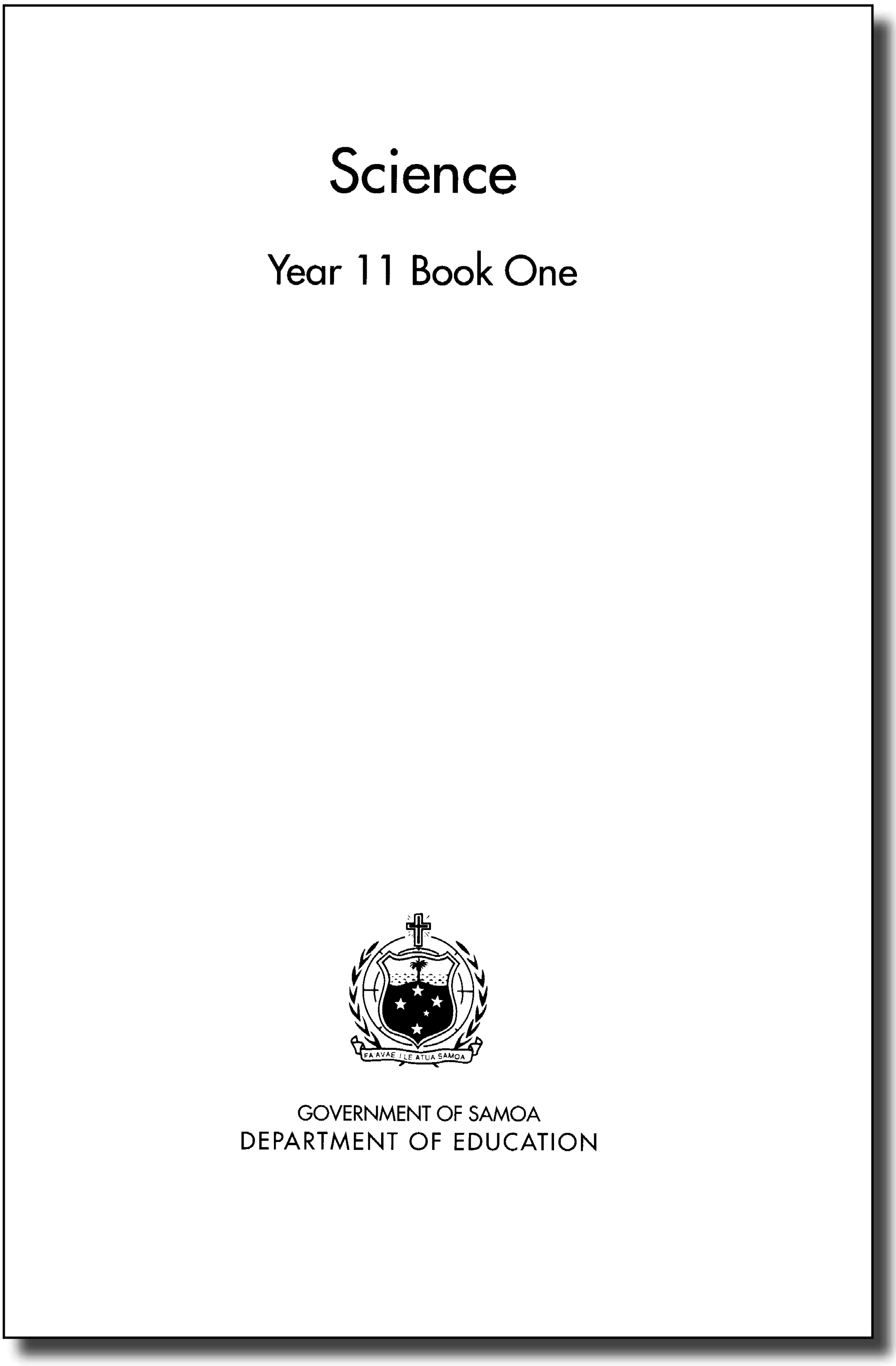
Book 1

Year 11

Science



Science

Year 11 Book One

GOVERNMENT OF SAMOA
DEPARTMENT OF EDUCATION

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Unit 1: REVISION

Introduction

This is a revision chapter. Use it to remind you what was covered in Year 10 Science.

Plants

Flowering plants produce seeds that hold an embryo plant. When a seed germinates, the embryo plant inside it grows into a seedling and then into an adult plant.

Asexual reproduction uses a part, such as the stem, of the parent plant to grow a new plant. The new plant has the same genetic make up as the parent. Plants can reproduce very quickly using asexual reproduction. Examples of plants that reproduce asexually include suckers, tubers, corms and rhizomes. People use cuttings, headsets and tissue culture to produce plants asexually.

Sexual reproduction produces offspring that have a different genetic make-up to the two parent plants and may be better suited to the environment than the parents.

There are four processes important in sexual reproduction in plants:

1. **Making gametes** — Adult plants have flowers that produce pollen and ovules.
2. **Pollination** — Pollen is transferred from the anther to the stigma.
3. **Fertilisation** — The male gamete joins with the female gamete.
4. **Dispersal** — The seeds are spread away from the parent plant.

Pollination occurs when pollen is transferred from an anther to a stigma. In animal-pollinated plants the petals are often scented and brightly coloured to attract the animal to the flower. The pollen sticks to the animal and is taken to the next flower it goes to. Wind is also used to transport pollen from one plant to another. These plants often have flowers that have dull colours and no scent.

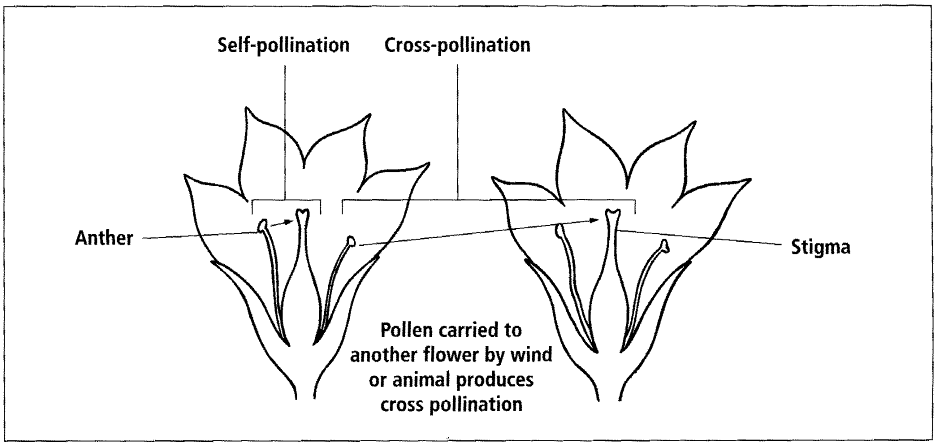


Diagram 1.1
Self- and cross-pollination.

There are two types of pollination: **cross-pollination** and **self-pollination.** Cross-pollination occurs when the pollen from the flower of one plant travels to the stigma of the flower of another plant from the same species. Self-pollination occurs when the pollen travels to the stigma in a flower on the same plant.

Seeds have a hard testa, an embryo plant and a cotyledon that stores the sugars that the embryo plant will need until it can make sugars itself.

Germination is the growth of the embryo plant inside the seed, which splits the testa open and the radicle and plumule grow into a seedling plant. Plants grow by their cells dividing to make new cells and the cells getting bigger.

Activity 1 Plants

Aim To revise information about plants.

1. Copy the diagram below and match the labels A-H with the part names listed below.

ovary	sepal	petal	anther
style	filament	stigma	ovule

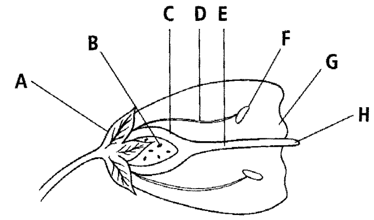


Diagram 1.2
Flower parts.

2. Rewrite the following table in your book. Match the flower part with its correct function.

Part of the flower	**Function**
Stigma	Makes pollen.
Style	Bright colours to attract animals to the flower.
Ovary	Place where pollen lands and begins to grow.
Anther	Holds anther in place.
Filament	Protects the flower.
Sepal	Holds stigma in place.
Petals	Makes ovules.

3. What is the difference between cross-pollination and self-pollination?
4. What is the difference between asexual and sexual reproduction?

Cell Processes

Diffusion is the movement of a chemical from an area where it is in a high concentration to an area where it is in a low concentration. This movement happens when moving particles bang into each other. Diffusion happens quicker in hot temperatures. For example, when you make coffee with boiling water the sugar quickly diffuses evenly in the hot water.

Osmosis is the movement of water through a semi-permeable membrane. The water moves from an area of high concentration to an area of low concentration.

Photosynthesis is the process plants use to make sugars. Carbon dioxide, water, light and chlorophyll are needed for plants to carry out photosynthesis. Glucose sugar and oxygen are produced. The plant uses the glucose and oxygen for respiration or stores the glucose as starch.

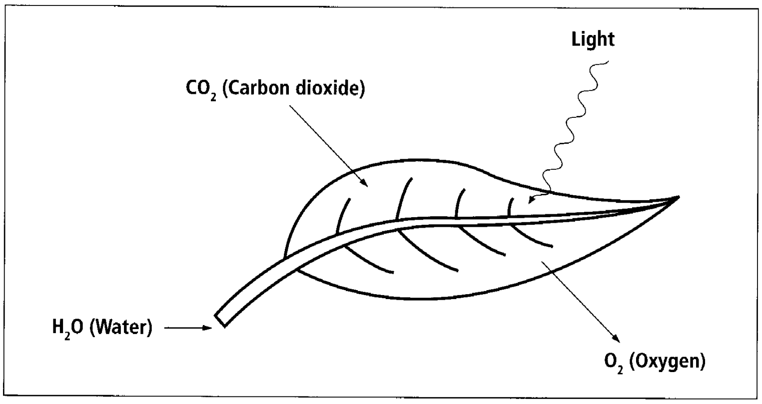


Diagram 1.3
How materials needed for photosynthesis enter the leaf.

Respiration is the process used by cells to get energy from chemicals to use for their life processes. Glucose and oxygen are needed for respiration. The process of respiration produces carbon dioxide and water.

Mitosis is the process of cell division where one cell forms two cells. Each cell has a copy of the same genetic material. These cells are used for growth, repair and replacement of other cells.

All cells require oxygen and glucose sugar to carry out respiration to get the energy they need to live. When plant cells with chloroplasts are in light they also require carbon dioxide and water to carry out photosynthesis. Oxygen is a waste product of photosynthesis. Humans and other animals use the oxygen produced by plants to carry out respiration.

Activity 2

Cell Processes

Aim To revise information about cell processes.

1. Describe two examples of diffusion.
2. What is the difference between osmosis and diffusion?
3. Write the word equation showing the process of photosynthesis.
4. Name three things the cells produced by mitosis are used for.

Variation

Variation is the difference in living things that can be caused by environmental or genetic factors. **Genetic variation** happens through mixing of genetic material during sexual reproduction. Genetic variation is important to a group of organisms as it improves their chances of survival if conditions in their environment change.

Continuous variation can be measured. Finger length is an example of continuous variation. Information on continuous variation is recorded in frequency tables and presented in frequency histograms. When using frequency tables and histograms it is important to choose carefully which data classes to use. If the data classes used are too wide or too narrow the pattern in the data is not easily seen.

Discrete variation can be counted and is always a whole number (*e.g. 1, 2, 3 or 4*). Having a straight or hitchhiker thumb, or being male or female are examples of discrete variation. Information about discrete variation can be recorded in frequency tables and presented in bar graphs.

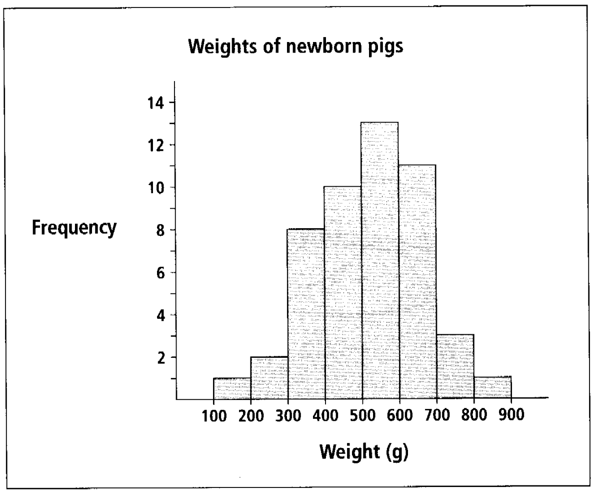


Diagram 1.4
Frequency histogram used for data on continuous variation.

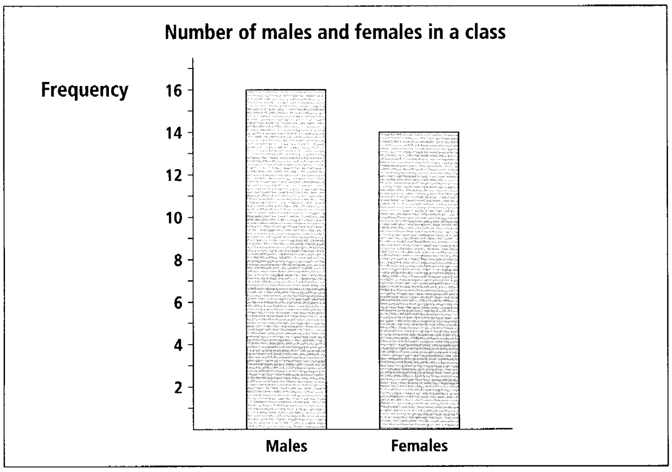


Diagram 1.5
Bar graph used for data on discrete variation.

Activity 3 Variation

Aim To revise information about variation.

1. Draw the table below in your exercise book. Put the following variations into the table under the correct heading:

foot length	hair length
can or cannot roll tongue	height
dimple cheek or smooth cheek	weight
attached or hanging earlobe	

Continuous variation	Discrete variation

2. What causes genetic variation? Explain why this is important for survival.
3. State two differences between continuous variation and discrete variation.

Pathogens

Pathogens are micro-organisms that cause diseases. Pathogens can be transferred from one person to another. The pathogen grows and feeds on the host or reproduces in host cells. This is what causes the disease.

The skin and fluids such as tears, stomach acid and mucous are the body's first defence against pathogens. The job of these defences is to stop pathogens from getting into the body.

If the pathogens get into the body the second defence is the white blood cells. White blood cells are called **phagocytes**. Phagocytes eat the pathogens and the body cells they have damaged.

Phagocytes are part of the body's inflammatory response. The inflammatory response is a series of steps used to help fight pathogens that have entered a body.

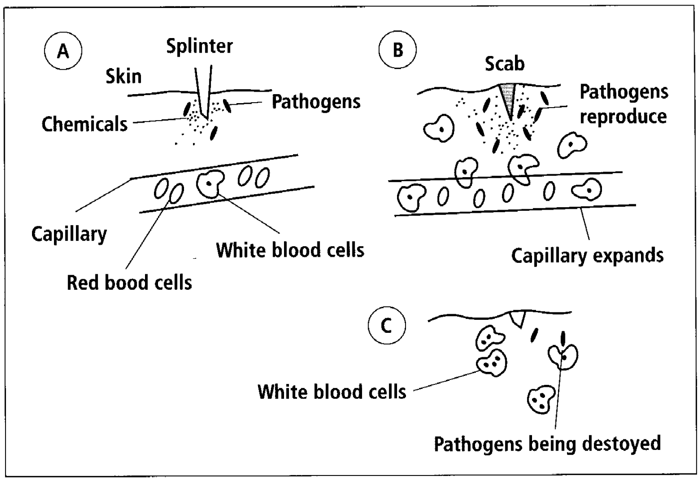


Diagram 1.6
The inflammatory response.

The third line of defence against pathogens is the making of **antibodies**. This happens about five days after the pathogens have entered the body. Antibodies are proteins that join onto the outside of the pathogen and burst it. This stops the pathogen from reproducing and makes it easier for the white blood cells to eat it.

The production of antibodies against a pathogen is called natural immunity. Passive artificial immunity is given by injecting antibodies into a person. Active artificial immunity occurs when a healthy person is injected with dead or weak pathogens and their body makes antibodies against the pathogen. The advantage of natural and active immunity is that the body remembers how to make the antibodies and the next time it is exposed to the pathogen it makes antibodies immediately.

Different pathogens cause different symptoms. Fevers and chills are common symptoms. The pulse rate is also increased during an infection. Headaches, aching joints and diarrhoea are other symptoms of infection.

HIV is transferred between people by the transfer of infected cells in body fluids such as blood and semen. HIV kills people by infecting the cells of the immune system. This lets AIDS develop and the person dies from disease because their infected immune system is unable to fight pathogens.

The pathogens that cause food poisoning harm the person by producing toxins or by infecting the person's digestive system. Careful handling, cooking and storage of foods can stop food poisoning. Foods can be preserved by a number of ways that stop the bacteria from growing and reproducing in the food.

Activity 4

Pathogens

Injected with dead or weak pathogens; injecting antibodies into the person; body makes antibodies against the pathogen; body remembers pathogen.

Aim To revise information on pathogens.

1. How does the body stop pathogens from getting inside the body?
2. What are phagocytes and what do they do?
3. Sort the statements in the box to the left into two groups under the headings: **passive artificial immunity**; and **active artificial immunity**.
4. Why does AIDS always result in death?
5. How do pathogens cause food poisoning?

Digestive System

The digestive system ingests food, then breaks it down into nutrients using a process called digestion. There are four processes involved in digestion. These are **ingestion**, **digestion**, **absorption** and **egestion.** Ingestion is the intake of food. Digestion is the breaking down of food into nutrients. Absorption is the diffusion of these nutrients into the bloodstream. The undigested waste products are then egested (removed) by the body. Each part of the digestive system carries out one or more of the processes of ingestion, digestion, absorption and egestion.

Physical digestion breaks down lumps of food until they become a liquid. Physical digestion occurs in the mouth and stomach.

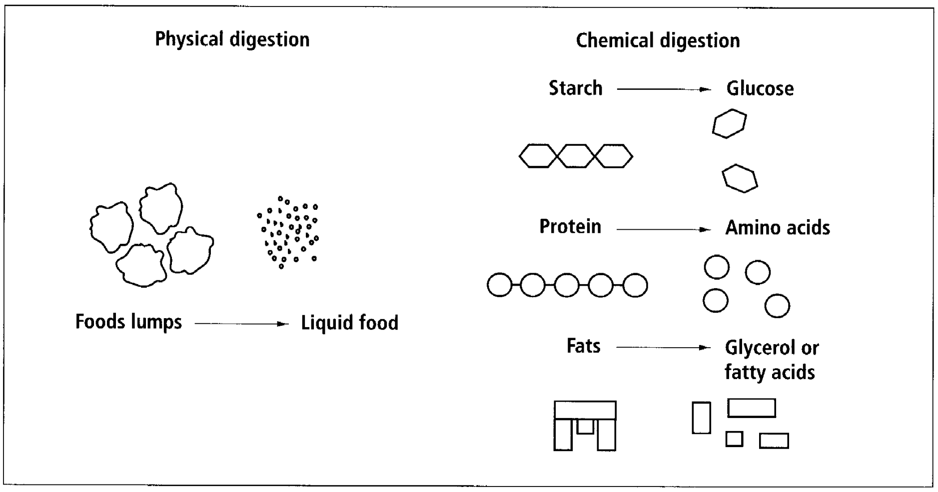


Diagram 1.7
Physical and chemical digestion.

Chemical digestion occurs when enzymes break down large chemicals in foods into small nutrients that the body is able to absorb into the blood. The mouth, stomach, small intestine, liver and pancreas produce different enzymes to digest different nutrients.

All animals have slightly different digestive systems. The digestive system of an animal is suitable for the types of food that it eats. Some animals use micro-organisms to digest the fibre in plant material. These animals have a part in their digestive system that keeps the micro-organisms alive.

Birds have some special features related to their way of life. They have no teeth which gives them a lower weight. It is easier for birds to fly when they have a lower weight.

There are many diseases and malfunctions that may cause the digestive system to not function correctly. When a disease or malfunction occurs in the digestive system, the body is unable to get the nutrients it needs and the person will lack the energy needed to carry out everyday activities.

Activity 5 Digestive System

Aim To revise information about the digestive system.

1. Explain the difference between physical digestion and chemical digestion.
2. Why do animals such as horses have different digestive systems to humans?
3. What happens when there is a disease or malfunction in the digestive system?
4. The processes carried out in the digestive system are ingestion, digestion, absorption and egestion. Describe each process in your own words.

Skeleto-Muscular System

The skeleto-muscular system is made up of bones, muscles, tendons and ligaments. Some animals have an **exoskeleton** on the outside of their bodies and some have an **endoskeleton** on the inside of their bodies. For example, coral and crabs have exoskeletons and humans and fish have endoskeletons.

The functions of the skeleton are to give shape, support and protection. Muscles join onto the skeleton in ways that allow us to move. Bones store calcium and phosphorus and make blood cells. Bones inside ears allow animals to hear sounds.

The four main parts of the human skeleton are vertebral column, ribcage, skull and limbs. These parts are made up of bones of different shapes and sizes.

Bones are light and strong and made out of protein and calcium phosphate. They have bone cells that grow between the protein fibres and crystals of calcium phosphate.

Tendons tie the muscles to the bones. This lets the muscles pull on the bones and move them.

Joints hold the ends of bones together. The **ligaments** link the bones together. Cartilage, on the ends of the bones, is smooth and slippery so that the bones of the joint can move easily and without pain. Some joints are movable, for example, ball and socket joints and hinge joints. This means that when muscles pull on the bones in these joints the bones move. Some joints are fixed and the bones cannot move: *e.g. The joints between the bones of the skull of an adult are fixed joints.*

Muscles are made up of fibres with proteins inside them. These proteins are able to get shorter and longer. This is called contracting and relaxing. When a muscle contracts it gets shorter and thicker. Muscles that cause movement work in antagonistic pairs. One muscle contracts to move the bone in one direction and the other contracts to move the bone in the opposite direction.

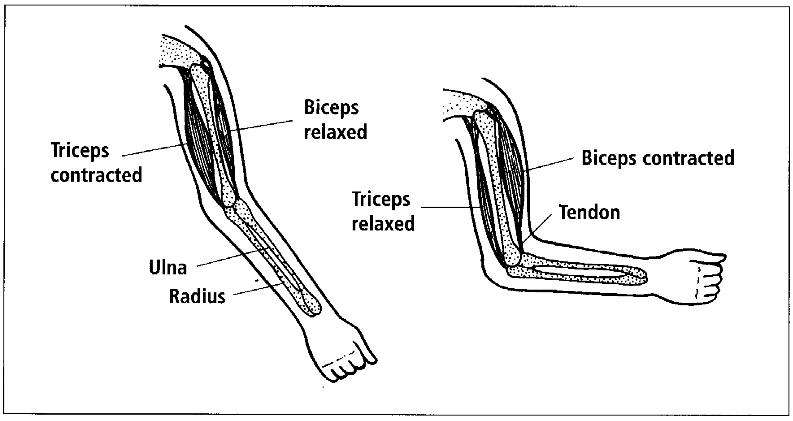


Diagram 1.8
Antagonistic muscles in the arm.

Muscles need energy to contract. Firstly this comes from aerobic respiration but if the exercise continues and there is not enough oxygen the muscles use anaerobic respiration. Lactic acid is a waste product of this respiration. If the amount of lactic acid in the muscle builds up it causes muscle fatigue.

Activity 6

Skeleto-Muscular System

Aim To revise information about the skeleto-muscular system.

1. List three reasons why the skeleton is important to humans.
2. Name the four main parts of the human skeleton.
3. What is the difference between muscles, tendons and ligaments?
4. Describe how a person's muscles, bones, tendons, joints and ligaments work together to move a person's arm.

Adaptations And Environment

The habitat and its environment are important to living organisms. Different organisms have different adaptations that help them to live in the habitat.

Adaptations can be structural, behavioural or functional. **Structural adaptations** are the physical parts of plants and animals. For example, your heart and the branches of a tree are structural adaptations.

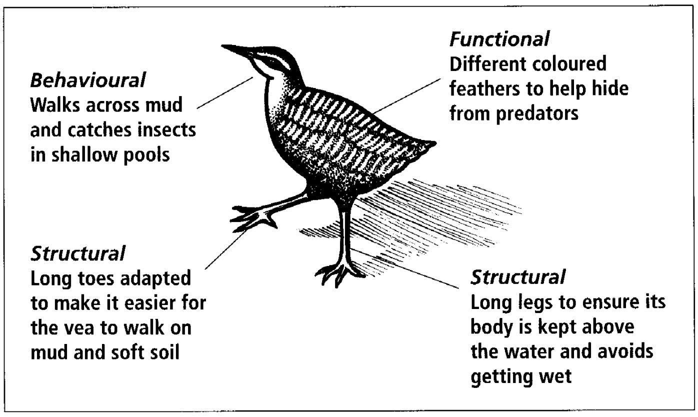


Diagram 1.9
Adaptations of vea.

Behavioural adaptations are the way a plant responds to its environment and the way an animal behaves. Examples of this are plants that respond to their environment by growing towards the most light. The way pusi move quickly out of holes to catch another animal is an example of behavioural adaptation.

Functional adaptations are the abilities of the living organism to make chemicals or control something inside itself. The ability of the nofu to produce poisonous chemicals is a functional adaptation. Another functional adaptation is the ability of nui to produce strong fibres in its leaves.

Life histories show how an organism lives and carries out growth and reproduction.

Human activities change the habitats and environments of plants and animals. Sometimes the changes mean the organism can no longer live in the area. Sometimes the human activities change the balance of organisms living in an area.

Convection currents in the air and water around the world influence the weather in Samoa. El Niño weather patterns occur every two to seven years. Often cyclones occur with these weather patterns. The Meteorology Division uses measuring equipment at weather stations around Savai'i and Upolo to collect information about the weather conditions in Samoa.

Activity 7

Adaptations And Environment

Aim To revise information about adaptations and environment.

1. Give two examples of behavioural, structural and functional adaptations.
2. Describe or draw a diagram to show the life history of a common organism such as a turtle or pig.
3. What affect do humans have on other living organisms?
4. What do convection currents in air and water affect?

Changing Earth

Soil is the surface layer of Earth that supports plant life. It is made up of fine particles of **inorganic matter**. Living organisms and dead plant and animal material are called **organic matter**. The organic matter in the soil is broken down into minerals which are then absorbed by plants. Having lots of organic matter or humus in the soil improves the structure of the soil and provides a good supply of minerals for plant growth.

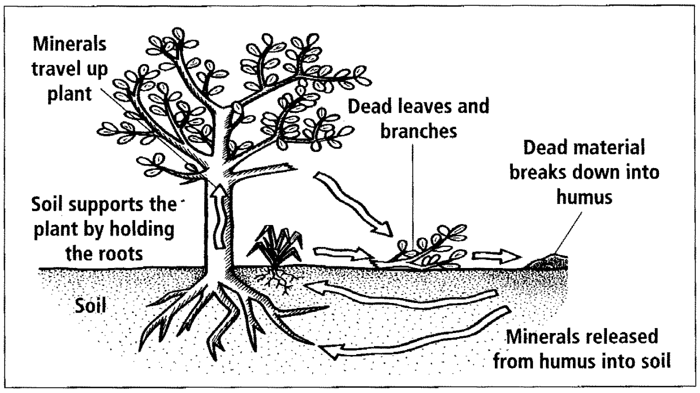


Diagram 1.10
Recycling minerals.

Loam soils are made up of a mix of silt, sand, and clay particles. These soils are good for growing plants because the different particles they contain make them well draining and well aerated (filled with air). Soil structure is related to the way the particles in the soil group together in **peds**. Good soil structure allows lots of air spaces between the peds.

Soil will have a texture from smooth to gritty. Clay soils feel smooth and sand is very gritty. Good soils for growing plants have textures somewhere in between smooth and gritty.

A soil profile shows all the layers in the soil from the plants on the top to the parent material or rock at the bottom.

Weathering breaks rock into smaller pieces that then form soil. Soil can be lost by **erosion**. During erosion, soil is washed away by the flow of water, such as heavy rain or the effects of a river.

The Earth is a sphere made up of four layers: the crust, mantle, liquid outer core and solid inner core. The crust layer is made up of a number of large plates. Some plates are mostly heavy, ocean-bottom material. Other plates are mostly lighter continental material. The plates move across the surface of the Earth, pushed by the convection current of the magma in the mantle layer.

There are three different types of plate boundary. There are places called **construction** boundaries, where new material is forming. **Convergent** boundaries are areas where two plates are moving into each other. The plate made out of the heavier material subducts (moves sideways and downward) under the lighter plate. This causes lots of earthquakes and volcanic eruptions. **Transform** boundaries, where the plates slide past each other, are also areas where more earthquakes occur.

The 'Ring of Fire' is an area around the Pacific Ocean where there are a number of plate boundaries that are subduction zones. Most of the Earth's earthquakes and volcanic activity occur in the 'Ring of Fire'. Hot spots are areas in the Earth's crust where volcanoes occur that are not on plate boundaries.

Activity 8 Changing Earth

Aim To revise information on changing Earth.

1. What is loam soil?
2. What does a soil profile show?
3. Name the four layers of the Earth.
4. Explain the difference between the three different types of plate boundary.
5. What is the Ring of Fire?

Unit summary

Copy out each of the following sentences and fill in the missing word(s). The capital letter is the first letter of each missing word.

Plants

1. Animal-pollinated flowers often have bright, (S _ _ _ _ _ _) flowers.
2. Germination is the growth of the (E _ _ _ _ _) plant inside the seed.
3. The scientific name for a 'sex cell' is a (G _ _ _ _ _).
4. When pollen is transferred from an anther to a stigma it is called (P _ _ _ _ _ _ _ _ _ _ _).

Cell processes

1. The movement of a chemical from an area of high concentration to an area of low concentration is called (D _ _ _ _ _ _ _ _).
2. The movement of a chemical from an area of high concentration to an area of low concentration through a semi-permeable membrane is called (O _ _ _ _ _ _).
3. At the end of photosynthesis plants store the glucose formed as (S _ _ _ _ _).
4. Humans use the (O _ _ _ _ _) produced by plants to carry out respiration.
5. The cells produced by mitosis have the same (G _ _ _ _ _ _) material as the parent cell.

Variation

1. Genetic variation improves the chances of (S _ _ _ _ _ _ _) of a group of organisms.
2. The information graphed on histograms is (C _ _ _ _ _ _ _ _ _ _) data.
3. The information graphed on bar graphs is (D _ _ _ _ _ _ _) data.
4. Genetic variation is caused by (S _ _ _ _ _) reproduction.
5. Environmental variation is caused by the (H _ _ _ _ _ _) of an organism.

Pathogens

1. Pathogens are micro-organisms which cause (D _ _ _ _ _ _ _ _).
2. Fluids such as (M _ _ _ _ _ _) help to stop pathogens from entering the body.
3. White blood cells are called phagocytes because they (E _ _) pathogens.
4. Proteins that the body makes to attack pathogens are called (A _ _ _ _ _ _ _ _ _ _).
5. The HIV virus effects the (I _ _ _ _ _ _) system.

Digestive system

1. The teeth help with (I _ _ _ _ _ _ _ _ _) by cutting the food so it fits in the mouth.
2. Most of the chemical digestion occurs in the (S _ _ _ _ I _ _ _ _ _ _ _ _ _).
3. Chemicals that break down food are called (E _ _ _ _ _ _ _).
4. Some animals use (M _ _ _ _ -_ _ _ _ _ _ _ _ _ _) to help digest their food.
5. People with malfunctions of the digestive system will lack (E _ _ _ _ _) because they are not able to get the nutrients they need.

