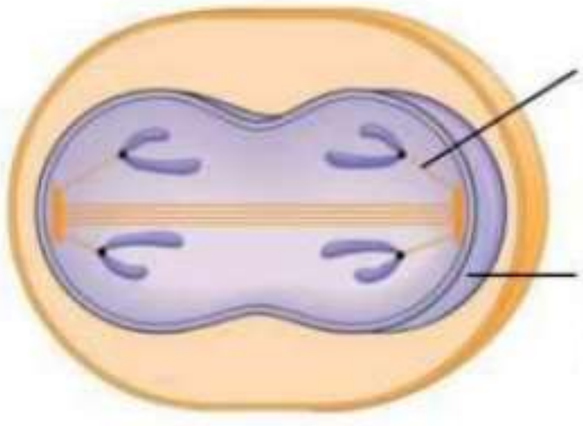
(a) Bacteria



(b) Dinoflagellates



(c) Diatoms and some yeasts



(d) Most eukaryotes

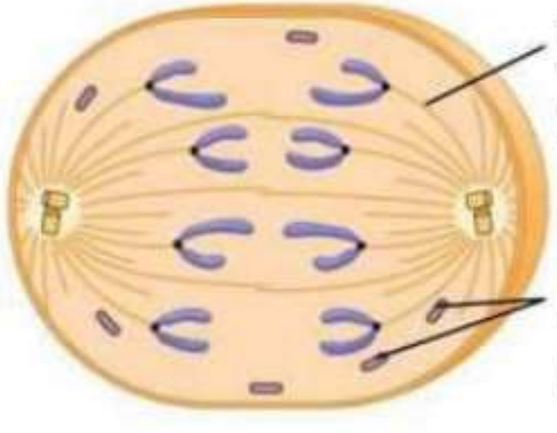


Figure 12.13a

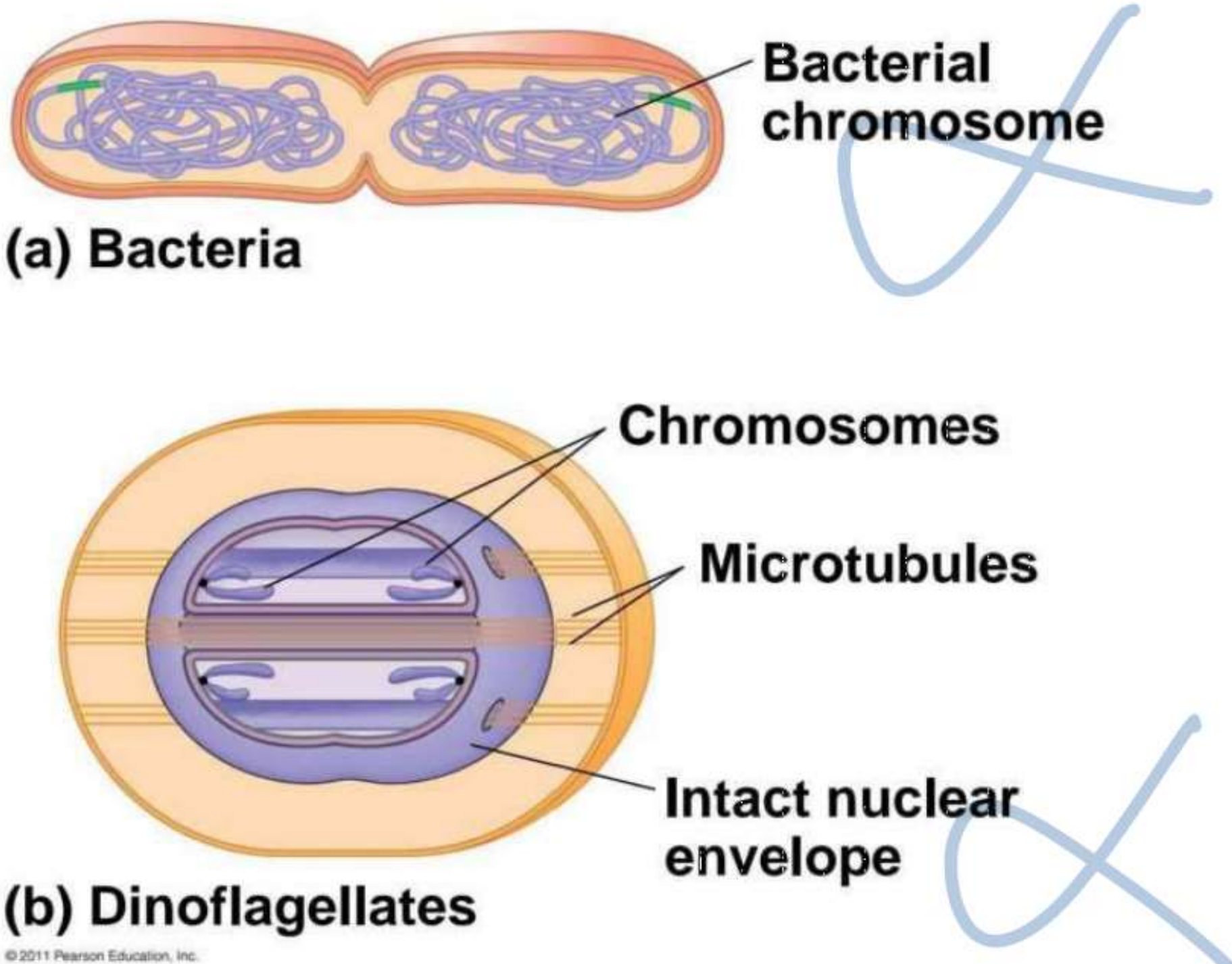
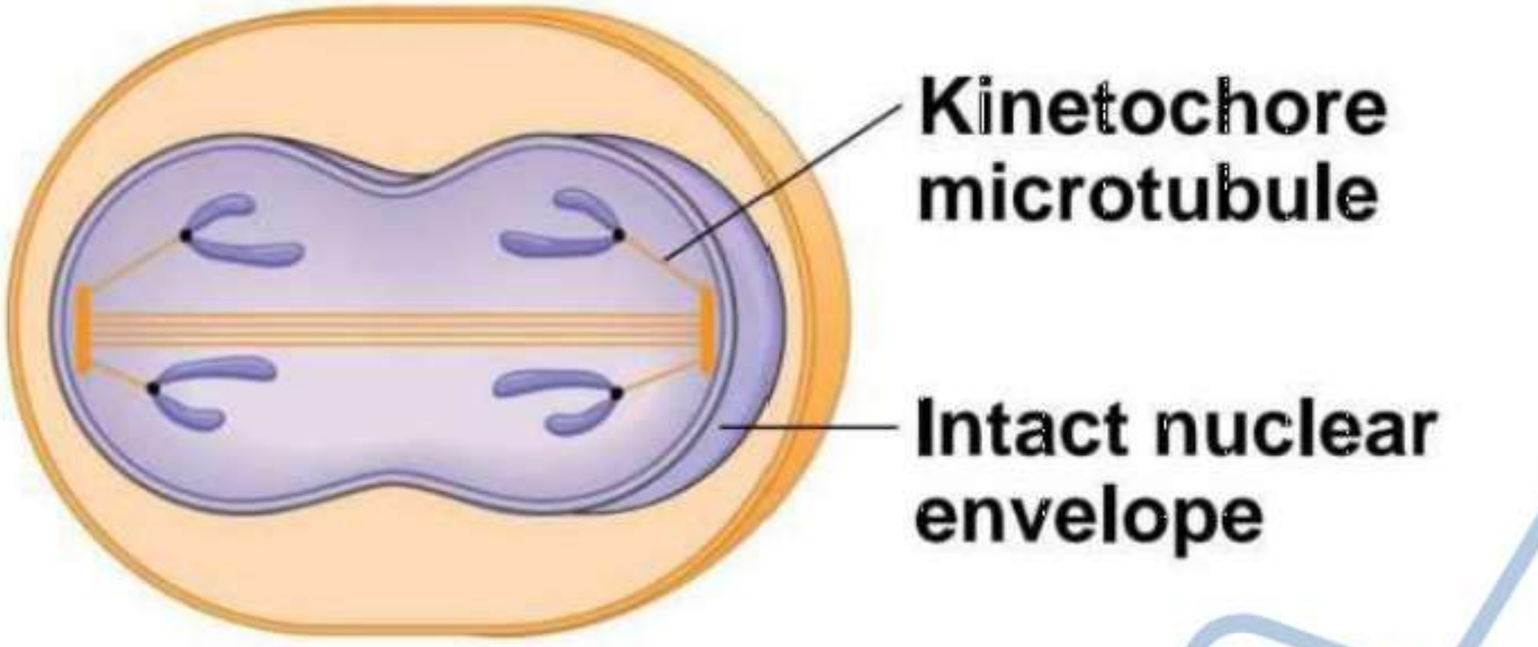
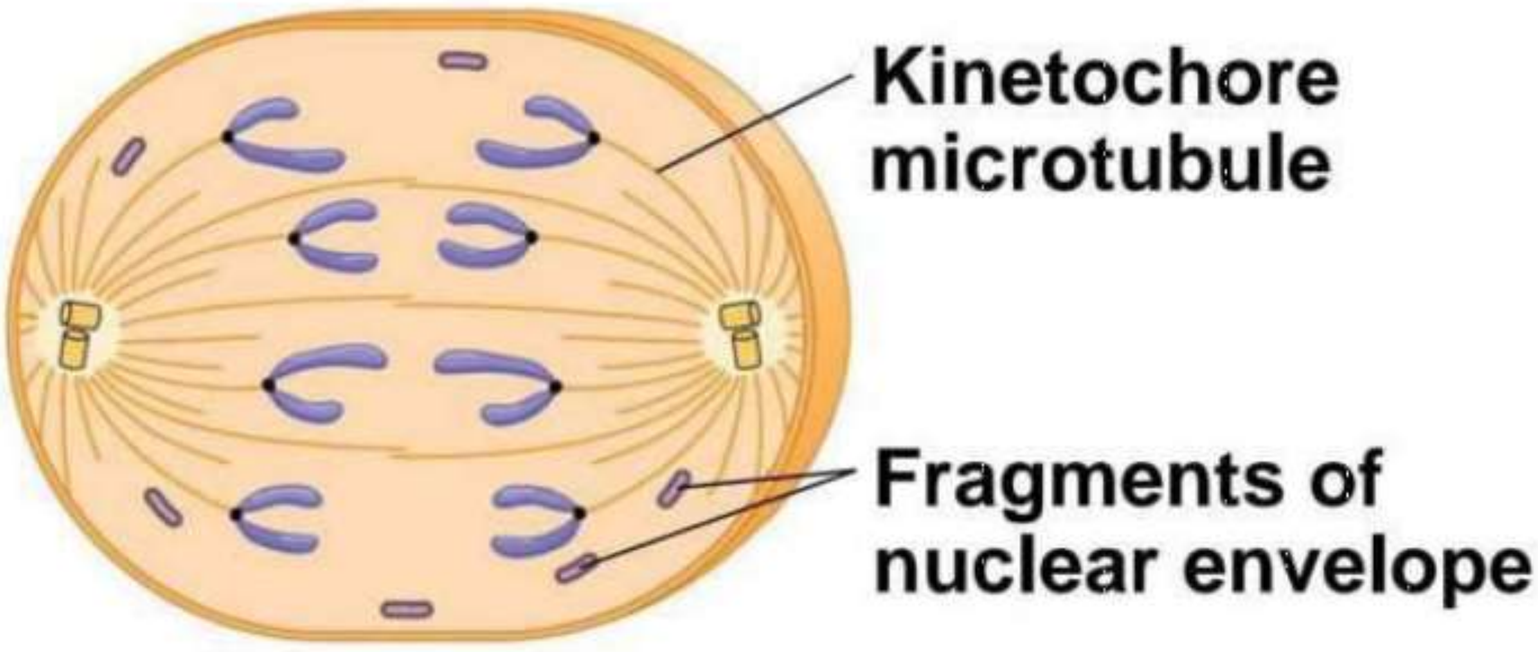


Figure 12.13b



(c) Diatoms and some yeasts



(d) Most eukaryotes

How to regulate/control the cell cycle

Concept 12.3: The eukaryotic cell cycle is regulated by a molecular control system

- The frequency of cell division varies with the type of cell

هش كل الخلايا تنقسم بنفس السرعة أو المعدل ← بسبب

- These differences result from regulation at the molecular level

على مستوى الجزيء

i.e.

