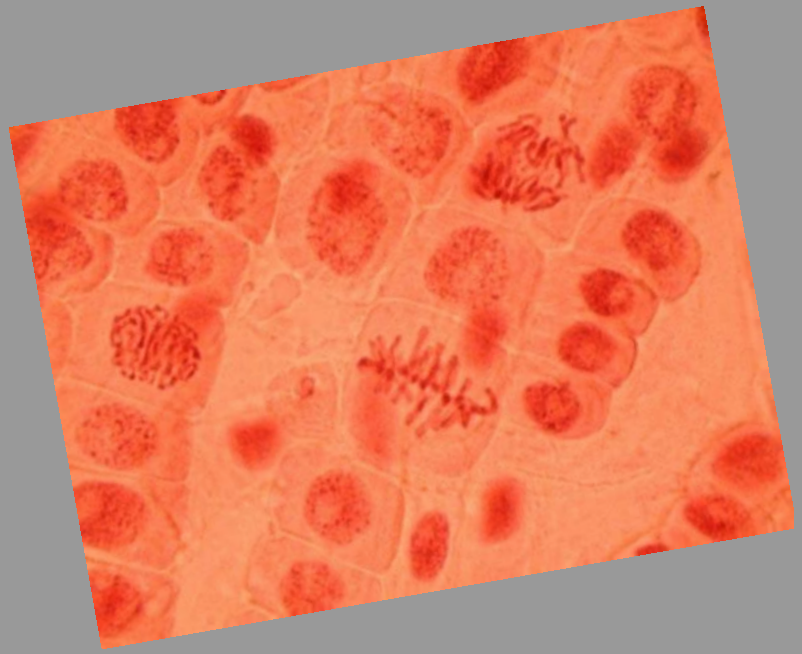
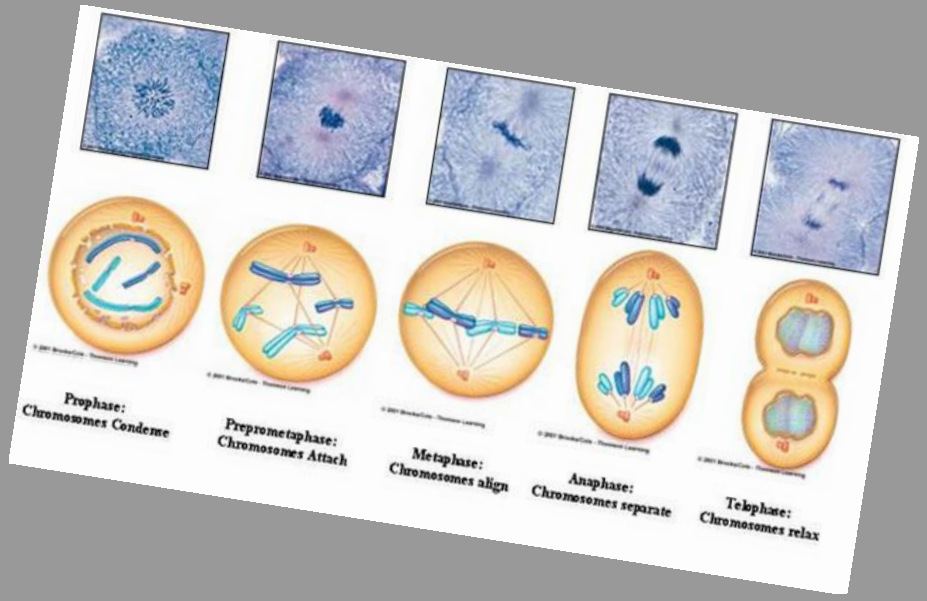
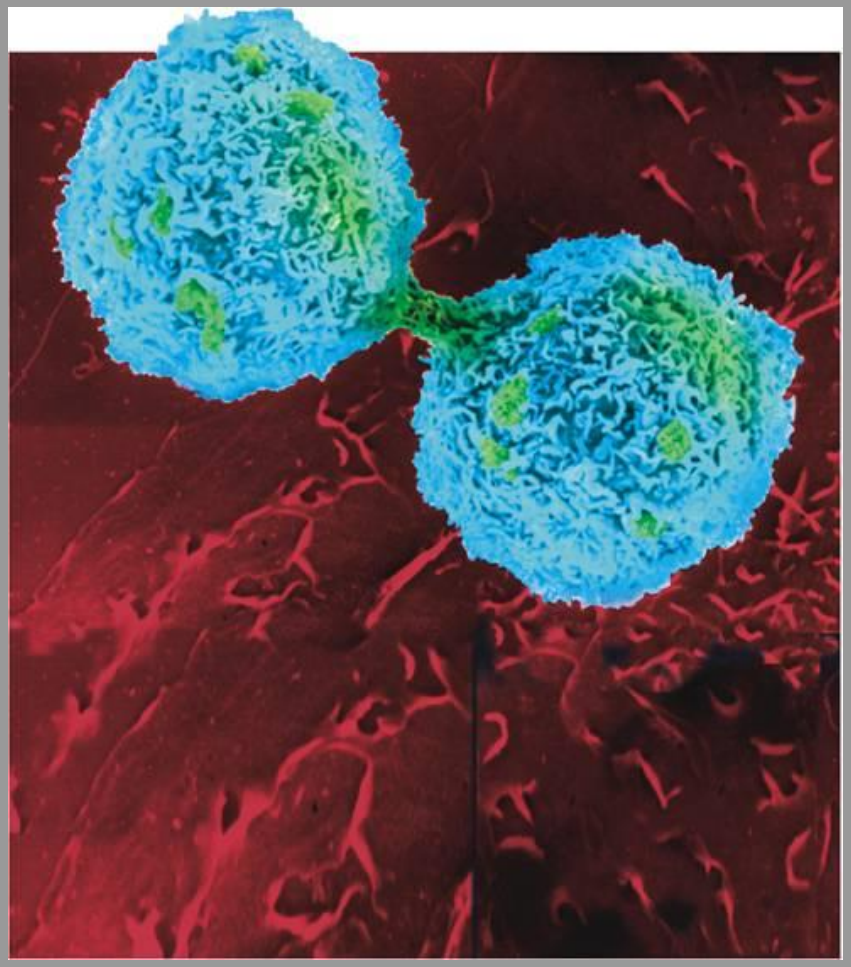
Chapter 10 Cell Growth and Division





10–1 Cell Growth



Limits to Cell Growth

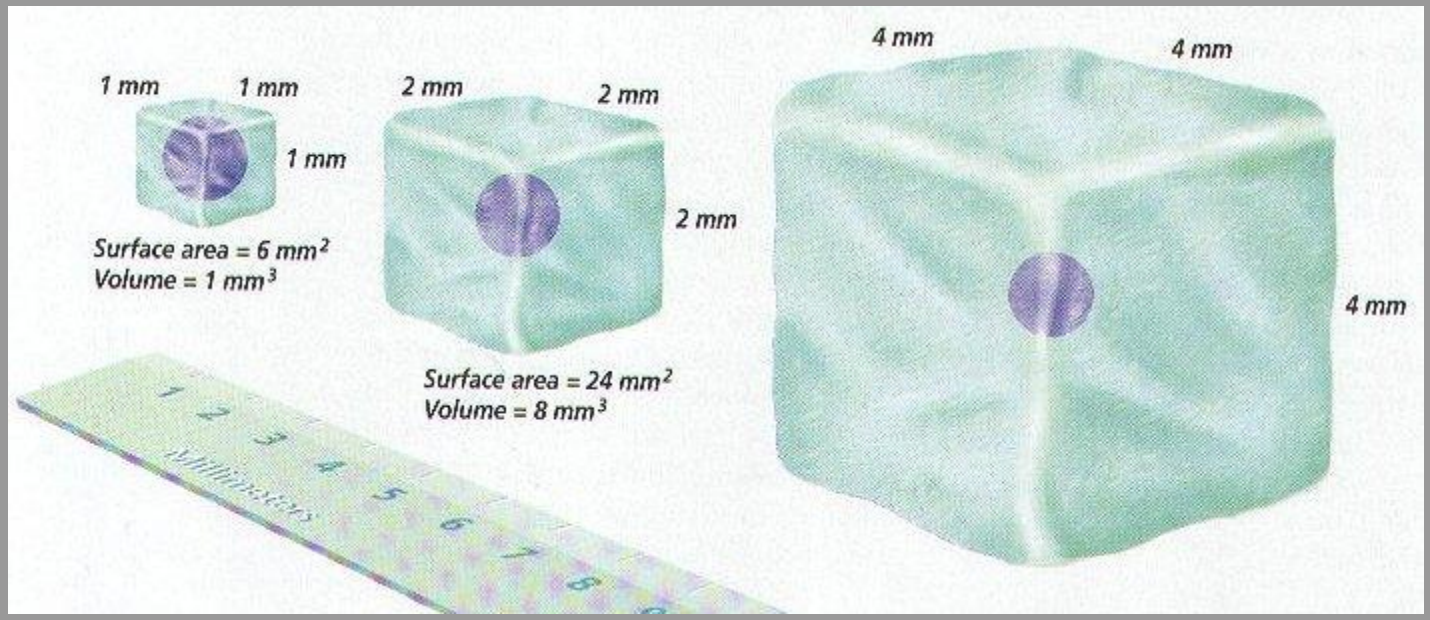
- The larger a cell becomes, the more demands the cell places on its DNA. In addition, the cell has more trouble moving enough nutrients and wastes across the cell membrane.
  - The rate at which food, oxygen, water, and wastes are moved in and out of the cell is dependent on the surface area of the cell.
  - The rate at which food, oxygen, and water are used and waste is produced depends on the cell's volume.

Ratio of Surface Area to Volume

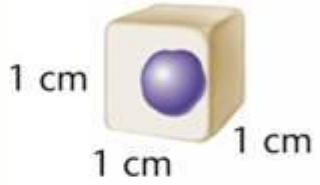
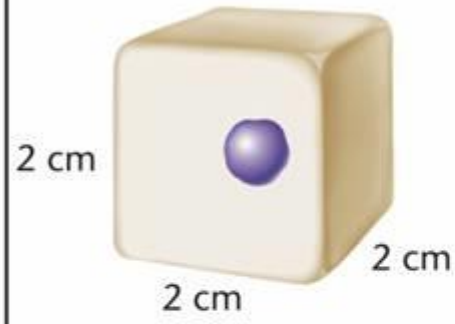
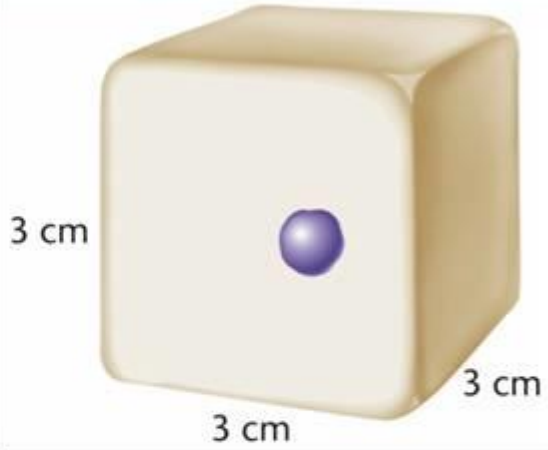
- As the length of a cell increases, its volume increases faster than the surface area.
  - The decrease in the cell's ratio of surface area to volume makes it more difficult for the cell to move needed materials in and waste products out quickly enough for the cell to survive.

If a cell got too large, it would be more difficult to get oxygen in and waste products out.

Volume increases faster than surface area.



