

LECTURE (2)

Human Genetics



3rd stage

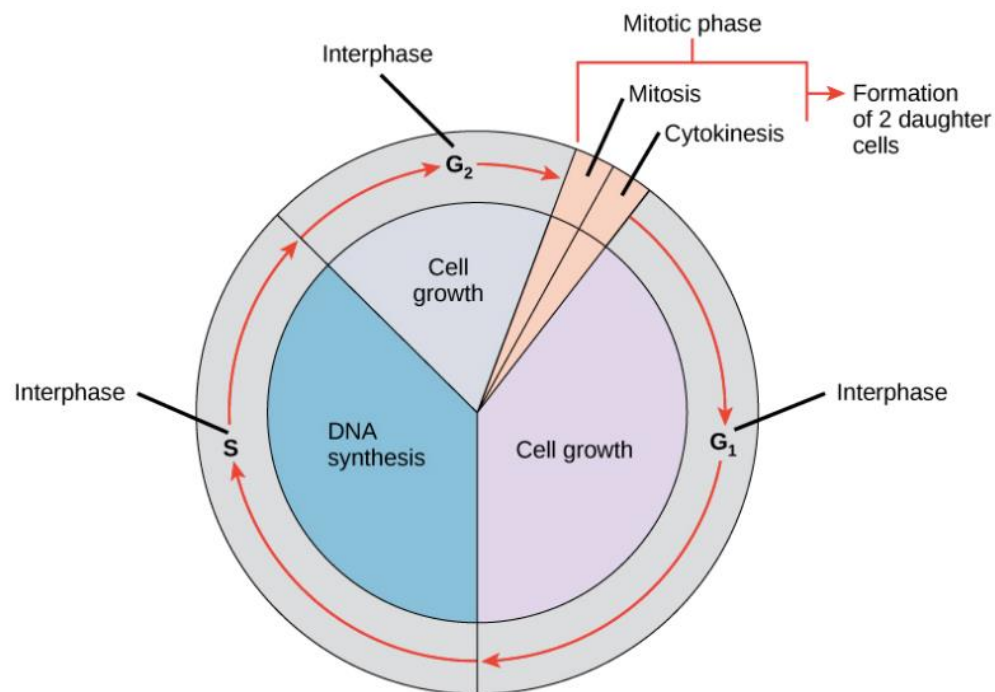
Dr. Zahraa Alzaidi

➤ Interphase

Preparation for division happens in three steps:

- ✚ **G1** : During G1 phase, also called the **first gap phase**, the cell grows physically larger, copies organelles, and makes the molecular building blocks it will need in later steps.
- ✚ **S phase**: In S phase, the **cell synthesizes a complete copy of the DNA** in its nucleus. It also duplicates a microtubule-organizing structure called the centrosome. The centrosomes help separate DNA during M phase.
- ✚ **G2**: During the **second gap phase**, or G2 phase, the cell grows more, makes proteins and organelles, and begins to reorganize its contents in preparation for **mitosis**. G2 phase ends when mitosis begins

The G1, S, and G2 phases together are known as **interphase**. The word (inter)- means between, reflecting that interphase takes place between one mitotic (M) phase and the next.



➤ M phase

During the **mitotic (M) phase**, the cell divides its **copied DNA and cytoplasm** to make two new cells. M phase involves two distinct division-related processes: **mitosis and cytokinesis**.

In mitosis, the nuclear DNA of the cell condenses into visible chromosomes and is pulled apart by the mitotic spindle, a specialized structure made out of microtubules. Mitosis takes place in four stages: **prophase** (sometimes divided into early **prophase and pro-metaphase**), **metaphase**, **anaphase**, and **telophase**.

