NEW

NATIONAL SCIENCE

YEAR 10

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Contents

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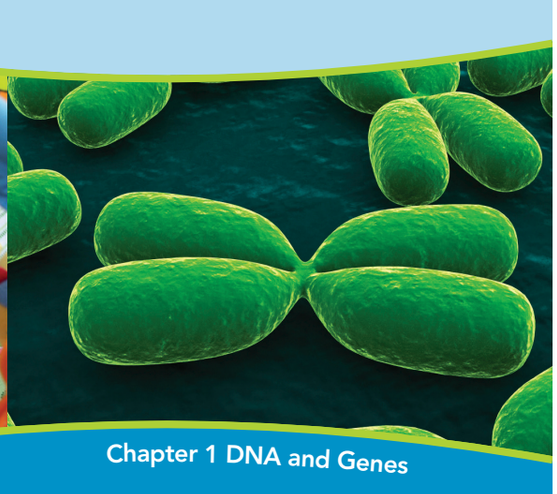
1 DNA and Genes

This chapter examines how hereditary information is passed from one generation to the next. It explains the structure of DNA and its role in controlling the characteristics of organisms. You will solve problems and predict the probability of offspring inheriting a certain trait. You will also investigate how technology has advanced scientific understanding of genetics and is used to assist people in their daily lives or provide new career opportunities.



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How much do you remember or already know?

1. What are cells?
2. How can you distinguish plant cells from animal cells?
3. Name the basic parts of all cells.
4. What is the function of the nucleus?
5. Describe the cell membrane.
6. What is cytoplasm?
7. Name some specialised animal cells.
8. What is a tissue?
9. Name three organs of the human body and state their function.
10. What is mitosis?
11. Why is mitosis important?
12. What is the difference between asexual and sexual reproduction?
13. Name some organisms that reproduce by asexual reproduction.
14. Name some organisms that reproduce by sexual reproduction.
15. What is the difference between inherited characteristics and acquired characteristics?
16. Name some of your own inherited characteristics.
17. Name some of your acquired characteristics.
18. What are organic molecules?
19. What is a macromolecule?
20. Name the four main types of macromolecules of organic compounds.
21. What is the basic unit of carbohydrates?
22. What is the basic unit of proteins?
23. What is the basic unit of lipids?
24. What is the basic unit of nucleic acids?
25. How many different amino acids are commonly found in proteins?
26. Name the two types of nucleic acid.
27. Why does the body need proteins?
28. Why does the body need carbohydrates?
29. What is the function of nucleic acids?
30. Define fertilisation.

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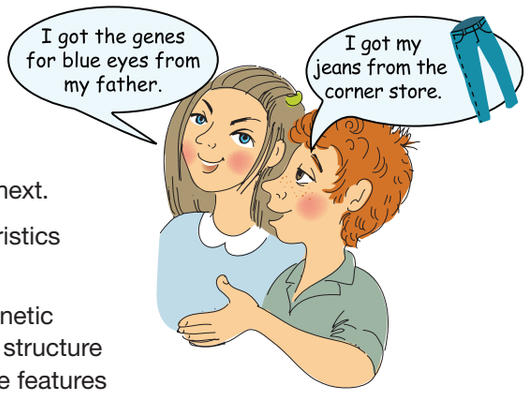
1.1 DNA

1.1.1 The role of DNA



What features do you have that are like your mother? Your father? Your grandmother? Your grandfather? **Heredity** is the transmission of characteristics from one generation to the next.

The study of heredity and how variation of inherited characteristics occurs is called **genetics**.

DNA (**d**eoxyribose **n**ucleic **a**cid) is the molecule that holds genetic information. DNA can replicate itself. Its code determines the structure of the proteins made by the cell. These proteins determine the features of an organism. Thus, DNA controls the characteristics of an organism. DNA is often called the 'blueprint of life'. Changes in the code cause changes in protein production which can lead to new variations of features.

A **genome** is the entire genetic code for an organism. Scientists have mapped the genomes for many species and the development of new technologies makes the process quicker, cheaper and easier. The storage of this information has required fast computers with massive storage capacity. These computers are able to analyse and sort the large amounts of information in the databases. The Human Genome Project has mapped the DNA sequence for humans.

1.1.1.1 What is heredity? .....

1.1.1.2 What is genetics? .....

.....

1.1.1.3 What does DNA stand for? .....

1.1.1.4 What is the role of DNA? .....

.....

1.1.1.5 Why is DNA often called the 'blueprint of life'? .....

.....

1.1.1.6 What happens if there is a change in DNA? .....

.....

1.1.1.7 What is a genome? .....

1.1.1.8 Discuss how our knowledge of genomes is linked to the developments of new technologies.

.....

.....

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1.1.4 The structure of DNA

The basic unit of DNA is the nucleotide. A nucleotide consists of a sugar, a phosphate group and a nitrogenous base. Nucleotides join together to form a double helix which is like a twisted ladder. The 'sides' of the ladder are the sugar and phosphate. The 'rungs' of the ladder are two nitrogenous bases linked together as complementary pairs.

The four nitrogenous bases are:

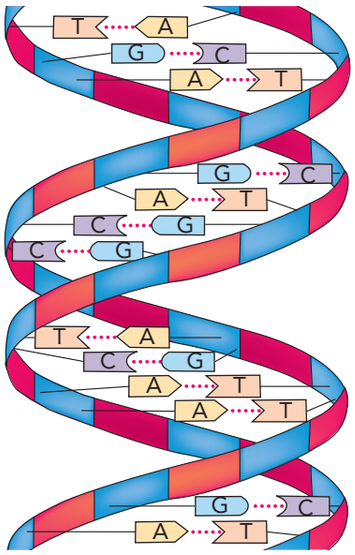
A = adenine T = thymine C = cytosine G = guanine

They ALWAYS link: A always with T; C always with G.

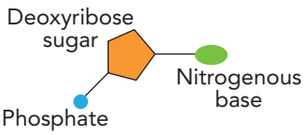
The code is read down one side, e.g. if one side has a sequence ATTCGG, then the complementary code on the other side is TAAGCC. A **gene** is a segment of DNA with a specific sequence of bases.

The DNA code is a triplet code. This means that three bases make up the code for each specific amino acid. A gene consists of many bases that code for a specific sequence of amino acids. Genes vary in length from about 8000 base pairs to more than two million base pairs. The length of a DNA molecule is given by the number of base pairs (bp) and not by the number of genes present.

DNA



A nucleotide



1.1.4.1 What is the basic unit of DNA? .....

1.1.4.2 What are the 'sides' of the 'ladder' of the double helix?

.....

