

# **OCR (A) Biology A-level**

## **Topic 2.6: Cell division, cell diversity and cellular organisation**

### Notes

The role of **mitosis and the cell cycle** is to produce **identical daughter cells for growth and asexual reproduction** of cells. All the cells produced by mitosis are **genetically identical** therefore **mitosis does not give rise to genetic variation**.

During the cell cycle, a cell it forms, it grows and then divides to form daughter cells. There are three stages of the cell cycle and it is controlled by checkpoints.

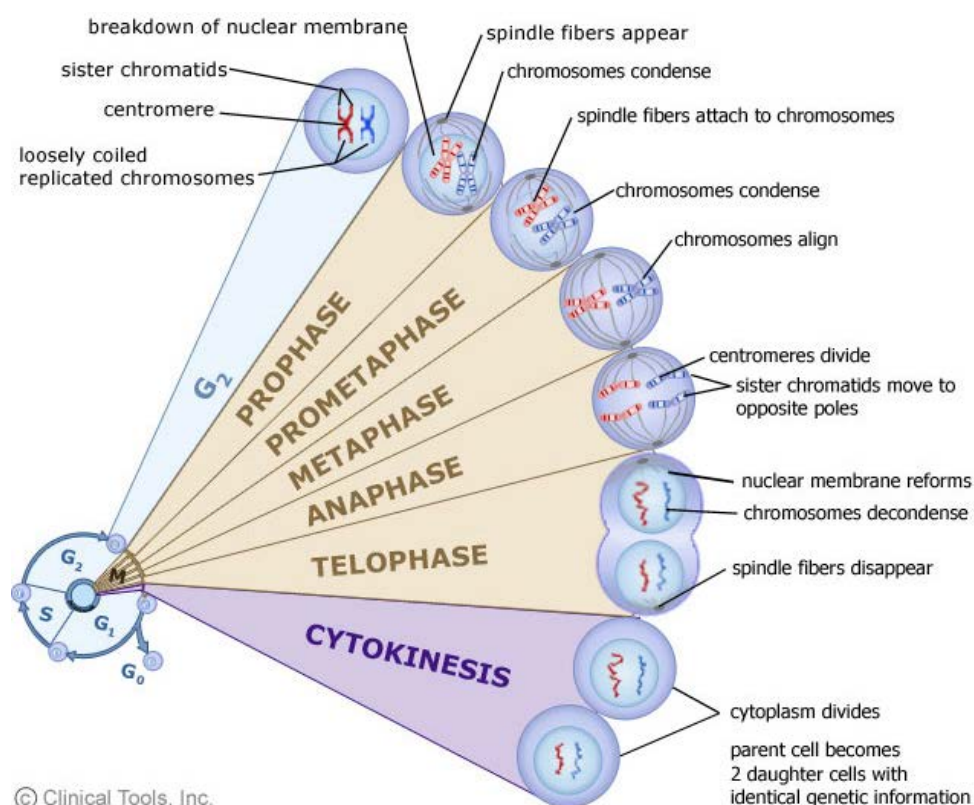
- **Mitosis** – mitosis is a form of cell division that produces identical cells, there are four stages of mitosis: **prophase, metaphase, anaphase and telophase**.
- **Cytokinesis** – during cytokinesis the parent and replicated organelles move to opposite sides of the cell and the **cytoplasm divides** thus producing two daughter cells
- **Interphase** – during this stage the cell **grows and then prepares to divide** – chromosomes and some organelles are replicated, chromosomes also begin to condense

During **prophase**, the **nuclear envelope** breaks down and **subsequently disappears**. The chromosomes **condense** and the centrioles **move to opposite poles** of the cell for the purpose of **spindle formation**.

During **metaphase**, the chromosomes **move to the equator** and attach to the **spindle fibres** via **centromeres**.

In the **anaphase** stage, the sister **chromatids are separated**.

During **telophase**, the nuclear **envelope reforms**, creating two daughter cells. The **spindle is broken down** and subsequently disappears. The chromosomes **uncoil**.



## Meiosis

**Meiosis** is a form of cell division that gives rise to **genetic variation**. The main role of meiosis is **production of haploid gametes** as cells produced by meiosis have half the number of chromosomes. Meiosis produces genetically different cells, genetic variation is achieved through:

- **Crossing over of chromatids** where pairs of chromosomes line up and exchange some of their genetic material
- **Independent assortment of chromosomes** – there are various combinations of chromosome arrangement

This form of cell division is a two phase process in which **four haploid gametes** are generated from a diploid cell. During **meiosis I**, homologous chromosomes separate therefore there is only one chromosome of every pair per gamete, whereas in **meiosis II** the sister chromatids separate.

