

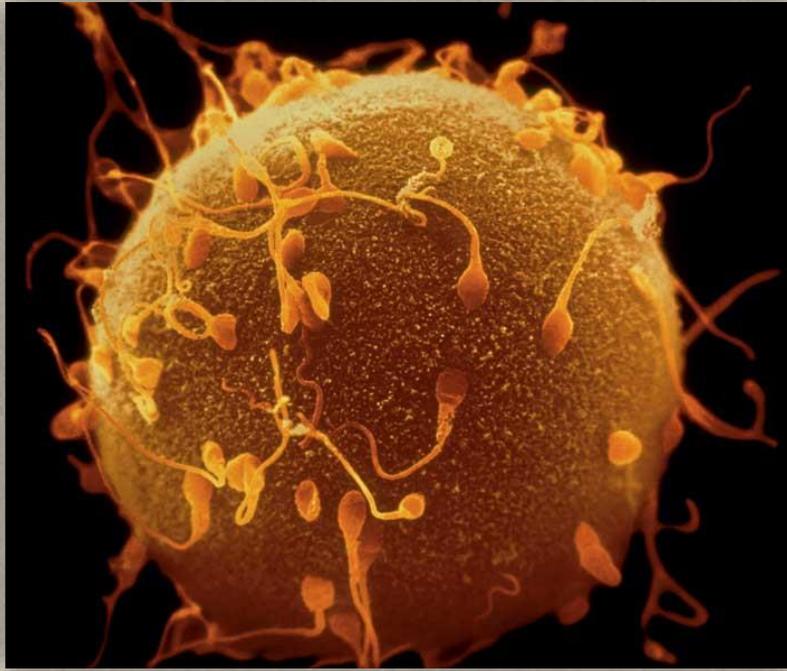
The Cell Cycle



Mitosis

DNA and Cell Division

Background Information



Once an egg becomes fertilized, cellular divisions begins, eventually producing a whole organism



All cells derived from the zygote contain the same genetic material



Organization of DNA

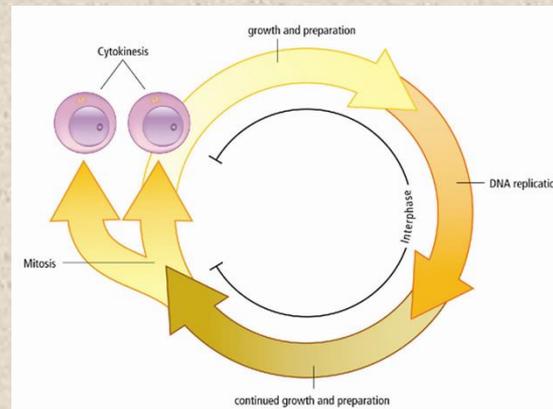
Don't copy

- All cells have DNA (chromosomes).
- Almost all cells divide for reproduction, growth or repair.
- Each new cell needs the exact same DNA as the original cell.
- The original cell is called the mother cell and the two new cells are called daughter cells.
- The DNA in the nucleus must replicate before the cell divides.

The Cell Cycle

Start notes

- Cells divide to help organisms grow, and to replace old, dead cells
- The process of growing and dividing is called the Cell Cycle
- The Cell Cycle is divided into three stages:

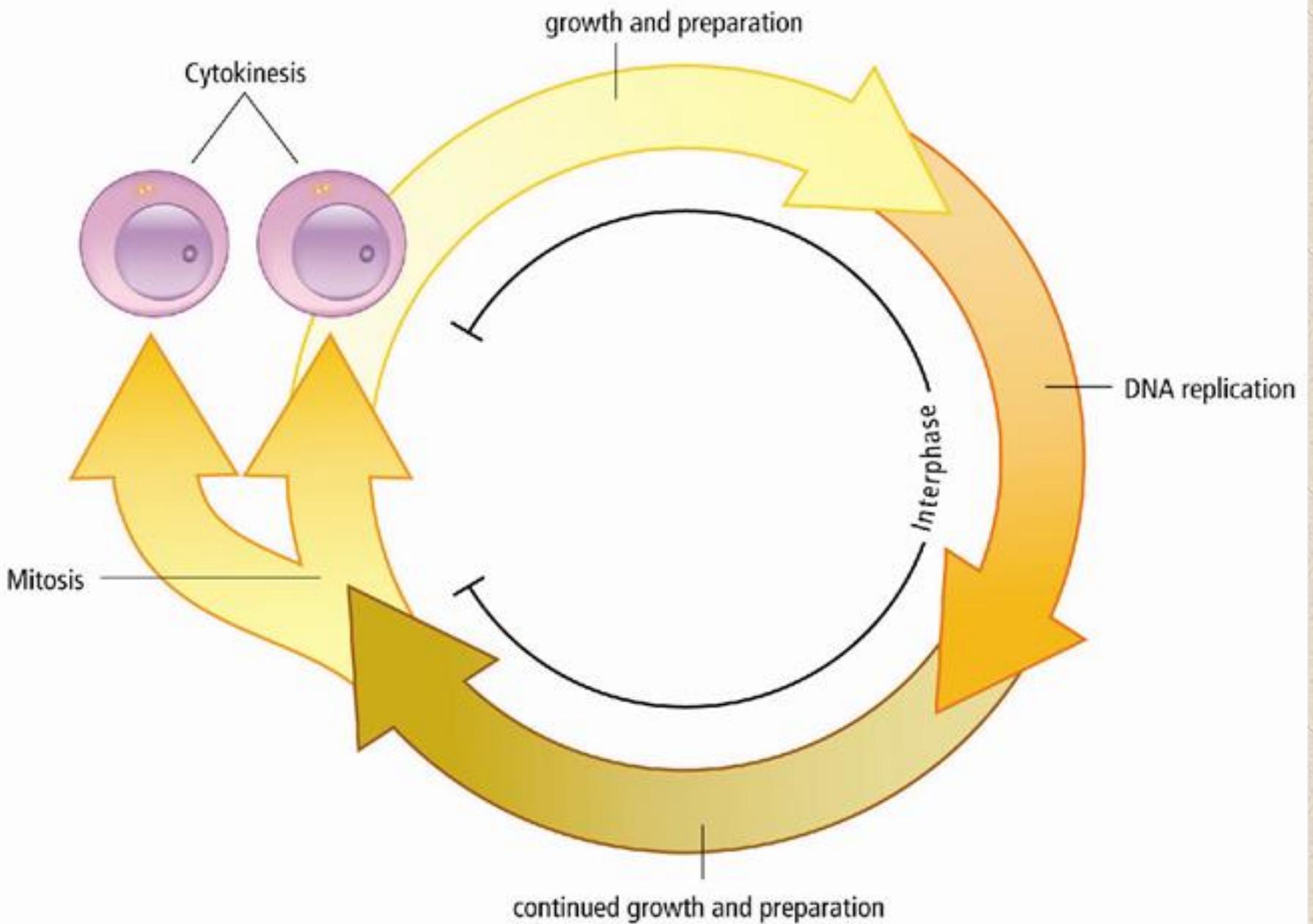


Interphase - the stage in which cells carry out the functions necessary for survival, and prepare to divide

Mitosis - the stage where the cell divides the genetic contents of the cell into two parts

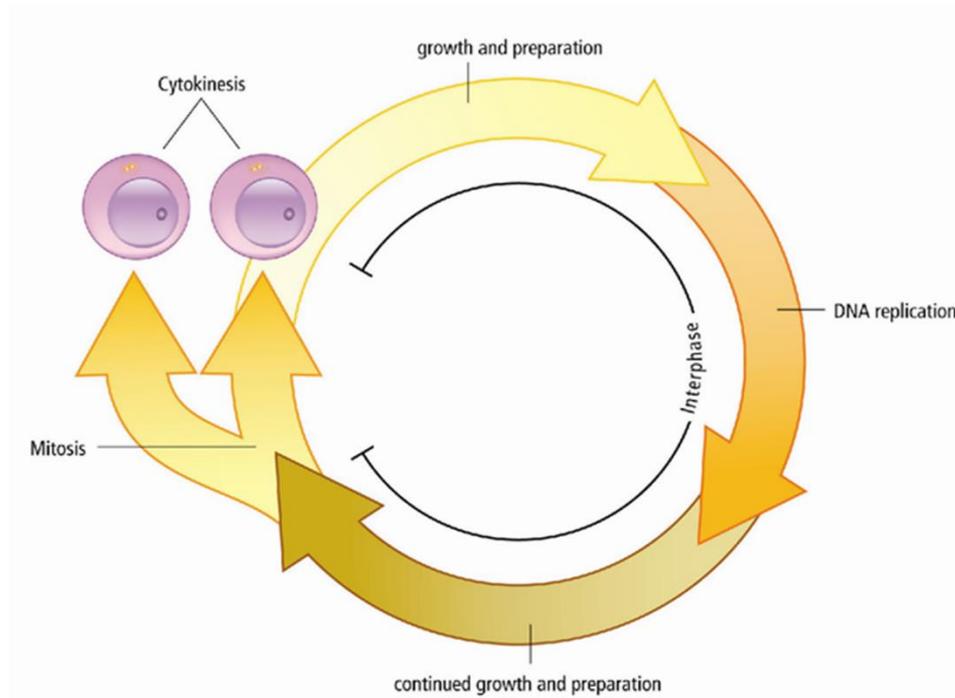
Cytokinesis - the stage where the contents of the cytoplasm are separated and the cell splits into two cells

• (called daughter cells)



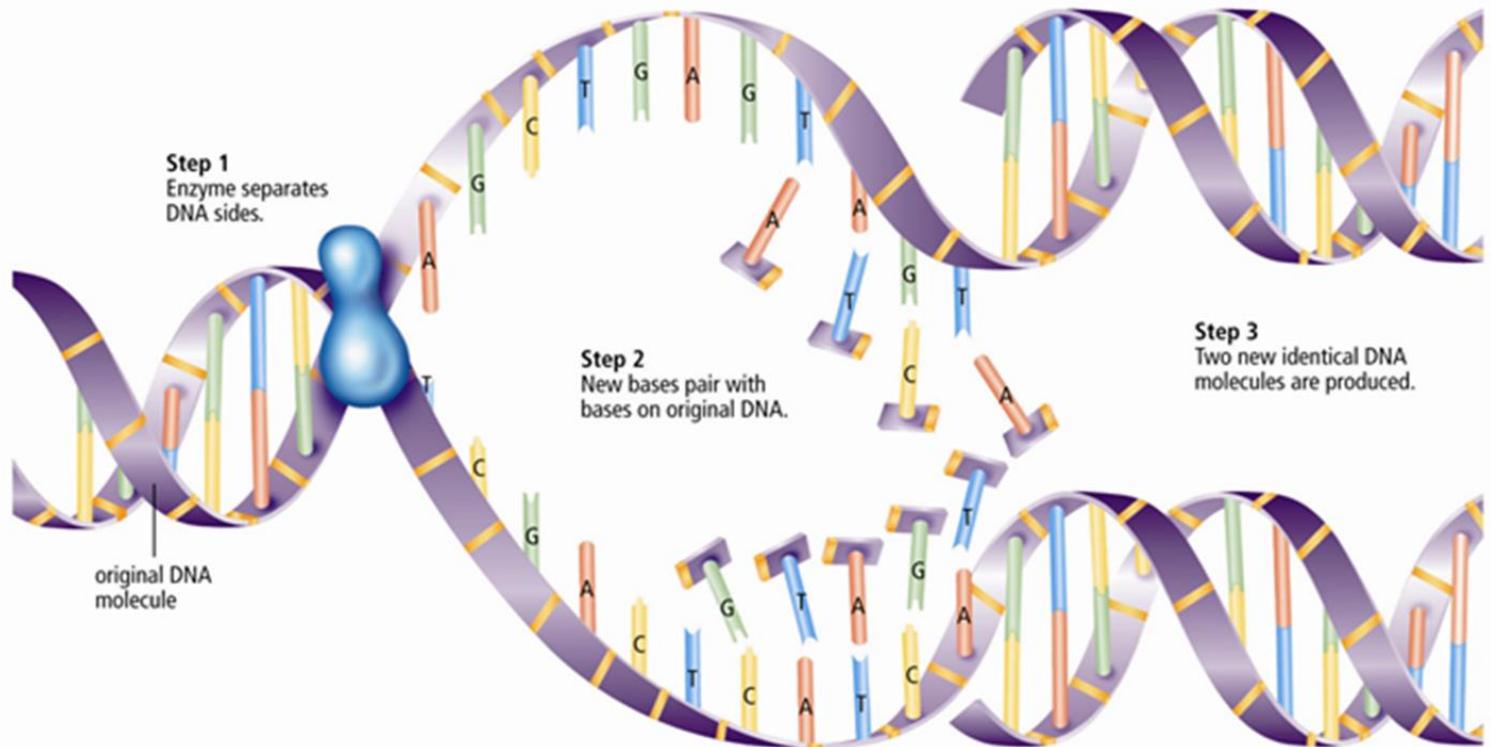
• Interphase - This is the longest stage of the cell cycle

Phase I - cell grows and performs regular functions. Some organelles duplicate



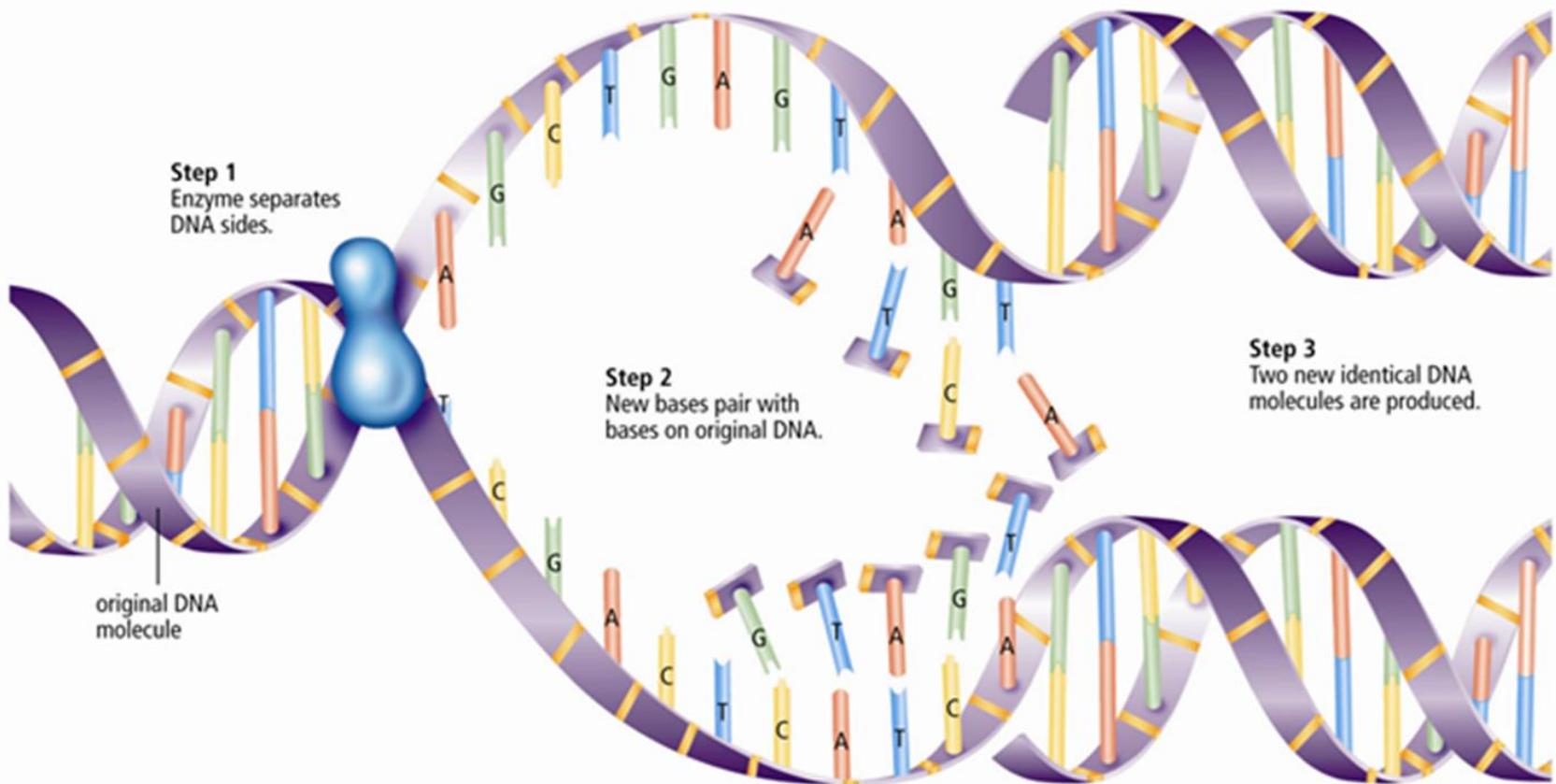
•Phase II - replication of DNA

1) In order to duplicate, an enzyme unwinds the DNA and the steps of the ladder break apart