- Cancer cells manage to escape the usual controls on the cell cycle

بيخلقو عليها the normal regulation system

تنقسم بسرعة كبيرة جداً

importance of cell cycle control

The timing and rate of cell division in different parts of a plant or animal are crucial to normal growth, development, and maintenance. The frequency of cell division varies with the type of cell. ① For example, human skin cells divide frequently throughout life, whereas ② liver cells maintain the ability to divide but keep it in reserve until an appropriate need arises—say, to repair a wound. ③ Some of the most specialized cells, such as fully formed nerve cells and muscle cells, do not divide at all in a mature human. These cell cycle differences result from regulation at the molecular level. The mechanisms of this regulation are of great interest, not only to understand the life cycles of normal cells but also to learn how cancer cells manage to escape the usual controls.

① → خلايا الجلد تبقى تنقسم وتتجدد طوال العمر [لو انجرح عمو كبير ← ح يلتئم الجرح]

② liver cells have the ability for division, ولكن ما تنقسم ٢٤ ساعة، تحتفظ بقدرتها تلك إلى وقت الحاجة (a)

③ (b)

الأهمية (a) + (b)

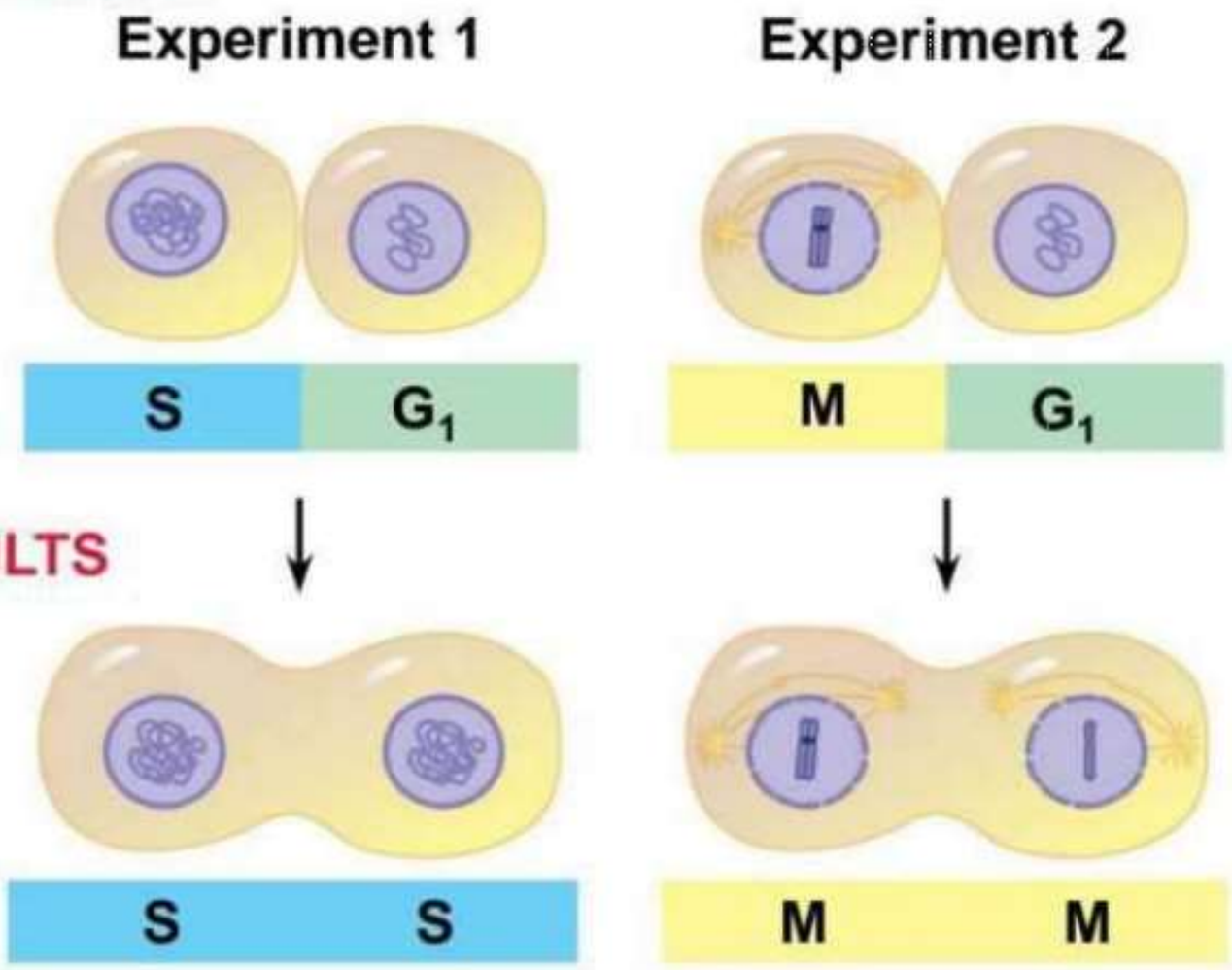
Evidence for Cytoplasmic Signals

- The cell cycle appears to be driven by specific chemical signals present in the cytoplasm
- Some evidence for this hypothesis comes from experiments in which cultured mammalian cells at different phases of the cell cycle were fused to form a single cell with two nuclei

Conclusion The results of fusing a G_1 cell with a cell in the S or M phase of the cell cycle suggest that molecules present in the cytoplasm during the S or M phase control the progression to those phases.

Figure 12.14

EXPERIMENT



When a cell in the S phase was fused with a cell in G_1, the G_1 nucleus immediately entered the S phase—DNA was synthesized.

When a cell in the M phase was fused with a cell in G_1, the G_1 nucleus immediately began mitosis—a spindle formed and chromatin condensed, even though the chromosome had not been duplicated.

G_1 → M phase
skipped stages

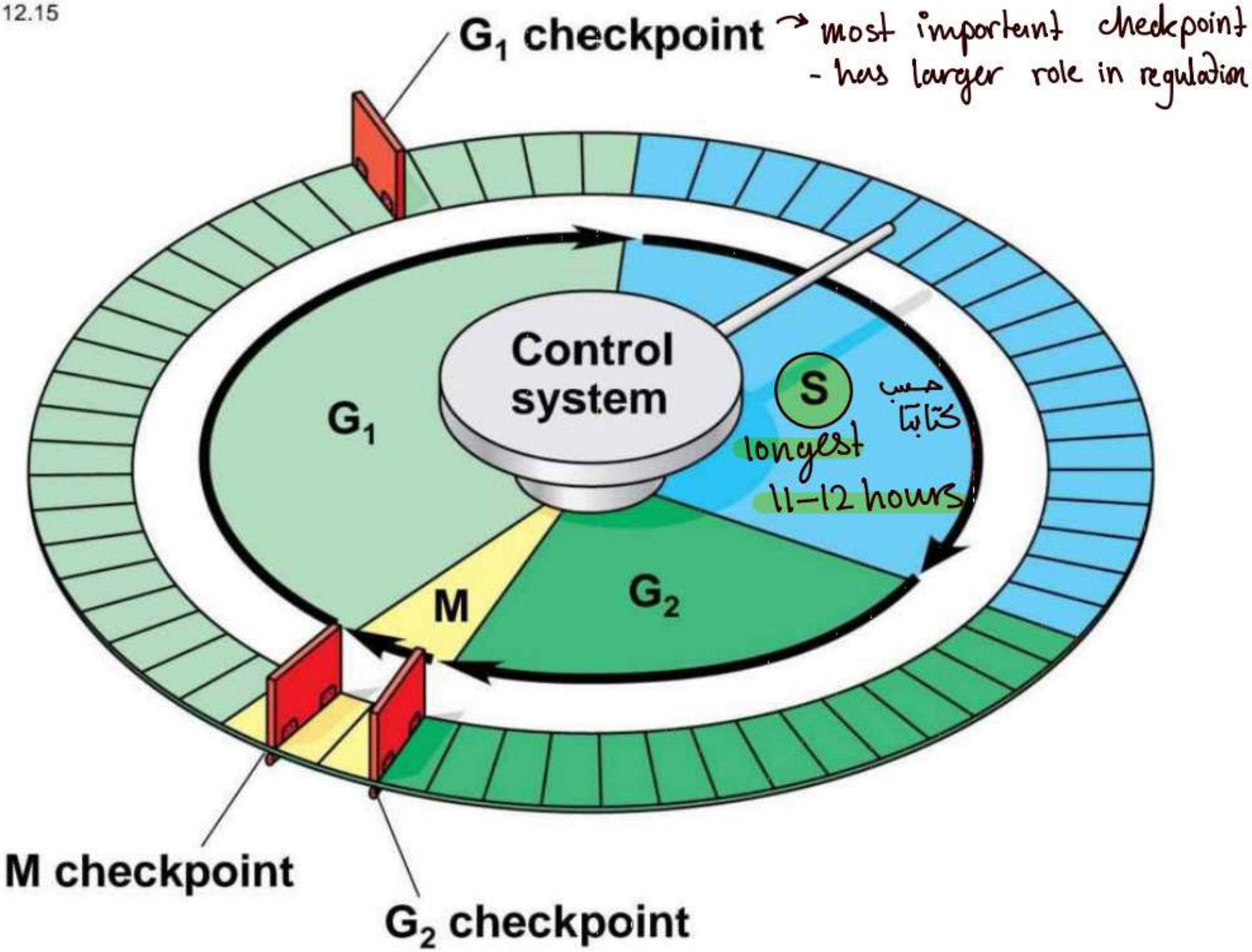
ماهرقت
s phase

The Cell Cycle Control System

- The sequential events of the cell cycle are directed by a distinct **cell cycle control system**, which is similar to a clock [clock wise]
- The cell cycle control system is regulated by both internal and external controls → بكلوها ماتروح بالاتجاه العكسي
  unidirectional بكلوها
- The clock has specific **checkpoints** where the cell cycle stops until a go-ahead signal is received

* we have 3 checkpoints
  - G_1 checkpoint in G_1 phase
  - G_2 checkpoint [btw G_2 & M]
  - M checkpoint in M phase