Limits to Cell Growth

Ratio of Surface Area to Volume in Cells			
Cell Size			
Surface Area (length x width x 6)	1 cm x 1 cm x 6 = 6 cm^2	2 cm x 2 cm x 6 = 24 cm^2	3 cm x 3 cm x 6 = 54 cm^2
Volume (length x width x height)	1 cm x 1 cm x 1 cm = 1 cm^3	2 cm x 2 cm x 2 cm = 8 cm^3	3 cm x 3 cm x 3 cm = 27 cm^3
Ratio of Surface Area to Volume	6 / 1 = 6 : 1	24 / 8 = 3 : 1	54 / 27 = 2 : 1

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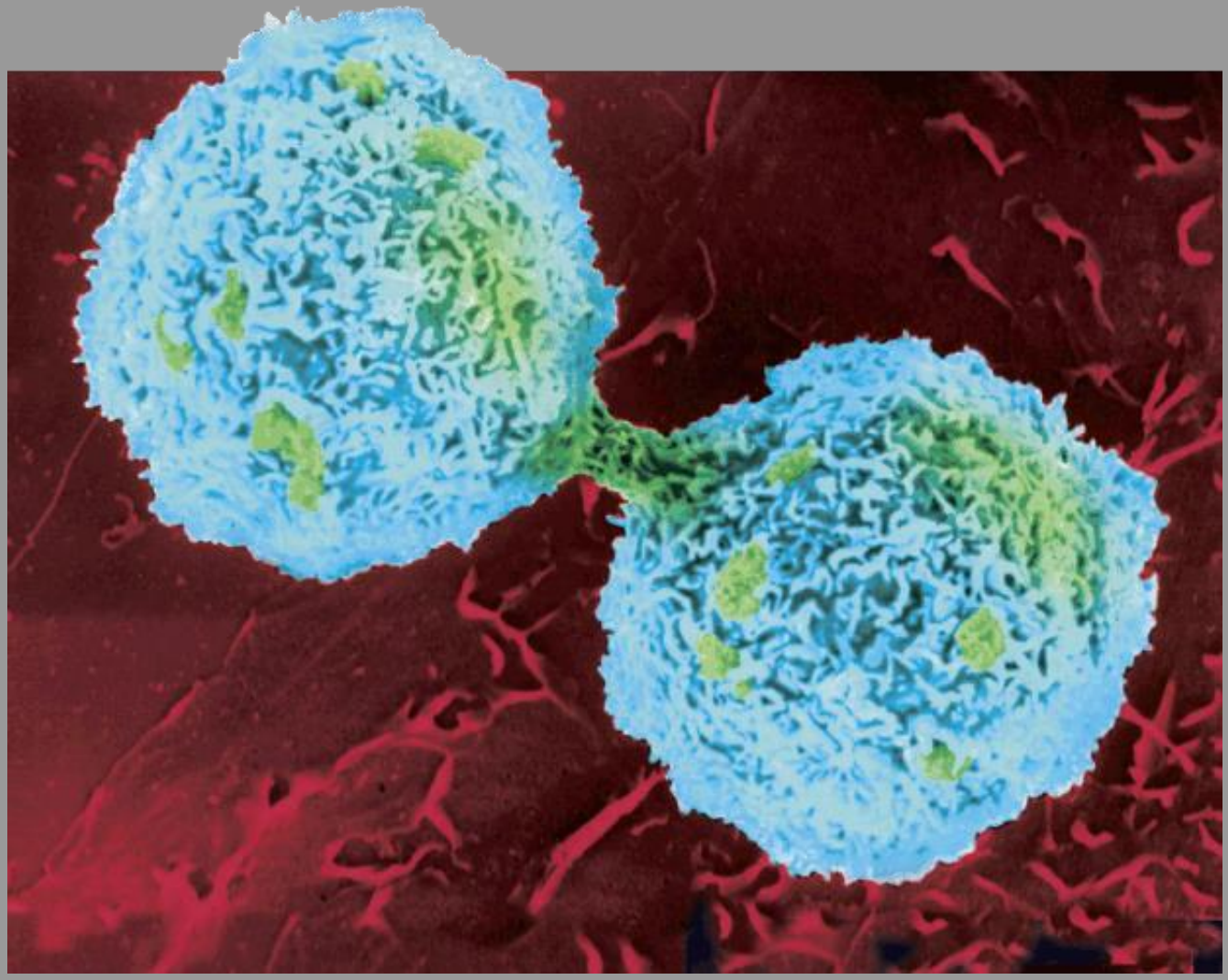
Division of the Cell

- Before it becomes too large, a growing cell divides forming two “daughter” cells.
- The process by which a cell divides into two new daughter cells is called cell division.

10-2 Cell Division

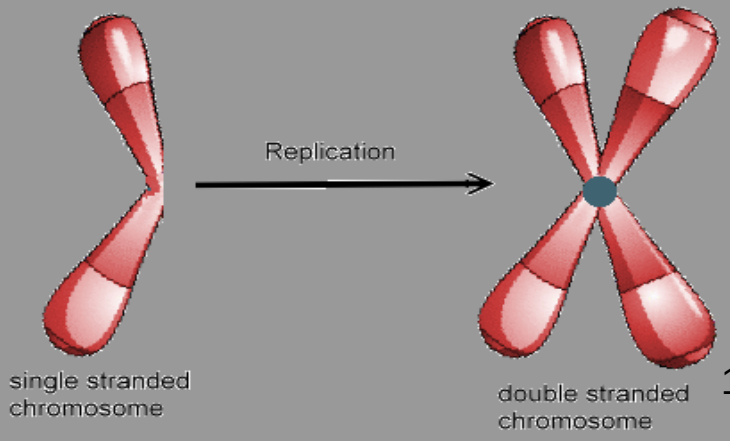


Cell Division

- In eukaryotes, cell division occurs in two major stages.
  - The first stage, division of the cell nucleus, is called **mitosis.**
  - The second stage, division of the cell cytoplasm, is called **cytokinesis.**
- Most eukaryotic cells go through a regular cycle of interphase, mitosis and cytokinesis. **Mitosis has four phases: Prophase, Metaphase, Anaphase and Telophase. The events shown are typical of animal cells.**

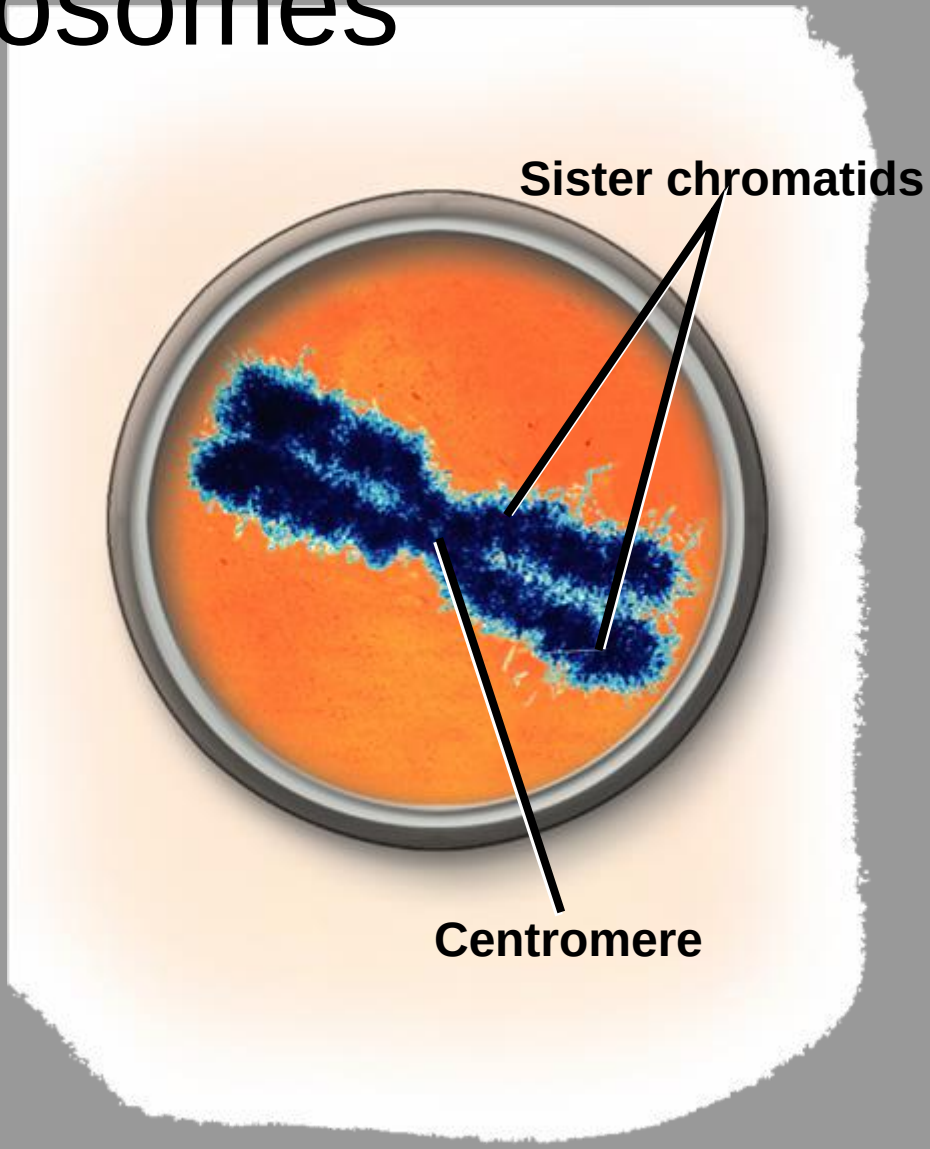
Chromosomes

- Genetic information is passed from one generation to the next on **chromosomes**.
  - Each organism has a specific number of chromosomes.
  - During cell division chromatin condenses into chromosomes.
  - Before cell division, each chromosome is duplicated, or copied.



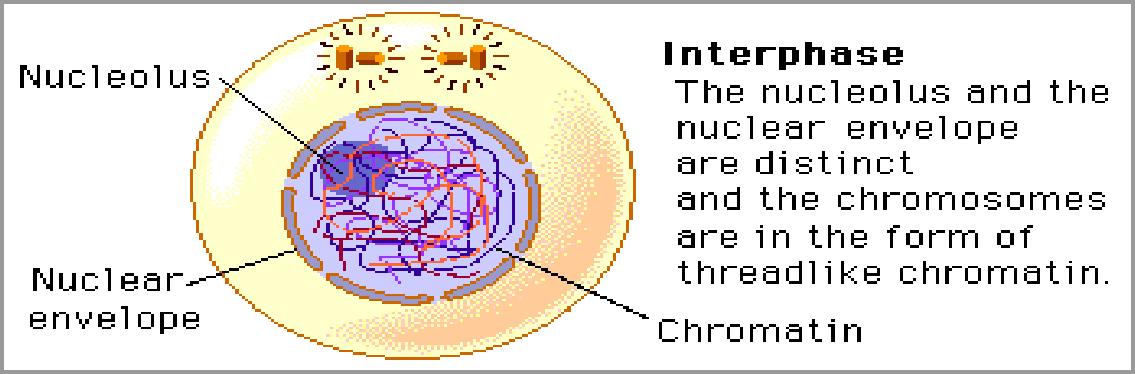
Chromosomes

- Each chromosome consists of two identical “sister” chromatids.
- Each pair of chromatids is attached at an area called the **centromere.**
- When the cell divides, the chromatids separate.
- Each new cell gets one chromatid.

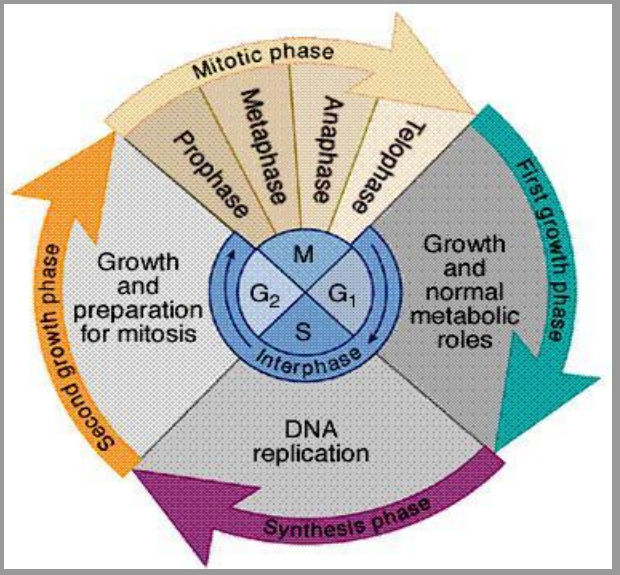


The Cell Cycle

- The **cell cycle** is the series of events that cells go through as they grow and divide.
  - **Interphase** is the period of growth that occurs between cell divisions.

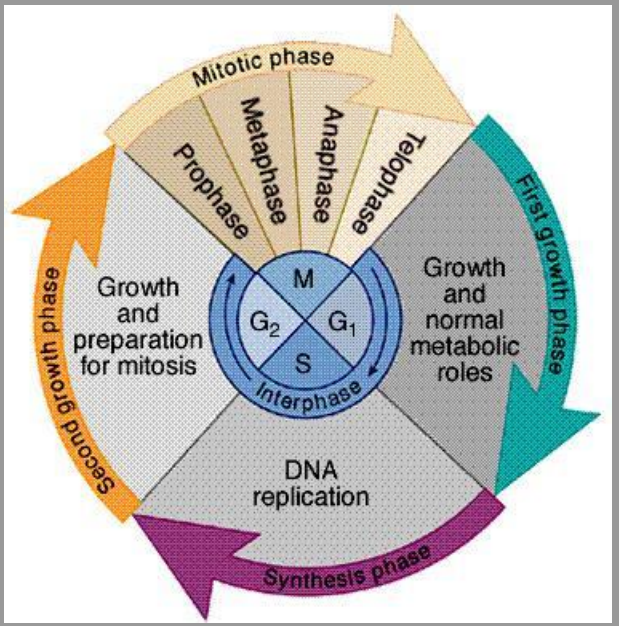


The Cell Cycle



- During the cell cycle:
  - a cell grows
  - prepares for division
  - divides to form two daughter cells, each of which begins the cycle again
- The cell cycle consists of four phases:
  - G_1 (First Gap Phase)
  - S Phase
  - G_2 (Second Gap Phase)
  - M Phase

Events of the Cell Cycle



- During G_1, the cell
  - increases in size
  - synthesizes new proteins and organelles
- During the S phase,
  - chromosomes are replicated
  - DNA synthesis takes place
  - Once a cell enters the S phase, it usually completes the rest of the cell cycle.