Skeleto-muscular system

1. The type of skeleton that is on the outside of the body is called an (E _ _ _ _ _ _ _ _ _ _ _).
2. Bones store (C _ _ _ _ _ _ _) and (P _ _ _ _ _ _ _ _ _ _).
3. Muscles that cause movement are called (A _ _ _ _ _ _ _ _ _ _ _ _) pairs.
4. The slippery material on the ends of bones is called (C _ _ _ _ _ _ _ _ _).
5. A build up of lactic acid causes (M _ _ _ _ _ F _ _ _ _ _ _ _).

Adaptations and environment

1. (A _ _ _ _ _ _ _ _ _ _ _) help the organism to live in an area.
2. Being active at night is a (B _ _ _ _ _ _ _ _ _ _ _) adaptation.
3. The ability of plants to make chlorophyll is a (F _ _ _ _ _ _ _ _ _ _) adaptation.
4. El Niño weather patterns sometimes bring (C _ _ _ _ _ _ _ _).

Changing earth

1. The sand, clay and silt make up part of the (I _ _ _ _ _ _ _ _ _) matter in soil.
2. When wind, rain and ice break rocks into smaller pieces it is called (W _ _ _ _ _ _ _ _ _ _).
3. The mantle layer of the Earth is made up of (M _ _ _ _).
4. A plate boundary where new crust material is forming is called a (C _ _ _ _ _ _ _ _ _ _ _ _) boundary.
5. Most of the world's (E _ _ _ _ _ _ _ _ _ _ _) and (V _ _ _ _ _ _ _ _) activity occur in the 'Ring of Fire'.

Unit 2: EXCRETORY SYSTEMS

Language note:

The word family for the word 'excrete' includes: excretes, excreted, excreting, excretion, excretory.

In this unit, you will investigate the structure and function of the excretory system and how the organ systems in the body work together to keep us alive.

When our bodies are doing things like running and thinking, we are using energy. The energy is formed during a series of chemical reactions carried out in the cells of our bodies. These chemical reactions are one of the ways that our body forms **wastes** that are no longer useful to us. Sometimes the wastes produced are poisonous to us and must be removed as soon as possible. If these wastes are not removed the amounts of them in the body increase and cause us harm. The **excretory system** is a group of organs working to remove these wastes from the body so that they don't cause us harm.

The excretory system is made up of two **kidneys** and the **bladder**. Each kidney is connected to the bladder by a thin tube called the **ureter**. The bladder opens to the outside of the body through a tube called the **urethra**. In males the urethra goes down the inside of the penis.

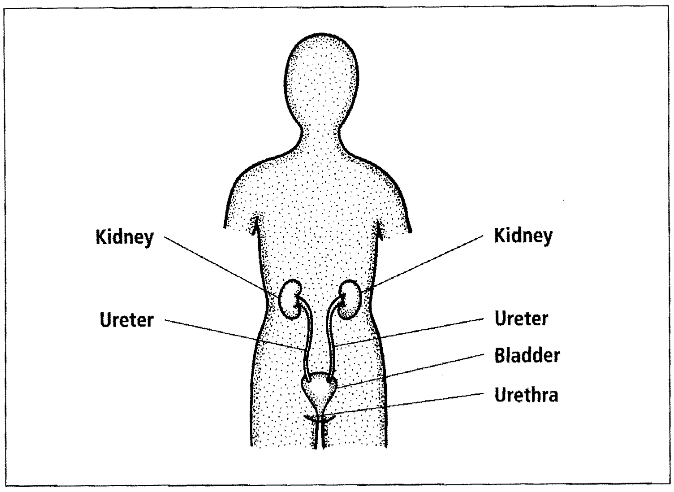


Diagram 2.1
Human excretory system.

Activity 1

Materials needed:
Pig or chicken.

Excretory Systems

Aim To investigate the structures that form part of the excretory system.

Pig excretory system

If you get the chance, look at the kidneys and liver while they are still inside the dead pig. Pigs have excretory systems similar to humans.

1. Draw or describe the size, shape and location of the liver and kidneys and their coverings.
2. Try to find the bladder. It is a small, white, tough, oval-shaped organ up inside the body between the hind legs.
3. Remove the kidneys and liver. Draw or describe the size and shape of the kidneys and liver. Record any other details you notice.
4. Cut one of the kidneys open. Draw or describe the inside structure.
5. Cut the liver open. Draw or describe the inside structure.

Chicken excretory system

The kidneys in chickens are set into the backbone of the chicken. They are softer than the kidneys from mammals such as pigs and are usually destroyed when they are removed from the chicken.

1. Locate the kidneys or parts of the kidneys.
2. Draw or describe their size, shape and location.
3. Remove some of the kidney and describe its colour, texture etc.

Removing Wastes

The liver is an important organ that works with the excretory system. It is able to change harmful waste materials into less harmful materials that can be more easily excreted. The most important waste removed by the liver is ammonia. The liver takes the waste ammonia and changes it into urea. Urea is less harmful to our bodies and the kidneys are able to excrete urea much more easily. The liver releases the urea into the blood and it flows in the circulation system to the kidneys.

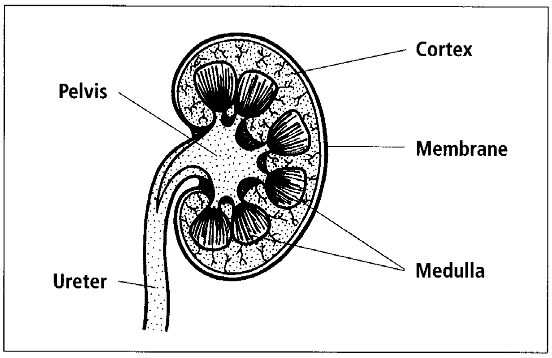


Diagram 2.2
Inside a kidney.

Blood flowing in the artery to the kidney carries the waste materials into the kidney. The blood pressure inside the kidneys causes small materials to be filtered from the blood into small tubes that run through the kidney. Some of these small materials are needed by the body, for example glucose. The kidney is designed to take the materials that are not wastes and put them back into the blood. Any materials that the body does not want are left in the tubes. These include ions such as sodium, potassium, chlorine and hydrogen. It can also include some vitamins, such as vitamin C, that the body has too much of and can't store.

The waste materials, such as urea, move along the tubes in the kidney. Other materials, such as water, may or may not be added to the wastes in the tubes. If your body has lots of water then more water will be added to the wastes. If your body does not have much water the kidney will take some water from the tubes and put it back in the blood. Some water is always lost in the urine as it is used to dilute the urea so that it doesn't harm the body. All the wastes in the tubes are collected together to form the urine.

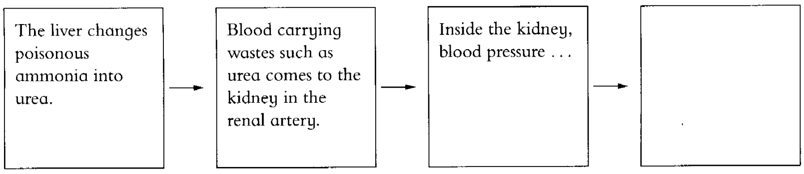
The urine travels down the ureter into the bladder where it is stored until it is released. The bladder slowly stretches as more urine is added to it. When the bladder is full nerves tell the brain that the bladder needs to be emptied. When the person is ready the muscles around the urethra relax and the urine is released.

Activity 2

Making Urine

Aim To show the process the body uses to excrete harmful materials and other wastes.

1. Complete the following in your exercise book:
   a. Name the harmful material that the liver removes from our bodies.
   b. Name the material that the liver produces and the kidneys excrete.
   c. Explain why ammonia is changed into urea. (Two reasons needed.)
   d. How do waste materials get to the kidney?
   e. What happens to the small materials in the blood when the blood gets inside the kidney?
   f. What happens to the useful materials that go into the tubes of the kidneys?
   g. Different things happen to some of the water in the tubes of the kidneys. Explain what could happen and why.
   h. Name the liquid that is produced by the kidney.
   i. Describe how the bladder works.
   j. Name seven materials that could be found in urine.
2. Complete the following flow chart to show how urine is formed by the kidneys.



The liver changes poisonous ammonia into urea.

Blood carrying wastes such as urea comes to the kidney in the renal artery.

Inside the kidney, blood pressure . . .

Diagram 2.3
How urine is formed.

Other Organs That Remove Wastes

The lungs, intestines and skin are organs that work with the excretory organs to help the body get rid of wastes.

Lungs

The lungs are the organ that removes most of the waste carbon dioxide from the body. The cells in the body produce carbon dioxide as a waste product. It is formed during the process of respiration which cells use to release energy from sugars.

The carbon dioxide moves out of the cells and dissolves into the liquid part of the blood in the capillaries. It then travels from the capillaries into the veins and through the circulation system to the lungs. In the lungs the carbon dioxide goes from the blood into the air inside the lungs. It is breathed out with the air. At the same time, oxygen goes from the air in the lungs into the blood and is then transported to the cells.

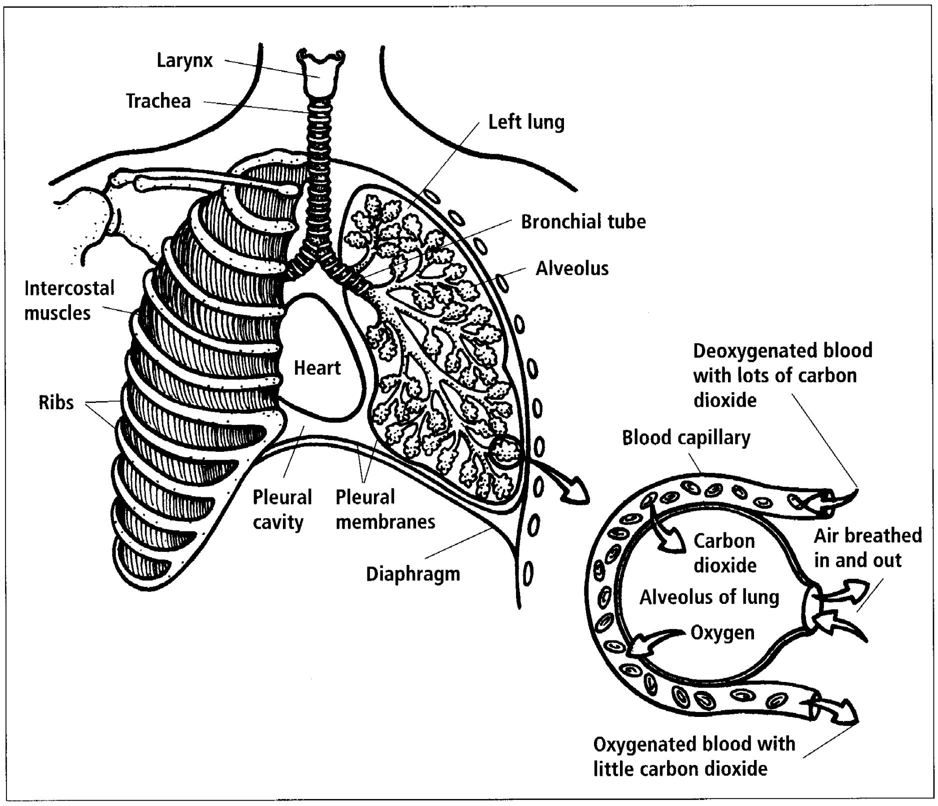


Diagram 2.4
The lungs remove carbon dioxide from the blood.

Skin

The skin is used to help the body get rid of some salts and water. When the body is too hot it sweats. The sweat is made up of salts and water. This means that when a person sweats they are excreting water and salts.

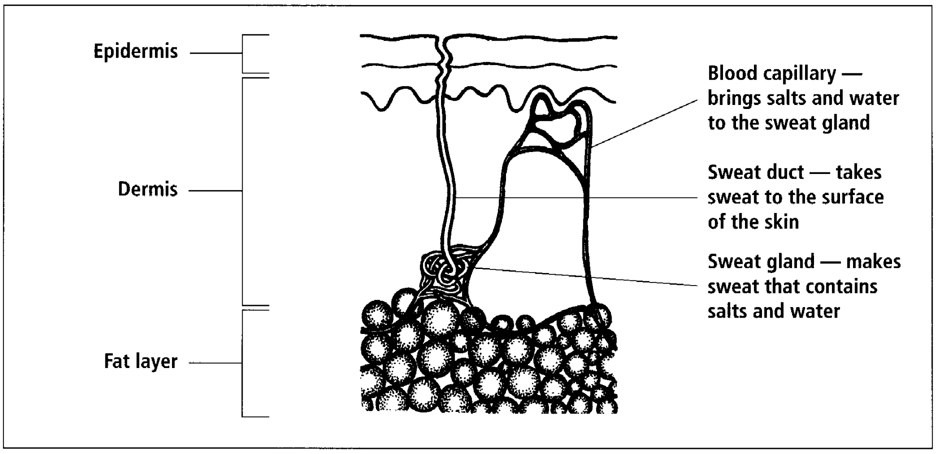


Diagram 2.5
The skin helps to remove salts from the body.

Intestines

Some of the wastes that are made by the liver are stored and then released into the intestines. The types of wastes that are excreted in this way are cholesterol and other fats. These wastes move through the intestine with the food and are removed from the body with the faeces.

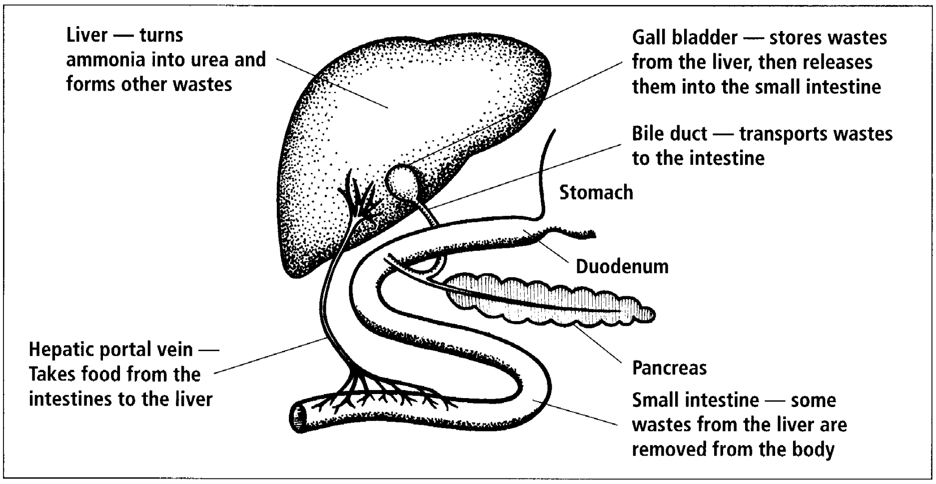


Diagram 2.6
Wastes go from the liver into the small intestine.

There is one type of waste that is not excreted by the body. This is the undigested food. It passes through the intestine and is released. This waste is called faeces. Faeces are egested from the body, not excreted. Wastes that are excreted are the wastes that have been produced by chemical reactions occurring in the cells in the organs of the body.

Activity 3

Organs That Help The Excretory System

Aim To sort information on the organs that help the excretory system remove wastes.

1. Rewrite the table below, matching the organ with the waste it removes and how it removes the wastes.

Organs	**Waste**	**How wastes are removed**
Lungs	Cholesterol	Dissolves in the blood, then into the air and is breathed out.
Skin	Carbon dioxide	Sweat is formed which removes the wastes from the body.
Intestines	Salts and water	Wastes formed in the liver are released into the bile. The bile is used to help digest food and the wastes are released with the faeces.

2. Describe what happens in egestion.
3. Explain how excretion and egestion are different.

Activity 4

Research

Aim To research information on a topic related to excretion.

Select a topic, find out about the topic and then present the information you found to the class. You can present your work in a report, a poster or a talk.

Possible topics:

- Kidney stones (*e.g. What they are, how they form, what happens when you get them, how they are treated*).
- Kidney failure.
- Hepatitis.
- Detailed kidney structure.
- Water balance in the body.
- Kidney machine.
- Liver cancer.
- Detailed liver structure.
- Excretion in fish.

Organ Systems Working Together

The excretory system can only work properly when it is linked to the other organ systems in the body. The circulatory, respiratory and excretory systems all work together to keep our bodies healthy.

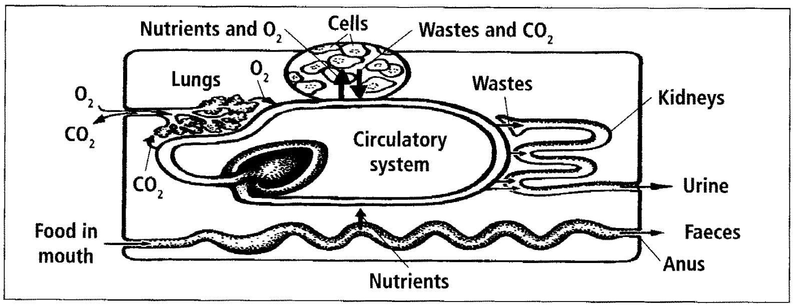


Diagram 2.7 *Organ systems working together.*

Activity 5 Organ Systems Working Together

Aim To record information on how the circulatory, respiratory and excretory systems work together to keep our bodies healthy.

1. Use the information in the boxes below to draw a diagram or write an essay that shows how the main organs of these systems work together to keep the body alive. More information is available in Year 9 Science Book 1 and Year 10 Science Book 1.

Circulatory system	**Respiratory system**	**Excretory system**
Heart, arteries, veins, capillaries	Lungs, diaphragm, nose, trachea	Kidneys, ureter, bladder, urethra
Food, oxygen and other materials are transported around the body in arteries. In the capillaries the food and oxygen move into the cells. In the capillaries wastes from the cells go into the blood. The veins carry the blood back to the heart. The heart is a pump that pushes the blood around the body.	The diaphragm helps to pull air in through the nose. The air travels from the nose to the trachea and into the lungs. In the lungs the oxygen in the air moves into blood capillaries. In the lungs carbon dioxide waste in the blood moves into the air in the lungs. The diaphragm relaxes and pushes the air out of the lungs.	The kidneys filter wastes from the blood. The kidneys then take some materials back into the blood. The kidneys add some other material from the blood to the fluid. The fluid becomes urine. Urine travels down the ureter to the bladder. The bladder stores the urine. The urine flows out through the urethra.

2. The digestive system is another important organ system. Explain why the digestive system is important to the other organ systems in the body.

Activity 6 Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all have only the key words written down. Some people use concept maps as their study notes.

Unit 3: REPRODUCTIVE SYSTEM

Language note:

The word family for the word 'reproduce' includes: reproduces, reproduced, reproduction, reproductive.

In this unit, you will investigate the structure and function of the reproductive system.

All living organisms must produce young organisms called **offspring**. The reproductive system makes the cells that are needed to form offspring. In some living organisms, such as people, the reproductive system holds the offspring for a time while they develop. The offspring are then born and are looked after by the parents.

The reproductive system of a female bird forms an egg around the offspring. The bird sits on the eggs to keep them warm as the young birds develop inside them. After the offspring hatches out of the egg, the parents feed the offspring as it continues to develop and grow.

Each living organism has a life history. A diagram of the life history of a living organism can show the processes involved in reproduction and growth.

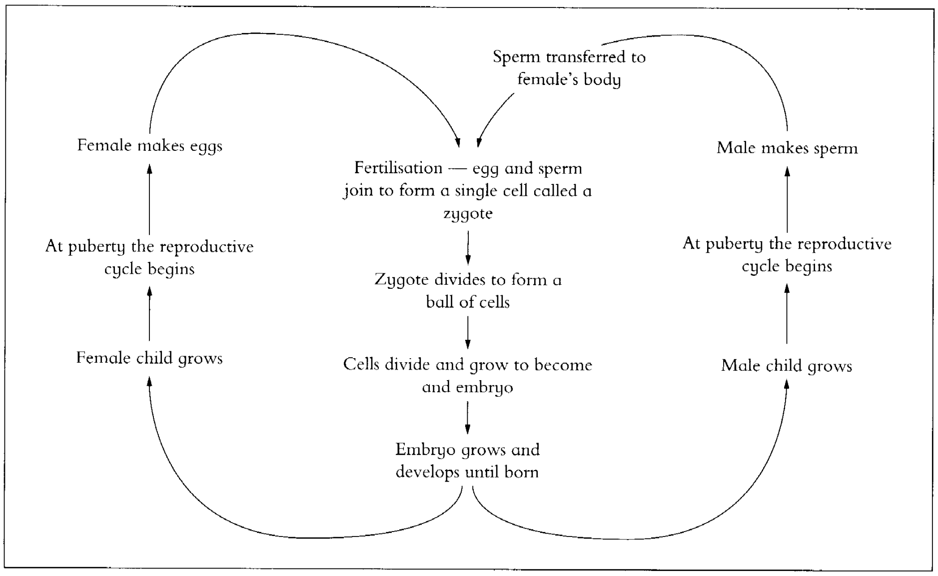


Diagram 3.1
Life history of humans.

The reproductive system is the only body system in which the parts in males and females have different structures. When children are born their reproductive system is not fully developed. It doesn't develop fully until after the child has reached **puberty**. Puberty begins from about the age of ten to thirteen. Puberty starts with changes to the amounts of reproductive hormones the body produces. **Hormones** are chemicals that act as messengers. They are made in one organ and travel in the bloodstream to another organ where they cause a change of some kind. The higher levels of reproductive hormones cause the reproductive organs to become larger. The hormones cause the person to begin making **gametes**. In male mammals and some other animals the gametes, called **sperm**, are made in the testicles. The gametes made by females are called **eggs**. One egg and one sperm join to form the new offspring.

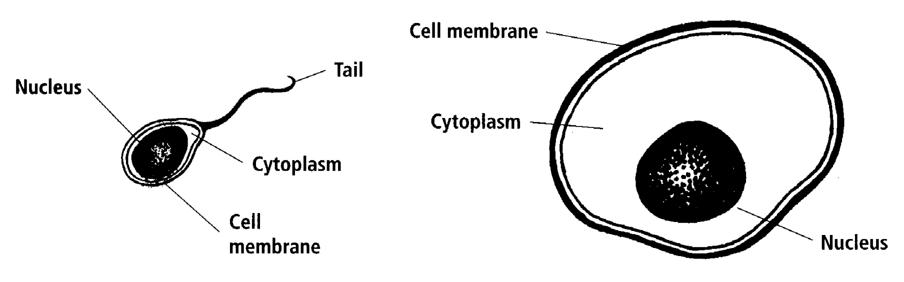


Diagram 3.2
Human gametes.

Secondary sex characteristics in males

- Growth of thicker hairs.
- Growth of hair on face, underarms, chest, pubic area, legs.
- Larynx larger and voice deeper.
- Skin becomes coarser.
- Sebaceous glands are more active, often resulting in acne.
- Increased sweating from underarms.
- Penis and testicles become larger.
- More muscle tissue.
- Rapid bone growth.

The higher levels of reproductive hormones also cause a number of other changes called **secondary sex characteristics**. In males the higher level of the hormone testosterone causes the secondary sex characteristics.

At puberty the ovaries of females make more of the hormones oestrogen and progesterone. The higher levels of these hormones cause the changes to the body that occur at puberty.

Secondary sex characteristics in females

- Growth of hair on underarms and pubic area.
- Breasts and hips get bigger due to fat deposits.
- Vagina, uterus and external genitalia get bigger.
- Menstrual cycle begins.
- Sebaceous glands are more active, often resulting in acne.
- Increased sweating from underarms.
- Rapid bone growth.

Activity 1

Changes At Puberty

Aim To record information about the changes that occur during puberty.

1. Explain what 'gametes' are.
2. Copy and complete the following table and sort the phrases into the correct column.

Secondary sex characteristics only in males	Secondary sex characteristics found in both males and females	Secondary sex characteristics only in females

Reproductive organs get bigger.

Menstrual cycle starts.

Growth of hair on underarms and pubic area.

Growth of hair on face.

Larynx larger and voice deeper.

Sebaceous glands more active.

Breasts and hips get bigger.

Increased sweating from underarms.

More muscle tissue.

3. Describe what happens at puberty to cause the development of secondary sex characteristics.

Human Reproduction

Language note:
One ovary, two ovaries.

The main parts of the human female reproductive system are the ovaries, oviduct, uterus, cervix and vagina.

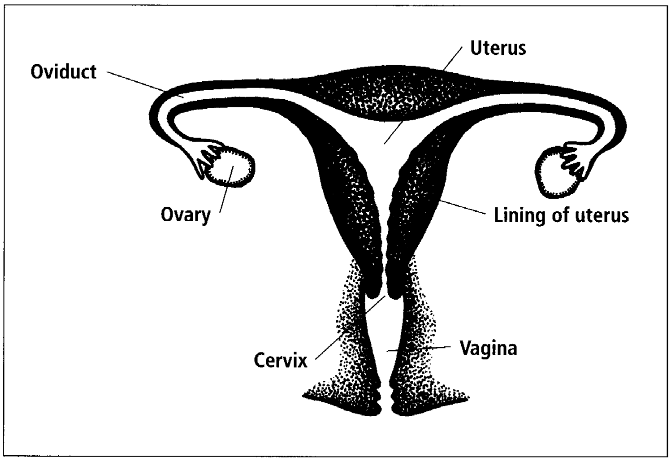


Diagram 3.3
Female reproductive system.

After puberty the reproductive system of the female produces gametes called eggs. Eggs are made in the **ovaries**. Usually one egg is released from one of the ovaries every 28 days. This 28-day cycle is called the **menstrual cycle**.

The menstrual cycle involves development of a cell into an egg and includes changes to the wall of the uterus. The cycle begins with a flow of blood, cells and tissue which lasts about four or five days. This flow is called a **period**. The blood, cells and tissue lost during the period are from the lining of the uterus. At the same time as the period is occurring a new egg is beginning to develop in one of the ovaries. The egg releases the hormone **oestrogen**. Oestrogen causes the uterus to begin to repair itself after the period has finished. The egg develops until day 14 in the cycle when it bursts out the side of the ovary and moves into the oviduct. From day 14 to 28 the egg travels down the oviduct and into the uterus. If it is not fertilised it is lost out of the uterus in the next period.

From the sixth day to the 28th day of the cycle the blood lining on the uterus wall becomes thicker and thicker. A hormone called **progesterone** causes this thickening of the lining on the uterine wall. The ovary releases progesterone after the egg has burst from the ovary. The thickening of the blood lining on the wall makes the uterus ready to receive the egg if the egg gets fertilised by a sperm cell. If the egg is not fertilised the next period begins on the 28th day and there is again a flow of blood, cells and tissue from the lining of the uterus.

If the egg is fertilised by a sperm cell the period will not occur. Instead the egg, now called a **zygote**, will go into the lining of the uterus and begin to develop into a baby.

Activity 2 Menstrual Cycle

Aim To record information about the menstrual cycle.

1. Take the information on the previous page about the menstrual cycle and summarise it into the following table.

Note: There are lots of days during the menstrual cycle when the same thing will be happening. For example, there are lots of days when the 'lining of the uterus is getting thicker' so you will have to repeat this description.

Day	What is happening to the egg?	What is happening to the lining of the uterus?
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
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27		
28		

2. Diagram 3.4 (on the next page) shows changes in the lining of the uterus over 28 days. Explain what is occurring at the days marked A, B, C, D and E.

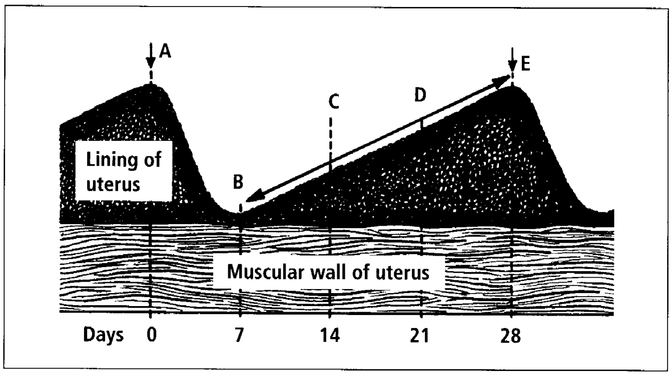


Diagram 3.4
The menstrual cycle.

3. Describe how the menstrual cycle changes if the egg is fertilised.
4. Explain why the menstrual cycle changes when the egg is fertilised.
5. What does the hormone oestrogen do during the menstrual cycle?
6. What does the hormone progesterone do during the menstrual cycle?

The Male Reproductive System

Language note:
Testis for one and testes for two. The testes are also called testicles.

The main parts of the male reproductive system are the testes, scrotum, sperm duct, penis, prostate gland and seminal vesicles.

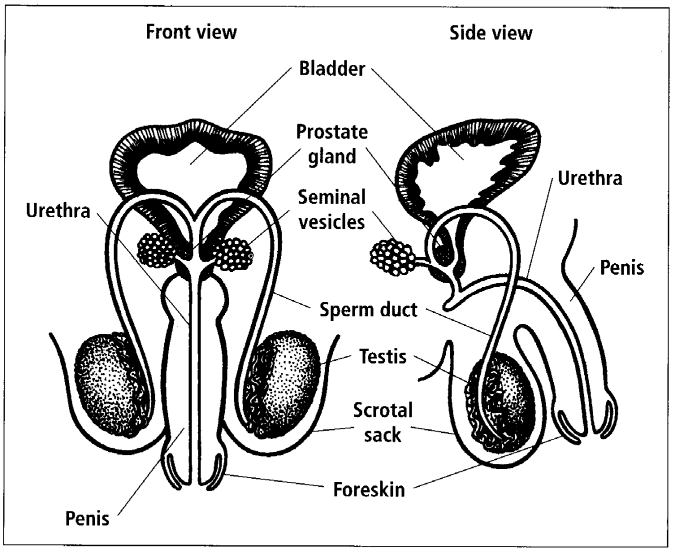


Diagram 3.5
Male reproductive system.

Each day a large number of the cells in the tubes in the testicles begin to develop into sperm cells. About 10 to 30 billion sperm are produced every month. If the sperm are not released they break down and are absorbed back into the testes. Sperm production can only occur at about 33°C . This is why the testes hang on the outside of the body in the **scrotum** where the temperature is cooler.

During reproduction the penis is used to put millions of sperm into the vagina of the female. Before the sperm are released into the female they travel along the sperm duct and are mixed with fluids from the prostate gland and the seminal vesicles. The fluids help to keep the sperm alive and active. Up to 300 million sperm can be released at a time. Only about three million sperm manage to swim to the egg cell and only one can fertilise it.

Once inside the female the sperm use their long tails to swim up the vagina. Then they swim through the cervix, uterus and into the oviduct. Sperm can live for 48 hours and it takes them about 10 hours to swim from the vagina up to the oviduct. If an egg has been released from the ovary and is in the oviduct one of the sperm cells will join with it. This is called **fertilisation**. The cell produced at fertilisation is called a **zygote**.

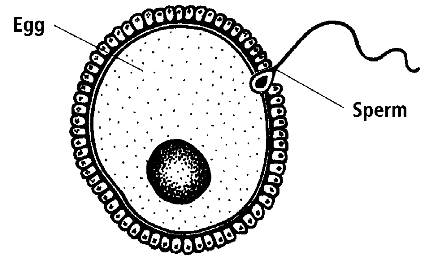


Diagram 3.6
Fertilisation.