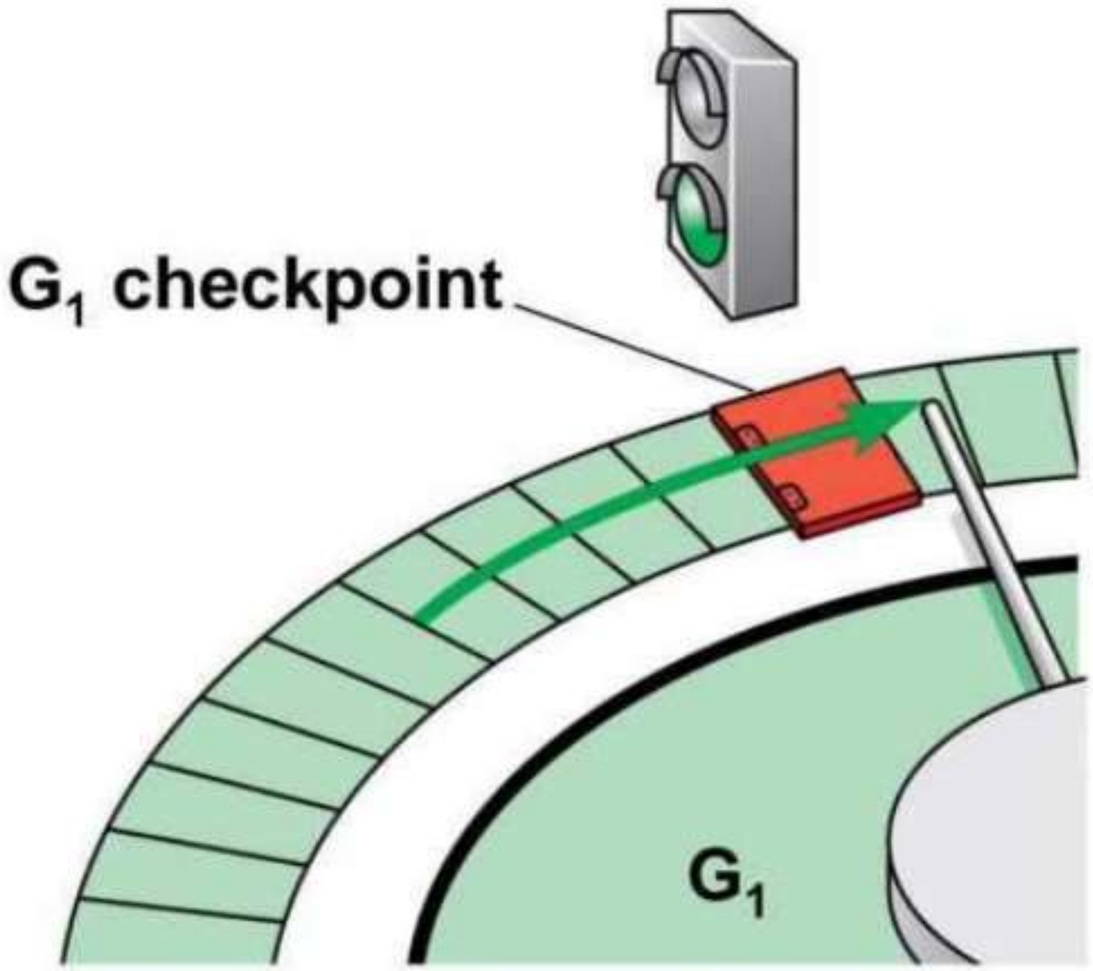
Figure 12.15



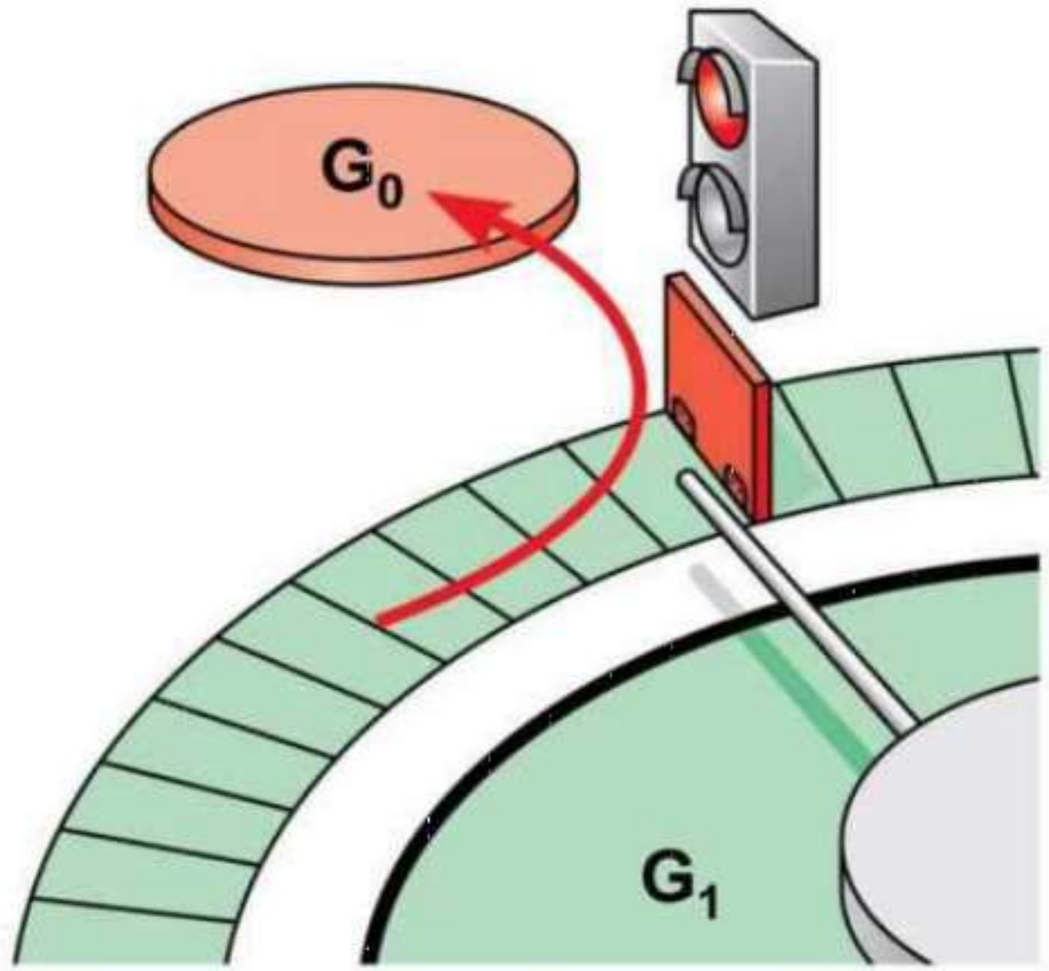
- For many cells, the G_1 checkpoint seems to be the most important
- If a cell receives a go-ahead signal at the G_1 checkpoint, it will usually complete the S, G_2, and M phases and divide
- If the cell does not receive the go-ahead signal, it will exit the cycle, switching into a nondividing state called the **G_0 phase**

ممكن تبقى فيه وممكن تطلع منه وتكمل دورة الخلية

Figure 12.16

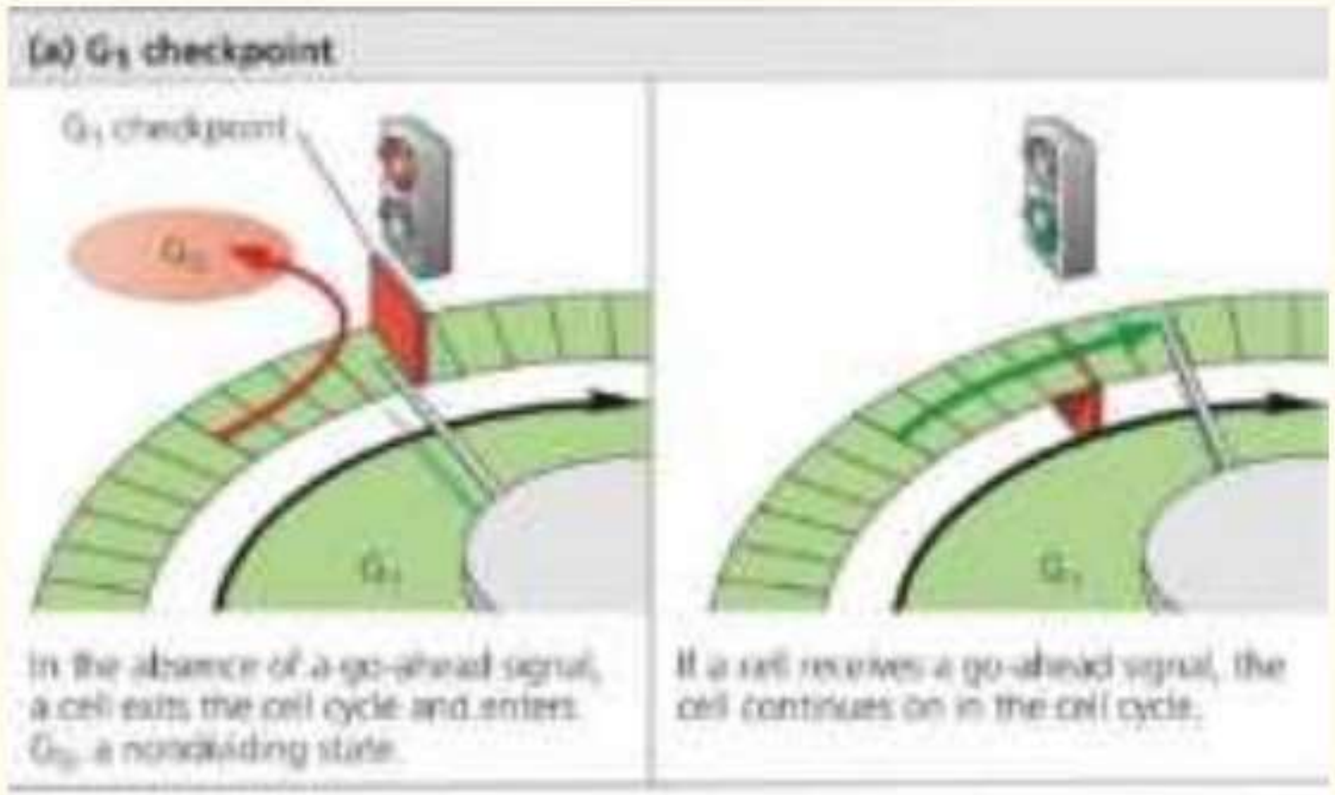


(a) Cell receives a go-ahead signal.



(b) Cell does not receive a go-ahead signal.