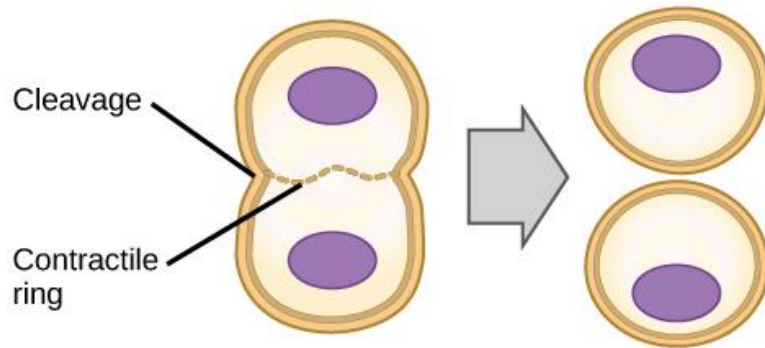
➤ Cytokinesis

In cytokinesis, **the cytoplasm of the cell is split in two**, making two new cells. Cytokinesis usually begins just as mitosis is ending, with a little overlap. Importantly, cytokinesis takes place differently in animal and plant cells.

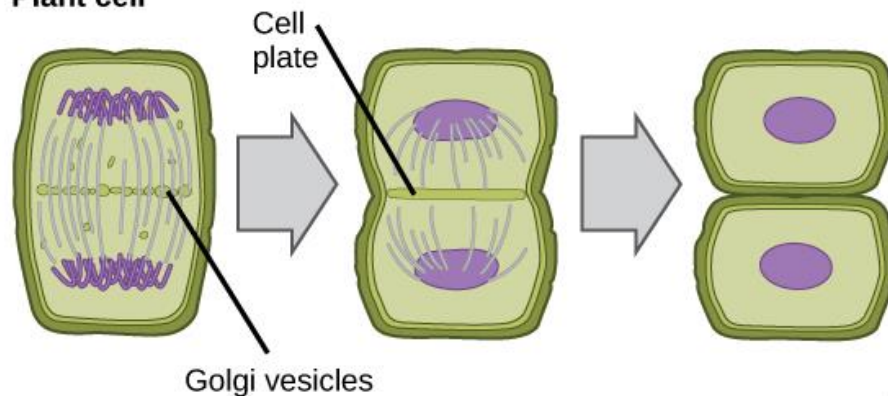
In animals, cell division occurs when a band of **cytoskeletal fibers** called the **contractile ring** contracts **inward** and pinches the cell in two, a process called **contractile cytokinesis**.

Plant cells are much stiffer than animal cells; they're surrounded by a rigid **cell wall**. Because of this, plant cells divide in two by **building a new structure down the middle of the cell**. This structure, known as the **cell plate**.

Animal cell



Plant cell



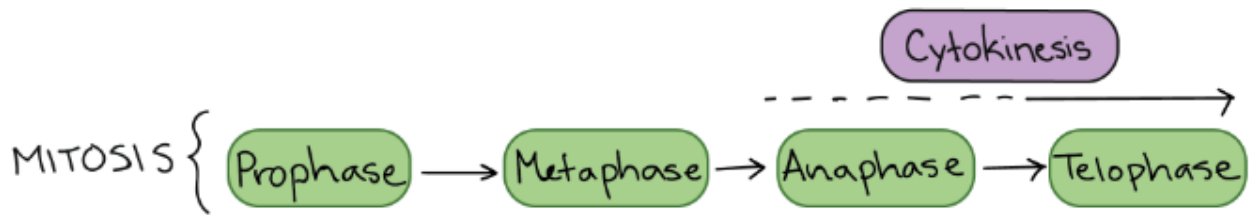
❖ Mitosis

Mitosis is a type of cell division in which one cell (**the mother**) divides to produce **two** new cells (**the daughters**) that are genetically identical to itself. In the context of the cell cycle, mitosis is the part of the division process in which the DNA of the cell's nucleus is split into two equal sets of chromosomes. In all of these cases, the “goal” of mitosis is to make sure that each daughter cell gets a perfect, **full set of chromosomes**. Cells with too few or too many chromosomes usually don't function well: they may not survive, or they may even cause cancer.

