

Cell Biology

ANS

Lecture 3 Theory

Cell Cycle and Cell division

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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.

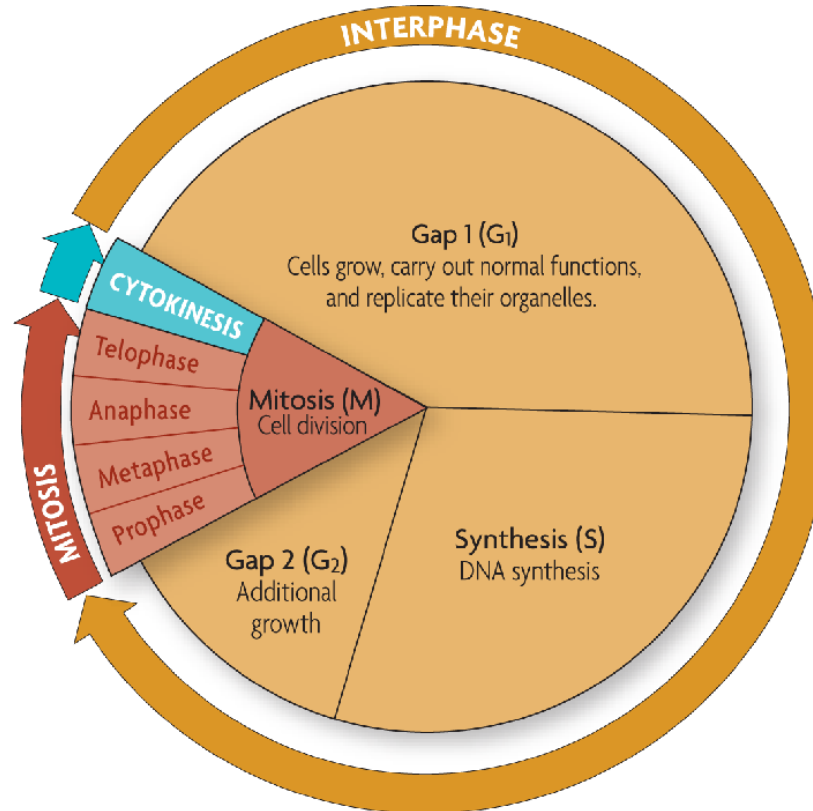
The cell cycle is a repeated pattern of growth and division that occurs in eukaryotic cells.

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

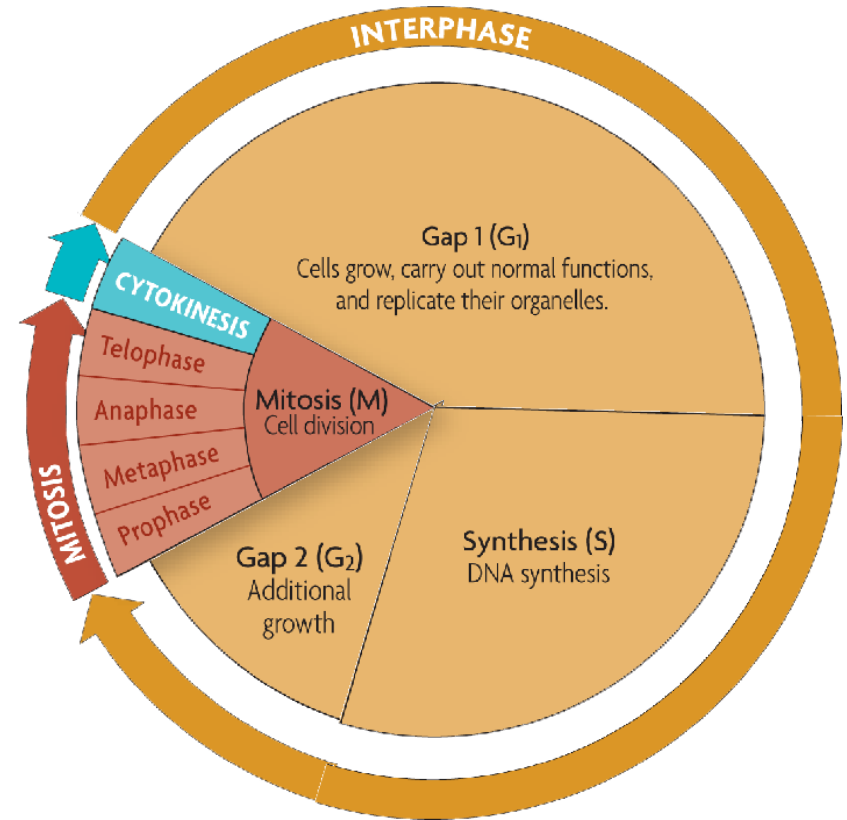
The first phase represents cell growth while the last two phases represent cell division.