[stop signal]

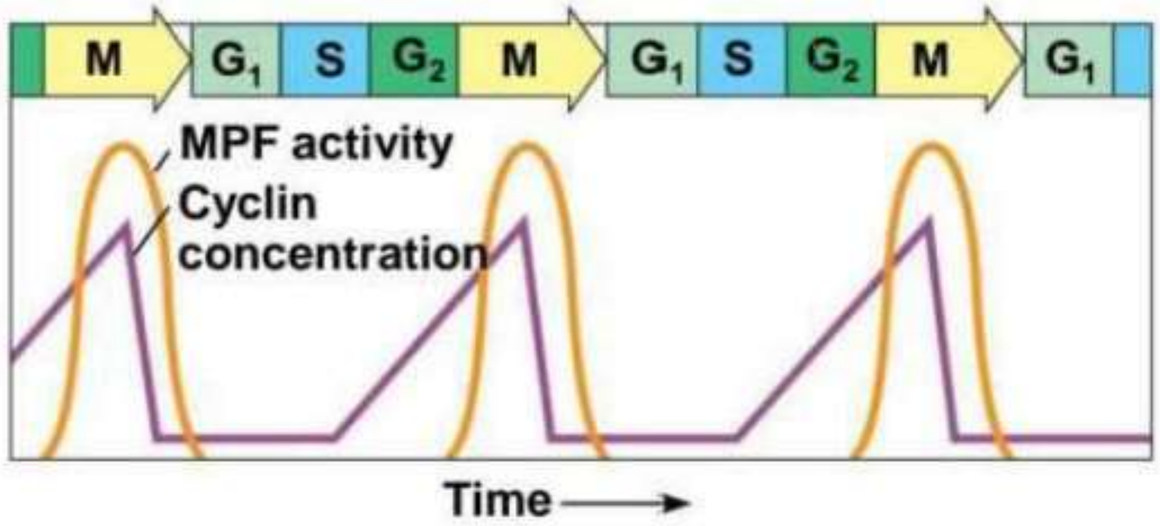


at least 1 chromosome isn't attached to the spindle fibre ⟹ stop signal

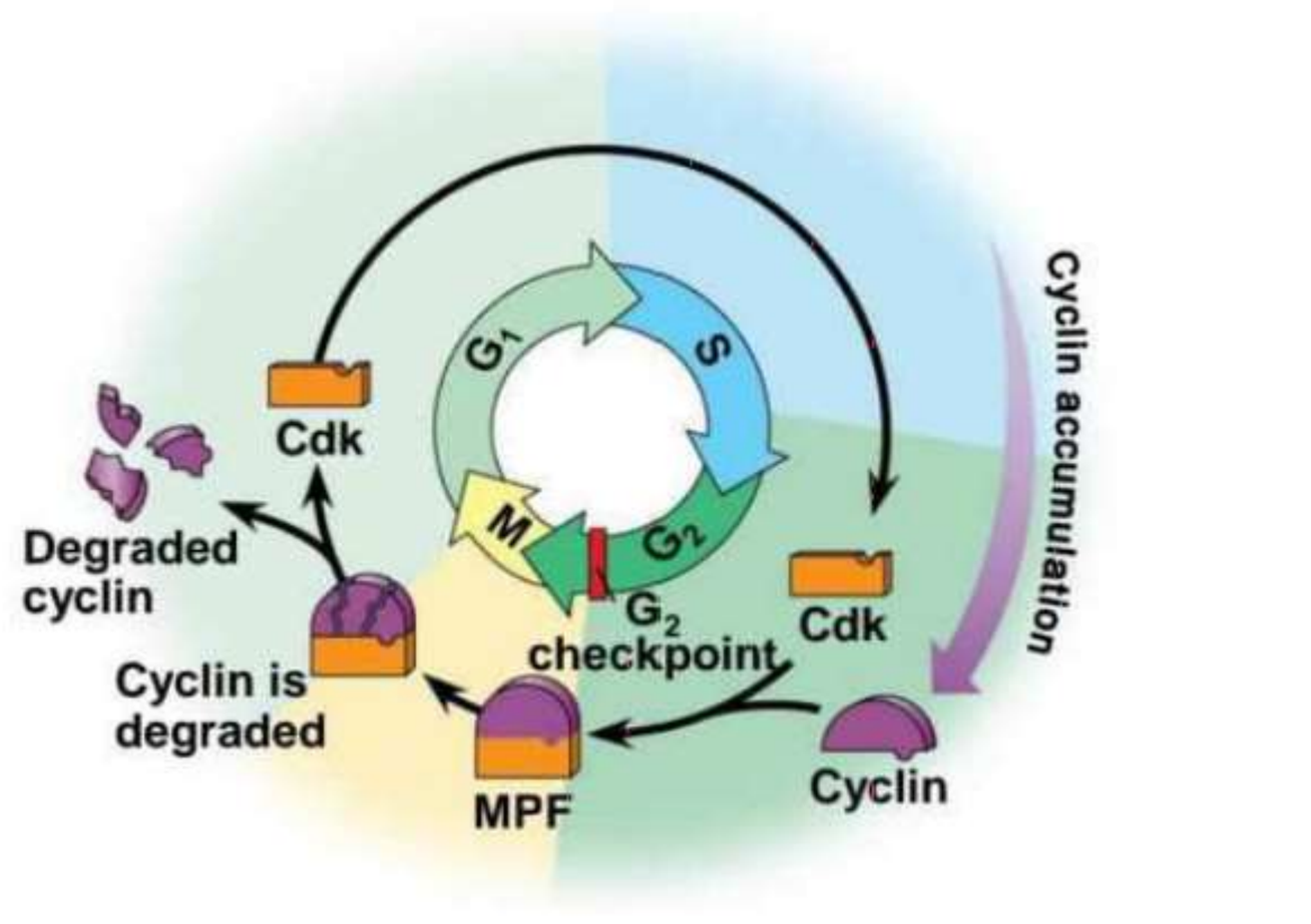
The Cell Cycle Clock: Cyclins and Cyclin-Dependent Kinases

- Two types of regulatory proteins are involved in cell cycle control: **cyclins** and **cyclin-dependent kinases (Cdks)**
- Cdks activity fluctuates during the cell cycle because it is controled by cyclins, so named because their concentrations vary with the cell cycle
- **MPF** (maturation-promoting factor) is a cyclin-Cdk complex that triggers a cell's passage past the G_2 checkpoint into the M phase

Figure 12.17

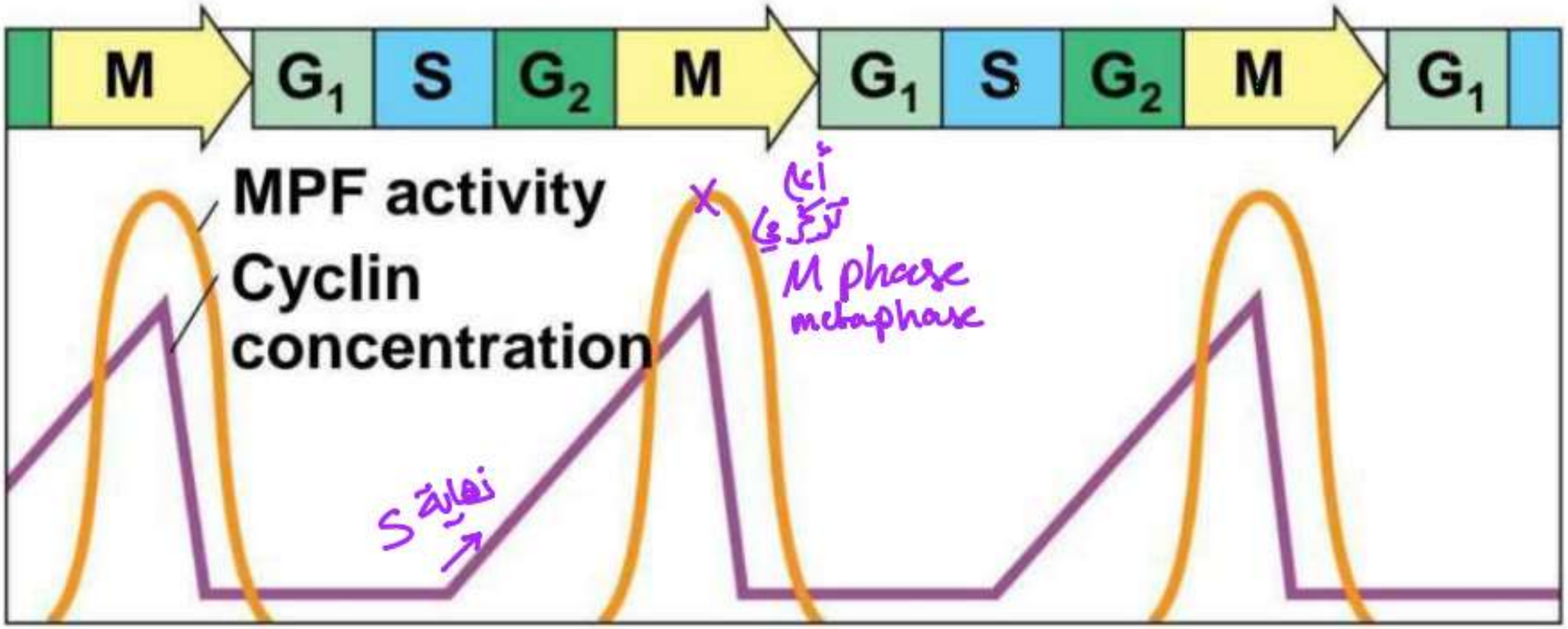


(a) Fluctuation of MPF activity and cyclin concentration during the cell cycle



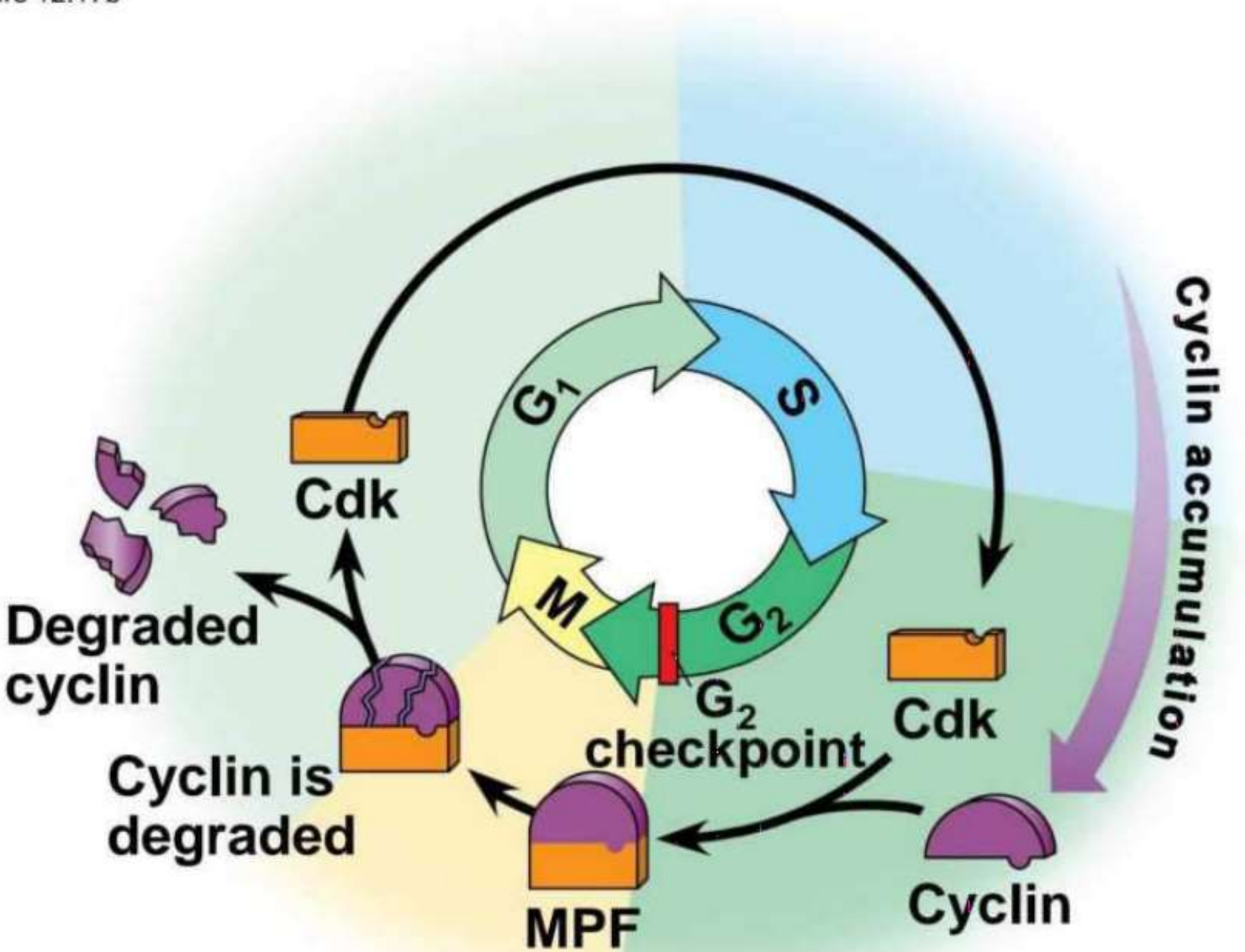
(b) Molecular mechanisms that help regulate the cell cycle