○ Phases of mitosis

Mitosis consists of **four** basic phases: **prophase**, **metaphase**, **anaphase**, and **telophase**. Some textbooks list five, breaking prophase into an early phase (called **prophase**) and a late phase (called **prometaphase**). These phases occur in strict sequential order, and cytokinesis - the process of

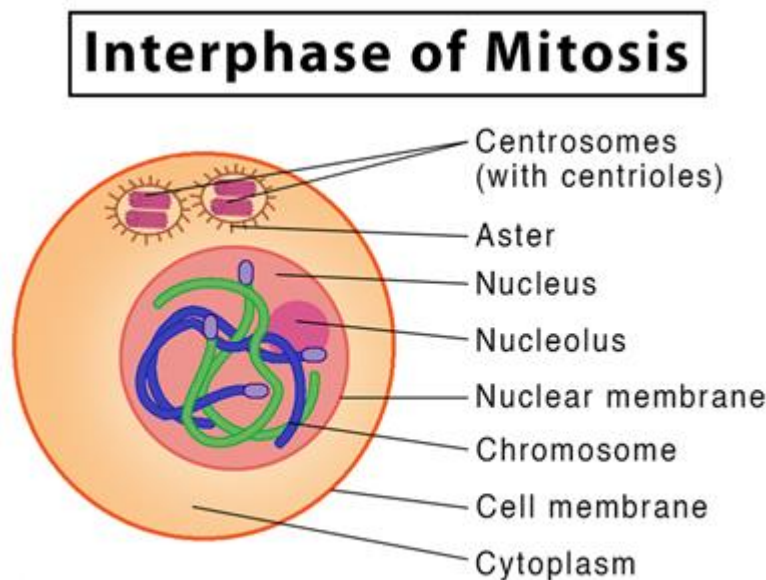
dividing the cell contents to make two new cells - starts in **anaphase** or **telophase**.



The cell in interphase has **already copied its DNA**, so the chromosomes in the nucleus each consist of **two connected copies**, called **sister chromatids**. You can't see the chromosomes very clearly at this point, because they are still in their long, stringy.

The cell has also made a copy of **its centrosome**, an organelle that will play a key role in mitosis, so there are **two centrosomes**

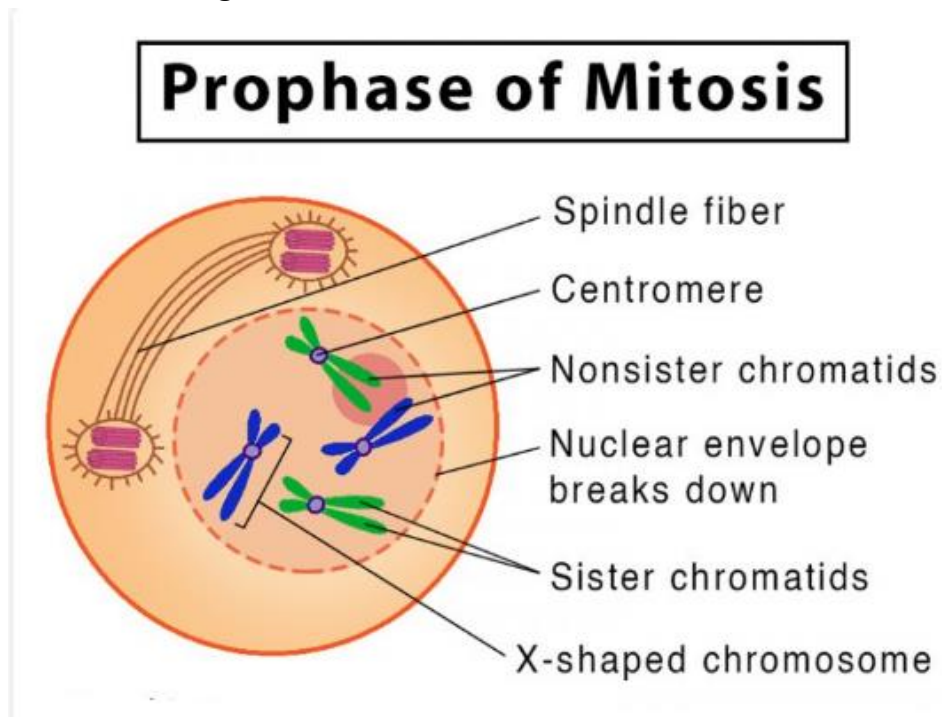
Late prophase (prometaphase). The nuclear envelope breaks down and the chromosomes are fully condensed.