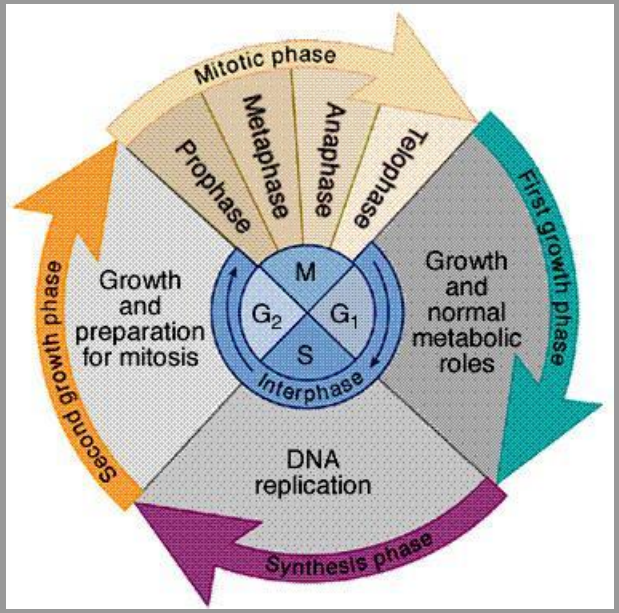
Events of the Cell Cycle

- The G_2 Phase (Second Gap Phase)
  - organelles and molecules required for cell division are produced
  - Short phase
  - Once G_2 is complete, the cell is ready to start the M phase—Mitosis

Cell division

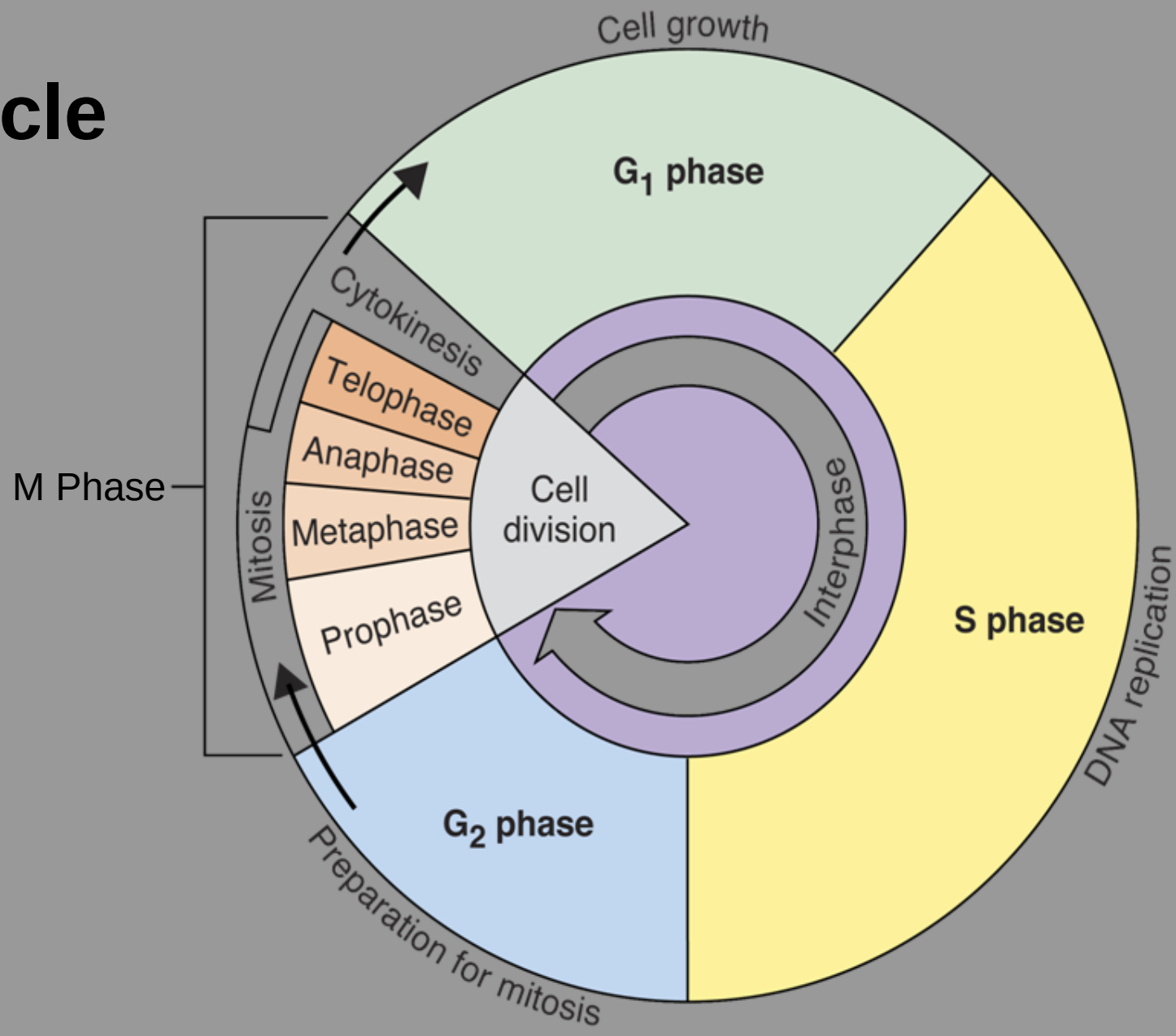
Cell division is made up of 2 parts.

1. Mitosis — division of the nucleus. Divided into 4 phases.
2. Cytokinesis — division of the cytoplasm.



Cell Cycle

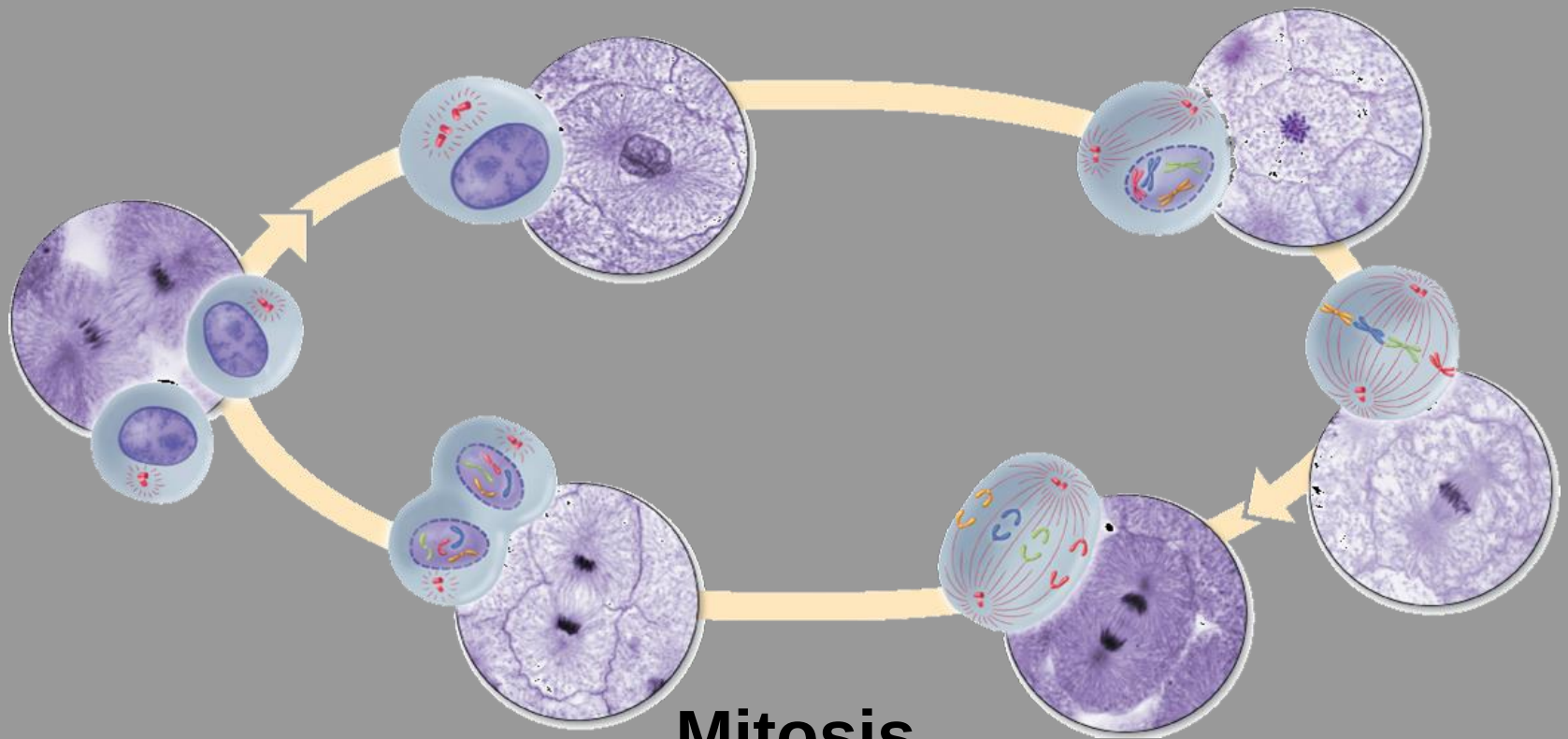
As the length of a cell increases, its volume increases faster than its surface area. The resulting decrease in the cell's ratio of surface area to volume makes it more difficult for the cell to move needed materials in and waste products out.



Mitosis

- Biologists divide the events of mitosis into four phases:
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase

