Inheritance

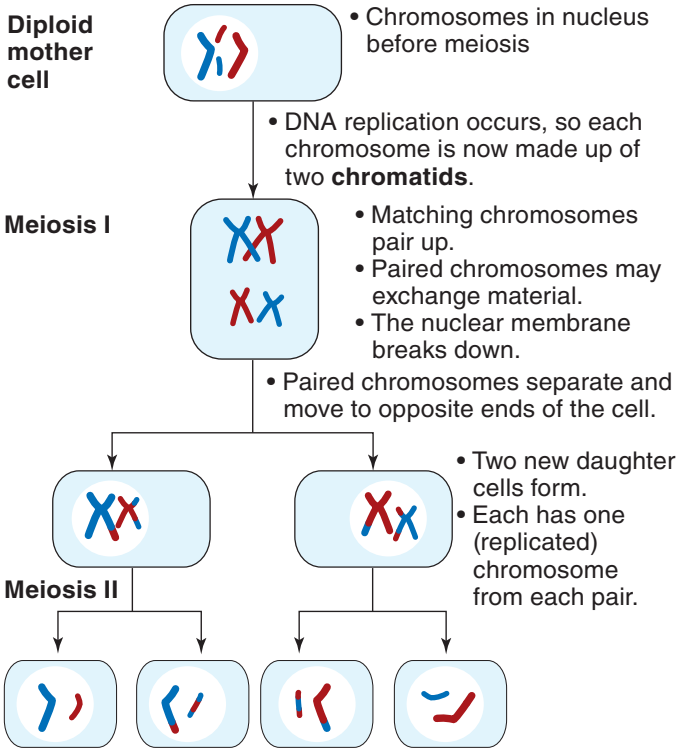
'He gets it from his father.' 'It skips a generation.' Every day we hear remarks about the inheritance of different **traits**. Just how do our parents pass on their **genes** to us?

Genetic inheritance and variation

Genes are passed on from parent to offspring when reproduction occurs. A special type of cell division called **meiosis** occurs in sexually reproducing species.

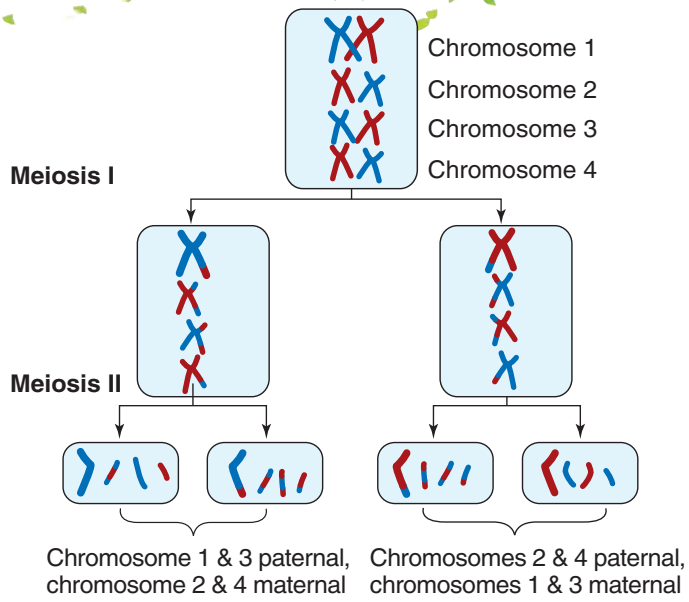
Meiosis

During meiosis, chromosomes replicate and divide so that one of each pair moves into a new cell (such a cell is called a **gamete**). Human cells contain 23 pairs of chromosomes. When gametes are produced (in the **ovaries** of girls and the testes of boys), each gamete contains 23 chromosomes — one member of each chromosome pair.



Replicated chromosomes are pulled apart so each cell contains one chromosome from each pair.

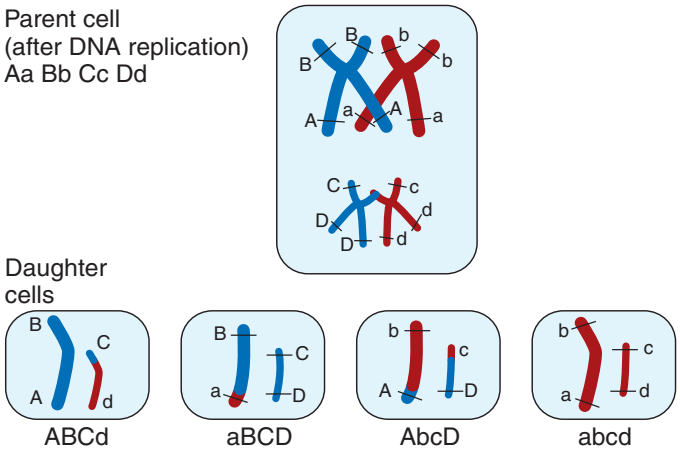
In this simplified overview of meiosis, chromosomes from the father are shown in blue and those from the mother are shown in red. During meiosis, chromosomes replicate once and there are two cell divisions, resulting in four **haploid** daughter cells, which are gametes. Each gamete has a different combination of chromosomes and genes.



