**CELL DIVISION**

This is the process where a cell’s cytoplasm divides giving rise to another cell. Before a cell divides the nucleus must first divide to produce two or more nuclei. There are two types of nuclear division in living cells - **mitosis** and **meiosis**. Before we discuss the type and how a cell divides it is important to remind ourselves on the structure of a chromosome. This is because chromosomes are the most important structures in every cell during division as they are responsible for the transmission of hereditary information from one generation to the next.

**The Structure of a Chromosome**

A chromosome is made up of two parts known as **chromatids**. The chromatids are held together at a point called centromere which may occur anywhere along the length of the chromosome. Studies have revealed that chromosomes within cells exist in pairs with each of the paired chromosomes termed **homologous** chromosomes. Homologous chromosomes are similar in structure and contain genes that code for same character. The reason why there are pairs of chromosomes in a cell is that one set comes from the female parent by way of egg and the other from the male parent by way of sperm.

The number of chromosomes in a cell varies with species of organisms. Fruit fly for example has eight chromosomes, cats have thirty-eight, dogs have seventy-eight. Human beings have forty-six or 23 pairs with only one pair termed sex or X and Y chromosomes differing in their composition and structure. The male or Y chromosome is shorter than the X or female chromosomes and lacks some of the genes found on the female chromosome.

**The Cell Cycle**

These are sequences of activities occurring between one cell division and the next.

The cell cycle is separated into three main stages:

1. Interphase: where synthesis of all the materials required for the functioning and growth of the cell occurs as well as where DNA replication takes place.
2. Mitosis: where the nucleus of the cell divides.
3. Cell division/cytokinesis, where the cytoplasm divides followed by the division of the entire cell.

**M I T O S I S**

Mitosis is the process by which a cell’s nucleus divides to produce two daughter nuclei containing identical sets of chromosomes to the parent’s cell. It is usually followed by division of the whole cell to form two daughter cells.

Mitosis although a continuous process with no distinction between the phases, is divided into four stages for convenience; Prophase, metaphase, anaphase and telophase.

**THE STAGES OF MITOSIS**

**Interphase**

This is where all the materials required by the cell is synthesized. The DNA of each chromosome also replicates making each chromosome to exist as a pair of chromatids joined by a centromere. At this stage the cell is 4n (4 copies of each DNA molecule, 2 in each homologous chromosome).

During interphase chromosomes become loosely coiled, thread-like material, that is difficult to see, called chromatin.

**Prophase**

This is the longest phase of the cell division. The chromosomes become thicker and shorter as a result of tight packaging of its components. Centriole replicates and moves to the opposite poles of the cell and begin to produce short microtubules called asters. Finally, the nuclear envelop breaks away and spindle fibers are formed.

**Metaphase**

At metaphase the chromosome line up around the equator of the spindle and become attached through the centromere on the spindle fiber.

**Anaphase**

The spindle fiber split in two and the spindle fiber pull the daughter centromere to opposite poles. The separated chromatids are pulled along behind the centromeres.

**Telophase**

The chromatid on reaching the poles of the cell uncoils and lengthens to form a chromatin again. Spindle fibers disintegrate, nuclear envelop reforms around each of the polar chromosomes. Telophase may lead directly to cytokinesis.

**Cytokinesis**

This is the division of the cytoplasm or the entire cell into two or more daughter cells. In preparation for division, the cell organelles become evenly distributed towards the two poles of the telophase cell along with the chromosomes.

**THE SIGNIFICANCE OF MITOSIS**

1. **Genetic Stability**

Mitosis is a kind of division by which identical daughter cells are produced having the same amount and type of genetic constitution as that of the parent cell. The number of chromosomes remains the same in all the cells produced making the daughter cells retain the same characters as those of the parent cell.

1. **Growth**

It is responsible for growth and development of multi-cellular organisms from a single-celled zygote. It helps the cell in maintaining proper size. It is also a method of multiplication in unicellular organisms.

