Mitosis and Cytokinesis

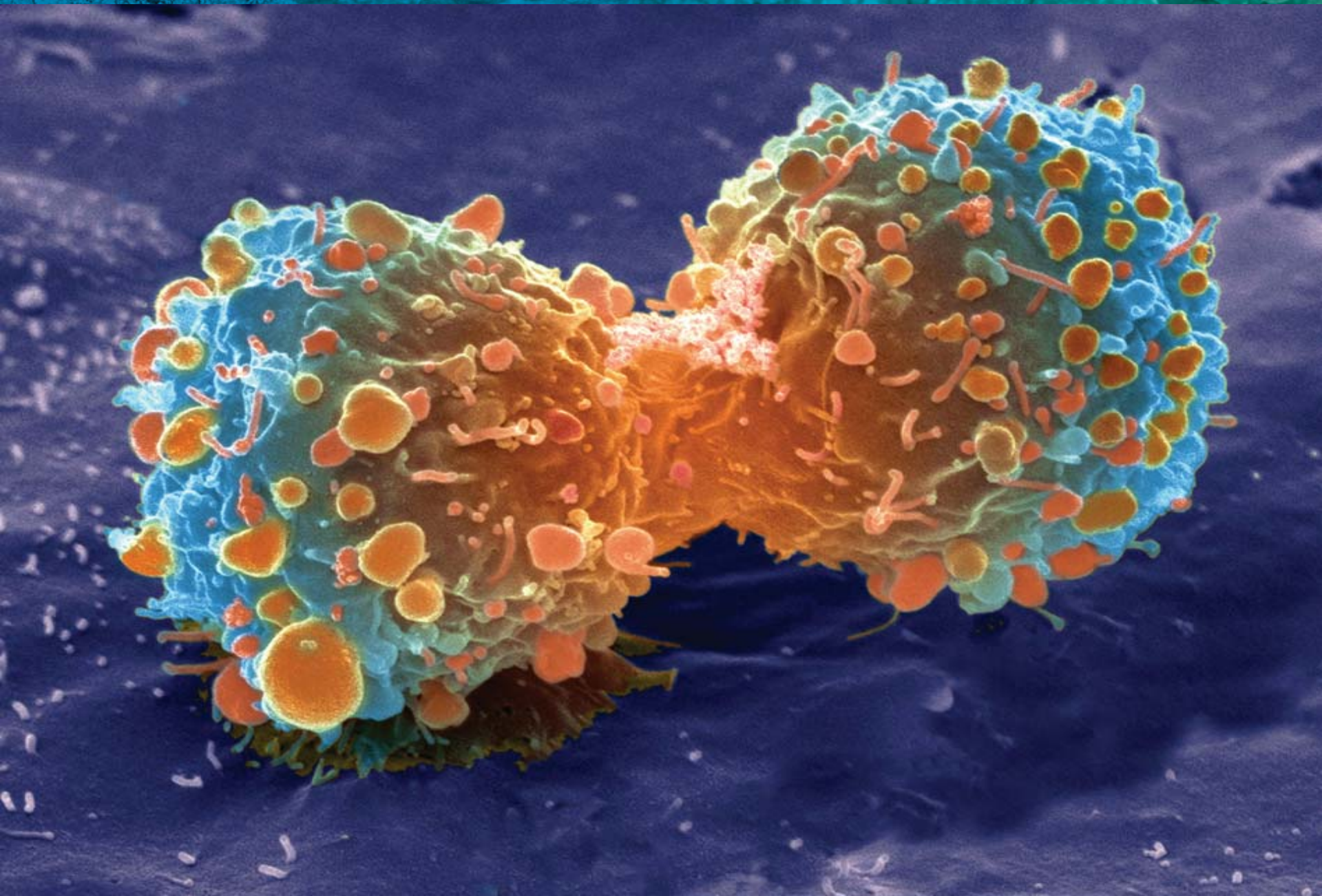
B-2.6 Summarize the characteristics of the cell cycle: interphase (called G1, S, G2); the phases of mitosis (called prophase, metaphase, anaphase, and telophase); and plant and animal cytokinesis.

The cell cycle is a repeated pattern of growth and division that occurs in eukaryotic cells.

This cycle consists of three phases: G1, S, G2

The first phase represents cell growth while the last two phases represent cell division.