Figure 12.17a

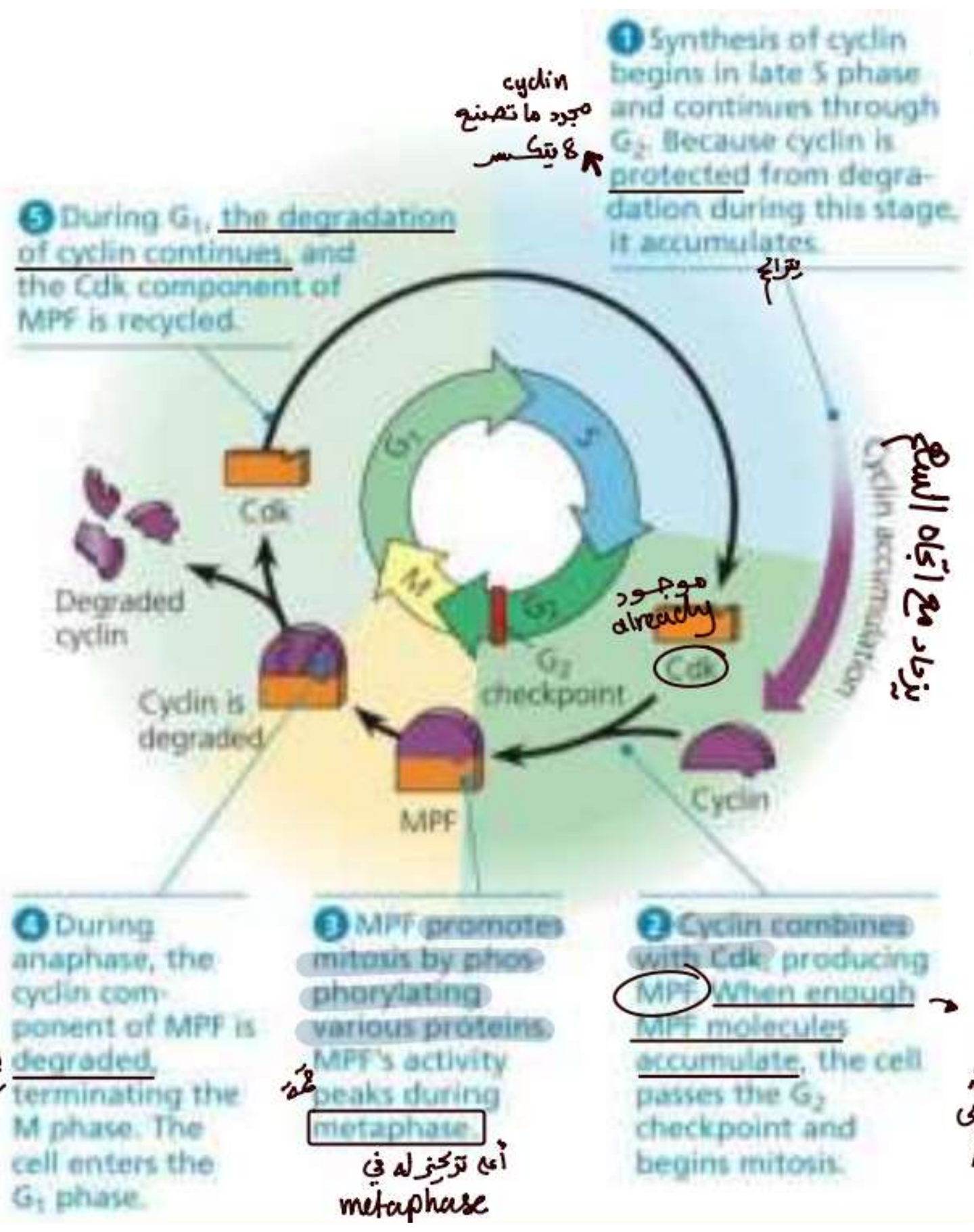


(a) Fluctuation of MPF activity and cyclin concentration during the cell cycle

Figure 12.17b



(b) Molecular mechanisms that help regulate the cell cycle



cyclin مجرد ما تصنع يتكسر

S → G2 خلال ذلك تصنع cyclin يحفزها إشارة للذهاب إلى

يتراكم

موجود already

يزداد مع الاتجاه

يتكسر إشارة لخلايا M phase دخوله G1

تعتبرها إشارة للخروج منه إلى G2 M

أي تتركز له في metaphase

Stop and Go Signs: Internal and External Signals at the Checkpoints

- An example of an internal signal is that kinetochores not attached to spindle microtubules send a molecular signal that delays anaphase
- Some external signals are **growth factors**, proteins released by certain cells that stimulate other cells to divide
- For example, platelet-derived growth factor (PDGF) stimulates the division of human fibroblast cells in culture

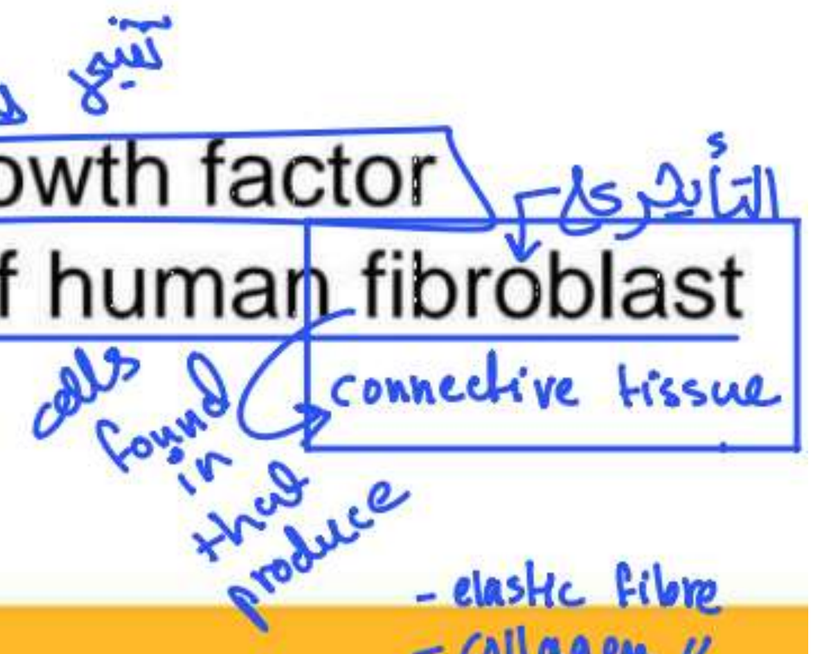


Figure 12.18

1 A sample of human connective tissue is cut up into small pieces. → ولكن ما رجع خلايا

Scalpels

Petri dish

Enzymetic hydrolysis

2 Enzymes digest the extracellular matrix, resulting in a suspension of free fibroblasts.

3 Cells are transferred to culture vessels.

4 PDGF is added to half the vessels.

10 µm

ع خلايا فقط + كل اللي سكناجوه الانقسام

بدون بلشتاين ع خلايا فقط

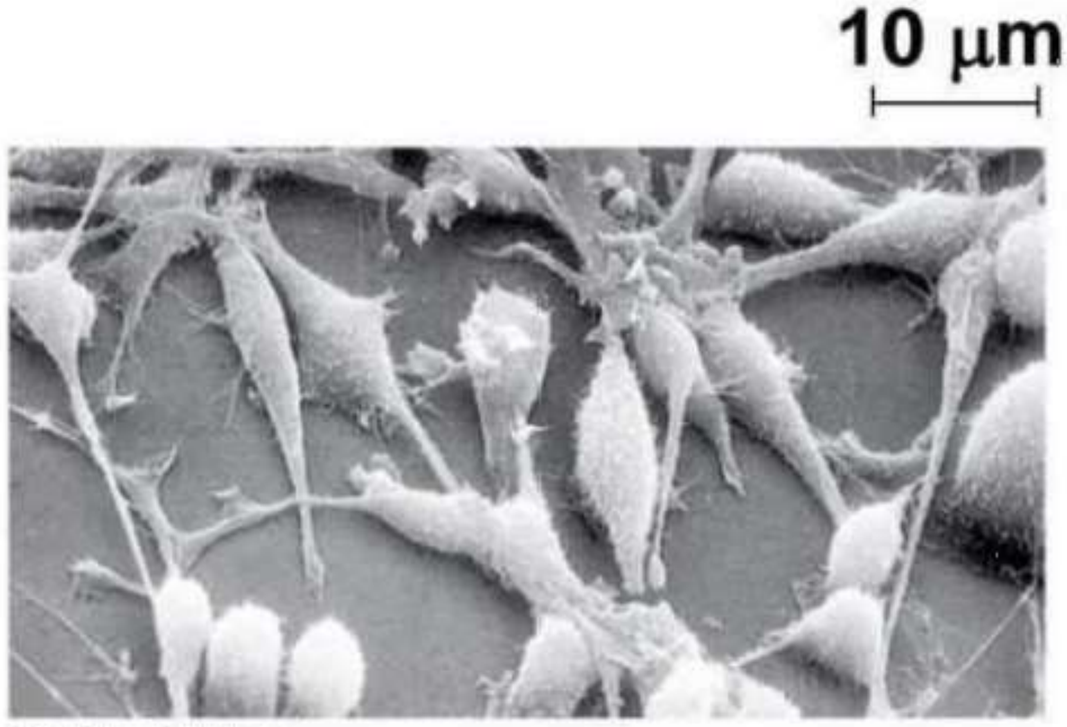
Without PDGF

With PDGF

خلايا/4 نفس العدد

they divided + multiplied

Figure 12.18a



- A clear example of external signals (2) is **density-dependent inhibition**, in which crowded cells stop dividing → because of its density

