

1.6- CELL DIVISION

MITOSIS

Definition: Mitosis is the division of the nucleus into two genetically identical daughter nuclei.

Before mitosis:

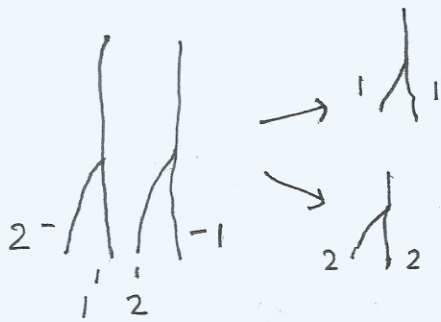
all of the DNA in the nucleus must be replicated



Each chromosome is converted from a single DNA molecule into 2 identical DNA molecules called **chromatids**.

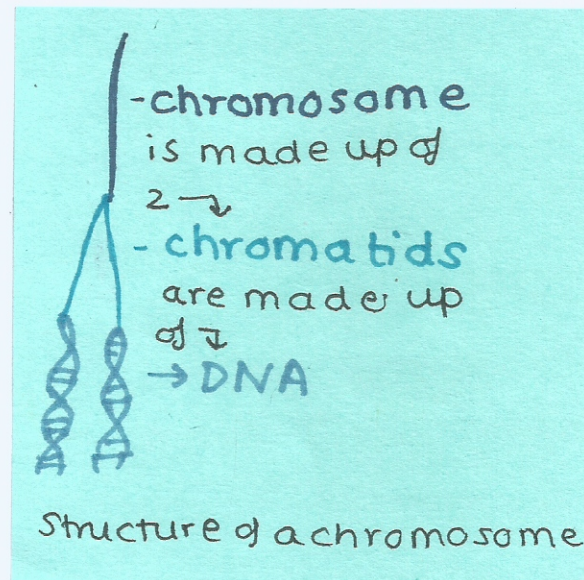


one of the chromatids passes to each of the daughter nucleus.



Examples of mitosis:

- during embryonic development
- growth
- tissue repair
- asexual reproduction



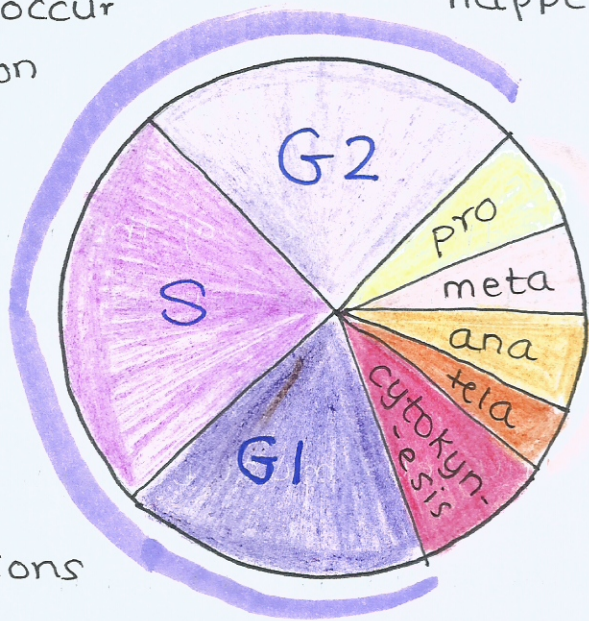
Phases of mitosis are:-

- Prophase
- Anaphase
- Metaphase
- Telophase

INTERPHASE

↳ reactions of cell respiration also occur during cell division

→ DNA replication in the nucleus, protein synthesis in the cytoplasm happen during interphase.



— Inter phase
- active phase in the life of a cell where many metabolic reactions occur.

During interphase, no. of mitochondria and chloroplasts ↑. It happens due to the growth and division of mitochondria. In plants, chloroplasts increase in the same way.

↓
Synthesize cellulose and use vesicles to add it to their cell walls.

G1 phase:

Cellular components apart from the chromosomes are duplicated. The cell grows and prepares itself for DNA replication.

S phase:

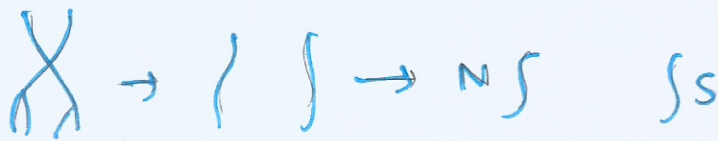
Synthesis stage in which each chromosome (DNA) is replicated.

G2 phase:

The cell finishes growing and prepares for cell division.

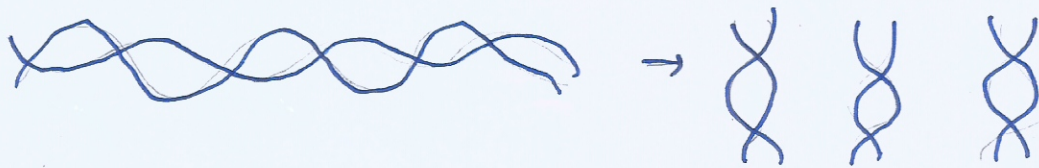
SUPERCOWLING OF CHROMOSOMES

The two chromatids that make up each chromosome are separated and moved to the opposite sides of the cell.



