

# REPRODUCTION

→ There are two types of reproduction — mitosis & meiosis

- In mitosis, a cell divides and the resulting daughter cells are genetically identical to the parent cell

- asexual reproduction • growth in multicellular organisms
- repair of damaged tissues

- In meiosis, a cell divides and the resulting daughter cells have half the number of chromosomes as the parent cell

Both mitosis & meiosis have processes to ensure that the daughter cells have the correct number of chromosomes

# CHROMOSOMES

1. Most cells contain two copies of each chromosome — one inherited from the father and one from the mother

- these pairs of chromosomes are said to be homologous pairs

2. In a homologous pair of chromosomes, each chromosome has the same size and sequence of genes.

- However, homologous chromosomes are not genetically identical to one another as they may contain different forms of a gene known as alleles

3. A cell that has two copies of each chromosome is said to be diploid

- A cell that only has one copy of each chromosome is said to be haploid

- most cells are diploid, but sex cells, known as gametes are haploid

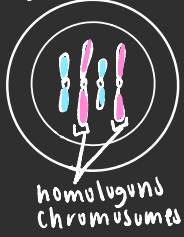
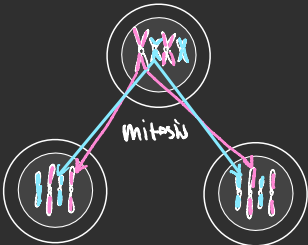
- in humans, the male gamete is called the sperm and the female gamete is called the egg/ovum

4. The haploid number is usually denoted by the symbol  $n$  so the diploid number is denoted by  $2n$

- Humans have 23 pairs of chromosomes or a total of 46. Human body cells are diploid ( $2n=46$ ) and sperm and egg cells are haploid ( $n=23$ )

# MITOSIS

- a type of cell division that gives rise to genetically identical daughter cells in which the chromosome number is maintained

| Process                                                                                                                                                                                       | Description                                                                                                                                                                               | No. of chromosomes                                                                                                                                                                                         | Amount of DNA                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| <p>At the start<br/>[Parent cell]</p>  <p>homologous chromosomes</p>                                          | <p>The chromosomes in each cell are homologous pairs</p>                                                                                                                                  | <p><math>2n</math></p>                                                                                                                                                                                     | <p><math>x</math></p>                          |
| <p>DNA replication</p> <p>two copies of one chromosome (homologous chromosomes)</p>  <p>sister chromatids</p> | <p>Each chromosome is copied</p>                                                                                                                                                          | <p><math>2n</math><br/>(After DNA replication, the number of chromosomes remain the same. Both copies of the chromosome are held together to form a single structure, so it counts as one chromosome.)</p> | <p><math>2x</math> (Amount of DNA doubles)</p> |
| <p>Separation of chromosome copies</p>  <p>Mitosis</p> <p>Two genetically identical daughter cells</p>       | <p>The chromosome copies separate</p> <p>Each daughter cell receives one copy of each chromosome</p> <p>Each daughter cell is genetically identical to each other and the parent cell</p> | <p><math>2n</math></p>                                                                                                                                                                                     | <p><math>x</math></p>                          |

Why is mitosis important?

(a) Growth in multicellular organisms

- each multicellular organism begins as a single cell (zygote)
- the single cell divides by mitosis to give rise to a ball of cells known as an embryo
- the cells of an embryo continue to divide by mitosis to a fully formed organism
- mitosis also gives rise to the growth of different parts of the body that may continue throughout the organism's life

(b) Repair of damaged / worn-out parts

- when a part of the body cell is damaged, cells surrounding the damaged area will divide by mitosis to repair it
- many types of cells die after some time and they are replaced by mitosis

(c) Asexual reproduction

► Asexual reproduction is the process that results in the production of genetically identical offspring from one parent, without the fusion of gametes

Examples of asexual reproduction:

- stem tuber (swollen end of an underground stem)
  - has many buds
  - during favourable seasons, the buds will use up the food stored in the tuber to grow into new plants
  - there will be many new plants as there are buds
  - eg. potato
- rhizome
  - underground storage stem
  - bears scale leaves and buds
  - each bud can grow into a new plant
- runner
  - slender shoot that arises from a bud in the parent plant
  - grows horizontally over the surface of the soil
  - buds develop along its length
  - each bud develops roots and leaves, and becomes a new plant



