



Cell Cycle and Cell Division

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Course: Cell biology (MA 219)

Fall-Semester

Week 4

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Outline

- Cell cycle
- Mitosis
- Four stages
- Significance of Mitosis
- Cytokinesis

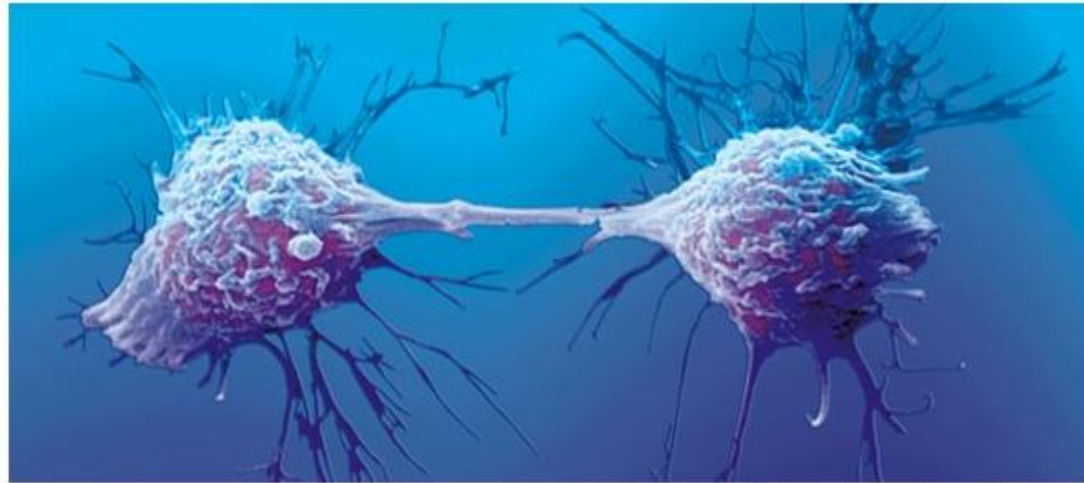


Objectives

- To have an overview of the Cell cycle as well as stages of mitosis.

Cell Cycle

- Cells grow, prepare for division, and divide.
- **Somatic Cell**: body cell
 - Skin, hair, muscle, etc.
- Daughter cells are **Diploid**
 - They have 2 copies of chromosomes
- The cycle starts over again.



Cell Division



- 2 kinds of cell division:
 - 1. Mitosis: division of somatic cells
 - 2. Meiosis: creation of new sex cells



Sperm cells



Human egg cell

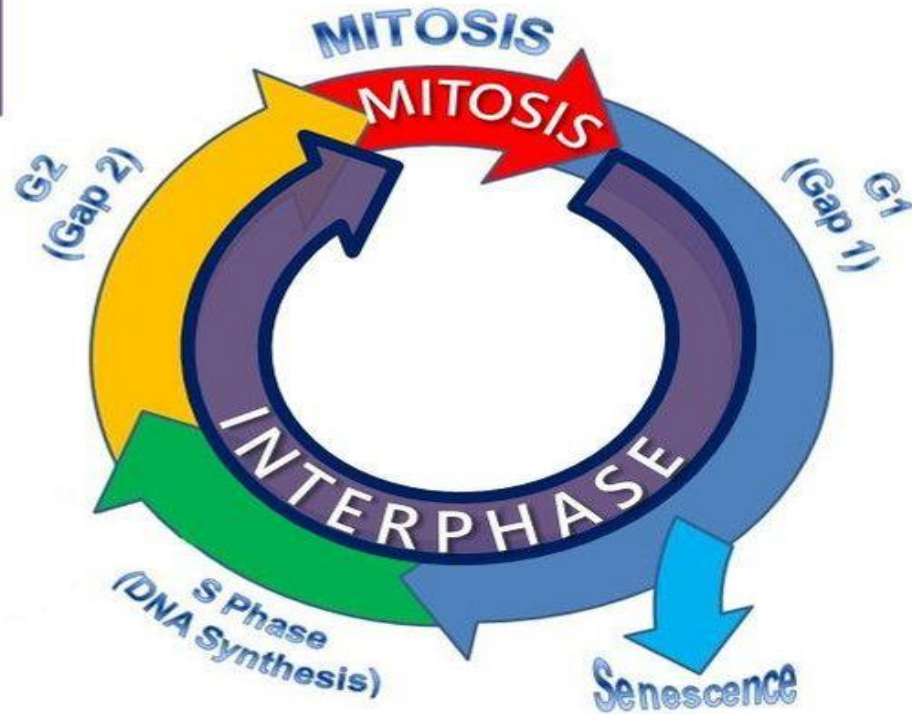
The Cell Cycle
Has 2 Divisions:

- 1) INTERPHASE
- 2) MITOSIS

INTERPHASE
Has 3 Divisions:

- 1) G1 (Gap 1)
- 2) S Phase (DNA Synthesis)
- 3) G2 (Gap 2)

The Cell Cycle



Cell Cycle

Interphase: Divided into 3 phases:

◆ G_1 = 1st Gap

- cell doing its “everyday job”
- cell *grows*

◆ **S** = DNA Synthesis

- copies DNA (chromosomes)