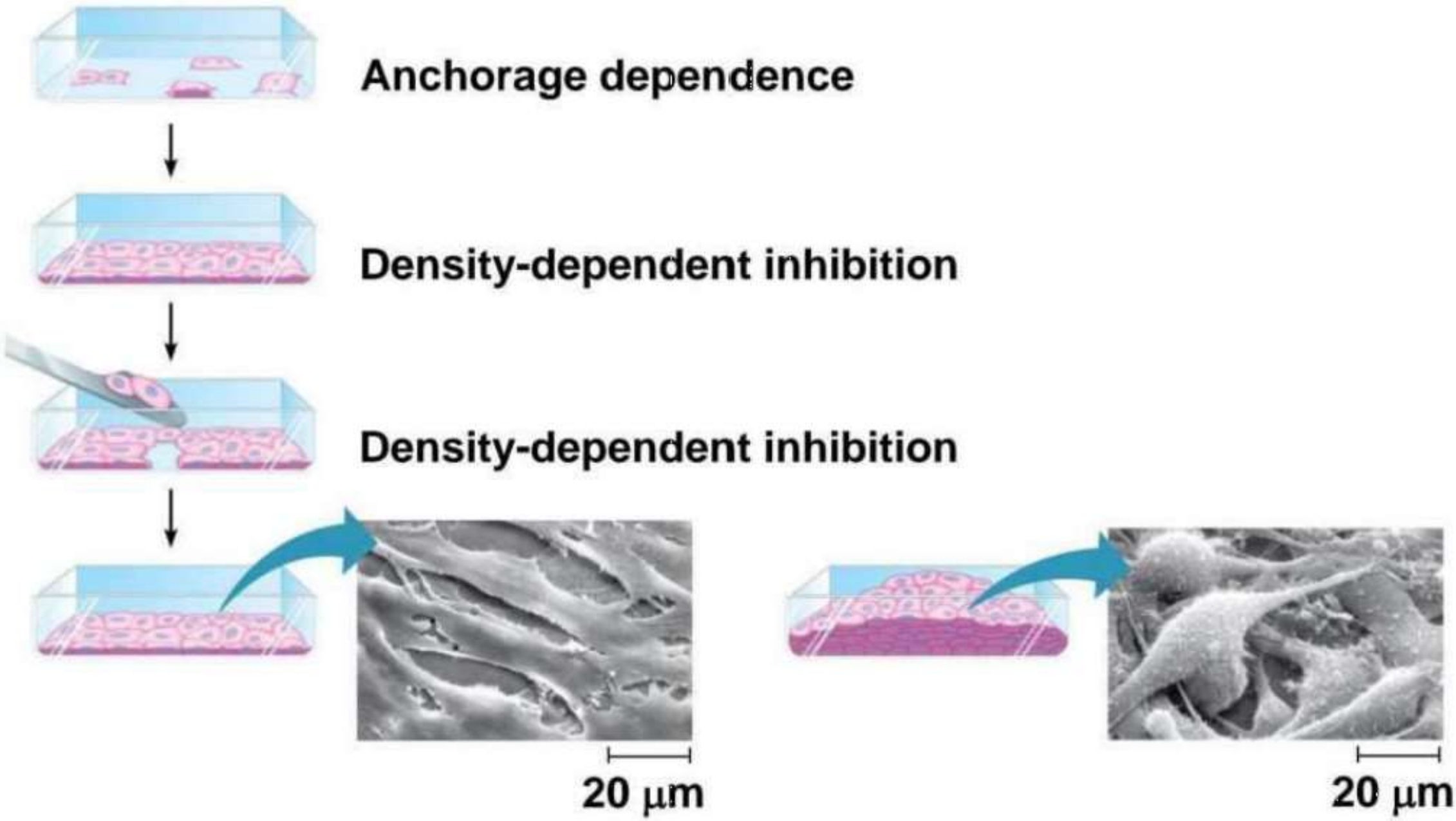
عشانه ما يخيروا layers فوق بعض

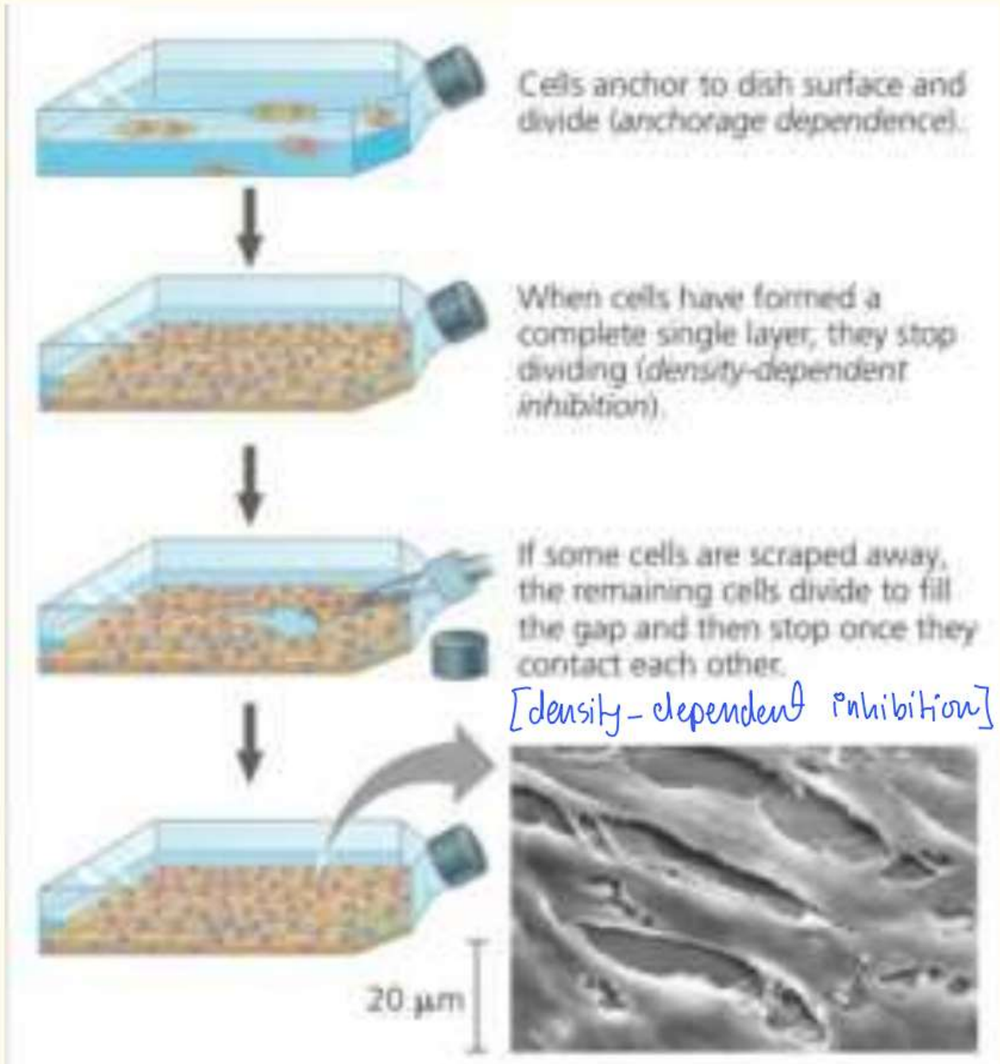
- Most animal cells also exhibit (3) **anchorage dependence**, in which they must be attached to a substratum in order to divide

الخلايا اذا لقت اشي تثبت فيه/ح يزدار انقسامها

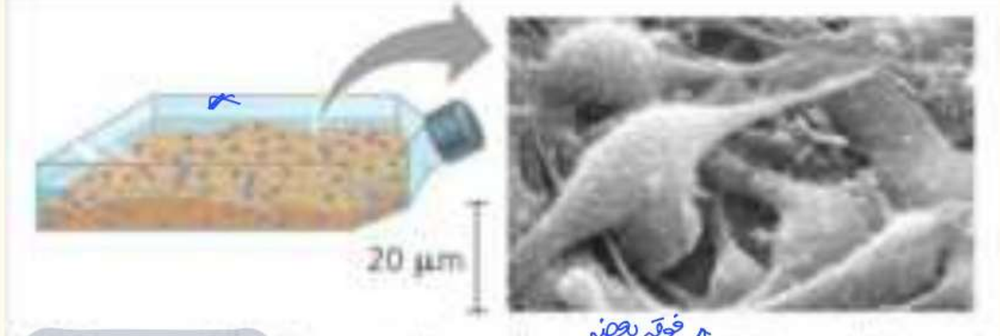
- Cancer cells exhibit neither density-dependent inhibition nor anchorage dependence

Figure 12.19





(a) **Normal mammalian cells.** Cell density is limited to a single layer by contact with neighboring cells and the availability of nutrients, growth factors, and a substratum for attachment.



(b) **Cancer cells.** Cancer cells usually continue to divide well beyond a single layer, forming a dump of overlapping cells. They do not exhibit anchorage dependence or density-dependent inhibition.

Figure 12.19a

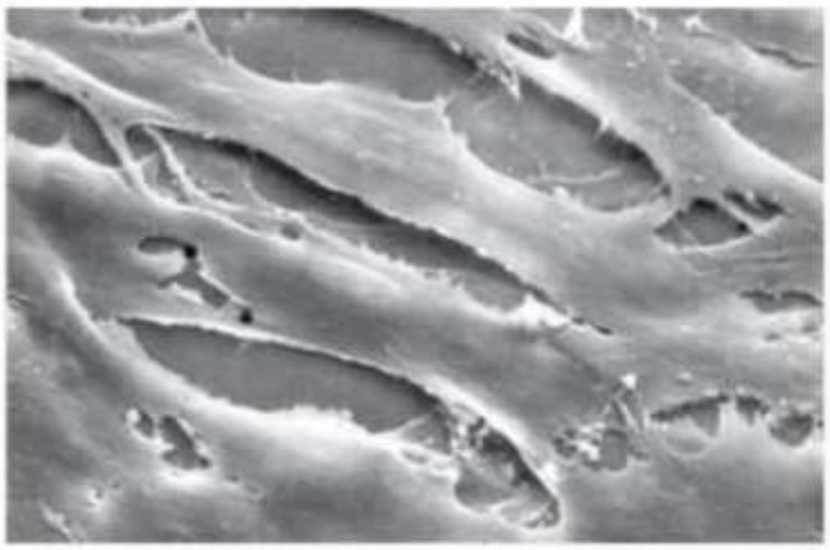
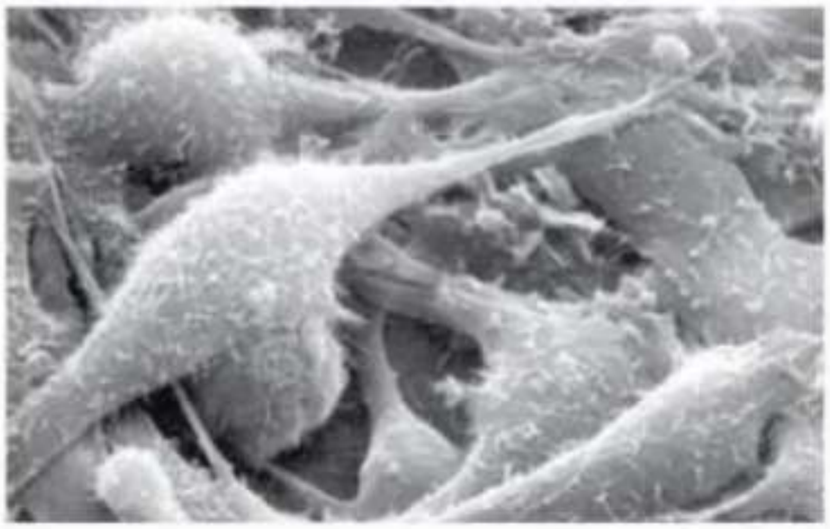


Figure 12.19b



Loss of Cell Cycle Controls in Cancer Cells

- Cancer cells do not respond normally to the body's control mechanisms
- Cancer cells may not need growth factors to grow and divide
  - They may make their own growth factor
  - They may convey a growth factor's signal without the presence of the growth factor
  - They may have an abnormal cell cycle control system

- A normal cell is converted to a cancerous cell by a process called **transformation**

جهاز المناعة يحارب أي خلية غريبة سواء كانت داخلية او خارجية [الخلايا السرطانية خلايا داخلية لأنها كانت طبيعية ثم تحولت] وهذه المحاربة تكتشف ① قوة جهاز المناعة ② كمية الخلايا السرطانية

- Cancer cells that are not eliminated by the immune system form tumors (أورام), masses of abnormal cells within otherwise normal tissue