Independent assortment: maternal (red) and paternal (blue) chromosomes 'go their own way' when gametes are formed. This diagram shows just four chromosome pairs, so with 23 pairs, for example, many different combinations are possible.

During meiosis different combinations of chromosomes may end up together in the gametes. This is called **independent assortment**. It simply means that the chromosomes inherited from the father and those inherited from the mother do not stay together in sets, but behave independently.

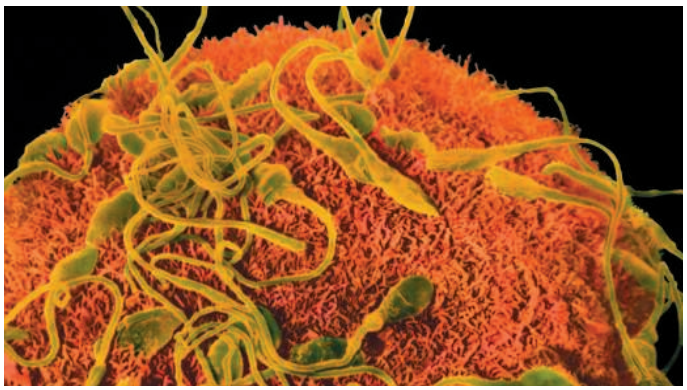
Another important process, called **crossing over**, takes place during meiosis. In this process, pairs of chromosomes exchange information so that different combinations of genes on a chromosome occur in different gametes.



Dominant alleles A and B are both on one chromosome. Through crossing over, a parent who has AB on one chromosome and ab on the other could produce gametes with any combination of these **alleles**. C and D are on one chromosome, and c and d are on its pair. Again, by crossing over, different combinations may be created. When this is extended to include all of the thousands of genes on all 23 pairs of the chromosomes, it can be seen that no two gametes are likely to have exactly the same combination of alleles.

Results of meiosis and sexual reproduction

Sexual reproduction generates variation in offspring because different gene combinations arise during gamete formation, and because one set of chromosomes comes from the father and another from the mother. This is the reason why every child born, except for identical twins, is unique. So, two sisters with the same parents may look and behave very differently.



When a sperm cell fuses with an ovum, a zygote is formed, at which time the two single sets of chromosomes combine in the nucleus. The cell that is formed has a pair of every chromosome, and the potential to give rise to every different cell type that the organism will have.

Genetic variation is vital to the adaptability of a species. Sexual reproduction results in a huge number of different gene combinations in any population. Under some environmental conditions, some of these gene combinations generate organisms that thrive while others don't do as well.

For example, if the Earth's environment suddenly changed so that there was less oxygen in the air, people adapted to the low oxygen levels present at high altitudes would have an advantage. They would survive better and over generations the genetic make-up of human populations would change (since things such as efficient use of oxygen and high red blood cell production are strongly affected by genes). Another environmental change such as an increase in temperature or UV levels might favour other alleles.

In a population that reproduced asexually, it could take a very long time for favourable alleles to occur in one genetic line. Each individual is genetically 'shut-off' from exchanging information with others of the species, and will only gain new favourable alleles by the process of random **mutation**. But with sexual reproduction and the mixing of alleles, favourable combinations of alleles can be formed far more quickly.

Sexual reproduction is beneficial to species because it means there is always a variety of **phenotype** present to survive, whatever changes there might be in the environment.

Activities

REMEMBER

1 Copy and complete the following:
During meiosis, one parent cell gives rise to _____ daughter cells that have _____ the number of chromosomes compared to the parent cell. The daughter cells are _____, not **diploid**. Meiosis involves one round of **DNA** _____ and _____ cell divisions.

2 Copy and complete the following:
(a) _____ produces gamete (ova) containing _____ chromosomes.
(b) Father produces gametes (_____) containing _____ chromosomes.
(c) One sperm fertilises an _____ to form a _____ with _____ chromosomes.
(d) _____ grows and develops into a new individual with traits from both _____.

3 Name three features of sexual reproduction that increase the variation present in offspring.

4 Why is sexual reproduction beneficial to species?

MATCH

5 Match the correct definitions with the terms below:

Independent assortment	the exchange of genetic material between paired chromosomes during meiosis
Crossing over	fusion of paternal and maternal gametes and subsequent mixing of their genetic material
Fertilisation	when gametes form, maternal and paternal chromosomes do not move in sets into the same gamete but combine in different ways

THINK

6 Some plant species reproduce asexually when conditions suit them well, but switch to sexual reproduction if conditions become less favourable. Why might this be so? (*Hint:* Remember, asexual reproduction produces identical offspring.)

DESIGN AND CREATE

7 Produce a poster explaining the inheritance of cystic fibrosis. Remember to represent that it is a recessive condition carried on chromosome 7. Include the processes involved in gamete formation and sexual reproduction, showing how alleles may or may not be passed on by parents who are **carriers**.

✓ learning

I CAN:

- ☐ describe meiosis
- ☐ explain how sexual reproduction gives rise to variation in offspring
- ☐ explain why variation is important to species.