▶ The cell cycle has four main stages.

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



- The main stages of the cell cycle are gap 1, synthesis, gap 2, and mitosis.
- **Gap 1 (G₁)**: cell growth and normal functions
- **DNA synthesis (S)**: copies DNA
- **Gap 2 (G₂)**: additional growth (**chromatids become replicated chromosomes**)
- **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.

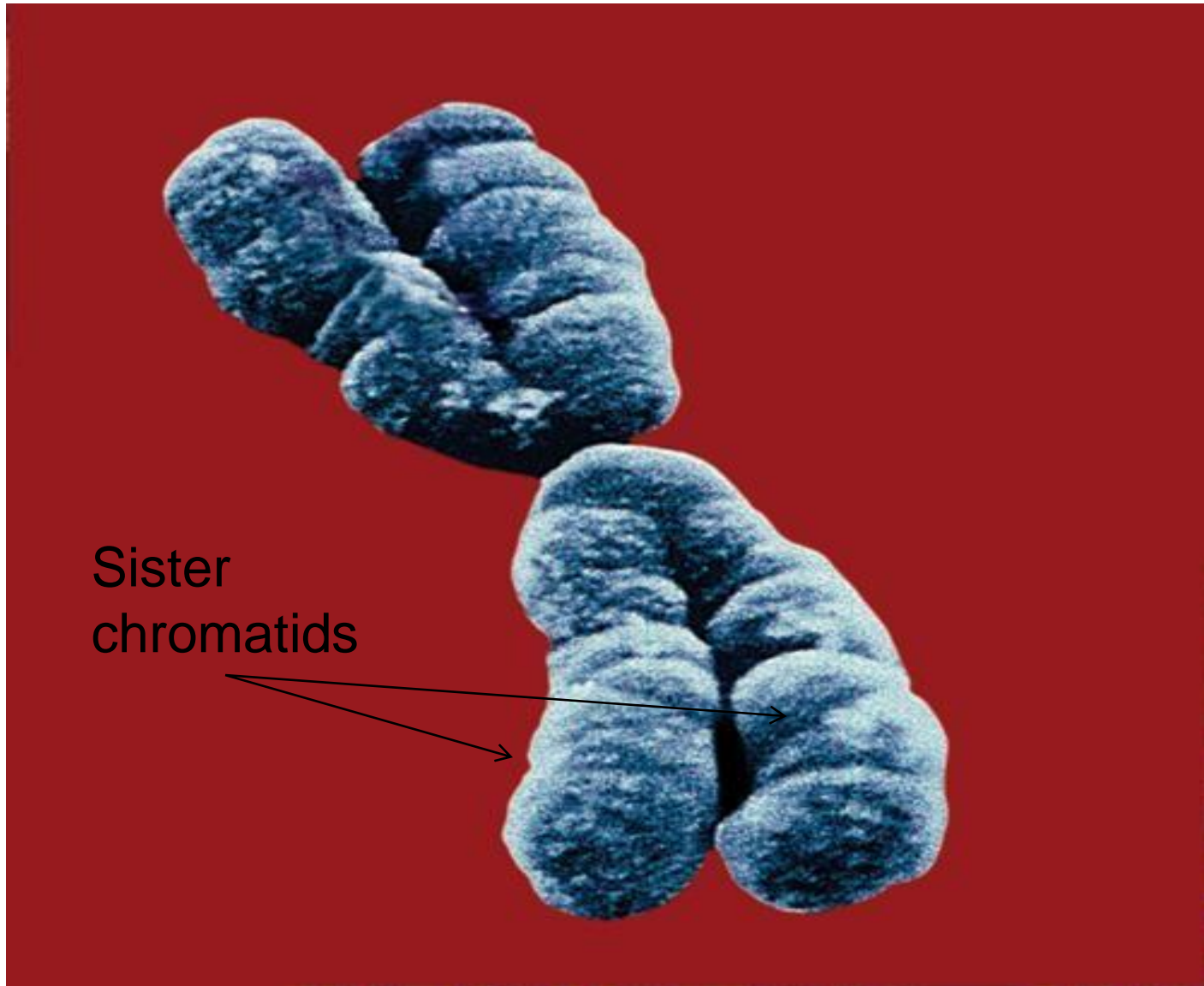


Interphase

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.