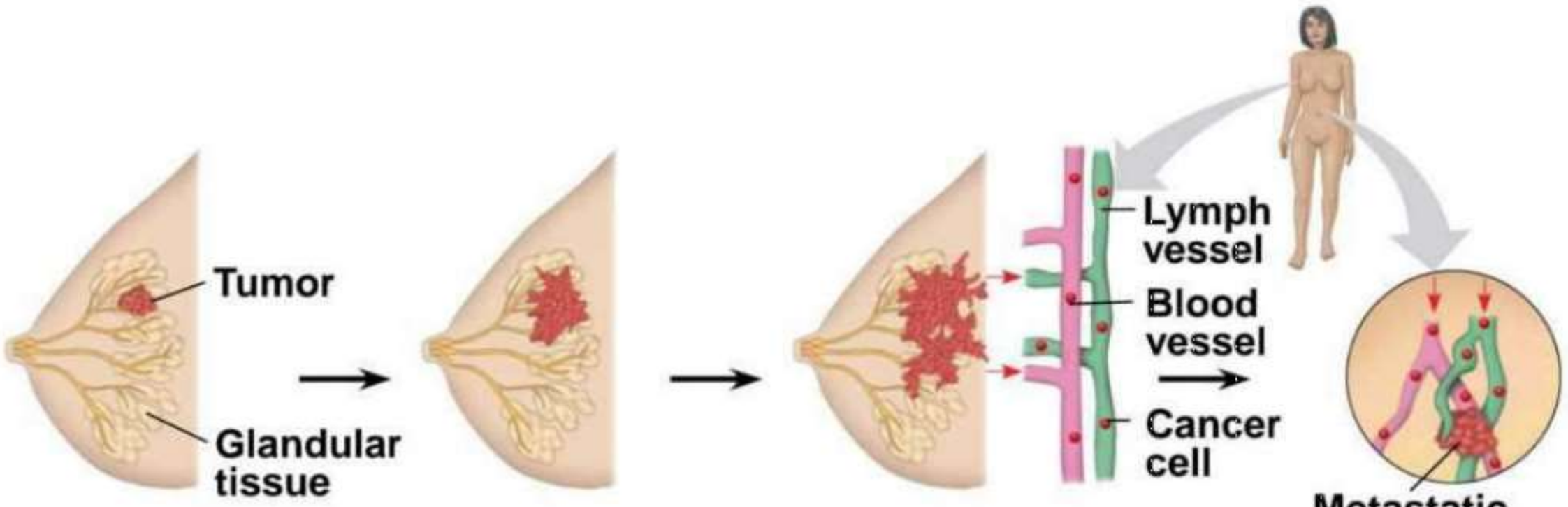
(a) If abnormal cells remain only at the original site, the lump is called a **benign tumor** (سرطان غير خطير)

ضغطت الكتلة بين الخلايا ولم تزد حجمها / غير خطير

(b) **Malignant tumors** invade surrounding tissues and can **metastasize** (→ to spread), exporting cancer cells to other parts of the body, where they may form additional tumors

Figure 12.20

* Breast cancer



1. A tumor grows from a single cancer cell.

لو اكتشف بهذه المرحلة نستطيع ازالة tumor وخلايا الورم

2. Cancer cells invade neighboring tissue.

[still at the same organ]

يمكن يغزيوا the tissue أو انسجة الذي حاوطة

3. Cancer cells spread through lymph and blood vessels to other parts of the body.

الأكثر خطورة

4. Cancer cells may survive and establish a new tumor in another part of the body.

- Recent advances in understanding the cell cycle and cell cycle signaling have led to advances in cancer treatment

