Book 1

Year 10

Science

Science

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GOVERNMENT OF SĀMOA
MINISTRY OF EDUCATION, SPORTS AND CULTURE

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Unit 1: REVISION

Introduction

This is a revision chapter. Use it to remind yourself of what was covered in Year 9 Science.

Plants

Plants carry out the same life processes as animals. They move, respire, sense, grow, reproduce, get rid of wastes by excretion and feed using nutrients. These processes occur in the leaves, stems, roots and flowers. These parts may look different in each plant but their functions are still the same.

Plants make their own food using a process called photosynthesis. Photosynthesis occurs mainly in the leaves, which are the main organs of the plant. The green coloured chemical called chlorophyll is used during photosynthesis. To carry out photosynthesis, plants need light to shine on their leaves. The stems and branches hold the leaves up so that they can get as much light as possible.

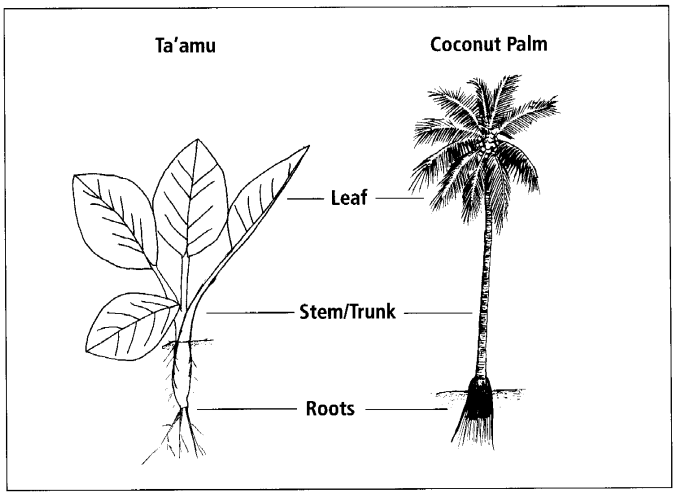


Diagram 1.1
Comparing plant parts.

The xylem and the phloem tissues are found inside the stem of the plant. The cells in the xylem are used to transport water and minerals from the roots to the leaves. The cells in the phloem are used to transport sugar throughout the plant.

Activity 1 Plants

Aim: To revise work on plants.

- Copy the puzzle below into your book. Complete the puzzle using the clues to help you. One has been done for you.

1.					R					
2.					E					
3.				S						
4.				P						
5.	N	U	T	R	I	T	I	O	N	
					R					
6.				E						

Clues: Life processes of plants.

1. Getting bigger.
2. Getting rid of waste.
3. Respond to light.
4. Making more of itself.
5. Using nutrients.
6. Flowers open and close.

- Copy the following diagram into your books. Label the parts with the correct name and list a function of each part.

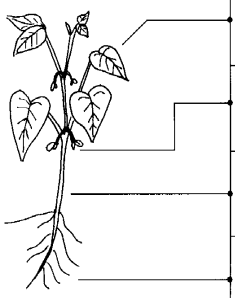
Plant Parts	Name	Function
		

Diagram 1.2
Plant parts.

Organisms and cells

Organisms are made up of organ systems that work together to carry out life processes. Organ systems, such as the circulation system, are made up of organs such as the lungs and heart. Organs are made up of tissues, and tissues are made up of cells.

Light microscopes are used to view cells and tissues. To look at cells of a tissue, the tissue is cut or torn so that it is thin enough to use. This makes it easier to see the detail of individual cells. The sample is then placed on a glass microscope slide and a drop of water or stain is added. It is then covered with a cover slip.

Magnification is the number of times larger the object is when it is being looked at under the microscope. Magnification is worked out by multiplying the magnification of the eyepiece lens by the magnification of the objective lens.

What people are able to see under the microscope can be turned into a biological drawing. These show the detail of the cells or tissues that have been viewed.

Plant and animal cells have a cell membrane, cytoplasm and a nucleus. Plant cells also have a cell wall and a large vacuole. Some have green chloroplasts.

Chromosomes are found inside the nucleus of plant cells. Chromosomes are made up of DNA. DNA carries the genetic information that gives the cell instructions for growth and other cell activities.

Activity 2 Organisms And Cells

Aim: To revise work on organisms and cells.

- Complete the following questions:

1. Name three organs in the human body.
2. Name three organ systems in the human body.
3. How do you work out the magnification of an object under the microscope?
4. What does a biological drawing show?
5. What three organelles can be present in a plant cell but not in an animal cell?

◧ Copy the following diagram into your exercise book. Label the letters with the correct name from the following list:

Cell membrane	Cell wall
Nucleus	Vacuole
Cytoplasm	Chloroplast

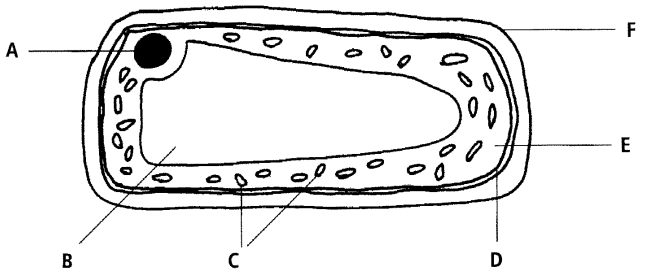


Diagram 1.3
Plant cell.

Food

Different foods are used for energy, growth and repair, and protecting the body. Foods are made up of six main nutrients. These are: proteins, carbohydrates, fats, vitamins, minerals and water. Each of these nutrients gives the body different things.