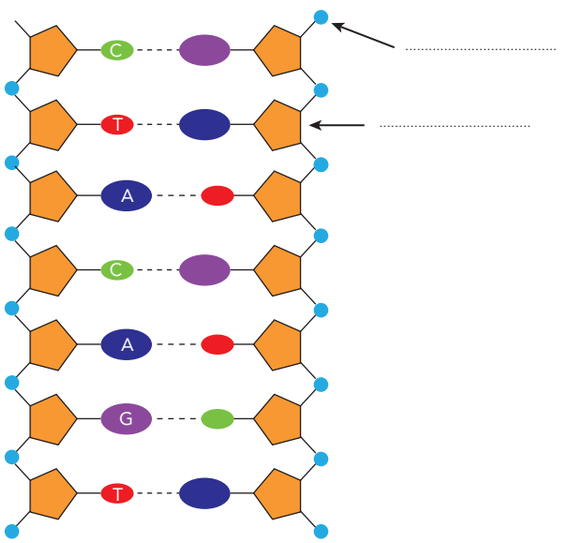
1.1.4.3 Identify the two pairs of complementary bases. .....

1.1.4.4 How many bases are in the DNA code for *one* amino acid? .....

1.1.4.5 How many amino acids would be produced by the code – AAGGTATTGCTC? .....

1.1.4.6 The diagram shows a section of DNA that has been untwisted.

Fill in the code for the bases on the right-hand side and identify the sugar and the phosphate symbols.

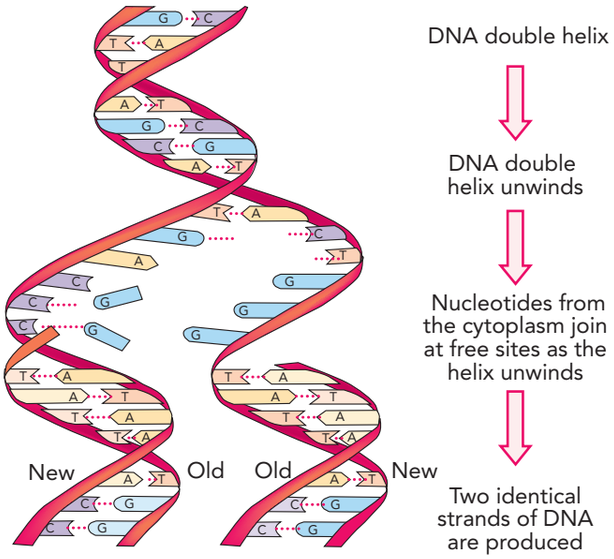


1.1.5 DNA replication

Before a cell can divide the DNA replicates (copies itself). This is essential to provide two exact copies of DNA so each new daughter cell has its own copy of DNA. In DNA replication:

- The molecule untwists.
- The molecule unzips.
- Two separate strands form.
- Each side of the double helix acts as a template and free nucleotides join each separated strand.
- Each new section is zipped up.

The process makes one exact copy of each side of the original DNA.



The complementary pairing of the nitrogenous bases is highly important and means there is only a small chance of error occurring in DNA replication. The new DNA will have the same code as the original DNA.

1.1.5.1 What is DNA replication? .....

.....

1.1.5.2 Why is DNA replication important? .....

.....

.....

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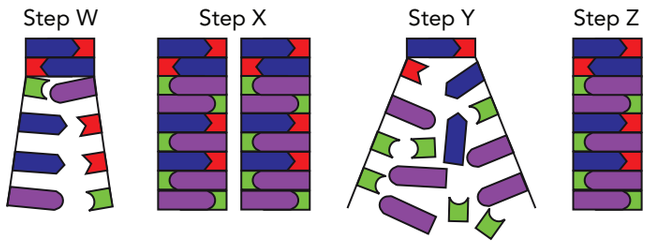
1.1.5.3 Why is complementary pairing of the nitrogenous bases important for replication? .....

.....

.....

1.1.5.4 What is the correct order for the adjacent steps in DNA replication?

.....



1.1.5.5 Use the key to draw the four different nucleotides that are in DNA.

Key

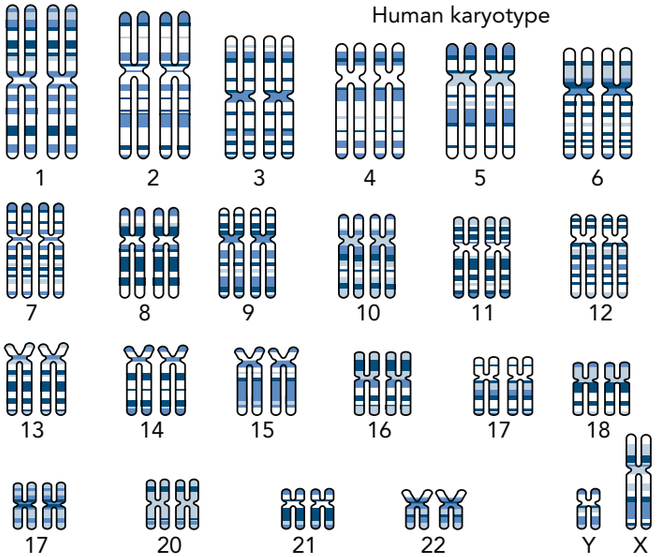
G
C
T
A

Phosphate

Deoxyribose sugar

1.1.6 Karyotypes

A **karyotype** is an arrangement of all the chromosomes from the nucleus arranged in order from the largest to the smallest with the sex chromosomes last. A karyotype shows the number, size and shape of each chromosome. The centromere is the part that links sister chromatids and is seen during cell division. The centromere divides a chromosome into two arms and the position of the centromere helps to identify different chromosomes. Karyotypes are used in cell biology and genetics to provide information about gender, relationships between different species, cellular functions and chromosomal abnormalities which can cause genetic diseases.



Humans have 46 chromosomes (23 pairs).
There are 22 pairs of **autosomes** (chromosomes which do not determine a person's sex) and the **sex chromosomes** are called the **X** and **Y chromosomes**. Females are XX and males are XY. Genetic diseases caused by chromosome abnormalities include Down syndrome (trisomy 21) in which the person has three copies of chromosome 21, Turner syndrome (XO) in which the person appears female and has only one X chromosome, Jacob syndrome (XYY) is male with an extra Y chromosome and Klinefelter syndrome (XXY) is male with an extra X chromosome.

1.1.6.1 What is a karyotype? .....

.....

1.1.6.2 What is shown in a karyotype? .....

.....

1.1.6.3 How can karyotypes be used? .....

.....

.....

1.1.6.4 How many chromosomes do humans have? .....

1.1.6.5 What is the difference between autosomes and sex chromosomes? .....

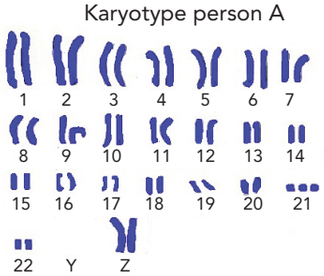
.....