◆ G_2 = 2nd Gap

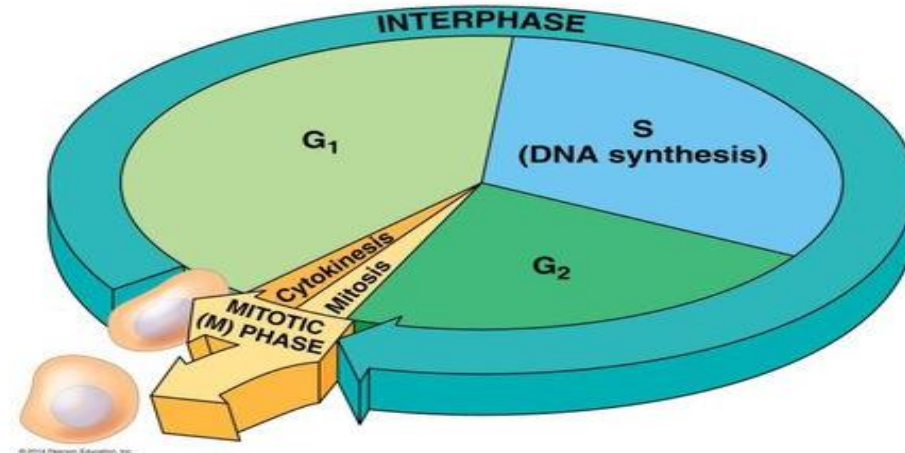
- prepares for division
- cell *grows* (more)