Activity 3 Reproductive Systems

Aim To record information on the functioning of the parts of the female and male reproductive systems.

1. Record information about the structure and function of each of the parts labelled on the diagrams of the female and male reproductive systems. You may have to read all the information above and below on the functioning of female and male reproductive systems to find the functioning of each of the parts. For example:

Oviduct —The tube from the ovary to the uterus. Fertilisation occurs in the oviduct.

Development Of The Embryo

After fertilisation the zygote formed travels down the oviduct into the uterus. It takes three to four days to move down the oviduct. As it travels the cell divides a number of times to form a ball of cells. The ball of cells is about 0.1 mm long. The ball of cells will become the **embryo**. Embryo is the scientific name for the baby. Once in the uterus the ball of cells goes into the uterus lining which is now thick and spongy because it has lots of capillaries and areas holding blood in it. The process of the ball of cells going into the lining of the uterus is called **implantation**.

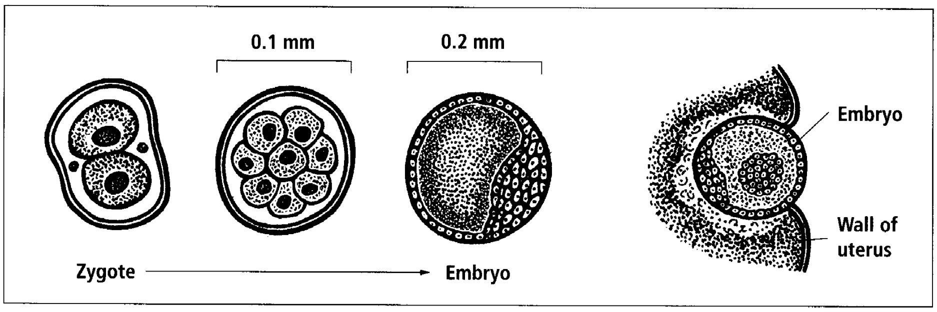


Diagram 3.7
Development of an embryo from fertilisation to implantation.

The cells continue to divide and part of the ball of cells start the **placenta** forming. The placenta is an area where the blood vessels from the embryo and the mother sit very close together, so that materials such as food and oxygen can pass from the mother to the embryo. Carbon dioxide and other wastes move from the embryo into the mother's blood. The mother's lungs and kidneys then remove these wastes.

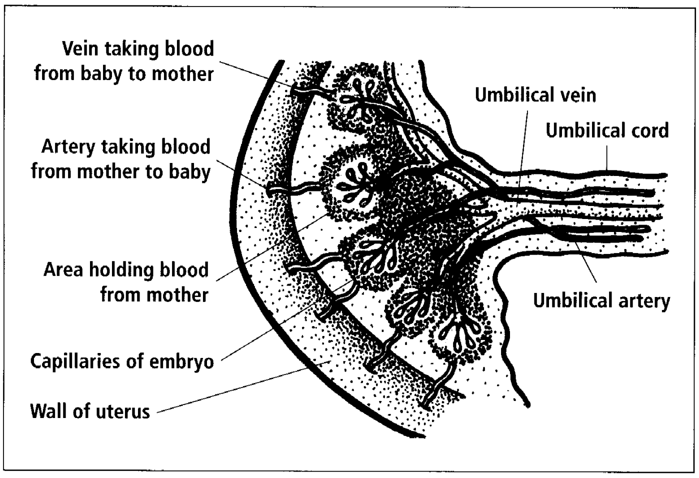
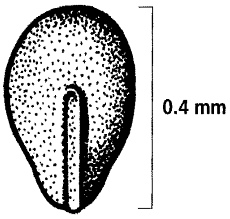
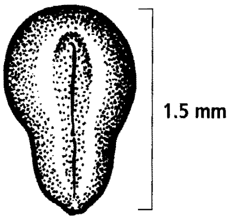
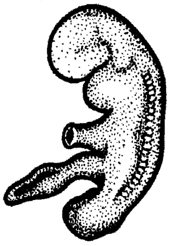
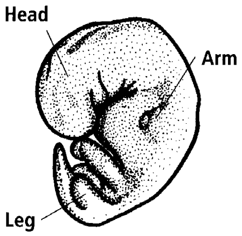
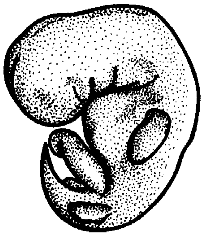
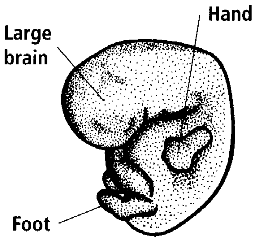


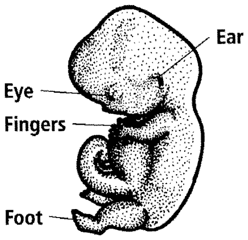
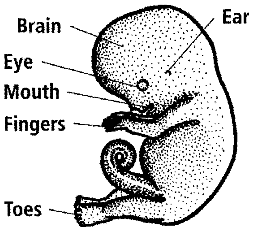
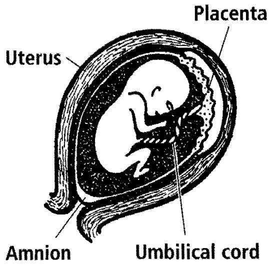
Diagram 3.8
The placenta.

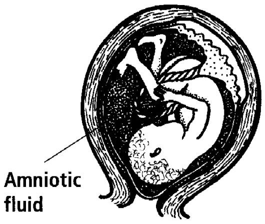
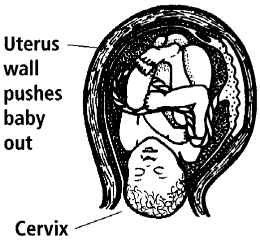
While the placenta develops, the rest of the ball of cells continues to change and form the embryo. The first thing the embryo does is make its own blood and blood vessels so that the materials can go between the mother's blood and the baby's blood via the placenta. Once food and oxygen are coming to the embryo from the mother, the embryo develops very quickly. In the uterus the embryo is in a tough bag called an **amnion**. The amnion is filled with **amniotic fluid**. The fluid helps to protect the embryo from bumps.

The following table gives information about development of the embryo.

Time since fertilisation	Information	Diagram
16 days	0.4 mm long. The embryo is a flat, round shape. The cells are beginning to change into three different types of cell.	
20 days	1.5 mm long. The nervous system (brain and spinal cord) begins to form.	
25 days	2.5 to 3 mm long. The eyes, ears, heart and liver are forming.	
27 days	3 to 5 mm long. The brain and spinal cord are the largest organs. The arms are just beginning to form.	

Time since fertilisation	Information	Diagram
29 days	4 to 6 mm long. The mouth, tongue, lungs, stomach and intestines are forming.	
35 days	5 to 7 mm long. Brain and head grow rapidly. Nose and kidneys are forming. The arms and legs grow.	
38 days	9 to 11 mm long. Lower jaw, face and feet starting to form.	
41 days	10 to 13 mm long. Heart formed. Teeth and reproductive system forming. The embryo can smell.	
45 days	11 to 14 mm long. Bones begin to form. Eyelids have formed. The kidneys start making urine.	

Time since fertilisation	Information	Diagram
48 days	13 to 18 mm long. The brain is working and making brain waves. The muscles are forming.	
56 days (eight weeks)	23 to 26 mm long. All the essential outside and inside parts have formed. The embryo now looks like a human so is now called a foetus.	
Weeks 10 to 11	The foetus begins to show if it is a male or female. Fingernails begin to grow and the liver and pancreas begin to work. The foetus can make sounds.	
Weeks 12 to 13	The foetus moves around. The heartbeat can be heard using special equipment. The foetus breathes fluid in and out and can use its hands. Hair starts to grow.	
Week 16	The foetus continues to grow. All parts are formed. The fingerprints form.	
Week 18	The foetus grows very rapidly. The foetus sleeps.	

Time since fertilisation	Information	Diagram
Week 20	The brain grows rapidly.	
Week 22	The foetus has a thin layer of skin and can hear sounds.	
Week 30	Body growth slows down but the brain continues to grow.	
Week 38	The foetus is fully developed. The skull is not fully solid so that it can change shape to make it easier for the head to come out during birth.	
Week 40	The foetus is fully developed and is born about 40 weeks from fertilisation.	

Activity 4 Development Of The Embryo And Foetus

Aim To record information about the development of the embryo and foetus.

1. Name the parts labelled A to E in Diagram 3.9 on the next page.
2. Look at the processes labelled 1, 2 and 3 in Diagram 3.9. One of the processes is called fertilisation and another is called implantation. Explain what is happening at 1, 2 and 3 on the diagram.
3. Diagram 3.10 on the following page shows what is happening in the placenta. Use the information in the diagram to explain how the embryo gets food and oxygen. How is carbon dioxide and urea removed from the embryo?

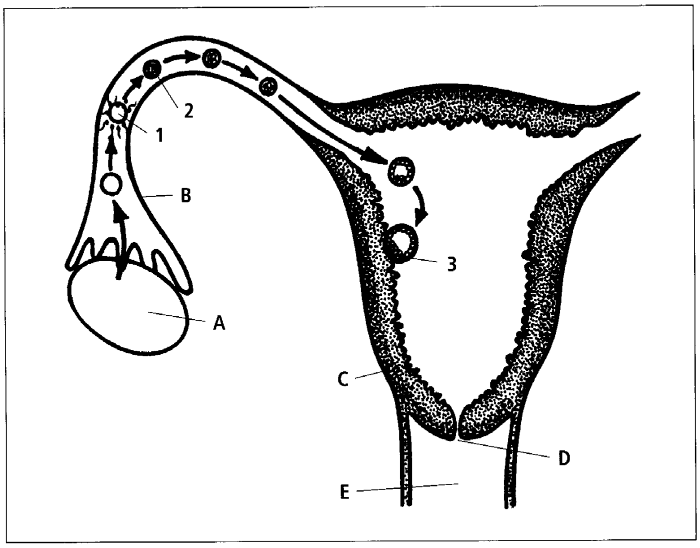


Diagram 3.9
Reproduction structures and processes.

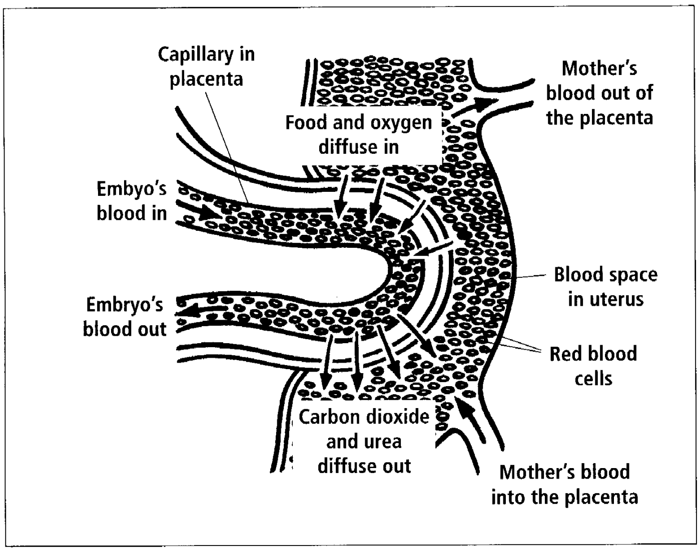


Diagram 3.10
The placenta.

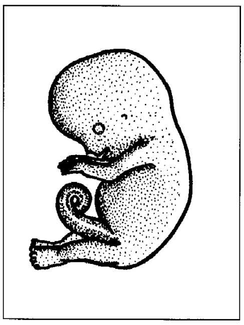


Diagram 3.11
A foetus.

4. Look at Diagram 3.11 of a foetus. Use the information about the development of the embryo and foetus to work out how old it is. Describe the features that tell you how old the foetus is.
5. Embryo, foetus and baby are all terms that describe different phases of development. Describe the key features of development during each of these phases.
6. Finding more information: The CDU Environmental science book Making More of Me has further information on fertilisation, menstrual cycle, pregnancy and birth. The following websites have information about the development of the embryo:

http://www.visembryo.com/baby/hp.html
http://www.w-cpc.org/fetal.html
http://embryo.soad.umich.edu/carnStages/carnStages.html

Activity 5 Investigation Of Reproductive Systems

Materials needed:

Reproductive parts of a male or female pig or chicken.

Aim To investigate the structure of the reproductive system.

1. Identify the parts of the reproductive system.
2. Draw diagrams to show the size, shape and location of the different parts of the reproductive system.
3. Compare the shapes and positions of the parts of the reproductive structures in pigs and humans. Record the similarities and differences you identify. Give reasons for the differences.
4. Explain why the testes of a pig stick out behind the body where they could get damaged.

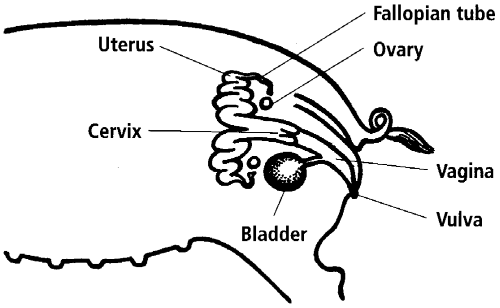


Diagram 3.12
Female pig reproductive system.

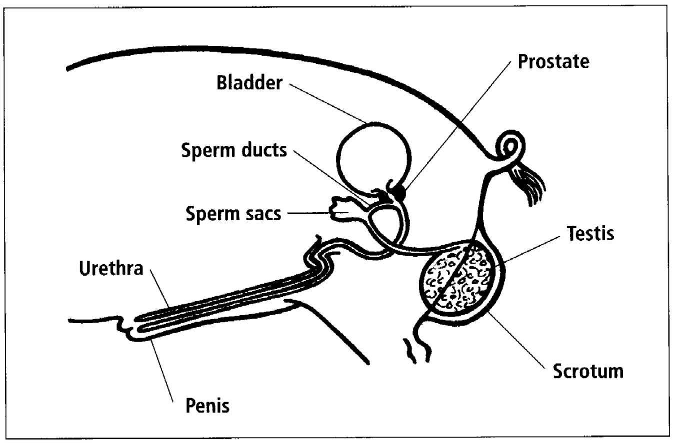


Diagram 3.14
Male pig reproductive system.

5. Female pigs have two ovaries that release many eggs at the same time every 21 days. It takes 114 days for the fertilised eggs to develop from fertilisation until birth. The female feeds the piglets with milk for six to eight weeks and then she is ready for mating again. How does this compare with the way the female human reproductive system works?

Activity 6 Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

Unit 4: CELLS AND MEIOSIS

In this unit, you will process information about the detailed structure of the organelles found in cells and investigate cell division for reproduction.

Cells

All living things are made up of cells. In a large organism, such as a person, the cells in the body work together to keep the person alive. Often the cells have a special job to do.

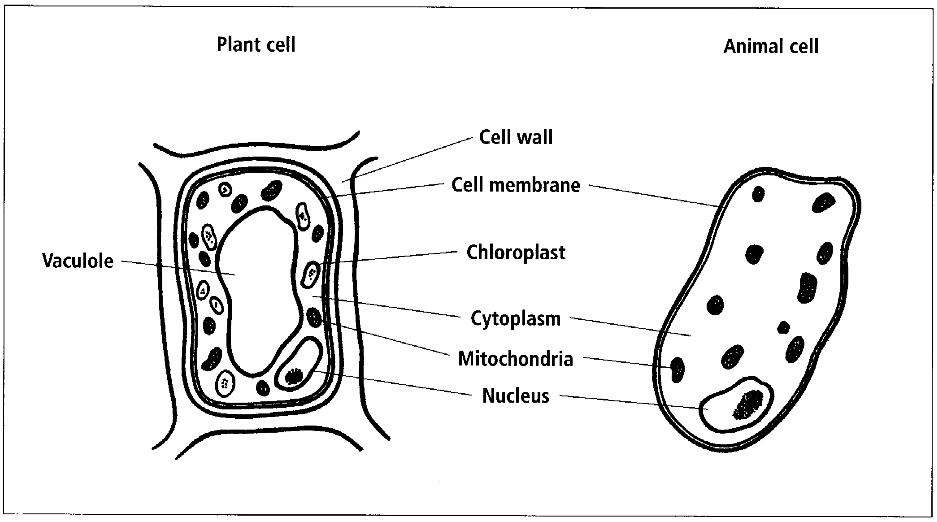


Diagram 4.1
Plant and animal cells.

All cells have parts inside them called **organelles**. Some organelles found in plant cells are not found in animal cells. Most organelles are so small that they cannot be seen with a light microscope. Only the nucleus, chloroplasts and cell wall or membrane can be seen.

Activity 1

Looking At Cells

Materials needed:
Book 1 Year 9 Science;
Different leaves;
Microscope slides;
Water;
Cover slip (if available);
Microscope.

Aim To use a microscope to look at cells.

1. Read pages 18 to 25 in Book 1 Year 9 Science to review using microscopes, making slides and biological drawing.
2. Tear a leaf to get a thin piece. You may have to do this two or three times to get a thin piece of leaf. Look closely at the torn edge to see if there is a thin layer of cells.
3. Place a piece of leaf, with a thin torn edge, in the centre of the slide and cover it with a drop of water.
4. Hold the cover slip at an angle. Touch one edge in the water drop and carefully lower the cover slip.
5. Place the slide on the stage of the microscope. Focus on the slide using low power.
6. Move the slide around the stage until a thin piece of leaf is under the lens.
7. Draw two or three cells. Label the cell wall and chloroplasts (if they can be seen).

Cell Organelles

The organelles found in plant and animal cells have different structures and different functions. See the next two pages for details.

Activity 2

Cell Organelles

Aim To process information on the detailed structure and function of cell organelles.

1. Copy the following table and complete it by selecting information relevant to the structure and function of each organelle from the information given on the next two pages about cell organelles.

Organelle	**Structure** (what it looks like)	**Function** (what it does)
cell wall		
cell membrane		
nucleus		
chromosomes		
cytoplasm		
vacuole		
chloroplast		
mitochondria		

Cell wall

Only plant cells, fungi, bacteria and some one-celled organisms have a cell wall. The cell wall protects the cell, keeps the cell the same shape and stops too much water from getting into the cell. The wall is thick and made up of fibres of cellulose in a matrix of other **polysaccharides** and protein.

In plants the cell walls are joined together to give extra support to the plant. Wood is mainly several layers of materials that make up the cell wall.

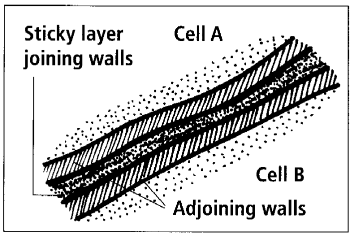


Diagram 4.2
Cell wall.

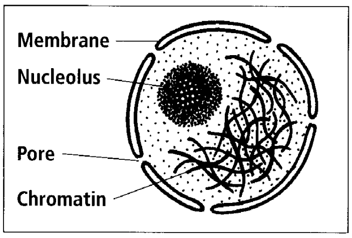


Diagram 4.3
Nucleus.

Nucleus

The nucleus is a small round structure. It is surrounded by a thin double membrane that holds the parts of the nucleus together. Small gaps in the membrane, called pores, let materials move between the nucleus and the cytoplasm.

The nucleus contains chromatin and a nucleolus. The chromatin will form chromosomes when the cell is about to divide. The nucleolus makes small organelles called **ribosomes**. Ribosomes help the cell to make proteins.

Language note: nucleus (one), nuclei (more than one).

Cell membrane

All cells have a cell membrane. It forms the outside boundary of the cell. The cell membrane lets oxygen, water and nutrients into the cell. It also lets out wastes, such as carbon dioxide. The membrane is very thin and is made up of two layers with small proteins in it.

The cells in the intestine have very long, folded membranes so that they can absorb the digested food more easily.

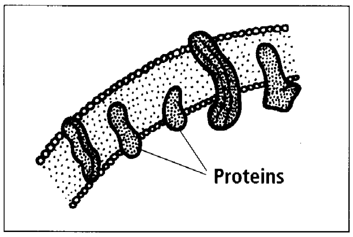


Diagram 4.4
Cell membrane.

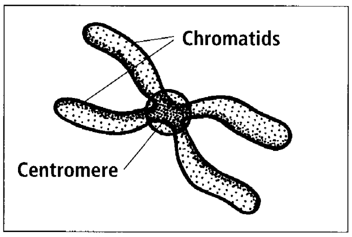


Diagram 4.5
A chromosome about to divide in two.

Chromosomes

The chromatin in the nucleus is made up of long thin threads of the materials DNA (deoxyribonucleic acid) and protein. Just before a cell divides into two, the chromatin twists up to form chromosomes.

The chromosomes carry genetic information. Genetic information controls all the life processes of the cell. The nuclei of sperm and egg cells only have half the number of chromosomes that a normal cell has.

Chloroplast

Chloroplasts are only found in plant cells. They are a small round organelle found in the cytoplasm. They are a green colour because they are filled with the green pigment chlorophyll. The chlorophyll is used during photosynthesis to help the plant use light energy to make sugar.

Not all plant cells have chloroplasts, only the ones that carry out photosynthesis.

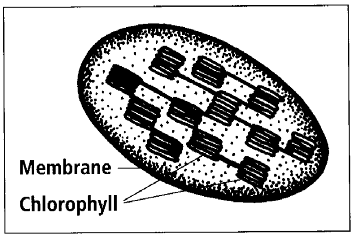
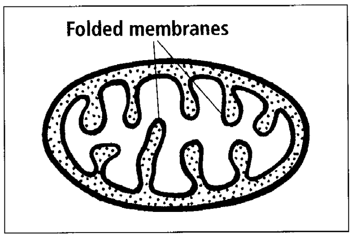


Diagram 4.6
Chloroplast.



Mitochondria

Mitochondria are found in both plant and animal cells. They are a small bean shaped organelle found in the cytoplasm. The chemical reactions for respiration occur inside the mitochondria. It has lots of folded membranes inside it so that there are places for the chemical reactions to occur.

Diagram 4.7
Mitochondria.

Cytoplasm

The cytoplasm is a mixture of chemicals that form a jelly-like substance. It holds the cell organelles such as the nucleus, chloroplasts (in plant cells) and mitochondria.

Some chemical reactions needed for life happen in the cytoplasm of the cell.

Vacuole

In a plant cell the vacuole is like a large bag. The vacuole is surrounded by a thin membrane that lets materials pass between the vacuole and the cytoplasm. The vacuole stores water and other minerals until the plant cell organelles need the materials.

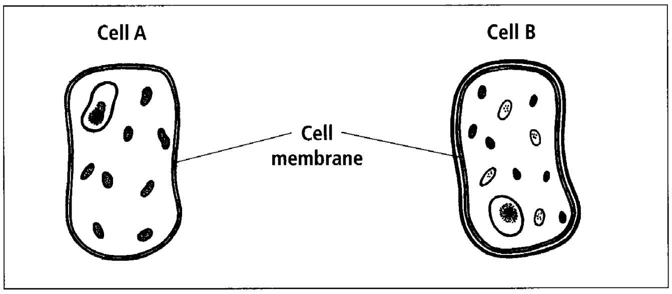
Animal cells sometimes have one or more small vacuoles. Bacteria and other unicellular organisms often have vacuoles that contain food.

2. Divide the organelles listed below into two groups:

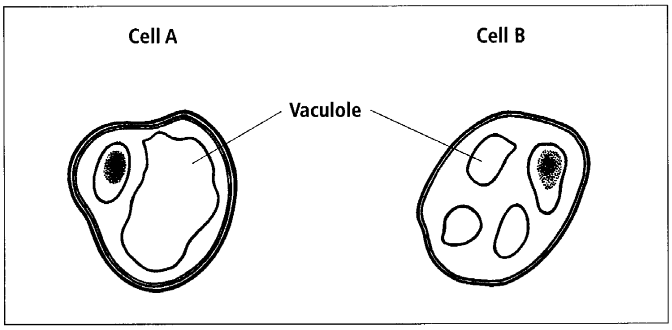
cell wall
cell membrane
nucleus
chromosomes
cytoplasm
vacuole
chloroplast
mitochondria

Organelles found only in plant cells	**Organelle found in both plant and animal cells**

3. Which of the following cells, A or B, is a plant cell? Give reasons for your answer.



4. Vacuoles are different in plant cells and animals cells. Which of the following cells is an animal cell? Give a reason for your answer.



5. What is different about the nucleus of egg cells? Explain why egg cells have this difference.

One-celled Organisms

There are a number of organisms that are very small and are made up of only one cell. One-celled organisms live in fresh water or salt water.

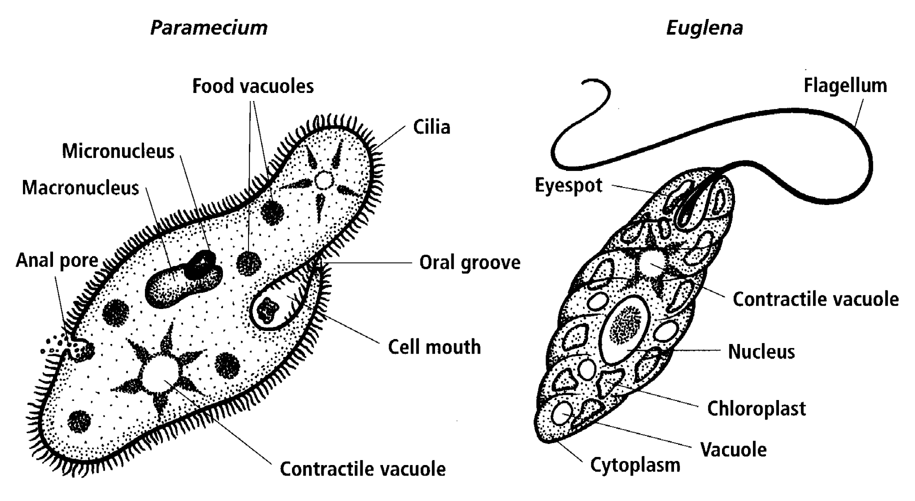


Diagram 4.8
Organisms made up of one cell.

Language note:
One flagellum, two or more flagella.

Some one-celled organisms are able to move from place to place. They have organelles called **cilia** or **flagella** to help them move.The organism with cilia has many short hairs around its body. The hairs beat quickly in waves around the body, which pushes the organism through the water it lives in. A flagellum is a long thread that is moved in a circle to move the organism forward. Sometimes the organism has two or three flagella.

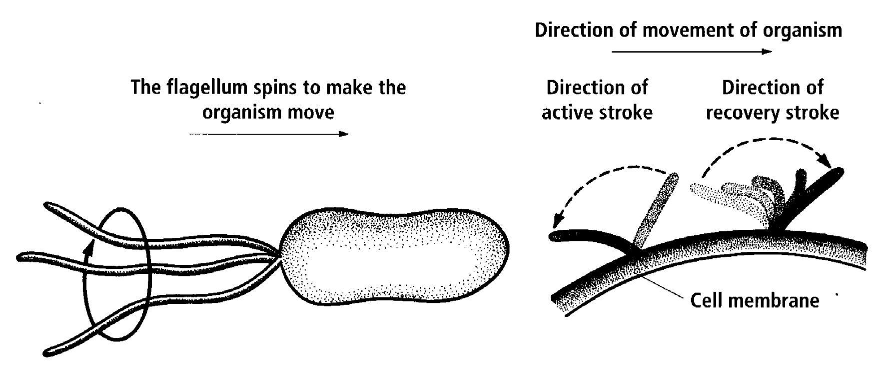


Diagram 4.9
Moving using cilia and flagella.

One-celled organisms have to have extra organelles so that they are able to carry out all the life processes that plants and animals carry out. *Paramecium* are animals so they also have an area where food is taken in. This is called the oral groove and cell mouth. *Paramecium* also has an area where waste material is released. This is called the anal pore.

Organisms that live in fresh water have water coming into the cell all the time. If the cell has too much water inside it it may burst open and the organism would die. Therefore they need an organelle to remove the water. The organelle is called a **contractile vacuole**. The contractile vacuole slowly fills up with water and when full, empties the water outside the cell. It then begins to fill up again. The organism may have more than one contractile vacuole.

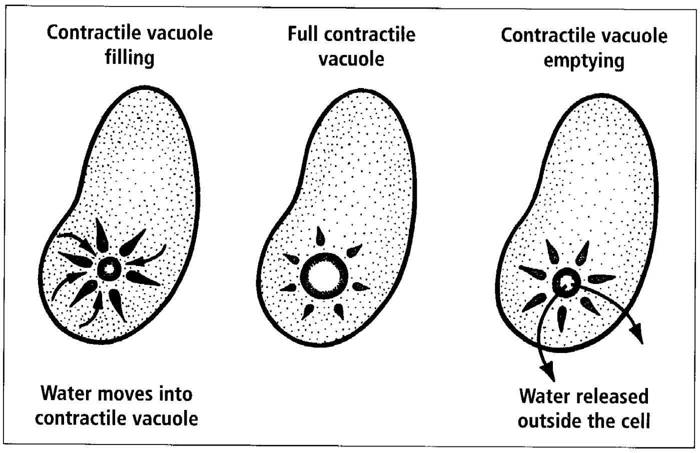


Diagram 4.10
Functioning of a contractile vacuole.

Some one-celled organisms also have areas that are sensitive to chemicals or light. Diagram 4.8 shows *Euglena* with an eye spot that is sensitive to light. This means that the organism senses light and can move towards it. This is helpful to the organism as in brighter light the organism can carry out photosynthesis at a quicker rate.

Yeast and bacteria are also one-celled organisms. Yeast cells are often used in food production because they make carbon dioxide. Carbon dioxide makes foods, such as bread, rise during making. The bread rises because the yeast give off carbon dioxide gas which makes the bread dough expand. The holes in bread are the places where bubbles of carbon dioxide formed in the bread. Yeast is an easy organism to store and grow. Yeast also makes alcohol so is used in the brewing of beer. The bubbles in beer are bubbles of carbon dioxide given off by the yeast.

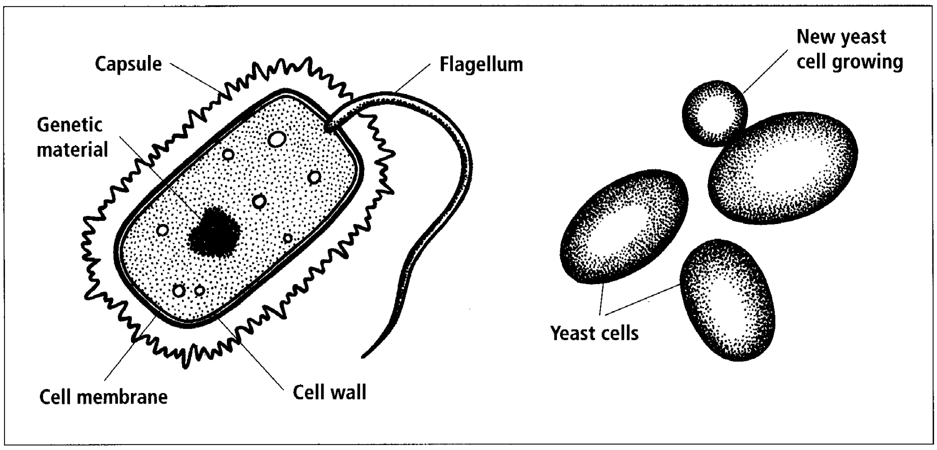


Diagram 4.11
Bacteria and yeast.