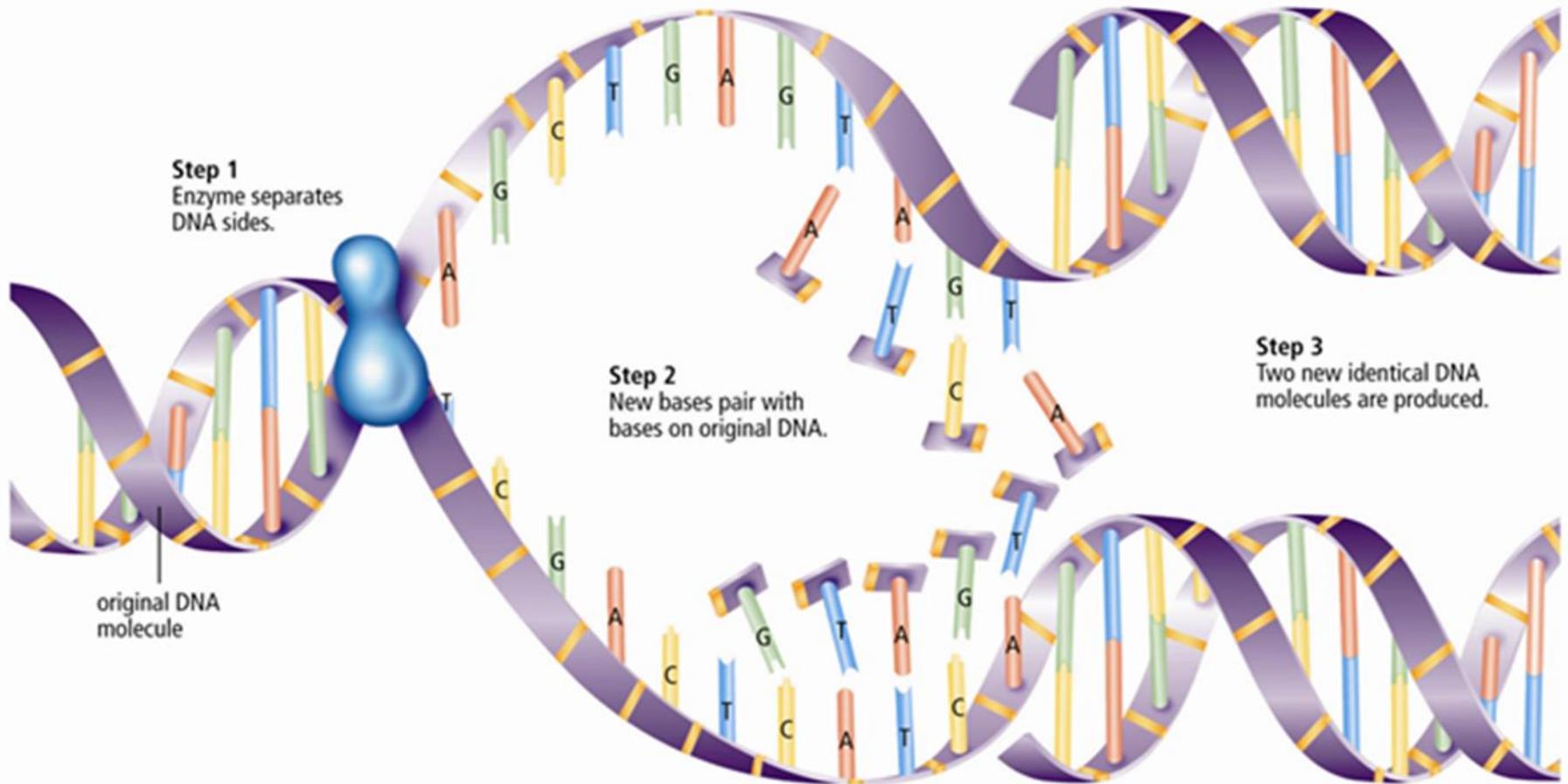


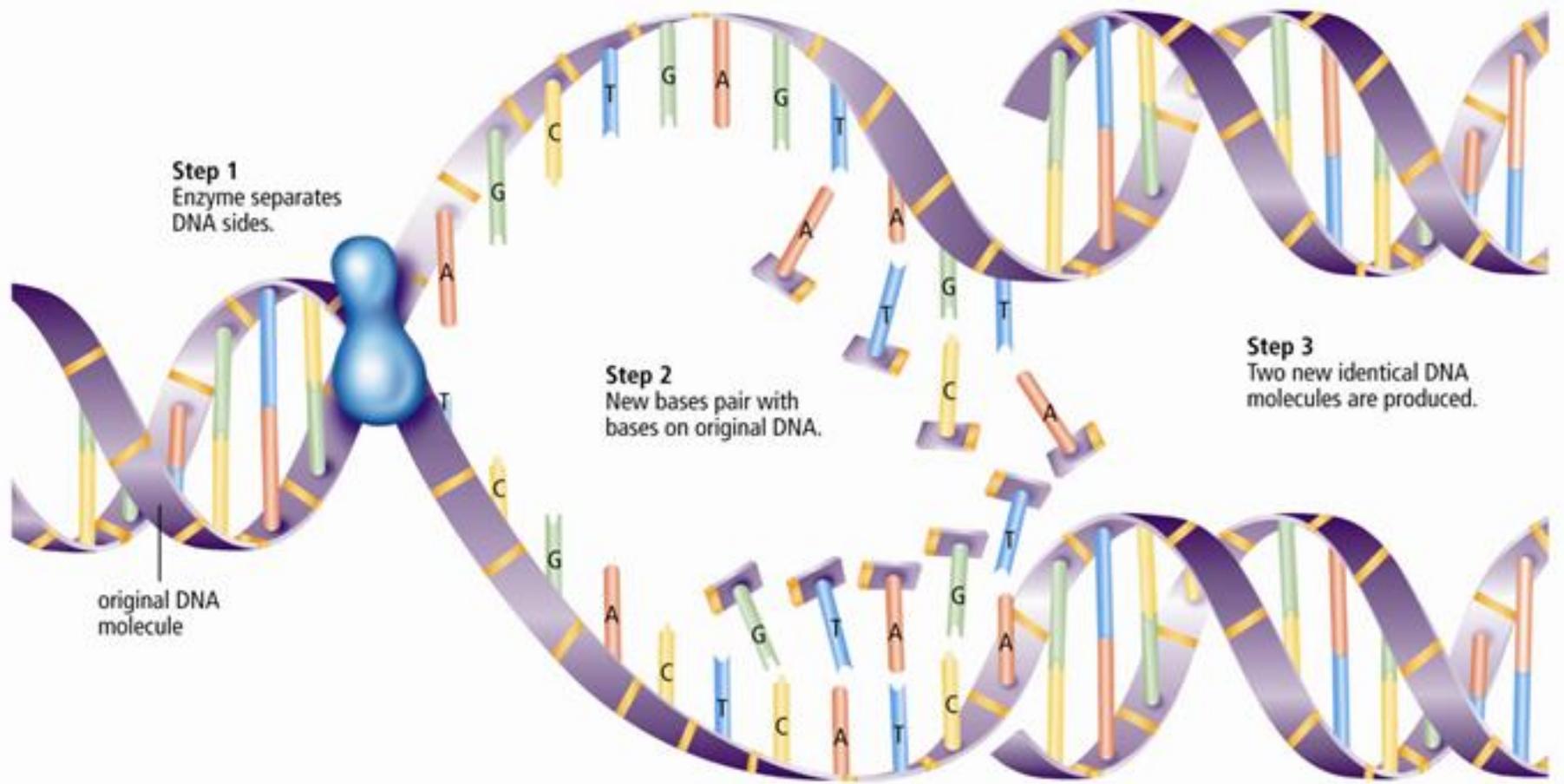
2) New bases come in and pair up with each side of the DNA molecule

- (A with T, C with G)



3) This process results in two identical DNA molecules





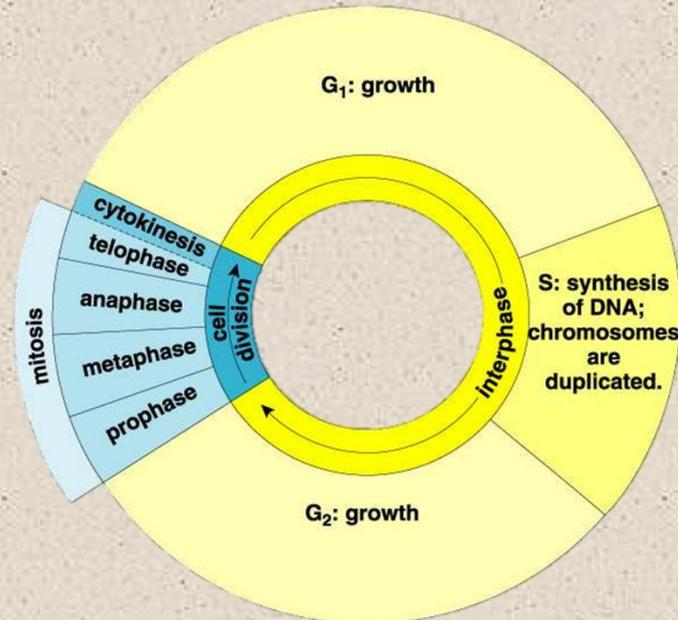
Phase III - Cell continues to grow, organelles duplicate. DNA is present as chromatin

Number of genes in sequenced genomes

- *E. coli* 4300
- Yeast 6000
- Roundworm 18,600
- Fruit fly 13-14,000
- Mosquito 13-14,000
- Mouse 30-35,000
- Human 30-35,000

Mitosis

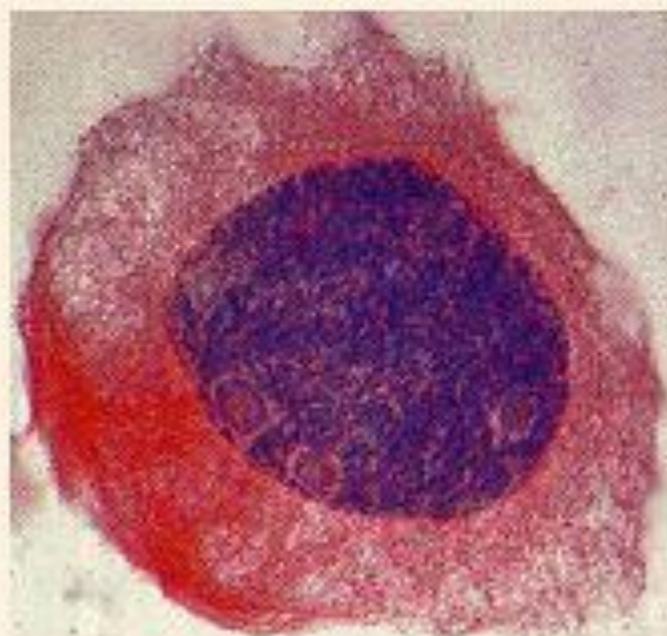
- Mitosis has several stages, which are broken down into four distinct parts: prophase, metaphase, anaphase, and telophase (PMAT)
(party mainly after ten)
- In between Mitosis the cell is in Interphase



Interphase

DNA is duplicated

DNA is in the form of chromatin



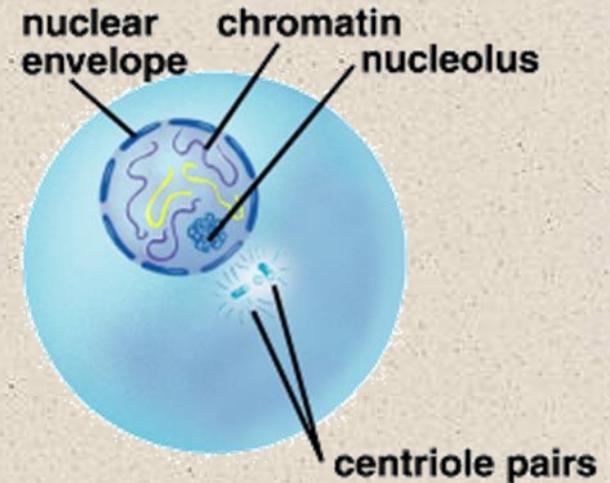
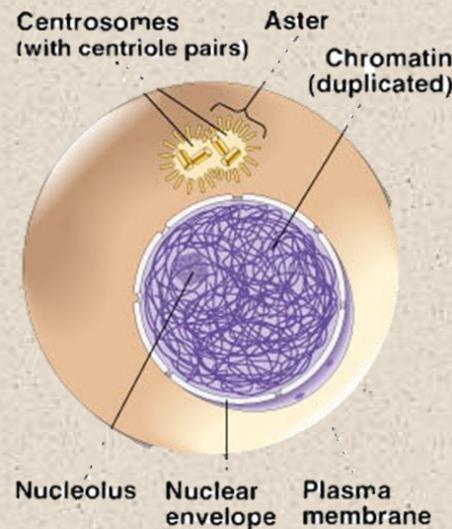
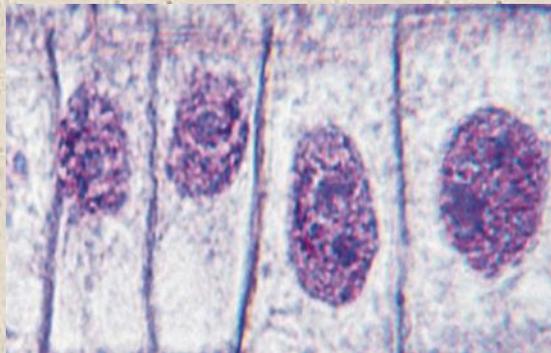
A non-dividing cell:

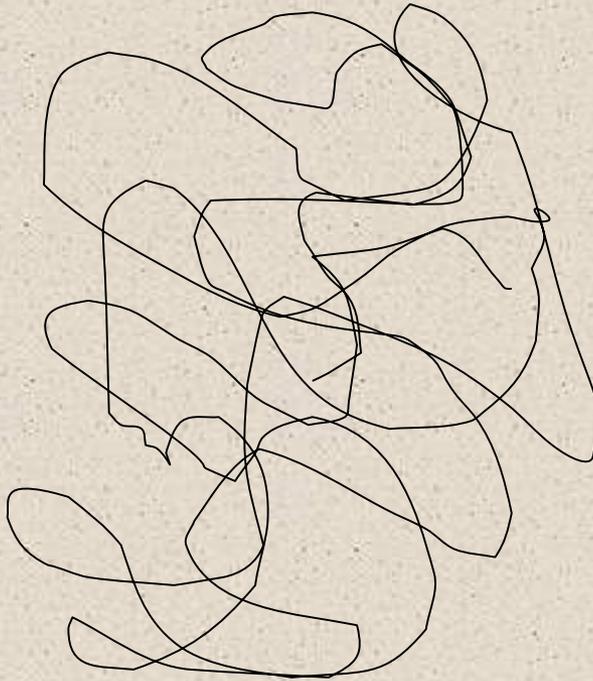
Not notes

- 90% of a cell's life is spent not dividing.
- This phase is called interphase.
- The DNA in this phase is not condensed thus is chromatin.
- At some point during this phase the DNA is doubled or replicated.
- Two copies are made, one for each of the new cells.

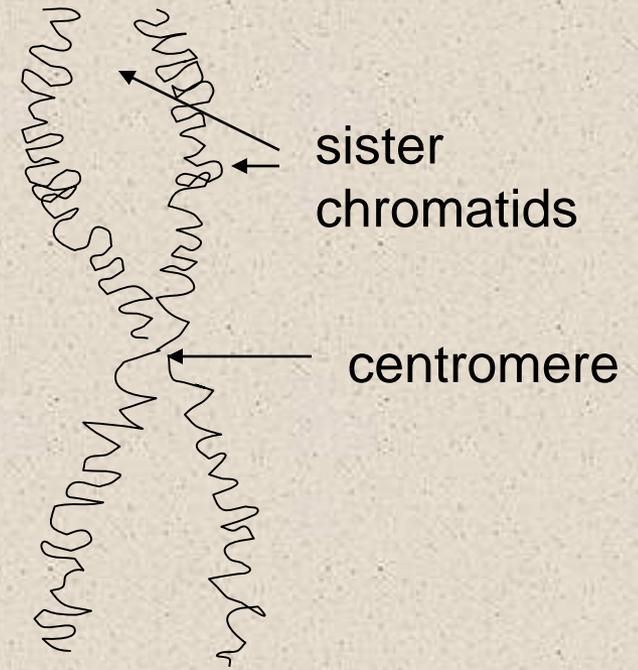
A. Interphase

1. Chromosomes are extended (not condensed) and therefore are not visible.
2. Chromosomes replicate.
 - Each chromosome is now made out of two identical sister chromatids joined at a **centromere**.
 - There is now twice the genetic information, although there is the same number of chromosomes as before.
3. Centrioles replicate.
4. Nuclear membrane is still present.
5. Nucleolus is visible.