Sister
chromatids

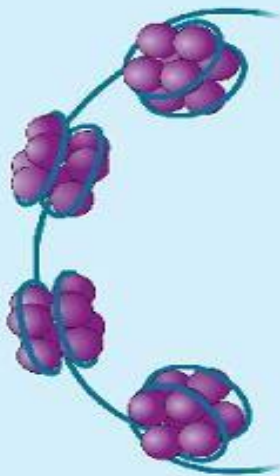
How does 6.5 feet of DNA condense into a chromosome?

Chromosomes condense at the start of mitosis.

- DNA wraps around proteins (histones) that condense it.
- In a typical human cell, there is about 6.5 feet of DNA!



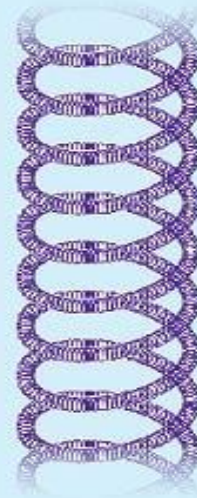
DNA double
helix



DNA and
histones

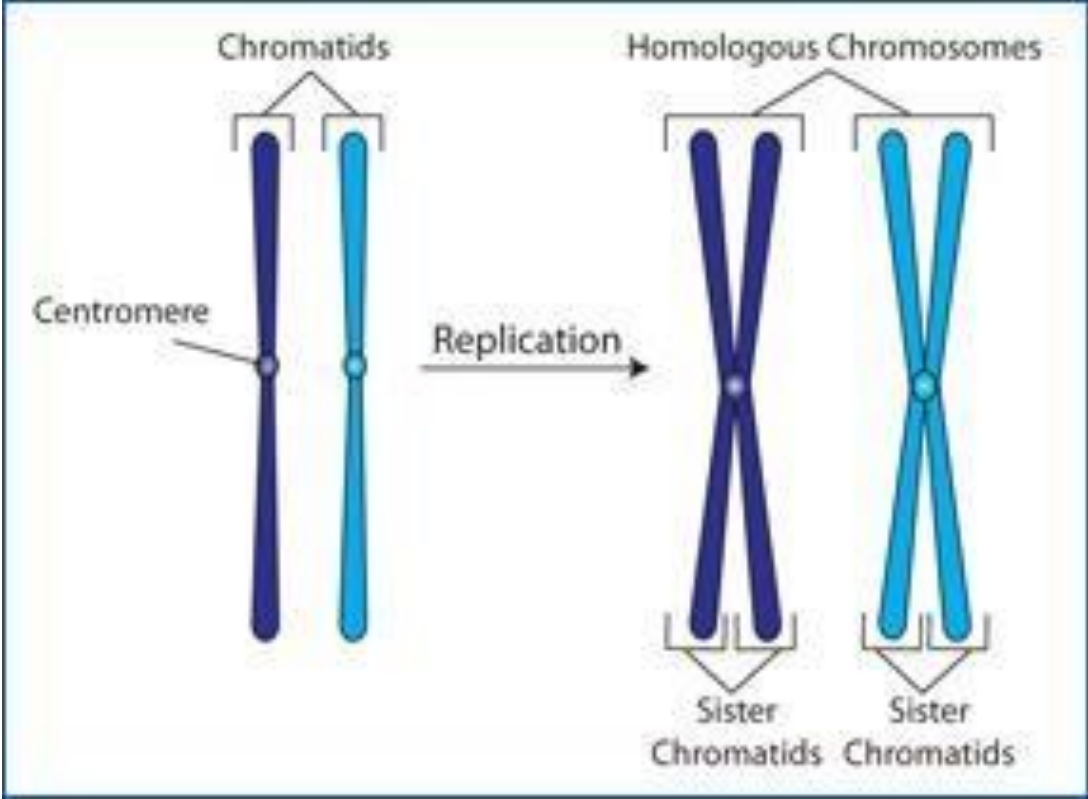


Chromatin



Supercoiled
DNA





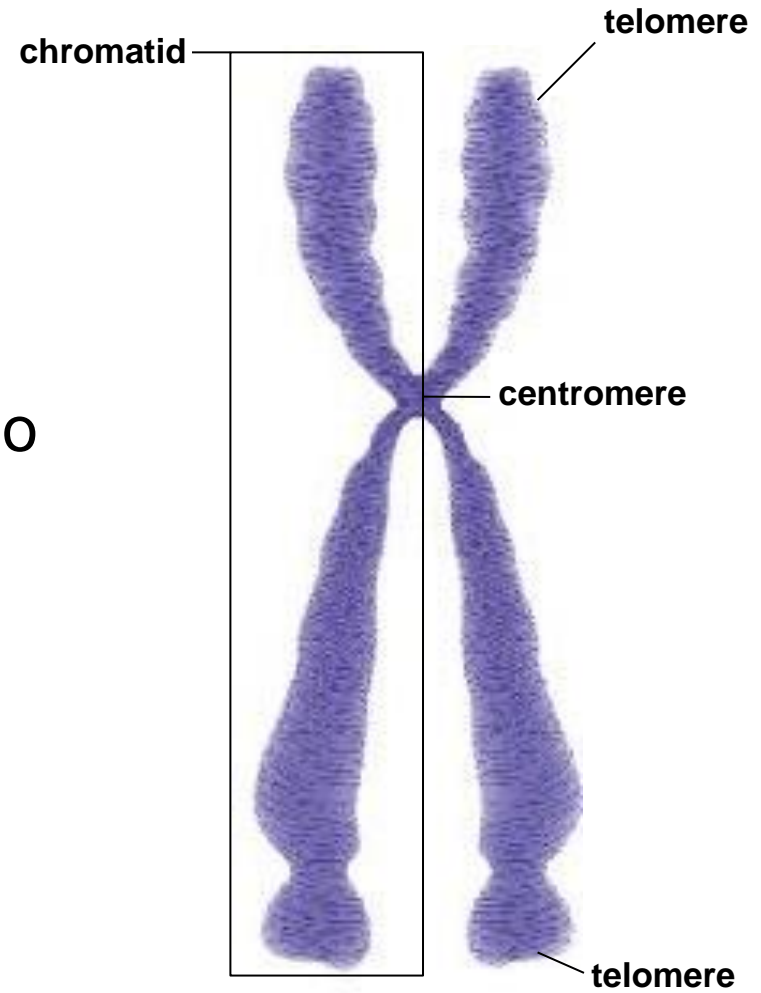
Mitosis