Bacteria cells are lots of different shapes and sizes. They can be round, rod or spiral shaped. Sometimes they are surrounded by a jelly-like capsule which protects the cell. Many types of bacteria are disease-causing pathogens that damage animal and plant cells.

Activity 3

One-celled Organisms

Aim To record information about one-celled organisms.

1. *Euglena* has some features found in animal cells, some found in plant cells and some found in both. List the features that are plant cell features, those that are animal cell features and those that are both plant and animal cell features.
2. Describe the features of *Paramecium* that show it is an animal cell.
3. What is the purpose of a contractile vacuole? Why do some one-celled animals need to have a contractile vacuole?
4. What is the advantage to a one-celled organism in having an area that can sense the environment?
5. Explain why people use yeast.

Organisms Made Up Of Lots Of Cells

Plants and animals are called **multi-celled organisms** because they are made up of lots and lots of cells. The cells in a multi-celled organism have different shapes, sizes and organelles present, depending on their function.

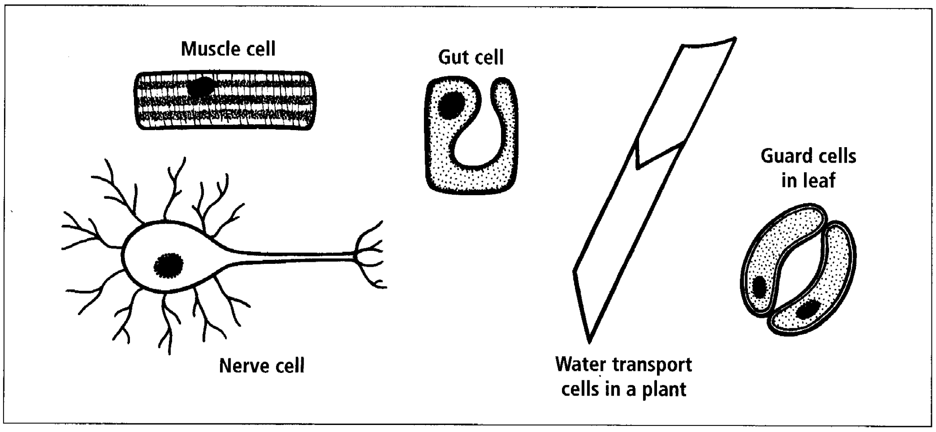


Diagram 4.12
Cells have different shapes.

Cells that need a lot of energy have lots of mitochondria. Muscle cells are an example of cells that use a lot of energy.

Cells that are making proteins have a lot of ribosomes. An example of a cell that is making proteins is a digestive system cell, making enzymes to digest food.

Some cells have extra organelles because they do a special job in the multi-celled organism. For example, inside the eye there are two types of cells that help people see light and colours. These cells are called rod and cone cells. Rod and cone cells have round shaped organelles that hold chemicals which sense light.

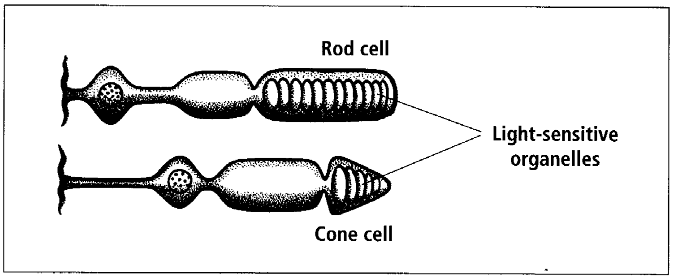


Diagram 4.13
Light sensitive organelles in rod and cone cells.

Activity 4 Multi-celled Organisms

Aim To record information about multi-celled organisms.

1. Take notes on the information about multi-celled organisms.
2. Sperm cells need lots for energy to swim up to the egg cell. Which organelle would a sperm cell have lots of? Explain why.

Meiosis

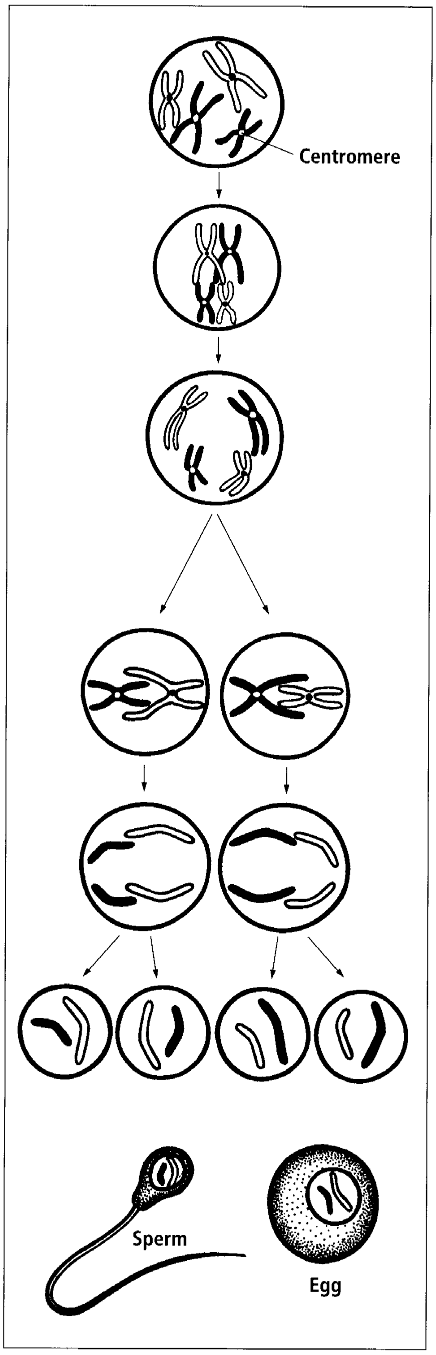
For reproduction, males and females make special cells called gametes. Gametes carry the genetic information from the parents to the offspring. Gametes are made in the reproductive organs, ovaries and testes. Part of the process of making gametes involves a type of cell division called **meiosis**. It is similar to **mitosis**, the cell division that occurs when a cell divides into two during growth. There are also differences (*e.g. Meiosis ends with four cells being made*).

In meiosis the cells divide twice. The second division occurs as soon as the first one finishes. Because the chromosomes are not copied at the beginning of the second division the cells at the end of meiosis only have half as many chromosomes as the cell at the start. Humans have 46 chromosomes in their body cells but only 23 in their gametes. In the first stage of meiosis the homologous pairs of chromosomes line up on the centre of the cell. Cells have pairs of chromosomes because they get one of the pair from each parent. The sperm cell and the egg cell carry one chromosome from each pair and when fertilisation occurs the zygote has two copies of each chromosome. These are called **homologous pairs** of chromosomes.

The following table shows the numbers of chromosomes in the body cells and in the gametes produced by meiosis.

Organism	Number of chromosomes in body cells	Number of chromosomes in gametes
Cat	32	16
Dog	78	39
Cow	60	30
Horse	64	32
Corn	20	10
Dogfish	62	31
Earthworm	36	18
House fly	12	6
Lettuce	18	9
Sea urchin	40	20

Meiosis is a continuous process but has to be drawn in a series of steps. The diagrams on the next page show the steps in the two divisions of meiosis.



First division

Each chromosome is copied. The copy and the original are joined at the centromere.

Homologous pairs of chromosomes line up on the centre of the cell.

One chromosome from each homologous pair pulled to opposite sides of the cell.

Second division

The chromosomes line up on the centre of the cell.

The centromere breaks and the chromatids move apart.

Meiosis is now complete. Four cells have been made. Each cell has half the number of chromosomes that the cell at the beginning had.

In males, each of the cells formed at the end of meiosis develops into a sperm cell. In females, only one of these cells will develop into an egg.

Diagram 4.14
Meiosis — cell division for reproduction.

Activity 5

Meiosis

Aim To record information about meiosis.

1. Copy Diagram 4.14 showing the sequence of events in meiosis.
2. Copy and complete the following chart to compare cell division by mitosis and meiosis.

	Meiosis	**Mitosis**
What is it used for?		
Where does it occur?		
How many cells are formed?		
How many chromosomes are in each cell?		

3. Explain how the process of meiosis is different to mitosis.
4. Explain why it is important for the cells made by meiosis to have only half the number of chromosomes that the normal cell has.
5. The following websites give more information on the process of meiosis and how it is similar yet different to mitosis.

http://www.biology.arizona.edu/cell_bio/tutorials/meiosis/page3.html

http://www.accessexcellence.org/AB/GG/meiosis.html

http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/M/Meiosis.html

Activity 6

Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

Unit 5: GENETICS

In this unit, you will investigate the way different characteristics are inherited. In Year 10 you may have looked at the similarities and differences in characteristics of the members of your class and may have drawn bar graphs of the results. This was an investigation into variation. This unit looks at the way genetic information causes variation.

Instructions Called Genes

Each cell carries all the instructions for growth and the variation of characteristics. These instructions are called **genes**. Each gene is a part of a chromosome. We have two copies of most genes. One copy is in each pair of a homologous pair of chromosomes. Sometimes the chromosomes and genes are called the **genetic material.**

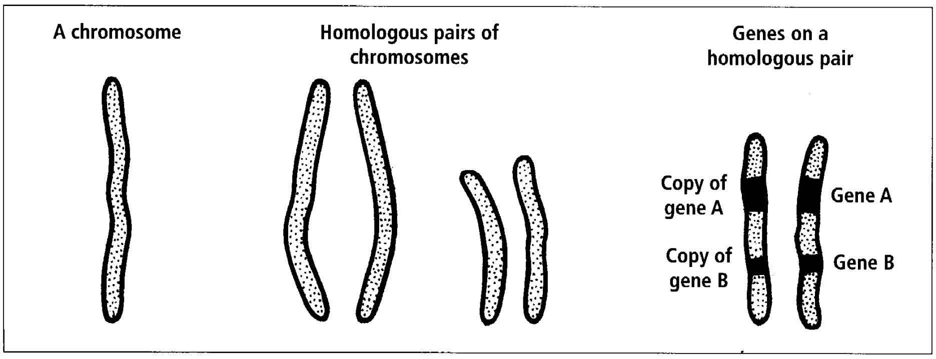


Diagram 5.1
Chromosomes.

Inside each chromosome is a chemical called deoxyribonucleic acid or DNA. The DNA is a chemical language that has all the instructions that a cell needs in order to function. During mitosis, cell division for growth, the DNA in each of the chromosomes is copied before the cell divides. One of the copies of each chromosome goes into each of the new cells. This way each cell always has two copies of all the instructions for life.

When an organism is reproducing, meiosis which is cell division for reproduction, always separates the homologous pairs of chromosomes and only one of each pair goes into each new cell formed. These new cells are the gametes (eggs or sperm in humans). This means that the gametes only have one copy of each gene.

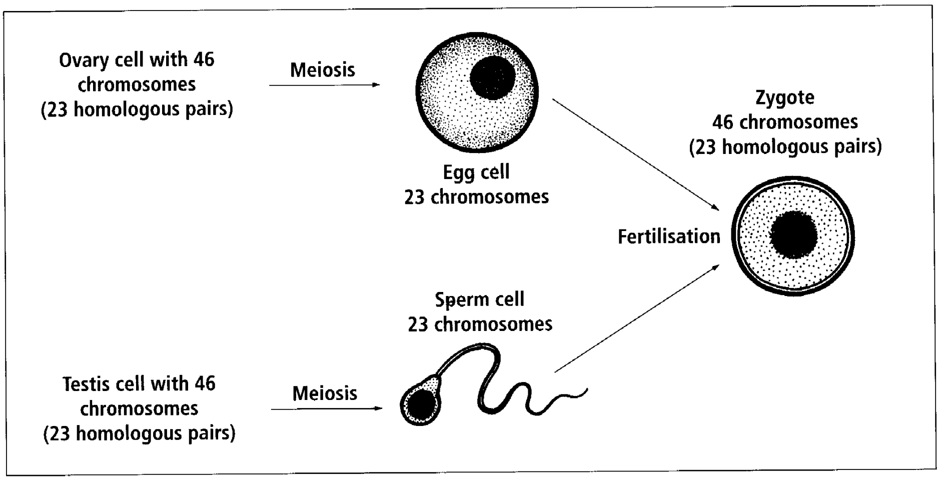


Diagram 5.2
Meiosis and fertilisation change the number of chromosomes.

Activity 1

Chromosomes, Genes And DNA

Aim To record information about chromosomes, genes and DNA.

1. Use the information above to help you to draw a diagram or describe what the relationship is between chromosomes, genes and DNA.
2. Describe the role of chromosomes, genes and DNA.
3. Explain how the cells in the human body have 23 pairs of chromosomes when an egg or sperm cell only has 23 single chromosomes.

Genes And Alleles

Genes cause some of the variation in the way people look. Often a gene for a characteristic has two or more forms and this is what causes the variation. These different forms of the same gene are called **alleles**. Alleles for a gene give different instructions to the cell for the same characteristic. For example a gene controls the shape of a person's earlobe. One allele gives instructions for a hanging earlobe and a different allele gives instructions for an attached earlobe. The allele for the hanging earlobe is the **dominant** allele. This means that if a person has at least one copy of the dominant allele they will have hanging earlobes. Letters are used to represent the alleles of a gene. The dominant allele is always given a capital letter. In the example on the next page the dominant allele for hanging earlobes are given the letter 'E' and the allele for attached earlobes is 'e'.

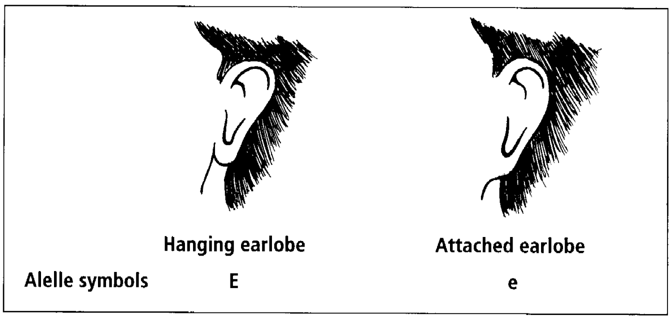


Diagram 5.3
Earlobes inheritance.

The allele for attached earlobes is **recessive**. A person has to have two copies of the recessive allele before they will have attached earlobes. The following diagram shows the alleles for some human characteristics. Characteristics or traits are controlled by genes which means they are inherited from parents.

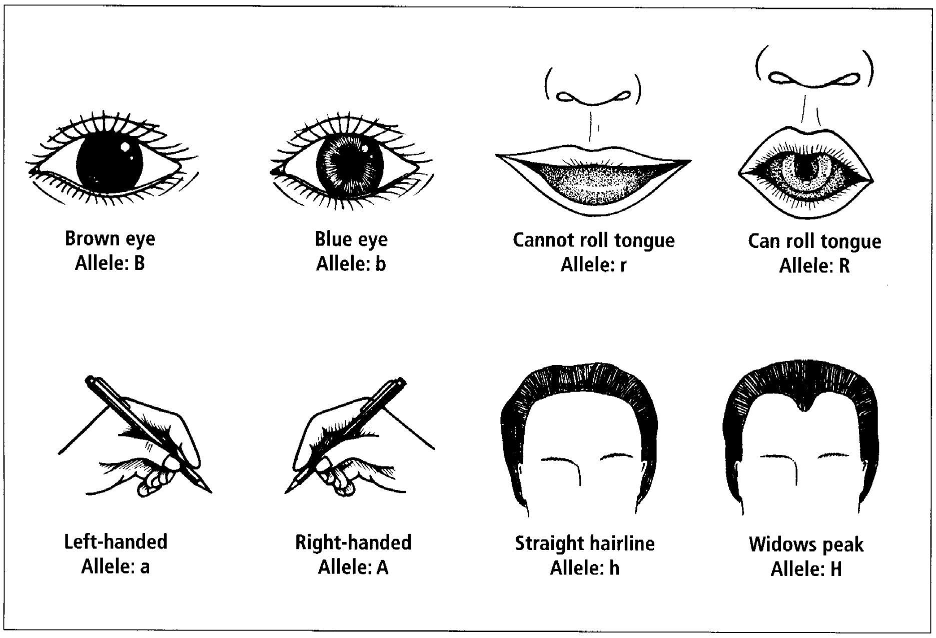


Diagram 5.4A
Examples of alleles for different characteristics.

Hair on middle segment
Allele: M

No hair on middle segment
Allele: m

Bent thumb
Allele: T

Stright thumb
Allele: t

Smooth chin
Allele: f

Cleft chin
Allele: F

Smooth cheek
Allele: d

Dimpled cheek
Allele: D

Diagram 5.4B
Examples of alleles for different characteristics.

A person who writes using their right hand is said to have the **phenotype** 'right-handed'. Phenotype is the form of the characteristic that you can see. The names under each of the drawings in Diagram 5.4 are the phenotypes. For example smooth chin, cleft chin, can roll tongue and cannot roll tongue are all phenotypes.

Each person has two copies of each gene, one copy on each of the pair of homologous chromosomes. One copy is from your mother and one is from your father. Sometimes the two copies of the gene are the same allele and sometimes they are different alleles. The alleles that a person has of a gene is called their **genotype**. Genotypes are written using the symbols for the alleles. AA, Aa or aa are examples of how genotypes are written. The words **homozygous** and **heterozygous** can be used to describe the genotype of an organism. Homozygous means the two alleles are the same: i.e. AA or aa. Heterozygous means that the alleles are different: i.e. Aa.

Genotype	**Description of genotype**
AA	Homozygous dominant
Aa	Heterozygous
aa	Homozygous recessive

The genotype of a person with the right-handed phenotype could be homozygous dominant AA or heterozygous Aa. The genotype of a left-handed person is homozygous recessive aa. We know the exact genotype of a person with the left-handed phenotype because to be left-handed they must have two copies of the recessive allele, a. If the person has one dominant A allele then they would have the right-handed phenotype. The only way to find out if the right-handed person is AA or Aa is to study inheritance of right-handed and left-handedness in the rest of the family. Because the allele for left-handedness is not very common you may have to study lots of generations and still not be able to work it out for sure.

Activity 2

Genes And Alleles

Aim To record information about genes and alleles.

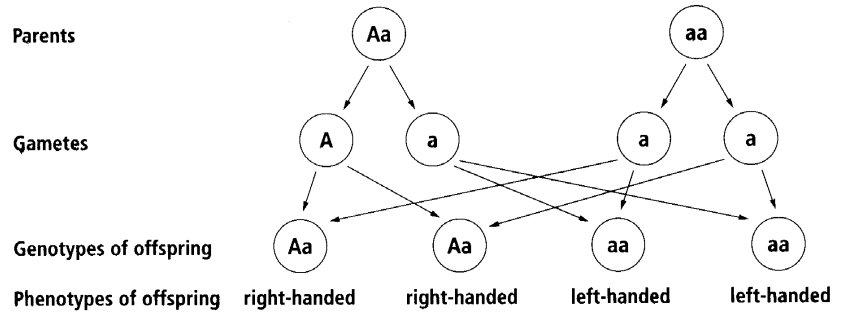
1. Describe the relationship between each of the following pairs:
   - Genes and alleles.
   - Dominant allele and recessive allele.
   - Phenotype and genotype.
   - Homozygous alleles and heterozygous alleles.
2. What is a trait or characteristic?
3. Draw up a table that records the phenotype and genotype you have for each of the characteristics listed in Diagrams 5.3 and 5.4. If you have brown eyes your phenotype is 'brown eyes' and your genotype is 'BB' or 'Bb'. If you have the recessive allele then your phenotype is 'blue eyes' and your genotype can only be 'bb'.

Using Genetics

People use knowledge of genetics to work out the possible patterns of inheritance in plants, animals and people. The following question is the sort of question that genetics can help find possible answers.

If a heterozygous right-handed person and a left-handed person have children, how many of the children would be expected to be left-handed?

The following shows how this sort of question can be answered using a Punnett square.



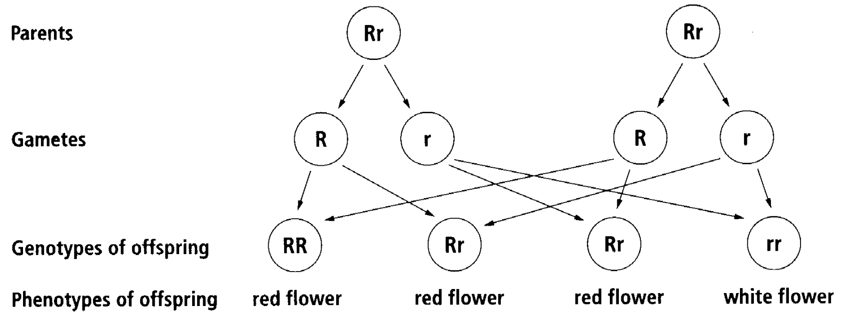
Genotype ratio of offspring: $\frac{2}{4}$ or $\frac{1}{2}$ Aa, and $\frac{2}{4}$ or $\frac{1}{2}$ aa

Phenotype ratio of offspring: $\frac{2}{4}$ or $\frac{1}{2}$ right-handed, and $\frac{2}{4}$ or $\frac{1}{2}$ left-handed

Diagram 5.5A
Genetic cross diagram one.

Step 1 Write out the parents' genotype.
Step 2 Write down the gametes that each person can make.
Step 3 Follow the arrows to work out the possible genotypes of the offspring.
Step 4 Write down the phenotype of each of the offspring.
Step 5 Work out the amount of offspring with each genotype.
Step 6 Work out the amount of offspring with each phenotype.

Here is another example of using a Punnett square. In a type of plant red flowers (R) is dominant to white flowers (r). Two heterozygous red flowers are crossed. What percentage of the offspring would be expected to have red flowers?



Genotype ratio of offspring: 50% Rr, 25% RR and 25% rr

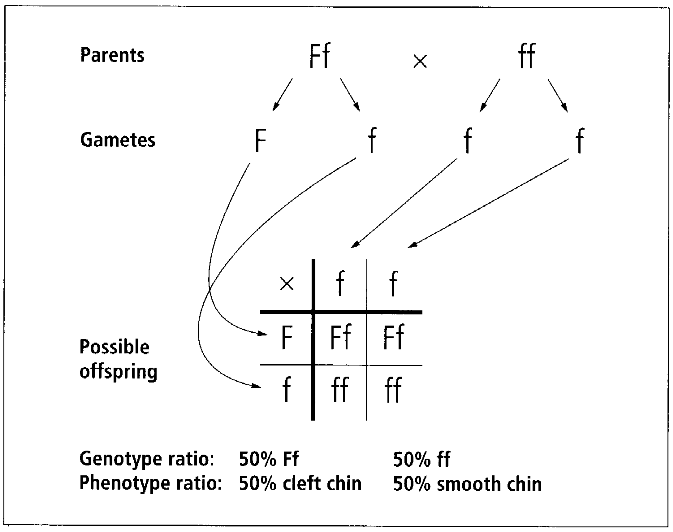
Phenotype ratio of offspring: 75% red flower and 25% white flower

Diagram 5.5B
Genetic cross diagram two.

Some points about doing genetic problems

- In a heterozygous parent or offspring the dominant allele is always written first: i.e. Rr, not rR.
- Write the labels (parents, gametes, etc.), the circles and the arrows everytime you do a genetic problem until you are clear what each step is about.
- Punnett squares can be written in a circle form or in a square form. See Diagram 5.5.
- The genotype and phenotype ratio can be written as fractions ($\frac{1}{4}$), percentages (25%) or ratios (3:1).
- The purpose of the Punnett square is to work out the genotypes and phenotypes of the possible offspring. It is not complete until the genotype and phenotype ratios have been worked out.
- The genotype and phenotype ratios that are worked out using the Punnett squares are only the **expected** ratios. The **actual** ratios can only be found by counting the number of offspring and then working out the actual ratios. There are a lot of opportunities for chance happenings in genetic crosses especially when the number of offspring is small. For example, the expected ratio of girls to boys in a family is one girl to one boy. Many families do not have this expected ratio of girls and boys.

The following example of solving a genetic problem uses a different shaped Punnett square. What are the possible offspring from a person that is Ff for cleft chin and a person that is ff?

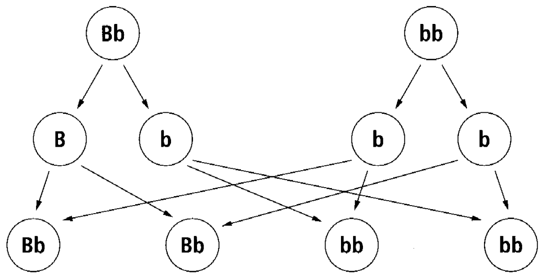


×	f	f
F	Ff	Ff
f	ff	ff

Genotype ratio: 50% Ff 50% ff
Phenotype ratio: 50% cleft chin 50% smooth chin

Diagram 5.6
Using a square Punnett square.

The following diagram compares the layout of the two different shapes of Punnett squares that can be used to solve genetic problems. What is the expected genotype and phenotype ratios of a cross between a heterozygous brown-eyed person and a homozygous recessive blue-eyed person?



×	B	b
b	Bb	bb
b	Bb	bb

Genotype ratio	**50% Bb 50% bb**	**50% Bb 50% bb**
Phenotype ratio	**50% Brown eyes** **50% Blue eyes**	**50% Brown eyes** **50% Blue eyes**

Diagram 5.7
Using the different types of Punnett square.

Activity 3 Genetic Problems

Aim To work out the expected genotype and phenotype ratios for the offspring of a number of genetic crosses.

1. In some types of plants, red flowers (R) are dominant to yellow flowers (r). Use either the circle or square Punnett square to work out the expected genotype and phenotype ratios for the offspring of a number of genetic crosses.
   a. **RR × Rr**
   b. **Rr × rr**
   c. **RR × RR**
   d. **rr × rr**
   e. **Rr × Rr**
   f. **rr × RR**
2. In horses, black coat colour (B) is dominant to chestnut (red-brown) coat colour (b). Use either the circle or square Punnett squares to work out the expected genotype and phenotype ratios for the offspring of a number of genetic crosses.
   a. A cross between a homozygous dominant horse and a homozygous recessive horse.
   b. A cross between a homozygous dominant horse and a heterozygous horse.
   c. A cross between two heterozygous horses.
   d. A cross between a heterozygous horse and a homozygous recessive horse.
   e. A cross between two homozygous recessive horses.
   f. A cross between two homozygous dominant horses.

3. Describe each of the following genotypes as homozygous dominant, homozygous recessive or heterozygous.

   Tt **dd** **HH** **mm** **TT** **Rr**

4. Use the information in Diagram 5.4 to describe the phenotype of each of the genotypes listed in question three above.
5. Use the information in Diagram 5.4 to set up a number of genetic problems and then use Punnett squares to work out the expected genotype and phenotype ratios for the offspring.
6. Record the number of girls and boys in the families of the members of the class. How close are the expected and actual ratios of girls to boys in each family? Add the total number of girls in all the families. Add the number of boys. How close is the actual ratio of total number of girls to total number of boys to the expected ratio of $\frac{1}{2}$ girls and $\frac{1}{2}$ boys?
7. The information on the next page shows the results of breeding experiments with pea plants. The predicted ratio in each case is 3:1. Work out the actual ratio for each trait.

   Number of individuals

   787 tall plants : 277 short
   6022 yellow seeds : 2001 green seeds
   5474 round seeds : 1850 wrinkled seeds
   447 green pods : 152 yellow pods

   a. Which TWO characteristics give actual ratios closest to the expected ratio of 3:1?
   b. What is different about the number of individuals for those two characteristics?
   c. Why does that difference cause this effect?

8. In your groups design and carry out an experiment involving tossing a flat object such as a coin, to test the hypothesis that the effect of chance is reduced as the sample size gets bigger.

Genetic Crosses

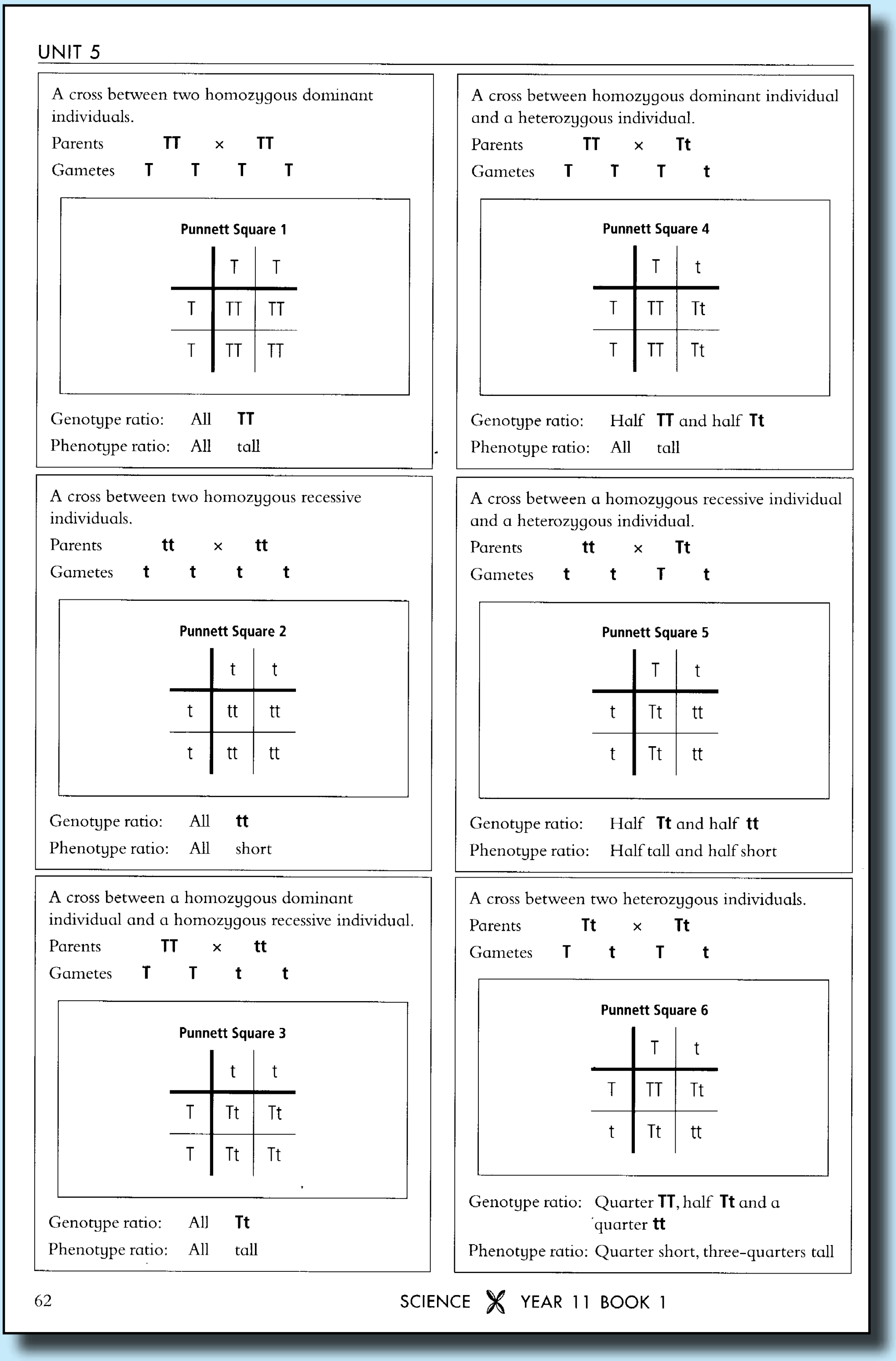
There are only six different crosses that can be done using one gene. The following examples (on the next page) use the characteristic of height in plants to show the genotype's six possible crosses.