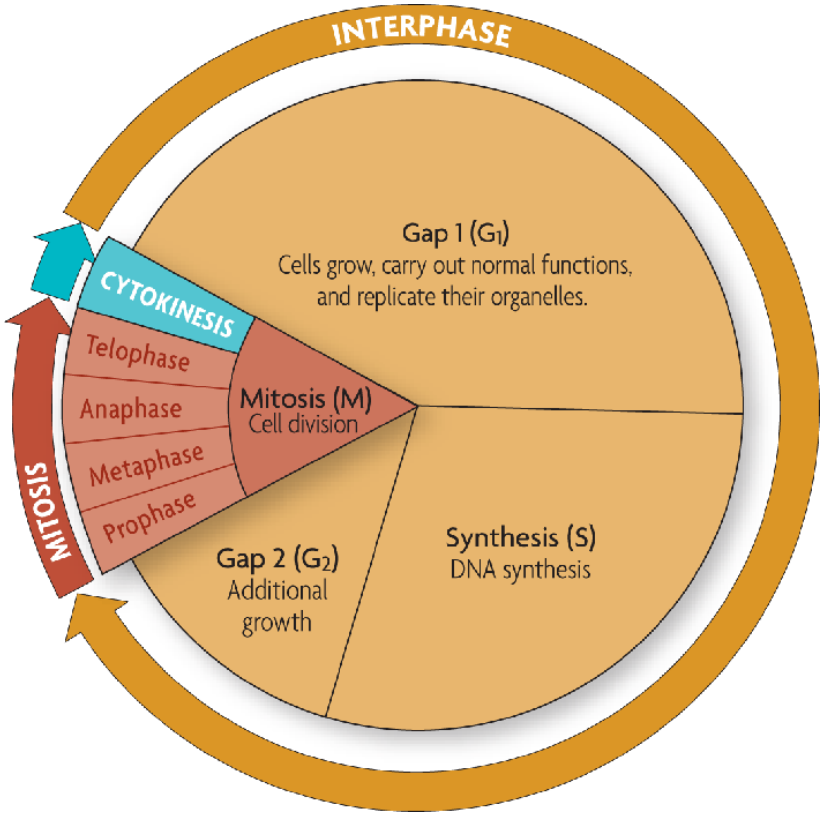
Mitosis and Cytokinesis



Mitosis and Cytokinesis

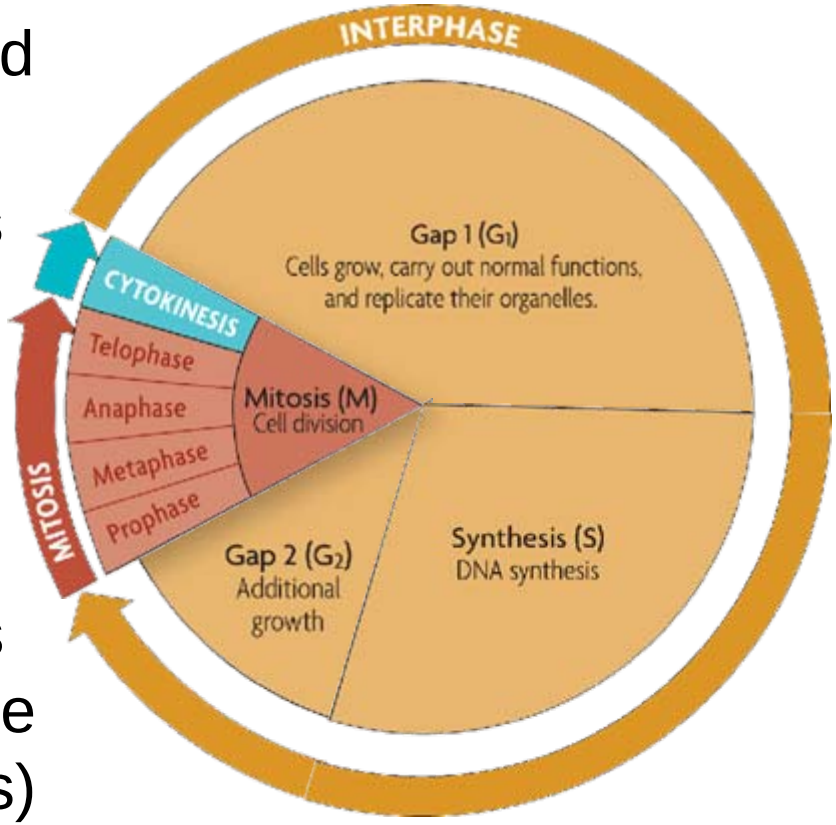
The cell cycle has four main stages.

- The cell cycle is a regular pattern of growth, DNA replication, and cell division.



Mitosis and Cytokinesis

- The main stages of the cell cycle are gap 1, synthesis, gap 2, and mitosis.
  - Gap 1 (G_1): cell growth and normal functions
  - DNA synthesis (S): copies DNA
  - Gap 2 (G_2): additional growth
  - Mitosis (M): includes division of the cell nucleus (mitosis) and division of the cell cytoplasm (cytokinesis)



- Mitosis occurs only if the cell is large enough and the DNA undamaged.

Interphase

Cells spend the majority of their cell cycle in interphase.

The purpose of interphase is for cell growth.

By the end of interphase a cell has two full sets of DNA (chromosomes) and is large enough to begin the division process.

Mitosis and Cytokinesis

- Interphase is divided into three phases. Each phase is characterized by specific processes involving different structures.
  - During the G1 (gap 1) phase, the cell grows and synthesizes proteins.
  - During the S (synthesis) phase, chromosomes replicate and divide to form identical sister chromatids held together by a centromere.
  - During the G2 (gap 2) phase, cells continue to grow and produce the proteins necessary for cell division.

Mitosis and Cytokinesis

Mitosis and Cytokinesis

Mitosis

•The purpose of mitosis is cell division: making two cells out of one.