▪ Mitosis Phase

- ◆ cell division occurs

signal to divide

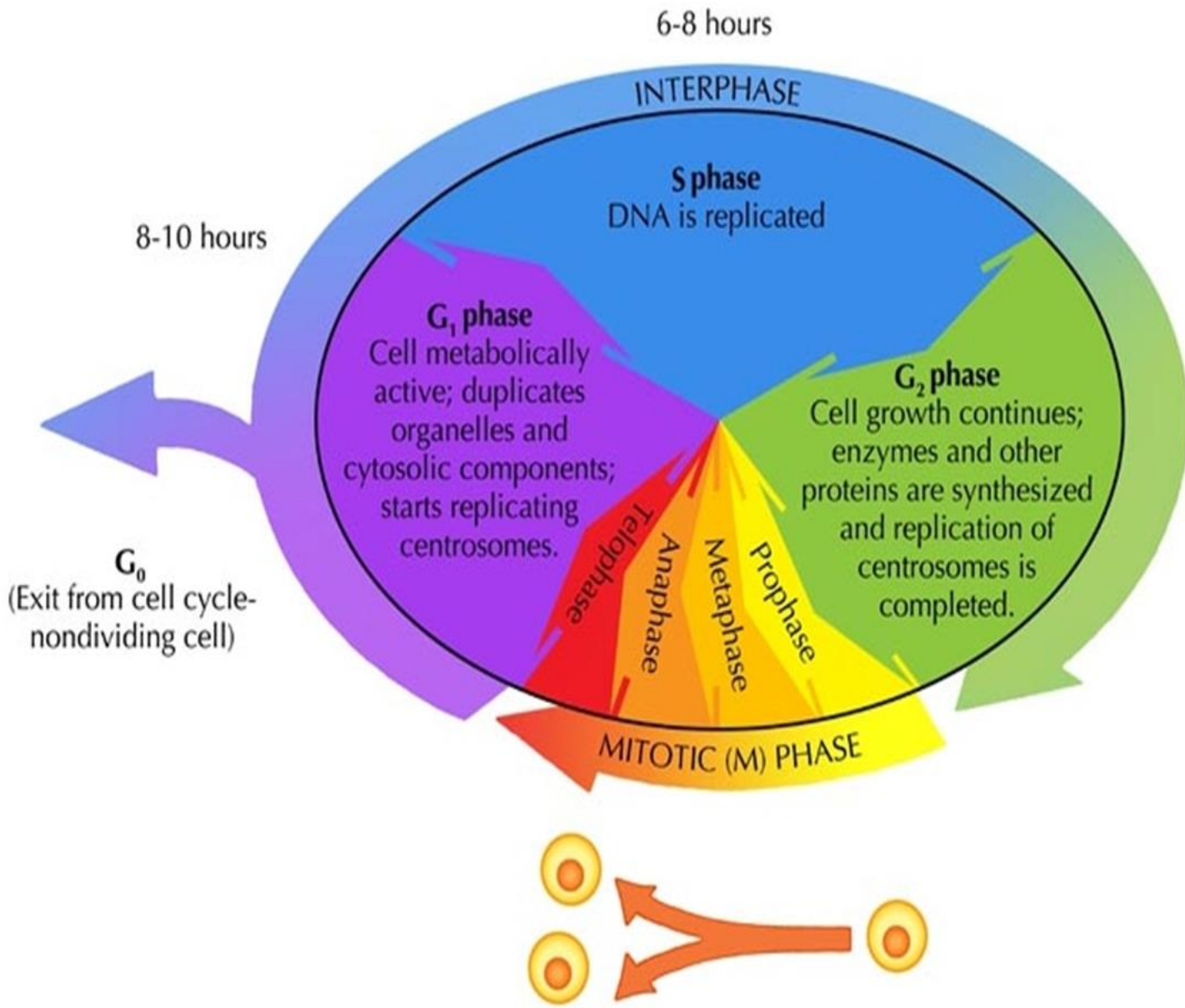
G_0



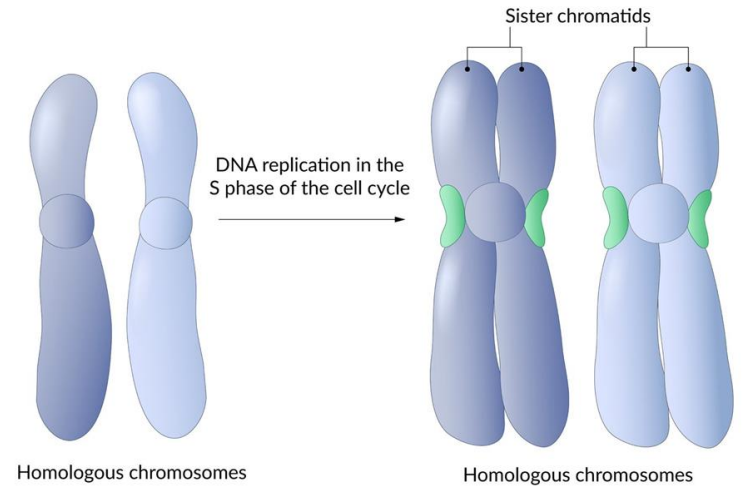
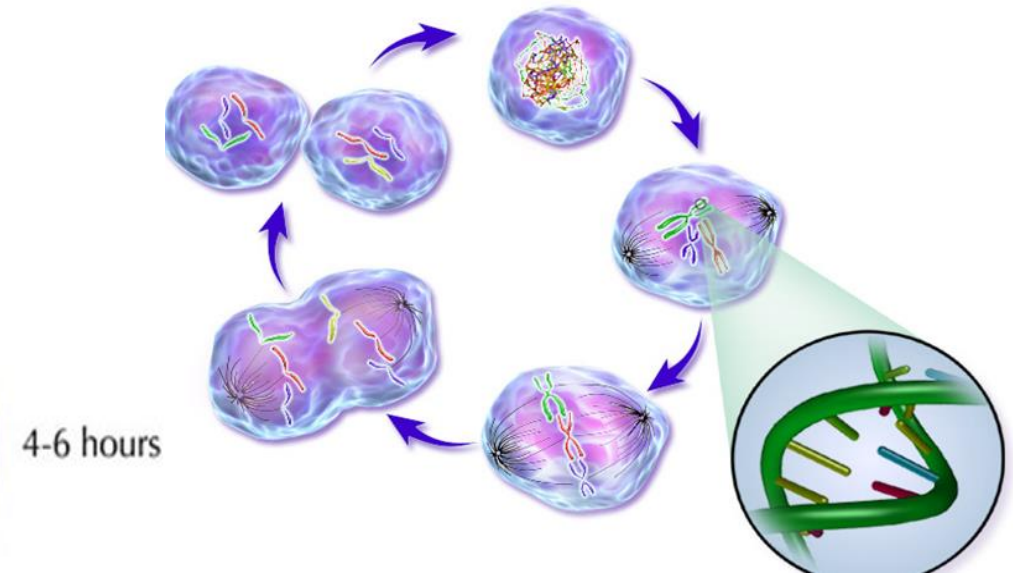
and formation 2 Diploid cells (Cytokinesis)

$G_1 + S + G_2 =$ Interphase (12 to 24 Hours in a mammalian cell)

M phase 1 to 2 hours



During the S phase



FIVE PHASES OF CELL CYCLE

"S" Phase

- **"G1" Phase** - Primary Growth Phase.
 - **"S" Phase** - DNA Synthesis & DNA Replication.
 - **"G2" Phase** - Secondary Growth Phase.
- (First 3 Phases are collectively called "Interphase")*
- **"M" Phase** - Mitosis (Karyokinesis - Nucleus Division)
 - **"C" Phase** - Cytokinesis (Cytoplasm Division)

- "S" Phase is also called as **Synthesis stage**.
- **DNA is copied or replicated** and produces **two similar daughter cells** in this stage.

"G1" Phase (Interphase)

- G1 Phase is also called as **"Gap - 1" or Interphase**
- G1 Phase is the **first growth stage after Cell Division**.
- Cell **mature by making more Cytoplasm & Organelles**.
- Cell **increases in size, produce RNA and synthesize Protein**.
- Cell carries on its **normal metabolic activities**.
- G1 Phase is **not visible under microscope**.

"G2" Phase

- G2 Phase is also called as **"Gap - 2"**.
- It is the **Second growth stage**.
- This phase occurs **after the DNA is replicated**.
- All the **cell structures needed for cell division are synthesized**.
- Both **organelles and proteins** are synthesized.

Mitosis

- Purpose:
 - Mitosis occurs in order for organisms to grow and develop.
 - In order to replenish dead or dying cells such as skin cells, and cells in the digestive tract.
- Karyokinesis
 - process of nuclear division (division of genetic material)
- Cytokinesis
 - Process of dividing cytoplasm/cell

- **Division of the Nucleus**
- **Only occurs in Eukaryotes**
- **Has Four stages**
- **Doesn't occur in some cells such as Brain cells**

Mitotic phases

Cell copies its DNA

Centrioles move to opposite poles

Chromosomes become visible

The nuclear envelope disintegrates

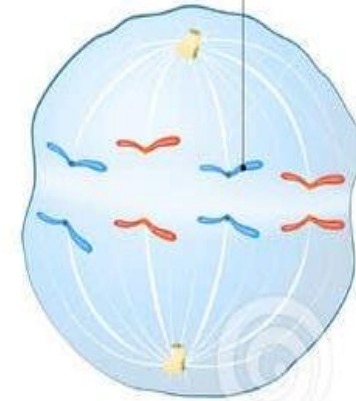
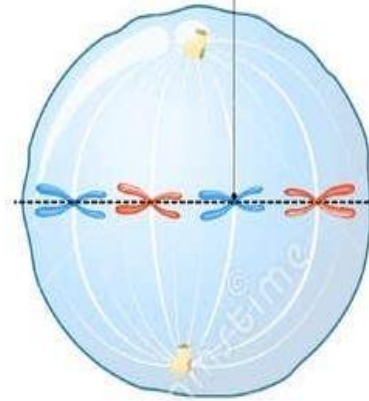
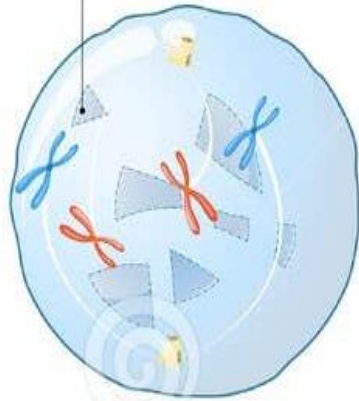
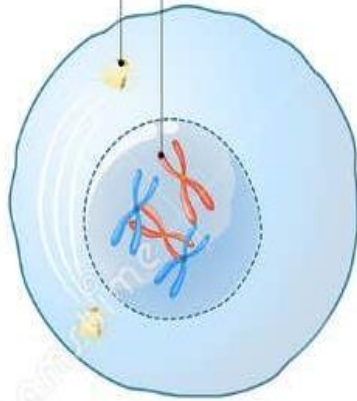
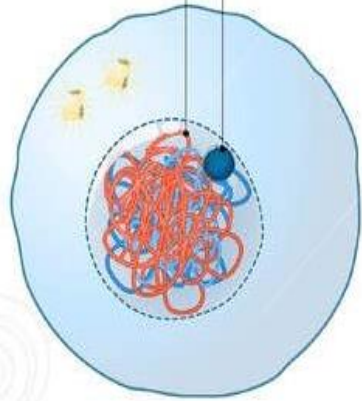
Arrangement of chromosomes at the equatorial plane