Mitosis

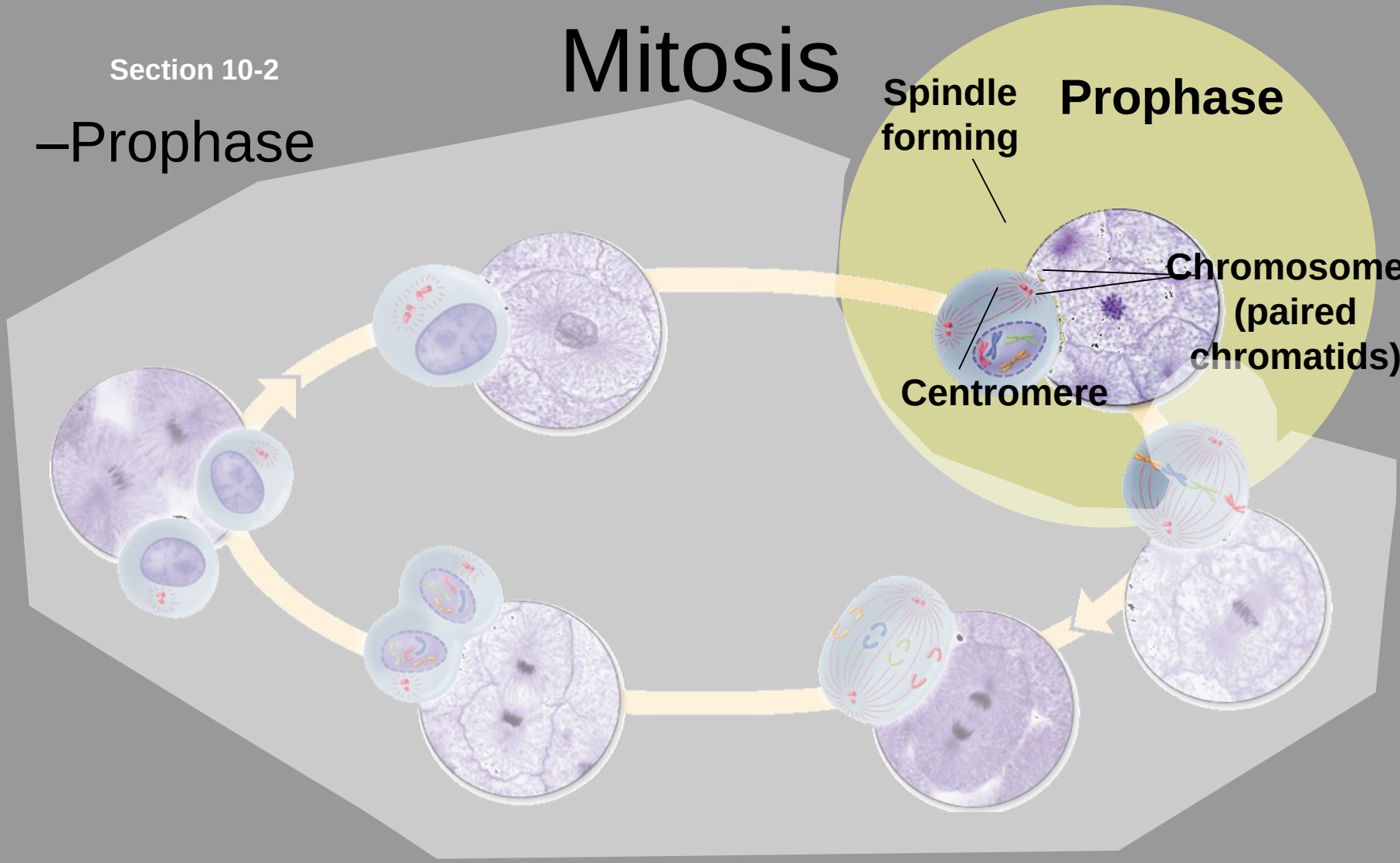


Mitosis

Section 10-2

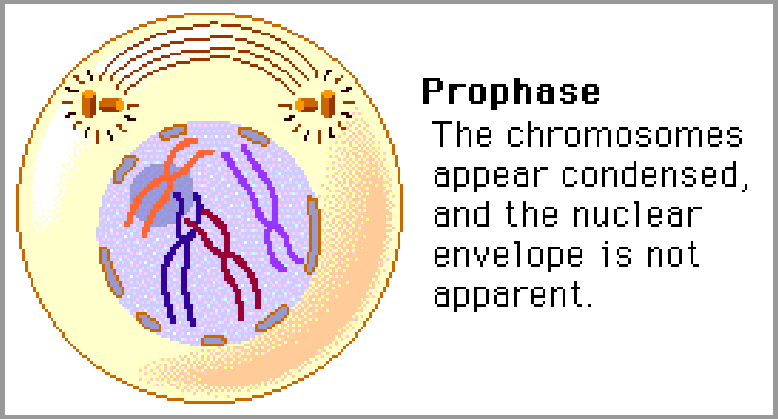
Mitosis

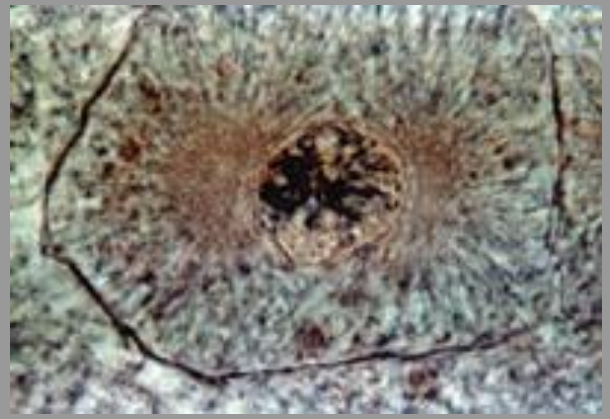
–Prophase



Prophase

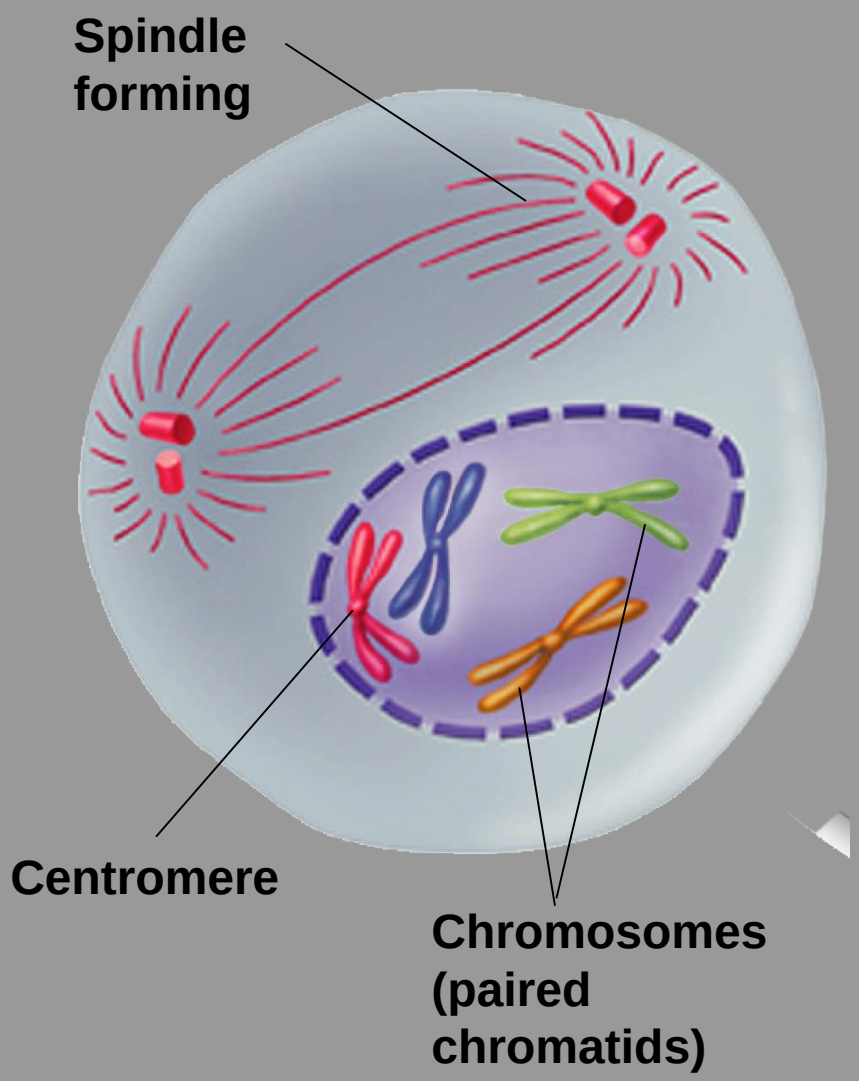
- Chromosomes are visible.
- Centrioles separate
- Spindle fibers form
- Nuclear membrane breaks down.





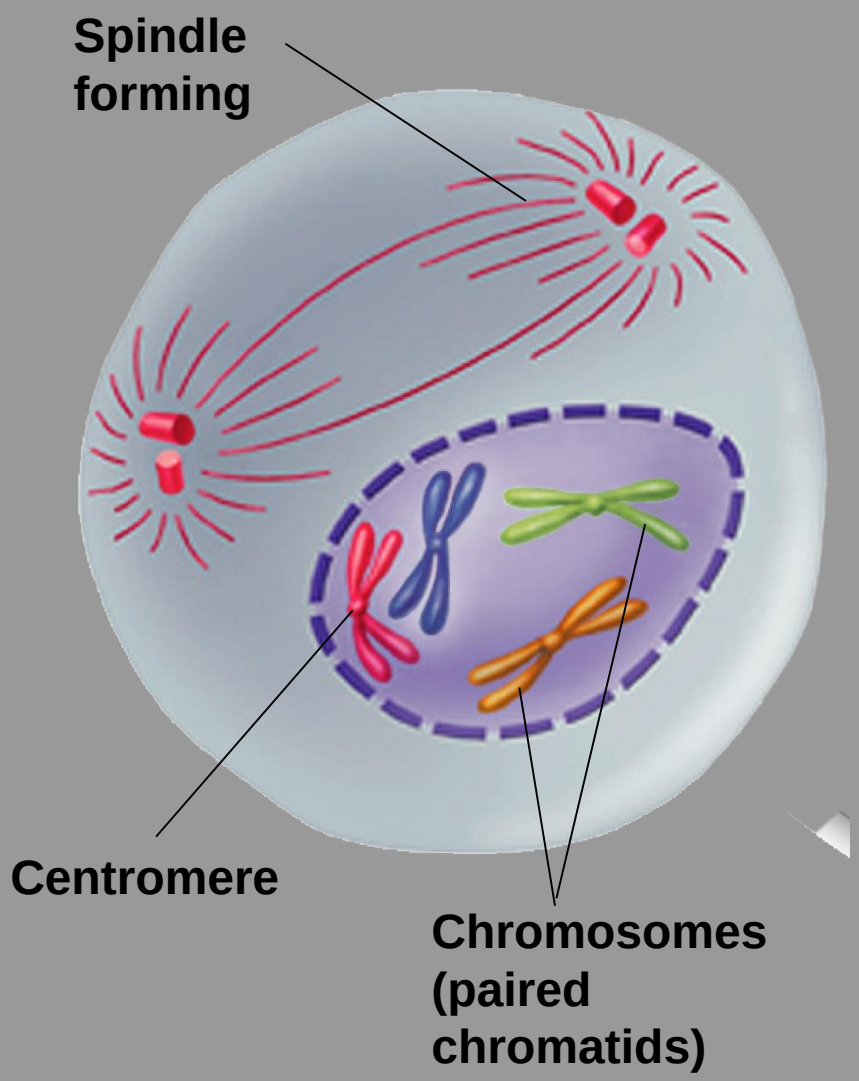
Mitosis

- Prophase
  - Prophase is the first and longest phase of mitosis.
  - The **centrioles** separate and take up positions on opposite sides of the nucleus.



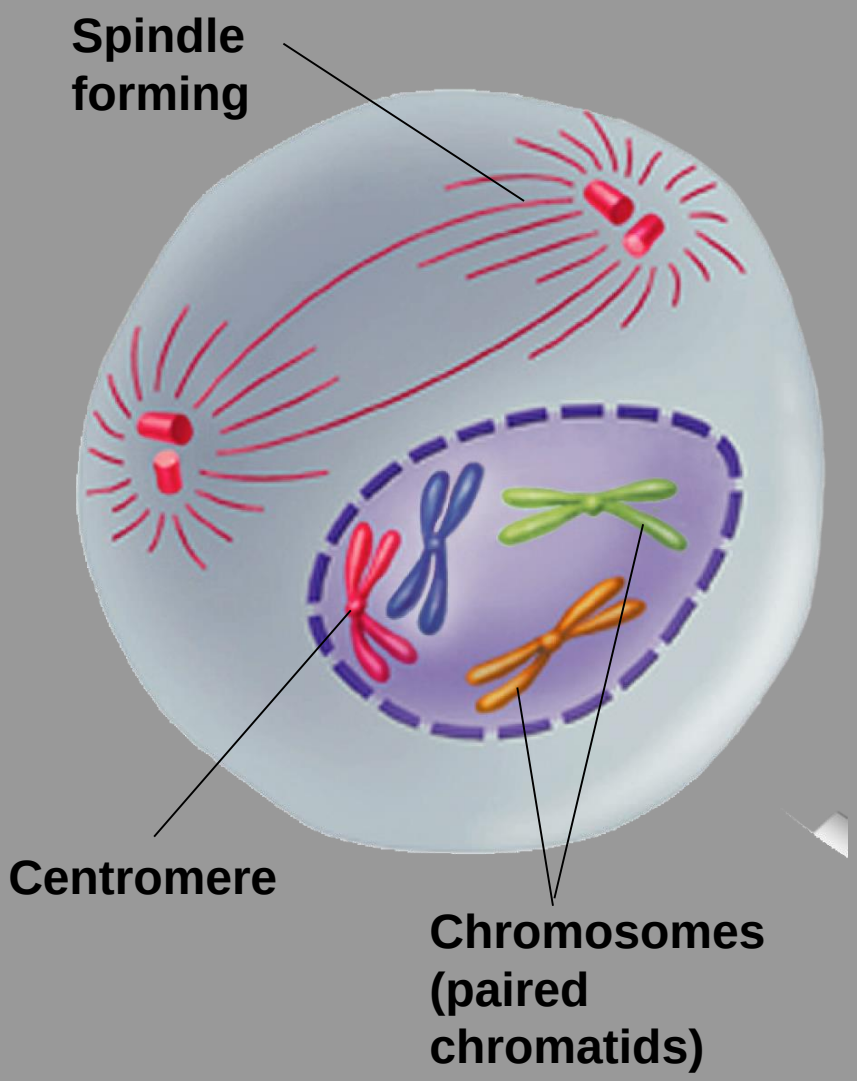
Mitosis

- The centrioles lie in a region called the centrosome.
- The centrosome helps to organize the **spindle**, a fanlike microtubule structure that helps separate the chromosomes.



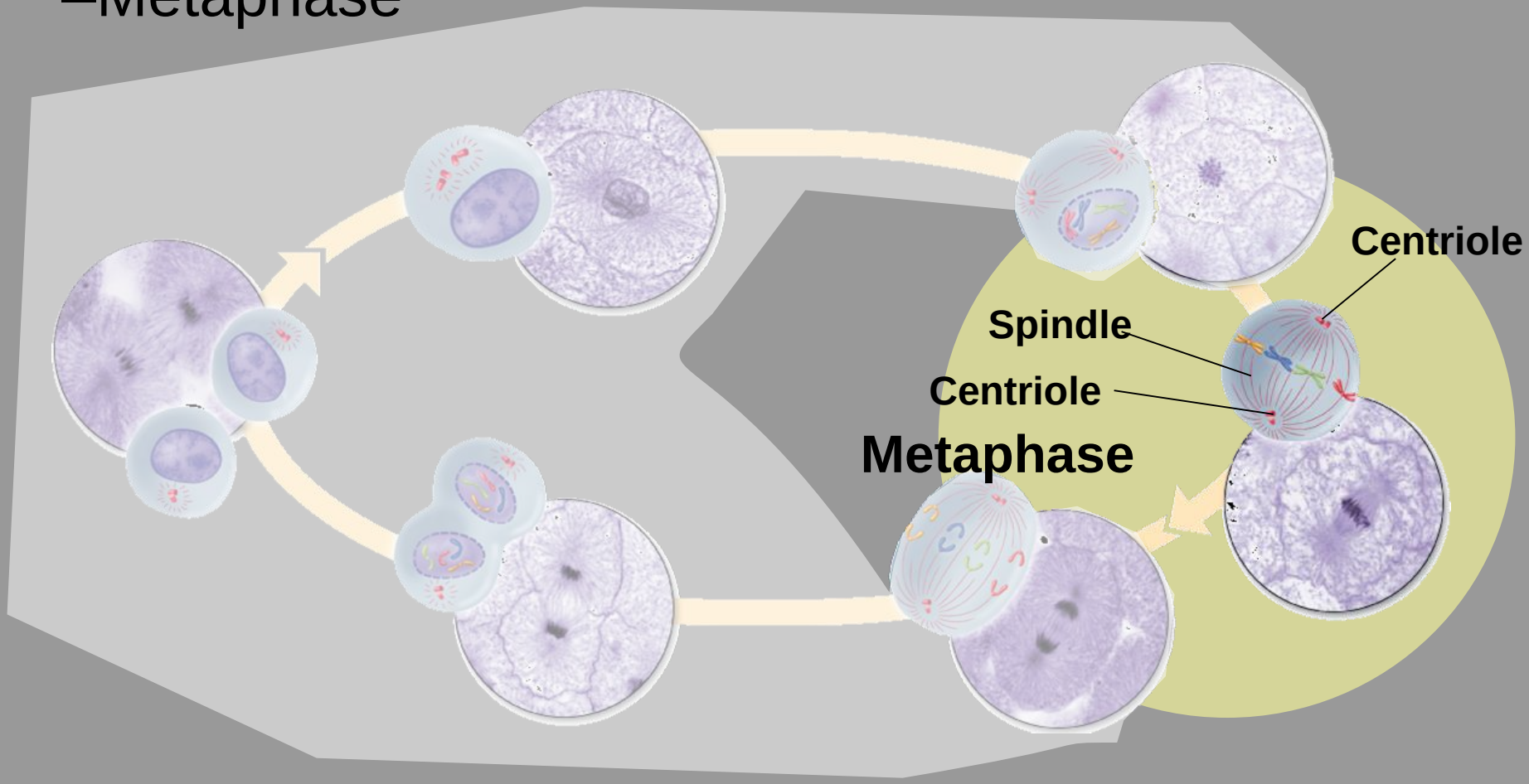
Mitosis

- Chromatin condenses into chromosomes.
- The centrioles separate and a spindle begins to form.
- The nuclear envelope breaks down.