- 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 chromatid**) have to break apart so that each new cell only has one double-stranded chromosome.
- **Two sister chromatids together make a chromosome**

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.

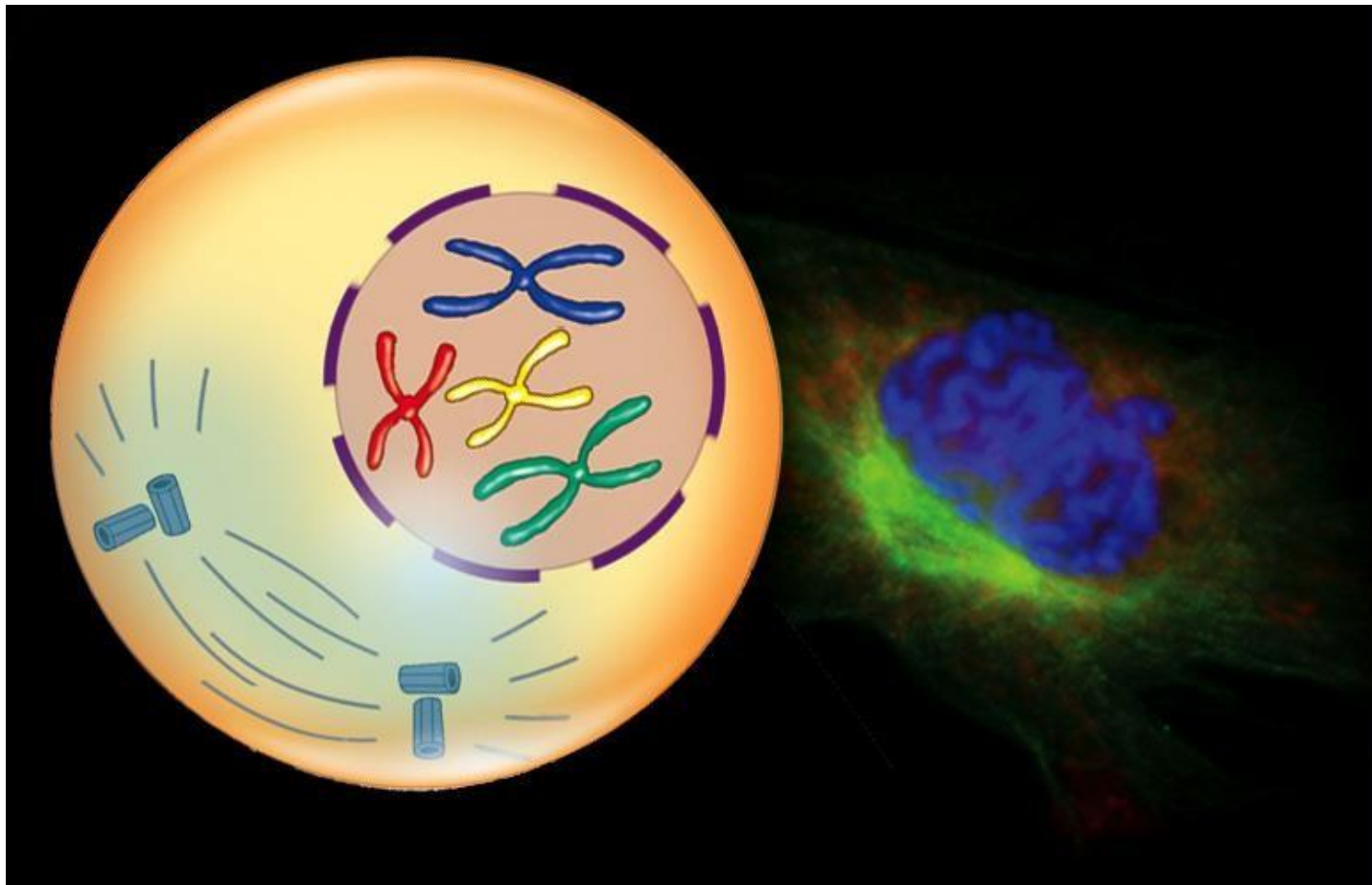
- DNA plus proteins is called chromatin.
- One half of a duplicated chromosome is a chromatid.
- Sister chromatids are held together at the centromere.
- **Telomeres** protect DNA and do not include genes.