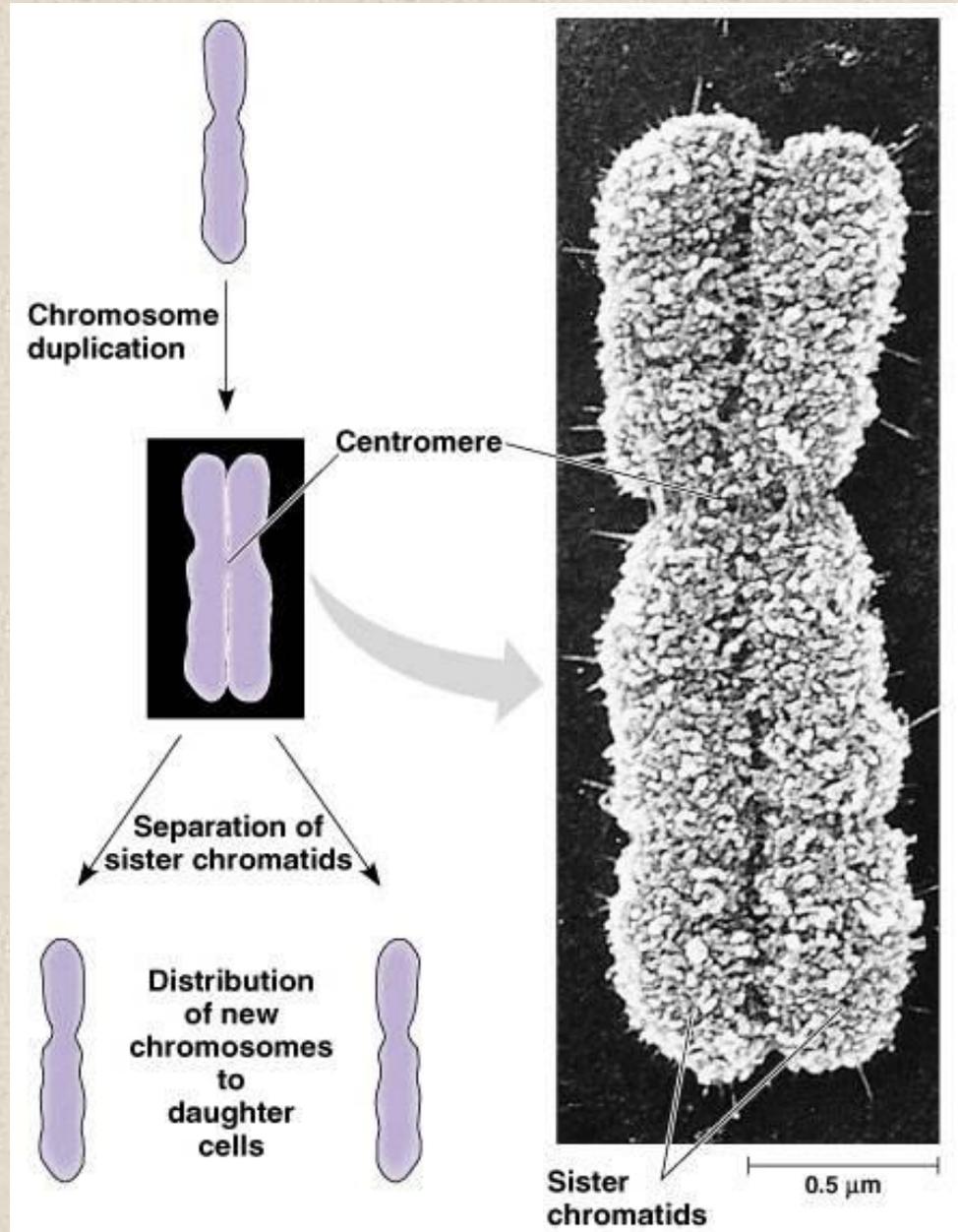


A piece of DNA or chromosome in an undividing cell



Same piece now has replicated and supercoiled ready for cell division.

In **mitosis or cell division** each chromosome is replicated and then the cell divides

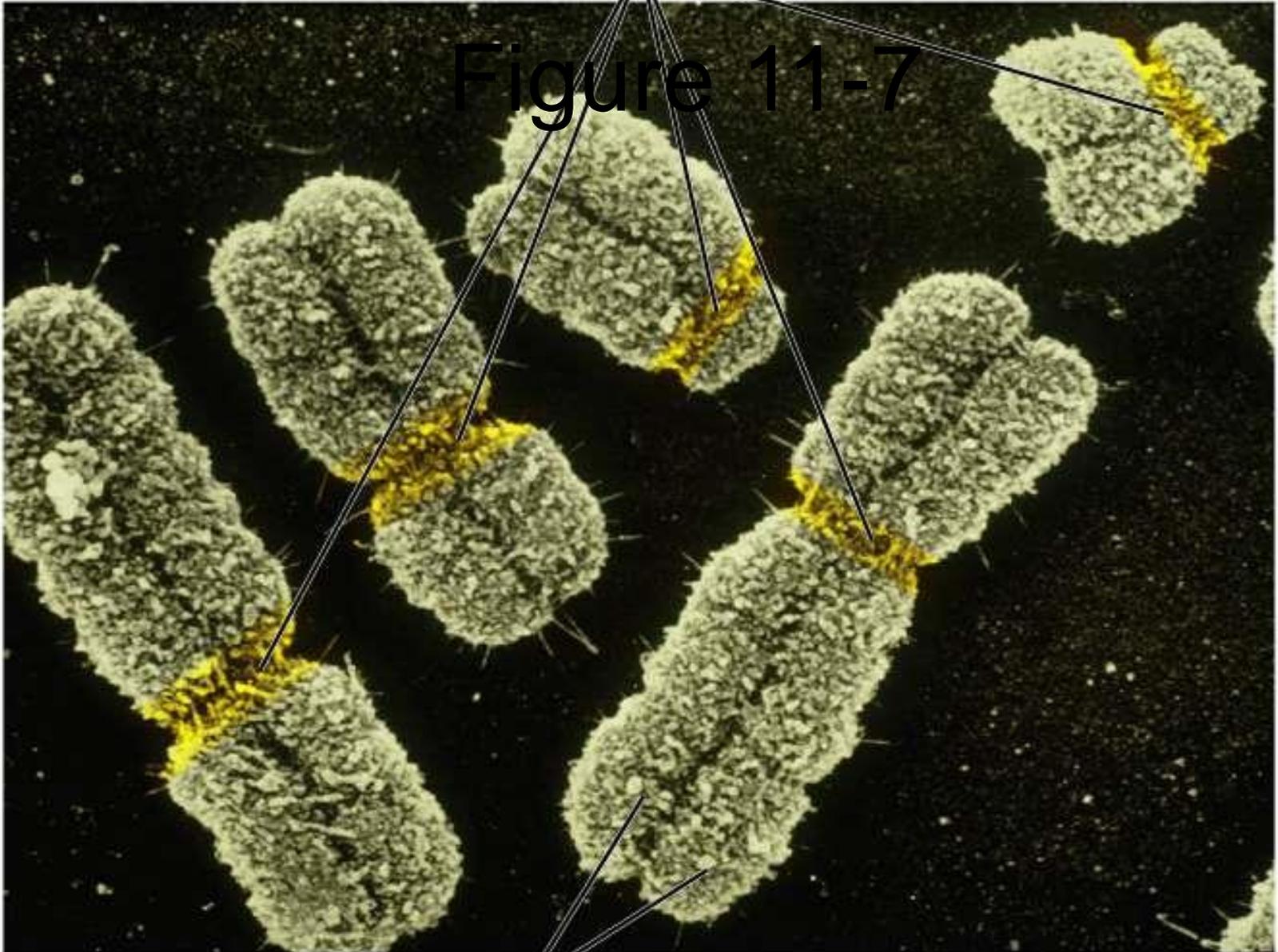


Chromosome Number in Different Species

Common Name	Genus and Species	Diploid Chromosome Number
Buffalo	<i>Bison bison</i>	60
Cat	<i>Felis catus</i>	38
Cattle	<i>Bos taurus, B. indicus</i>	60
Dog	<i>Canis familiaris</i>	78
Donkey	<i>E. asinus</i>	62
Goat	<i>Capra hircus</i>	60
Horse	<i>Equus caballus</i>	64
Human	<i>Homo sapiens</i>	46
Pig	<i>Sus scrofa</i>	38
Sheep	<i>Ovis aries</i>	54

centromeres

Figure 11-7



sister chromatids



1



2



3



4



5



6



7



8



9



10



11



12



13



14



15



16



17



18



Y

X



19



20



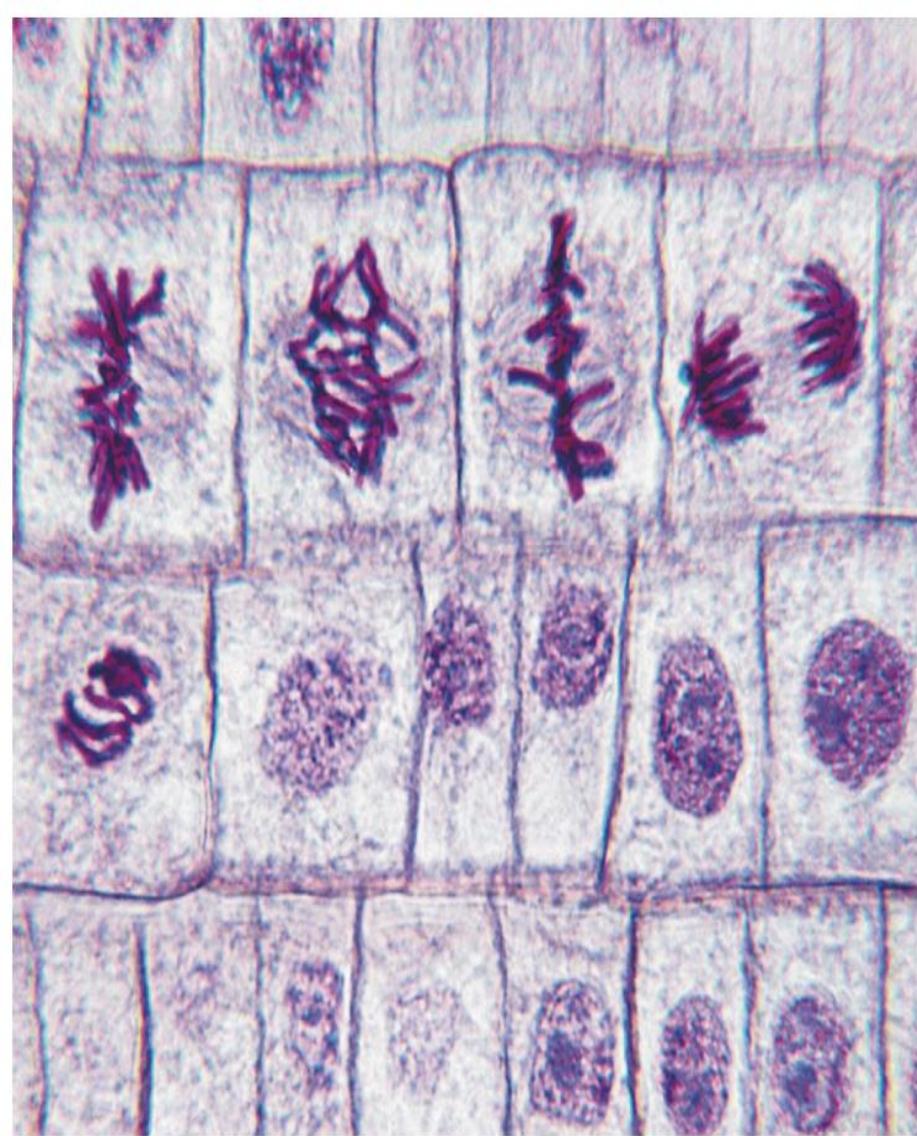
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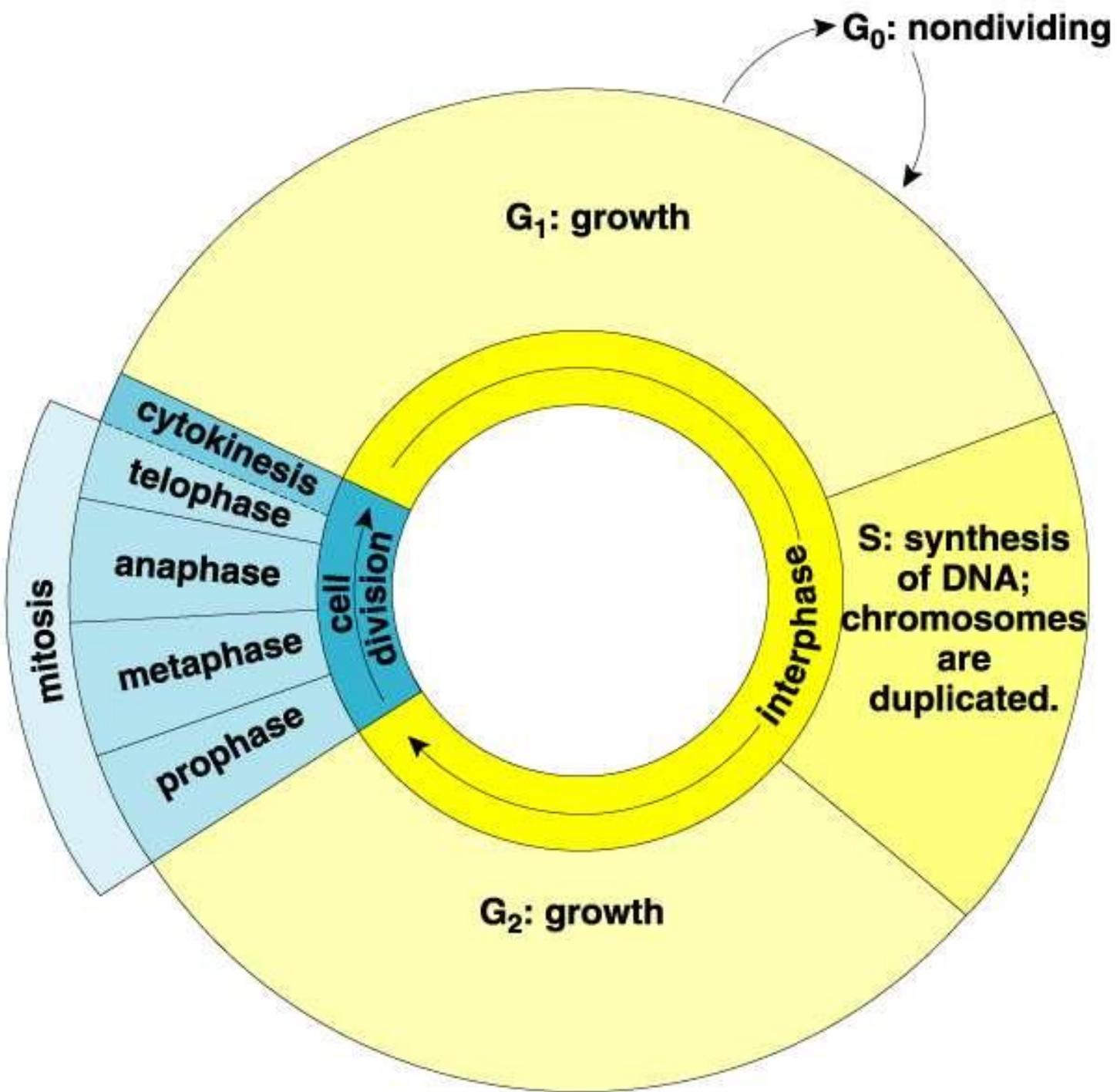