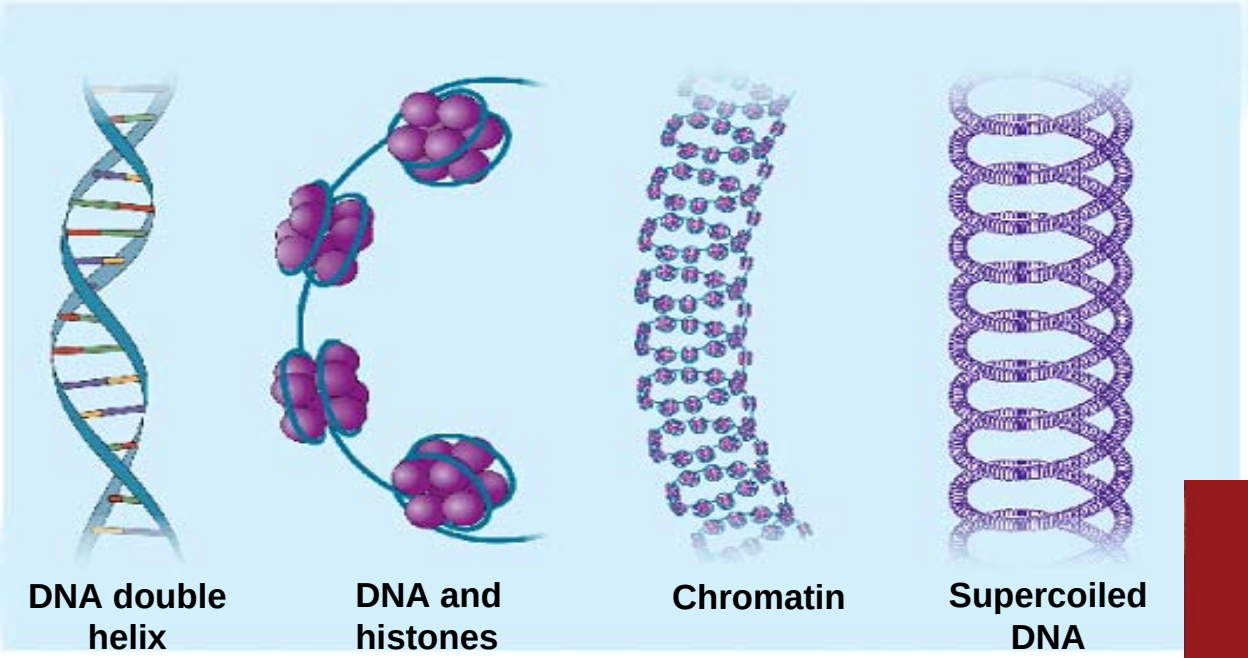
• Each cell has to have its own cytoplasm and DNA.

•The DNA is replicated in Interphase when two chromosome strands became four strands (two strands per chromatid).

•In mitosis the four strands (two sister chromatids) have to break apart so that each new cell only has one double-stranded chromosome.

Mitosis and Cytokinesis

- **Chromosomes condense at the start of mitosis.**
  - DNA wraps around proteins (histones) that condense it.



Mitosis and Cytokinesis

Mitosis is divided into four phases. Each phase is characterized by specific processes involving different structures.

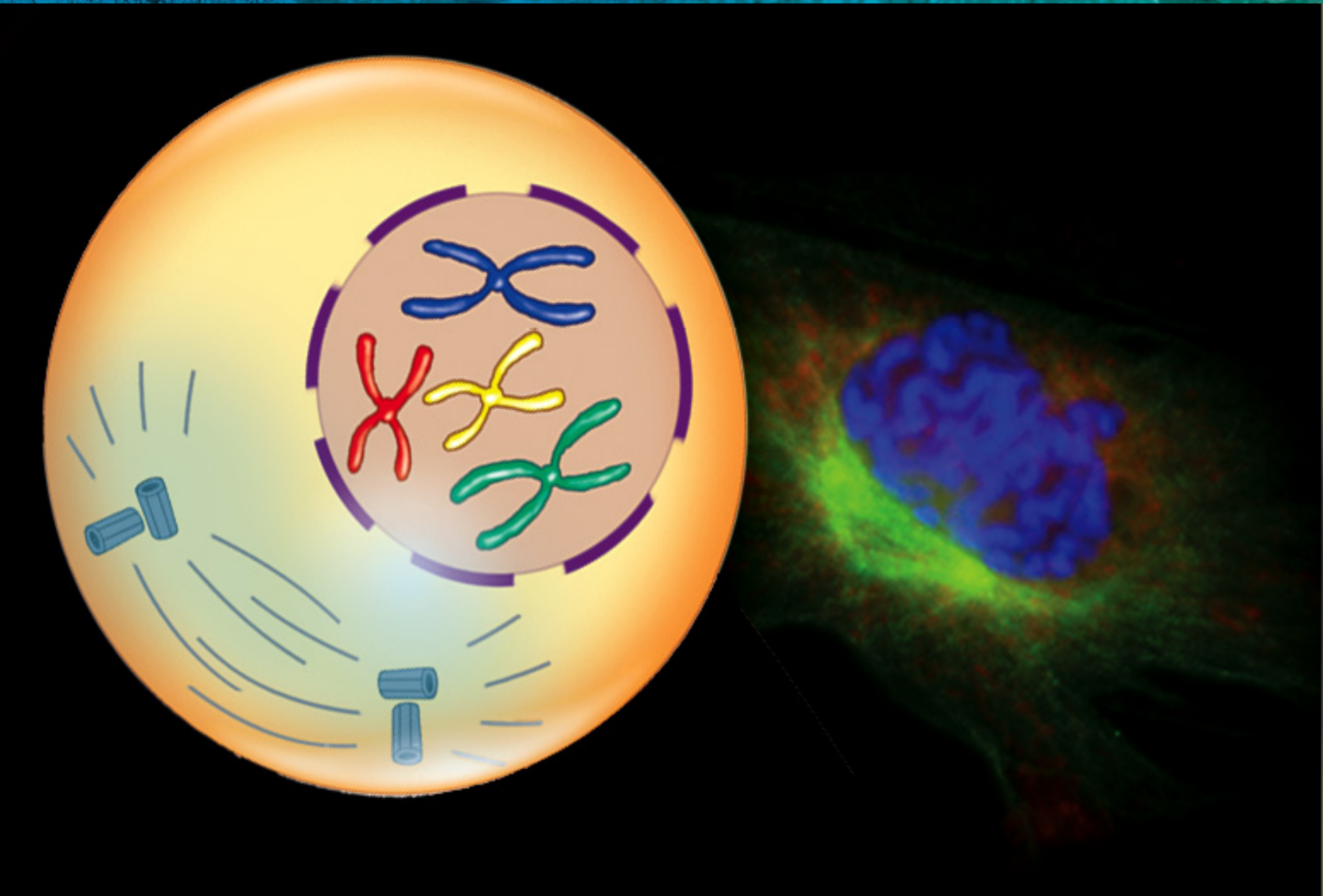
1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

Mitosis and Cytokinesis

Prophase is characterized by four events:

1. Chromosomes condense and are more visible.
2. The nuclear membrane (envelope) disappears.
3. Centrioles have separated and taken positions on the opposite poles of the cell.
4. Spindle fibers form and radiate toward the center of the cell.

