**Cell Division Summary Notes**

There are two types of cell division:

* + **Mitosis** occurs in body cells (somatic cells).
	+ **Meiosis** occurs in the sex organs (testes and ovaries) and produces gametes

Uncondensed genetic material is called **chromatin**

Condensed genetic material is called a **chromosome**

**Homologous chromosomes** have the same size, shape and gene location – one chromosome is from the mother and one from the father





DNA Replication

**Mitosis and the Cell Cycle**

Mitosis has one cell division and produces two diploid daughter cells (2n) that are genetically identical to the parent cell (2n). One **Cell Cycle lasts 24** hours and the cell will spend 80% in **Interphase** and the rest in the **Mitotic phase** (Mitosis (PMAT) and Cytokinesis).





***Notice: DNA content double in S phase when DNA replicates. DNA content then stays constant until Cytokinesis when the cytoplasm halves returning the DNA content to normal.***

Interphase



First part of the cell cycle - consists of G1, Synthesis and G2

* In G1 the cell increases in size as it is synthesising new organelles
* In S Synthesis the nuclear DNA replicates (but the chromosome number remains the same).
* In G2 the cell increases in size again and synthesises more organelles, proteins, ribosomal material and ATP
* A cell in interphase has a nucleolus, nuclear membrane and the DNA is visible as chromatin

**Mitotic Phase**

The second part of the Cell Cycle and has two parts – ***mitosis and cytokinesis***

***Mitosis***

Takes place in 4 stages – PMAT – Prophase, Metaphase, Anaphase and Telophase

*Prophase*



* Longest stage
* Chromatin condenses so chromosomes visible as two sister chromatids joined by a centromere
* Centrioles move to poles and form microtubule spindle
* Nuclear membrane and nucleolus disintegrate

***M****etaphase (****M****iddle)*



* Chromosomes line up in middle of the cell
* Attach to spindle by centromere



***A****naphase (****A****part)*

* Fastest stage
* Spindle contracts splitting the centromere
* Chromatids pulled apart to opposite poles (centromere leads the way)



***T****elophase (****T****wo)*

* Chromosomes de-condense to chromatin
* Spindle breaks down
* Nucleolus and nuclear membrane reform

*Cytokinesis (division of cytoplasm)*

* Animals: cell membrane pinches outside🡪in, forming a cleavage furrow
* Plants: cell plate laid down inside🡪out
* Two cells are now separate in their own right

The significance of Mitosis

* Important for growth, repeated cell renewal, damage repair and healing.
* Unrestricted mitosis leads to cancer and an irregular mass of cells called a tumour. Tumours prevent normal functioning of the body organs. A mutation in the cell division gene causes cancer.
* Asexual reproduction: allows numbers to increase rapidly and provides genetic stability, however this lack of genetic variation can lead to an inability to adapt if the environment changes.

*Calculating the mitotic number (the percentage of cells in mitosis)*

No of cells in prophase + metaphase + anaphase + telophase x100

 Total no of cells

*Calculating the percentage of the cell cycle spent in one stage*

 No of cells in desired stage x 100

Total number of cells on slide

You may be expected to use this figure to estimate how much **time** the cell would spend in this stage of the cycle (remember one cell cycle lasts 24 hours)

Percentage of time spent in stage x 24

 100

Comparing mitosis in animal and plant cells

|  |  |
| --- | --- |
| Plant Mitosis | Animal Mitosis |
| No centriole but spindle forms | Centrioles involved in spindle formation |
| Cell plate formed from inside 🡪 outwards by the fusion of Golgi body vesicles | Cleavage furrow formed from the cell membrane pinching outside 🡪 inwards |
| Only occurs in meristems in root and shoot tips | All cells except red blood cells (as they have no nucleus) |

**Meiosis**

Meiosis occurs during *gamete formation* in sexually reproducing organisms. It takes place in the reproductive organs - **ovaries** and **testes** - of both plant and animals.

During Meiosis the **diploid number of chromosomes (2n)** is **reduced** to the **haploid (n)** and the resulting gametes are genetically different.

Meiosis has two divisions but only one Interphase.

* ***You are not expected to describe the complete process of Meiosis but you are expected to describe the significance of differences between mitosis and meiosis***

Interphase

Occurs before meiosis I and is the same as interphase of mitosis – DNA replication, synthesis of organelles, ribosome subunits, ATP and cell increases in size.

Meiosis I – the reduction division (2n🡪n)



Prophase I

* chromatin condenses
* centrioles move to poles and spindle develops
* nucleolus and nuclear envelope disintegrate
* maternal and paternal chromosomes associate as homologous pairs (also called homologs or bivalents)
* ***Crossing over and recombination occur at chiasmata***



Metaphase I

* Bivalents are ***randomly distributed*** at the equator

Anaphase I



* Spindle fibres contract pulling chromosomes to poles, centromere remains intact
* Chromosomes are ***randomly, independently*** assorted at the poles producing new genetic combinations

Telophase I



* + When the chromosomes reach the opposite pole, the cell starts to divide across its middle.
	+ Nuclear envelope and nucleolus reform around each group of haploid chromosomes
	+ Spindle breaks down.
	+ Cytokinesis occurs.
	+ Meiosis II follows on immediately.

Meiosis II – the mitotic division

The **second** **division** of meiosis is called a ‘**mitotic**’ division, because it is similar to mitosis BUT there is no DNA replication - no interphase.



Prophase II

* centrioles move to poles and new spindle develops at ***right angles to the old spindle***
* chromatin condenses
* nucleolus and nuclear envelope disintegrate



Metaphase II

* Single chromosomes line up at equator and attach to spindle by the centromere



Anaphase II

* Spindle fibres contract pulling chromatids to poles, centromere splits



Telophase II

* + At the poles chromatids de-condense
	+ Nuclear envelope and nucleolus reform
	+ Spindle breaks down
	+ Cytokinesis occurs producing 4 haploid daughter cells.



Meiosis promotes genetic variation in 3 ways:

1. During sexual reproduction the **genotype of one parent is mixed with that of the other** when haploid gametes fuse.
2. **Crossing over** **and recombination** of homologous chromosomesduring **prophase I**.
3. **Independent/random assortment**: When homologous chromosomes separate in anaphase I they do so entirely **independently** of each other, so that the resulting daughter cells contain different combinations of chromosomes.

Comparing mitosis and meiosis

|  |  |  |
| --- | --- | --- |
| Feature | Mitosis | Meiosis |
| Number of divisions and resulting daughter cells | One division resulting in 2 daughter cells | Two divisions resulting in 4 daughter cells |
| Ploidy of cells | Parent cell – diploid 2nDaughter cells – diploid 2n | Parent cell – diploid 2nDaughter cells – haploid n |
| Genetic nature of daughter cells | Genetically identical (genetic stability) | Not genetically identical (genetic variation) |
| Pairing of homologous chromosomes  | No | Yes  |
| Crossing over and recombination | No | Yes in Prophase I |
| Random distribution of homologous chromosomes on equator | No | Yes in Metaphase I |
| Segregation of homologous chromosomes | No | Yes in Anaphase I |