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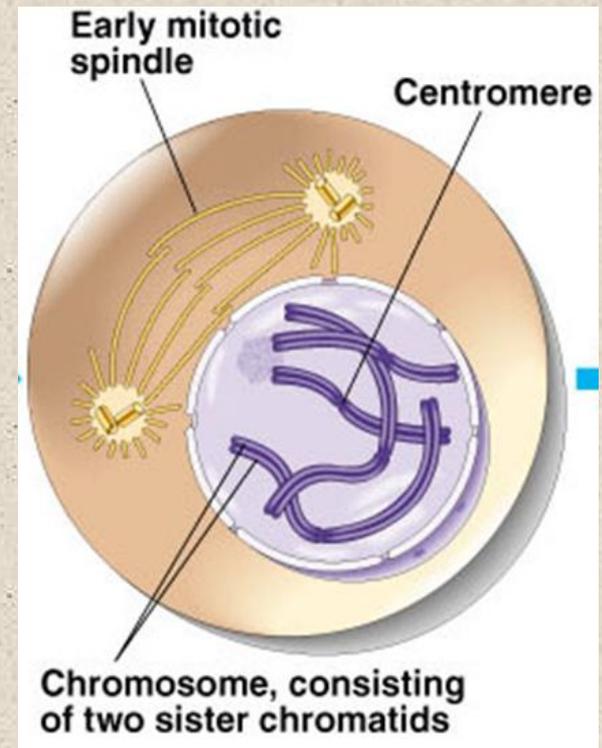
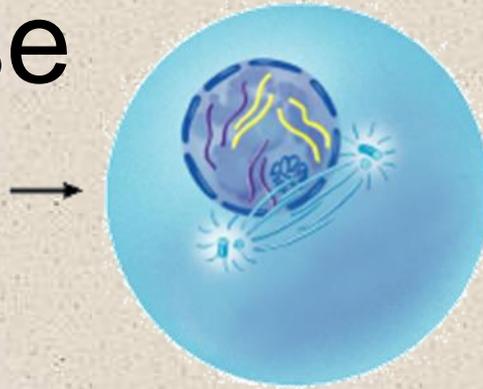
MITOSIS/ CELL DIVISION

- Stages include:
 - Prophase
 - Metaphase
 - Anaphase
 - Telophase





Prophase

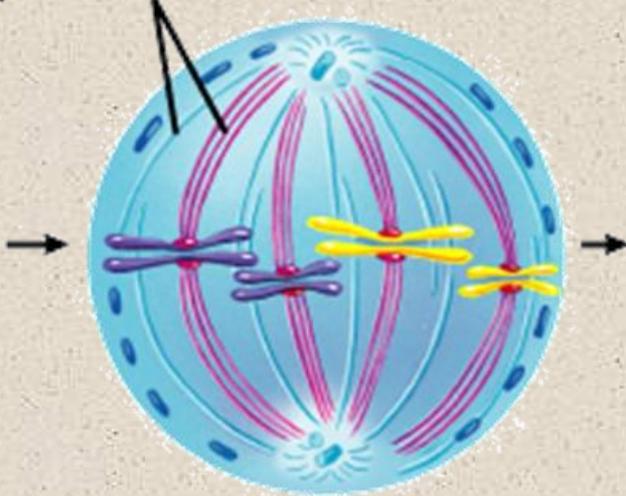


1. Chromosomes condense.
2. Nucleolus disappears.
3. Nuclear membrane disappears.
4. **Spindle apparatus**, composed of spindle fibres, forms and centrioles migrate apart.
5. Each chromosome becomes attached to a spindle fibre

Metaphase

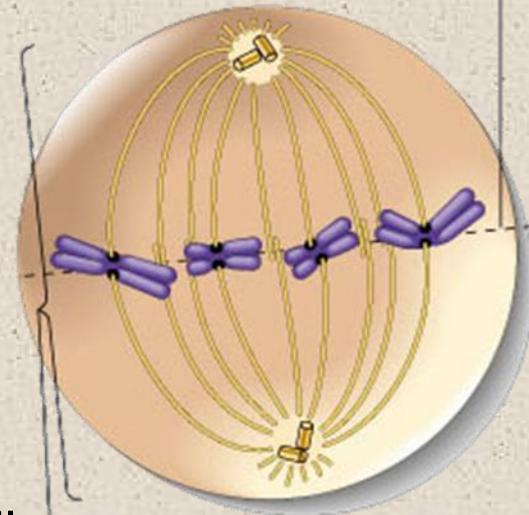
1. Chromosomes align in the "middle" (equator) of the cell; are pulled by the spindle fibres.

spindle microtubules



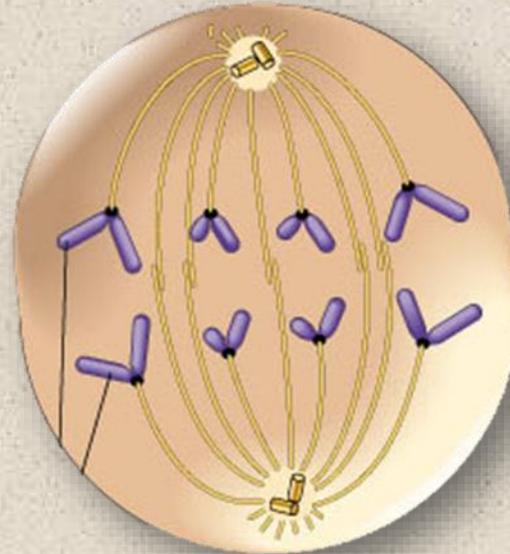
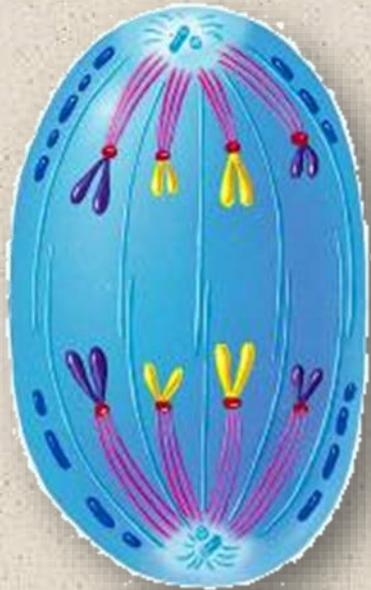
equator

spindle



A. Anaphase

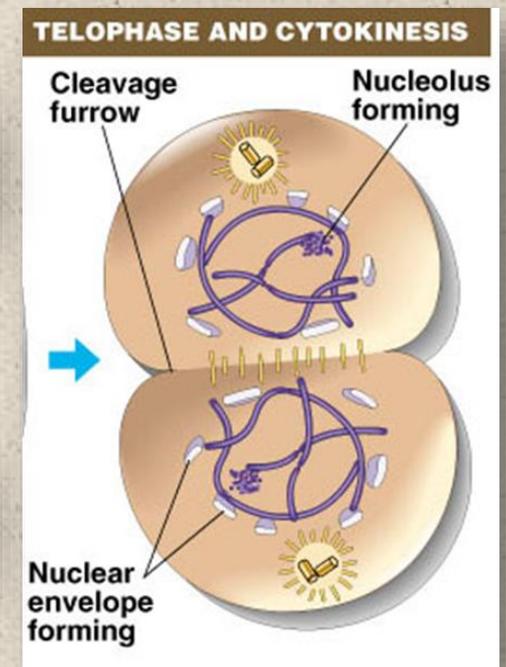
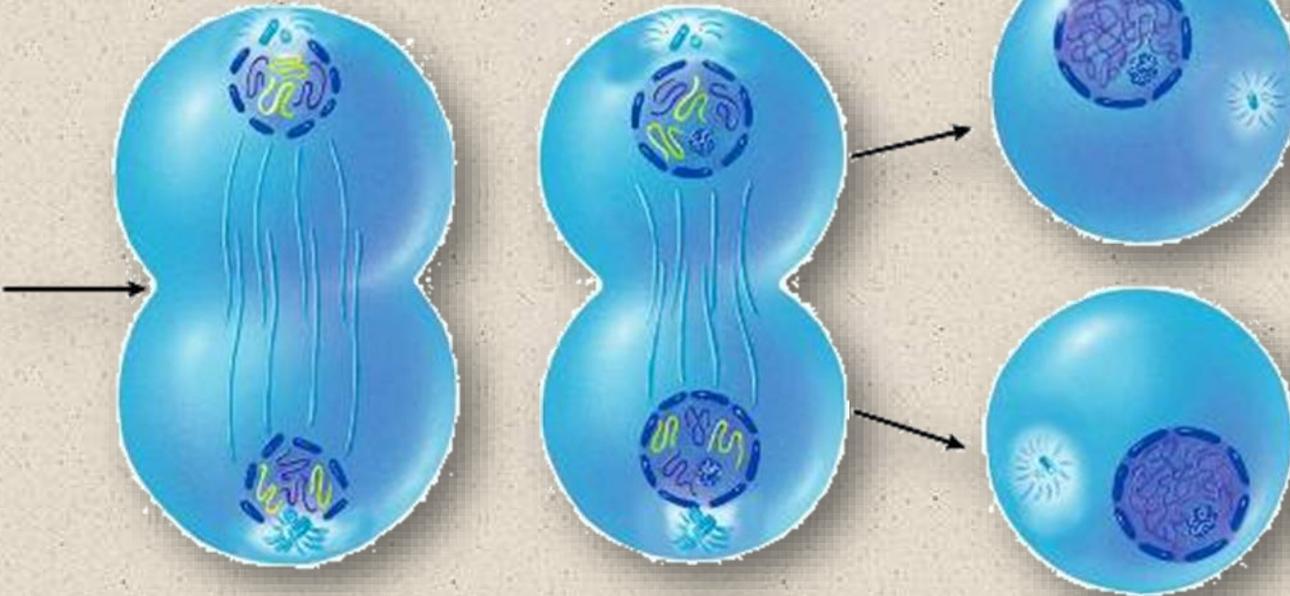
1. The centromere of each chromosome splits and one chromatid from each chromosome moves to the centrioles at the poles of the cell.
 - The chromatids, which are now separate, are now called chromosomes.
 - There are now twice as many chromosomes in the cell as there were in the parent cell.



Telophase

1. Nuclear membranes reform around each group of newly divided chromosomes.
2. Nucleoli (plural of nucleolus) reappear.
3. Spindles disappear.
4. Chromosomes extend, becoming invisible

• **Cytokinesis** occurs → cytoplasmic division of all the other materials in the cell; results in the formation of two new daughter cells with the correct number of chromosomes

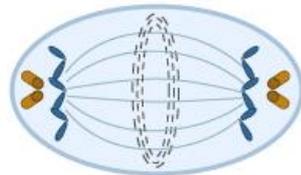


Cytokinesis

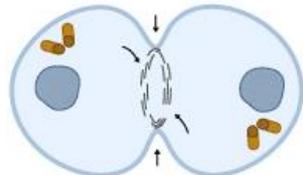
- Animals: The cell membrane pinches inward from both sides between the two poles until the daughter cells are formed.
- Plants: Plant cells form a region of new membranes and new cell wall material in the middle of the cell which moves outward. This is called a cell plate.

Telophase and Cytokinesis

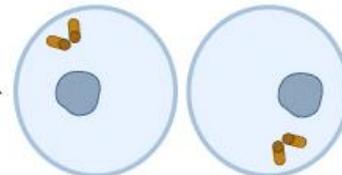
Animal Cell



1) After anaphase, microfilaments form around center of cell.

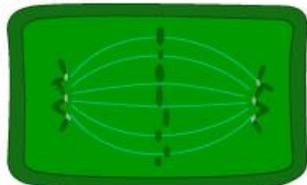


2) Microfilaments constrict forming cleavage furrow.

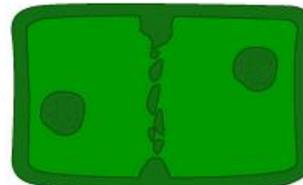


3) The cell is completely pinched by the microfilaments and two cells form.

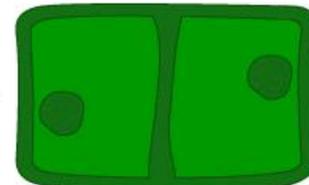
Plant Cell



1) Following anaphase, carbohydrate rich vesicles form around center of cell.

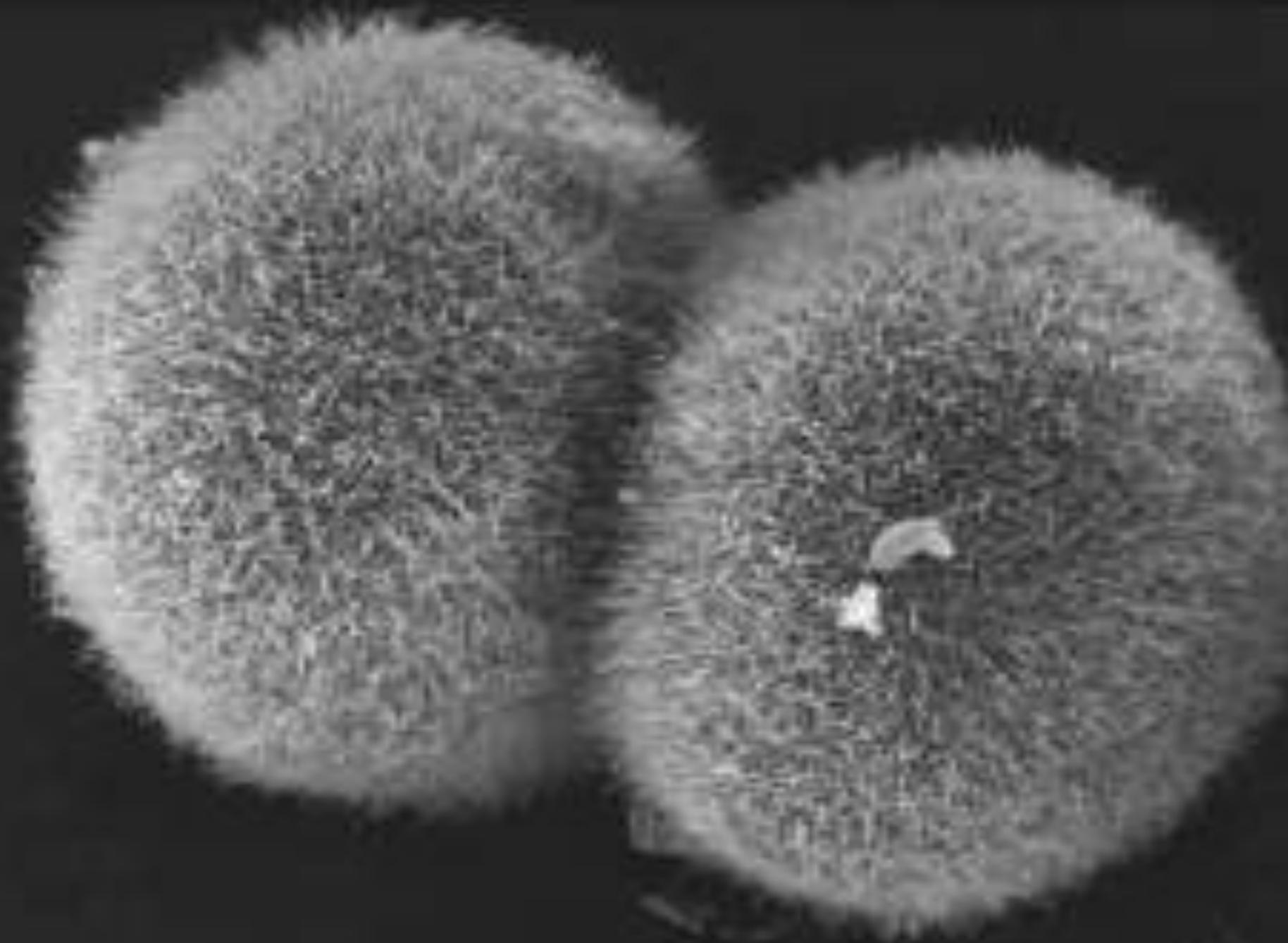


2) Vesicles fuse and cell plate begins to form.