1.1.6.6 The diagram shows the karyotype of person A. What is the gender of this person and what genetic disease do they have?

.....

.....

Karyotype person A



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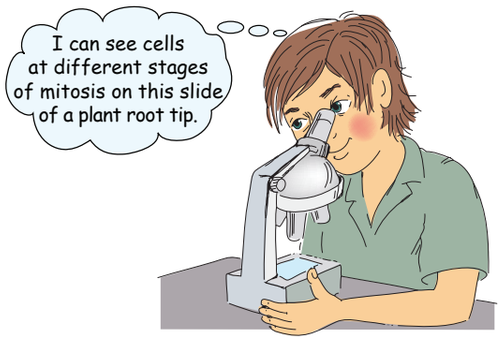
1.2 Mitosis, meiosis and fertilisation

1.2.1 Revising mitosis

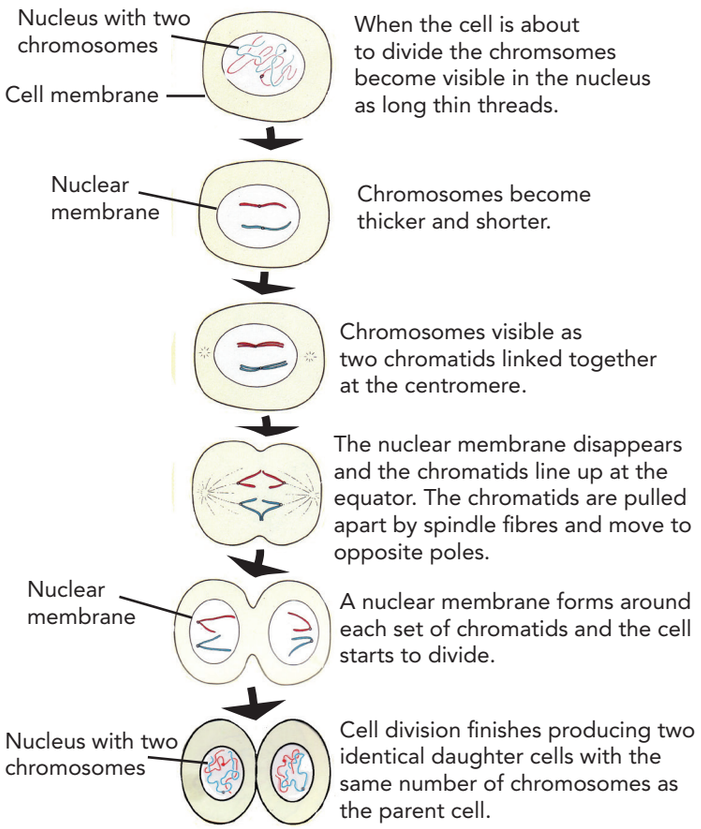
Mitosis is the division of the nucleus in cell division. Mitosis produces two identical daughter cells that each contain an exact copy of the chromosomes of the parent cell.



Mitosis is needed for:

- growth from a fertilised egg to an adult made of many cells
- healing wounds, cuts and broken bones with new cells
- replacing dead or damaged cells and old red blood cells.

Stages in mitosis



1.2.1.1 Define mitosis. .....

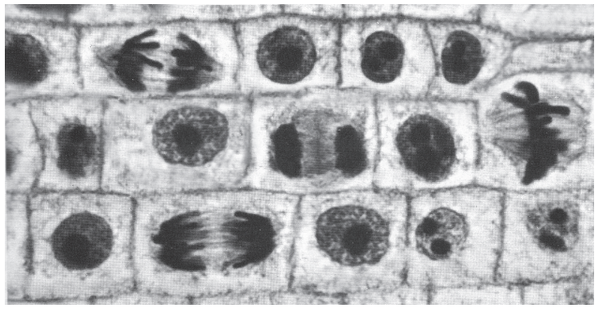
1.2.1.2 What is produced by mitosis? .....

1.2.1.3 Why is mitosis needed? .....

1.2.1.4 The picture was taken from the area of cell division in a plant root. Circle a cell that shows:

(a) Chromatids lining up at the equator.

(b) Chromatids being pulled apart by spindle fibres.



1.2.2 Meiosis

Meiosis is a two-stage cell division in sexually-reproducing organisms that produces cells with half the number of chromosomes as are in the original cell. It makes sex cells.

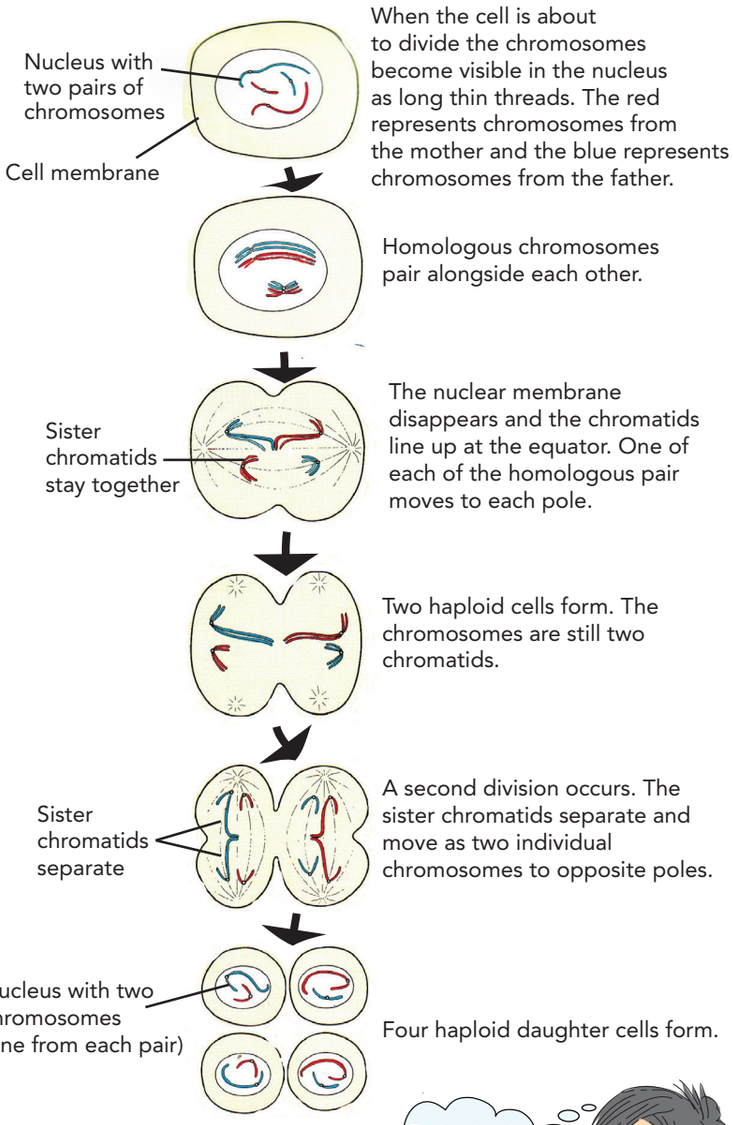
Meiosis is important as it allows genetic information to be passed from **two** parents to the offspring – it is needed for sexual reproduction. It is a source of **variation**. The mix of genes in each cell varies.

