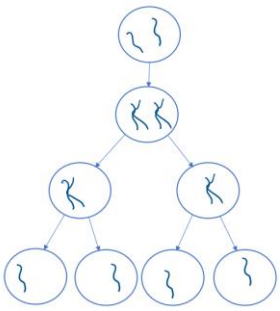
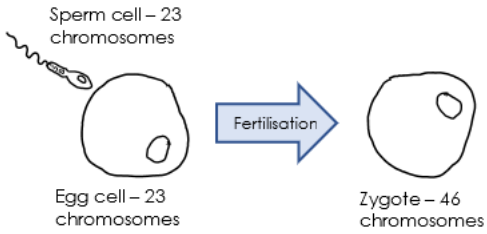
B3.3 Genetics Knowledge Organiser

Meiosis

1. Cells in reproductive organs divide by meiosis to form **gametes**
2. Meiosis halves the number of chromosomes in gametes



3. When a cell divides in meiosis: **copies** of the genetic information are made and the cell then divides twice to form **four** gametes, each with a **single set** of chromosomes. This makes the gametes genetically different from each other
4. Gametes join at **fertilisation** to form a **zygote** with the normal number of chromosomes.



5. After fertilisation, the new cell divides by mitosis and the number of cells increases. As the embryo develops, cells differentiate.

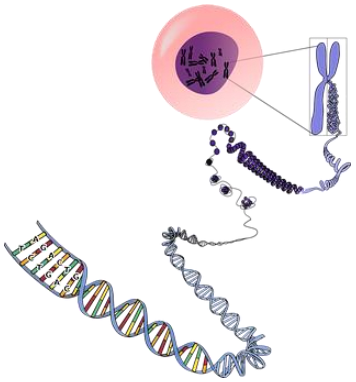
Types of reproduction

6. Organisms use either sexual or asexual reproduction to reproduce.
7. **Sexual reproduction** involves the joining (fusion) of male and female gametes:
   - **sperm and egg cells** in animals
   - **pollen and egg cells** in flowering plants.

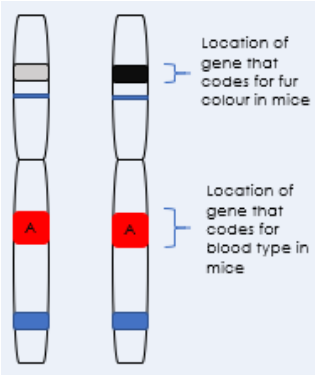
   In sexual reproduction there is mixing of genetic information which leads to **variety** in the offspring.
8. **Asexual reproduction** involves only one parent and no fusion of gametes. There is no mixing of genetic information so this leads to genetically identical offspring **(clones).**

DNA, genes and chromosomes

9. DNA is a **polymer.** It is made of two strands which form a **double helix.**
10. The DNA is contained in structures called **chromosomes.**
11. **A gene** is a small section of DNA on a chromosome. Each gene codes for a **particular sequence of amino acids,** to make a specific protein.
12. The **genome** of an organism is the entire genetic material of that organism.



13. Every chromosome is one of a pair so there are two copies of each gene in every genome
14. Different versions of genes are called **alleles.**



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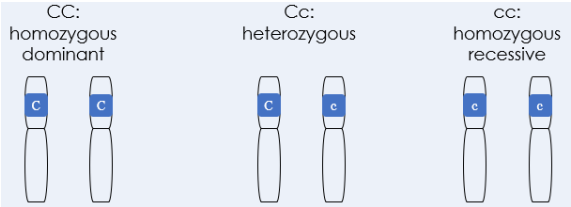
Inheritance

15. Some characteristics, for example fur colour in mice or red-green colour blindness, are controlled by one gene
16. The set of particular alleles present is called the **genotype.** The genotype (e.g. brown allele of the fur colour gene) is expressed to make the **phenotype** (e.g. brown fur).
17. A **dominant** allele is always expressed when present even when only one copy is present. A **recessive** allele is only expressed when there are two copies of it (i.e. no dominant allele)
18. If the two alleles present are the same, either both dominant or both recessive, then this is described as **homozygous.** If the one allele is dominant and one is recessive then this is described as **heterozygous**

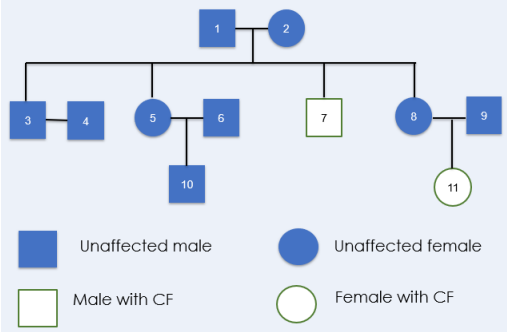


19. Most characteristics are the result of the interaction of many genes
20. **Punnett square** diagrams can be used to predict the genotypes of offspring. Capital letters are used to denote dominant alleles and lower-case letters are used to denote recessive alleles