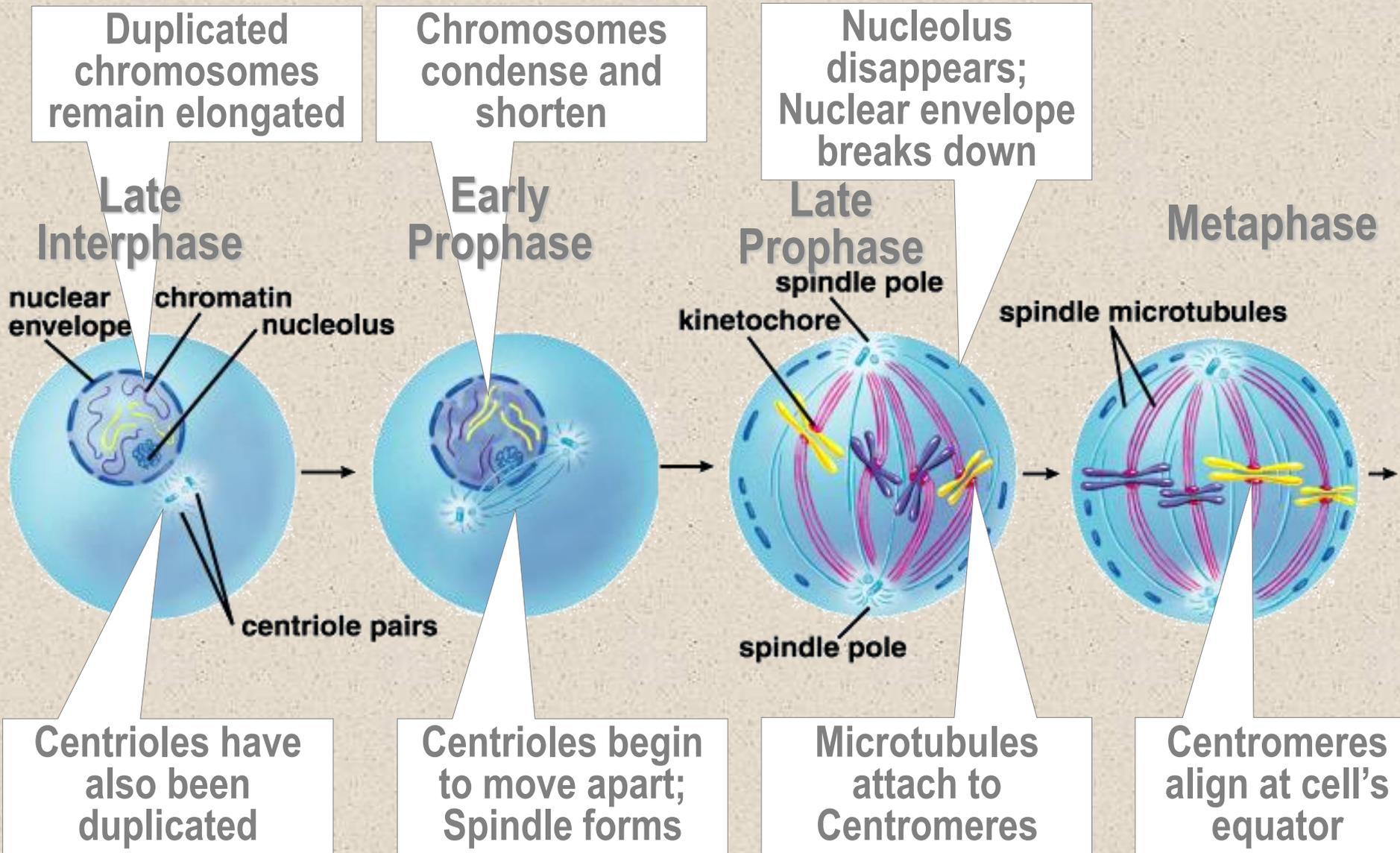


3) Cell plate is completely formed, creating two separate cells.

Cell type	Length of time
Red blood	120 days
Lymphocytes	Over one year
Other white	10 hours
Platelets	10 days
Bone	25-30 years
Brain	Lifetime
Colon	3-4 days
Skin	19-34 days
Spermatozoa	2-3 days
Stomach	2 days

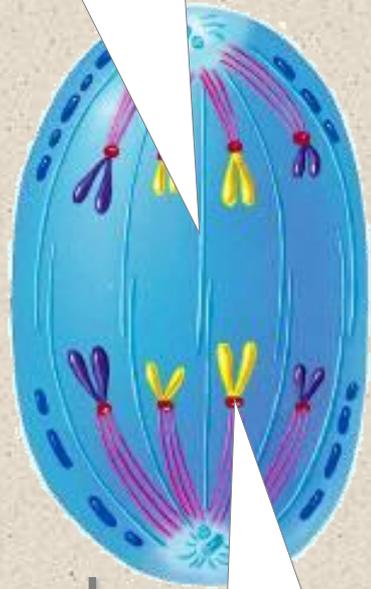


Mitosis: Review



Mitosis: Review (cont.)

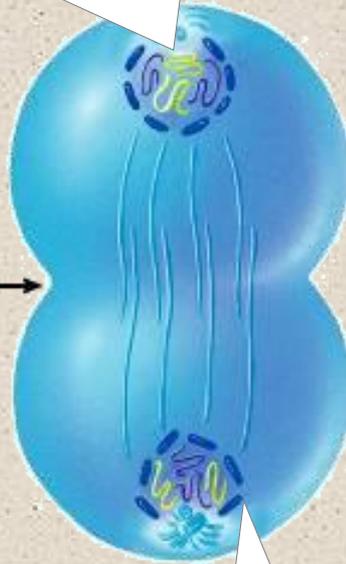
Free spindle fibers push poles apart



Anaphase

Chromatids become independent chromosomes

One set of chromosomes; Begin unwinding



Telophase

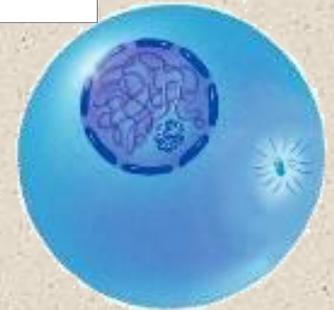
Nuclear envelope reforms

Cytoplasm divided along equator



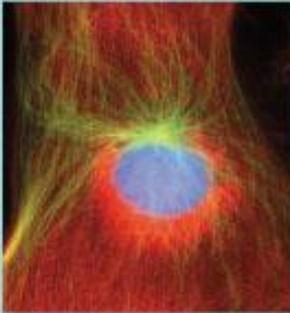
Cytokinesis

Each daughter gets 1 nucleus & half of cytoplasm

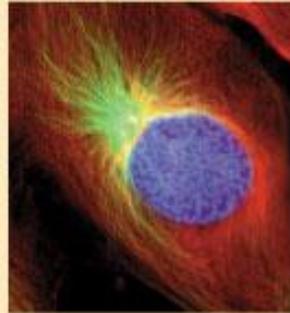


Next Interphase

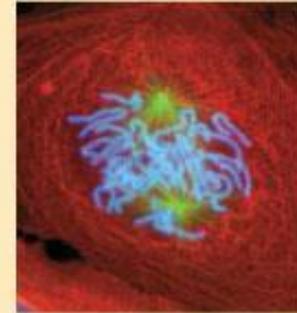
Spindle disappears; Nucleolus reappears



G₂ OF INTERPHASE

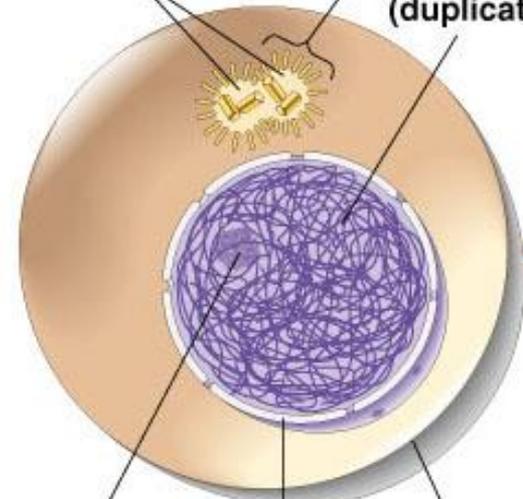


PROPHASE



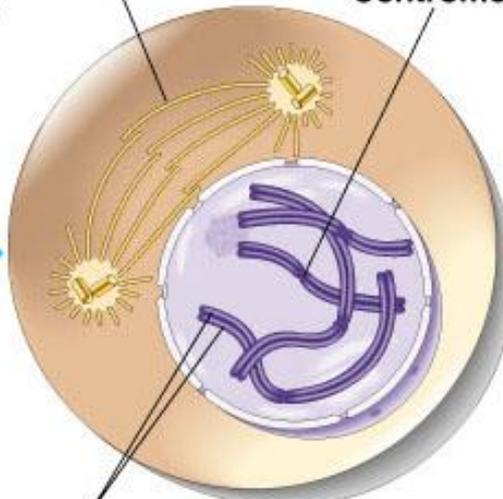
PROMETAPHASE

Centrosomes (with centriole pairs)
Aster
Chromatin (duplicated)



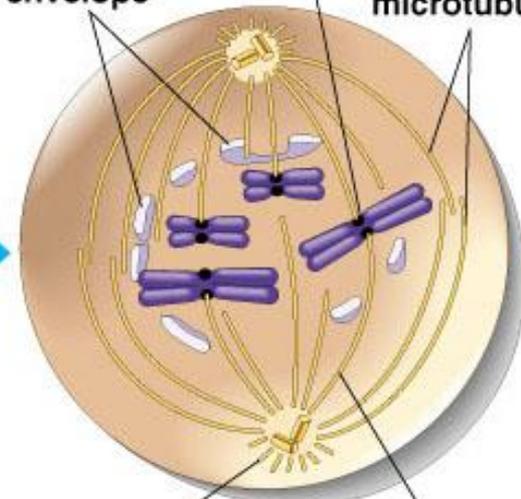
Nucleolus
Nuclear envelope
Plasma membrane

Early mitotic spindle

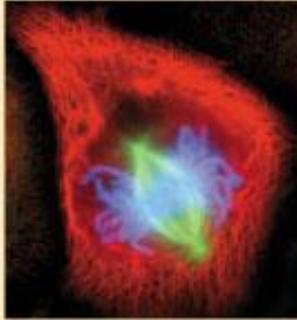


Centromere
Chromosome, consisting of two sister chromatids

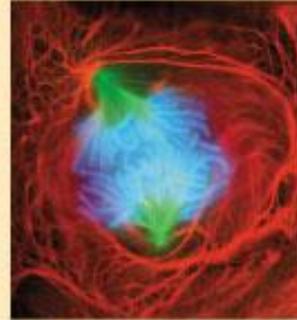
Fragments of nuclear envelope
Kinetochores
Nonkinetochore microtubules



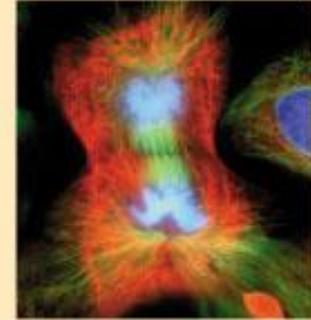
Spindle pole
Kinetochores
Kinetochore microtubule



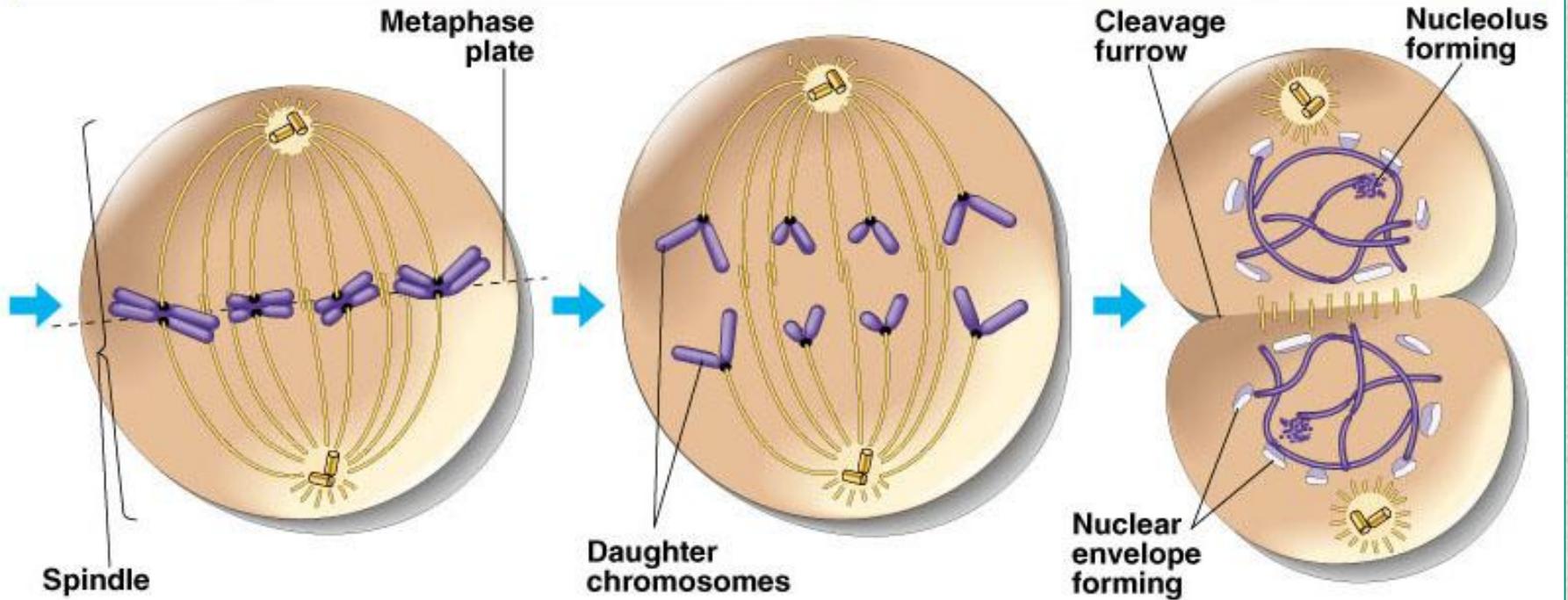
METAPHASE

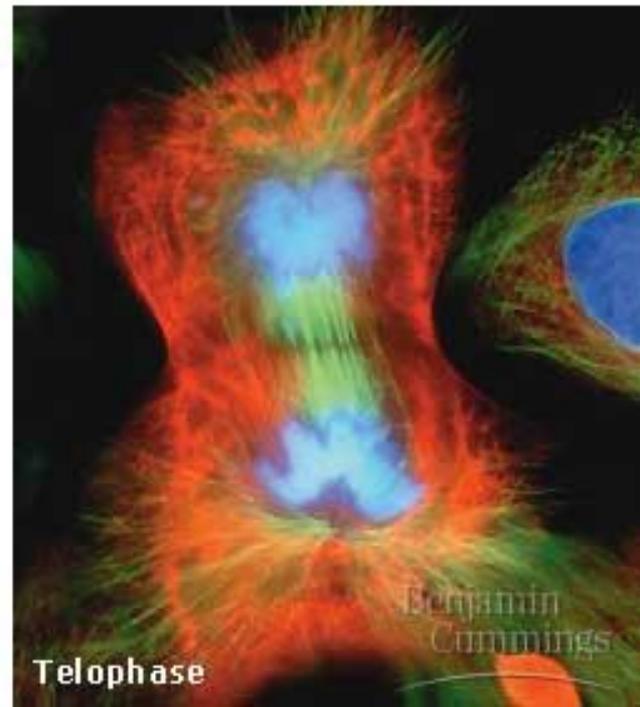
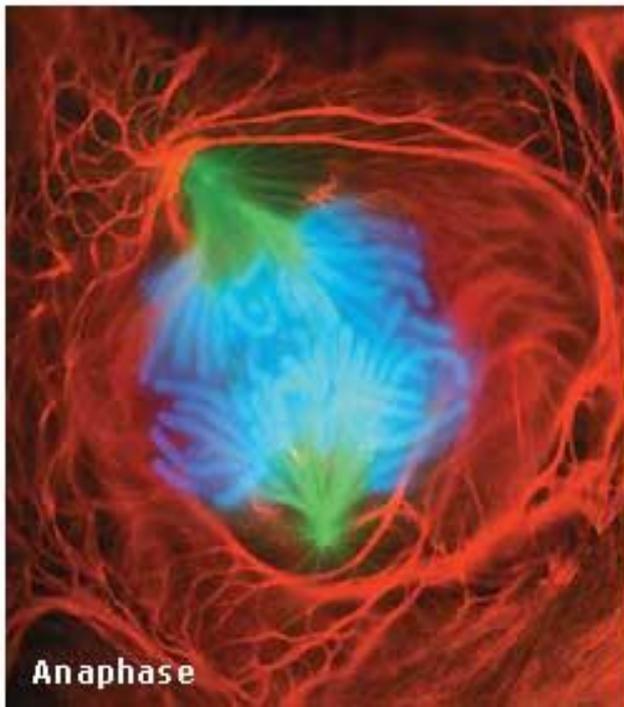
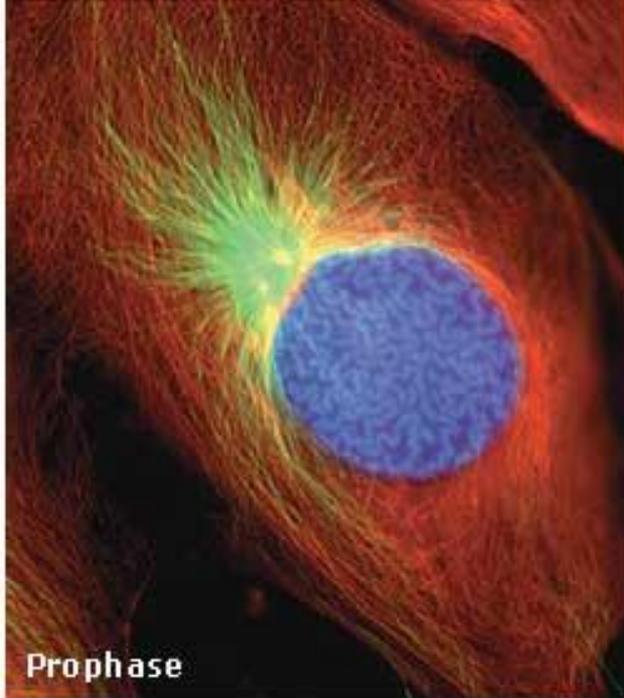
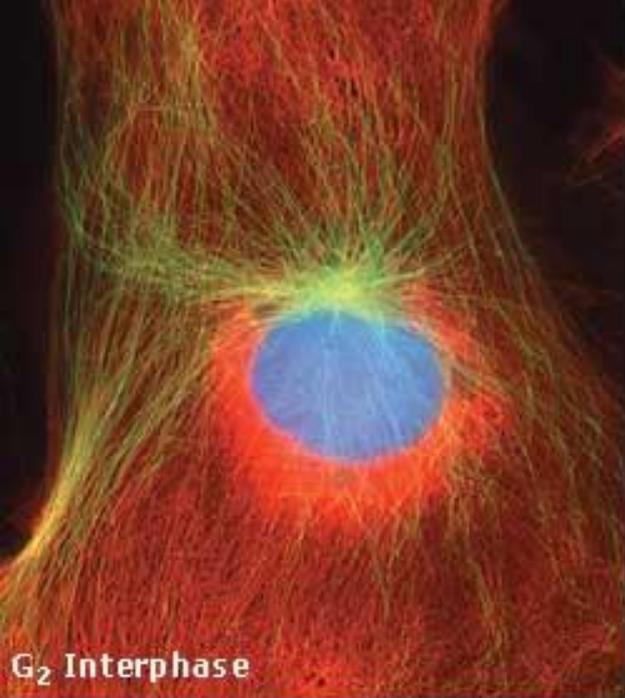