Meiosis occurs in the **reproductive organs** of plants and animals – in the ovaries and testes of animals and in the ovaries and anthers of plants.

A **gamete** is a sex cell with half the number of chromosomes, e.g. sperm or egg. Gametes unite during sexual reproduction to produce the first cell of a new individual. A cell containing two sets of chromosomes (***2n***), e.g. original parent cell, is called a **diploid** cell. The diploid number for humans is 46. A cell with only one set of chromosomes (***n***), e.g. gamete, is called a **haploid** cell. The haploid number for humans is 23.

An important step in meiosis is the pairing of the homologous chromosomes. **Homologous chromosomes** are the pairs of chromosomes with the genes for the same traits along their length – one is inherited from the mother and the other from the father.

Stages in meiosis



1.2.2.1 Define meiosis. .....

.....

1.2.2.2 Where does meiosis occur? .....

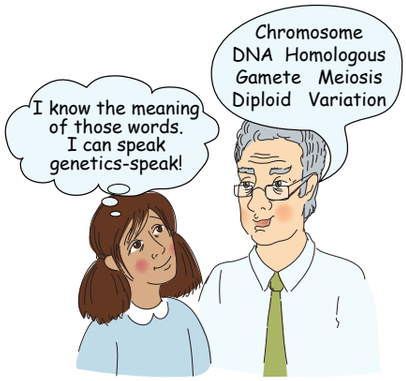
.....

1.2.2.3 What is a gamete? .....

1.2.2.4 Does meiosis produce haploid or diploid daughter cells? Explain your answer. .....

.....

1.2.2.5 Explain why meiosis is needed for sexual reproduction.



1.2.2.6 What are homologous chromosomes?

1.2.2.7 During meiosis the pair of homologous chromosomes separate randomly with one of each pair going to the daughter cell. This is called **random segregation**. If a cell has three pairs of chromosomes then meiosis can produce eight different combinations of chromosomes. Try working this out for yourself using two different colours to represent each homologous pair.

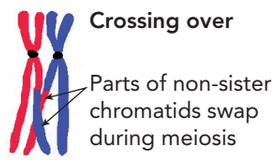
A mathematical formula to work out the number of possible variations possible is:

Number of variations = 2^n where n = haploid number

(a) Define random segregation.

(b) Work out how many possible different gametes *you* can produce. (Remember the diploid number for humans is 46.)

1.2.2.8 Sometimes during the early stages of meiosis when the homologous chromosomes are paired together, sections of non-sister chromatids are swapped in a process called **crossing over**.



(a) Define crossing over.

(b) Explain how crossing over can lead to different combinations of characteristics.

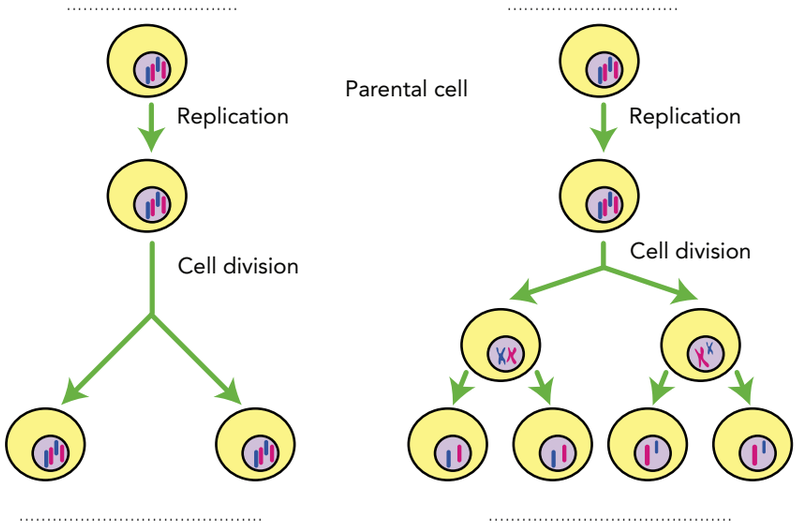
1.2.2.9 Name two processes that occur during meiosis that can lead to variation.

1.2.3 Comparing mitosis and meiosis

1.2.3.1 Complete the table to compare mitosis and meiosis.

Feature	Mitosis	Meiosis
Number of daughter cells produced		
Number of divisions in process		
Number of chromosomes in daughter cells		
Location of process		
Type of cells produced		
Why the process is needed		

1.2.3.2 The processes of mitosis and meiosis are shown below. Label the diagrams to show that you can distinguish between these two processes. Identify which daughter cells are haploid or diploid.



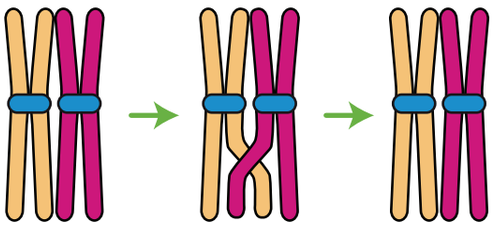
1.2.3.3 The diagram shows changes taking place in two homologous chromosomes.

(a) Name this process.

.....

(b) Does this sequence of events occur in mitosis or meiosis or both?

.....



(c) Explain why this process is important. .....

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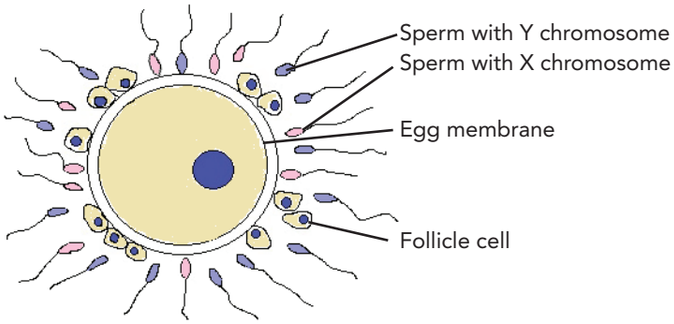
1.2.4 Fertilisation

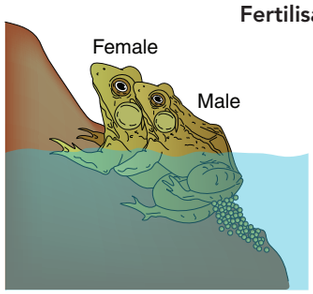
Fertilisation in humans



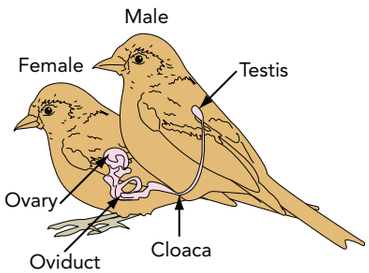
A **gamete** is a haploid sex cell: a sperm or an ovum. **Fertilisation** is the union of two gametes and the resulting fertilised egg is called a **zygote**. Because the offspring receive half their genetic information from their mother and half from their father, offspring are not identical to either parent or to other offspring – unless they are an identical twin. Identical twins occur when a zygote splits into two.