Activity 4

Genetic Crosses

Aim To record information about different genetic crosses.

- Some cattle have horns, others do not. In cattle, the allele for polled (no horns) (P) is dominant to the allele for horns (p). Develop a chart (like the one on the next page) showing the expected genotype and phenotype ratios for the six different crosses that are possible for the polled (no horns) allele and the horns allele.



A cross between two homozygous dominant individuals.

Parents **TT** × **TT**

Gametes **T T T T**

Punnett Square 1

	T	T
T	TT	TT
T	TT	TT

Genotype ratio: All **TT**

Phenotype ratio: All tall

A cross between two homozygous recessive individuals.

Parents **tt** × **tt**

Gametes **t t t t**

Punnett Square 2

	t	t
t	tt	tt
t	tt	tt

Genotype ratio: All **tt**

Phenotype ratio: All short

A cross between a homozygous dominant individual and a homozygous recessive individual.

Parents **TT** × **tt**

Gametes **T T t t**

Punnett Square 3

	t	t
T	Tt	Tt
T	Tt	Tt

Genotype ratio: All **Tt**

Phenotype ratio: All tall

A cross between homozygous dominant individual and a heterozygous individual.

Parents **TT** × **Tt**

Gametes **T T T t**

Punnett Square 4

	T	t
T	TT	Tt
T	TT	Tt

Genotype ratio: Half **TT** and half **Tt**

Phenotype ratio: All tall

A cross between a homozygous recessive individual and a heterozygous individual.

Parents **tt** × **Tt**

Gametes **t t T t**

Punnett Square 5

	T	t
t	Tt	tt
t	Tt	tt

Genotype ratio: Half **Tt** and half **tt**

Phenotype ratio: Half tall and half short

A cross between two heterozygous individuals.

Parents **Tt** × **Tt**

Gametes **T t T t**

Punnett Square 6

	T	t
T	TT	Tt
t	Tt	tt

Genotype ratio: Quarter **TT**, half **Tt** and a quarter **tt**

Phenotype ratio: Quarter short, three-quarters tall

Human Genetics

Human genetics is very complicated. With 46 chromosomes in each cell there are lots of genes. Some characteristics such as eye and hair colour have more than one gene that controls the characteristics. There are others factors that make it complicated. For example, a study of several families showed that brown hair colour and brown eye colour was inherited together.

During the 1990s and early 2000s the Human Genome Project scientists worked to map all the 46 chromosomes found in human cells. The following information comes from one of the many websites about the Human Genome Project.

> Begun in 1990, the US Human Genome Project is a 13-year effort co-ordinated by the Department of Energy and the National Institutes of Health. The project originally was planned to last 15 years but effective resource and technological advances have accelerated the expected completion date to 2003. Project goals are to:
>
> - *Identify* all of the approximately 30 000 genes in human DNA;
> - *Determine* the sequences of the 3 billion chemical base pairs that make up human DNA;
> - *Store* this information in databases;
> - *Improve* tools for data analysis;
> - *Transfer* related technologies to the private sector; and
> - *Address* the ethical, legal, and social issues (ELSI) that may arise from the project.
>
> Several types of genome maps have already been completed and a working draft of the entire human genome sequence was announced in June 2000 with analyses published in February 2001. An important feature of this project is the federal government's long-standing dedication to the transfer of technology to the private sector. By licensing technologies to private companies and awarding grants for innovative research, the project is catalysing the multibillion-dollar US biotechnology industry and fostering the development of new medical applications.
>
> http://www.ornl.gov/hgmis/
>
> http://www.ornl.gov/hgmis/publicat/hgn/v11n1/04draft.html
>
> http://www.ornl.gov/hgmis/project/journals/journals.html

Activity 5 Human Genome Project

Aim To record information about the human genome project.

1. Try to organise a time to visit the websites listed above, or see if your teacher can download this information for you.
2. Explain why the Human Genome Project is important to medical science.

Family Trees

Before genetic testing became available for a number of medical conditions scientists used family trees to investigate inheritance patterns.

Here is a family tree for the inheritance of thumb shape. The tree records the phenotypes of the individuals. The pattern of inheritance can be used to work out which allele is dominant and which is recessive. It can also be used to work out the genotypes of some homozygous and heterozygous individuals.

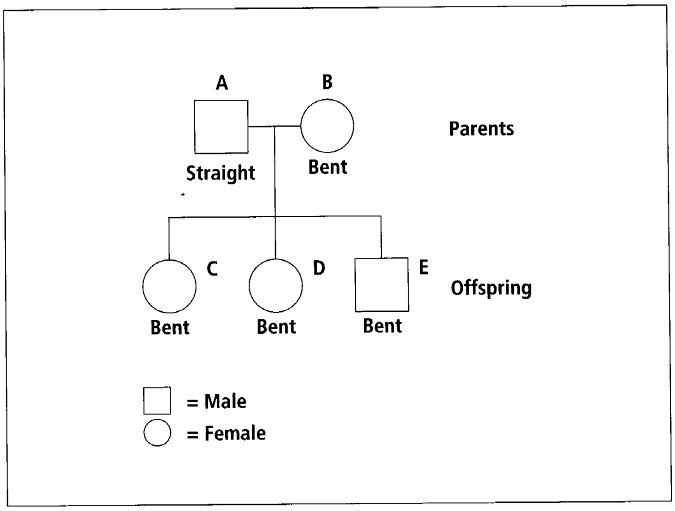


Diagram 5.8
Two generations.

1. **Question**:
   Which of the two phenotypes is recessive? Explain why.

   Answer:
   Straight is recessive because none of the offspring have the straight phenotype. In the offspring it is hidden by the dominant allele.

2. **Question**:
   What is the genotype of each of the people in the family tree? Explain your answer.

   Answer:
   A is **tt** *because he has the recessive straight thumb. B could be* **TT** *or* **Tt** *because she has at least one dominant allele for the bent thumb. There is not enough information to say which she is.*

   C, D and E are all **Tt**. *They have got the* **t** *allele from their father. They also have the* **T** *allele from their mother because they have bent thumbs.*

Activity 6 Family Trees

Aim To solve genetics problems involving family trees.

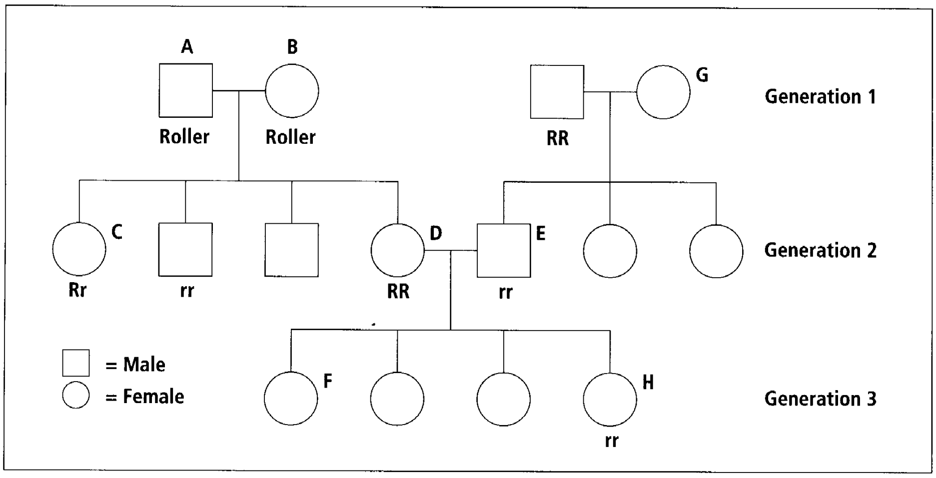


Diagram 5.9
Genetic crosses over three generations.

1. Look at the family tree above and answer the following questions:
   a. What is the genotype of the following individuals: A, B, F?
   b. What is the phenotype of the following individuals: C, D, E?
   c. What are the possible genotypes of G?
   d. The child labelled H is adopted from another family. Explain why H cannot be a genetic offspring of D and E.
2. Work with a partner. Choose one of the characteristics listed in Diagram 5.4. Make up a family tree showing three generations of a family that show the inheritance of the characteristic you have chosen.
3. Work with another pair. Get them to answer questions about the genotypes and phenotypes of the people on the family tree you have made up. Then you and your partner answer questions on the family tree they have developed.

Activity 7 Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

Unit 6: MICRO-ORGANISMS

In this unit, you will investigate the ways people use the life processes of micro-organisms to make different products.

Micro-organisms carry out all the life processes that other living things do. They move, respire, sense, grow, reproduce, excrete and feed. Viruses are a type of micro-organism that only carry out reproduction because they do not have all the cell parts that other micro-organisms do. The following diagrams show how micro-organisms carry out some of these processes. Information about the structure of micro-organisms and how they live can be found in Year 9 Science Book 1, pages 65–76.

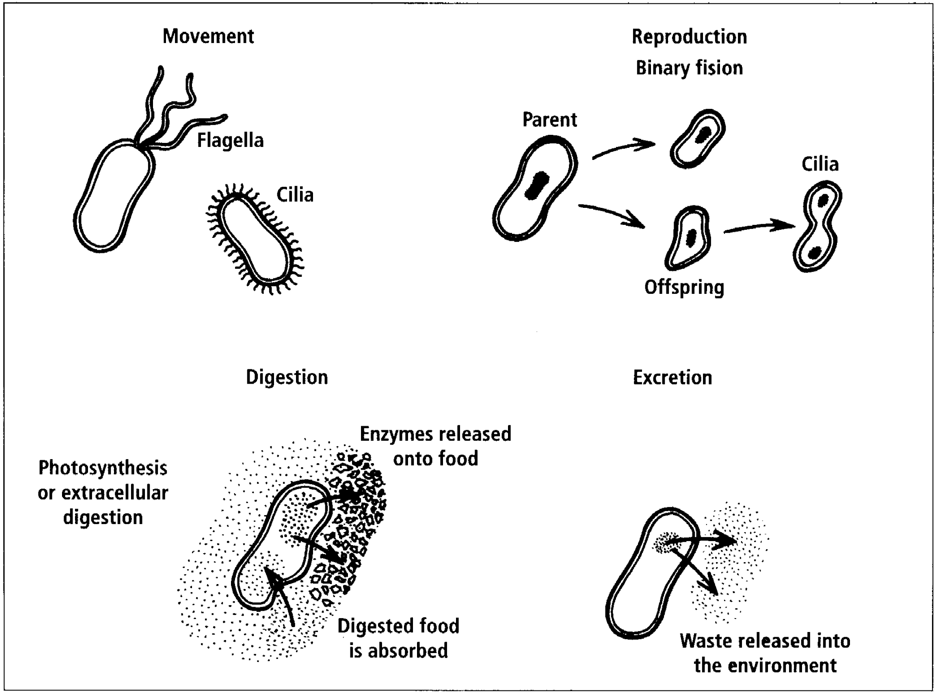


Diagram 6.1
Micro-organisms.

Activity 1 Life Processes Of Micro-organisms

Aim To revise understanding of micro-organisms.

Work in groups to develop a way to revise how micro-organisms carry out the life processes.

- You could write quiz questions and then test each other.
- One person in the group could name a life process and the rest of the group take turns giving one piece of information about that process.
- You could compare how micro-organisms carry out the life process with other living things such as humans.
- Each group could make a poster for the classroom wall showing how micro-organisms carry out one of the life processes.

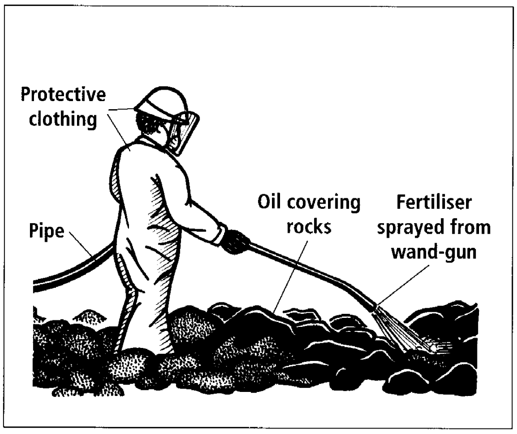
Using Micro-organisms

Micro-organisms can live in lots of different places, in lots of different ways using different processes.The rest of this unit looks at the ways people use micro-organisms.

Sometimes people use micro-organisms by simply encouraging the micro-organism to grow, reproduce and carry out its other life process the way it usually does. By giving micro-organisms all the right conditions they need, people are able to get micro-organisms to carry out natural processes more quickly, for example, making compost.

Compost

When feeding, micro-organisms, such as bacteria and fungi, break down dead plant and animal material releasing some nutrients for plants to use. People use the feeding process of micro-organisms to make compost. They give the micro-organism water, air and plant material for food, and it feeds, grows, and reproduces. These micro-organisms are found naturally in the environment. As the micro-organism lives, it breaks the plant material down so that it can be used as a fertiliser on gardens and plantations.



Removing oil

Another example of people giving a micro-organism the right conditions to feed and grow is the use of bacteria to clean up oil spills on beaches. Some of the bacteria that live on beaches can use oil when they respire and break the oil down into harmless chemicals such as carbon dioxide. So when a beach gets covered in oil from an oil spill, people spray the beach with fertilisers. The fertilisers cause the bacteria present to grow quickly and then break down the oil. Spraying the beach with fertiliser can help the bacteria to get rid of the oil up to five times faster than without the fertiliser.

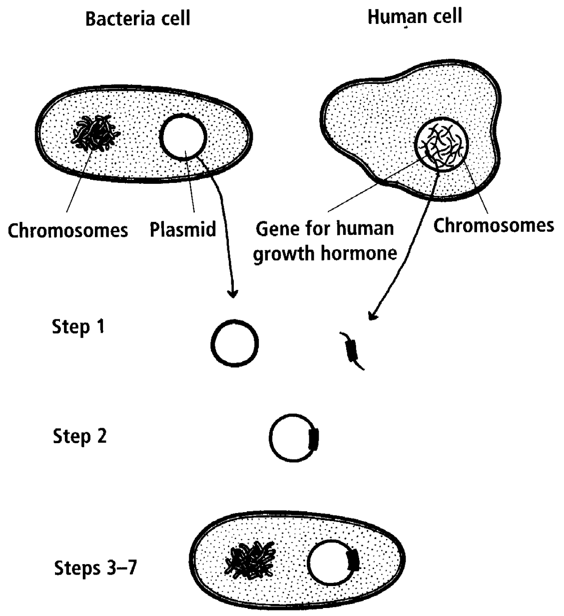
Diagram 6.2
Spraying fertiliser to clean up an oil spill.

Making antibiotics

Fungi and bacteria can make and secrete chemicals called antibiotics. Antibiotics kill other micro-organisms that are growing close to them. This allows the micro-organisms making the antibiotic to get the food that the other micro-organisms would have eaten. People grow antibiotic-making micro-organisms in large tanks and use the antibiotics they make in medicines.

Genetic engineering

Some bacteria are used in genetic engineering. Bacteria have a small circle of genetic material called a plasmid. The plasmid can be split and a piece of genetic material from an animal, plant or micro-organism can be joined into the plasmid. The plasmid is then put back into a bacterium. The bacteria grow and then divide using the new gene that has been added into their plasmid. The bacteria can also be used to add the gene into another organism.



Step 1: Plasmid and gene removed.

Step 2: Plasmid and gene joined.

Step 3: Plasmid placed back in bacteria (now called a recombinant bacteria).

Step 4: Recombinant bacteria reproduced.

Step 5: Recombinant bacteria given materials to make human growth hormone.

Step 6: Recombinant bacteria makes human growth hormone.

Step 7: Growth hormone given to people who lack the hormone naturally.

Diagram 6.3
Genetic engineering using bacteria.

Activity 2 Using Micro-organisms

Aim To record information on use of micro-organisms.

◧ Copy and complete the table on the next page.

Use	Type of micro-organism involved	Life process or part of micro-organism being used	What do people do to the micro-organism?
Making compost			
Removing oil			
Making antibiotics			
Genetic engineering			

Activity 3 Investigating The Use Of Micro-organisms

Aim To investigate how people use micro-organisms.

There are lots of different research and practical investigations that could be done depending on the resources available. Some possibilities are listed below. Carry out the research or investigation and use the information you find out to write up a report or case study. A 'case study' is a specific example of whatever you are studying. It can be used to show what was happening in the one example you studied or to show how one person did something. Present your report or case study to the class or compare it with a report or case study on a similar topic.

Whichever investigation you do, think about which micro-organism is being used and how the life processes of the micro-organism are important in the use.

1. To investigate the use of micro-organisms to make organic fertiliser.
   a. Interview someone that makes and uses organic fertilisers to find out about the making and using of the fertiliser.
   b. Try to find out about each of the following:
   - Why they make compost or organic fertiliser.
   - What plant material they use to make the compost or organic fertiliser.
   - How they make the compost or organic fertiliser.
   - When and where they use the compost or organic fertiliser.

You could set up a compost heap and make your own fertiliser.

Information on compost making can be found at:

http://www.hdra.org.uk/gh_comp.htm
http://muextension.missouri.edu/xplor/agguides/hort/g06956.htm
http://howstuffworks.lycoszone.com/composting2.htm
http://journeytoforever.org/compost_make.html
http://www.ext.vt.edu/pubs/envirohort/426-703/426-703.html
http://www.agf.gov.bc.ca/resmgmt/fppa/environ/mushroom/mush04.htm

2. Investigate the use of micro-organisms to make beer or another type of alcohol.
   a. Visit the Vailima beer factory to find out how the micro-organism, yeast, is used in beer making; or
   b. Interview someone that makes beer to find out about the process that they use.

Information on beer making can be found at:

http://howstuffworks.lycoszone.com/beer.htm
http://www.beertools.com/html/tutorial/index.shtml
http://www.owlnet.rice.edu/~reli205/andrew_beer/beer.html
http://www.uwrf.edu/biotech/workshop/activity/act1/labrb.htm
http://emuseum.mnsu.edu/prehistory/egypt/dailylife/makingbeer.html

3. To investigate the use of yeast in bread making, visit a bakery that makes its own bread to find out the steps in the process and how yeast is used.

Information on bread making can be found at:

http://www.cpinternet.com/~cappy90/bredmak4.htm
http://www.bartleby.com/87/0004.html
http://www.breadinfo.com/
http://www.freerecipe.org/Old_Fashioned_Advice/About_Bread-Making/
http://baking.about.com/library/weekly/aa020100.htm

4. Investigate the use of bacteria in yoghurt making. There is some information at the end of this unit on yoghurt making. Use it to produce:
   a. A flow chart of the yoghurt making process; or
   b. A poster of the yoghurt making process; or
   c. Notes about the yoghurt making process.
5. Investigate the use of bacteria and fungi. There is some information at the end of this unit which could be used as a starting point.

Yoghurt

People in south-eastern Europe and the middle East have known how to make yoghurt for centuries. Yoghurt is now made and used in most countries. Yoghurt is called a 'cultured milk product' because a culture of micro-organisms are used to make it. The culture used to make yoghurt has lactic acid-making bacteria in it. These bacteria change the lactose sugar in milk into lactic acid. This causes changes to the taste of the milk in yoghurt. It is not as sweet because the lactose has been changed to acid and the lactic acid gives the yoghurt a slightly sour acid taste.

Yoghurt contains most of the materials that make up milk except for the sugar lactose which the bacteria have changed into lactic acid. This is different to milk products such as cheese, ice cream, or butter, because they are made from only parts of the milk. Yoghurt lasts longer in the fridge than milk because the helpful lactic acid bacteria living in the yoghurt protect it from harmful pathogenic micro-organisms.

Yoghurts usually have other materials added to change it in some way. Many yoghurts have lumps of fruit added to add extra variety to the flavour. Sometimes the yoghurt is 'low fat' meaning that some of the fat has been removed from the milk as the yoghurt was being made. Some yoghurts may contain very small amounts of thickening agents, such as various plant polysaccharides (gums), gelatinised starch or gelatin. These materials hold the water in the body of the yoghurt.

Making Yoghurt

Milk from different types of animals is used to make yoghurt in various parts of the world but most of the yoghurt produced in large amounts is made from cow's milk. The process can start from whole milk, partially skimmed milk, skim milk or cream.

First the milk is heated until it almost boils. Its temperature must reach at least 85 °C (90 °C is more commonly used) and it is held at this temperature for at least 10 minutes. This evaporates some of the water and partly condenses the milk. It also changes the shape of the protein molecules so that they will later join together into a network. Bacteria in the milk are killed.

Yoghurt-making bacteria are added to the milk. They use the energy in the lactose sugar for respiration and turn the sugar into lactic acid. This slowly builds up the amount of lactic acid in the milk. As the amount of lactic acid gets higher the proteins in the milk join together in lumps. This is called **coagulation.** During coagulation the milk proteins form into a network of proteins throughout the milk. This forms a gel that traps water and gives the yoghurt its smooth moist texture. This makes yoghurt a solid that has the highest water content of all solid milk products.

The Bacteria

Yoghurt is made using a bacterial culture containing two different bacteria; streptococci (*Streptococci salivarius* subsp. *thermophilus*), and lactobacilli (*Lactobacilli delbrueckii* subsp. *bulgaricus*). Streptococci are round so can easily be seen with the rod-like lactobacilli. The bacteria are used together because the rate of lactic acid production is much higher when they are grown together. The streptococci bacteria grow faster and produce both acid and carbon dioxide. As they grow they form products that the lactobacilli bacteria need and then the lactobacilli stimulate further growth of the streptococci. This way of living together is called symbiosis, which means living together to benefit each other.

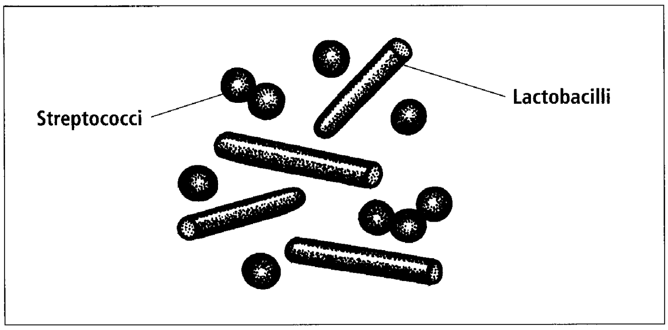


Diagram 6.4
Bacteria culture used to make yoghurt.

More details about the making of yoghurt

There are two types of plain yoghurt:

- Stirred style yoghurt.
- Set style yoghurt.

The following is a description of the making of stirred style yoghurt. The milk is **separated** into skim milk and cream, then **cream is added or removed** to get the same amount of fat in each batch. The skim milk and cream are then mixed together. Other ingredients are added. The mixture is then **pasteurised** for 30 minutes at 85° C or 10 minutes at 95° C. Pasteurisation removes all the other bacteria from the milk so that the yoghurt bacteria are able to grow. The mixture is then **homogenised** to make sure none of the parts of the milk or other ingredients separate out during incubation and storage. The milk is then cooled to an optimum growth temperature, the yoghurt starter culture is added. This is called **inoculation**.

The starter culture has equal amounts of the two bacteria, streptococci and lactobacilli. The milk and culture is put into a **fermentation** tank. The mixture in the fermentation tank is not stirred. Streptococci bacteria work best when the temperature is at 39° C and lactobacilli work best when the temperature is 45° C. To give the best results the temperature in the fermentation tank is kept between these two temperatures, at 43° C. The milk and culture are **incubated** at this temperature for four to six hours. During this time the bacteria grow, reproduce and use the lactose sugar for respiration. They excrete lactic acid as a waste product of their respiration. The lactic acid changes the flavour of the yoghurt and coagulates the proteins in the milk to form yoghurt.

The amount of acid being made by the bacteria is checked regularly. When it gets to 0.9% the tank is cooled down to about 22° C. Fruit and flavour may be added, then the yoghurt is **packaged**. It is then cooled and **stored** in a fridge at 5° C. Storage at this temperature slows down the activity of any bacteria in the yoghurt so that it lasts longer.

When making set style yoghurt, the yoghurt is packaged immediately after inoculation with the starter and is incubated in the packages.

Other Yoghurt Products

Acidophilus milk

Acidophilus milk is a traditional milk product made by the fermentation of milk with *Lactobacillus acidophilus*. This milk is thought to be good for the tubes of the digestive system. Skim or whole milk may be used. The milk is heated to a high temperature, *(e.g. 95° C)* for one hour. This is to make sure that all the other bacteria that may be present are killed. *Lactobacillus acidophilus* is very slow growing and other bacteria would easily stop it from growing. Milk is inoculated and incubated at 37° C until coagulated. Some acidophilus milk has an acidity as high as 1% lactic acid, but it is usually kept around 0.6–0.7%.

There is another type of acidophilus milk that is sweet tasting. The *Lactobacillus acidophilus* culture is added but the milk is kept at a low temperature so no incubation occurs meaning that the bacteria do not grow or reproduce much. The acidophilus milk has not been fermented so it does not have the high acid flavour of the normal acidophilus milk. Some people prefer acidophilius milk without the acid flavour.

Other products

There are many other fermented dairy products, including kefir, koumiss, beverages based on bulgaricus or bifidus strains, and labneh. Many of these have developed in regional areas. Because different starter micro-organisms are used, each has its own flavour and texture. Using different starter micro-organisms means that the end products of the fermentation process are often different, for example a gas or ethanol.

References:

http://distans.livstek.lth.se:2080/microscopy/f-yogurt.htm
http://distans.livstek.lth.se:2080/microscopy/f-bacter.htm
http://www.foodsci.uoguelph.ca/dairyedu/yogurt.html

Production Of Antibiotics

For a long time people have known about putting preparations from living things onto wounds to destroy infection. It was only late in the 19th century when people found out that micro-organisms could make chemicals that could kill other micro-organisms, such as disease-causing bacteria, but would be harmless to other organisms, such as humans.

In 1928, Sir Alexander Fleming, a Scottish biologist, found that *Penicillium notatum,* a common mould, had destroyed staphylococcus bacteria. In 1939 the American microbiologist, René Dubos, showed that a soil bacterium could decompose the capsule of the pneumococcus bacterium, without which the pneumococcus is harmless and does not cause pneumonia. Dubos then found a microbe in the soil, *Bacillus brevis,* that made a product called tyrothricin. Tyrothricin was found to be highly toxic to a wide range of bacteria and also to red blood and reproductive cells in humans, but it could be used as an ointment on the skin. Penicillin was finally isolated in 1939, and in 1944 Selman Waksman and Albert Schatz, American microbiologists, isolated streptomycin and a number of other antibiotics from *Streptomyces griseus.* The making of large amounts of antibiotics began during World War II with streptomycin and penicillin.

Now some antibiotics are produced using a fermentation process. Micro-organisms that make large amounts of antibiotic are grown under the best conditions. They are held in large fermentation tanks, kept warm and given all the oxygen and nutrients they need. The micro-organism is then strained out of the fermentation broth and then the antibiotic is removed from the broth by filtration, precipitation, and other separation methods.

In some cases, new antibiotics are made in a laboratory or produced by chemically modifying natural substances. Many antibiotics made in these ways are more effective against infecting organisms or are better absorbed by the body than the natural substances are. Some semisynthetic penicillins are effective against bacteria resistant to the parent substance.

Vancomycin is an antibiotic that behaves like penicillin. It is made by the bacterium *Streptomyces orientalis.* Vancomycin destroys bacteria such as staphylococci and enterococci. It seems to work by stopping the bacteria from making a cell wall, as penicillin does. It may also cause damage to the cell membrane. Vancomycin also harms human tissue so is usually only used for infections caused by micro-organisms that are resistant to penicillin. Vancomycin must be injected because it is not absorbed through the digestive system.

Why Bacteria Make Antibiotics

Studies show that *Streptomyces* micro-organisms make antibiotics when the food they are living on is almost all gone. Some *Streptomyces* cells in the colony begin to form spores. The spores get blown to new food sources. Some of the other cells in the colony produce antibiotics to protect the developing spores and their food source.

A number of scientific studies are looking at the amount of antibiotic the *Streptomyces* bacteria can make. People are using more antibiotics so strains that produce higher amounts of antibiotics are needed. In the past it has taken a long time to find a strain of micro-organism that will make higher amounts of antibiotic. In future these high antibiotic-making micro-organisms may be genetically engineered.

References:

http://www.factmonster.com/ce6/sci/A0856639.html
http://chemeng.stanford.edu/html/kao.html

Activity 4 Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

Unit 7: PHOTOSYNTHESIS AND RESPIRATION

In this unit, you will investigate how carbon is cycled through plants, animals and the environment. You will also investigate the processes of respiration and photosynthesis.

Carbon Cycle

There are a lot of materials that are cycled between plants, animals and the environment. Carbon is an example of a material that is cycled. Cycled means the actions of organisms make it pass from the environment to living organisms and back to the environment again. It is then taken in by organisms again and the cycle continues.

The following diagram shows how carbon moves from the environment, between organisms, and back to the environment. There are three main biological processes important in the moving of carbon. These are photosynthesis, respiration and decomposition.

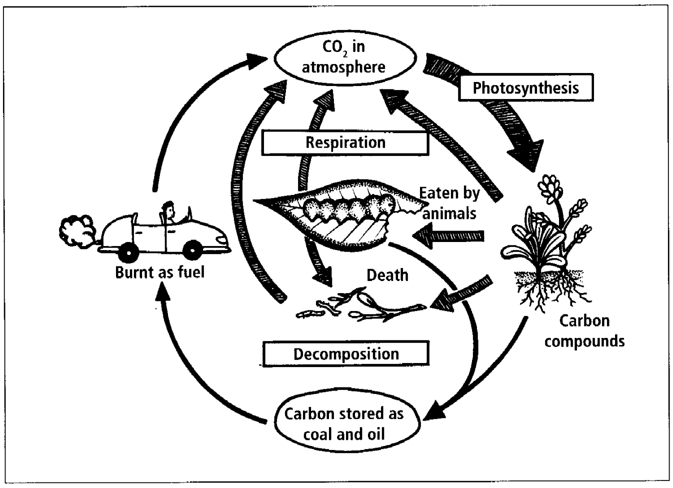


Diagram 7.1
Carbon cycle.

The top of Diagram 7.1 shows carbon in the atmosphere joined with oxygen in carbon dioxide gas. Carbon dioxide makes up 0.04% of the gases in the atmosphere. Plants use the carbon dioxide from the atmosphere when they carry out **photosynthesis**. They use energy from light to join the carbon dioxide with hydrogen to make it into a carbon compound called glucose. Plants can then change the glucose into other materials they need for growth such as proteins, fats and carbohydrates. When animals eat plants, the carbon in the carbon compounds go from the plant to the animal.

Both plants and animals use a process called **respiration** to supply energy for the life processes such as growth and movement. During respiration, carbon compounds are broken down and carbon dioxide is released back into the atmosphere.

When plants and animals release waste materials or die, the micro-organisms in the soil break down this plant and animal material. This is called **decomposition**. The small carbon compounds produced during decomposition are absorbed by the micro-organisms and used in the process of respiration. The respiration of micro-organisms releases carbon dioxide back into the atmosphere.

The bottom part of Diagram 7.1 shows how people **burning** carbon compounds stored in coal and oil also releases carbon dioxide and sulphur dioxide into the atmosphere. The burning of large amounts of fuels such as coal and oil has caused pollution problems in lots of places in the world. The gases carbon dioxide and sulphur dioxide cause pollution by dissolving in rainwater to form **acid rain.** Acid rain is a problem because it causes damage to the eyes, nose, throat and lungs of people and animals. Acid rain also reacts with building materials such as limestone and marble. This breaks down the limestone and marble and the building will be slowly destroyed.