Condensed, duplicated chromosome

Mitosis and Cytokinesis

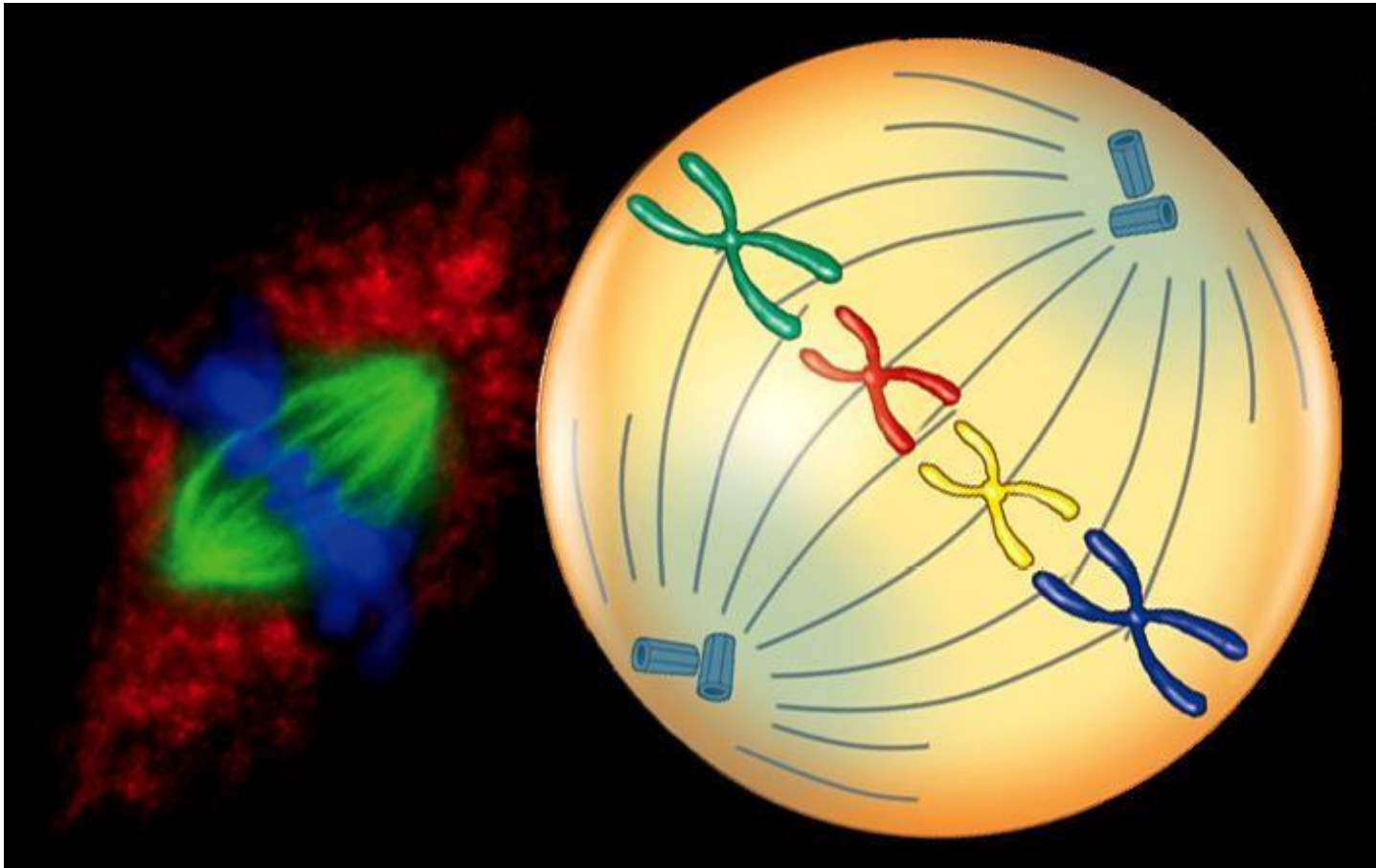
- Mitosis divides the cell's nucleus in four phases.
 - During prophase, chromosomes condense and spindle fibers form.