Sister chromatids move to opposite poles

Formed nuclear envelope

Chromosomes begin to decondense

Nucleolus



INTERPHASE

PROPHASE

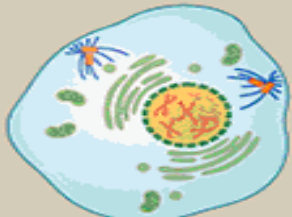
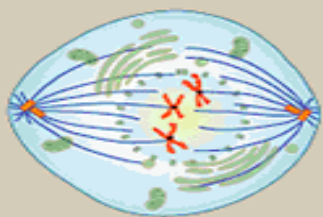
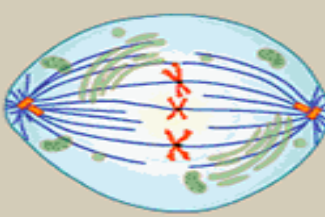
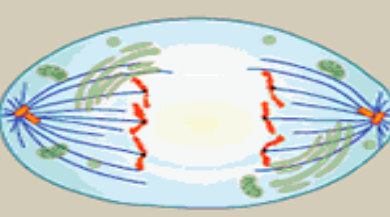
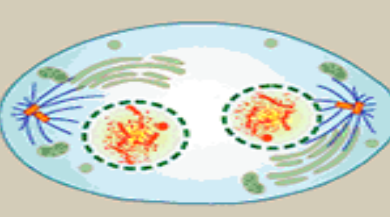
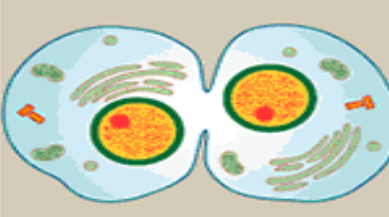
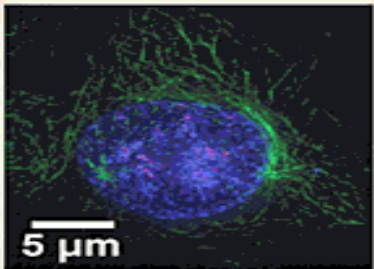
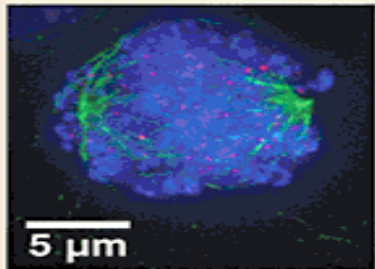
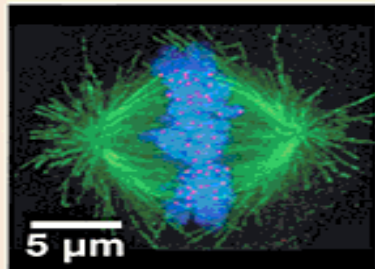
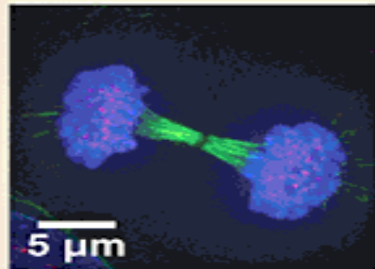
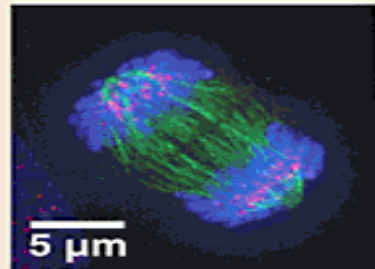
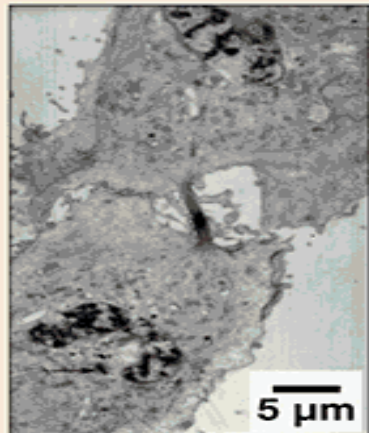
PROMETAPHASE