Formation Of Acid Rain

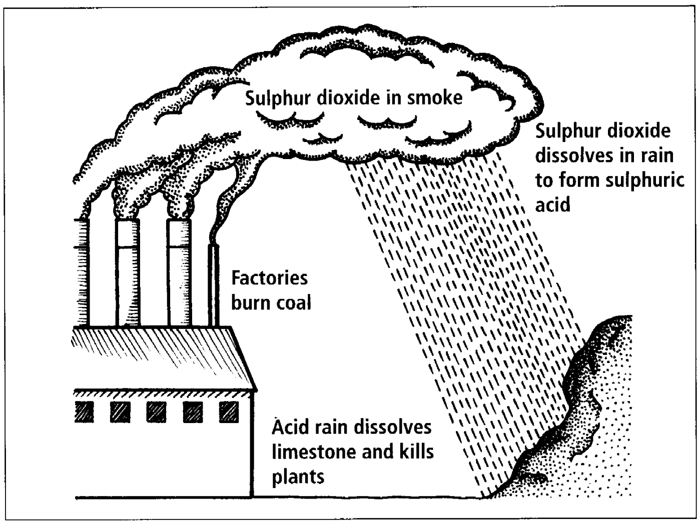


Diagram 7.2
Formation of acid rain.

Sulphur dioxide + water (rain) ⟶ sulphuric acid (acid rain)

Carbon dioxide + water (rain) ⟶ carbonic acid (acid rain)

Acid rain destroys buildings by reacting with some building materials.

Sulphuric acid + calcium carbonate ⟶ calcium sulphate + water +
(in acid rain) (in limestone or marble) carbon dioxide

Activity 1 Carbon Cycle

Aim To record information about the carbon cycle.

1. Copy the diagram below of the carbon cycle. Add the following labels to the correct arrows: **photosynthesis by plants**, **respiration by plants and animals**, **feeding by animals**, **burning of fuels by people**, **respiration by micro-organisms**.

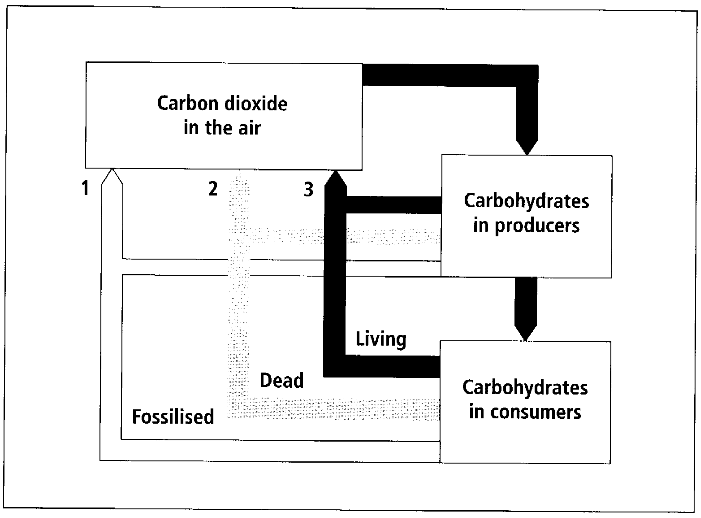


Diagram 7.3
The carbon cycle.

2. Draw a diagram to show a number of the different ways carbon is cycled in Samoa.
3. Discuss the effect that the increasing number of cars is having on the environment in Samoa.
4. Find out about global warming and the greenhouse effect.

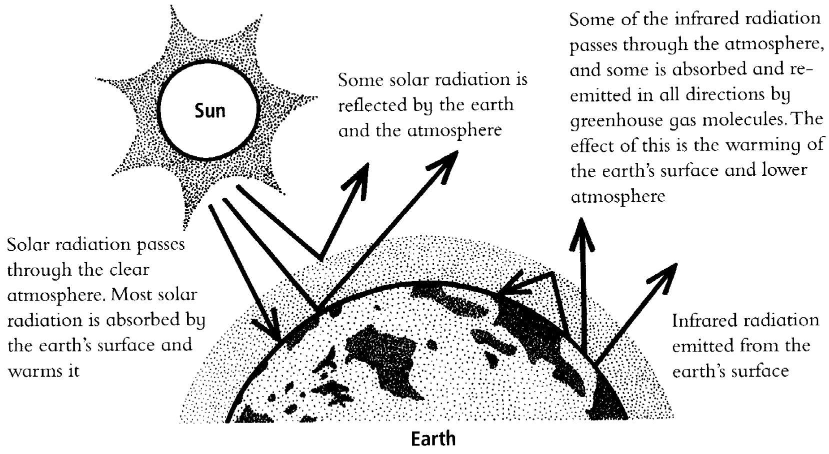


Diagram 7.4
The greenhouse effect.

What are greenhouse gases?

Some greenhouse gases occur naturally, others are caused by human activities. Greenhouse gases that are found naturally in the atmosphere include water vapour, carbon dioxide, methane, nitrous oxide and ozone. Human activities add to the levels of most of these naturally occurring gases. For example, carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, coal), wood and wood products are burned.

Methane is given off during the production and transport of coal, natural gas and oil. Methane is also formed in the decomposition of organic wastes in landfills. Animals, such as, cattle also give off methane gas as part of their digestive processes.

Nitrous oxide is given off during agricultural and industrial activities, as well as during burning of solid waste and fossil fuels.

Very powerful greenhouse gases that are not naturally occurring include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6). These gases are all produced in industrial processes and have lots of different uses.

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Methane traps over 21 times more heat per molecule than carbon dioxide and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. Often, estimates of greenhouse gas emissions are presented in units of millions of metric tons of carbon equivalents (MMTCE), which weights each gas by its GWP value, or Global Warming Potential.

http://www.epa.gov/globalwarming/emissions/index.html

These websites have information about global warming and the greenhouse effect:

http://www.epa.gov/globalwarming/
http://globalwarming.enviroweb.org/
http://www.climatehotmap.org/
http://www.sierraclub.org/globalwarming/

5. What effects will global warming have on Samoa?
6. Read the previous information about greenhouse gases. Which of these greenhouse gasses are important in Samoa? Explain why.
7. Explain what the carbon cycle has to do with global warming and the greenhouse effect.
8. Discuss what individual class members can do in Samoa to help reduce the greenhouse effect and global warming.
9. What are carbon credits'? What problem are they trying to solve and how is the use of carbon credits meant to solve the problem?

Respiration

All living organisms carry out respiration. Respiration is a series of chemical reactions that take place in the cells of a living organism. Without respiration occurring, the living organism dies. Sometimes people and textbooks confuse breathing and respiration. Sometimes breathing is called respiration. This is incorrect. Breathing is the getting of air in and out of the body. Breathing is needed by large organisms to get the oxygen needed for respiration into the body.

The chemical reaction for respiration is:

$$\text{Glucose} + \text{oxygen} \longrightarrow \text{Carbon dioxide} + \text{water}$$

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

Respiration releases lots of energy from the chemical bonds in the glucose and holds the energy in another chemical until it is used in the life processes of the cell.

Respiration is the same chemical reaction as burning. In burning, the energy is let out quickly as heat and light. In respiration, the energy release happens slowly, in small steps, and the energy is held in chemical bonds in a special chemical called ATP.

Cells use energy all the time so respiration is occurring all the time. Because of this, cells need a continuous supply of oxygen and glucose. In plant cells, oxygen can come from chemical reactions in photosynthesis but photosynthesis only occurs when there is enough light energy available. This means that the plant must get oxygen from the air into the leaves and stem. The trunks of large trees are mostly dead wood so these cells are not carrying out respiration. Only the thin layer of cells around the outside of the trunk is alive and therefore need a supply of oxygen. Plants have lenticels in their stems and trunks to allow oxygen in the air to get into the cells.

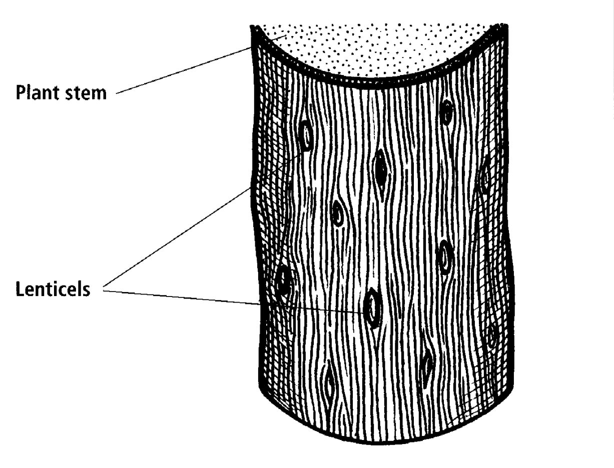


Diagram 7.5
Lenticels on a stem.

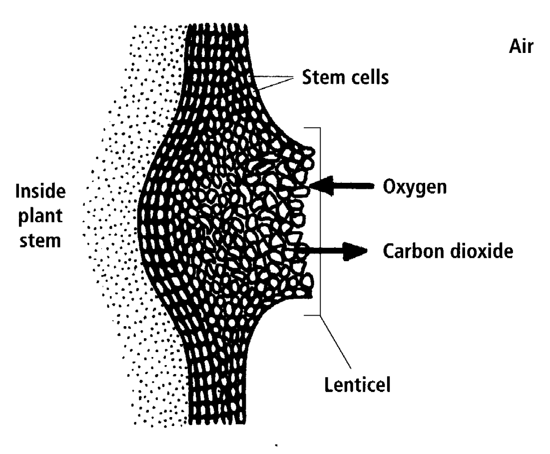


Diagram 7.6
Inside a lenticel.

Language note:

One stoma, two or more stomata.

A lenticel is a hole in the tough outer layer of cells around the stem or trunk of a plant. Oxygen can move into the plant cells through the lenticel. Any carbon dioxide that the plant does not need will go out through the lenticel.

In the leaves the plant has stomata and guard cells that let oxygen and carbon dioxide move in and out of the leaf.

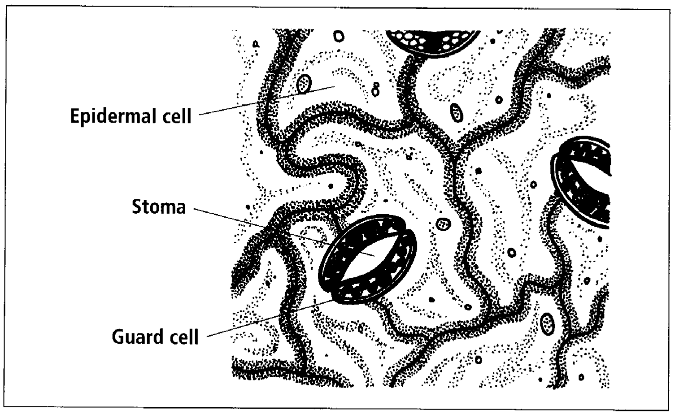


Diagram 7.7 ·
Stomata and guard cells in a leaf.

The guard cells around the stoma change shape to open and close the stoma. When the stoma opens to let the gases in and out the plant also loses water from the leaf. The loss of water is called transpiration. If the plant loses too much water, the guard cells close the stoma to stop more water from being lost. The stomata in some plants close during the hottest part of the day and then open again in the evening.

Activity 2

Respiration

Aim To investigate aspects of respiration.

Write the following questions in your exercise book and record your answers:

1. What is the purpose of respiration?
2. How many molecules of oxygen does it take to break down one glucose molecule into carbon dioxide and water?
3. How much water is produced from the break down of three glucose molecules?
4. What is the difference between breathing and respiration in animals?
5. Although respiration and burning are the same chemical reaction the energy released is in different forms.
    a. In what form is the energy released in each reaction?
    b. Explain why the energy from respiration must be in a different form than the energy released from burning.
6. Which parts of plants require oxygen?
7. Plants have two structures that are designed to allow the gases oxygen and carbon dioxide to move in and out of the plant.
    a. Describe the way the two structures function.
    b. Explain why the opening and the closing of the stomata needs to be controlled by the plant.

Photosynthesis

All green plants carry out photosynthesis. Photosynthesis only occurs in cells that have chloroplasts. Chloroplasts are small organelles that contain the green pigment chlorophyll. When carbon dioxide, water and light are present inside a chloroplast a series of chemical reactions occur. The energy in the light is used to split water into hydrogen and oxygen. The oxygen is a waste product so goes out of the chloroplast. During a series of chemical reactions that follow, the hydrogen atoms are joined with several carbon dioxide molecules to produce glucose.

The chemical reaction for photosynthesis is:

$$\text{Carbon dioxide} + \text{water} \xrightarrow[\text{chlorophyll}]{\text{light}} \text{Glucose} + \text{oxygen}$$

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$$

The light and chlorophyll are not chemicals so are written above and below the arrow to show that they are needed in the reaction. The water splitting part of photosynthesis can only happen if light is shining on the plant. If no light is shining on the plant, the plant will continue to make glucose until it runs out of the hydrogen from the water. When light shines on the plant again and the plant has a supply of water and carbon dioxide the plant will begin to carry out photosynthesis again.

Not all of the light that lands on the plant is used for photosynthesis. For example, green light is not used. Most of the green light is reflected off the leaf. This is why leaves look green. The green light is reflected back to our eyes.

The following graph shows how quickly photosynthesis happens in different colours of light. How quickly photosynthesis can happen is called the rate of photosynthesis. Photosynthesis happens more quickly in blue and red light. The rate of photosynthesis in green light is very low when compared with the rate in blue and red light.

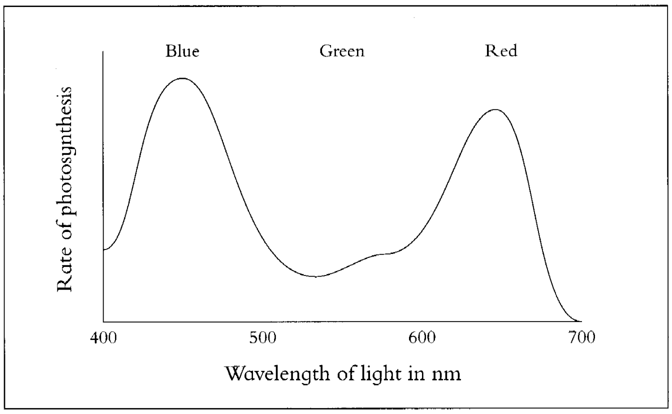


Diagram 7.8
Photosynthesis rate in different colours of light.

As soon as the glucose has been formed several glucose molecules are then joined together to produce starch. The glucose is stored as starch until it is needed for respiration or for making into other materials needed by the plant, such as protein.

Both the lenticels and the stomata are important in getting carbon dioxide gas into the plant when the cells are carrying out photosynthesis. When the stomata open they let carbon dioxide from the air diffuse into the air spaces in the leaf and then into the cells that are carrying out photosynthesis. The vein in the leaf brings water from the soil into the leaf so that some of it can be used for photosynthesis.

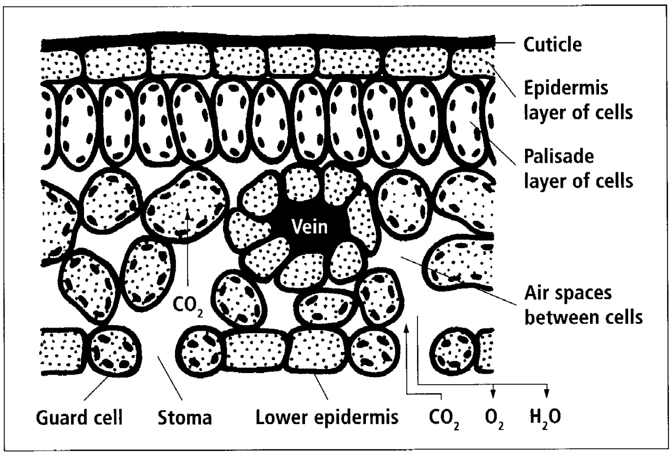


Diagram 7.9
Cross section view of a leaf.

Lots of factors change how quickly photosynthesis can happen. The effect of the colour of the light on the rate of photosynthesis is shown in Diagram 7.8. The brightness of the light is also important. The brighter the light the quicker the rate of photosynthesis (up to a point).

The temperature also affects the rate of photosynthesis. Diagram 7.10 shows the rate increases until the temperature gets to about 30ºC and then the rate of photosynthesis slows down. The rate may slow down because the plant is losing too much water and the stomata must close. When the stomata close, no more carbon dioxide can get into the leaf.

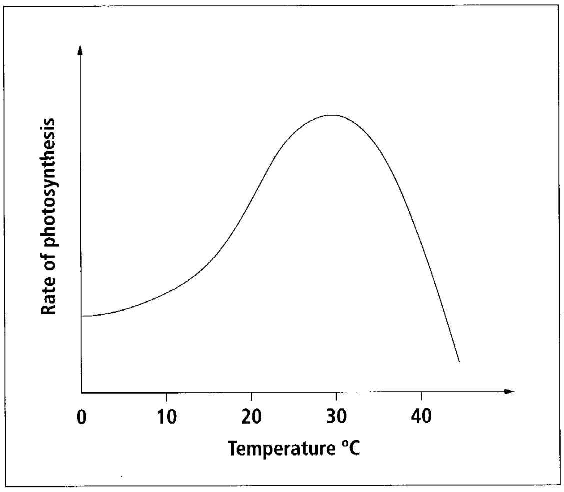


Diagram 7.10
Changes in the rate of photosynthesis with change in temperature.

Activity 3 Photosynthesis

Aim To record information about photosynthesis.

Record your work in your exercise book.

1. What is the purpose of photosynthesis?
2. Why do only some plant cells carry out photosynthesis?
3. Copy the symbol equation for photosynthesis.
4. Describe the trend that is showing in the graph in Diagram 7.8.
5. Use the information on the graph to explain what would happen to a plant that was grown under a green light for a long time.
6. The diagram below shows the set up of equipment to test the effect of the brightness of light (called light intensity) on how quickly the plant will carry out photosynthesis. How quickly the plant will carry out photosynthesis is measured by counting the number of bubbles of oxygen gas the water plant in the experiment gives off.
   a. How many bubbles are given off per minute when the light is at 200 units?
   b. Describe the trend shown by the results on the graph.

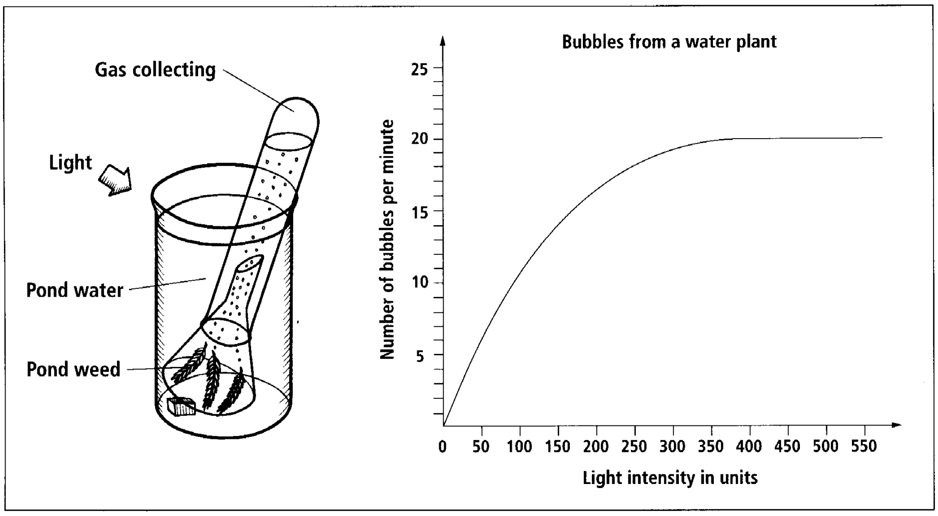


Diagram 7.11
Respiration rate of a plant.

Activity 4

Light And Photosynthesis

Materials needed:

Plants with soft leaves, growing in pots. Destarch by placing plant in dark for at least 12 hours;

Containers that do not let light in and are big enough to hold the plant;

Sheets of different coloured plastic that will let light through — white, black, red, blue, green, yellow;

2 Test tubes;

Hot plate or boiling water;

Meths;

Dish;

Iodine.

Warning:

Take care — meths fumes burn easily. Never leave meths or any other flammable liquid near open flames.

Aim To investigate how different aspects change the rate of photosynthesis.

1. Work in groups. Each group set up one plant.
2. Cut a large hole in the top of the cardboard box. Each group is to cover the hole with a different coloured plastic.
3. Describe what the plant looks like (*e.g. Colour of the leaves, direction of growth*).
4. Measure the height of the plant.
5. Place all the boxes and plants in the same area of the room.
6. Leave the plant inside the cardboard box for at least four days.
7. Remove the plant from the box.
8. Measure the height of the plant and record observations about the plant.
9. Each group remove a leaf from their plant. Place the leaf in a test tube and cover it with meths. Label the test tube.
10. Boil the test tube with the leaf in meths in a water bath for about 10 minutes. This will remove the chlorophyll.
11. Rinse each leaf in hot water to remove the meths and soften it.
12. Place the leaves on a dish and cover each with iodine. You may need to press on it to help the iodine get into the leaf.
13. Look for patches of the leaves that are a blue-black colour. This colour means that the leaf has starch stored. A brown colour means no starch therefore the leaf has not been carrying out photosynthesis.
14. Draw the shapes of each of the leaves and mark in the patches of blue-black and brown colour.
15. Write a conclusion and discuss your results.

Activity 5

Rate Of Photosynthesis

Materials needed:

10 cm^3 transparent plastic syringe;

50 cm^3 0.2 M sodium bicarbonate solution;

Cork borer (straw);

Stopwatch;

Strong source of light;

Plant or fresh leaves.

Aim To plan and carry out an investigation into how a factor changes the rate of photosynthesis.

There are a number of conditions and factors that change the rate at which plants carry out photosynthesis. This investigation requires you to plan, carry out and report on an investigation into the rate of photosynthesis. During the investigation you will have to measure the rate of photosynthesis. The method below uses a special technique using small circles of leaf called 'leaf discs' to measure the rate of photosynthesis.

Part A

Leaf discs are made by using a cork borer to remove a circle from a leaf. When leaf discs are placed in light and sodium hydrogen carbonate solution (a source of carbon dioxide) the oxygen produced by photosynthesis causes the leaf discs to float. The time it takes for the leaf discs to float can be used as an indirect measure of the rate of photosynthesis: i.e. The sooner they float, the faster the rate of photosynthesis.

Leaf discs will float when placed in sodium bicarbonate solution so the air inside the leaf discs must be removed at the beginning. Part A gives you practise at this technique.

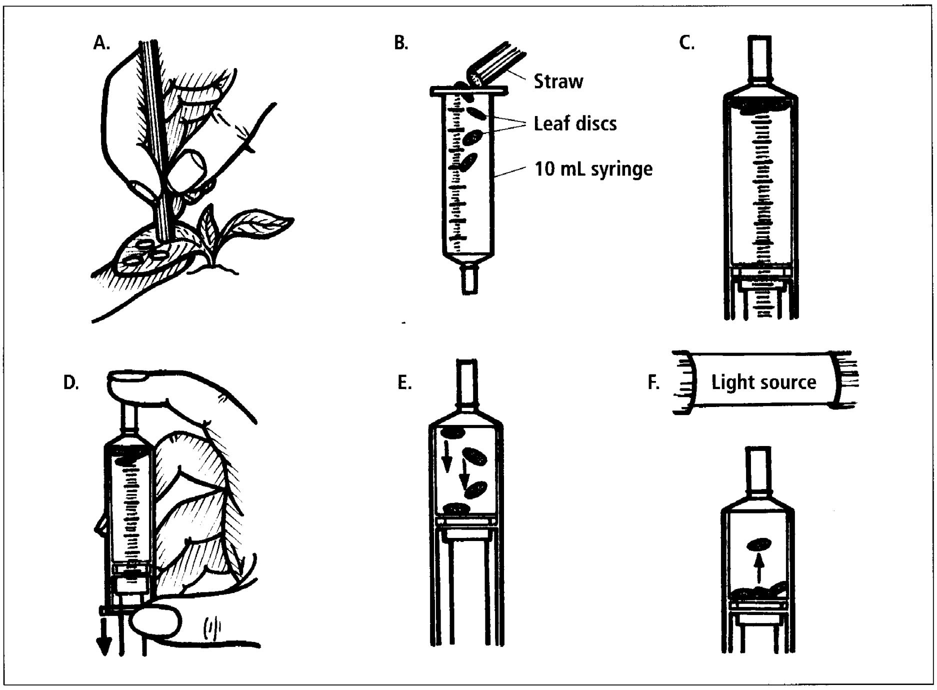


Diagram 7.12
Leaf disc investigation.

1. Using the No. 3 cork borer, cut out three discs from a leaf. See Diagram 7.12**A**.
2. Remove the plunger from a 10 cm^3 syringe. Place your finger over the nozzle, add about 5 cm^3 of the 0.2 M sodium bicarbonate solution.
3. Carefully put the leaf discs into the solution in the syringe. See Diagram 7.12**B**.
4. Carefully replace the plunger and point the syringe upwards. See Diagram 7.12**C**.
5. Push out all of the air.
6. Place a finger over the nozzle. Gently pull the plunger down. Many bubbles will appear on the leaf discs. This will remove the air from the leaf discs. See Diagram 7.12**D**.
7. Release your finger from the nozzle and tap the syringe vigorously so that the air bubbles rise to the top. Repeat steps 5, 6 and 7 until all the leaf discs sink. See Diagram 7.12**E**.

8. Put the syringe close to the strong light source and start a stopwatch. Record the time taken for each leaf disc to rise.
   See Diagram 7.12**F**.
9. If you have time, repeat steps 5, 6 and 7 to resink the leaf discs. Then repeat step 8.
10. Record information about the leaf disc technique and then hand this and your results in to your teacher.

Part B

Here is another method used to measure the rate of photosynthesis. It uses a water plant called *Elodea* that gives off bubbles of oxygen gas when it carries out photosynthesis.

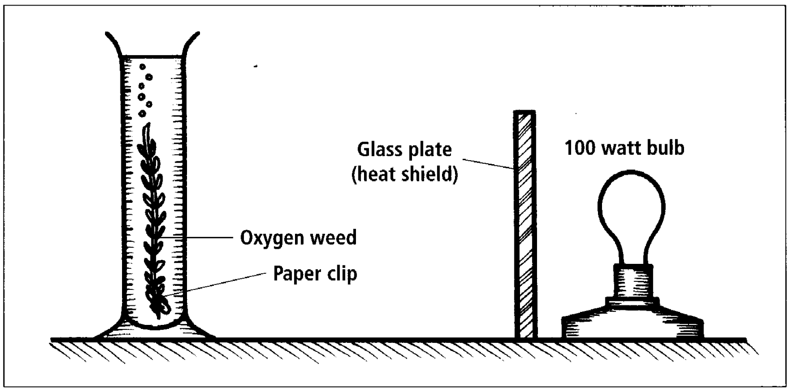


Diagram 7.13
Measuring the rate of photosynthesis by counting the number of bubbles given off.

In this next task you will plan, carry out and report on a leaf disc investigation into a factor that could affect the rate of photosynthesis.

1. Choose one of the factors from the list below that could effect the rate of photosynthesis:
   - Amount of light.
   - Temperature.
   - Amount of carbon dioxide.
   - Colour of light.
   - Sun or shade plant.
   - Species of plant.

2. Consider the changes you will have to make to the leaf disc investigation you carried out in task one to make it suitable for this investigation.
3. Write out a draft plan. Ask if any extra equipment and chemicals you need are available.
4. Carry out your plan, making and recording any modifications that you find are needed.
5. Write a report that includes:
   a. Aim or hypothesis.
   b. The final method you used in your investigation.
   c. Raw data.
   d. Processed results.
   e. Conclusion — what effect does the factor have on the rate of photosynthesis?
   f. Discussion of what your results show in relation to the importance of rate of photosynthesis to plant survival and growth.
   g. Attach your information and results from task 1 and your draft investigation plan.

Activity 6

Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

Unit 8: LOCAL LANDSCAPE

In this unit, you will investigate the special features of the local landscape, explain how it has formed and describe the effects of people on the landscape. You will also investigate the properties and importance of the oceans, lagoons and coral reefs that surround Samoa.

Islands as beautiful as Samoa always have a number of landscape features that are special. The local features have been produced by the geological forces that create volcanic islands, such as Samoa, and the weathering and erosion forces that have occurred since the islands were formed.

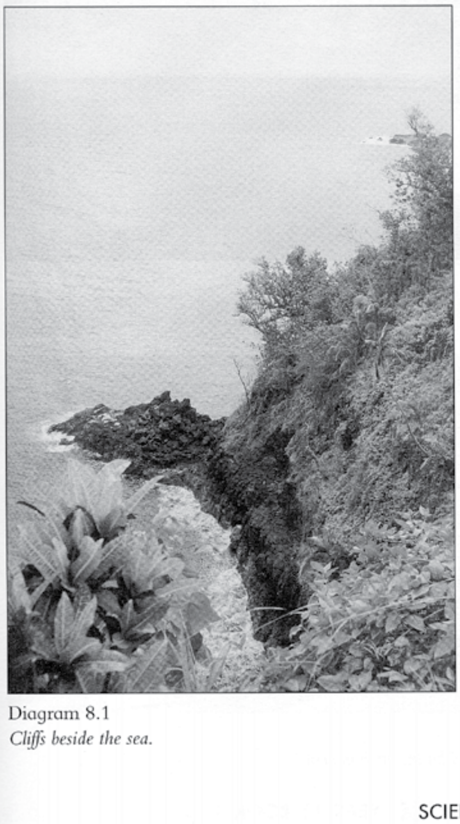


Diagram 8.1
Cliffs beside the sea.

Diagram 8.2
Lava in a lava flow.

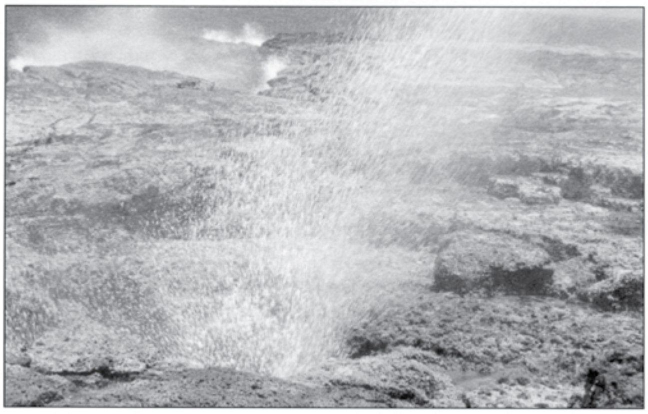


Diagram 8.3
Blowholes.

Diagram 8.4
Waterfall.

Diagram 8.5
People-made feature damaged by the environment.

Activity 1 Landscape Features In Samoa

Aim To record information on the features of the landscape in Samoa.