DNA molecules in chromosomes are long therefore it is important to package them into smaller structures.

This is known as condensation of chromosomes.



condensation occurs by repeated coiling of the DNA molecule to make the chromosome shorter and wider.

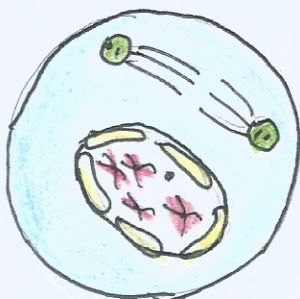
This process is known as supercoiling of DNA.

Proteins called **histones** help with supercoiling and enzymes are also involved.

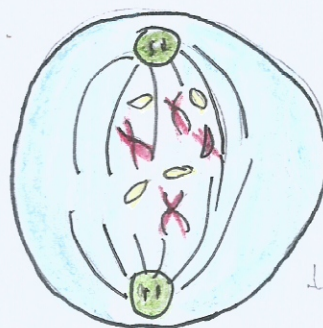
PHASES

1. PROPHASE:

- Chromosomes become shorter and fatter by coiling. Then they supercoil to become more dense.
- The nucleolus breaks down.
- Microtubules grow to form spindle fibres that link the poles of the cell.
- The nuclear membrane breaks down



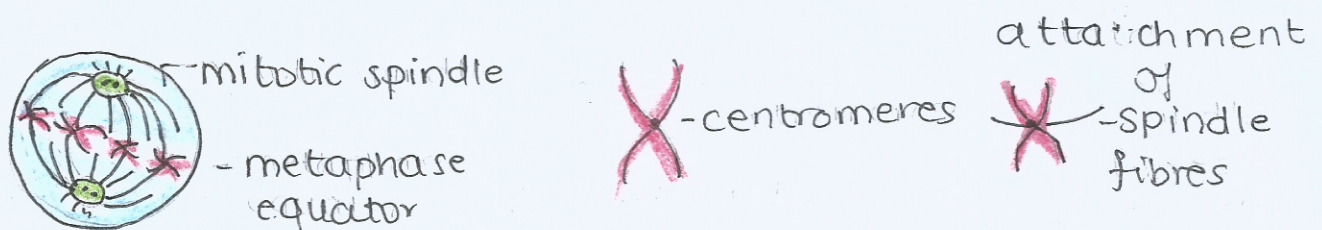
early stage



later stage

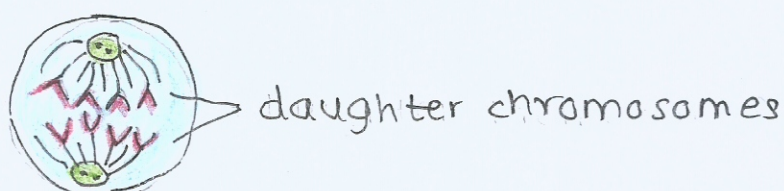
METAPHASE

- Microtubules continue growing and get attached to the centromeres on each chromosome.
- They get attached to the microtubules from different poles.
- Chromosomes get aligned on the equatorial plane of the cell if the attachment is correct.



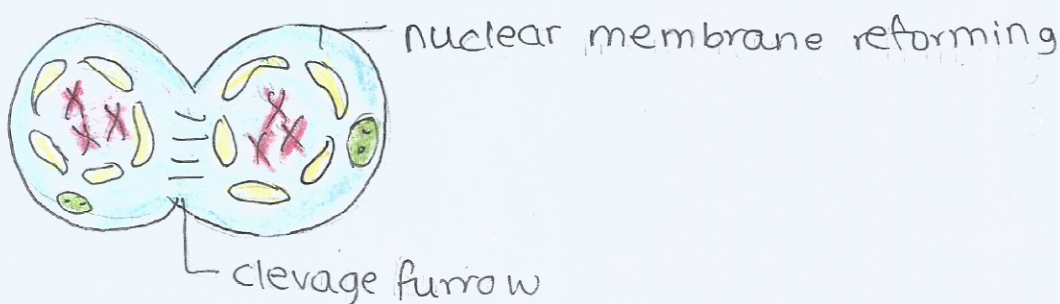
ANAPHASE

- Each centromere divides, allowing the sister chromatids to separate.
- The spindle microtubules pull the chromatids towards the poles of the cells.
- This is the reason why mitosis produces two genetically identical nuclei.



TELOPHASE

- Chromatids arrive at the opposite poles of a cell and decondense. Spindle fibres are no longer present.
- Nuclear membrane is reformed around each chromosome set and cytokinesis occurs, splitting the cell into two.



CYTOKINESIS

cells divide after mitosis when 2 genetically identical nuclei are present in the cell. The process of cell division is called cytokinesis.

IN ANIMAL CELLS:

The plasma membrane is pulled inwards around the equator of the cell to form a **cleavage furrow**.