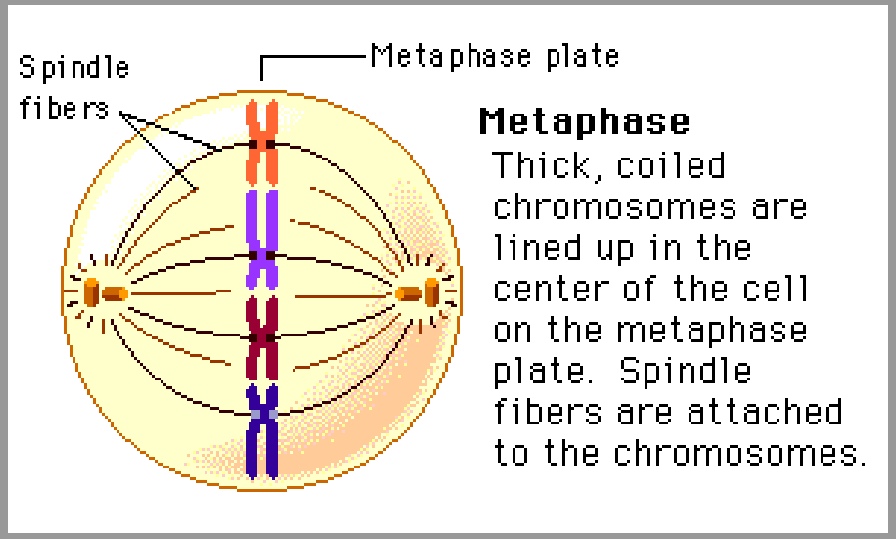
Mitosis

–Metaphase



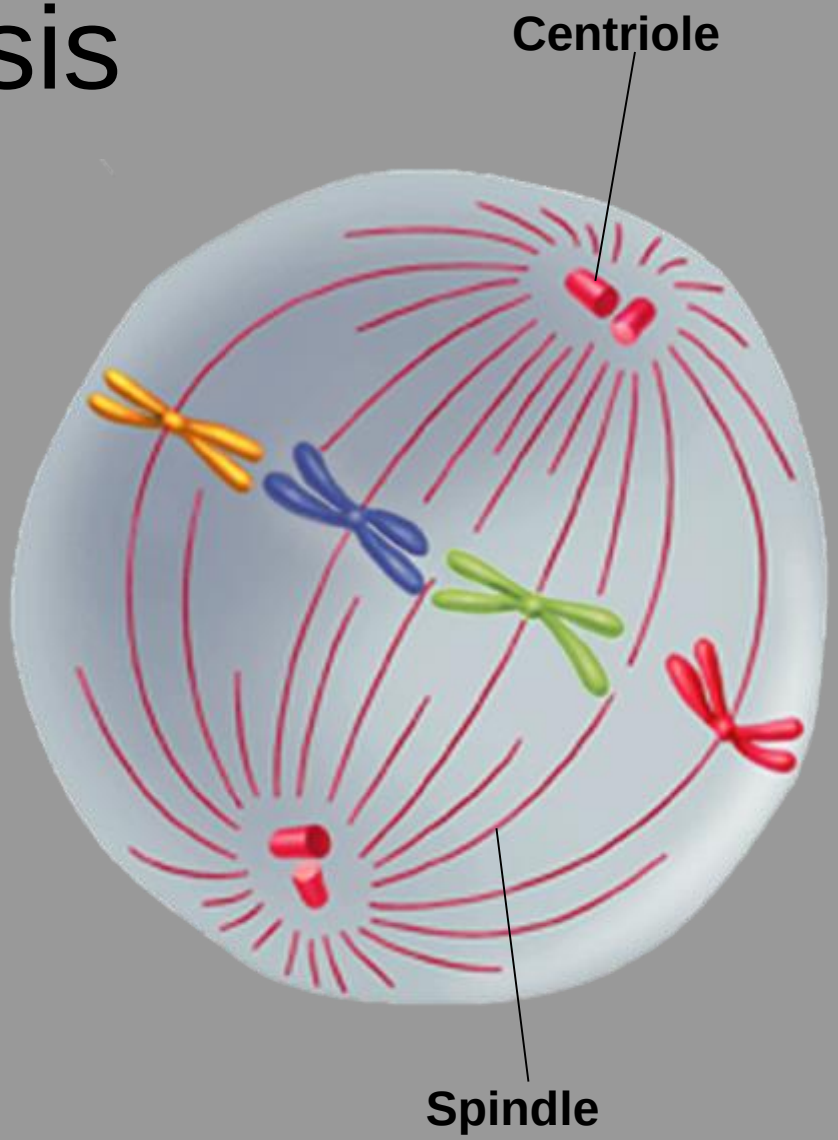
Metaphase

- Chromosomes line up in the middle of the cell



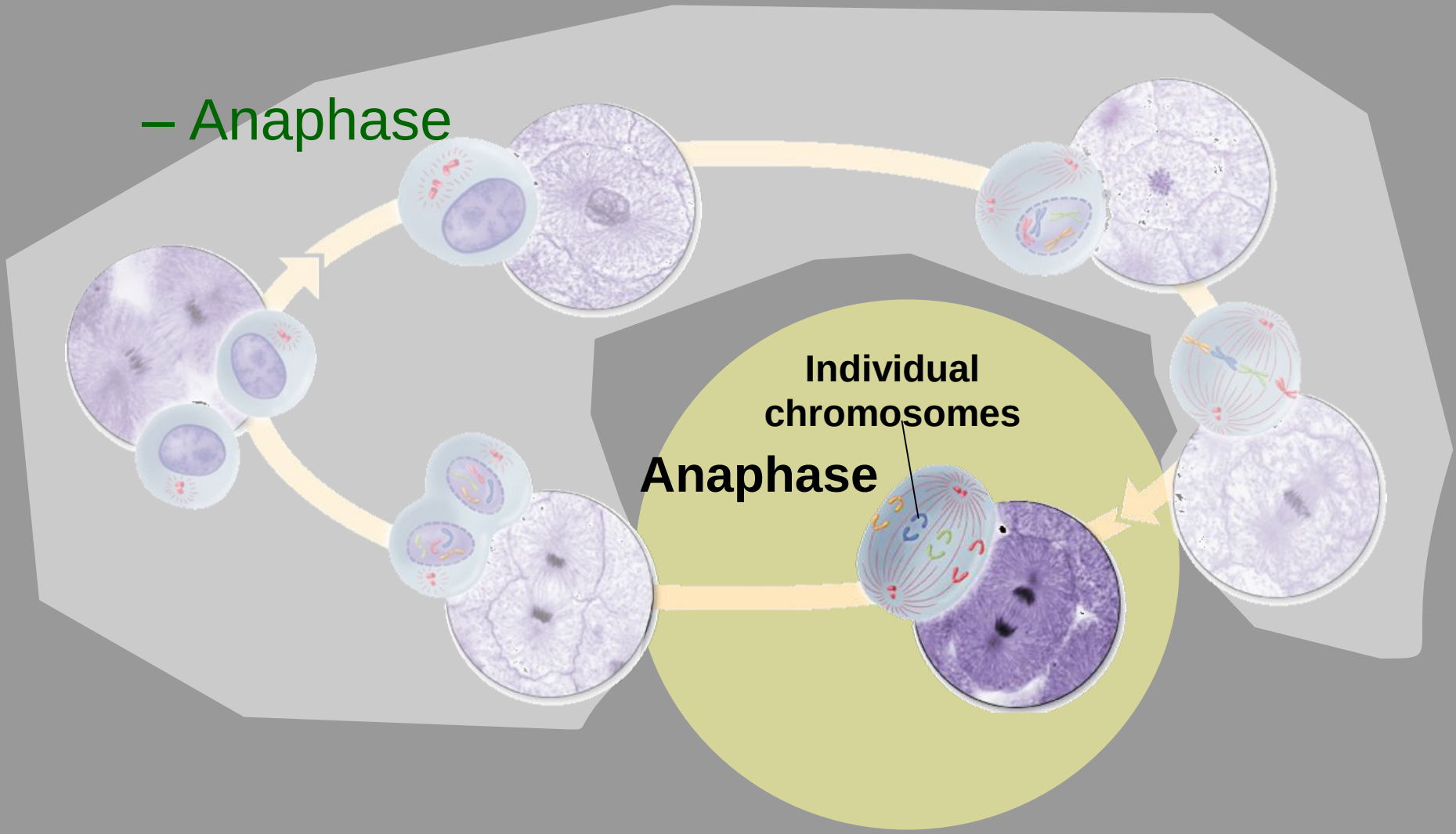
Mitosis

- Metaphase
  - The second phase of mitosis is metaphase.
  - The chromosomes line up across the center of the cell.
  - Microtubules connect the centromere of each chromosome to the poles of the spindle.



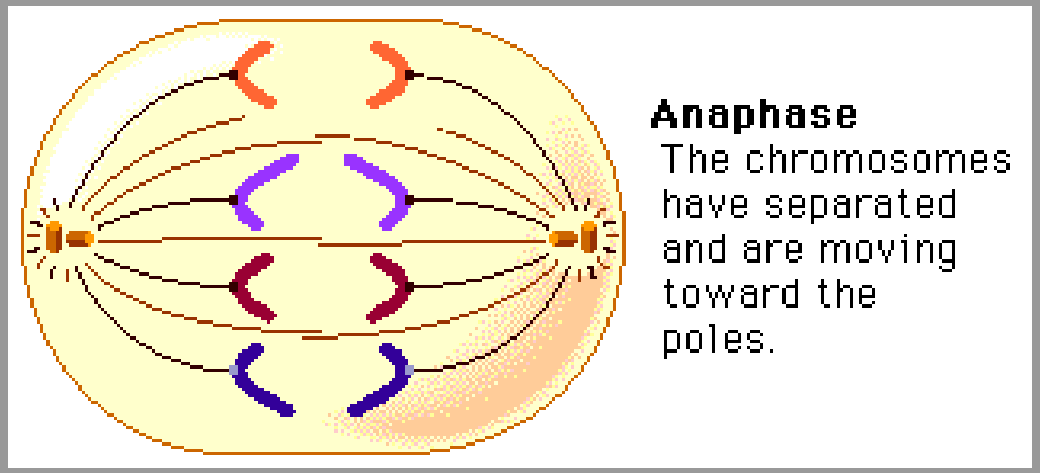
Mitosis

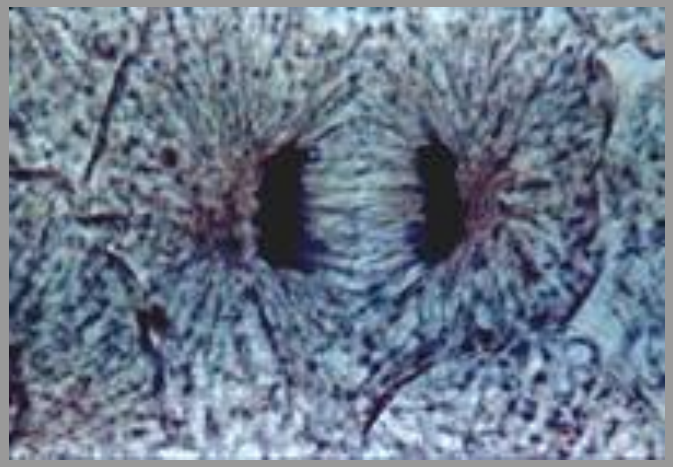
– Anaphase



Anaphase

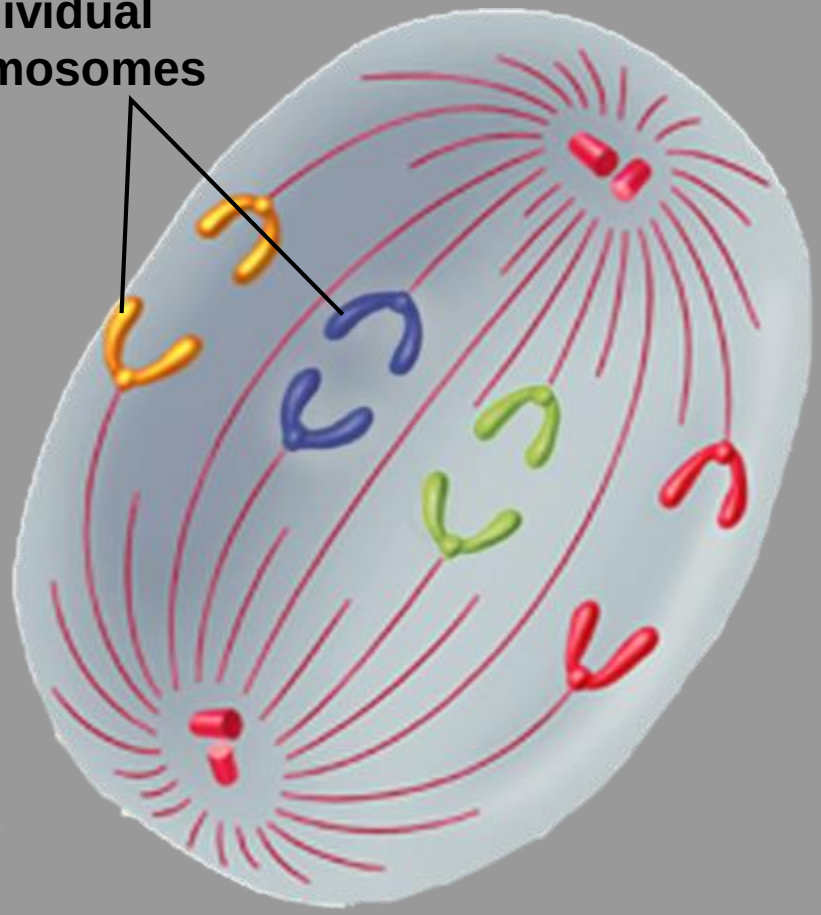
- Chromosomes are pulled **apart/away** from each other.