ANAPHASE



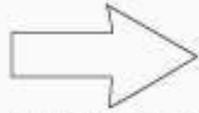
TELOPHASE AND CYTOKINESIS







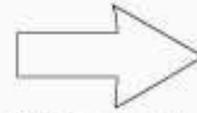
(a)



mitotic cell
division



(b)



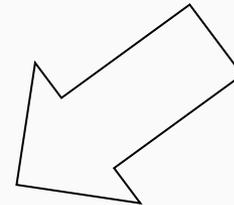
mitotic cell
division and
cellular
differentiation



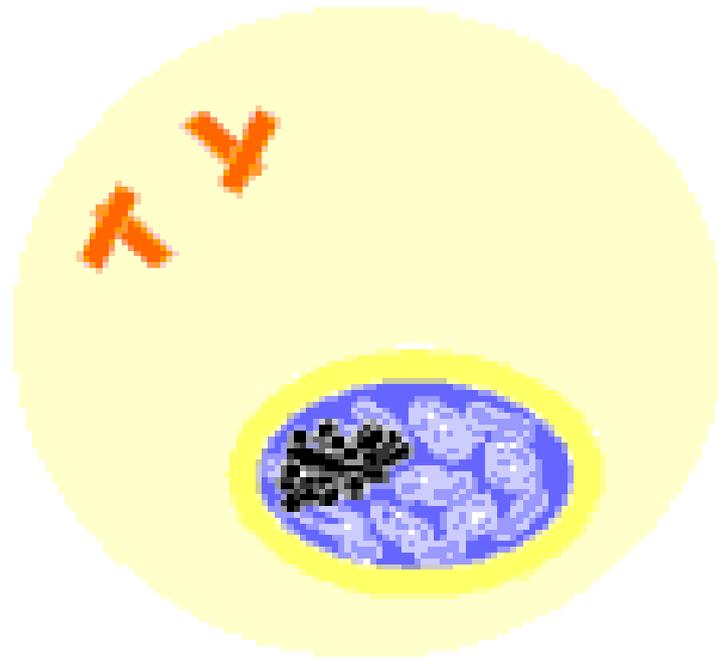
(c)



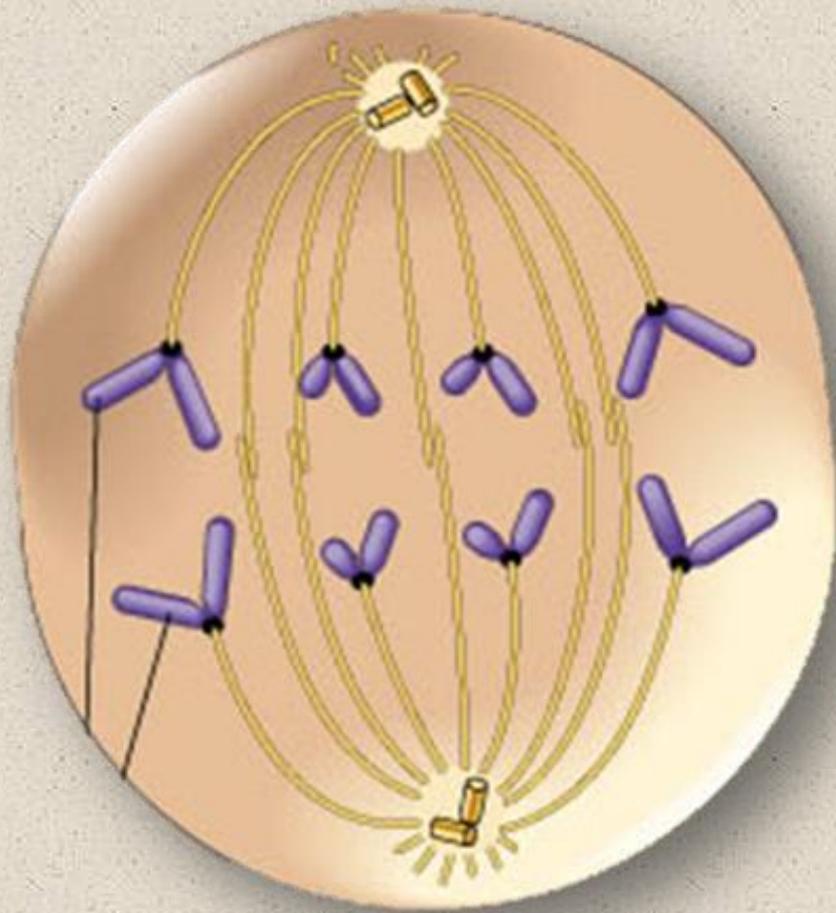
(d)