Mitosis and Cytokinesis

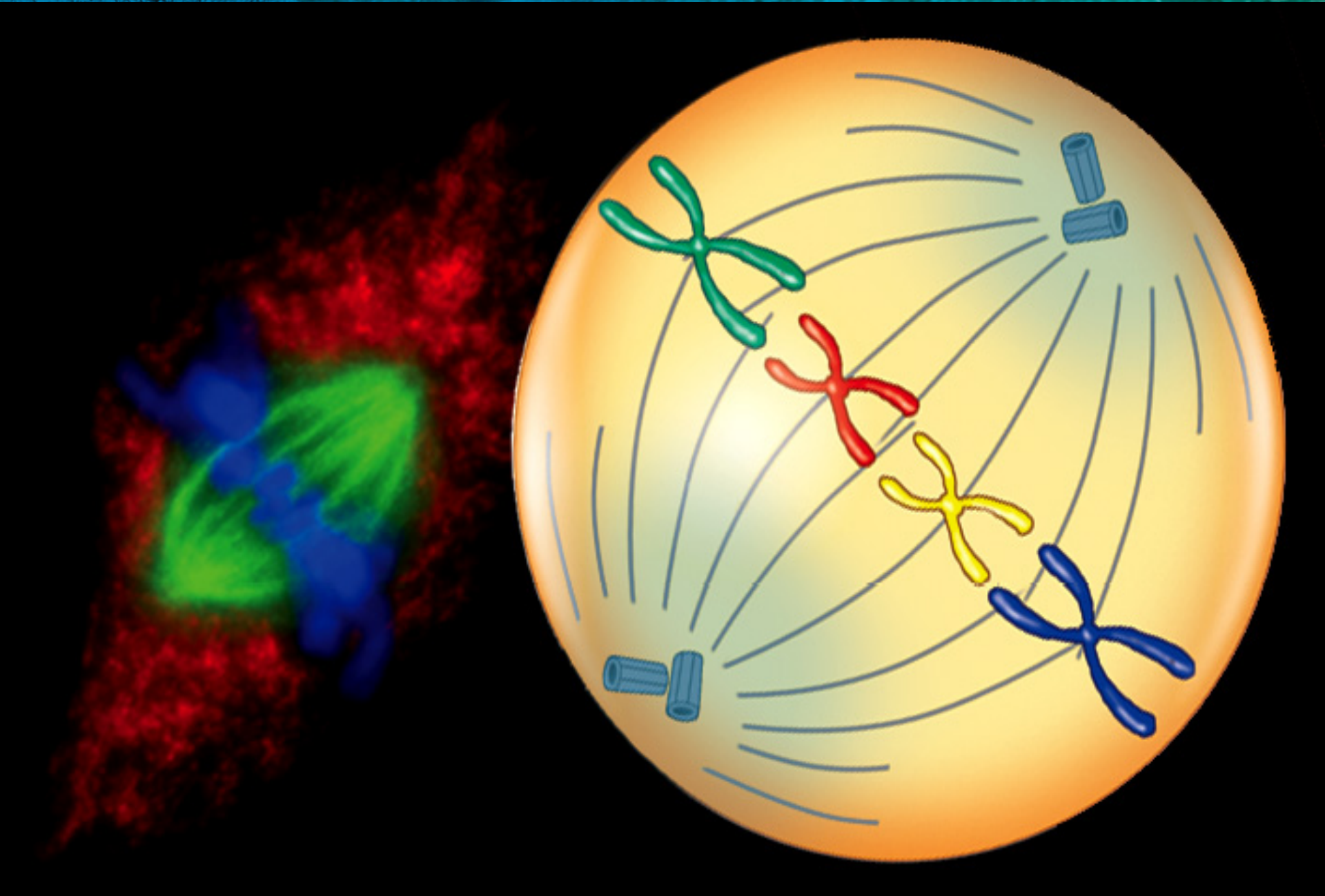


Mitosis and Cytokinesis

Metaphase (the shortest phase of mitosis) is characterized by two events:

1. Chromosomes line up across the middle of the cell. (Metaphase Plate)
2. Spindle fibers connect the centromere of each sister chromatid to the poles of the cell.