Fertilisation can be **internal** – inside the female's body, e.g. birds and mammals, or **external** – outside the female's body, e.g. fish and amphibians. In flowering plants the pollen tube grows down to the ovary and fertilisation is internal. Internal fertilisation is necessary for life on land as sperm need to be able to swim to meet the egg. In external fertilisation the sperm simply use the watery medium into which they are released to swim to the egg. Since the chances of meeting an egg is smaller in an external environment, species relying on external fertilisation produce much larger numbers of eggs than species relying on internal fertilisation.

Fertilisation



External fertilisation
The female frog releases many eggs into the water. The male frog releases sperm which swim to the eggs and fertilisation occurs outside the female's body.



Internal fertilisation
In most birds, the male presses his sexual opening (cloaca) against the female's sexual opening (cloaca). After mating, the sperm swim up the oviduct in the female and fertilise the egg inside the female's body.

Males release millions of sperm at a time. It is random which sperm unites with a particular egg, so fertilisation is another source of variation in organisms that reproduce sexually.

1.2.4.1 Define fertilisation. .....

1.2.4.2 Define zygote. .....

1.2.4.3 How do identical twins form? .....

1.2.4.4 Distinguish between internal and external fertilisation. .....

.....

1.2.4.5 Explain why species that use external fertilisation produce much larger numbers of eggs than species which use internal fertilisation.

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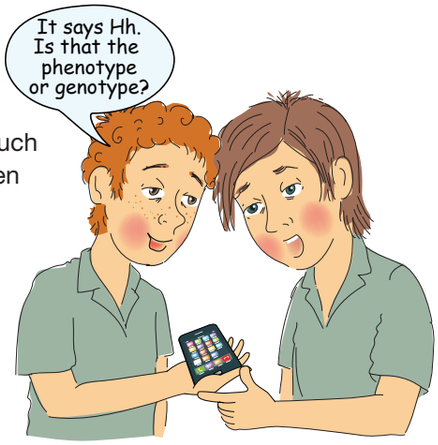
1.3.2 Genes and alleles



Since Mendel, many scientists have investigated genetics and inheritance patterns. We now know that a Mendelian characteristic such as pod colour is a **gene**. The different forms of the gene such as green pod colour and yellow pod colour are **alleles**.

Writing conventions

When working with alleles and genes and working out inheritance probabilities the following rules are used.

The allele for the dominant trait is given a capital letter, e.g. H.

The allele for the recessive trait is given a lower case letter, e.g. h.

If both alleles are present, the dominant allele is written first, e.g. Hh.

(It is preferable not to choose a letter of the alphabet that looks similar in both upper and lower case, e.g. s, c.)

Genotype and phenotype

The **genotype** is the genetic make-up and gives the alleles present. For an individual, each gene has two alleles – one from the father and one from the mother, e.g. HH, Hh or hh (though there are exceptions, e.g. some genes on the X chromosome have no corresponding position on the Y chromosome which is shorter than the X chromosome in humans). The **phenotype** is the physical or physiological appearance of an organism, e.g. green pea pod colour, which is due to having a particular genotype.

1.3.2.1 What is the difference between a gene and an allele? .....

.....

.....

1.3.2.2 Distinguish between genotype and phenotype. .....

.....

.....

1.3.2.3 If you were going to work out some inheritance probabilities, what letters would you choose for each of the following? (You may have to go back to Mendel's experiments to remember which trait is dominant and which one is recessive.)

Purple flower colour	White flower colour .....
Dwarf stem length	Tall stem length .....
Round seed shape	Wrinkled seed shape .....
Green pod colour	Yellow pod colour .....
Terminal flower position	Axial flower position .....

1.3.2.4 A student was trying to solve a genetics problem about coat colour in mice. He was told the allele for black coat dominates over the allele for brown coat. He gave brown coat colour the letter B and black coat colour the letter b. His teacher marked him incorrect. Explain why he was wrong.

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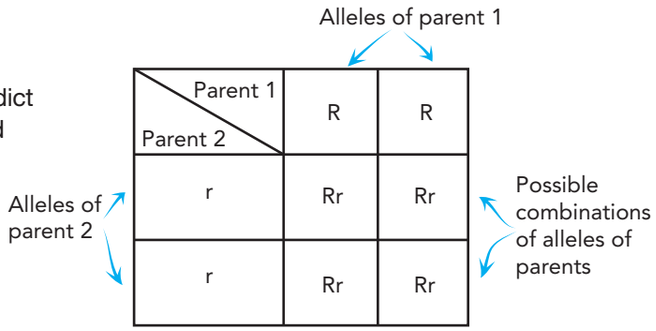
1.3.3 Punnett squares

The **Punnett square** is a diagram that is used to predict the outcome of a particular genetic cross. It is named after Reginald Punnett. Punnett squares are used to solve genetics problems. In the square the alleles of the parents are separated to show the possible gametes. When the grid is filled in the possible combinations of alleles in zygotes are shown.



Homozygous and heterozygous

If an organism has identical alleles for a characteristic then it is **homozygous** for that characteristic, e.g. TT for tall stem length in peas or tt for dwarf stem length in peas. If an organism has two different alleles for a characteristic then it is **heterozygous** for that characteristic, e.g. Tt for stem length in peas – this plant would appear tall as the appearance of the dominant allele shows in the phenotype.

1.3.3.1 Who devised the Punnett square as a way to work out the probability of a genetic cross?

.....

1.3.3.2 Why are Punnett squares used? .....

1.3.3.3 Distinguish between homozygous and heterozygous. .....

.....

1.3.3.4 If a pea plant was heterozygous for each of the following characteristics, what is its genotype and phenotype for each characteristic?

Stem length – heterozygous genotype ..... heterozygous phenotype .....

Flower colour – heterozygous genotype ..... heterozygous phenotype .....

Seed shape – heterozygous genotype ..... heterozygous phenotype .....