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

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

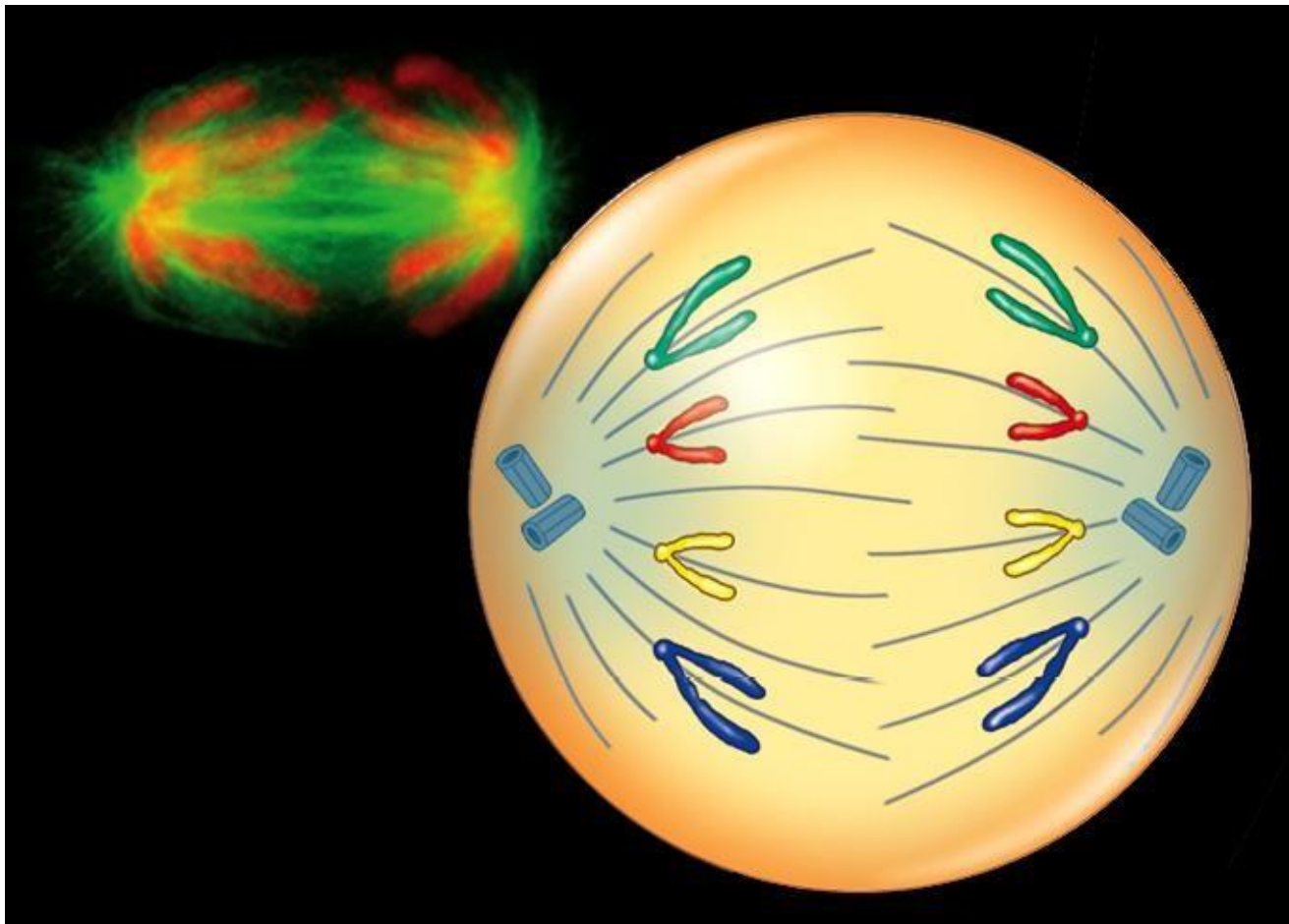
- Mitosis divides the cell's nucleus in four phases.
 - During metaphase, chromosomes line up in the middle of the cell.