Mitosis and Cytokinesis

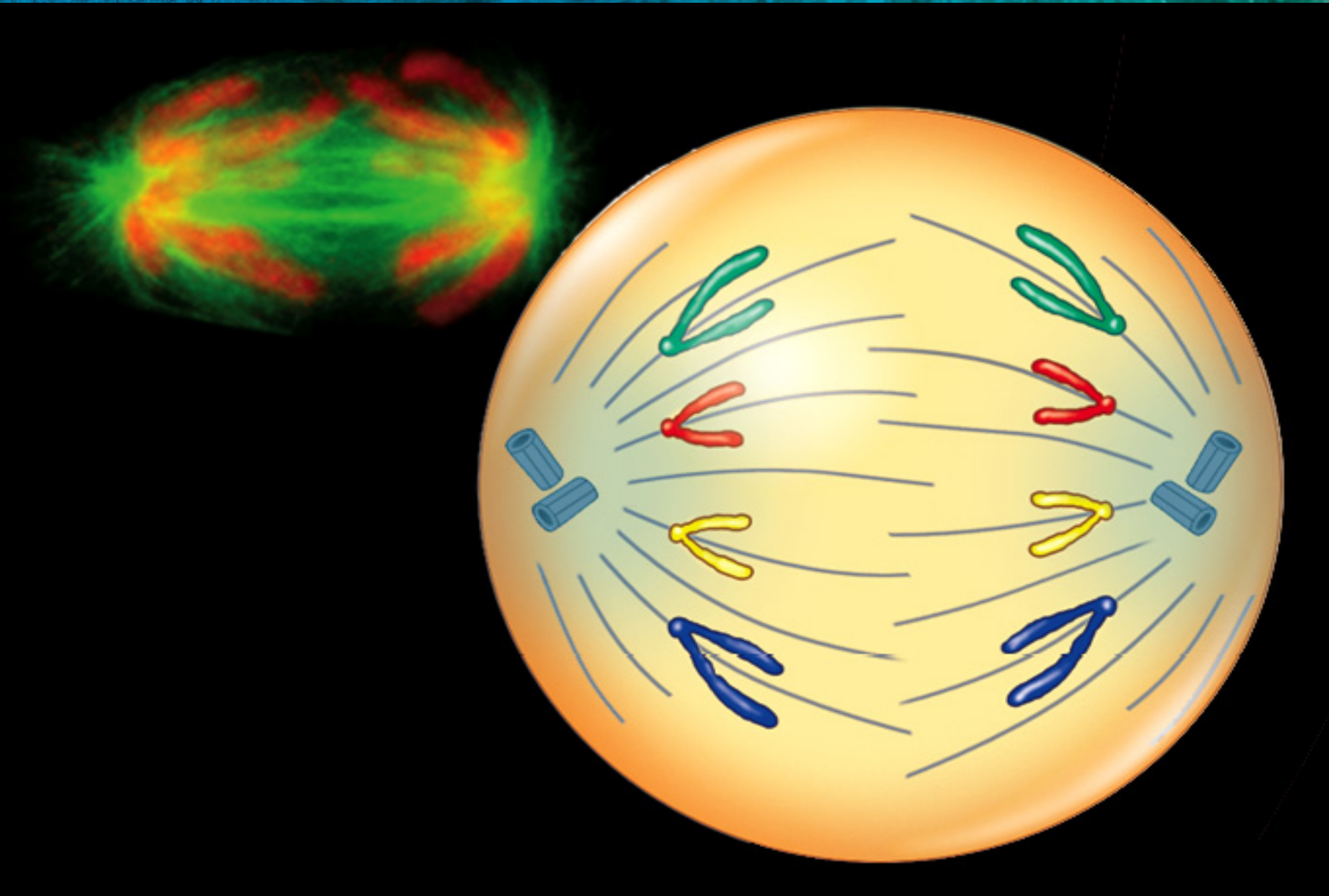


Mitosis and Cytokinesis

Anaphase is characterized by three events:

1. Centromeres that join the sister chromatids split.
2. Sister chromatids separate becoming individual chromosomes.
3. Separated chromatids move to opposite poles of the cell.