1.3.3.5 Draw a Punnett square to show why Mendel found that a cross between a 'true-breeding' (homozygous) tall pea plant and a 'true-breeding' (homozygous) dwarf pea plant always produced tall pea plant offspring.

(*Note:* When solving genetics problems you should always begin with a key to show the code for the dominant and recessive alleles and then show the cross for the parent genotype and phenotypes. Then draw the Punnett square and then write out the genotypes and phenotypes of the offspring in a conclusion.)

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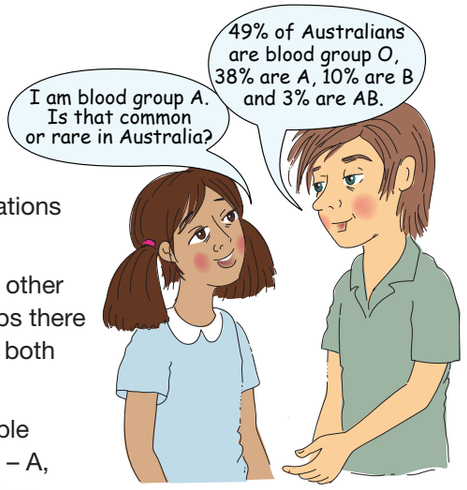
1.4.3 Human blood groups



Mendel was fortunate when he chose pea plants and the seven characteristics to investigate as these features follow the simple monohybrid cross model. Human blood groups show two complications when working out inheritance – multiple alleles and codominance.

Codominance occurs when one allele does *not* dominate over the other and *both* are exhibited in the phenotype, e.g. in human blood groups there is an allele A blood type and an allele B blood type; if a person has both these alleles then they are blood type AB.

Multiple alleles is a situation where there are more than two possible alleles for a gene. In humans there are three alleles for blood group – A, B and i (sometimes they are written as I^A, I^B, and I^i). Remember that an individual can only have two alleles present in their genotype.

1.4.3.1 Define codominance. .....

.....

1.4.3.2 Define multiple alleles. .....

.....

1.4.3.3 Given that the human blood group alleles A and B are codominant and both dominate over allele i, complete the table to show the allele combinations that give blood groups A, B, AB and O.

Blood group	A	B	AB	O
Allele combination				

1.4.3.4 A woman is blood group O and is suing a man who is blood group B for child support. Her child is blood group A. Will she win her case? Use a Punnett grid to explain your reasoning.

.....

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1.4.3.5 A man who is blood group B marries a woman with blood group AB. They have three children, a son blood group B, a daughter blood group A and a son who is blood group AB. Draw a family tree for blood group B for this family.

1.5 Mutations

1.5.1 Types of mutations

A **mutation** is a permanent change in the genetic information. The change can be a small localised change in a gene (**gene mutation**) or a large-scale chromosomal alteration (**chromosome mutation**). If the change occurs in a body cell (**somatic mutation**) then the individual will be affected and the change will not be inherited by future offspring. If the change occurs in the reproductive organ, e.g. ovary or testis or during meiosis and the formation of the gamete (**germ cell mutation**) then the offspring will inherit the altered genetic information.

1.5.1.1 Define mutation. .....

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1.5.1.2 Distinguish between a gene mutation and a chromosome mutation. .....

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1.5.1.3 What is the difference between a somatic mutation and a germ cell mutation? .....

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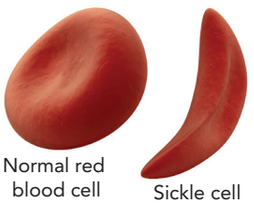
1.5.1.4 **Sickle-cell anaemia** is caused by a gene mutation in the code for the protein haemoglobin. Haemoglobin is the red pigment in red blood cells that carries oxygen around the body from the lungs to cells for respiration. The mutant haemoglobin forms red blood cells that have a sickle shape.



Normal red blood cell | Sickle cell

In a family, a woman and her eldest son have sickle-cell anaemia. Her husband, both her parents and her young twin daughters do not have sickle-cell anaemia.

(a) Draw a family tree for sickle-cell anaemia in this family.

(b) From this family tree, can you determine if the allele for sickle-cell anaemia is dominant or recessive? Explain your reasoning.

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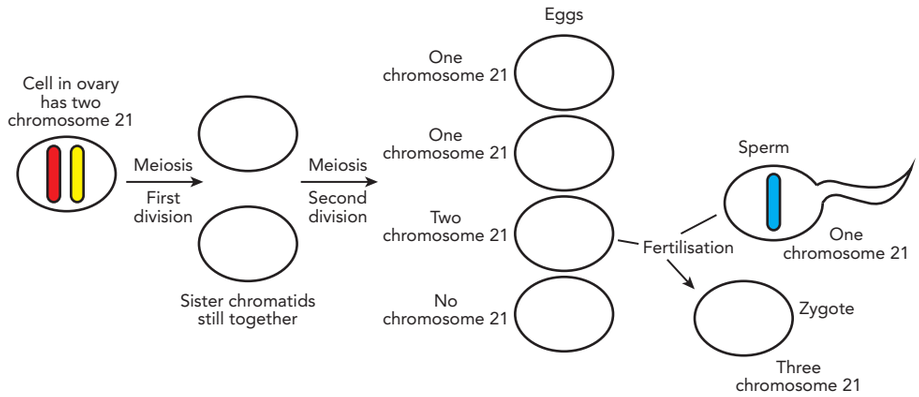
1.5.1.5 **Down syndrome** (trisomy 21) is a chromosome mutation. There are several ways in which a gamete can end up with an extra copy of chromosome 21. One cause of Down syndrome is when chromatids do *not* separate so that one gamete gets two copies of chromosome 21 and another gamete has no copies of chromosome 21.

Complete the diagram to show how a child can be born with three copies of chromosome 21.



1.5.1.6 A mutation in a somatic cell can cause a change in the functioning of that body cell so that it causes cancer or some other disease. What type of cell division is involved in the growth of a cancer caused by a mutation in a body cell?

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1.5.1.7 When a cell needs to make a particular protein the gene that has the code for that protein is '**switched on**'. This is called **gene expression**. The proteins being produced by a cell at any particular moment depend upon the needs of the cell at that moment. For example, a cell in the pancreas would switch on the gene to make insulin but would switch off the gene to make haemoglobin while a young red blood cell in the bone marrow would switch on the gene to make haemoglobin and switch off the gene to make insulin (a red blood cell loses its nucleus as it matures and leaves the bone marrow).

(a) What is meant by gene expression? .....

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(b) BRCA1 stands for the gene **BR**east **CA**ncer 1 gene. It is a tumour suppressor gene. The BRCA1 gene has the code to make a protein that protects against unwanted cell growth. The mutated form of this gene is associated with many cancers especially breast and ovarian cancer. The faulty protein made by the mutated gene cannot stop the abnormal cells from dividing and producing more abnormal cells. (A tumour is a cancer lump.)