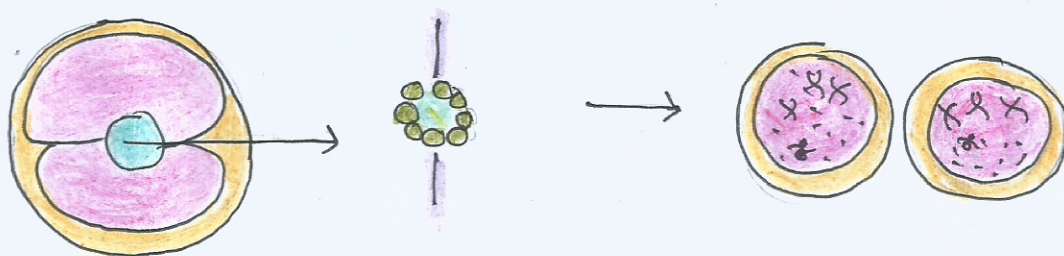


A ring of contractile proteins are responsible as they are present in the plasma membrane near the equator.

ACTIN AND MYOSIN - proteins responsible for contraction.

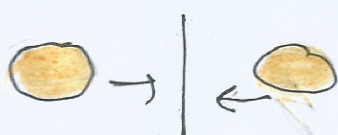


The cleavage furrow reaches the centre and the cell is pinched off to form 2 daughter cells.



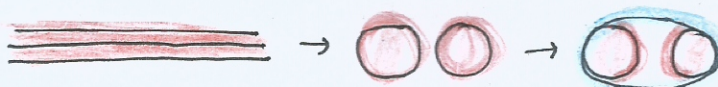
IN PLANT CELLS:

Vesicles move to the equator where they form tubular structures across the equator.



These vesicles fuse with the tubular structures and merge to form 2 layers of membrane.

These 2 layers develop into the plasma membranes of 2 daughter cells. They are connected to the existing plasma membranes at the sides of the cells, completing the cytoplasm division.



In the next stage, pectins and other substances are brought in the vesicles. They get deposited by exocytosis between the two new membranes.



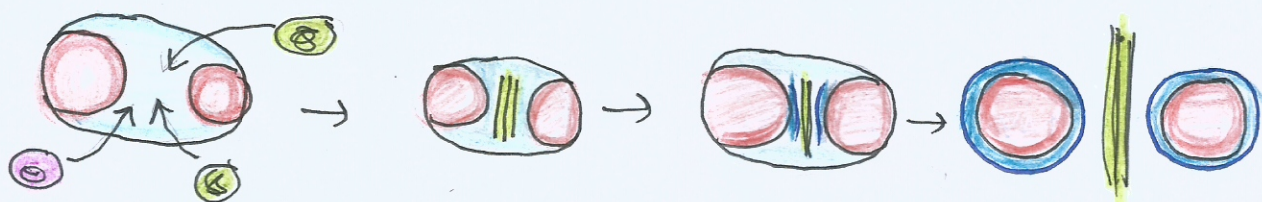
A middle **lamella** is formed that links the new cell walls.



Both the daughter cells bring **cellulose** to the equator and deposit it by exocytosis next to the middle **lamella**.



Each cell builds its own cell wall adjacent to the equator.



CYCLINS:

Control the stages of the cell cycle.

They are a group of proteins that ensure that tasks are performed at the right time and that the cell only moves to the next stage when it is ready.

They bind to enzymes called cyclin-dependent kinases.



They become active



get attached with phosphate groups



other proteins get activated



carry out specific tasks of the cell cycles. G



4 types:

cyclin A

cyclin B

cyclin D

cyclin E

D - triggers cell to move from $G_0 \rightarrow G_1 \rightarrow S$

E - prepares cell for **DNA replication** in S phase.

A - activates DNA replication in nucleus in S phase.

B - assembly of mitotic spindles & preparation of mitosis.

TUMOUR FORMATION AND CANCER:

Mutagens, oncogenes and metastasis are involved in the development of primary and secondary tumours.

TUMOURS: They are abnormal groups of cells that develop at any stage of life in any part of the body.

Benign tumours

- The cells adhere to each other and do not invade nearby tissues or move to other parts of the body.
- Do not cause much harm and are classified as benign.

Malignant tumours

- The cells can get detached and move elsewhere in the body and develop into secondary tumours.
- Likely to be life threatening.
- The diseases due to malignant tumours are known as cancer.

Chemicals and agents that cause cancer are known as carcinogens.

MUTAGENS - Agents that cause gene mutations which lead to cancer. They are carcinogenic.

MUTATION:- random changes to the base sequence of genes. Most genes do not cause cancer when they mutate.

ONCOGENES - The genes that can cause cancer after mutating are called oncogenes. Oncogenes in a normal cell are involved in the control of the cell cycle and division.

This why mutations in them result in uncontrolled cell division and form tumours.

Several mutations should occur in a cell for it to become a tumour cell.

METASTASIS: movement of cells from a primary tumour to set up secondary tumours in the body.