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.

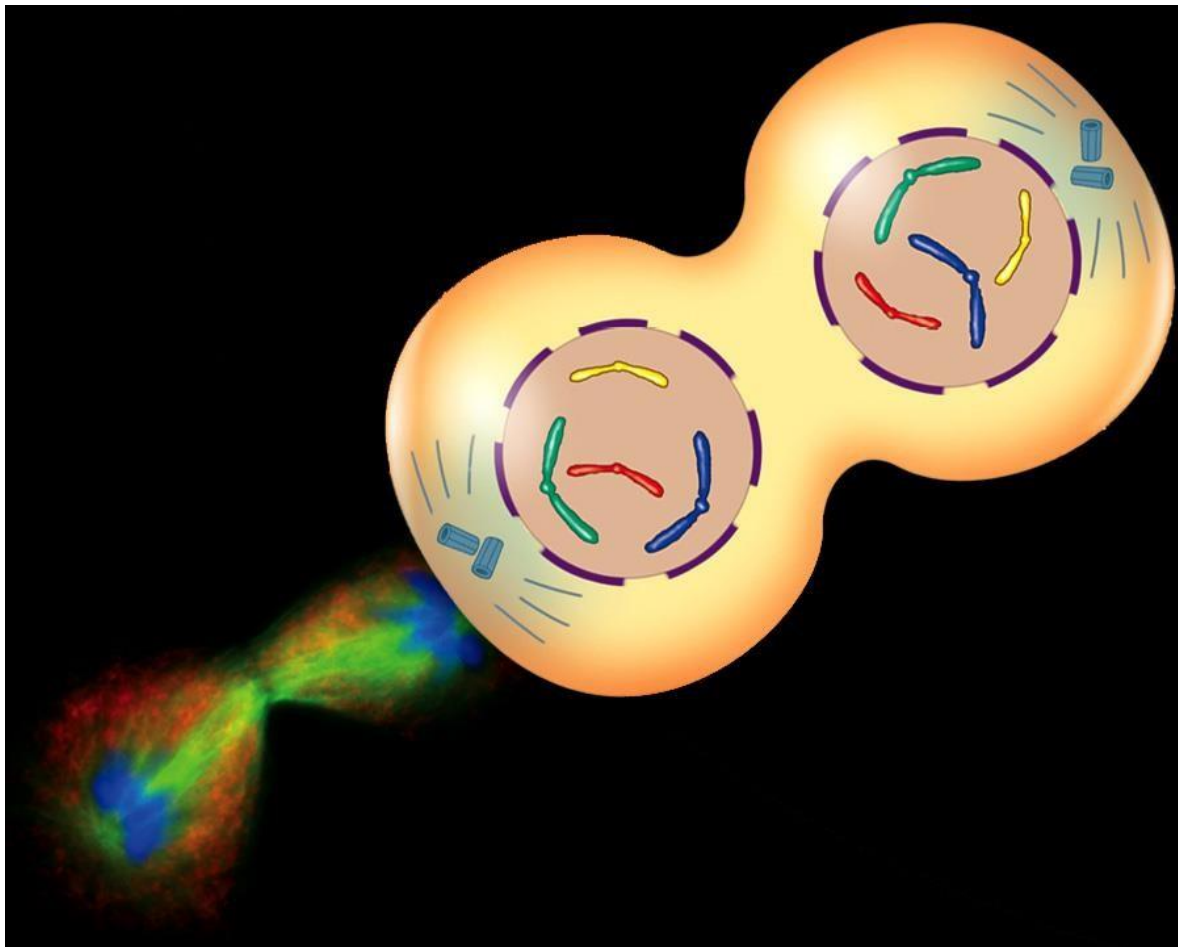
- Mitosis divides the cell's nucleus in four phases.
 - During anaphase, sister chromatids separate to opposite sides of the cell.