	C	c
c	Cc	cc
c	Cc	cc

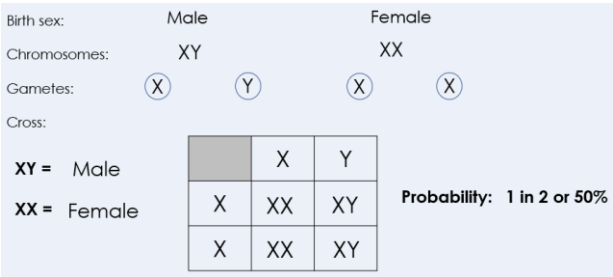
Inherited disorders

21. **Polydactyly** is an inherited disorder where sufferers have extra digits; it is caused by a dominant allele.
22. **Cystic fibrosis** is an inherited disorder where sufferers have lung problems due to a faulty cell membrane protein; it is caused by a recessive allele
23. An individual can be a **carrier** of a recessive disorder, but not of a dominant disorder.
24. **Family trees** show over several generations which individuals had a particular phenotype. This can be used to derive the genotype



Sex determination

25. Ordinary human body cells contain 23 pairs of chromosomes. 22 pairs control characteristics only, but one of the pairs carries the genes that determine sex.
26. In females the sex chromosomes are the same (XX). In males the chromosomes are different (XY).



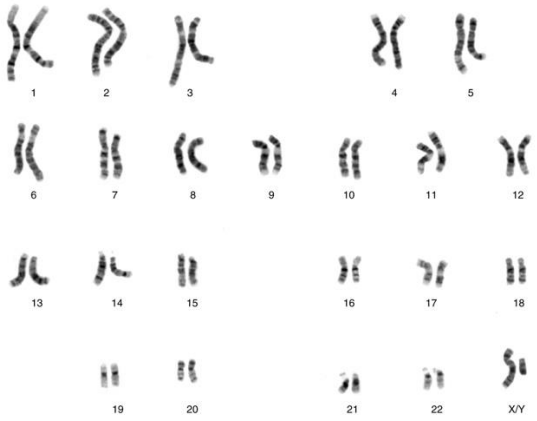
Separate science only

Types of reproduction

27. There are **advantages to sexual reproduction:**
    - It produces **variation** in the offspring
    - If the environment changes variation gives a survival advantage by **natural selection**
28. There are also **advantages to asexual reproduction:**
    - **Only one parent** is needed
    - It is more **time and energy efficient** as organisms do not need to find a mate
    - It is **faster** than sexual reproduction
    - Many identical offspring can be produced when conditions are favourable.
29. Some organisms reproduce by both methods depending on the circumstances. **Malarial parasites** reproduce asexually in the human host, but sexually in the mosquito. Many **fungi** reproduce asexually by **spores** but also reproduce sexually to give variation. Many plants produce seeds sexually, but also reproduce asexually by **runners** such as strawberry plants, or bulb division such as daffodils.

The development of our understanding of genetics

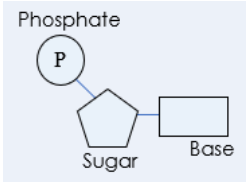
30. Our current understanding of genetics has developed over time. In the mid-19th century **Gregor Mendel** carried out breeding experiments on plants. One of his observations was that the inheritance of each characteristic is determined by **'units'** that are passed on to descendants unchanged. **The importance of Mendel's discovery was not recognised until after his death.**
31. In the late 19th century behaviour of chromosomes during cell division was observed. In the early 20th century it was observed that chromosomes and Mendel's 'units' behaved in similar ways. **This led to the idea that the 'units', now called genes, were located on chromosomes.**
32. A **karyotype** diagram can be used to display the chromosomes of an individual.



33. In the mid-20th century the structure of DNA was determined and the mechanism of gene function worked out. This scientific work by many scientists led to the gene theory being developed. **Watson, Crick, Wilkins and Franklin** played a part in the development of the DNA model.

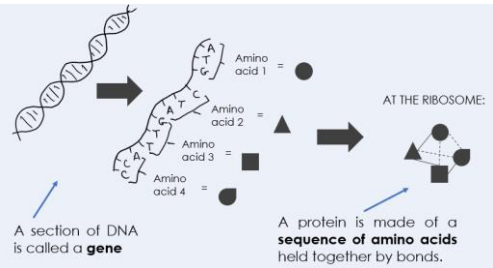
DNA and protein synthesis

34. The **monomers** of DNA are called **nucleotides**. The DNA polymer is made up of repeating nucleotide units.

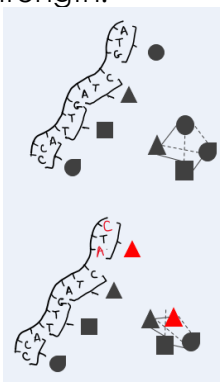


35. The long strands of DNA consist of **alternating sugar and phosphate sections.** Attached to each sugar is one of the four **bases.** In the complementary strands **a C is always linked to a G on the opposite strand and a T to an A.**

36. A sequence of **three bases** is the code for a particular **amino acid**. The order of bases **controls the order** in which amino acids are assembled to produce a particular protein.



37. Proteins are synthesised on ribosomes, according to a **template**. **Carrier molecules** bring specific amino acids to add to the growing protein chain in the correct order. When the protein chain is complete it folds up to form a **unique shape**. This unique shape enables the proteins to do their job as enzymes, hormones or forming structures in the body such as collagen.
38. **Mutations** occur continuously. Most do not alter the protein, or only alter it slightly so that its appearance or function is not changed. **A few mutations code for an altered protein with a different shape.** An enzyme may no longer fit the substrate binding site or a structural protein may lose its strength.



39. A change in DNA structure may result in a change in the protein synthesised by a gene.