1. **Regeneration**

Mitosis helps in restoring wear and tear in body tissues, replacement of damaged or lost part, healing of wounds and regeneration of detached parts (as in tails of lizards).

1. **Asexual Reproduction**

Mitosis is the basis of asexual reproduction, the production of new individual of species by one parent organism.

**M E I O S I S**

Meiosis is the form of nuclear division in which the chromosome number is halved from the diploid (2n) number to haploid number (n). In meiosis two cycles of nuclear divisions occur. These are meiosis I where the homologous chromosomes separate and meiosis II where the sister chromatids separate. Meiosis mainly occurs during the formation of gametes (sperm and egg) in animals that reproduce sexually while in plant it occurs during the formation of spores.

**Interphase I**

This is the first stage of meiosis. During this stage the cell gets ready for meiosis by duplicating its chromosomes and centriole.

**Prophases I**

This is the second phase of meiotic division and the longest. At the beginning of this stage chromatin strand of DNA coil up in to individual chromosomes. The chromosomes are made up of two sister chromatids which are identical copies of the same DNA and which are joined together at the centromere.

During meiotic prophase there are three major events that occur and do not occur during mitosis. These are:

1. **Synapsis**:

Homologous chromosomes are usually laying randomly in the nucleus. But during meiosis they pair up together point to point to form a bivalent. This process of pairing is called **synapsis.**

1. **Crossing over:**

Once the pairing is completed, the homologous chromosomes begin to exchange the genes through a process called crossing over.

1. **Chiasma**:

After the crossing over, the paired chromosomes begin to separate back. When these chromosomes are separating with each other, they make a unique pattern with each of the cross over points still attached. This situation is called chiasma. At this point the chromosomes are not purely paternal or maternal but will have their gene being shuffled thus, causing genetic variation.

The spindle fiber starts to form from the centriole and the centriole starts to move away from each other towards the poles of the cell. The nucleus disappears and the nuclear envelop breaks apart.

**Metaphase I**

The tetrads (bivalent) line up around the equator of the spindle, and attach themselves by their centromeres.

**Anaphase I**

The fifth stage begins with the spindle fibres contracting into the centriole. The sister chromatids remain attached but the tetrad spits up. The cell begins to elongate ready to split.

**Telophase I**

At telophase, the chromosomes are now at the poles of the cell. The cells continue to elongate and is almost ready to be divided. Nuclei and the nuclear envelop begin to appear around the chromosomes. At this stage the chromosome number is half but still having double chromatid.

**Cytokinesis**

The cell splits into two daughter cells. The daughter cells are haploid cells because the homologous chromosome pairs Split-up during interphase I. the sister chromatids are still intact.

**Prophase II**

This is similar to prophase I except that synapsis, crossing over, and chiasma do not occur. This stage is absent if interphase II is absent. The nucleoli and nuclear envelop disappear and the chromatids shorten and thicken. The centrioles begin to move apart from each other and begin to form spindle fibres. The chromosomes begin to move towards the center of the cell.

**Metaphase II**

During metaphase two the sister chromatids are lined up separately at the metaphase plane as in metaphase I. The spindle fibre is complete and the sister chromatids are attached to it through their centromere.

**Anaphase II**

Anaphase II is a little different from the anaphase I. Here the sister chromatids detach and move away from each other. The split chromosome begins to move towards the centriole as the spindle fibre contracts. Cell also begins to elongate.

**Telophase II**

The chromosomes arrive at the poles of the cell. Nuclei and nuclear envelop begins to form around the chromosomes. The spindle fibre disappears, the cells are almost ready to be divided.

**Cytokinesis II**

The cell splits and there are four different cells created from the original. Each cell is the haploid cell with the different single set of the chromosomes.

**SIGNIFICANCE OF MEIOSIS**

1. **Sexual reproduction**

This restores the normal diploid state of the cell otherwise it will lead to doubling of the chromosome for each successive sexual reproduction generation.

1. **Genetic variation**

Meiosis also provides opportunity for new combination of genes to occur in the gametes. This leads to genetic variation in the offspring produced by the fusion of the gametes.