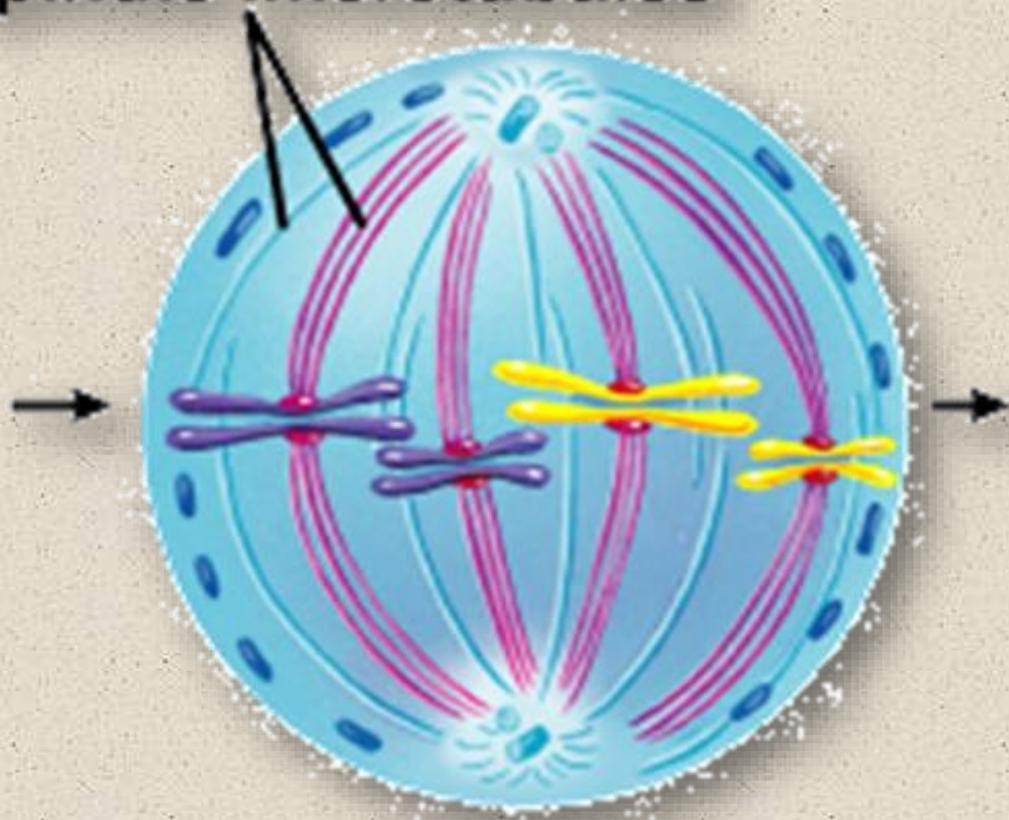
Mitosis in Animals

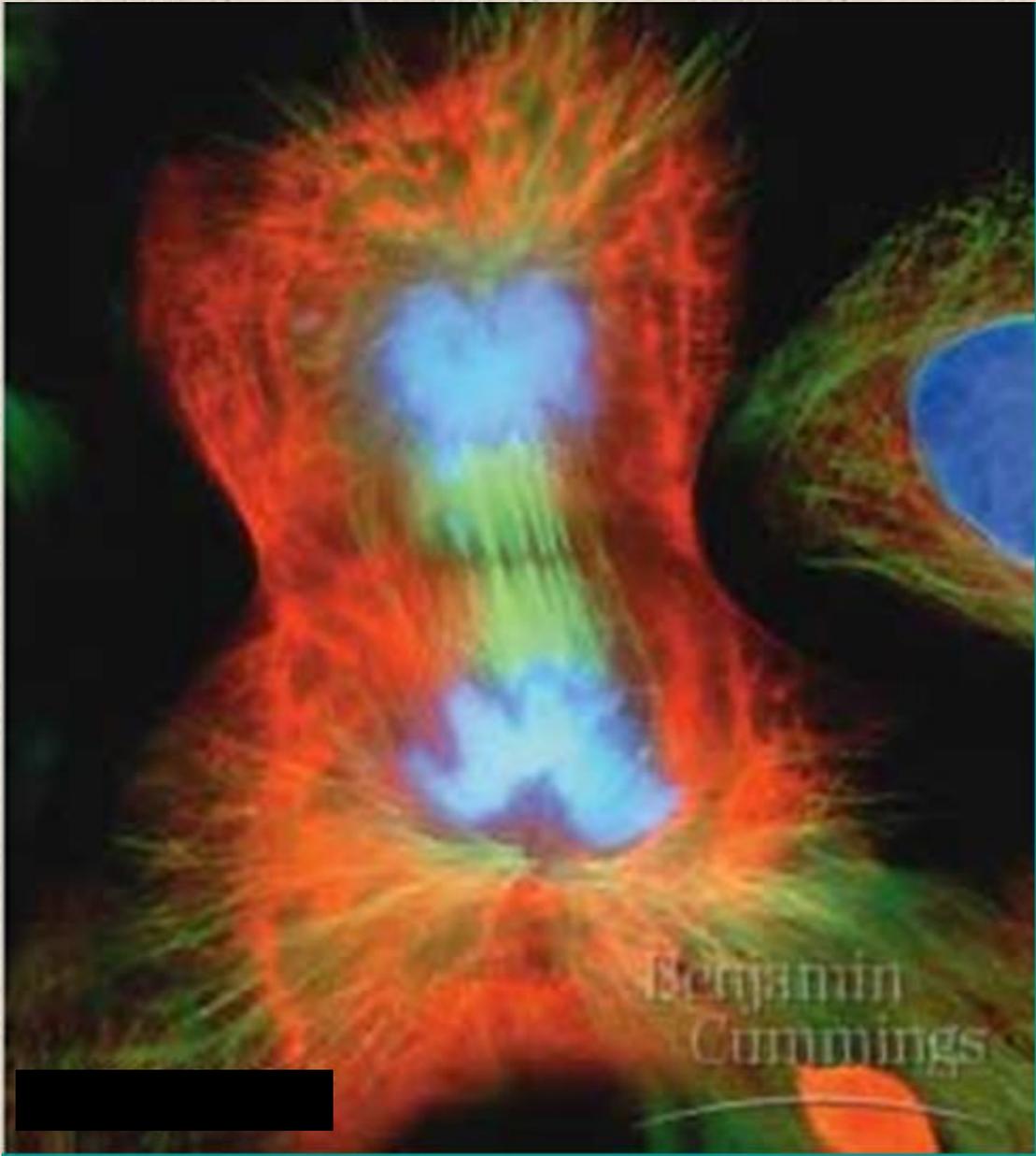


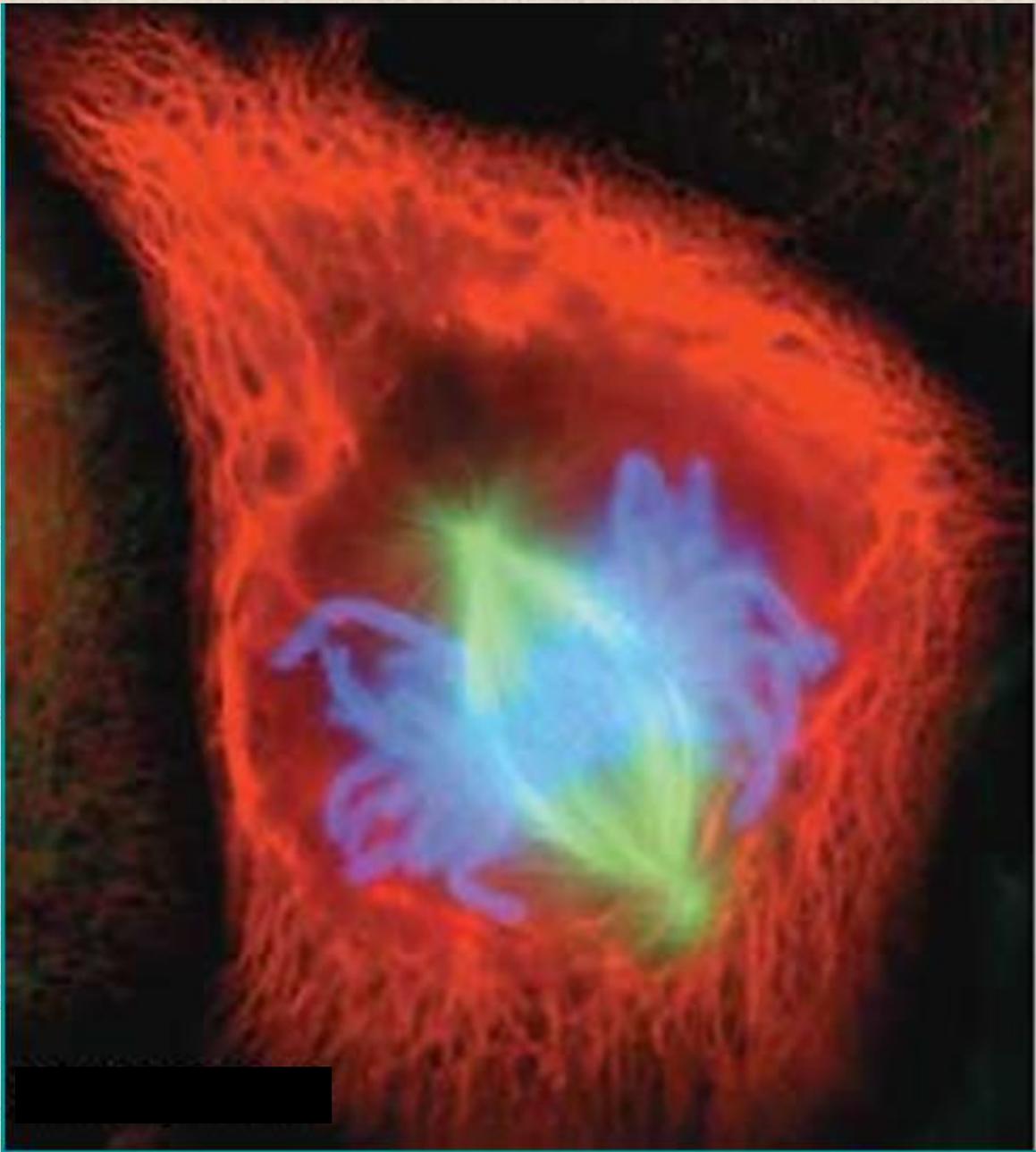
Identify the Stage



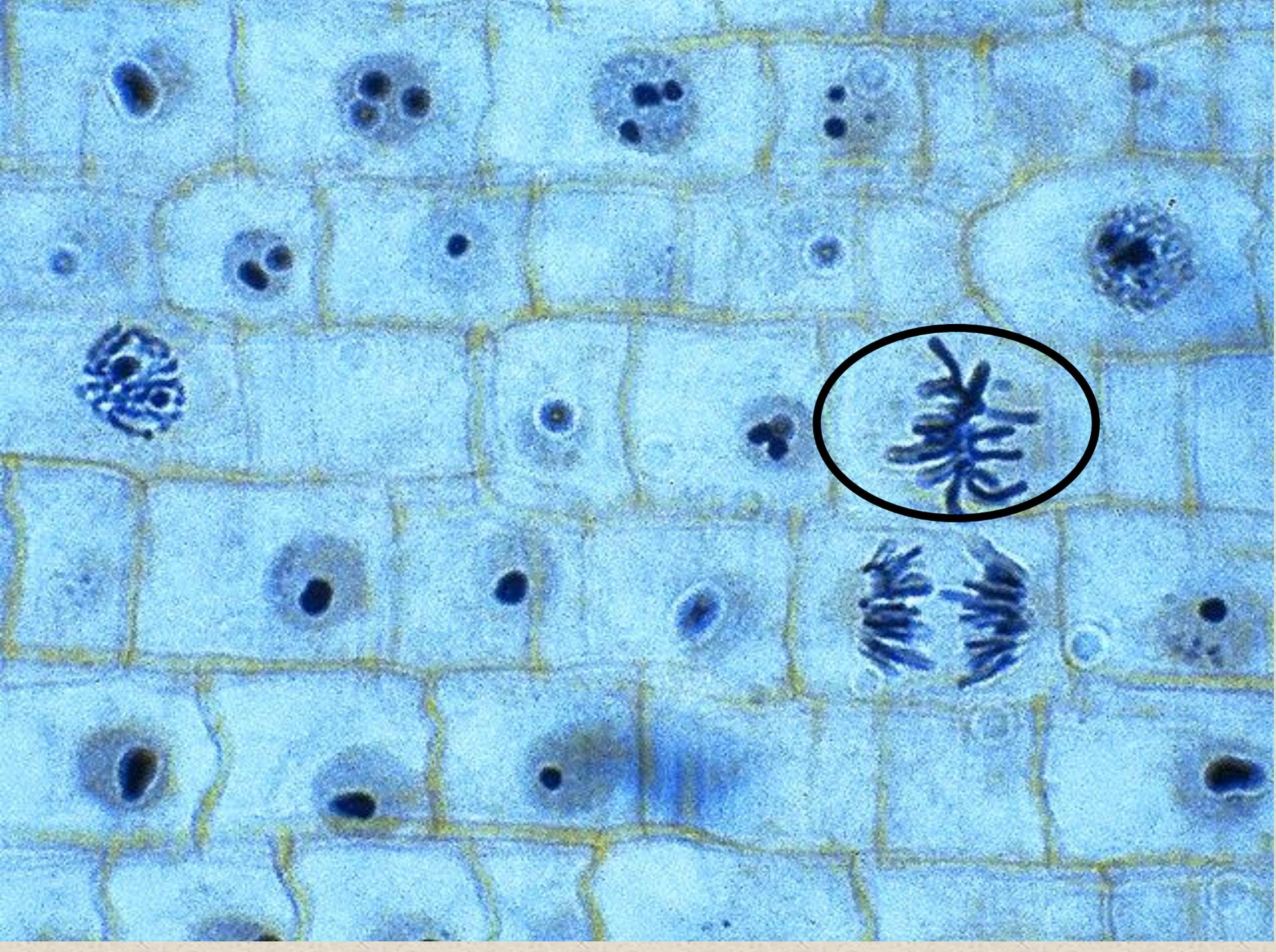
spindle microtubules

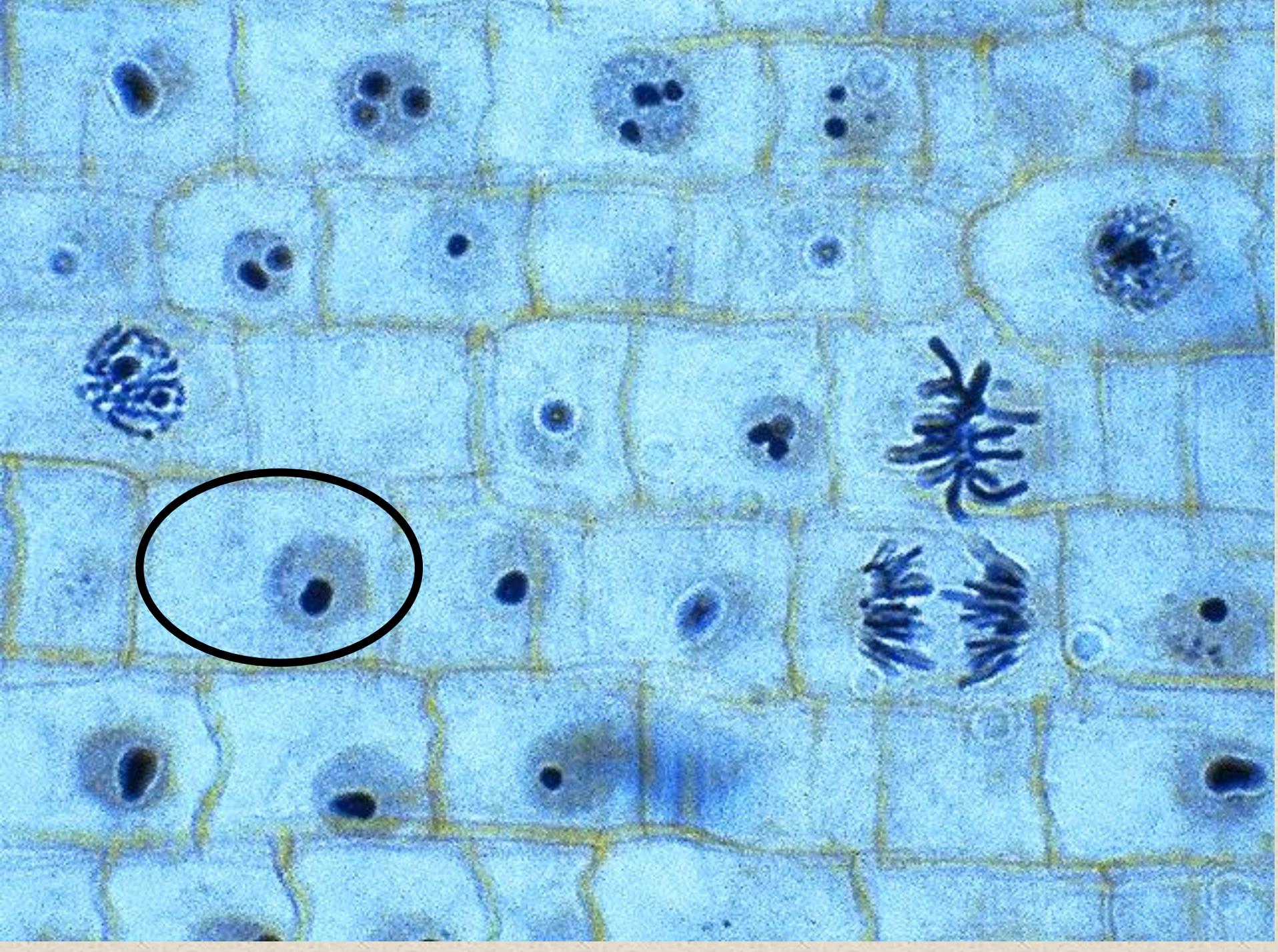


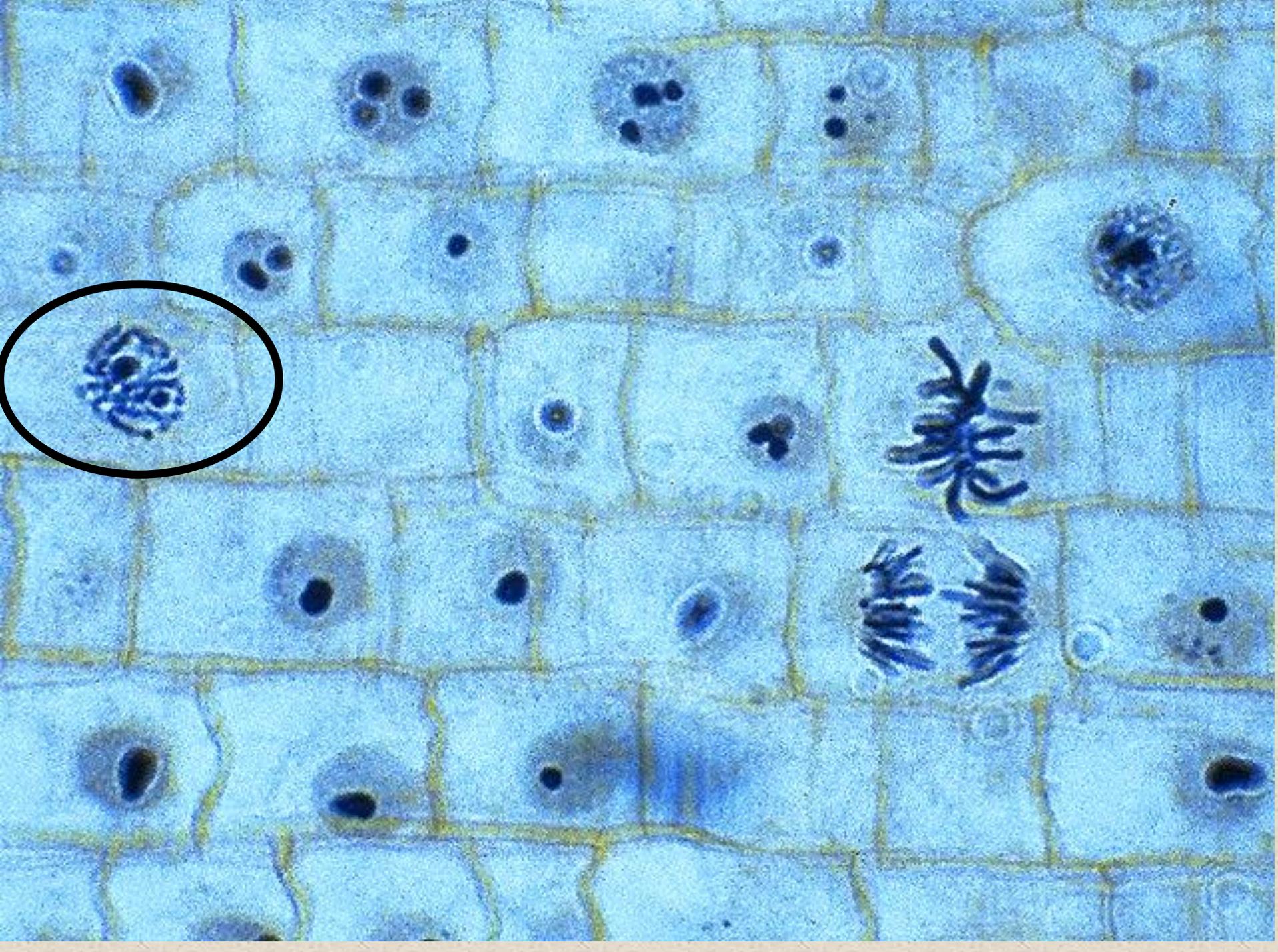


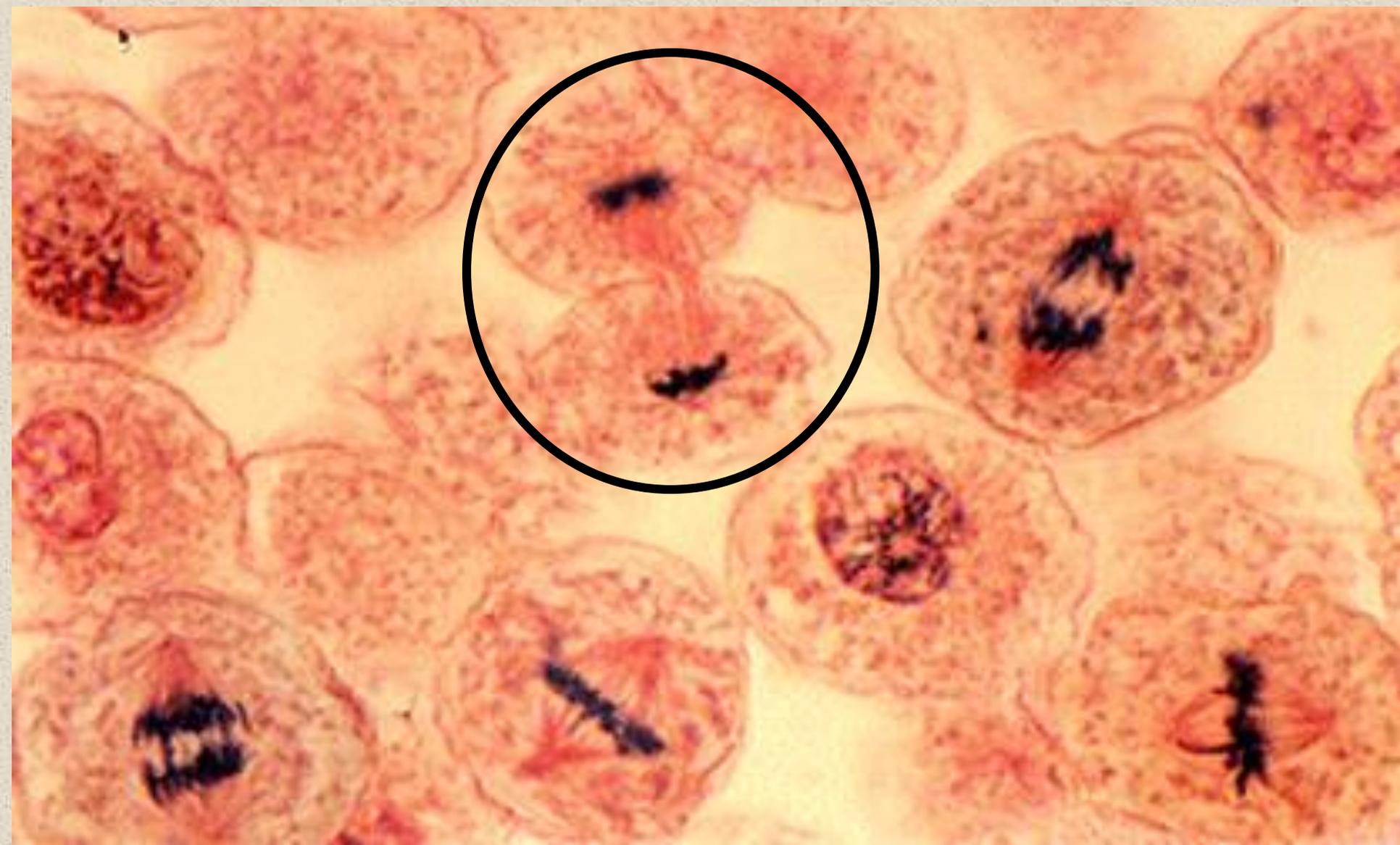