METAPHASE

ANAPHASE

TELOPHASE

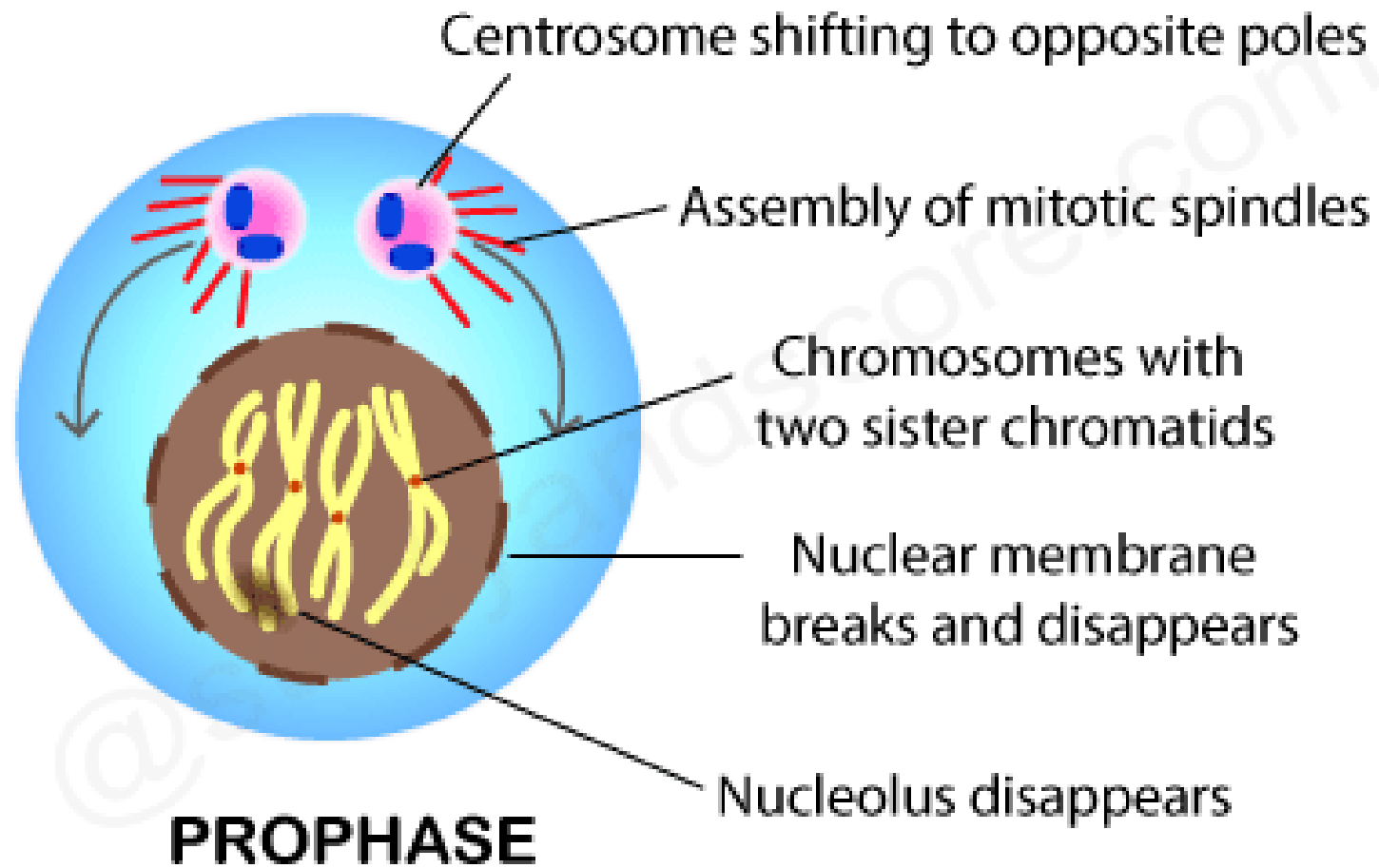


Prophase	Prometaphase	Metaphase	Anaphase	Telophase	Cytokinesis
					
<ul style="list-style-type: none"> Chromosomes condense and become visible Spindle fibers emerge from the centrosomes Nuclear envelope breaks down Centrosomes move toward opposite poles 	<ul style="list-style-type: none"> Chromosomes continue to condense Kinetochores appear at the centromeres Mitotic spindle microtubules attach to kinetochores 	<ul style="list-style-type: none"> Chromosomes are lined up at the metaphase plate Each sister chromatid is attached to a spindle fiber originating from opposite poles 	<ul style="list-style-type: none"> Centromeres split in two Sister chromatids (now called chromosomes) are pulled toward opposite poles Certain spindle fibers begin to elongate the cell 	<ul style="list-style-type: none"> Chromosomes arrive at opposite poles and begin to decondense Nuclear envelope material surrounds each set of chromosomes The mitotic spindle breaks down Spindle fibers continue to push poles apart 	<ul style="list-style-type: none"> Animal cells: a cleavage furrow separates the daughter cells Plant cells: a cell plate, the precursor to a new cell wall, separates the daughter cells 

