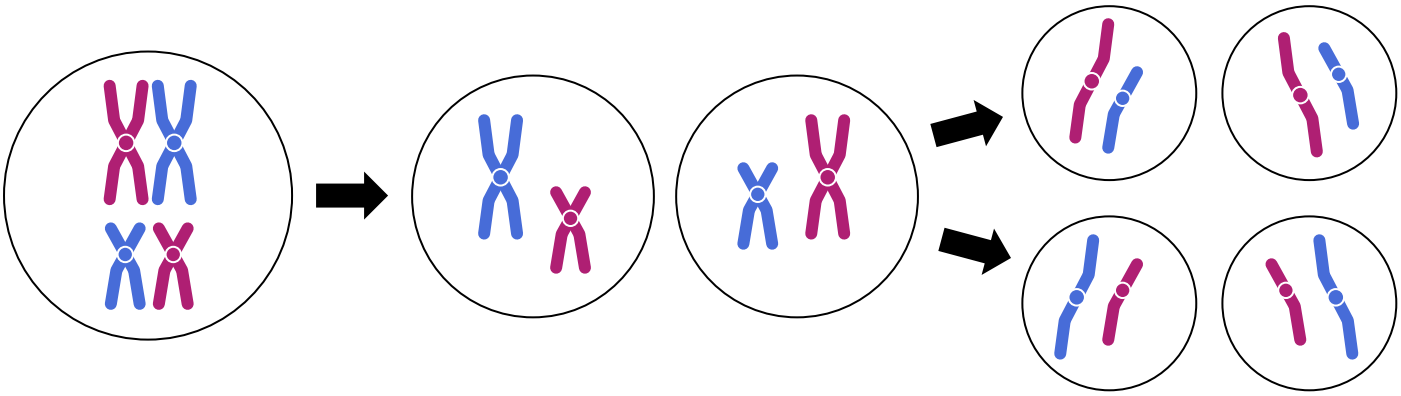
# 3.3 Meiosis

## Stages of Meiosis

*Define meiosis*

The reduction division of a diploid cell to produce four haploid daughter cells

*Complete the following diagram to show meiosis in a cell containing FOUR chromosomes*



*Identify the main differences between meiosis I and meiosis II*

Meiosis I:

Involves the separation of homologous chromosomes (bivalents / tetrads)

Is a reduction division (diploid to haploid)

Promotes genetic variation (crossing over and random assortment)

Meiosis II:

Involves the separation of sister chromatids

Is a mitotic division (haploid to haploid)

Does not promote genetic variation

*Differentiate between homologous chromosomes and sister chromatids*

Homologous chromosomes are the maternal and paternal copies of a given chromosomes

Homologous chromosomes have the same structure and the same genes at the same loci positions

Sister chromatids are the duplicated copies of the chromosome's DNA (copied during S phase of interphase)

*Compare the processes of meiosis and mitosis*

| | **Meiosis** | **Mitosis** |
|---|---|---|
| Type of cell produced | Sex cells (gametes) | Body (somatic) cells |
| Number of cells produced | Four | Two |
| Number of divisions | Two | One |
| Ploidy of daughter cells | Haploid | Diploid |
| Genetics of daughter cells | Shows genetic variation | Are genetically identical |

**Genetic Variation**

*Outline how crossing over and independent assortment give rise to infinite genetic variety*

Crossing Over:

Crossing over involves the exchange of genetic material between non-sister chromatids of a bivalent

Bivalents are connected at points called chiasma during the process of synapsis (during Prophase I)

It is at these chiasma that recombination occurs

Independent Assortment:

Bivalents will line up at the cell's equator in a random orientation during Metaphase I

Meaning there is equal probability of a gamete containing the maternal OR paternal copy for any chromosome pair

Because human cells have 23 chromosome pairs, there are 2^23 possible chromosome combinations

(This equates to over 8 million different gamete combinations)

*Explain how random gamete fusion promotes variation within a species*

When two haploid gametes fuse, they form a diploid zygote which can grow into a new organism

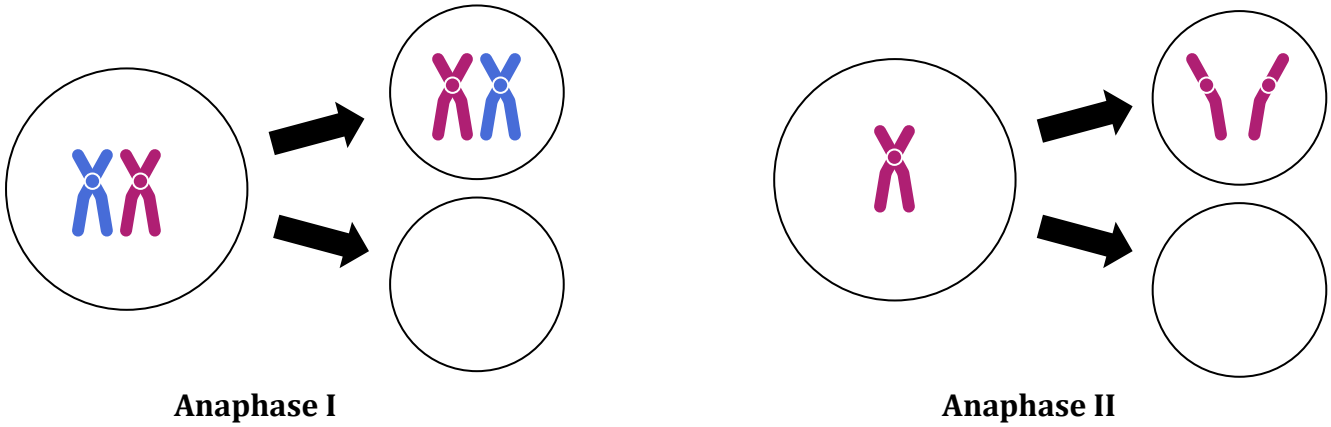
Because gamete fusion is random, each successive offspring will be composed of a distinct combination of

maternal and paternal chromosomes

This means every member of a species is unique (promoting biodiversity)

**Non-Disjunction**

*Explain, with the aid of the diagrams, how non-disjunction can give rise to aneuploidy*



**Anaphase I** **Anaphase II**

Non-disjunction describes the failure of chromosomes to separate during cell division

If non-disjunction occurs in anaphase I, all four gametes will be affected (two = n + 1 ; two = n – 1)

If non-disjunction occurs in anaphase II, only two of the gametes are affected (two = n ; one = n + 1 ; one = n – 1)

If a gamete with one extra chromosome fuses with a normal gamete, the offspring will have trisomy

*List the genetic condition that causes Down syndrome and identify a contributing factor*

Down syndrome is caused by trisomy 21

Increased maternal age increases the risk of non-disjunction

*Describe the method by which cells are obtained for karyotyping*

Cells are isolated and treated with drugs to promote cell division (makes chromosomes visible to microscope)

Cells are arrested during mitosis and then chromosomes are isolated and visualised

*Compare the benefits and risks associated with amniocentesis and chorionic villi sampling*

Amniocentesis:

Cells are extracted from the amniotic fluid

Occurs later in the pregnancy (~15 weeks) but has a slightly lower risk of miscarriage (~0.5%)

Chorionic Villi Sampling:

Cells are extracted from the placenta (chorionic villus)

Occurs earlier in the pregnancy (~11 weeks) but has a slightly higher risk of miscarriage (~1%)