1. Draw a large outline sketch map of Samoa.
   a. Mark on your map at least one example of each of the special landscape features of Samoa. These include waterfalls, cliffs, caves, lava flows, volcanoes, blow holes, a chain of volcanoes in a line, rock formations (*e.g. Sliding rocks*), bays, lakes, pools, rivers and streams.
   b. Mark on the map of Samoa the special environmental features. These include rainforest, swamp forest, mangrove swamps and cloud forests. What other special environmental features can you add to your map?
   c. On the map of Samoa mark in features the are made by people: *e.g. The National Park, Faleolo Airport, memorials, Apia township, star mounds.*
2. Remember that something that is thought of as 'just the cliff' you walk past everyday IS a special landscape feature. Even a flat area is a special local landscape feature.
   a. Find out more details about the local landscape around your school or village. What are the landscape's special features?
   b. Organise a field trip to visit unusual areas of the local landscape so that you can make detailed sketches of the feature or area. Also carry out Activity 2 (see below), while on the field trip.
   c. Organise a speaker to come into the class and speak about the local landscape and how it was formed or ask other people about the local landscape.
   d. Work in groups to present information that has been found about a feature of the local landscape. Each group can present information about a different feature.
3. Find out more about the history of the local area. For example, if the area has caves — did people live in these caves? When did they stop living in the caves? Why did they stop living in the caves?

Activity 2 Local Landscape Features

Aim To investigate how the local landscape was formed and has changed.

1. Organise a field trip to observe the local landscape. Look for evidence of how the landscape was formed and how it has changed since it was formed. Look for the following evidence:

- Is there evidence of volcanic action? Is there a volcano nearby? Has it erupted recently? Erupted means given off ash, gases, rocks or lava.
- Are there areas where the land has been washed away? This is evidence of erosion by water.

- Are plants growing in the rocks? Look at the rock around the roots of the plants. Can you see cracks in the rock and are there any rock chips? These are evidence of weathering.
- Does the landscape look like it is being changed by wind? Look at the trees around the area. Are they leaning in the same direction? Have they been affected by the wind?
- How have people changed the local landscape? What positive changes have occurred? What is the result of the positive changes? What negative effects on the landscape have happened? What are the result of the negative effects? What can people do to reduce their negative impact on the local landscape? What can the local people do to change the negative effects on the local landscape?

Changes To The Local Landscape

The landscape around us is always changing. Usually these changes occur very slowly over a number of years. These changes occur by weathering and erosion. Weathering is the name for the breakdown of rocks into small pieces. Wind, water, ice, plants and animals are the main ways that rocks are weathered.

Activity 3

Changes To The Local Landscape

Aim To record information about changes to the local landscape.

In Book 3 of the Year 9 Science books there is a unit that includes information on the rock cycle. Review the rock cycle if it is unfamiliar to you.

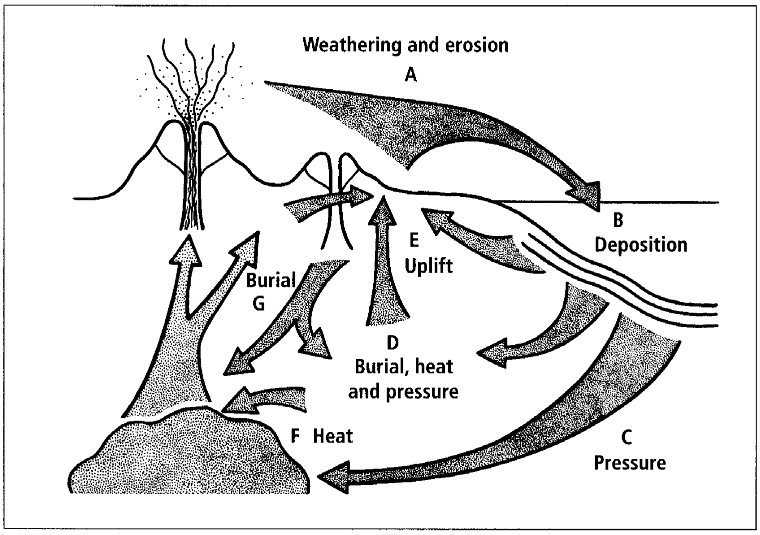


Diagram 8.6
Rock cycle.

1. Use the rock cycle diagram to explain where the rocks in Samoa have come from and what is happening to them now. Also explain what possible things will happen to the rocks in the future.
2. Discuss how wind, water, ice, plants and animals cause weathering of rocks.
3. Choose a local landscape feature and describe how it is being weathered.

Oceans, Lagoons And Coral Reefs

More than seventy per cent of the world's surface consists of oceans. In an island environment the oceans have a huge impact on the way of life of people, other animals and plants. The oceans influence climate and provide habitats for many organisms. These organisms are resources for people. Island life relies on the variety of resources provided by the ocean. But in many countries around the world the ocean and the coral reefs are being damaged.

The following information comes from the Global Coral Reef Monitoring Network (GCRMN) 2000 report.

Coral reefs of the world have continued to decline since the previous GCRMN report in 1998. Assessments to late 2000 are that 27% of the world's reefs have been effectively lost, with the largest single cause being the massive climate-related coral bleaching event of 1998. This destroyed about 16% of the coral reefs of the world in nine months during the largest El Niño and La Niña climate changes ever recorded. While there is a good chance that many of the 16% of damaged reefs will recover slowly, probably half of these reefs will never adequately recover. These will add to the 11% of the world's reefs already lost due to human impacts such as sediment and nutrient pollution, over-exploitation and mining of sand and rock and development on, and 'reclamation' of, coral reefs.

The extensive reefs in the Pacific and off Australia are in reasonably good health with a positive outlook; unless global climate change events like those of 1998 strike these areas. Indications are that bleaching may recur with severe localised bleaching mortality near Fiji and the Solomon Islands in early 2000.

Regions of the world	**Per cent of reef destroyed pre 1998**	**Per cent destroyed in 1998**	**Per cent of reef in critical stage loss 2–10 years**	**Per cent of reef threatened loss 10–30 years**
Arabian region	2	33	6	7
Wider Indian ocean	13	46	12	11
Australia, Papua New Guinea	1	3	3	6
Southeast and east Asia	16	18	24	30
Wider Pacific ocean	4	5	9	14
Caribbean Atlantic	21	1	11	22
Global status 2000*	11	16	14	18

**Mean values adjusted for the proportional area in each region of the global total of coral reefs.*

Coral reef experts from around the world have provided data on current losses and have predicted potential losses assuming a 'business-as-usual' scenario with little effective conservation. They stressed that many reefs lost in 1998 should recover with some clear evidence of slow recovery.

By 1992, 10% of the worlds reefs were lost; 30% were in a critical state with predictions of loss in 10 to 20 years without effective management; and a further 30% were threatened with destruction in 20 to 40 years. The global 1998 Reefs@Risk analysis from the World Resources Institute suggested that 27% of the world's existing reefs were under immediate threat of significant damage and a further 31% under a medium level of risk.

The Pacific — Micronesia, Melanesia and Polynesia: These vast coral reef areas mostly escaped coral bleaching mortality in 1998 with the exception of major losses in Palau and significant bleaching coral losses in Fiji and the Solomon Islands in early 2000. Most of the reefs are in good to excellent condition, with some damage from development on the high islands and over-fishing around centres of population. Few countries are conserving their coral reefs by establishing marine protected areas, but traditional management of coral reef resources is still active and effective.

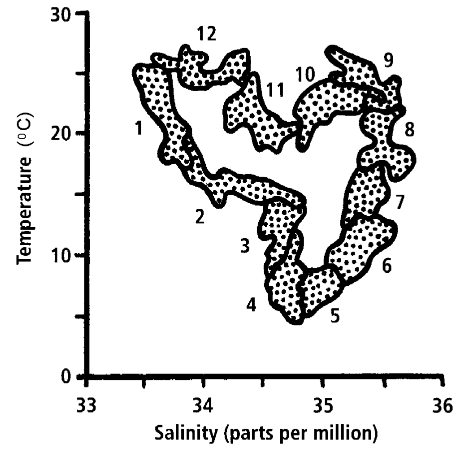
Activity 4 Oceans, Lagoons And Coral Reefs

Aim To process and interpret information about the ocean, lagoons and reefs.

1. Read and take notes from the information in Appendix II on ocean salinity and ocean temperature.

The following graph shows the temperature and salinity of water in the Great Barrier Reef Lagoon over 12 months of the year. The readings for each month are circled.

Water temperature and salinity for Great Barrier Reef Lagoon over a 12 month period



2. Read the graph and answer the following questions:
   a. Describe the change in salinity and temperature from month one to twelve.
   b. Draw up a table to record the range of temperature and salinity for each month. For example, the temperature range for month one is 17 - 25°C and the salinity is 33.4–33.8 ppm.
   c. Over which month(s) does the temperature change the least?
   d. Over which month(s) does the salinity change the least?
3. Use the information from the Global Coral Reef Monitoring Network (GCRMN) 2000 report to describe what is happening to coral reefs around the world. Also explain why it is happening.

4. Complete the following:
   a. Draw a bar graph showing the percentage of the reef destroyed pre-1998 and percentage of the reef destroyed in 1998 for each of the regions of the world.
   b. Draw a bar graph showing the percentage of the reef in critical stage loss 2–10 years and percentage of the reef threatened loss 10–30 years.
   c. Describe the trend shown by each region.
   d. How do the trends for the regions containing Samoa and Australia compare to the rest of the world?

Activity 5

Materials needed:
pH paper or Universal Indicator solution;
Thermometer.

Investigating The Ocean

Aim To investigate the physical and chemical properties of the ocean.

Select an area of beach to study. If possible, different groups could study different areas and then the results could be compared.

1. Design a method and use it to measure the temperature at different depths of water. Write this activity up as a separate investigation. Include the results, averaged results, graph, conclusion and discussion.
2. Use pH paper or Universal Indicator solution to measure the pH of the water.
3. Record the names of all the organisms found in the local area. Use the scale 'many — some — few' to say how many of each type of organism is present.
4. Describe the wave action at the beach, for example, is it strong, medium, or weak? Is it calm, rolling, or crashing? Time how long it is between waves.

Activity 6

Materials needed:
Fresh (rain or tap) water;
Seawater;
Measuring cylinder;
Burner or hot plate;
2 test tubes or flasks the same size, with rubber stopper and thermometer;
2 thermometers with a one hole fitted stopper;
3 beakers;
Ice;
Stop watch, clock or watch.

Properties Of Rainwater And Seawater

The overall aim of the following tasks is to compare the boiling point, freezing point and heat capacity of rainwater and seawater.

Part A

Aim To investigate differences in the time seawater and rainwater take to boil.

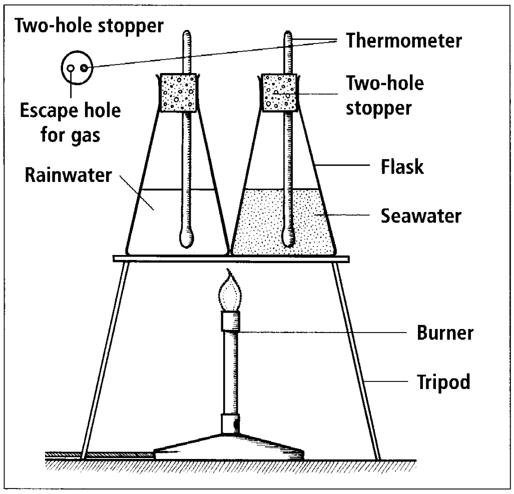
Hypothesis: Which do you think will boil first: seawater or rainwater? Why do you think it will be the one you have chosen?

Method

Working in groups, read all the instructions for the activity and discuss how you will carry out each task.

1. Accurately measure a sample of rainwater. Use enough water to half fill the flask or test tube.
2. Put the thermometer through the stopper and put the stopper on the flask or test tube. Make sure the bottom of the thermometer is under the water.

3. Repeat with a sample of seawater, making sure you use the same amount of seawater as rainwater.
4. Leave for five minutes so that both samples are at the same temperature.



5. Record the temperature of the rainwater and seawater in the flasks.
6. Begin heating the two flasks of water over the same burner flame. Make sure both flasks get the same amount of heat.
7. Record the temperature every 30 seconds. When the water begins bubbling and the temperature levels off, the water is boiling. Keep recording the temperature for three minutes after you see bubbles.
8. Graph your data.

◧ What is the boiling point of each type of water? How long did it take each type of water to reach the boiling point? What may have caused any differences?

Diagram 8.7
Boiling saltwater and fresh water.

Part B

Aim To investigate differences in the freezing point of seawater and rainwater.

Hypothesis: Which do you think will freeze first: seawater or rainwater? Why do you think it will be the one you have chosen?

Method

1. Accurately measure a sample of rainwater. Use enough water to half fill the test tube.
2. Put the thermometer through the stopper and put the stopper on the test tube. Make sure the bottom of the thermometer is under the water.
3. Repeat with a sample of seawater, making sure you use the same amount of seawater as rainwater.
4. Record the temperature of the water in each test tube.
5. Fill the bottom of a beaker with chunks of ice. Place the two test tubes of water in the ice.
6. Record the temperatures every 30 seconds until they level off.
7. Graph your data.

◧ What is the freezing point of rainwater? Seawater? Can you explain any differences?

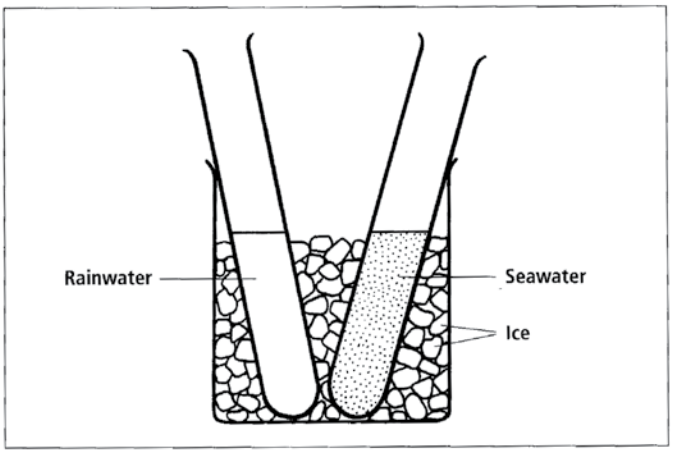


Diagram 8.8

The freezing point of fresh water and saltwater.

Part C

Aim To compare how much heat water and air can store.

Hypothesis: Which will heat and cool more slowly: water or air? Why do you think it will be the one you have chosen?

Method

1. Fill one flask with water and leave one flask empty. This flask is filled with air.
2. Put the thermometers through rubber stoppers and put the stoppers on the flasks.
3. Record the temperature in each flask at room temperature.
4. Place both flasks on top of the burner or hot plate and start the stop watch.
5. Record the time it takes for the water and air to reach 40° C.
6. Remove both flasks from the heat and place them in ice water.
7. Record the time it takes for each flask to reach its original room temperature.

◧ Which flask took longer to reach its original room temperature? Record your observations.

Activity 7 Importance Of Oceans, Lagoons And Reefs

Aim To discuss the importance of the oceans, lagoons and reefs to the Samoan way of life.

Select one of the topics listed below. In each case you must:

1. Give scientific information about the oceans, lagoons and reefs around Samoa.
2. Describe how the oceans, lagoons and reefs are used by local people.
3. Explain how the oceans, lagoons and reefs are important to local people.

When finished, share your writing with other members of your class.

- **Topic 1** — Write a recount of something that happened in your family or your village that shows how important the oceans, lagoons and reefs are.
- **Topic 2** — Write a short story set in the past, present or future that shows how important the oceans, lagoons and reefs are to local people.
- **Topic 3** — Write an argument for taking care of the oceans, lagoons and reefs around Samoa in order to attract tourists to Samoa.
- **Topic 4** — Write a speech in which you outline why it is important to look after the oceans, lagoons and reefs around Samoa.
- **Topic 5** — Write an essay in which you outline ways that the local people ensure that the oceans, lagoons and reefs around Samoa are going to be there for future generations.
- **Topic 6** — Make a pamphlet that outlines what visitors to Samoa should do to ensure they do not damage the oceans, lagoons and reefs around Samoa. The 'visitors' could include people that are interested in fishing, snorkeling or surfing.

Activity 8 Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

Unit 9: LOCAL COMMUNITY

In this unit, you will investigate patterns and inter-relationships in natural communities. You will also investigate and report on a local environmental issue.

Diagram 9.1A and 9.1B
Natural communities.

Zonation

Different organisms have adapted to live in slightly different habitats. Every habitat has areas that have slightly different environmental conditions. The areas with slightly different habitats form zones that provide a better habitat for some organisms. This means that more of that type of organism will be found in that area or zone. The distribution of organisms caused by differences in the environmental conditions of the habitat is called zonation. Zonation is easy to see in some places but difficult to see in others. On the rocks by the Alofaaga blowholes there is an easy to see, simple zonation. Around the opening of each blowhole there is a zone with lots of different organisms including seaweeds, sponges and shellfish such as barnacles. Further out from the blowhole opening is a zone with fewer of these organisms. Then there is a zone with shellfish called periwinkles and crabs.

Each of the zones around the blowhole opening has different environmental conditions. The zone around the blowhole opening is often covered in spray from the sea. A bit further out from the opening it is not so often covered in spray so fewer organisms are able to survive there. Further out from the opening the habitat is only suitable for organisms that can survive without being splashed with water. These organisms can also move into the area closer to the blowhole opening to get food.

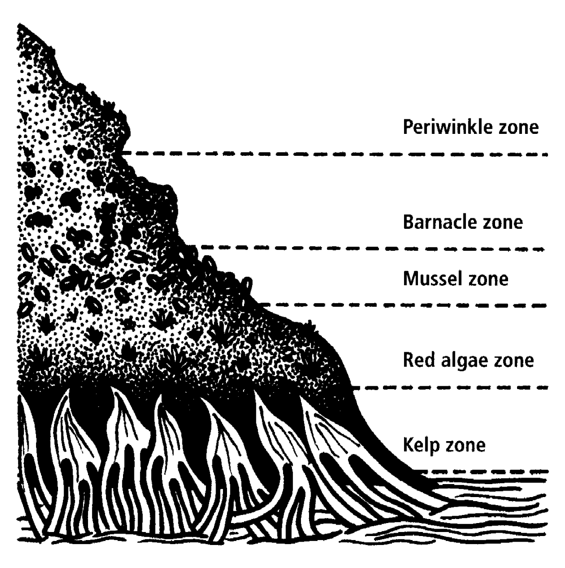


Diagram 9.2
Rocky shore zonation.

Plant communities also show zonation patterns. The diagram on the next page shows the zonation pattern of plants growing on both sides of a mountain. The environments on the different sides of the mountain are different so the zonation pattern shown by the distribution of plants is different.

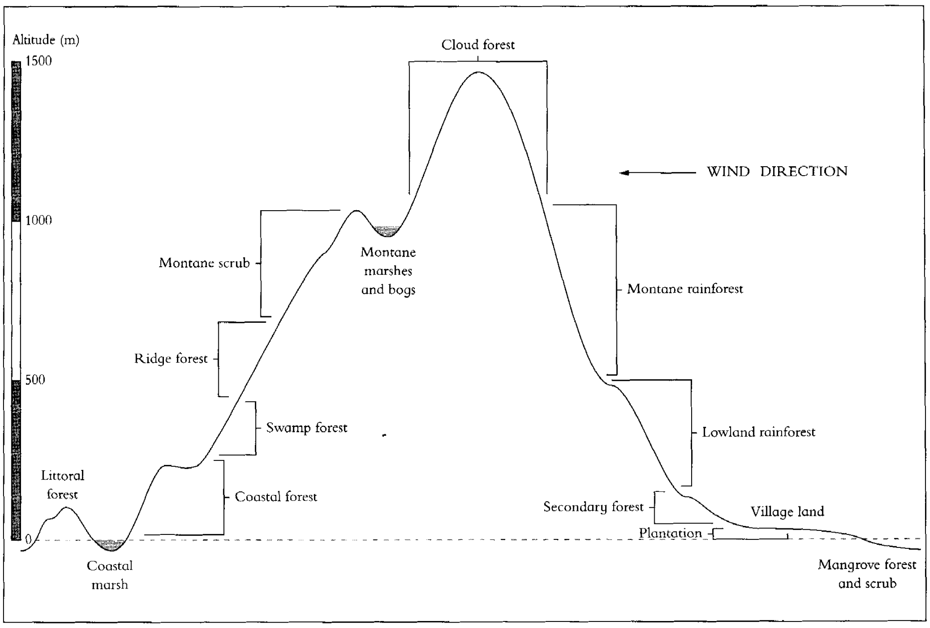


Diagram 9.3
Zonation of plants growing on a volcanic island.

Stratification

In a forest or grassland community the plants grow to different heights. The plants at the different heights form layers. This pattern of layers in a forest is called stratification. The following diagram shows examples of the layers in a forest community.

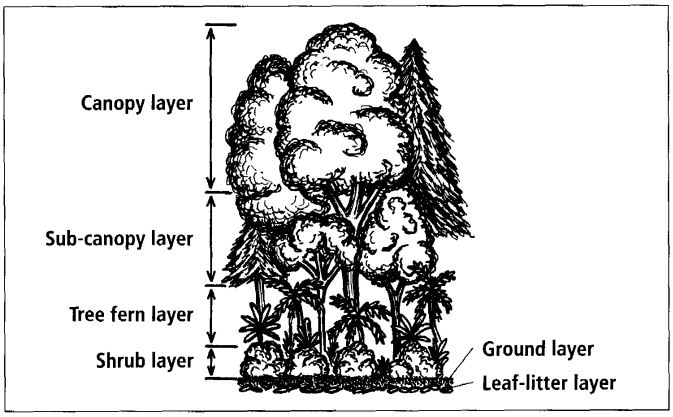


Diagram 9.4
Stratification in a forest.

The different layers in the forest have different environmental conditions. The different environmental conditions in each of the layers are caused by the interaction between the environment and the other layers of plants. For example, the trees in the canopy layer get lots of light and they are exposed to the wind. These trees shelter the plants in the other layer from the wind so the other layers have less wind. The other layers also have less light because the canopy trees shade the lower layers. This means that the trees that live in the canopy layer must be adapted to high light, high wind environments. The plants living in the shrub layer are adapted to low light, low wind environments.

Another important feature of stratification is that the layers also provide a protected environment for seedling trees to grow. The seedling of the canopy trees have a slow growth rate and remain small until something happens to cause the death of one of the canopy trees. The high levels of light under the dead canopy tree means that the seedlings can grow quickly and one of the seedlings will grow to take the place of the dead tree.

Succession

Succession is the way a community changes over time. An example of the early stages of succession is occurring on the Saleaula lava fields. The black rock of the lava fields is a harsh, hot environment. In the beginning only a few plants are able to grow in the small cracks in the rocks. But as these few plants grow they change the environment of the lava field. As their roots grow larger they break up the rock into small pieces. This is the first step in formation of soil. These plants also shade the rock. This provides slightly cooler areas in which other plants can grow. These changes to the environment will continue to occur over time. As each change occurs new plants are able to grow and the original plants will die out.

The following photo shows the effect of the environmental conditions on plant growth. In area **A** there are very few plants growing as the black rock absorbs heat quickly and gets very hot. Area **B** is a small area where the lava is lower than the surrounding lava. In this lower area water collects, the humidity is higher and there is shelter from wind. There are more plants growing in area **B**. The rate of succession has been quicker in area **B** because the environmental conditions are better for the plants.

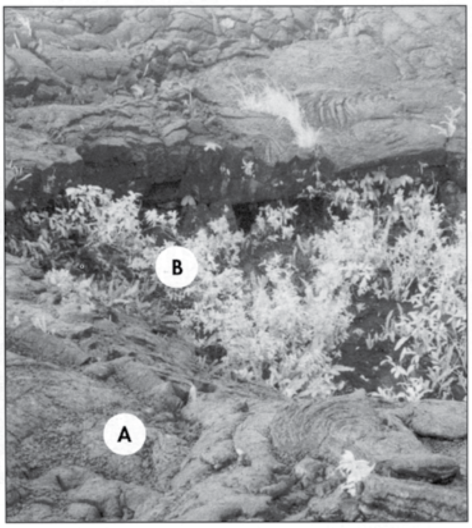


Diagram 9.5
Succession on the lava fields.

Succession works by a sequence of plant growth, changed environmental conditions and then replacement of the first plants with new types of plants. This takes time to happen and continues to happen over a long period of time. The first plants to grow change the environment so that it becomes suitable for new plants. These plants grow and change the environment more and make it suitable for other different plants to grow. All the changes to the environment now make it unsuitable for the first plants so they die out.

One of the best places to study succession is in an area where there have been lots of landslides over the years. The area where each landslide of a different age occurred will be in a different stage of succession. Areas where there have been fires in different years is another place to study succession. The process of succession will occur quickly in Samoa because of the warm environment that causes quick growth rate of plants.

Activity 1 Patterns In Natural Communities

Aim To investigate patterns in natural communities.

1. Copy and complete the table:

	What is it?	Examples of where it happens	Features of the pattern
Zonation			
Stratification			
Succession			

2. Think about an area that was cleared of all its plants and then left for a number of months or years. Answer the following questions to describe the succession that occurred.
    a. Which plants grew first?
    b. Which taller plants replaced them?
    c. Which types of plants grew next?

3. Think about an area of forest. Answer the following questions to describe the stratification of the forest.
    a. What type of material is on the ground? Are there lots of dead leaves or a thin layer of leaves? This is the leaf-litter layer.
    b. What types of plants are growing close to the ground? This is the ground layer. How tall are the ground layer plants?
    c. What types of shrubs are growing in the shrub layer? How tall are the shrubs?
    d. What types of trees are growing in the sub-canopy layer? How tall are sub-canopy trees?
    e. What types of tress are growing in the canopy layer? How tall are the canopy trees?

4. Think about a place where the animals or plants are found in zones. You may have to think carefully as zonation is often hard to recognise. For example, around a coral reef the fish are found in zones. Some live in between the coral itself while others live around the outside of the reef. Another place where zonation occurs is by a pond or shoreline. Complete the following to describe an example of zonation:
    a. Is the zonation mostly about plants or animals?
    b. Make a sketch map of the area. On the map mark in the main type of organisms found in each zone.

Activity 2 Zonation

Materials needed:
Rope or string;
Thermometer;
Light meter;
Pen and paper.

Aim To investigate the zonation pattern of a community.

1. Visit a local area that shows zonation.
2. Draw a sketch-map of the area.
3. Place the rope or string across the habitat in a way that makes the line go across the zones of organisms in the area.
4. Start at one end of the rope. Name the organism at the end of the rope. Measure the environmental factors such as air temperature, soil temperature, amount of wind, wave action, light, etc. Record this information in a way that you can write it up later.
5. Take five steps along the line given by the rope and record the name of the organism. You may have to record the name of the organism every two steps in a small area or every 10 steps in a large area. When you get to the end of the rope move it along and continue to record the names of the organisms. If no rope is available just try to walk a straight line across the area and take samples as you go.
6. Present the data collected in a table.
7. Describe the pattern of zonation in the area.

Activity 3 Stratification

Materials needed:
Thermometer;
Light meter;
Rope or string;
Pen and paper.

Aim To investigate the stratification of a forest.

1. Visit a local area that shows stratification.
2. Place the rope or string through the community.
3. Draw a profile diagram to show the stratification. A profile diagram is a scale drawing that shows the distance along the line and the height and shape of the plants. Diagram 9.6 shows what a profile looks like.
4. Record the names of the plants on the profile diagram.
5. Measure the temperature and light at each metre along the rope. Estimate the amount of wind each layer receives. Record this information on the profile diagram.
6. Look for the presence of animals. Do different animals live in the different layers? Do some animals live across more than one layer? Explain your answers.
7. Describe the stratification pattern shown in the area.

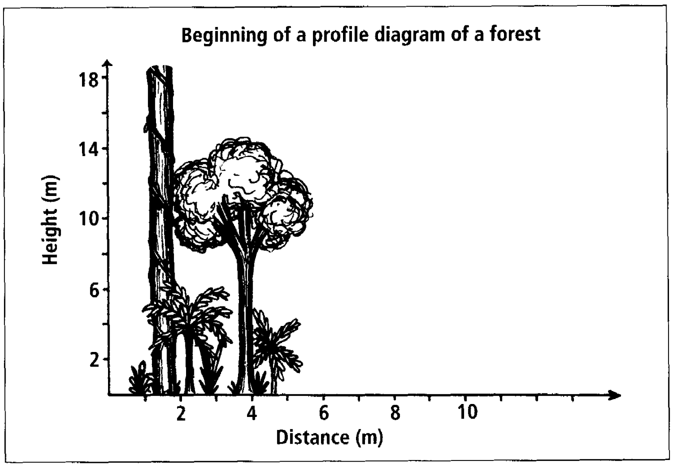


Diagram 9.6
A stratification profile.

Activity 4

Succession

Materials needed:
Thermometer;
Light meter;
Pen and paper.

Aim To investigate succession.

1. Visit a local area that shows succession at different stages.
2. Draw a sketch of the plants at each of the different stages. Add the names of the different types of plants to your sketch.
3. Measure or describe the environmental conditions in each area.
4. Discuss what you have found out about succession.

Inter-relationships

In each natural community there are a number of inter-relationships between organisms. The organisms use other types of organisms as sources of food. Organisms also compete with organisms of the same type for food, space and water. Organisms have different adaptations to help them survive. The Year 11 Environmental Science Book, The Natural World Around Us, has lots of information and activities that can be used to study the relationships within communities and the adaptations that organisms have.

Local Environmental Issue

In Units 7 and 8 there has been the beginnings of discussions on environmental issues that affect the people living in Samoa. Environmental issues are also discussed in the Year 11 Environmental Science Book, The Natural World Around Us. As the number of people in Samoa grows the local environment will be put under more and more pressure. It is important that people are aware of the effect they are having on the environment and understand why it is important to use the environment in a responsible way.

Activity 5 Local Environmental Issue

Aim To present information on a local environmental issue.

1. Select an environmental issue topic. Possible topics include:
   - Introduced plants.
   - Solid waste management.
   - Sewage treatment.
   - Dogs.
   - Human population numbers.
   - Soil loss.
2. Complete the following in your exercise book:
   a. Develop a survey that asks people their opinions and ideas about the local environmental issue that you are investigating.
   b. Survey the opinions of at least 10 people.
   c. Present the findings of your survey to the rest of the class.
3. Continue to research and find out more about the environmental issue. You will have to contact people that are involved with the issue or are working on the issue. Some questions to think about include:
   - What is happening to cause the issue?
   - What is currently being done about the issue? Is this effective?
   - Are other ideas on how to deal with the issue being discussed? How could these ideas be used? Will they be effective?
4. Present the information from your research on the local environmental issue in a pamphlet or poster. Include information on:
   - What the issue is about.
   - The opinions that people have on the issue.
   - What you think should be done about the issue.
   - Why it is important to use the local environment in a responsible way.
   - Ways people can change what they are now doing so that they are using the local environment in a responsible way.

Activity 6 Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

Unit 10 : SPACE EXPLORATION

In this unit, you will carry out research into an example of space research or exploration. You will also investigate how some difficulties of space research and exploration are overcome.

Space Exploration

People have always been interested in finding out more about the sun, moon, planets, stars and other bodies in space. Ancient astronomers discovered that some points of light moved amongst the stars. These points of light were the planets. The planets were named after the Roman Gods: Jupiter, Mars, Mercury, Venus and Saturn. These astronomers also observed comets and meteors.

In the 15th- and 16th-century physicists developed laws of motion that described how the planets move. The orbits of the planets around the sun were calculated. In the 17th century the telescope was developed and used to explore space. The development of telescopes was an important advancement in the exploration of space as it allowed a range of new observations to be made.