Mitosis and Cytokinesis

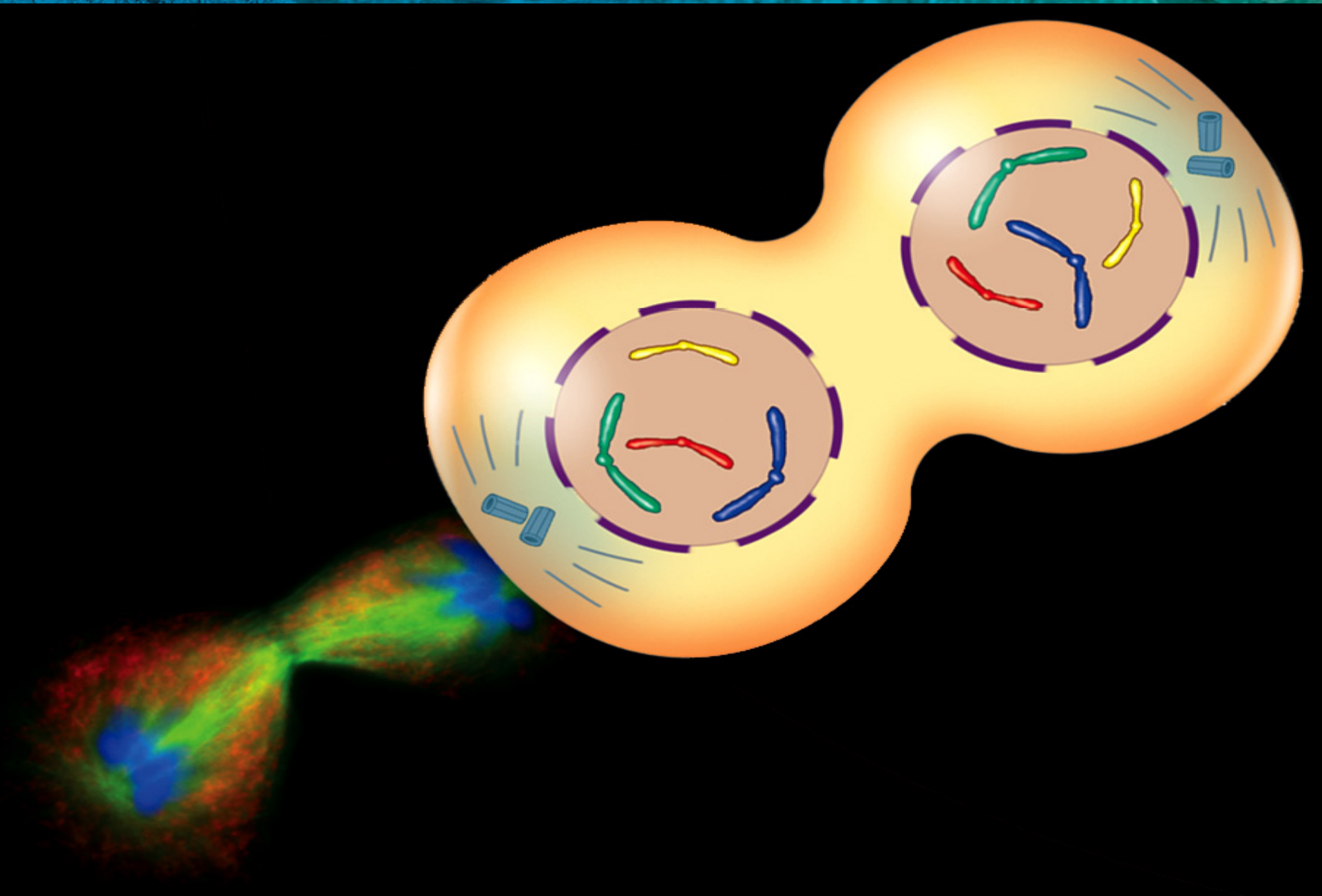


Mitosis and Cytokinesis

Telophase (the last phase of mitosis) consists of four events:

1. Chromosomes (each consisting of a single chromatid) uncoil.
2. A nuclear envelope forms around the chromosomes at each pole of the cell.
3. Spindle fibers break down and dissolve.
4. Cytokinesis begins.

Mitosis and Cytokinesis

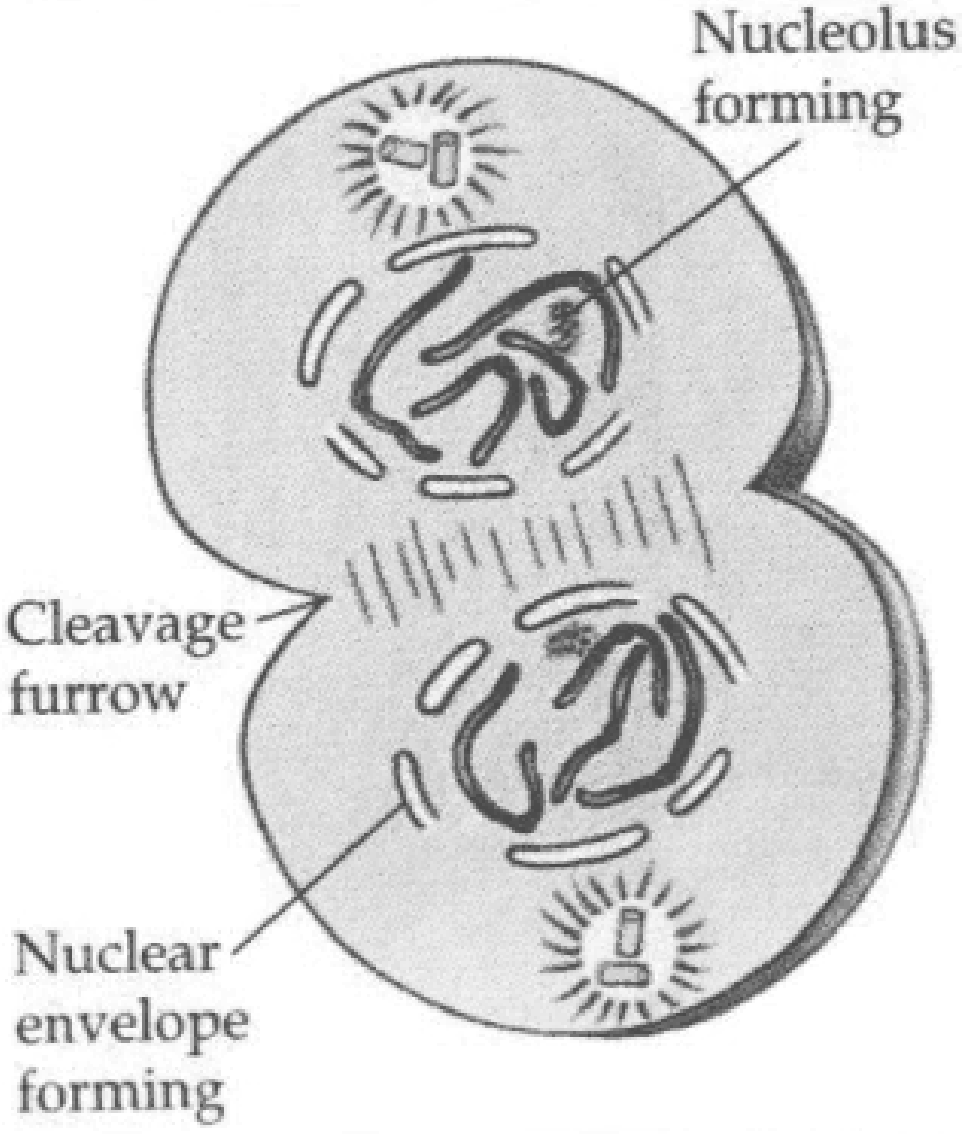


Cytokinesis

•Cytokinesis is the division of the cytoplasm into two individual cells.
•The process of cytokinesis differs somewhat in plant and animal cells.
•In animal cells the cell membrane forms a **cleavage furrow** that eventually pinches the cell into two nearly equal parts, each part containing its own nucleus and cytoplasmic organelles.
•In plant cells a structure known as a cell plate forms midway between the divided nuclei, which gradually develops into a separating membrane.
•The cell wall forms in the cell plate.