MITOSIS

Uses of Mitosis

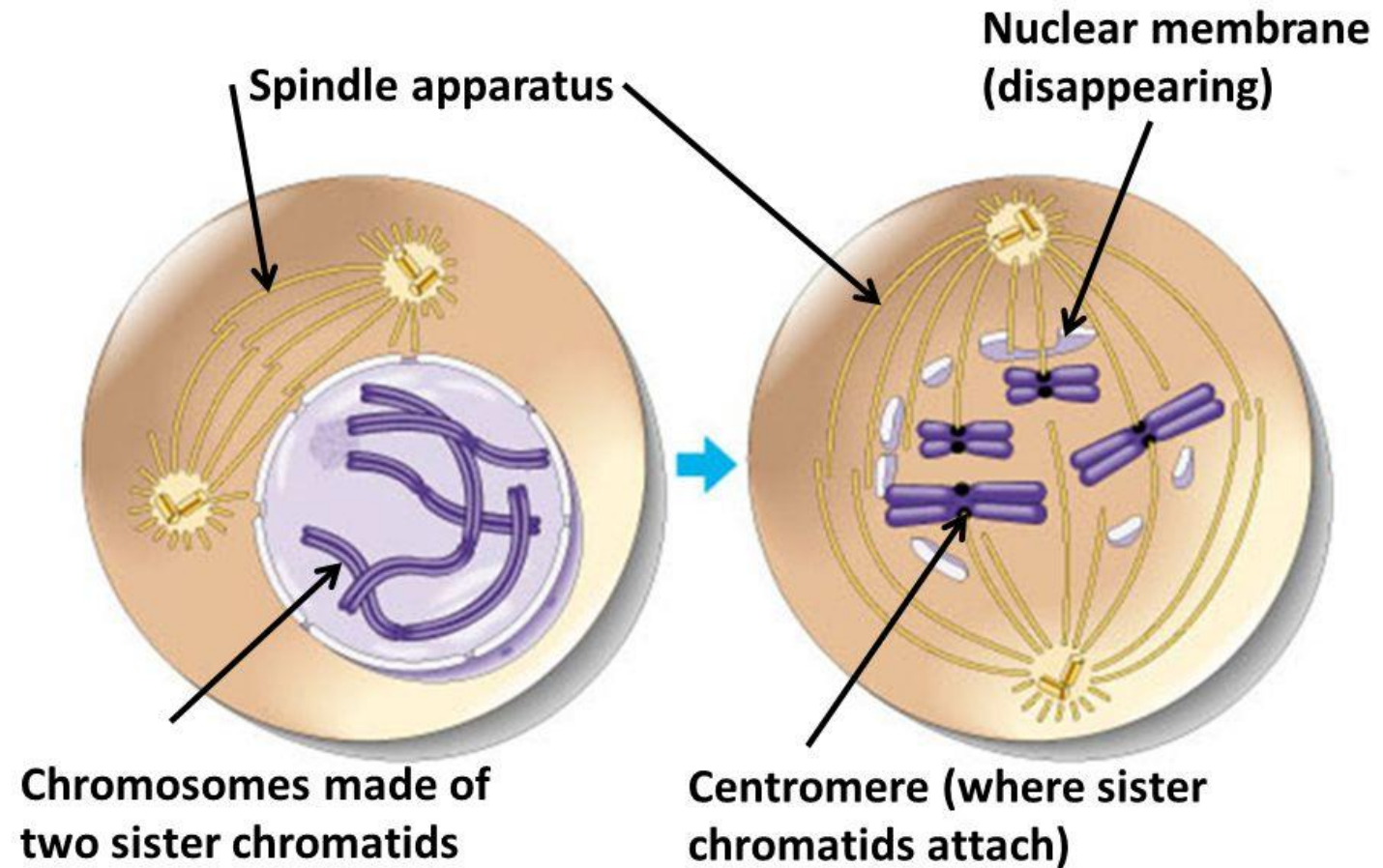
- **Growth**
 - ◆ Organisms grow by increasing number of cells, not cell size
- **Tissue Repair**
 - ◆ Wounds close by creating cells identical to those that were lost or injured
- **Embryonic Growth**
 - ◆ Increasing cell number
- **Asexual Reproduction (Binary Fission)**
 - ◆ Creating whole new organisms only through mitosis