The stages of meiosis I are **prophase I, metaphase I, anaphase I and telophase I**.

Prophase I closely resembles the prophase stage of mitosis, with the exception of **synapsis** and crossing over of homologous chromosomes (at chiasmata) which allow the genetic exchange to occur.

Metaphase I is when each pair of bivalents **align at the equator**. The position of each bivalent is random (Random assortment) and this contributes to genetic variation.

During **anaphase I**, the homologous chromosomes separate whereas during telophase I the **nuclear envelope reforms** around haploid nuclei containing half the number of chromosomes.

During meiosis II composed of prophase II, metaphase II, anaphase II and telophase II, **another round of cell division occurs**, leading to formation of four haploid daughter cells, containing single chromosomes. It is during Anaphase II that the centromeres split separating chromatids.

## Cellular organisation

Cells group together to form tissues with the purpose of performing a common function. Examples of tissues include **xylem and phloem tissues** in plants. Organs are **groups of tissues which work together** to perform a wider function whereas an organ system is composed of many organs which work together to perform an essential life function.

### Tissue types and their functions:

- **Xylem**- transport water and minerals as well as provide **structural support**. They are **long cylinders** made of **dead tissue** with **open ends**. Xylem vessels are thickened with a tough substance called **lignin**. They consist of **parenchyma, fibres and vessels** and are produced by **meristem cells** which produce smaller cells that elongate.

- **Phloem** - tubes made of living cells which are involved in **translocation** which is the movement of **food substances and nutrients from** leaves to storage organs and growing plants of the plant. The meristem tissue produces cells that **elongate and line up end-to-end to form a long tube**. Their ends do not break down completely but produce perforated structures known as sieve plates. Metabolically active **companion cells** are located next to sieve plates and are involved in mediating the movement of photosynthesis products upwards and downwards in the tubes.
- **Epithelial** – sheet of cells that serves as a **lining/cover a surface**. There are two types, squamous which are smooth, flat and very thin, fitting closely together to create a smooth surface, such as the **lining of blood vessels and cheeks**. Whereas **ciliated epithelium** is composed of column shaped cells containing cilia which form the lining of structures such as trachea and bronchi. The cilia move together to **move the mucus produced by goblet cells along**. Ciliated epithelium is also found in the oviducts.
- **Connective** – involved in **providing support** and holding various structures together, examples include **cartilage and bone**
- **Muscle** – specialised for **movement through contraction**
- **Nervous** – specialised for **impulse conduction**

## Stem cells

**Stem cells** are **undifferentiated** cells which are genetically identical and have the ability to develop into any of the various kinds of cells. Stem cells have various uses in research and medicine, for instance **repair of damaged tissues**, treatment of **neurological disorders** such as **Parkinson's and Alzheimer's** as well as **studying development**.

The process by which a cell specialised to carry out a particular function is known as differentiation. Stem cells can be found in the **bone marrow** where they differentiate into **erythrocytes (red blood cells) and neutrophils (white blood cells)**. The role of erythrocytes is **transporting oxygen in the blood**. They are relatively short lived as they are constantly destroyed and created. Whereas the neutrophils are involved in attacking and destroying foreign microorganisms in the process of **phagocytosis**.

Plants **retain their ability to differentiate** into different types of cells throughout their life. Division of plant cells occurs at a high rate in **meristems**. Dividing meristem cells are known as the **cambium** and give rise to **xylem and phloem** tissue.

### Other specialised cells:

- **Sperm cells** – male gametes, made in the testes throughout a man's life, they are adapted to **reach, penetrate and fertilise** the ovum i.e. the female gamete

- **Palisade cells** – most basic plant cell type, contain **many chloroplasts** and are specialised for **photosynthesis**
- **Root hair cells** – specialised **epidermal cells** found in **close proximity to root tips**. They have thin and long extensions which serve for the purpose of **increasing surface area and maximising the contact with water** which contains **essential mineral ions** which are absorbed through the roots. They are short-lived and are constantly produced in the **root tip**.
- **Guard cells** – found in pairs in the **epidermis of leaves** and are involved in controlling the **opening and closing of stomata**. **Guard cells** contain chloroplasts whereas epidermal cells do not. They respond to **water influx** which causes them to alter their shape, causing stoma to open.