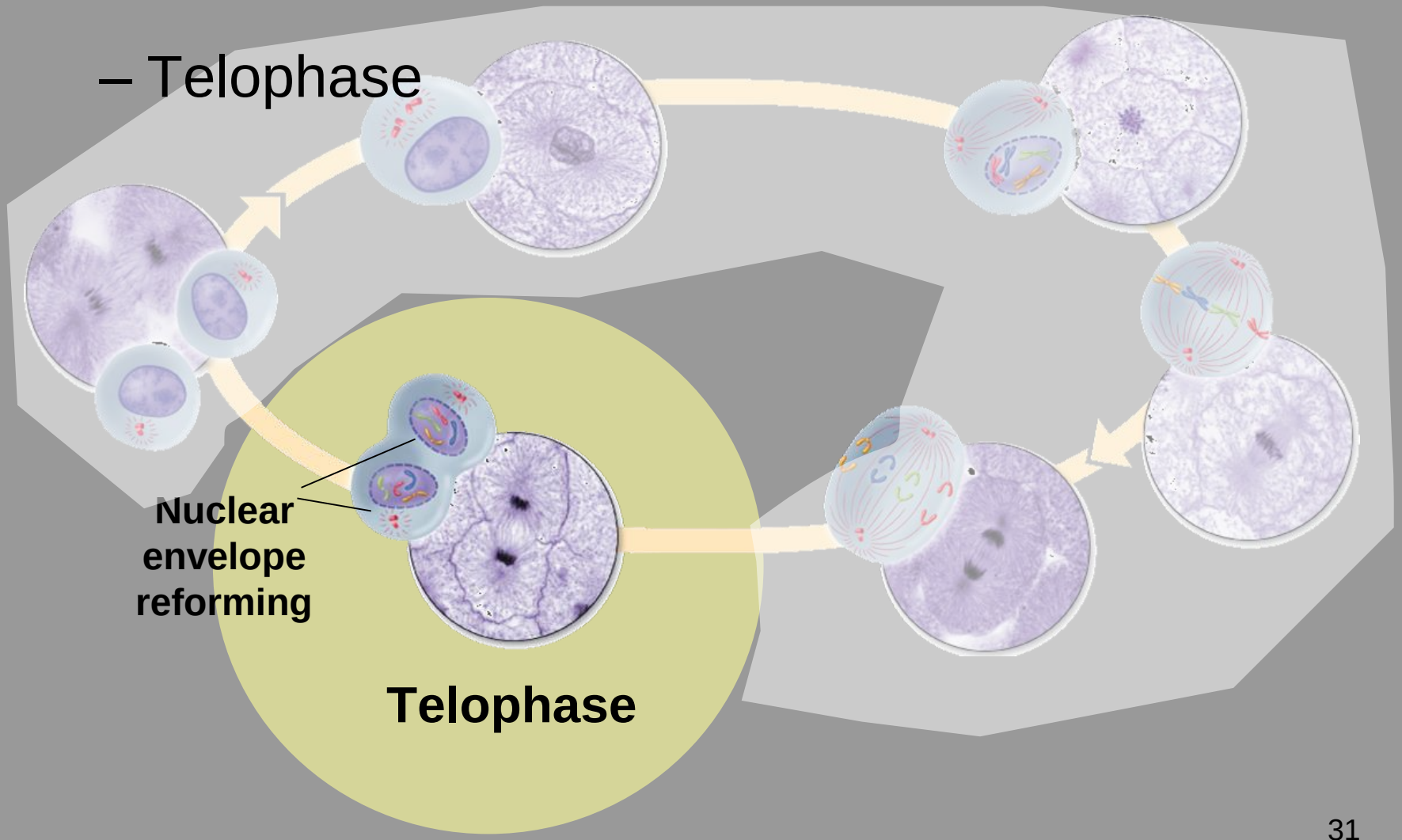
Mitosis

- Anaphase
  - Anaphase is the third phase of mitosis.
  - The sister chromatids separate into individual chromosomes.
  - The chromosomes continue to move until they have separated into two groups.



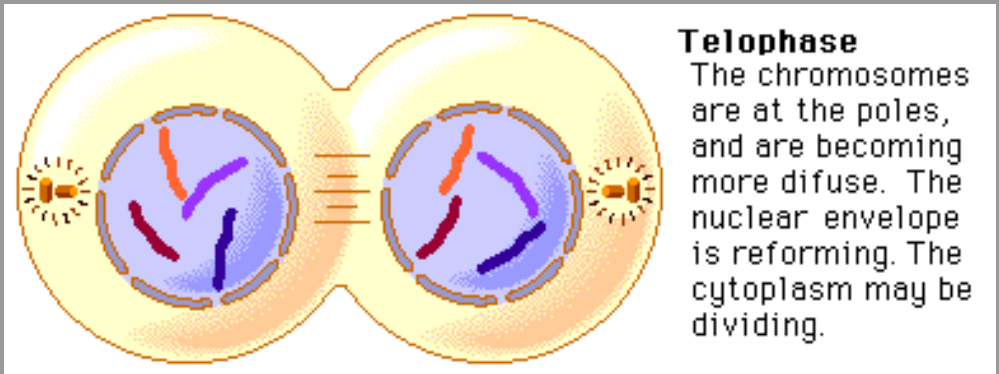
Mitosis

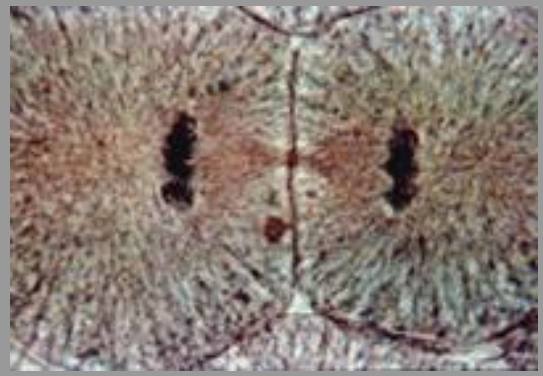
– Telophase



Telophase

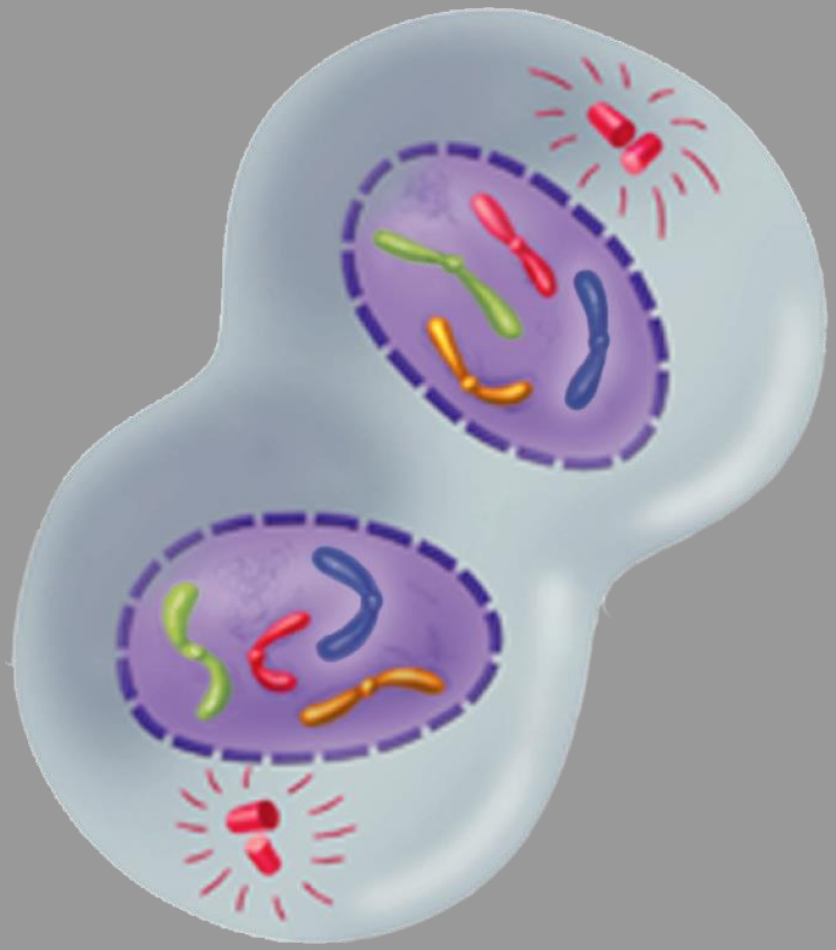
- The opposite of prophase occurs.
- Chromosomes disappear back to chromatin
- Nuclear membrane reforms
- Spindle fibers break apart and disappear





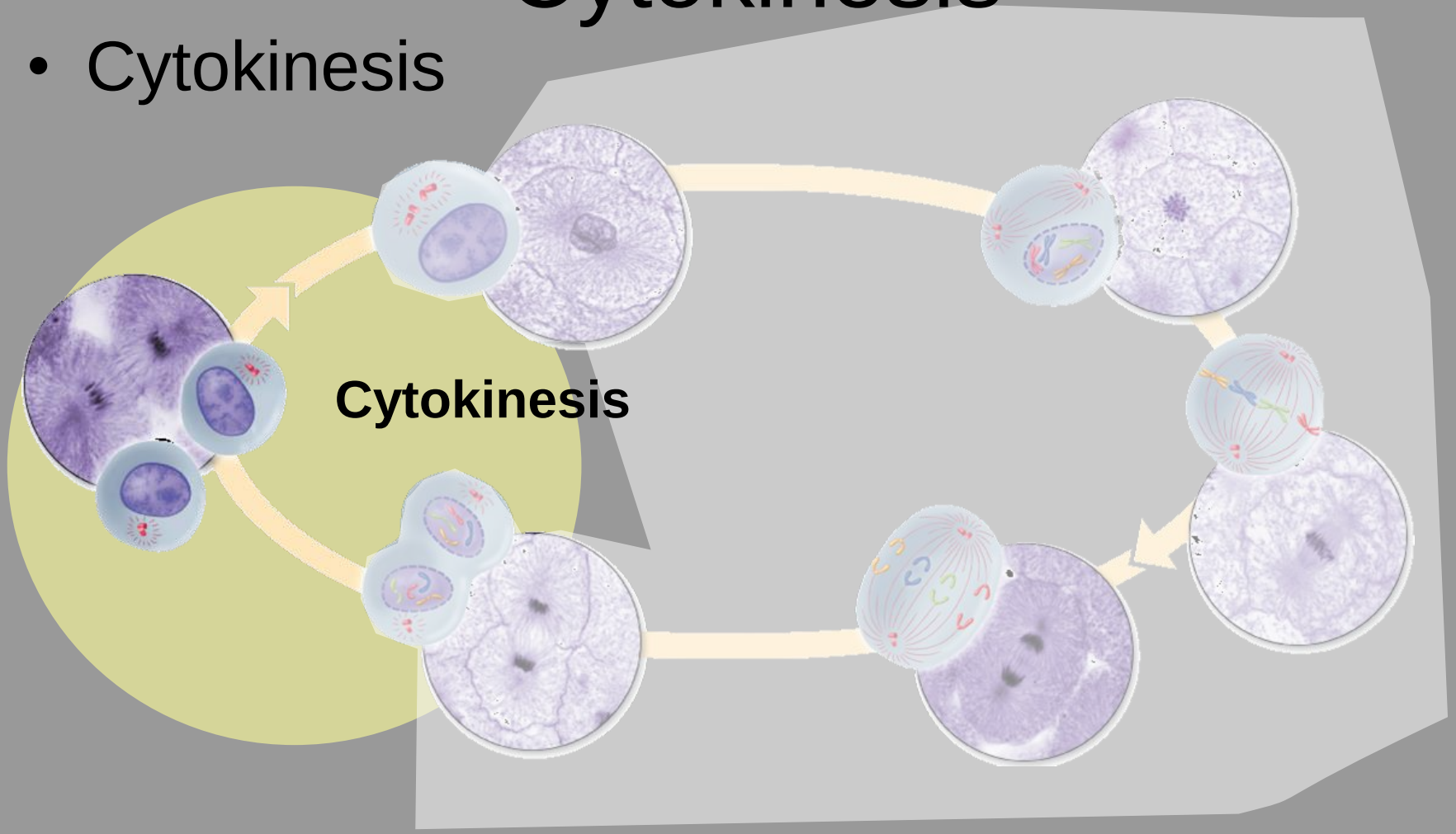
Mitosis

- Telophase
  - Telophase is the fourth and final phase of mitosis.
  - Chromosomes gather at opposite ends of the cell and lose their distinct shape.
  - A new nuclear envelope forms around each cluster of chromosomes.