Is the mutation of the BRCA1 gene a somatic mutation or a germ cell mutation? .....

(c) Explain why the mutation of the BRCA1 gene leads to a lump forming, e.g. in the breast.

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1.5.2 Mutagens

A **mutagen** is a chemical, biological or physical agent that causes a permanent change in the genetic information (causes a mutation). The rate of mutation is directly related to the dose of mutagen received. A large dose in a short time or a series of small doses over a long time can both be harmful. Many mutagens are also carcinogens. A **carcinogen** is any substance or radiation that directly causes a cancer. Not all mutations are harmful – some mutations are neutral and do not affect the organism or its life expectancy, while other mutations can be helpful, e.g. radiation-resistant fungi have been found inside Chernobyl.

Ionising radiation, e.g. UV radiation, X-rays and gamma rays can alter DNA to cause cancers and other harmful conditions. UV light can cause skin cancers, eye cataracts and pterygiums (growths on the conjunctiva of the eyes). The nuclear industry is regulated by several organisations and by governments, e.g. the International Commission on Radiological Protection (ICRP), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). ARPANSA provides information and services to help those who may have a health or safety concern involving exposure to radiation. Harmful mutations associated with nuclear radiation cause health problems which include thyroid cancer, leukaemia and radiation sickness.

Chemical agents that cause mutations include environmental poisons and irritants, e.g. benzene, nitrous acid, formaldehyde, thalidomide, asbestos, tobacco tar and high alcohol intake. Tobacco smoke contains more than 70 carcinogens, e.g. tar, benzene, formaldehyde, arsenic. There are several cancers associated with smoking, e.g. cancers of the lung, mouth, larynx, pharynx, oesophagus, liver, pancreas, stomach, kidney, bladder and bowel.

Biological agents include viruses, bacteria and other micro-organisms. Some viruses can join with human chromosomes, altering genes and triggering the growth of a cancer. For example, human immunodeficiency virus (HIV) increases the risk of Kaposi sarcoma, cervical cancer and non-Hodgkin's lymphoma and hepatitis B virus increases the risk of liver cancer.

1.5.2.1 Define a mutagen. .....

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1.5.2.2 Define a carcinogen. .....

1.5.2.3 Complete the table to summarise the different types of mutagens.

Type of mutagen	Examples
Ionising radiation	
Chemical agents	
Biological agents	

1.7 Indigenous heredity

1.7.1 Indigenous kinship and marriage

Before reading the information below watch one or two short videos about kinship structures of Aboriginal and Torres Strait Islander peoples. Videos produced by Reconciliation Australia and NATSICC are good examples.

Now read on: Aboriginal kinship is a vital feature of Aboriginal culture. It rejects the notion of the nuclear family and encourages individuals to develop a flexible understanding of the family unit and relationships with others. Family structures in Indigenous culture provide identity, nurture each individual's spiritual and cultural belonging, and establish strong links with the community. Family is the foundation that provides emotional and psychological support, and the cohesive forces that bind Aboriginal people together.

Kinship describes a person's responsibilities towards others, the land, and natural resources. Kinship determines how people relate to one another and their surroundings, to create cohesive and harmonious communities. Kinship also determines how Aboriginal peoples relate to others through marriage, ceremony, funeral roles, and behaviour patterns. People who hold a position in the kinship system have a responsibility to adhere to kinship principles through their actions.

Kinship is a system of social relationships that uses terms such as mother, father, son and daughter, but these terms also apply to close relatives such as the father's brothers and mother's sisters who are all fathers or mothers respectively. So, uncles are also considered fathers to their nieces and nephews, and cousins would be thought of as brothers or sisters in Aboriginal culture. Kinship provides a guide to expected behaviour, indicating, for example, the expectation of sexual familiarity, how people make or tell jokes, restraint, or complete avoidance. The most important avoidance relationship is between a man and his actual or potential mothers-in-law: all the women considered as mothers to his wife.

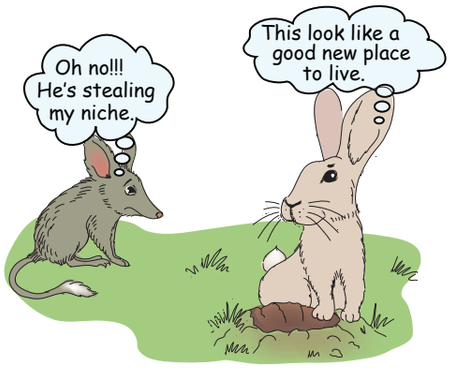
While Aboriginal peoples have a rich history and deep understanding of their environment and had no scientific knowledge of genetics, studies have shown that genetic mutations helped Aboriginal peoples survive in harsh climates, and their strict marriage and interrelationship customs perhaps accidentally helped avoid genetic mutations and ensured a wide and safe genetic mix. In addition, Indigenous skin names play a significant role in marriage. Individuals can only marry someone from a different skin name group. This ensures that people do not marry their relatives. In this way, the community remains genetically diverse.

1.7.1.1 Kinship in Aboriginal communities developed from three foundations: moiety, totems, and skin names. Define each of these and explain their importance to Aboriginal kinship.

1.7.1.2 Briefly explain how marriage customs of Aboriginal peoples have enabled them to adapt better to their living environments and have ensured genetic stability within clans.

2.2 Biodiversity

2.2.1 Filling the niches



Biodiversity refers to the variety of different life.

There are three levels of biodiversity – genetic diversity, species diversity and ecosystem diversity.

Genetic diversity refers to the range of different genes in the group and the size of the gene pool. This causes variation within a species.

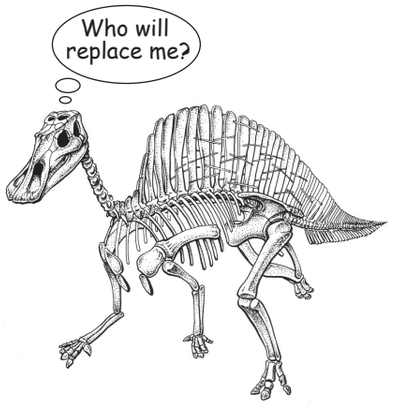
Species diversity refers to the number of different species (species richness) in an area. The relative abundance of each species in an area (species evenness) is often used as a diversity index when people talk about biodiversity in an area.

Ecosystem diversity refers to the variety of ecosystems on Earth. It also considers the range of communities in each area.

It is estimated there are 13.6 million species on Earth. Australia has about 7% of these species (about 1 million species) and is considered to be a country with megadiversity. Due to Australia's location and long isolation as an island continent, many plants and animals are unique to Australia. Preserving native species often means preserving native ecosystems.