✓ Prophase

It is the **first and the longest** of all phases of mitosis. Prophase shows the following distinct changes within the cell:

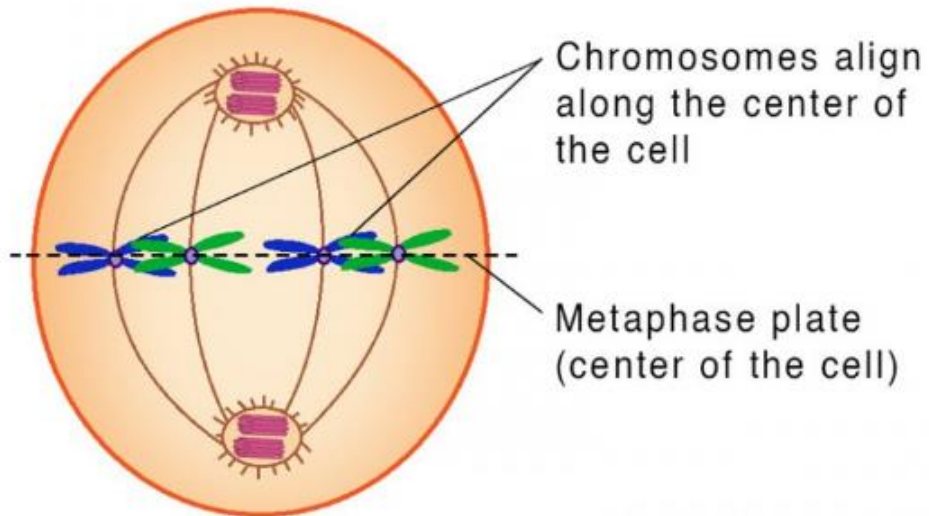
- ✚ The **chromosomes** start to condense (making them easier to pull apart later on). Each chromosome is made of two coiled filaments called **sister chromatids**.
- ✚ The mitotic **spindle fibers** begins to form. The spindle is a structure made of **microtubules**, strong fibers that are part of the cell's "skeleton." Its job is to **organize the chromosomes** and move them around during mitosis
- ✚ On reaching the end of this phase, the **nuclear envelope** starts to break apart thus releasing the chromosome.



✓ Metaphase

- ✚ It is the **second phase** of mitosis and is marked with the complete **disappearance** of the nuclear envelope that had started during prophase.
- ✚ The **chromosomes**, get attached to the spindle fibers present at the **opposite poles** along the middle of the cell.
- ✚ The spindle fibers then attach to each of the sister chromatids