✓ **At the end of prophase:**

- Endoplasmic reticulum
- Nuclear membrane
- Golgi complex
- **All disappears**

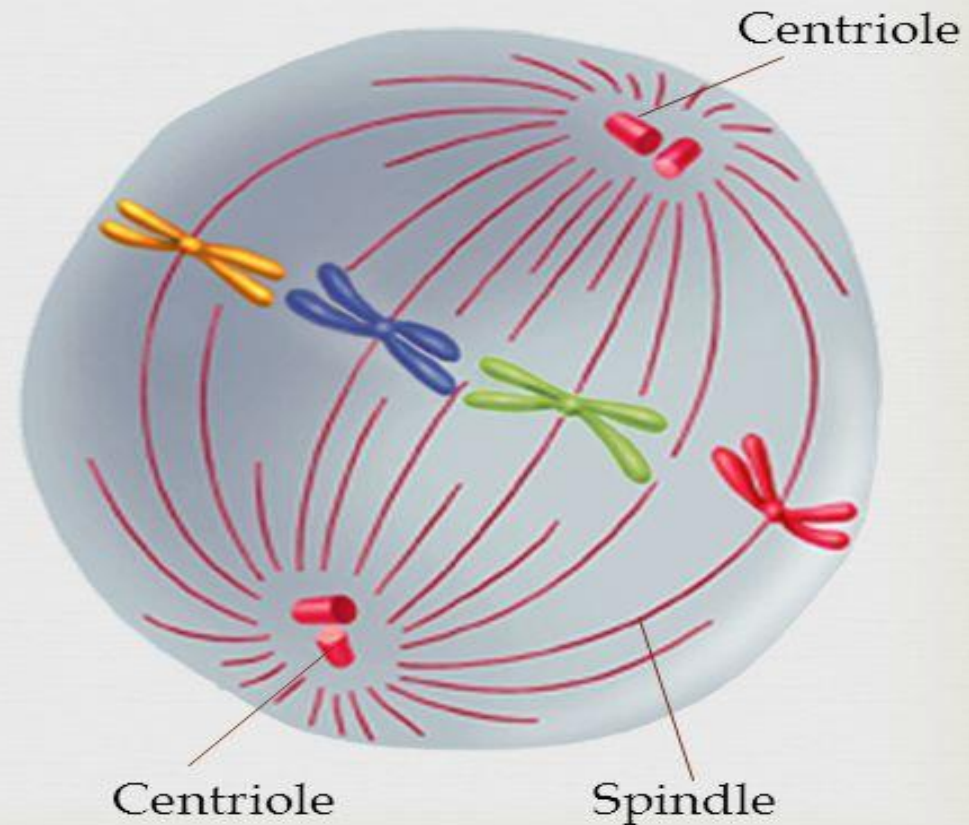
Early & Late Prophase



Metaphase



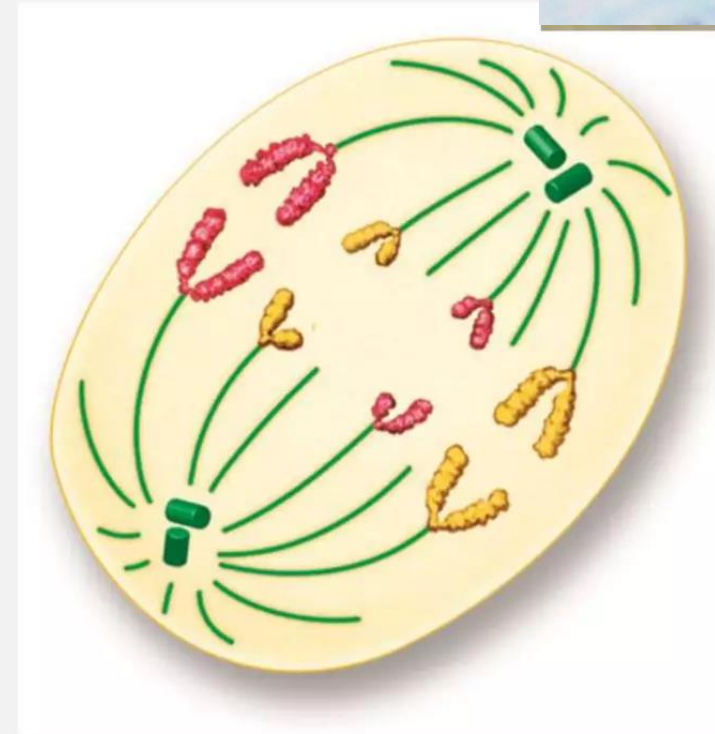
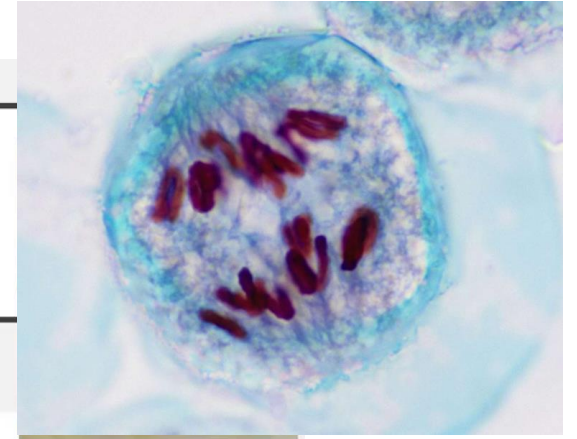
- ☞ The second phase of mitosis, *metaphase*, often lasts only a few minutes.
- ☞ During Metaphase:
 - ☞ The chromosomes line up across the center of the cell.
 - ☞ Each chromosome is connected to a spindle fiber at its centromere.



The nuclear membrane completely disappeared

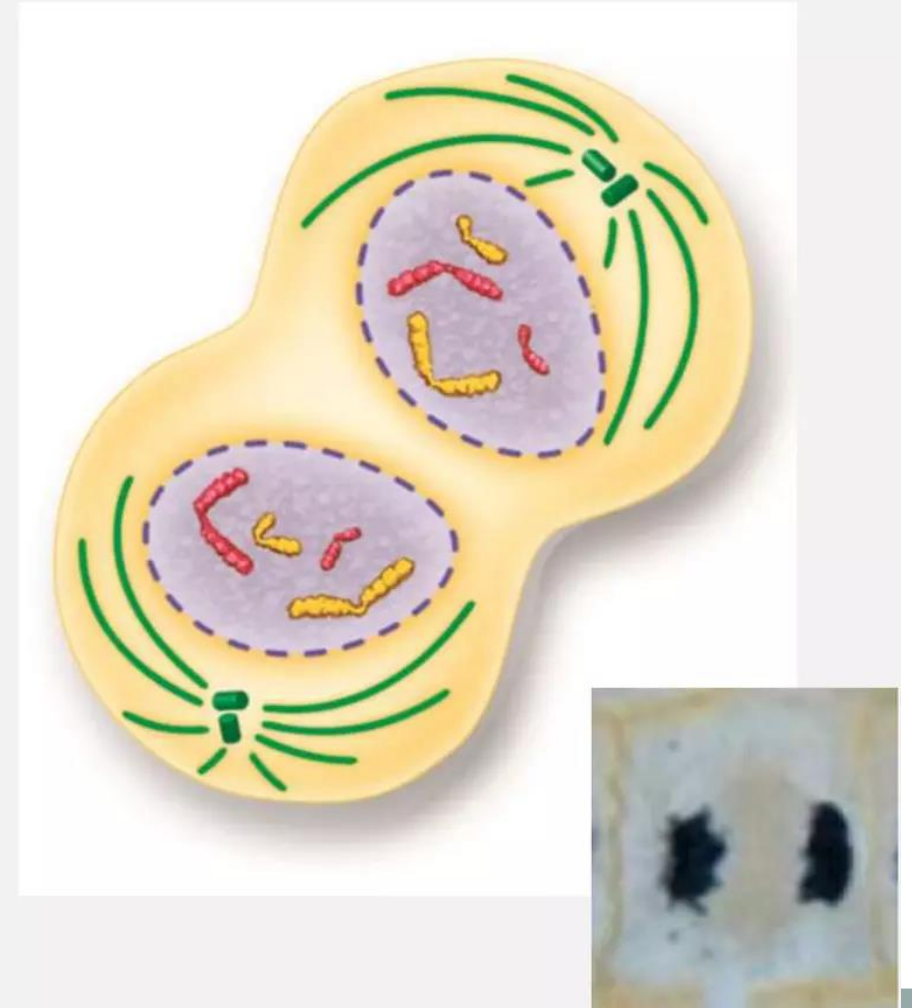
MITOSIS - ANAPHASE

- Sister chromatids separate at the centromere
- Spindle fibers shorten and pull the cleaved chromatids (now chromosomes) to the opposite poles of the cell



