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.**

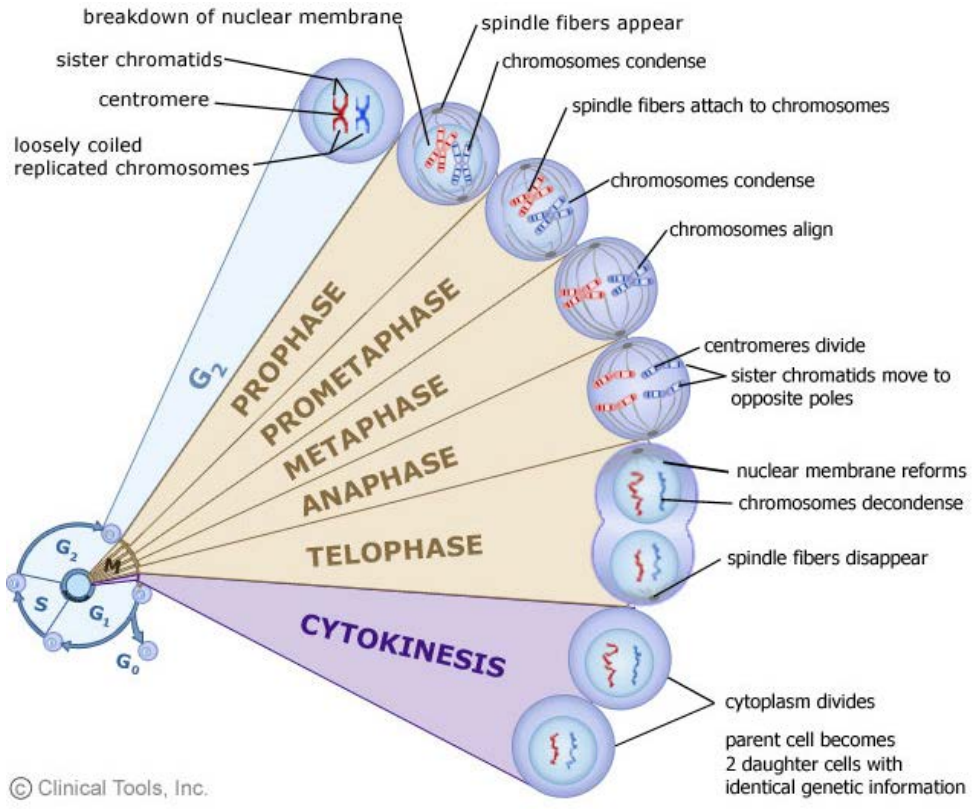
- **Cytokinesis** – during cytokinesis the parent and replicated organelles move to opposite sides of the cell and the **cytoplasm divides** thus producing two daughter cells
- **Interphase** – during this stage the cell **grows and then prepares to divide –** chromosomes and some organelles are replicated, 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 plans. 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.