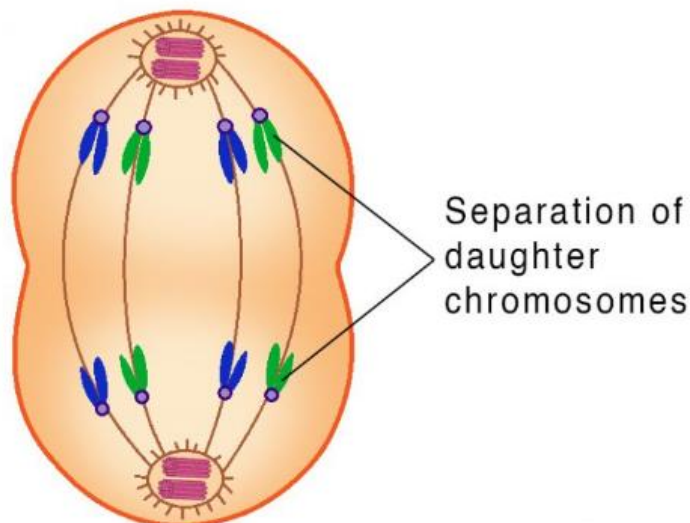
Metaphase of Mitosis



✓ Anaphase

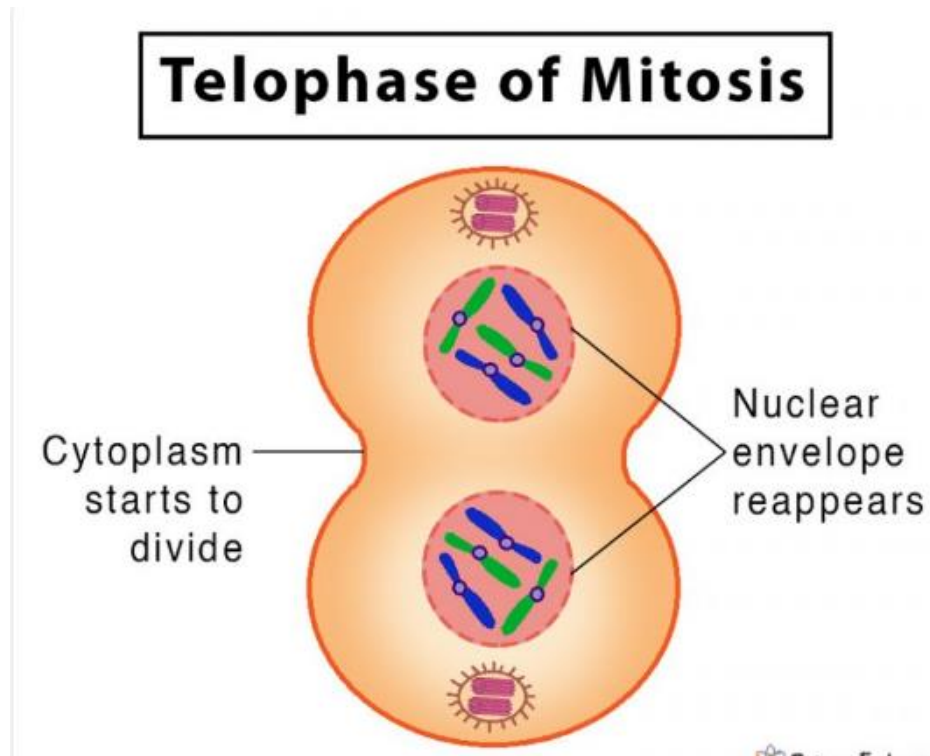
- ✚ It starts by splitting each paired chromosome into two sister chromatids, now known as **daughter chromosomes**.
- ✚ The daughter chromosomes are **pulled** towards the opposite end of the cell due to the **contraction of the spindle fibers**.
- ✚ At the end of this phase, each pole contains a complete set of chromosomes.

Anaphase of Mitosis



✓ Telophase

- ✚ It is the **last recognized phase** of mitosis marked by the end of the daughter chromosome's migration to the opposite poles.
- ✚ **Nuclear envelope redevelops** around each group of chromosomes to form daughter nuclei.
- ✚ Mitotic spindle fibers **disappears**



✓ Cytokinesis

This is the process where the cytoplasm gets **divided** to produce **two** independent daughter cells, each containing a **complete** set of chromosomes. In the end, mitosis results in two genetically identical daughter cells, each having **diploid (2n)** number of chromosomes.

Cytokinesis of Mitosis