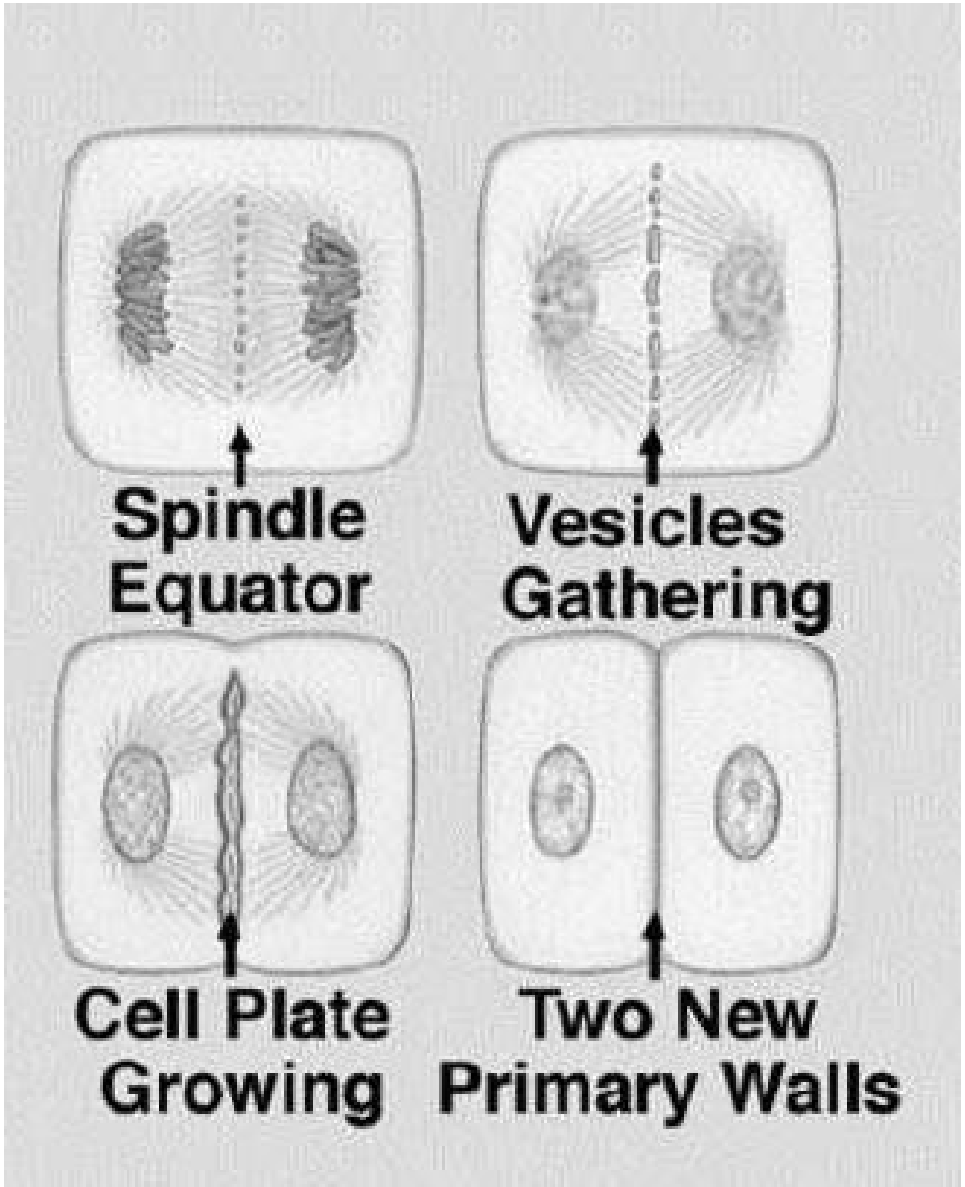
Mitosis and Cytokinesis

Animal Cell Telophase/Cytokinesis



Mitosis and Cytokinesis

Plant Cell Telophase/Cytokinesis



Mitosis and Cytokinesis

Cells divide at different rates.

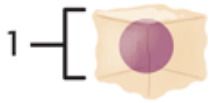
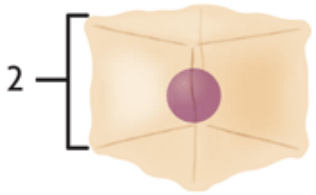
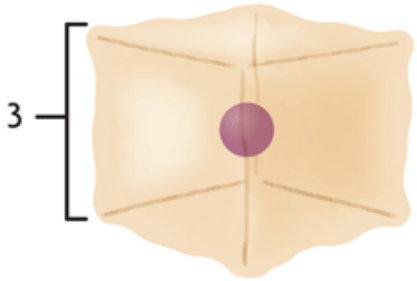
- The rate of cell division varies with the need for those types of cells.

FIGURE 5.2 CELL DIVISION	
CELL TYPE	**APPROXIMATE LIFE SPAN**
Skin cell	2 weeks
Red blood cell	4 months
Liver cell	300–500 days
Intestine—internal lining	4–5 days
Intestine—muscle and other tissues	16 years

- Some cells are unlikely to divide (G_0).