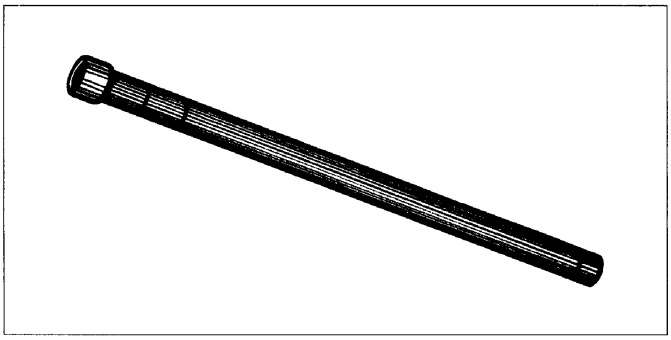


Diagram 10.1
Galileo's telescope.

Galileo was a famous scientist that constructed his first three-powered spyglass in June or July 1609. This was an early form of telescope. He later made a telescope that made things look twenty times bigger. He used the telescopes to observe the Moon, planets and stars. He discovered four satellites of Jupiter, and could see that the things called nebular patches were really stars.

Over the years, better and better telescopes have been produced. Now telescopes are used to keep a constant watch on what is happening in space.

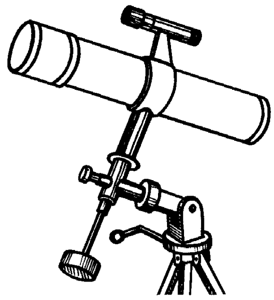


Diagram 10.2
Modern telescope.

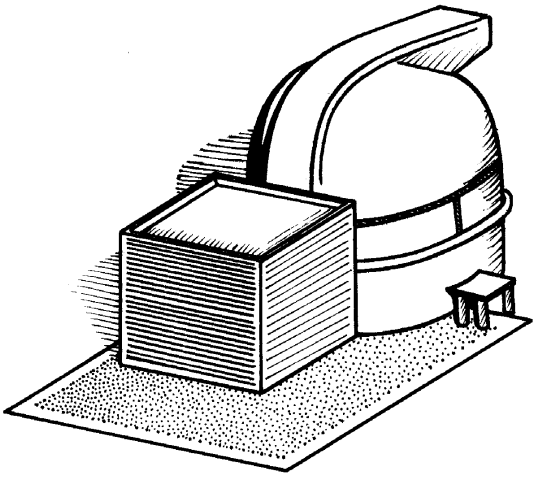


Diagram 10.3
University of Hawai'i's 2.2 metre telescope.

In the late 1950s space exploration was beginning to be done from space itself. At first people just tried to get the objects up into space and keep them there for a short time but later satellites and rockets carried scientific instruments that were used to explore space. On 4 October 1957 the first artificial object to orbit the Earth was launched by the USSR.The object was a satellite called Sputnik 1. Sputnik 1 stayed in orbit around Earth until 4 January 1958.

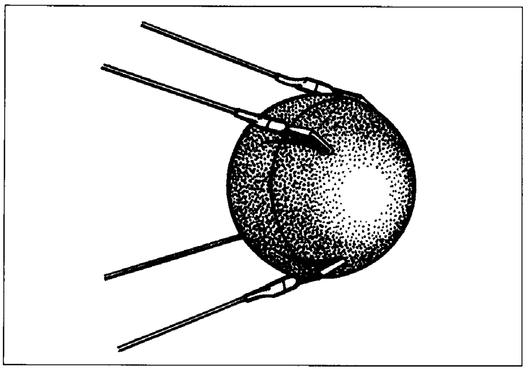


Diagram 10.4
Sputnik 1.

On 31 January 1958 the first USA rocket was launched into space. The rocket was called the Explorer 1. Since 1959, exploration of the solar system has increased due to the development of rockets that are able to break away from Earth's gravity and travel to the moon and planets.

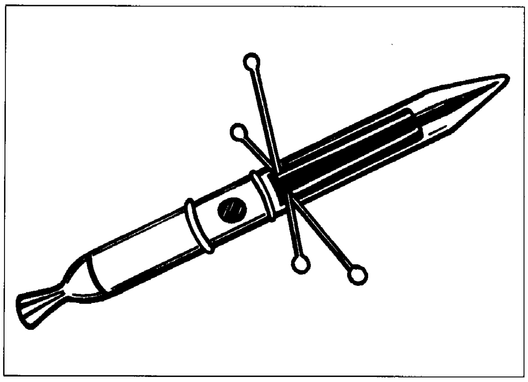


Diagram 10.5
Explorer 1.

Since these early examples of space exploration automated spacecraft have orbited and landed on Mars and Venus, explored the Sun's environment and observed comets and asteroids. Close range surveys have been made when flying past Mercury, Jupiter, Saturn, Uranus and Neptune. These spacecraft were able to take pictures and samples of the environments to provide us with new information about places that only appear as fuzzy discs of light in the distance.

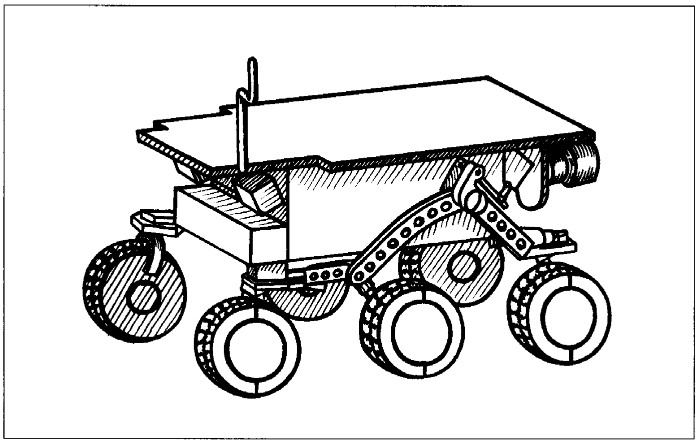


Diagram 10.6
Mars Sojourner vehicle.

Activity 1 Space Research Or Exploration

Aim To research information on space research or exploration and present a report.

Select a topic to research. It may help to read the information in Appendix III on 'the history of rockets', 'early astronauts', 'spacecraft' and 'how many moons' as these may give ideas for research topics. Possible topics could be:

- Apollo spacecraft.
- Moon landing.
- Neil Armstrong.
- The Mars Sojourner.
- Telescopes.

1. Collect information on your topic. Use a range of the different types of resources that are available. The following websites have information:

   http://www.nauts.com/history/index.html
   http://www.solarviews.com/eng/history.htm
   http://www.seds.org/
   http://www.seds.org/~spider/mars/mars.html
   http://www.space.com/
   http://www.universetoday.com/
   http://www.nasa.gov/

2. Process the collected information by selecting the key ideas. Organise the key ideas into a logical order.
3. Write up the ideas in a report.

Difficulties Of Space Research And Exploration

There are a number of difficulties that make space research and exploration problematic. These difficulties must be overcome before space research and exploration can be successful. Information on space travel can be found on the NASA website:

http://spaceflight.nasa.gov/

The following are all examples of difficulties with space research and exploration:

Large distances in space and the time it takes to get to far away objects

The distances between objects are very large. It takes years of planning to make sure the spacecraft will reach its target. Often a spacecraft has to be launched years ahead within a small number of days so that the target object and the spacecraft will fly past each other.

Harsh environments *e.g. Lack of oxygen, freezing cold or very hot temperatures*

When astronauts go on space walks they have to wear special clothing. They even have to carry their own oxygen with them.

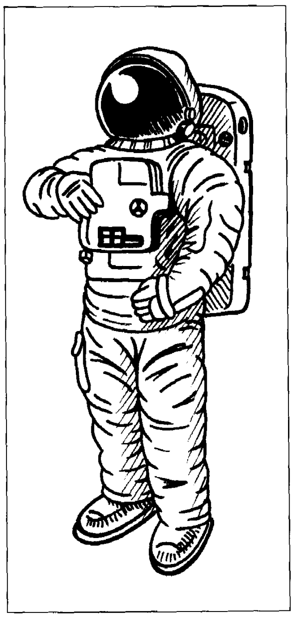


Diagram 10.7
Astronaut clothing.

(*See Appendix III for more information about this space suit.*)

The effect of weightlessness on astronauts

Here is part of an article from the NASA website about weightlessness.

> Imagine waking up in space. Groggy from sleep, you wonder . . . which way is up? And where are my arms and legs? Throw in a little motion sickness, and you'll get an idea of what it can feel like to be in space.
>
> Of course, it's not always so bad — otherwise no-one would want to become an astronaut! But first-time space travellers can be surprised by some very strange and confusing feelings. Consider, for example, 'up' and 'down'. On Earth we always know which way is up because gravity tells us. Sensors in our inner ears can feel the pull of gravity and tell our brain which way is up. In space, however, there is no pull of gravity and the world can suddenly seem topsy-turvy.
>
> Former shuttle astronaut Robert Parker recalls: 'One of the questions they asked us during our first flight was, "Close your eyes . . . now, how do you determine up?"' With his eyes closed, he couldn't tell. Up and down had vanished.

http://liftoff.msfc.nasa.gov/news/2002/news-mixup.asp

The following information is about what astronauts do to prepare for weightlessness.

> NASA's KC-135
>
> To give astronauts a preview of the weightlessness they will experience in space, NASA uses a modified KC-135 four-engine jet transport. By flying repeated parabolas, the aircraft creates short periods of weightlessness for the astronauts in the cargo bay. During these moments the astronauts can practise eating and drinking and using various kinds of equipment.
>
> Training sessions in the KC-135 normally last from one to two hours. Because many trainees experience motion sickness during the flights, the KC-135 is affectionately known as the 'Vomit Comet'.

http://liftoff.msfc.nasa.gov/news/2002/news-mixup.asp

Activity 2 Difficulties Of Space Research And Exploration

Aim To record information about the difficulties for space research and exploration.

1. Look at the reports other class members produced about space research or exploration. Is any information included on how the difficulties of space research and exploration are overcome?
2. Discuss, with other members of the class, any information found on how the difficulties of space research and exploration are overcome.
3. If there is not enough information, carry out further research on how the difficulties of space research and exploration are overcome.
4. Produce a report that explains how one difficulty for space research and exploration is overcome.

Activity 3 Study Notes

Aim To make study notes to use when revising this unit.

1. Read through all the material you have covered in this unit.
2. Read it again, this time highlighting the key science ideas.
3. Rewrite the key science ideas into a different form so that you can use them as study notes. There are lots of different forms of study notes but they all only have the key words written down.

APPENDIX I

Global Warming

According to the National Academy of Sciences, the Earth's surface temperature has risen by about one degree Fahrenheit in the past century, with accelerated warming during the past two decades. There is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities. Human activities have altered the chemical composition of the atmosphere through the build up of greenhouse gases — primarily carbon dioxide, methane and nitrous oxide. The heat-trapping property of these gases is undisputed although uncertainties exist about exactly how Earth's climate responds to them.

Greenhouse Effect

Energy from the sun drives the Earth's weather and climate and heats the Earth's surface; in turn, the Earth radiates energy back into space. Atmospheric greenhouse gases (water vapour, carbon dioxide and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. Without this natural 'greenhouse effect', temperatures would be much lower than they are now and life as known today would not be possible. Instead, thanks to greenhouse gases, the Earth's average temperature is a more hospitable 60°F. However, problems may arise when the atmospheric concentration of greenhouse gases increases. Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the Earth's atmosphere. Sulphate aerosols, a common air pollutant, cool the atmosphere by reflecting light back into space, however, sulphates are short-lived in the atmosphere and vary regionally. Why are greenhouse gas concentrations increasing? Scientists generally believe that the combustion of fossil fuels and other human activities are the primary reason for the increased concentration of carbon dioxide. Plant respiration and the decomposition of organic matter release more than ten times the CO_2 released by human activities, but these releases have generally been in balance during the centuries leading up to the industrial revolution with carbon dioxide absorbed by terrestrial vegetation and the oceans. What has changed in the last few hundred years is the additional release of carbon dioxide by human activities. Fossil fuels burned to run cars and trucks, heat homes and businesses and power factories are responsible for about 98% of US carbon dioxide emissions, 24% of methane emissions and 18% of nitrous oxide emissions. Increased agriculture, deforestation, landfills, industrial production and mining also contribute a significant share of emissions. In 1997, the United States emitted about one-fifth of the total global greenhouse gases.

http://www.epa.gov/globalwarming/climate/index.html

APPENDIX II

Salinity

Water makes up 96.5% of the ocean. The other 3.5% is salinity. Salinity is the total amount of dissolved solids (in grams) in 1000 grams (1 kg) of water, and is described as parts per thousand.

When the solids dissolve in the seawater they form ions. The most common ion in seawater is chlorine. Other ions in seawater include sodium, sulphate, magnesium, calcium and potassium. Seawater also contains dissolved gases, such as oxygen, nitrogen and carbon dioxide.

The salinity of the ocean is different in different places and can change. The ocean around Samoa, like that around the North Island of New Zealand, has medium levels of salinity. The salinity is changed by rainfall and evaporation. Near the equator and around the coast of countries the rainfall is greater than evaporation so the salinity will be lower.

The salinity affects the properties of the water in the ocean. It changes the viscosity (how runny the water is). Changes in salinity also change the osmotic pressure which is important for water balance in marine organisms.

http://icp.giss.nasa.gov/research/oceans/oceanchars/salinity.html

Ocean Temperature

The average temperature of the ocean around Samoa is between 26 and 28°C. Around New Zealand it is between 16 and 20°C. Sunlight reaching the ocean is transmitted to an average depth of 60 metres. In some areas the light can travel as deep as 300 metres. Wherever there is light in the ocean algae can live because they are able to carry out photosynthesis.

As the light travels through the ocean it is changed to heat energy that warms the ocean. The warmer surface water is mixed with the cooler deeper water. Some heat energy is removed from the ocean as water evaporates. This way the temperature of the ocean stays the same most of the year.

http://icp.giss.nasa.gov/research/oceans/oceanchars/temperature.html

APPENDIX III

The History Of Rockets

At the beginning of the 20th century scientists were experimenting with rockets. These first experiments involved rockets that were using solid fuel such as gun powder. The rockets were able to go up into the upper atmosphere but the solid fuel couldn't supply the power needed for the rocket to go into space. Liquid fuels would be needed to supply the amount of power needed.

On 16 March 1926, the first liquid-powered rocket was launched. It flew 46 metres into the air. Both the American and German groups interested in rockets began experimenting. In 1932 the German Army was showing interest in the German Rocket Society's work. A rocket called a 'Mirak' was launched as a demonstration to the German Army Rocket Research Group.

In December 1934, the German Army Rocket Research Group launched rockets powered by ethanol and liquid oxygen. Two years later the planning had begun for the V-2 rocket that was used during World War II. Between 1937 and 1941, 70 test rockets were launched. The first V-2 rocket flew in March 1942. It crashed soon after launching. The second was launched in August 1942. It went 11 kilometres before exploding. Then on 3 October 1942 a third V-2 rocket was launched. It travelled 193 kilometres exactly as planned and landed on its target. This launching is thought of as the beginning of the space age as this rocket is the basis for almost every rocket that is used now.

At the end of World War II the team of over 100 German rocket experts were taken to safety by the American forces. The rocket experts made more V-2 rockets and launched them over Europe.

Ten years later a Russian Army Colonel called Sergei Koroley became known as the Soviet Union's chief designer of spacecraft. He was the individual responsible for building the Vostok, Voshkod and Soyuz spacecraft which, since 1961, have carried all Soviet cosmonauts into orbit.

By February 1946, the entire German Rocket Team was reunited at White Sands in the USA. On April 16 the first USA V2 rocket was launched. This was the beginning of the USA space programme.

Up to 1952, 64 V2 rockets were launched. Each rocket carried scientific instruments, not explosives. A new version of the V2 rocket was developed. The V2 became the first stage of a two-stage rocket named Bumper. The top, second state was a WAC Corporal rocket.

With all the launches of rockets it became clear that much more room was needed, so in 1949 a new launch site was established at remote, deserted Cape Canaveral, in Florida. On 24 July 1950, a two-stage Bumper rocket became the first of hundreds to be launched from the 'Cape'.

In 1956, the US Army Ballistic Missile Agency was established at Redstone to develop the Jupiter intermediate range ballistic missile. A version of the rocket, known as the Jupiter C, was used on 31 January 1958, to launch America's first satellite, Explorer 1. Three years later, Alan Shepard, Virgil I and 'Gus' Grissom were launched on sub-orbital space flights. These flights paved the way for John Glenn's first orbital flight.

In 1958, the National Aeronautics and Space Administration or NASA was established and two years later, von Braun, his team and the entire Army Ballistic Missile Agency were transferred to NASA to become part of the NASA space programme.

In 1961, Alan Shepard landed in the Atlantic Ocean following his sub-orbital flight which made him the first American in space. The USA President, Kennedy, spoke about the USA being first to have people walk on the Moon. NASA's Marshall Center was charged with developing the family of giant rockets which would take people to the moon. The Saturn rockets that were developed to support the Apollo programme were, at the time, the most powerful space launch vehicles to have been invented.

The Saturn rockets first took people around the Moon, then to its cratered surface. On 20 July 1969, a transmission from the Moon's Sea of Tranquility reported: 'The Eagle has landed'. This was the first landing of people on the moon. Lunar excursion vehicles called Moon Buggies were also developed. These carried astronauts on far-ranging excursions in pursuit of samples of lunar soil and rock.

A team of scientists developed America's first space station — Skylab. Built to replace the upper stage of a Saturn V moon rocket, the Skylab module was successfully placed in orbit early on 14 May 1973.

Placing Skylab in orbit marked a major transition in the story of rocketry. Up until Skylab the focus had been on launch and recovery. Skylab changed this. For the first time, space became a place in which to live and work.

Lots of problems occurred at the beginning of Skylab's time in space. The problems were overcome and Skylab went on to make an important contibution to space exploration.

After Apollo, the designing of a new type of spacecraft was started. The new spacecraft was to become part of a national space transportation system.The new spacecraft became know as the 'Space Shuttle'. The Space Shuttle's main engines are among the most powerful, most sophisticated devices ever invented. They represent a quantum leap in technology advancement over the engines which powered the Apollo programme rockets. Each of the three main engines in the tail of the shuttle can provide almost a half-million pounds of thrust, a thrust equal to that produced by all eight of the Saturn 1's first stage engines. Unlike most previous rocket engines, which were designed to be used only once for only a few minutes, the space shuttle's main engines are designed to be used again and again, for up to 7.5 hours.The thrust to weight ratio for these engines is the best in the world, each engine weighs less than 7000 pounds but puts out huge amounts of power.

Twenty-four successful flights of the space shuttle lulled America into a sense of complacency. Shuttle launches became routine; ordinary citizens began being given opportunities to travel into space.Then the Challenger disaster happened with several people being killed. Teams of experts have been organised to find and fix the problems which led to the accident. Investigation quickly focused on a defective joint in the space shuttle's solid rocket motors. Rocket propulsion experts devised a number of modifications to the solid rocket motor design to remedy the fault. A vigorous test program was undertaken to show that the problems had been solved.

The disaster slowed down shuttle operations and gave an opportunity to address other shuttle-related concerns. Major steps were taken to enhance the reliability and safety of the turbine blades and turbo pumps in the shuttle's main engines.An escape system was created for the shuttle crew. Improvements were made to the orbiter's landing gear and brakes.

When America returned to manned spaceflight in 1988, it did so in a space vehicle which was vastly safer and more capable.

Early Astronauts

In April 1959, NASA announced its selection of seven men as the first American astronauts.They were: Navy Lieutenant M. Scott Carpenter; Air Force Captains L. Gordon Cooper, Jr., Virgil I. 'Gus' Grissom; Donald K. 'Deke' Slayton; Marine Lieutenant Colonel John H. Glenn, Jr and Navy Lieutenant Commanders Walter M. Schirra, Jr and Alan B. Shepard, Jr.

Each flew in Project Mercury except Slayton, who was grounded with a previously undiscovered heart condition. After doctors certified that the condition had cleared up, Slayton realised his ambition to fly in space 16 years after his selection. He was a member of the American crew of the Apollo Soyuz Test Project in July 1975, the world's first international manned space flight.

Spacecraft

NASA's automated spacecraft for solar system exploration come in many shapes and sizes. Even though each spacecraft is designed to do a particular job they have similar structures. Each spacecraft carries the different scientific instruments needed for the jobs it is to do. Each spacecraft also has to have the systems to supply electrical power, control its flight, process the data from the scientific instruments and communicate with Earth.

Electrical power is required to operate the spacecraft instruments and systems. NASA uses both solar energy from arrays of photovoltaic cells and small nuclear generators to power the spacecraft. Rechargeable batteries are used for backup and extra power.

Each spacecraft has a set of small thrusters that are used to control the position of the spacecraft. The thrusters are linked with devices that maintain a constant gaze at selected stars. Just as Earth's early seafarers used the stars to navigate the oceans, spacecraft use stars to maintain their bearings in space. With the devices locked onto fixed points of reference, flight controllers can keep a spacecraft's scientific instruments pointed at the target body and the craft's communications antennas pointed toward Earth. The thrusters can also be used to fine-tune the flight path and speed of the spacecraft to ensure that a target body is encountered at the planned distance and on the proper trajectory.

Between 1959 and 1971, NASA spacecraft studied the Moon and the solar environment; they also scanned the inner planets Mercury, Venus and Mars. For these early missions to look at the planets, NASA used a highly successful series of spacecraft called the Mariners. Their flights helped shape the planning of later missions. Between 1962 and 1975, seven Mariner missions conducted the first surveys of the planets close to Earth.

All of the Mariners used solar panels as their primary power source. The first and the final versions of the spacecraft had two wings covered with photovoltaic cells. Other Mariners were equipped with four solar panels extending from their octagonal bodies.

Although the Mariners ranged from the Mariner 2 Venus spacecraft, weighing in at 203 kilograms (447 pounds), to the Mariner 9 Mars Orbiter, weighing in at 974 kilograms (2147 pounds), their basic design remained quite similar throughout the program. The Mariner 5 Venus spacecraft, for example, had originally been a backup for the Mariner 4 Mars flyby. The Mariner 10 spacecraft sent to Venus and Mercury used components left over from the Mariner 9 Mars Orbiter programme.

In 1972, NASA launched the Pioneer 10, a Jupiter spacecraft, to explore the four outer planets of Jupiter, Saturn, Uranus and Neptune. Four NASA spacecraft, two Pioneers and two Voyagers, were sent in the 1970s to tour the outer regions of our solar system. Because of the distances involved, these travellers took anywhere from 20 months to 12 years to reach their destinations. Because the Sun's light becomes so faint in the outer solar system, these travellers do not use solar power but instead operate on electricity generated by heat from the decay of radioisotopes.

NASA also developed highly specialised spacecraft to revisit our neighbours Mars and Venus in the middle and late 1970s. Twin Viking Landers were equipped to serve as seismic and weather stations and as biology laboratories. Two advanced orbiters — descendants of the Mariner craft — carried the Viking Landers from Earth and then studied Martian features from above.

Two drum-shaped Pioneer spacecraft visited Venus in 1978. The Pioneer Venus Orbiter was equipped with a radar instrument that allowed it to 'see' through the planet's dense cloud cover to study surface features. The Pioneer Venus Multiprobe carried four probes that were dropped through the clouds. The probes and the main body — all of which contained scientific instruments — radioed information about the planet's atmosphere during their descent toward the surface.

A new generation of automated spacecraft — including Magellan, Galileo, Ulysses, Mars Observer and Cassini — is being developed and sent out into the solar system to make detailed examinations that will increase our understanding of our neighborhood and our own planet.

How many moons does Earth have? Read on . . .

An amateur astronomer has discovered what could be a new object orbiting the Earth; maybe it's a recently captured space rock, or maybe it's just a remnant from the Apollo program. Whatever it is, the object, dubbed J002E2, seems to orbit the Earth every 50-days in a wide orbit. If it turns out to be natural, the object will become the Earth's 3rd moon (and you thought we only had one), after Cruithne which was discovered in 1986 in a long erratic orbit. (BBC News Story) Sep 11, 2002, 8:33 p.m.

http://www.universetoday.com/

Spacesuits

The spacesuit in Diagram 10.7 is an example of a Pressure Garment Assembly spacesuit used during the Apollo missions. The suit was like a small spacecraft because it had to have everything needed to keep the astronaut alive. The suit was made to exactly fit each astronaut and was only used once. The space suit was a multi-layered shield against the harsh environment in space. It provided the astronaut with his own self-contained atmosphere and gave fresh oxygen, water, power and a way to communicate with others.

As well as protection and providing the material needed to live, the spacesuit had to be designed to let the astronaut move freely under the unusual conditions of walking on the moon.

The helmet attached directly to the suit by a pressure-sealing neck ring. It provided visual, thermal and mechanical protection to the Apollo astronaut's head. The visor on the front of the helmet had a wraparound fabric thermal cover for eye protection. The layered visor system was made up of an inner 'protective visor' made for filtering UV rays and infrared. The outer 'sun visor' filtered visible light and gave additional UV/IR protection.

Due to the need for multi-layered protection for work in space, the gloves worn by the astronauts made it hard for them to carry out same tasks with their hands. Each glove was made to fit an individual astronaut's hand, and fitted with layers of protection and special rubber tips to allow the best possible use of their hands.

http://www.thespacestore.com/apasrepbuc.html

KEY VOCABULARY

Related to plants and plant reproduction

chlorophyll
chloroplasts
diffusion
ovules
testa
anthers
cotyledon
cuttings
headsets
tissue
osmosis

Related to photosynthesis and respiration

decomposition
Carbon Cycle
methane
nitrous oxide
hydrofluorocarbons (HFCs)
perfluorocarbons (PFCs)
sulphur hexafluoride (SF6)
lenticel
a stoma, stomata
guard cells
transpiration

Related to excretory systems

bladder
kidneys
ureter
urethra
liver
capillaries
faeces
urine
small intestine
ingestion
digestion
excretion
egestion

Related to micro-organisms and diseases

antibiotics
a plasmid
pasteurised
homogenised
phagocytes
pathogens
antibodies
inflammatory response
inoculation
incubation
coagulate

Related to the reproductive cycle

secondary sex characteristics
offspring
puberty
hormones
gametes
sperm
testicles
oestrogen
testosterone
menstrual cycle
uterine wall
progesterone
zygote
scrotum
oviduct
placenta
implantation
foetus

Related to cells and meiosis

organelles
cell wall or membrane
polysaccharides
nucleus, nuclei
chromosomes
chromatin
nucleolus
ribosomes
chloroplast
cytoplasm
mitochondria
vacuole
cilia
flagella, flagellum
anal pore
contractile vacuole
meiosis
mitosis
centromere

Related to genetics

deoxyribonucleic acid (DNA)
homologous
homozygous
heterozygous
Punnett square
alleles
phenotype

Related to the local landscape and local communities

volcanic action
erupted
erosion
weathering, weathered
human impacts
reclamation
coral bleaching
mortality
the salinity
ions
osmotic pressure
zonation
layers
stratification
canopy layer
shrub layer
succession

Ways of expressing more information about a thing

Blood that flows in the artery to the kidney brings the waste material into the kidney.
Blood flowing in the artery to the kidney brings the waste materials into the kidney.
It is able to change harmful waste materials into less harmful materials that can be more easily excreted.
Any materials that the body does not want are left in the tubes.
The organelles found in plant and animal cells have different structures and different functions.

Ways of expressing the structure of a thing

The wall is thick and made up of fibres of cellulose.

Ways of expressing parts of things

The (main) parts of a flower are the . . .
The skeleto-muscular system is made up of the bones, the . . .
The Earth is a sphere made up of four layers: the crust, the . . .
The four processes involved in digestion are ingestion, digestion, absorption and egestion.

Ways of expressing examples

Some of these small materials are needed by the body, for example, glucose.
Examples of asexual reproduction include suckers, tubers, corms and rhizomes.
When our bodies are doing things like running and thinking, we are using energy.
Seawater contains dissolved gases, such as oxygen, nitrogen and carbon dioxide.
The most common ion in seawater is chlorine. Other ions in seawater include . . .
Atmospheric greenhouse gases (water vapour, carbon dioxide and other gases) trap some of the outgoing energy.

Ways of expressing definitions of things

The liver is an important organ that works with the excretory system.

Ways of expressing definitions of systems

The excretory system is a group of organs working to remove these wastes from the body.

Ways of expressing definitions of processes

Photosynthesis is the process plants use to make sugars.
Respiration is the process used by cells to get energy from chemicals.
Mitosis is the process of cell division where one cell forms two cells.
Self-pollination occurs when the pollen travels to the stigma in a flower on the same plant.
Osmosis is the movement of water from a higher concentration to a lower concentration through a semi-permeable membrane.
When plants and animals release waste materials or die, the micro-organisms in the soil break down this plant and animal material. This is called decomposition.

Using passives

Pollen is transferred from the anther to the stigma.
Wind is also used to transport pollen from one plant to another.
Each kidney is connected to the bladder by a thin tube called the ureter.

KEY VOCABULARY

Using passives to express functions

The bile is used to help (the body) digest food.

Both plants and animals use a process called respiration to supply energy for the life processes such as growth and movement.

Ways of expressing functions related to structure

The cells in the intestine have very long folder membranes so that they can absorb the digested food more easily.

In plants, the cell walls are joined together to give extra support to the plant.

Small gaps in the membrane, called pores, let materials move between the nucleus and the cytoplasm.

Ways of expressing how change occurs

The hormones cause the person to begin making gametes.

In males, the higher level of the hormone testosterone causes the secondary sex characteristics.

Oestrogen causes the uterus to begin to repair itself after the period has finished.

Ways of expressing time

At the beginning of the 20th century, . . .
Between 1937 and 1941, . . .
Since 1961, . . .
Two years later, . . .
During World War II, . . .
Up to 1952, . . .
On 16 March 1926, . . .
At the end of WWII, . . .
In December 1934, . . .
By February 1946, . . .

Vocabulary	Useful words that go with the key word	Other words
adaptations	structural adaptations, behavioural adaptations, functional adaptations, different adaptations, adapt to	adapt, adapts, adapted
atmosphere	the Earth's atmosphere	atmospheric
digestive	the digestive system, physical digestion, chemical digestion	digest, digestion
dispersal	seed dispersal	disperse
distribution	the distribution of organisms, the distribution of plants, wide distribution	
effects	negative effects, positive effects, have an effect on	
embryo	an embryo plant	embryonic
excretory	the excretory system	excrete, excretes, excreted, excreting, excretion
exposed	exposed to . . .	exposure
feature	an important feature of . . .	
fertilised		fertilisation
genetic	genetic material, genetic engineering, genotype ratio, the expected genotype, the genotype of a person	genes, genotype
global	global warming, global warning potential (GWP)	
greenhouse	the greenhouse effect, atmospheric greenhouse gases	
habitats	different habitats	
immunity	natural immunity, passive artificial immunity, active artificial immunity	immune
inter-relationships	inter-relationships between organisms	
issue	an environmental issue	
life history	the life history of . . .	
organisms	one celled organisms, multi celled organisms, micro-organisms	
permeable	semi-permeable membrane	permeate
pollination	cross-pollination, self pollination, animal-pollination	pollinated, pollen
pollution	sediment and nutrient pollution	pollute
reproduction	sexual reproduction, asexual reproduction	reproduce
reproductive	the reproductive organs, the reproductive system, human reproduction, animal reproduction	reproduces, reproduced, reproduction
respiration	aerobic respiration, anaerobic respiration	
variation	continuous variation, discrete variation	vary