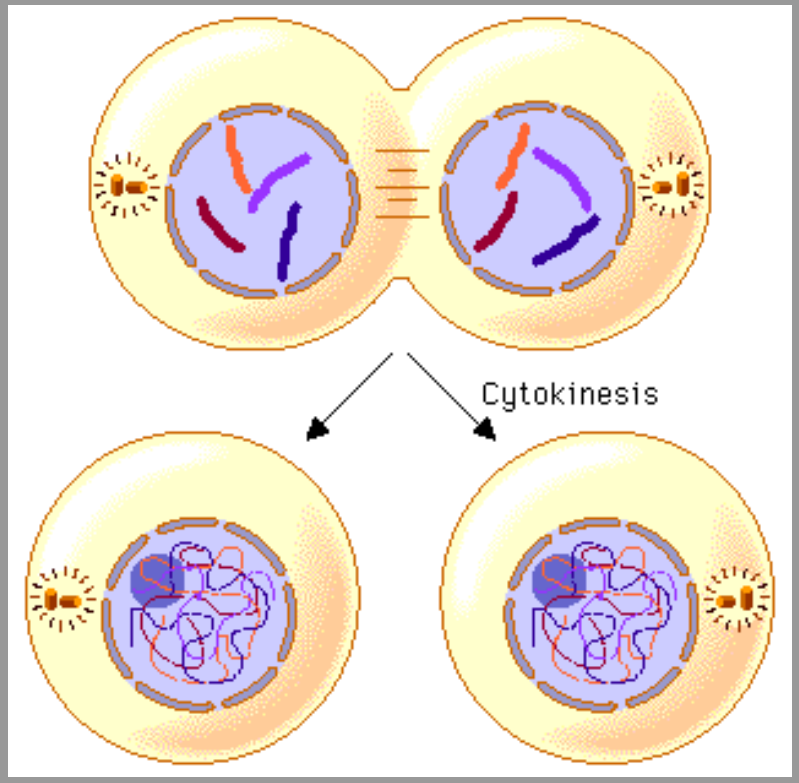
Cytokinesis

- Cytokinesis



Cytokinesis

- Cytokinesis occurs right after Mitosis and is the division of the cytoplasm.



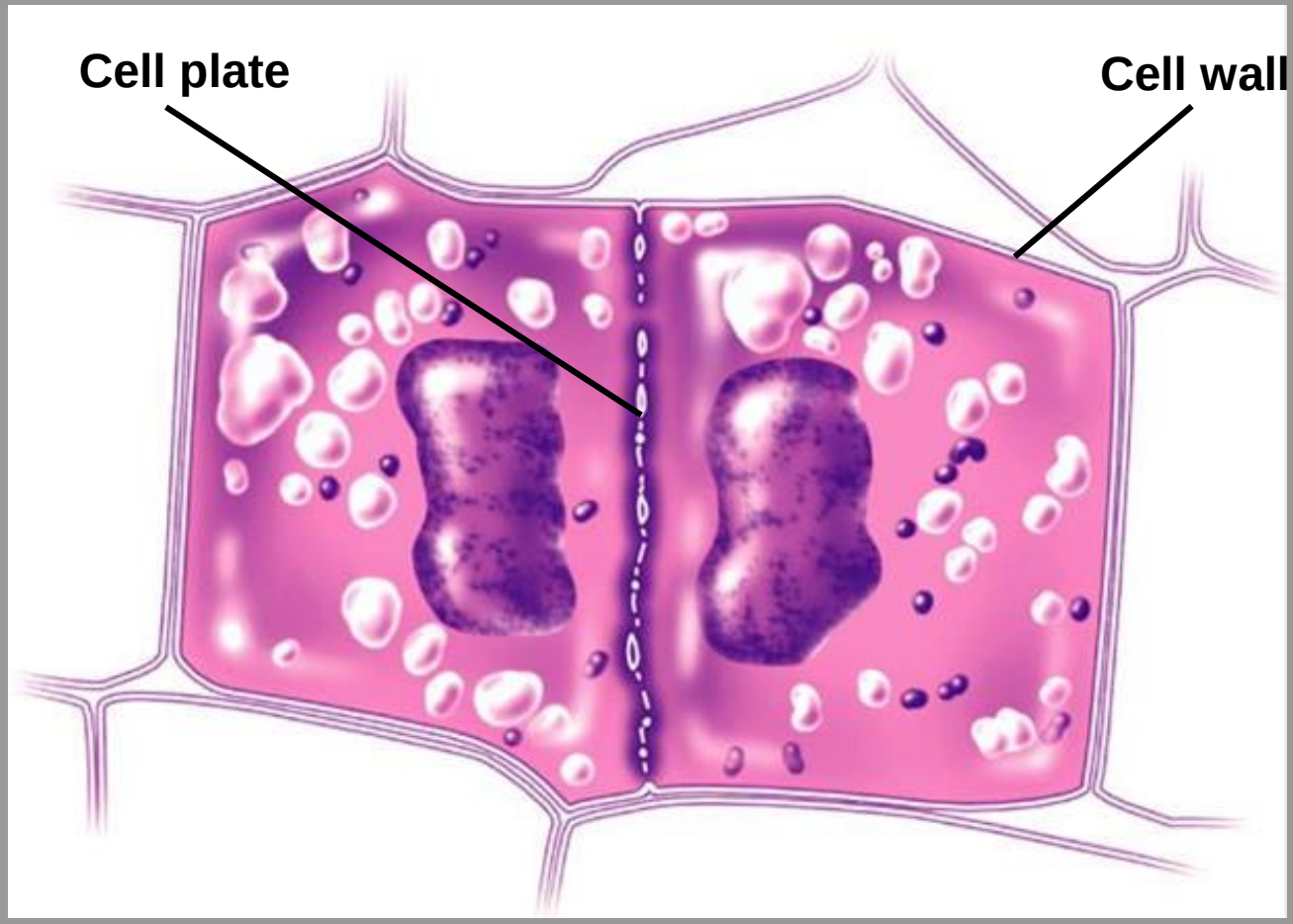
Cytokinesis

- During cytokinesis, the cytoplasm pinches in half.
- Each daughter cell has an identical set of duplicate chromosomes.

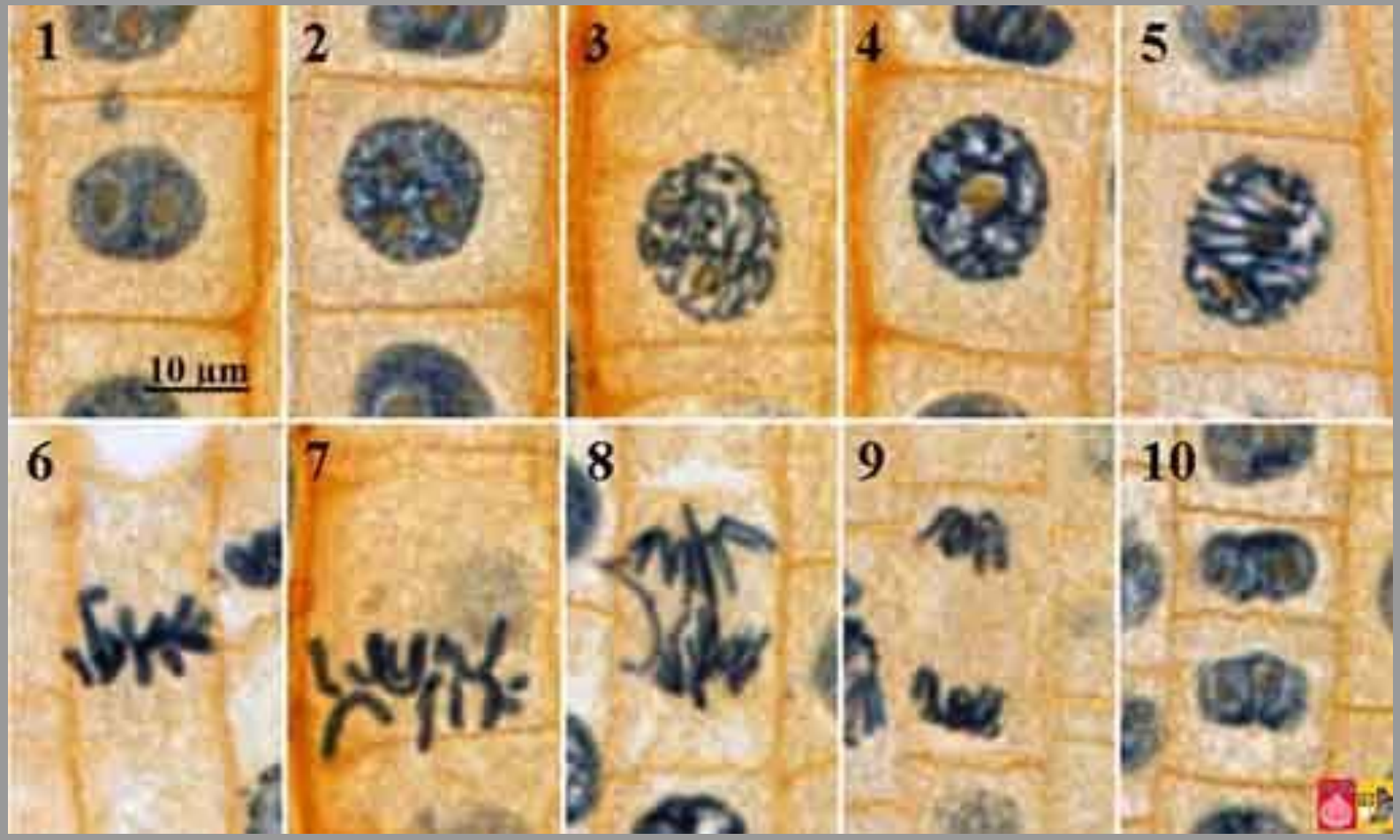
Cytokinesis

- In plants, a structure known as the cell plate forms midway between the divided nuclei.
- The cell plate gradually develops into a separating membrane.
- A cell wall then begins to appear in the cell plate.