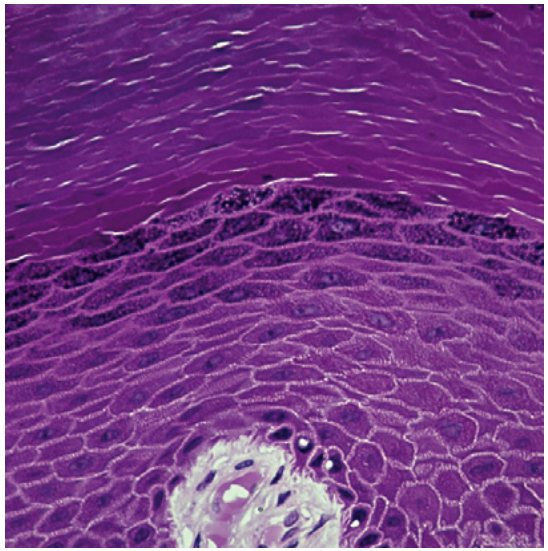
Mitosis and Cytokinesis

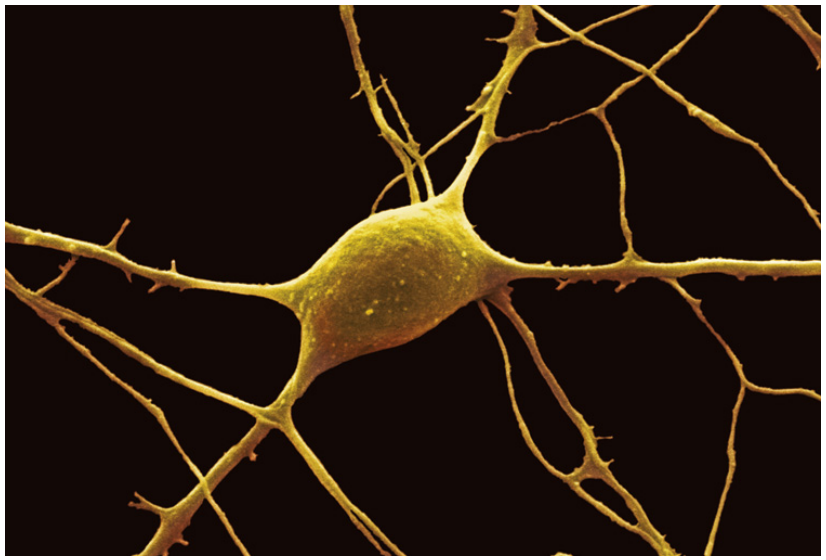
- **Cell size is limited.**
  - Volume increases faster than surface area.

Relative size			
Surface area (length × width × number of sides)	6	24	54
Volume (length × width × height)	1	8	27
Ratio of surface area to volume	$\frac{6}{1} = 6{:}1$	$\frac{24}{8} = 3{:}1$	$\frac{54}{27} = 2{:}1$

Mitosis and Cytokinesis

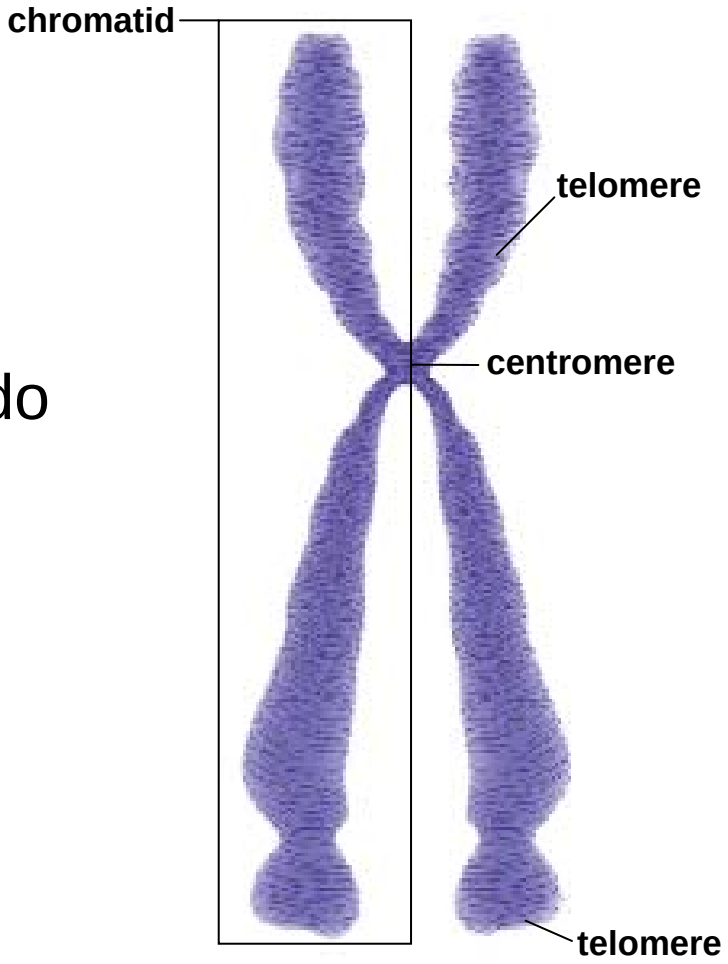
- Surface area must allow for adequate exchange of materials.
  - Cell growth is coordinated with division.
  - Cells that must be large have unique shapes.





Mitosis and Cytokinesis

- DNA plus proteins is called chromatin.
- One half of a duplicated chromosome is a chromatid.
- Sister chromatids are held together at the centromere.
- Telomeres protect DNA and do not include genes.



Condensed, duplicated chromosome

Mitosis and Cytokinesis

- **Mitosis and cytokinesis produce two genetically identical daughter cells.**
  - Interphase prepares the cell to divide.
  - During interphase, the DNA is duplicated.