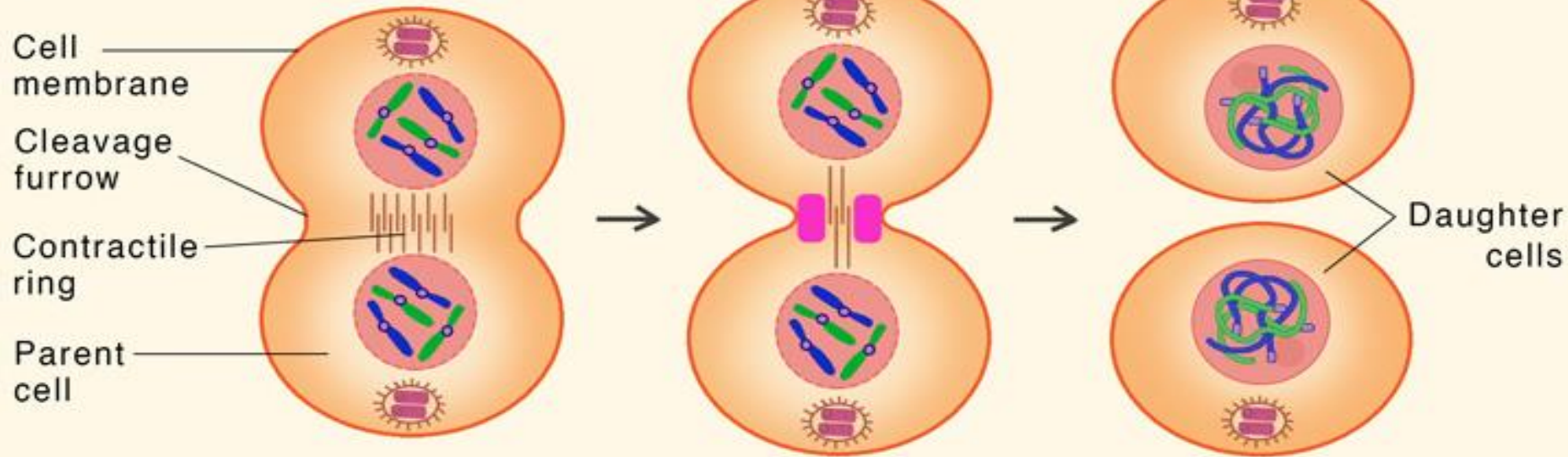
MITOSIS - TELOPHASE

- Opposite of prophase
- Nuclear envelope reforms (now there are two nuclei)
- Spindle breaks down
- Both sets of chromosomes relax (uncoil) back into chromatin



Cytokinesis

Animal cell



Telophase

A contractile ring of actin filaments forms at the cell center

The filaments constrict, forming a cleavage furrow

Cytokinesis

The furrow meets, forming 2 daughter cells

Cytokinesis

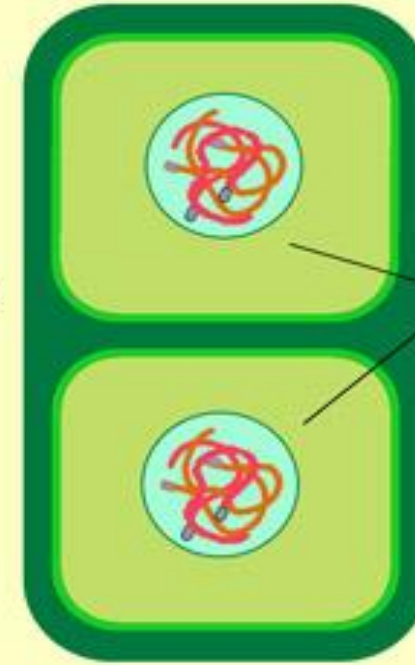
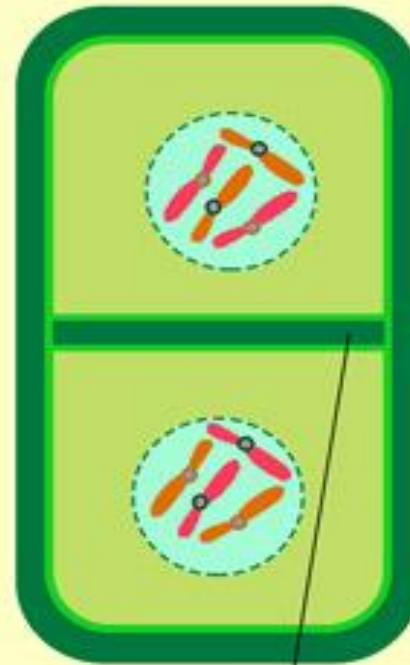
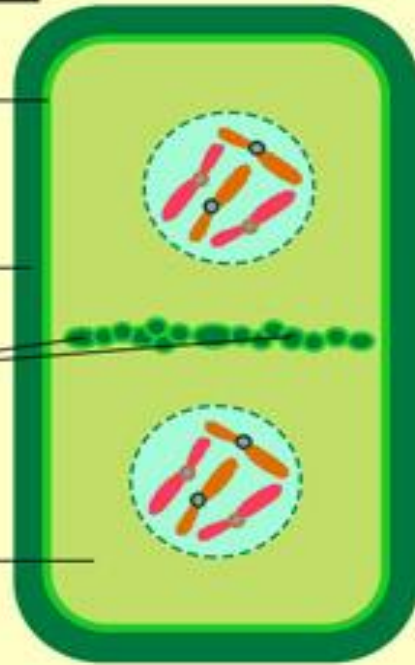
Plant cell

Cell membrane

Cell wall

Golgi vesicles

Parent cell



Daughter cells

Telophase

The Golgi vesicles accumulate at the metaphase plate

The vesicles fuse to form the cell plate

Cytokinesis

The cell plate fuses with the cell wall, forming 2 daughter cells