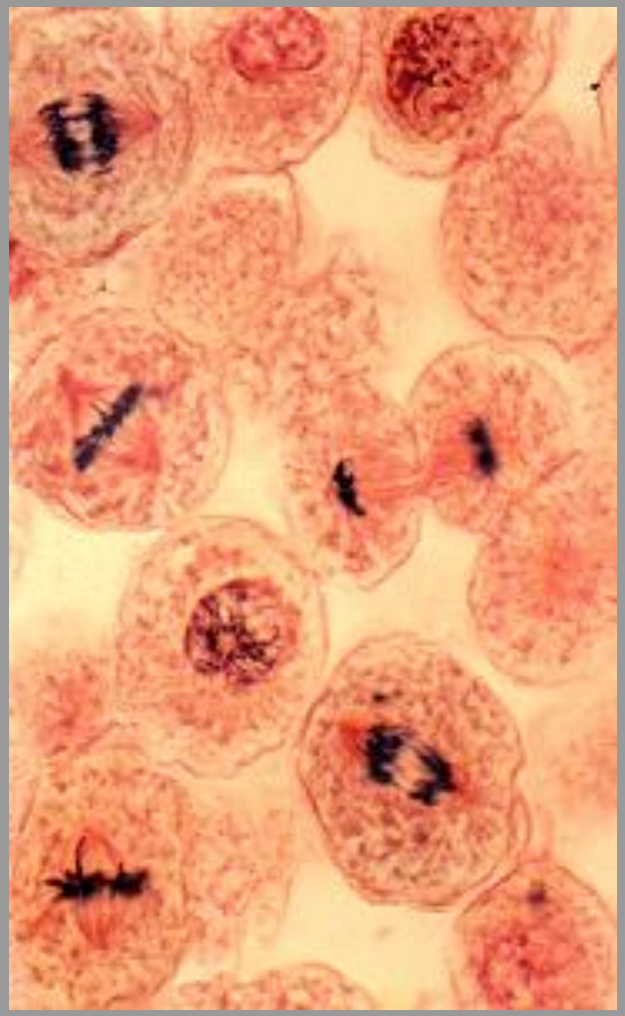
Cytokinesis

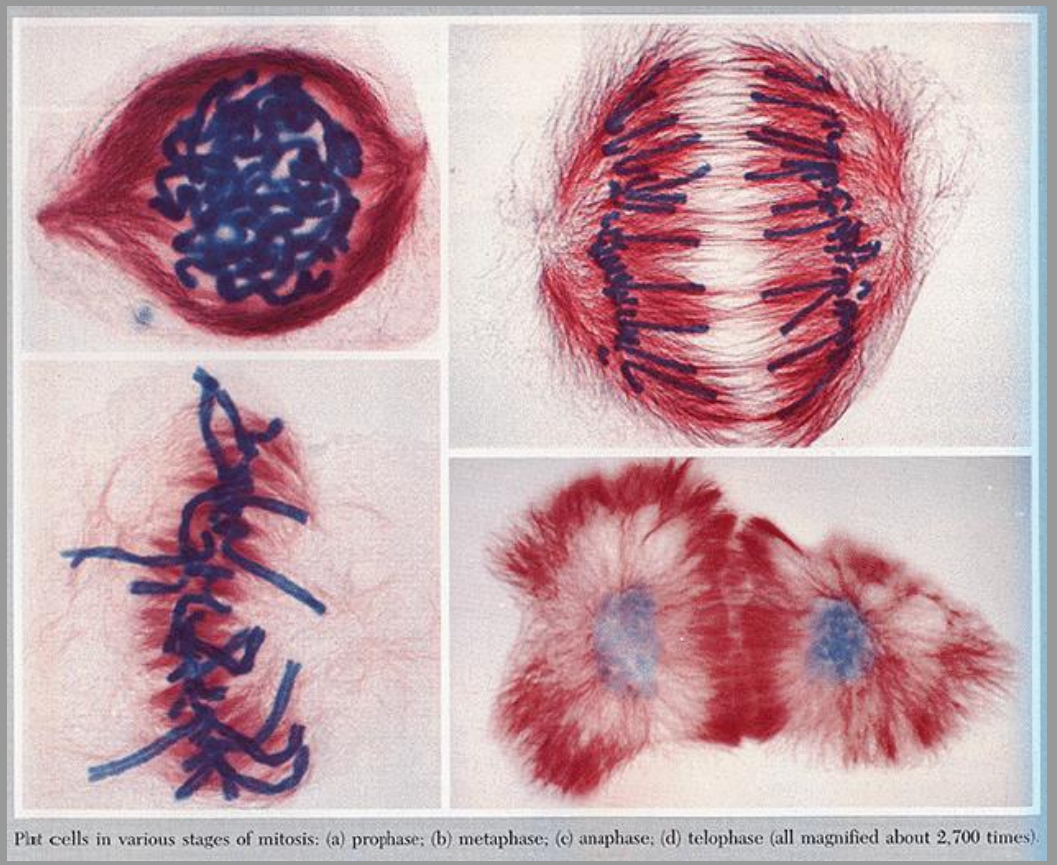


Look Familiar?? What stage of mitosis do you see?

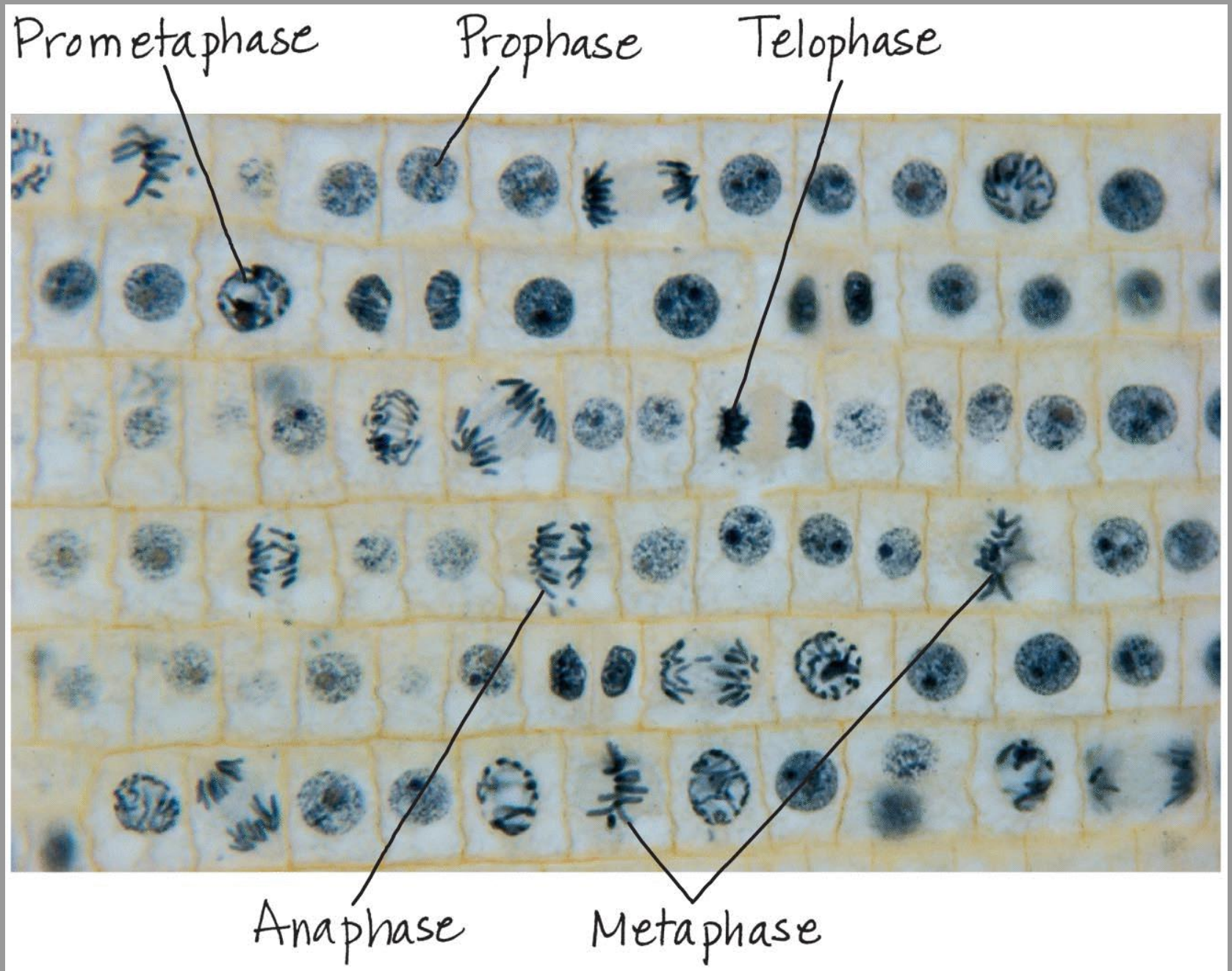


Can you tell the phase?





Plant cells in various stages of mitosis: (a) prophase; (b) metaphase; (c) anaphase; (d) telophase (all magnified about 2,700 times).



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10-3 Regulating the cell cycle

Controls on Cell Division

Experiments show that normal cells will reproduce until they come into contact with other cells.

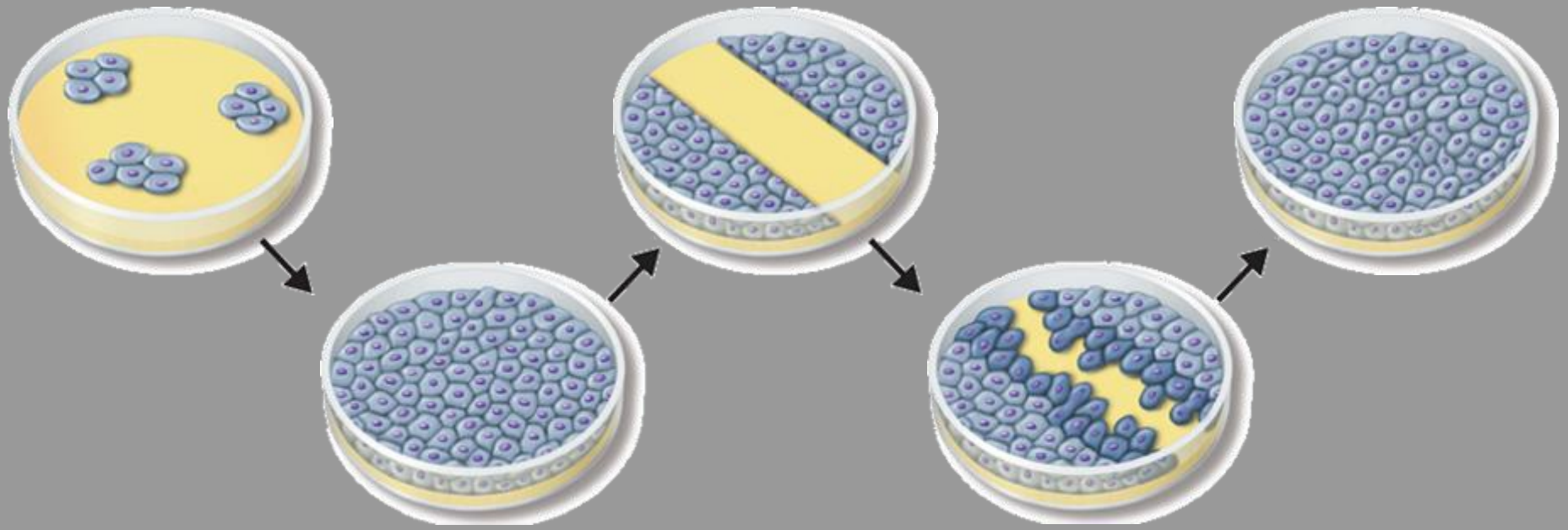
When cells come into contact with other cells, they respond by not growing.

This demonstrates that controls on cell growth and division can be turned on and off.

Similar happenings in the body when an injury such as a cut broken bone occur cells at the edge of the injury are stimulated to divide rapidly. This produces new cells starting the process of healing when healing nears completion the cell of cell division slow, controls on growth are restored and everything returns to normal

Controls on Cell Division

- Contact Inhibition

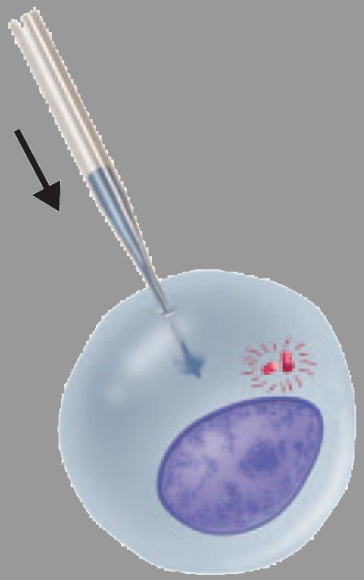


Cell Cycle Regulators

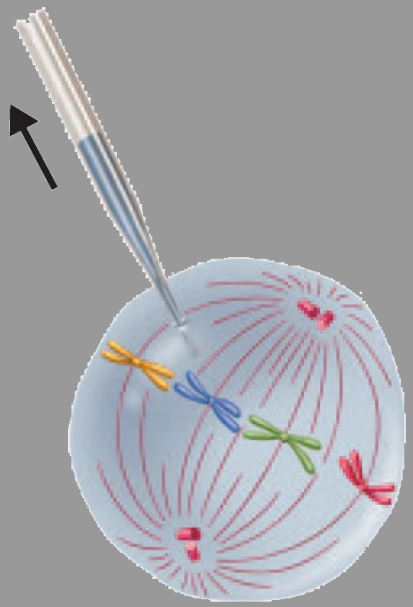
- **cycle is regulated by a specific protein**
  - **called cyclin**
    - regulates the timing of the cell cycle in eukaryotic cells

Cell Cycle Regulators

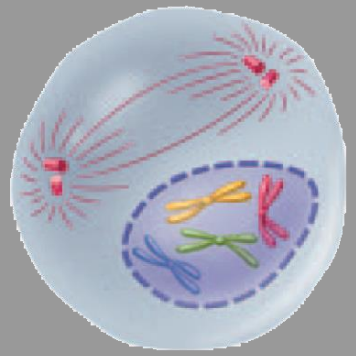
Cyclins were discovered during a similar experiment to this one.



A sample of cytoplasm is removed from a cell in mitosis.



The sample is injected into a second cell in G_2 of interphase.



As a result, the second cell enters mitosis.

Internal Regulators

- Proteins that respond to events inside the cell
- allow the cell cycle to proceed only when certain processes have happened inside the cell
- Examples- several regulatory proteins make sure that cells do not enter mitosis until all its chromosomes have been replicated
- Another regulatory protein prevents a cell from entering anaphase until all its chromosomes are attached to the mitotic spindle.

External Regulators

- Proteins that respond to events outside the cell
- direct cells to speed up or slow down the cell cycle
- Growth factors stimulate the growth and division of cells
- Growth regulators are important during embryonic development and wound healing
- Molecules found on neighboring cells have the opposite effect causing cells to slow down or stop their cell cycles. These signals prevent excessive cell growth and keep the tissues of the body from disrupting one another

Uncontrolled Cell Growth

- **Cancer - a disorder in which some of the body's own cells lose the ability to control growth**
  - Cancer cells do not respond to the signals that regulate growth; they divide uncontrollably and form masses of cells called tumors that can damage the surrounding tissues
  - Cancer cells may break loose from tumors and spread throughout the body, disrupting normal activities and causing serious medical problems or even death