Within each ecosystem there are many niches. A **niche** for a species is the way it uses all the living and non-living things in its environments.

Diversity after mass extinctions



The fossil record shows that there have been a number of global mass extinctions. The changes in the environment at these times were so rapid and disruptive that most species died out, e.g. the end of the Cretaceous period saw the extinction of the dinosaurs. This was bad for the dinosaurs – but great for the mammals!

The niches that had been filled by the great dinosaurs were now empty. Mammals had their chance to rule. The mammals of the time were only small and nocturnal, which was partly why they managed to survive the extinctions and over time new forms of mammals evolved to fill the empty niches. *Tyrannosaurus rex* was replaced with lions and bears.

2.2.1.1 Define biodiversity. .....

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2.2.1.2 Distinguish between genetic diversity, species diversity and ecosystem diversity.

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8.2.3.4 A group of students developed two theories to explain why substances burn.

Theory 1 When a substance burns it joins on to a component of the air. The amount of this component in the air is limited.

Theory 2 When a substance burns something escapes from the substance into the air. The amount of this 'something' able to fit into a given volume of air is limited.

The students made observations about things burning as they did several experiments. These observations are listed below. For each observation indicate:

(A) If the observation supports only theory 1.

(B) If the observation supports only theory 2.

(C) If the observation supports both theories.

(D) If the observation supports neither theory.

The observations

(a) When 1.0 grams of magnesium was burnt in the open air, 1.6 grams of white ash was formed. .....

(b) When 1.0 grams of magnesium was burnt in a sealed jar, the total mass of the apparatus before and after burning was the same. .....

(c) Magnesium burns more violently in pure oxygen than it does in air. .....

(d) A large amount of heat and light energy is given off when magnesium burns in air. .....

(e) Magnesium will not burn in a vacuum. .....

(f) A candle burning in a sealed jar goes out before all the candle is used up. .....

(g) A lit candle burns for less time in a small sealed container than it does in a large sealed container. .....

(h) A gust of air can blow out a burning candle. .....

(i) If a beaker is held above a burning candle it gets covered with a black, sooty substance. .....

(j) The ash remaining after a log of wood burns has much less mass than the original log. .....

(k) When a log is burned, a lot of smoke is produced. .....

(l) When methylated spirits burns, there is no ash or any residue at all. (There are two possible answers here – see if you can explain both.) .....

(m) An electric light globe gives off heat and light energy for months without any noticeable change. .....

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8.3.2 Analysing an experiment

Use the following information to answer the next EIGHT questions.

In an experiment, the same amount of hydrochloric acid was added to equal amounts of four different carbonates in different test tubes. The results are shown in the table.

Time (mins)	Volume of gas given off (mL)			
	Calcium carbonate	Copper carbonate	Magnesium carbonate	Zinc carbonate
1	1	2	1	1
2	3	5	4	2
3	7	9	8	5
4	11	16	13	9

8.3.2.1 Which of the following four factors *does not* have to be controlled for this to be a fair test of which compound is fastest to react with the acid?

(A) The concentration of the acid.
(B) Whether the test tubes are shaken or not.
(C) The mass of each compound used.
(D) The size of the test tube rack.

8.3.2.2 According to this data, which compound was the fastest to react with the acid?

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8.3.2.3 Justify your answer to Question 8.3.2.2.

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8.3.2.4 Which statement about the relative chemical activity of these compounds is true?

(A) The activity of calcium carbonate is greater than the activity of copper carbonate.
(B) The activity of zinc carbonate is greater than the activity of calcium carbonate.
(C) The activity of magnesium carbonate is greater than the activity of zinc carbonate.
(D) The activity of zinc carbonate is greater than the activity of copper carbonate.

8.3.2.5 Name the gas given off during these reactions. .....

8.3.2.6 Write the chemical formula for this gas. .....

8.3.2.7 Write the chemical formula for hydrochloric acid. .....

8.3.2.8 Write a word equation for the reaction between the calcium carbonate and the acid.

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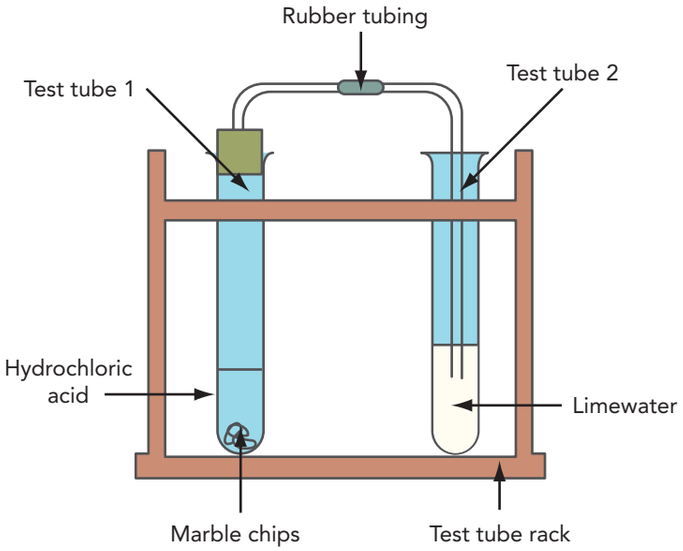
8.3.3 Hydrochloric acid and sodium carbonate

If you can, get the reactants for this experiment from your teacher and actually do it. If not, then still answer the questions here, putting in predictions of what would happen if you did do the experiment rather than your observations.

(a) You need some calcium carbonate in the form of marble chips, as well as hydrochloric acid, limewater, and a piece of bent glass with a cork. You will also need two test tubes and a test tube rack. Set up the equipment, as shown in the diagram.

(b) Put the sodium carbonate in one test tube and add 5 mL of hydrochloric acid. Quickly cork the tube and run the glass tubing into the second tube containing the limewater.

(c) Observe what happens in both test tubes.



8.3.3.1 What are the reagents for the reaction in the first test tube?

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8.3.3.2 What are the products of this reaction?

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8.3.3.3 What are the reagents for the reaction in the second test tube?

.....

8.3.3.4 What are the products of the reaction in the second test tube?

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8.3.3.5 What three pieces of evidence in the first test tube show that a reaction is occurring?

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8.3.3.6 What does the reaction in the second test tube prove?

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8.3.3.7 You have been given three beakers labelled X, Y and Z. Each contains a solution of sodium carbonate, a colourless chemical, dissolved in water. The solutions have three different concentrations and your task is to find out which is the most concentrated, the next most concentrated and the least concentrated by two different methods.

(a) Outline what you need to do for each method, indicating equipment you would need and how you would analyse your results to find the answer to the problem.

Method 1

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Method 2

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(b) Which would be the better method to use? Justify your answer.

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