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.

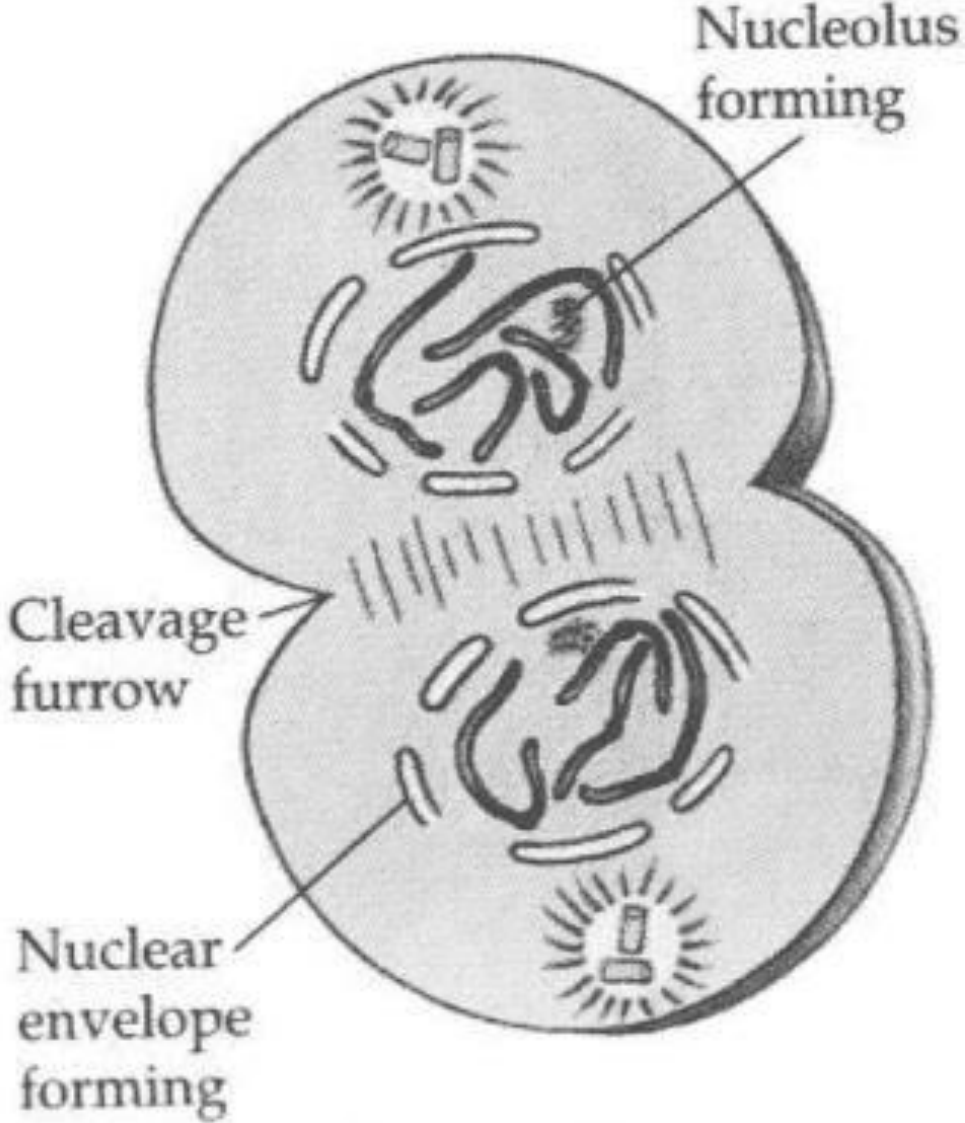
- Mitosis divides the cell's nucleus in four phases.
 - During telophase, the new nuclei form and chromosomes begin to uncoil.



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.

Animal Cell Telophase/Cytokinesis



- Cytokinesis differs in animal and plant cells.
 - In animal cells, the membrane pinches closed.
 - In plant cells, a **cell plate** forms.