Figure 12.21

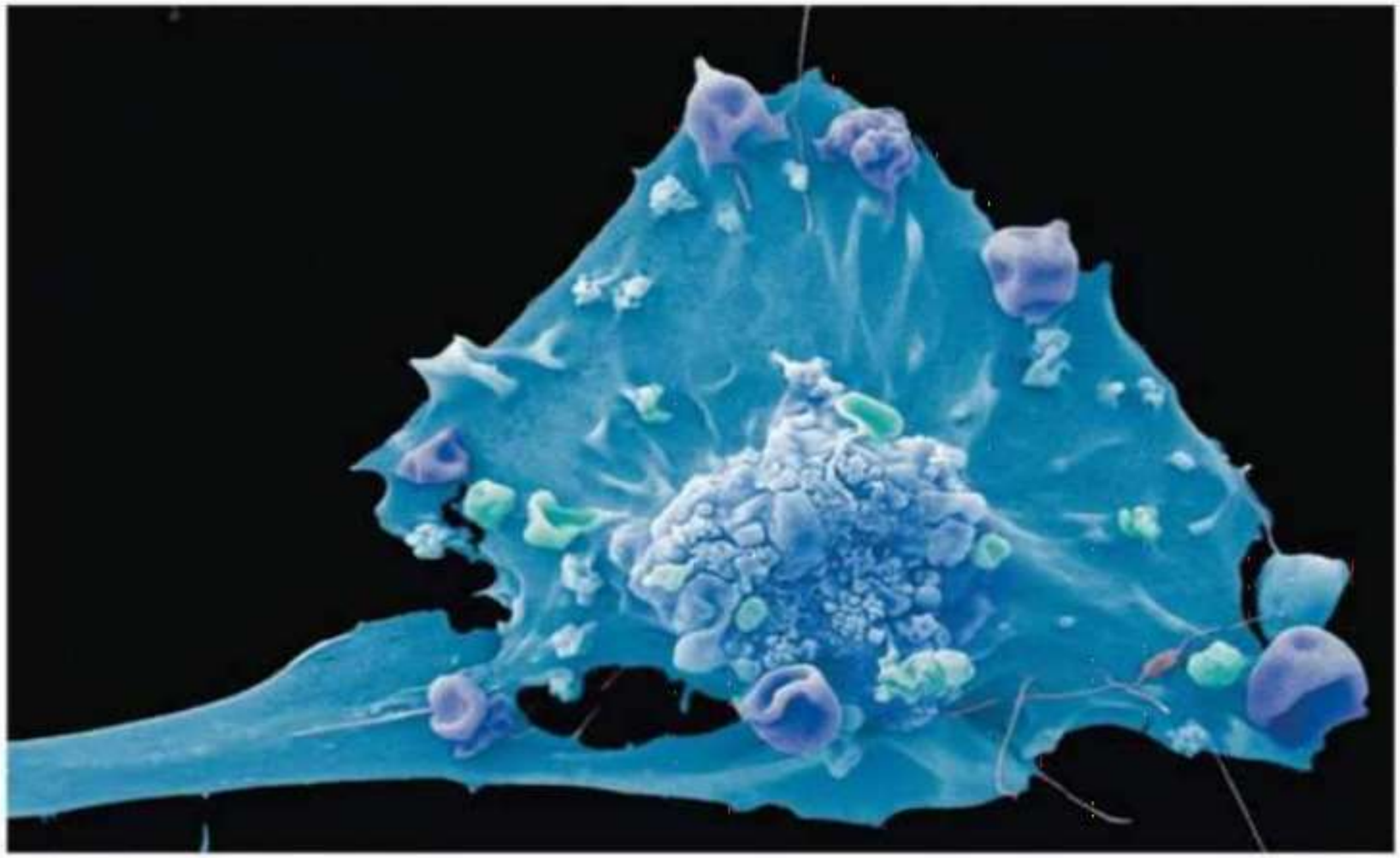


Figure 12.UN01

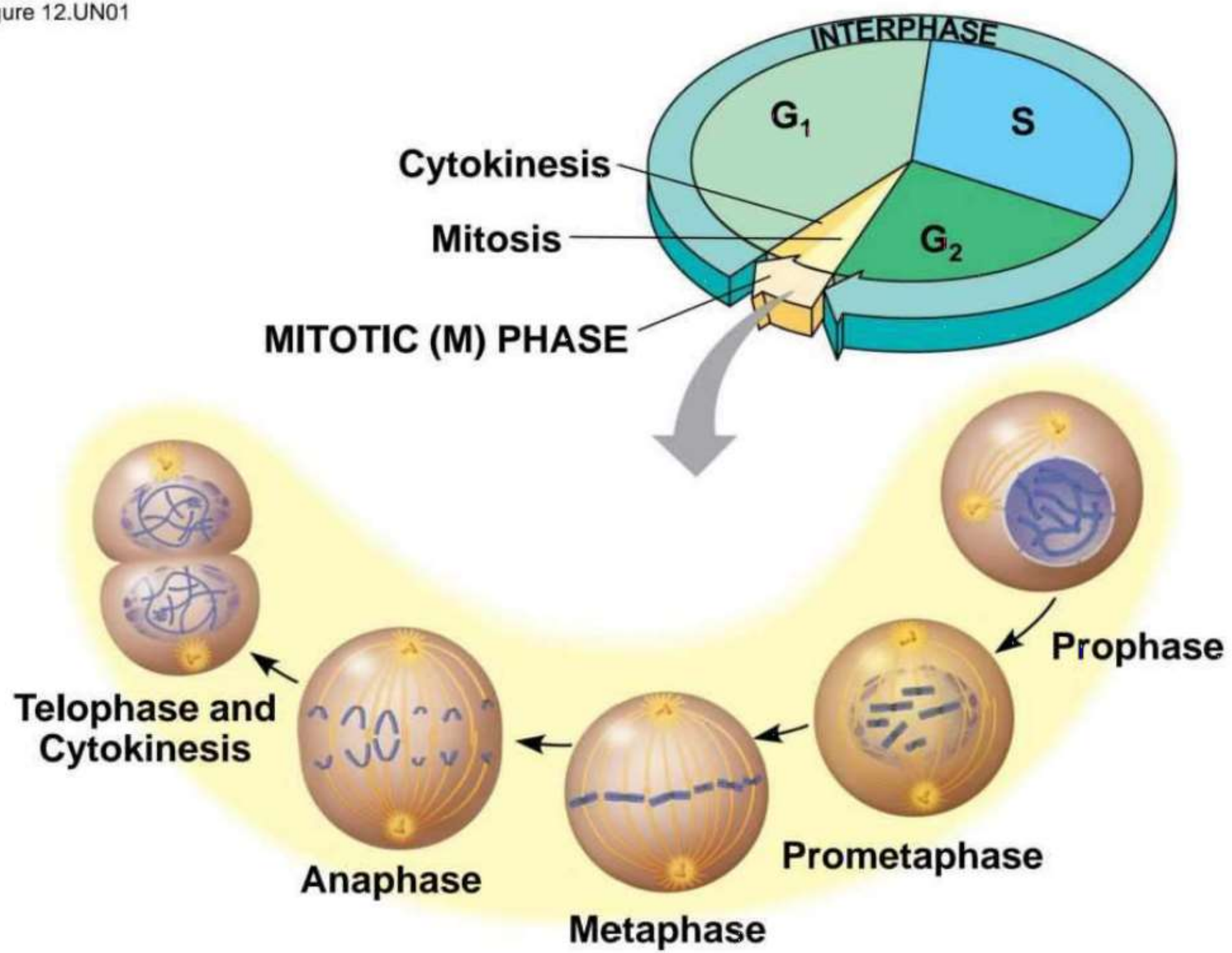


Figure 12.UN02

Figure 12.UN03

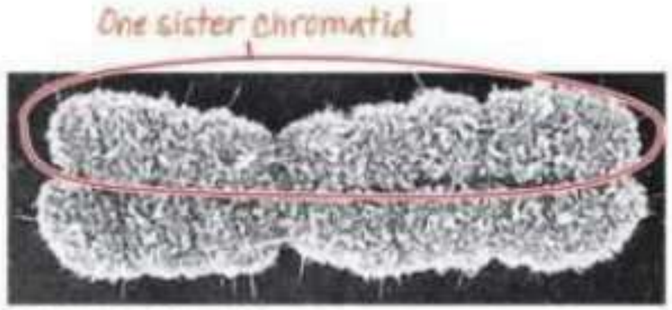


Figure 12.UN04

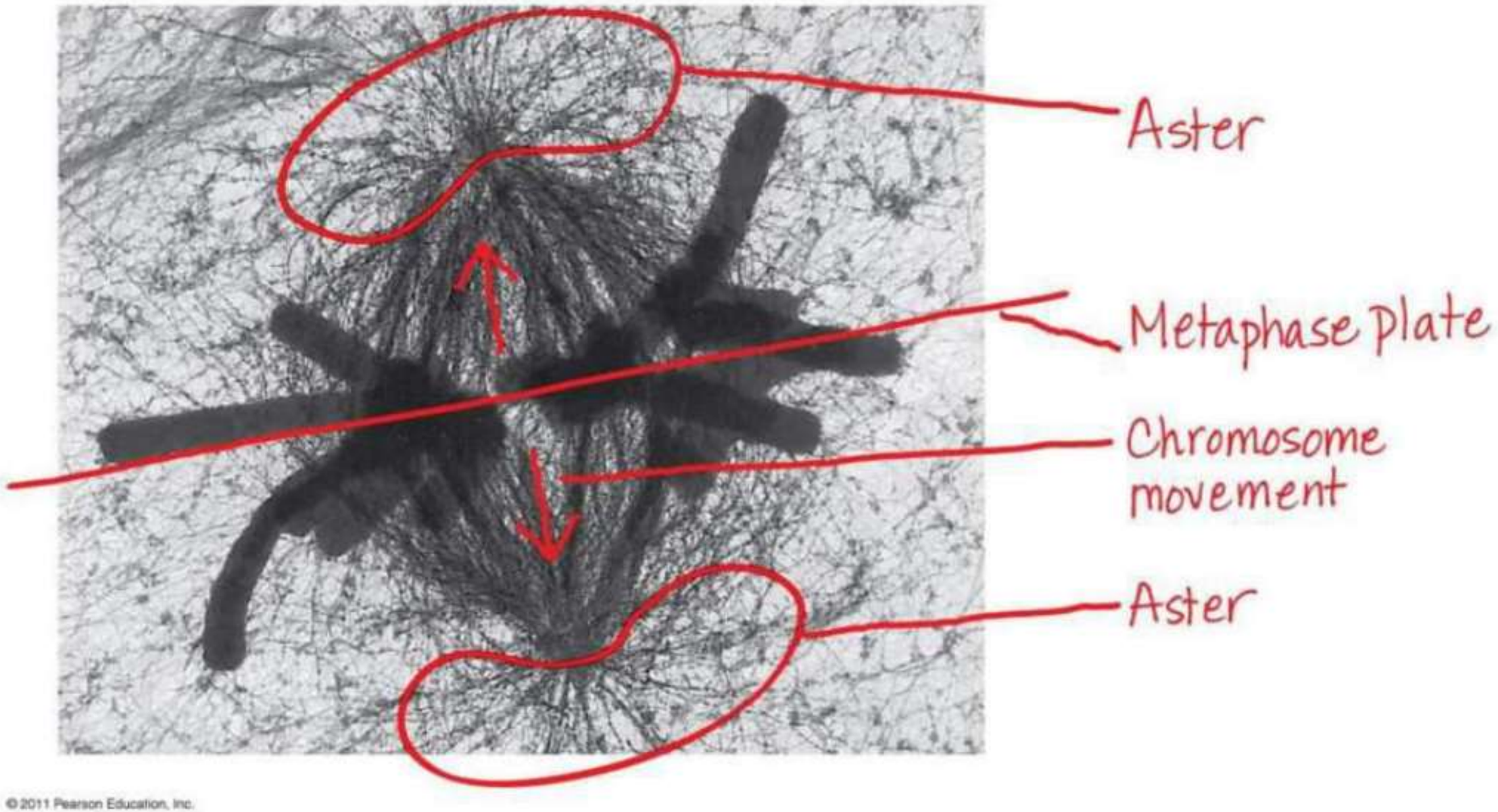


Figure 12.UN05

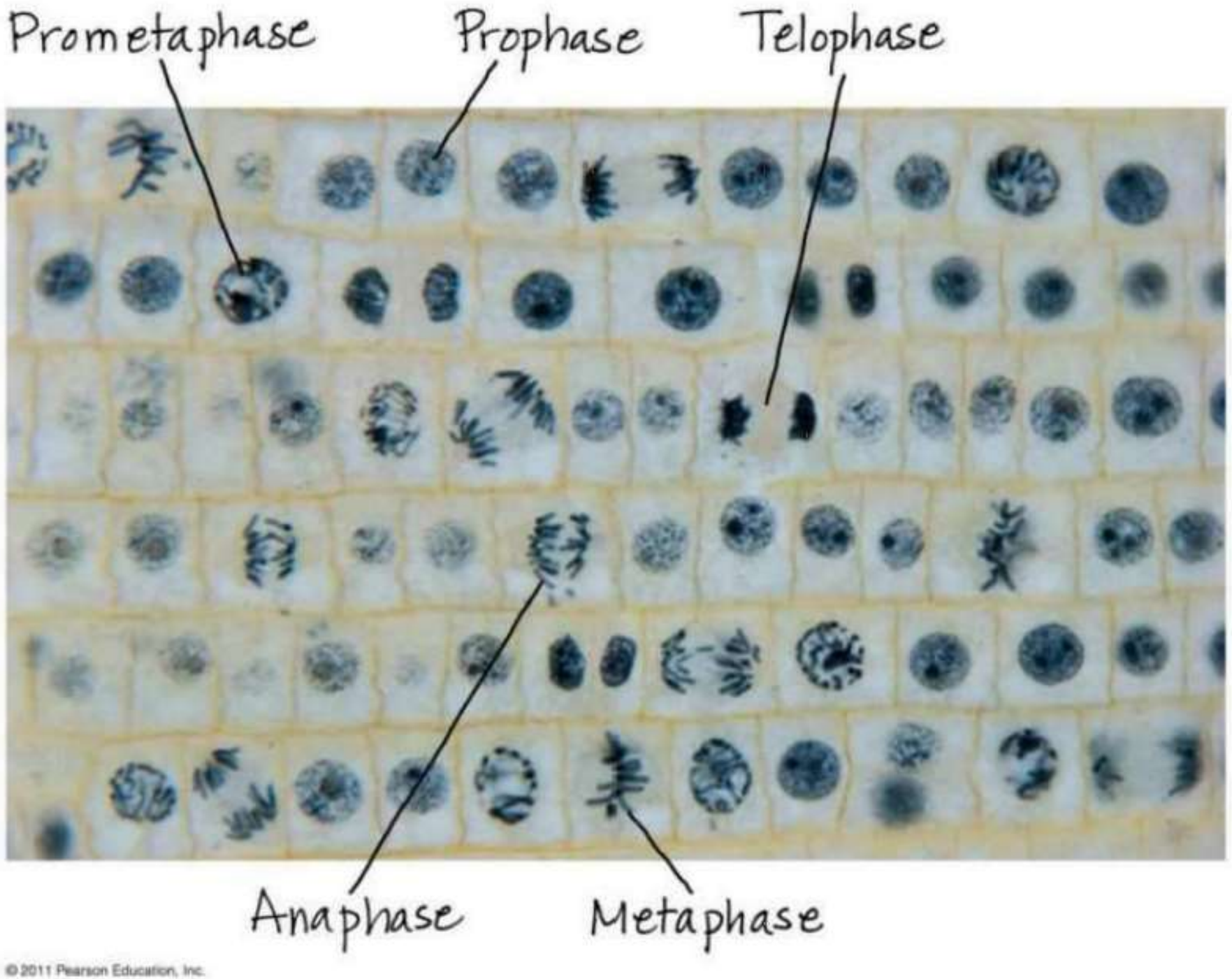


Figure 12.UN06

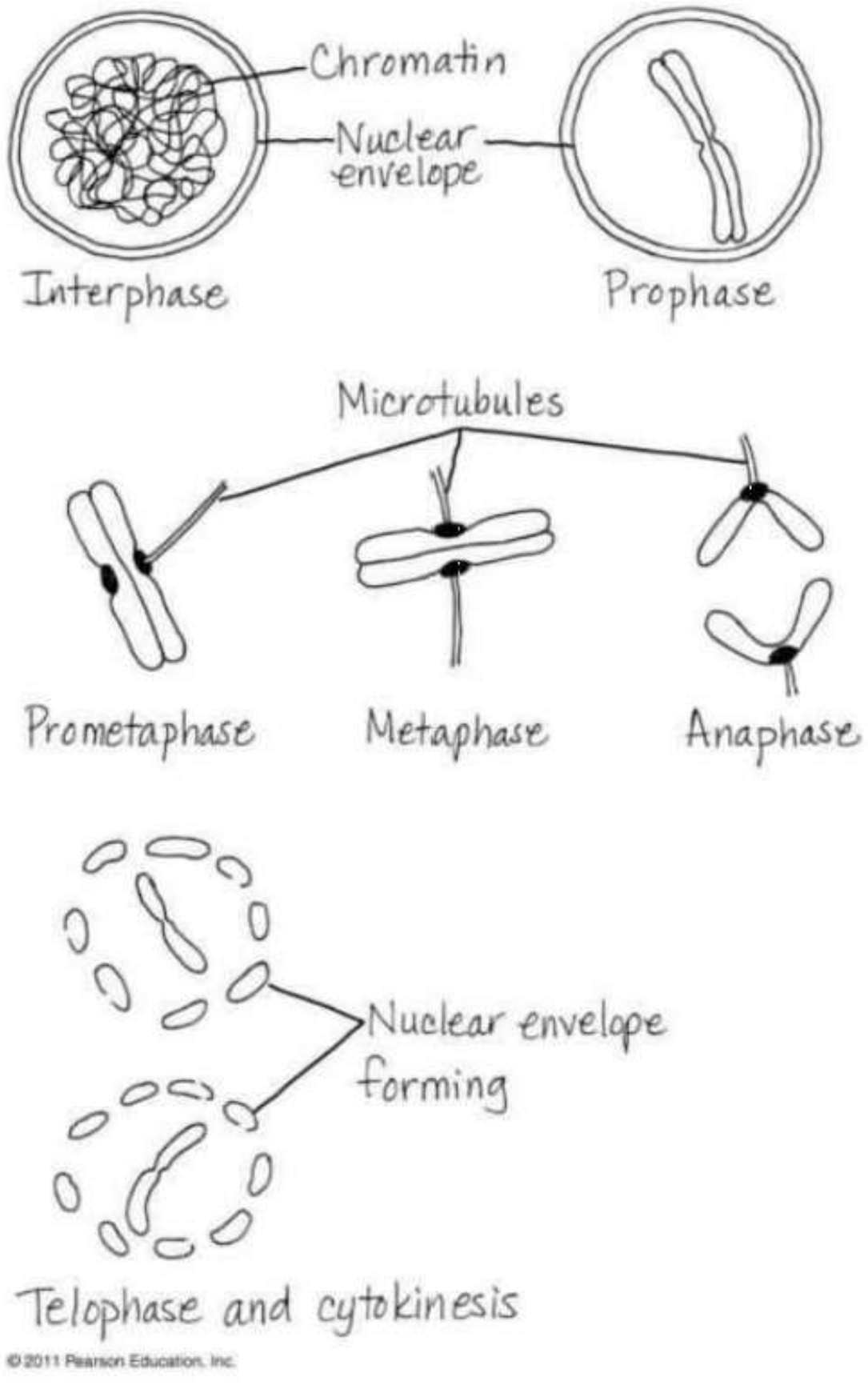


Figure 12.UN06