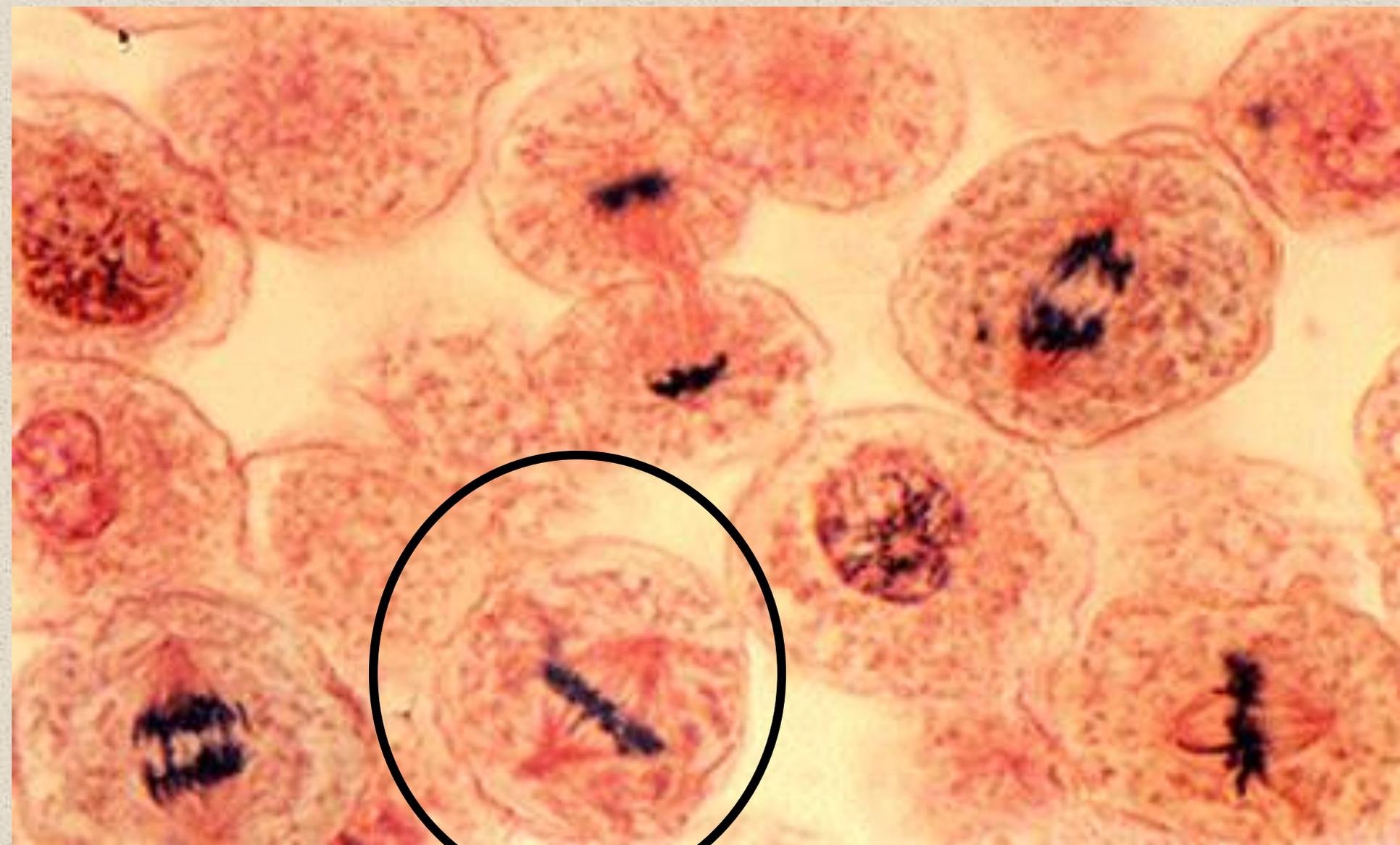


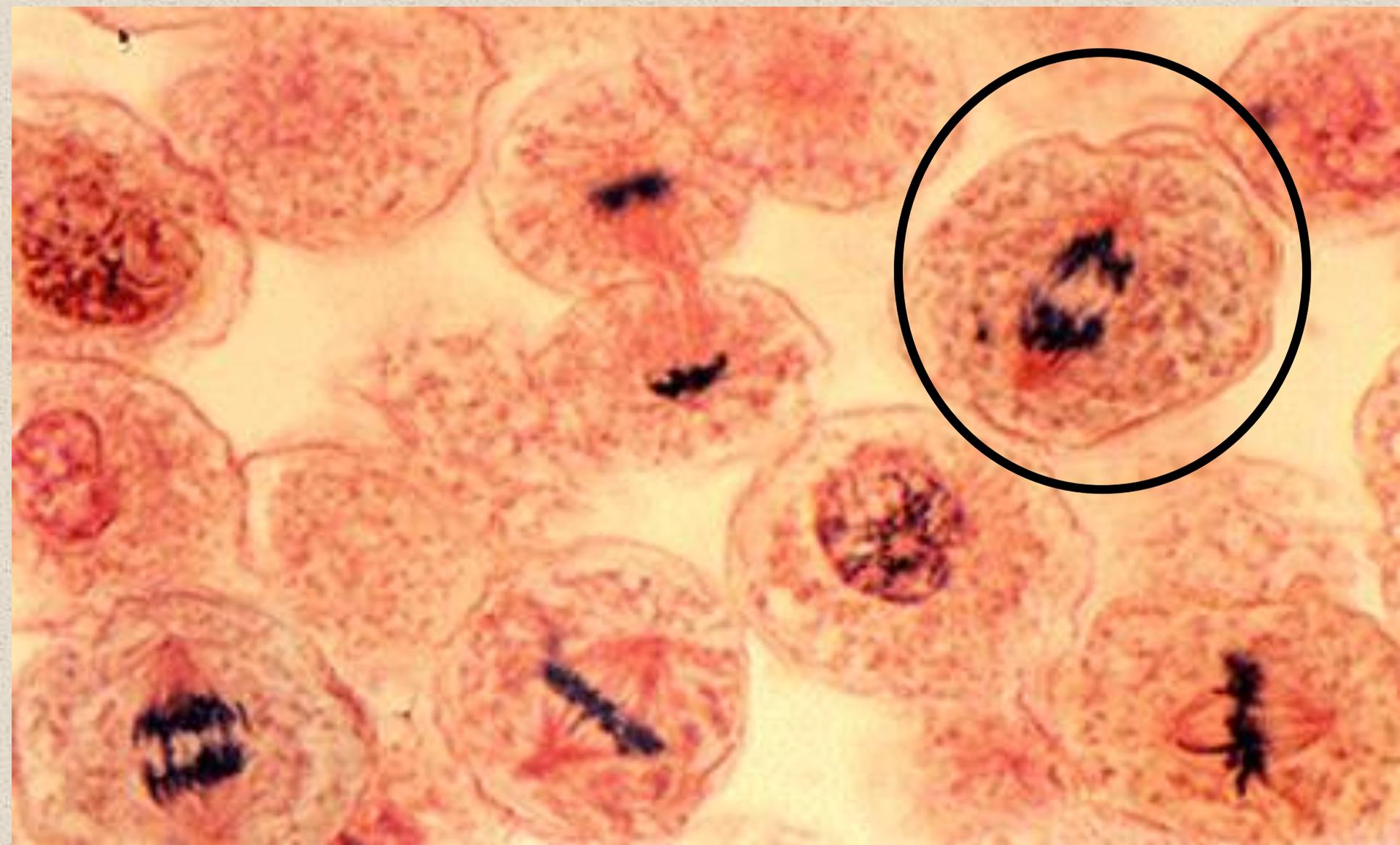


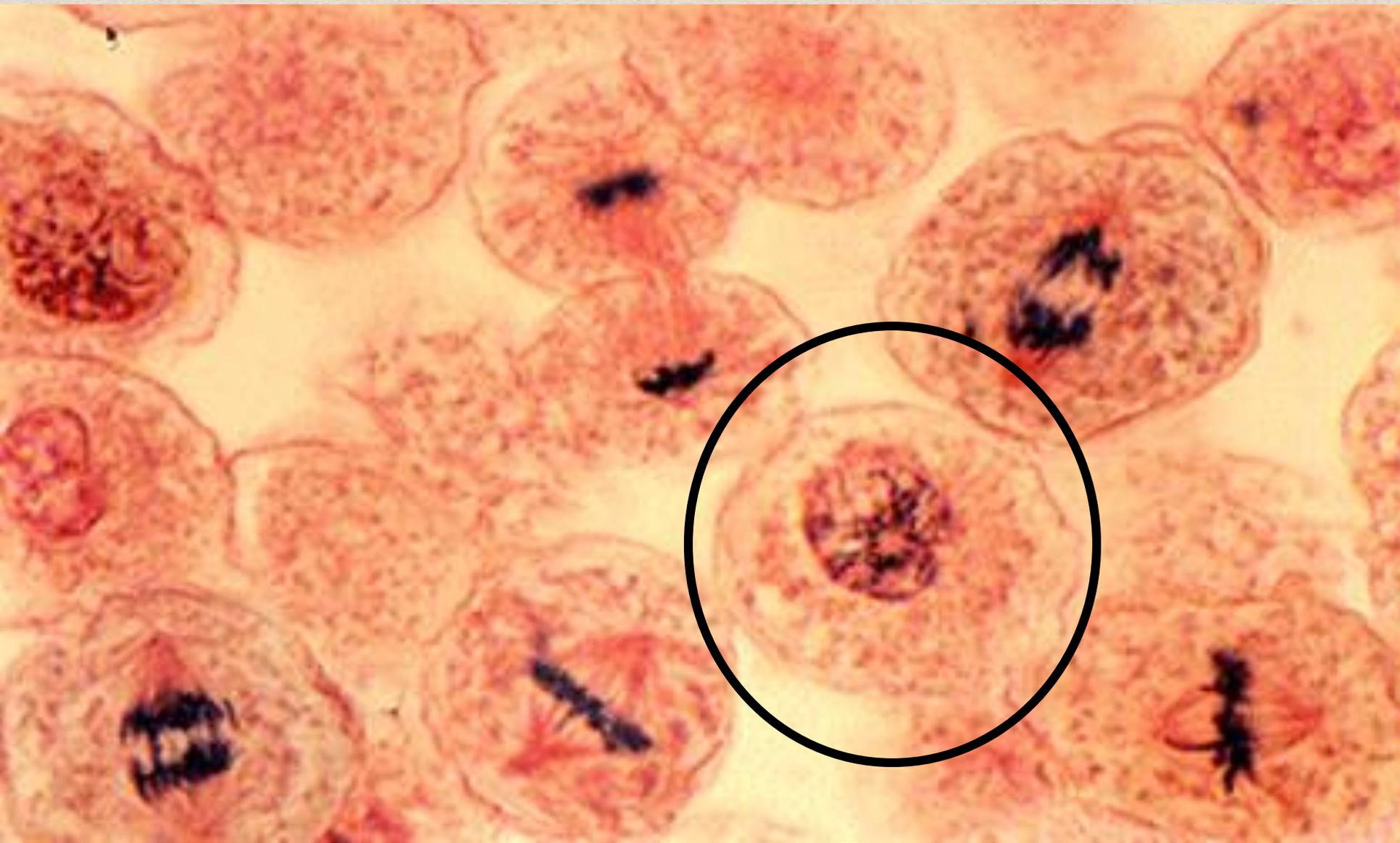


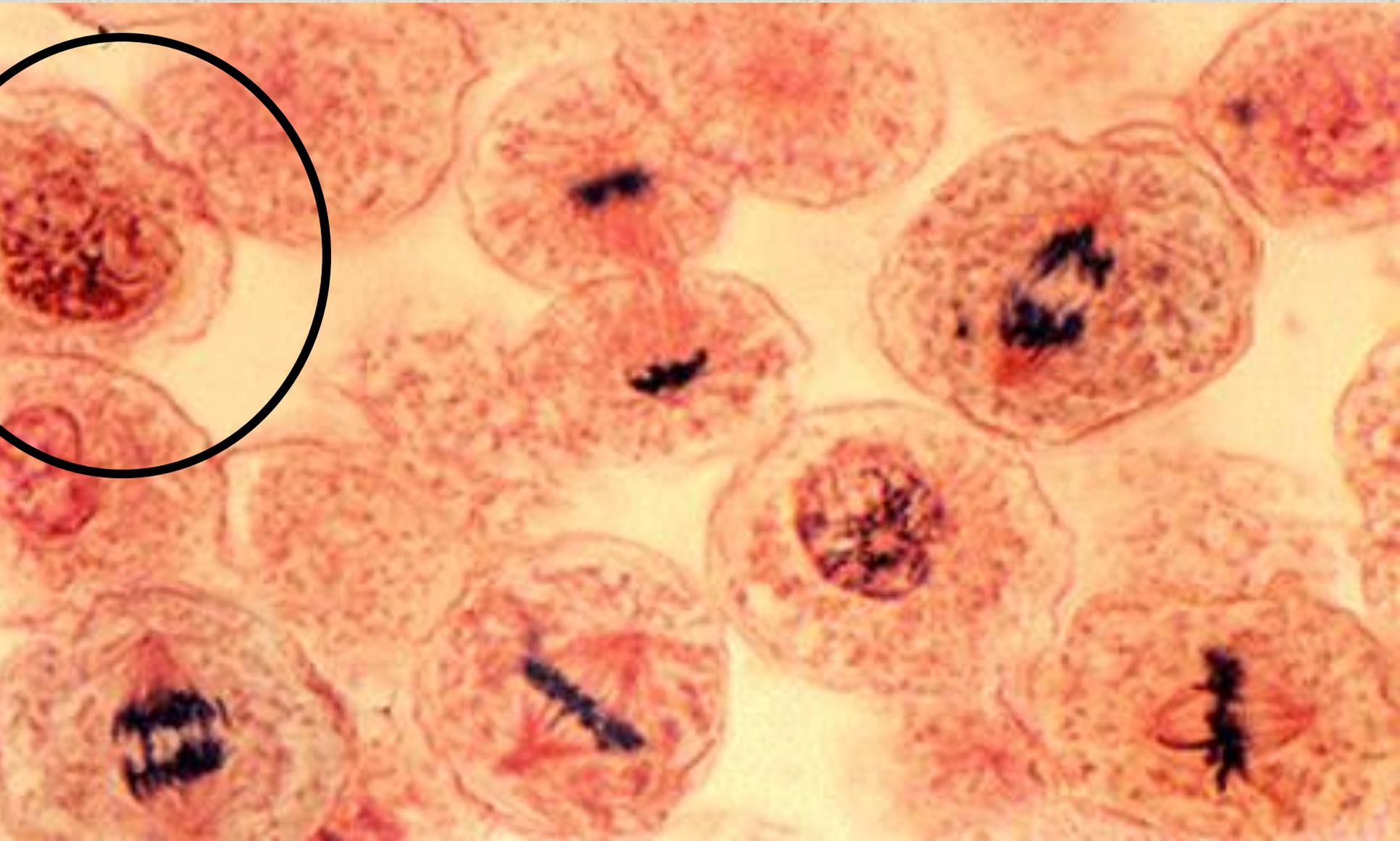












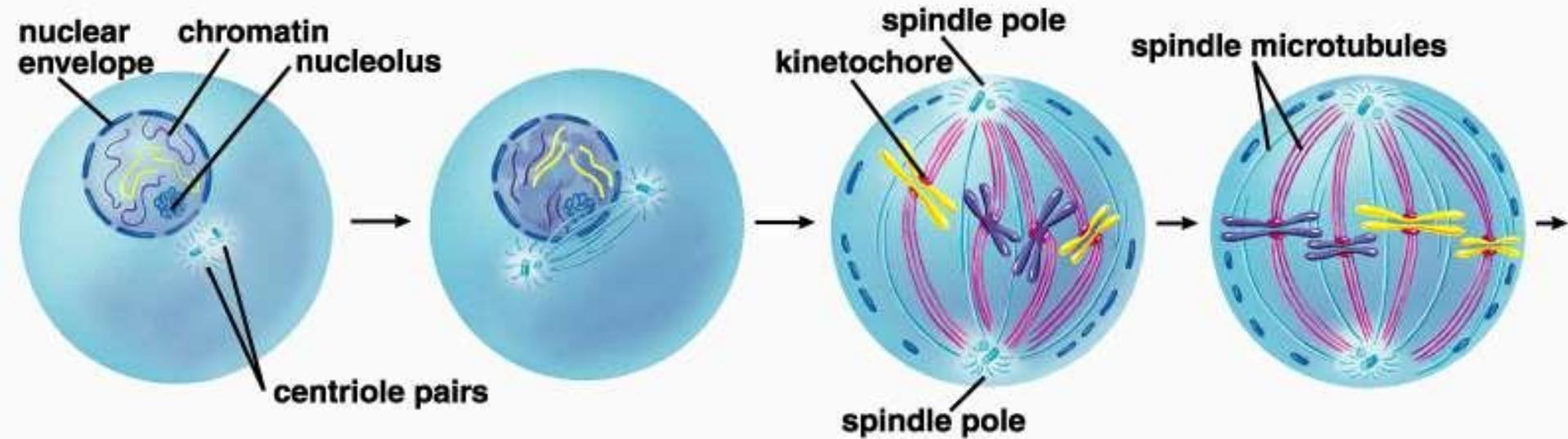
(a) LATE INTERPHASE

PROPHASE

(d) METAPHASE

(b) early

(c) late



(e) ANAPHASE

(f) TELOPHASE

(g) CYTOKINESIS

**(h) INTERPHASE OF
DAUGHTER CELLS**