# ASEXUAL REPRODUCTION

## ADVANTAGES

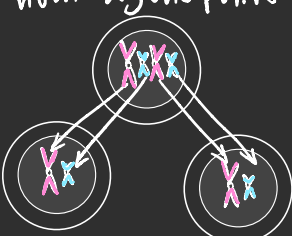
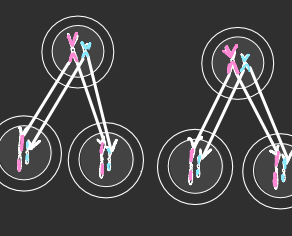
- only one parent is required
- fusion of gametes is not required
- all the beneficial qualities are passed on to the offspring
- this method of producing offspring is faster than sexual reproduction

## DISADVANTAGES

- there is no genetic variation in the offspring. Hence, the species are not well-adapted to changes in the environment. For example, if the parent does not have resistance to a particular disease, the offspring too would not have resistance to a particular disease. This means that the whole population of plants would be wiped out by a particular disease.

# MEIOSIS

► a type of cell division that gives rise to genetically dissimilar cells in which the chromosome number is halved due to the separation of homologous chromosomes

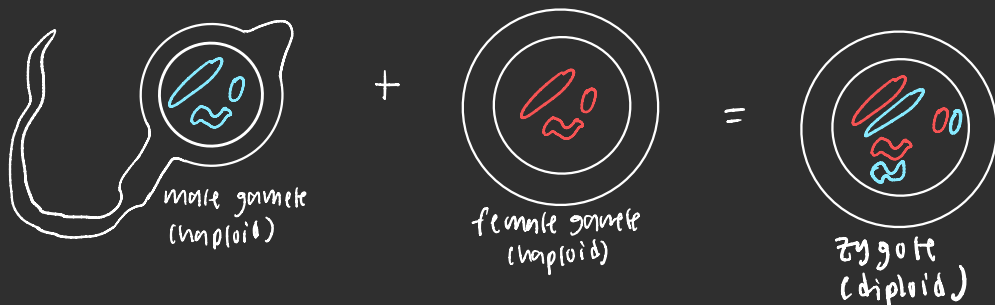
| Process                                                                                                                                     | Description                                                                                                                                                              | No. of chromosomes | Amount of DNA                |
|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------------|
| <p>At the start<br/>[parent cell]</p>                       | <p>The chromosomes in each cell are homologous pairs</p>                                                                                                                 | $2n$               | $x$                          |
| <p>DNA replication</p> <p>two copies of one chromosome</p>  | <p>Each chromosome is copied</p>                                                                                                                                         | $2n$               | $2x$ (Amount of DNA doubles) |
| <p>separation of homologous pairs</p>                      | <p>The homologous pairs of chromosomes separate</p> <p>Each daughter cell receives one chromosome from each homologous pair</p> <p>Each daughter cell is haploid</p>     | $n$                | $x$                          |
| <p>separation of chromosome copies</p>                    | <p>The chromosome copies separate as each daughter cell from the previous stage divides again</p> <p>Each of the four daughter cells has one copy of each chromosome</p> | $n$                | $\frac{1}{2} x$              |

# IMPORTANCE OF MEIOSIS

(a) meiosis produces haploid gametes

- during meiosis, each pair of homologous chromosomes in the parent cell & nucleus separates to form daughter cells. Each daughter cell only receives one copy of the homologous chromosomes, i.e. haploid number of chromosomes. During fertilisation, when the nucleus of the male gamete fuses with the nucleus of the female gamete, the normal diploid number of chromosomes is restored in the zygote

→ Fertilisation of male and female gametes:



haploid cell: cell with one set of chromosomes

diploid cell: cell with two sets of chromosomes, one set from the male parent and the other from the female parent

(b) meiosis produces gametes that are genetically dissimilar

- the greater the genetic variations, the better the species is adapted to changes in the environment. If organisms of the same species are varied, it is unlikely that a change in the environment will destroy the whole species. Those that survive will pass on their favourable genes to their offspring

Advantages:

- offspring may inherit beneficial qualities from both parents
- there is genetic variation in the offspring that is better adapted to changes in the environment

Disadvantages:

- two parents are required (except in plants / bisexual flowers)
- fusion of gametes is required
- this method of producing off-spring is slower than asexual reproduction

| Comparison                                           | meiosis                                                        | mitosis                                          |
|------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------|
| no. of daughter cells formed                         | four (daughter cells are known as gametes)                     | two                                              |
| no. of chromosomes in daughter cells                 | haploid                                                        | diploid                                          |
| Genetic similarity of daughter cells to parent cells | genetically dissimilar                                         | genetically identical                            |
| Function                                             | sexual reproduction & genetic variation                        | Asexual reproduction, growth and repair          |
| no. of parents                                       | requires two parents (except for plants with bisexual parents) | requires only one parent                         |
|                                                      | slower method of producing offspring                           | relatively quicker method of producing offspring |