Carbohydrates include sugars, starch and cellulose fibre. Sugars and starch provide the body with energy. The chemical iodine is used to test for the presence of starch. If starch is present the brown iodine solution changes colour to a dark blue-black colour. Benedict's solution is used to test for glucose. If glucose is present, the blue Benedict's solution turns a red-orange colour.

Fats and oils supply the body with energy and they protect organs such as the kidneys. Fats are important for the transport of vitamins and hormone production. Fats are used to store extra energy that is gained from food. Lots of foods contain small amounts of fats and oils. Meats often have large amounts of fat in them.

Proteins are chemicals made up of amino acids. They provide the materials for growth and repair of the body. Meats, eggs, milk, peas, beans, grains, rice, nuts and seeds are good sources of protein.

Vitamins and minerals help to protect the body from disease by making it possible for other nutrients in foods to be used by the body. Water is an important nutrient. People need to drink water every day.

Your body needs all of these nutrients. Some are needed in smaller amounts than others. To be healthy your body needs to get all the nutrients in the correct amounts. This is why it is important to have a balanced diet with a variety of different foods in it.

Activity 3 Foods

Aim: To revise work on foods.

- There are 12 key words hidden in the following word maze. The words are written forwards, backwards, up and down. Find each of the key words and write a sentence in your book to give the meaning of the key word.

X	O	D	I	O	D	I	N	E	I	N	G
P	I	M	I	N	E	R	A	L	E	F	C
Y	L	U	S	I	A	B	J	Y	J	S	H
F	R	O	B	E	N	E	D	I	C	T	S
Q	W	E	R	T	Y	U	I	O	P	A	S
C	A	R	B	O	H	Y	D	R	A	T	E
D	F	G	H	R	J	E	K	L	Z	X	C
W	V	B	N	P	N	I	M	A	T	I	V
A	M	I	N	O	A	C	I	D	S	I	O
T	L	K	R	J	H	G	F	D	F	S	A
E	U	C	F	G	L	U	C	O	S	E	T
R	Y	C	M	D	Y	J	L	B	A	R	A
A	D	H	C	R	A	T	S	M	X	D	F

Fat	Iodine	Oil
Carbohydrate	Protein	Amino acids
Water	Glucose	Starch
Mineral	Benedicts	Vitamin

Human circulation

The circulation system transports a range of materials around the body. The blood carries materials such as digested food, mineral salts, carbon dioxide, wastes and oxygen. The haemoglobin in the red blood cells carries the oxygen.

Blood vessels called arteries carry blood away from the heart. Veins carry the blood back to the heart. Between the arteries and veins are the small capillaries. Each body cell has a capillary close to it. Gas exchange occurs in the capillaries. Oxygen and food in the blood move into the cell, and carbon dioxide and wastes move from the cell into the blood.

The heart is made up of two pumps side by side. The right side receives blood from the body and pumps the blood to the lungs. The left side receives blood from the lungs and pumps blood to the body.

The pumping of the heart causes pressure in the arteries. This is felt as a pulse. The pulse rate changes with different activities. The pulse rate increases when the activity the body is doing requires more oxygen.

Activity 4 Circulation

Aim: To revise work on the human circulation system.

- Name five things carried by the blood.
- Describe how the functions of arteries, veins and capillaries differ.
- Copy the following diagram into your books. Label the letters with the correct name for the part from the following list:

Aorta	Left ventricle	Vena cava
Right ventricle	Right auricle	Septum
Left auricle	Pulmonary vein	Pulmonary artery

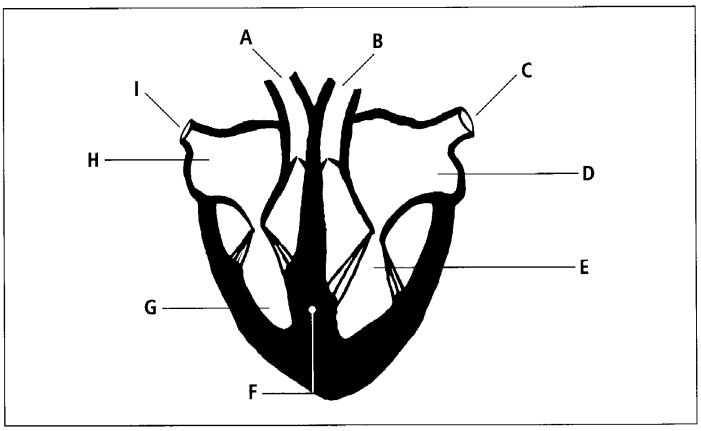


Diagram 1.4
Human heart.

Human respiration

Respiration is the process of using food to get energy. Respiration occurs in almost all cells. Oxygen is needed to carry out respiration.

Breathing is used to get air in and out of the body. The rib cage and diaphragm work together to pull air into the lungs. Mucous, hairs and cilia help to clean air as it enters the body.

Air travels through the trachea, bronchi and bronchiole to get to the alveoli in the lungs, where gas exchange takes place. During gas exchange the oxygen in the air moves into a blood capillary in the lungs, and carbon dioxide moves from the blood capillary into the alveoli. The blood leaving the lungs is high in oxygen and is called oxygenated blood.

Activity 5 Human Respiration System

Aim: To revise work on the human respiration system.

- Copy the following diagram into your books. Label the letters with the correct name from the following list:

Lungs	Bronchiole	Trachea
Nose	Cartilage	Bronchi
Throat	Alveoli	

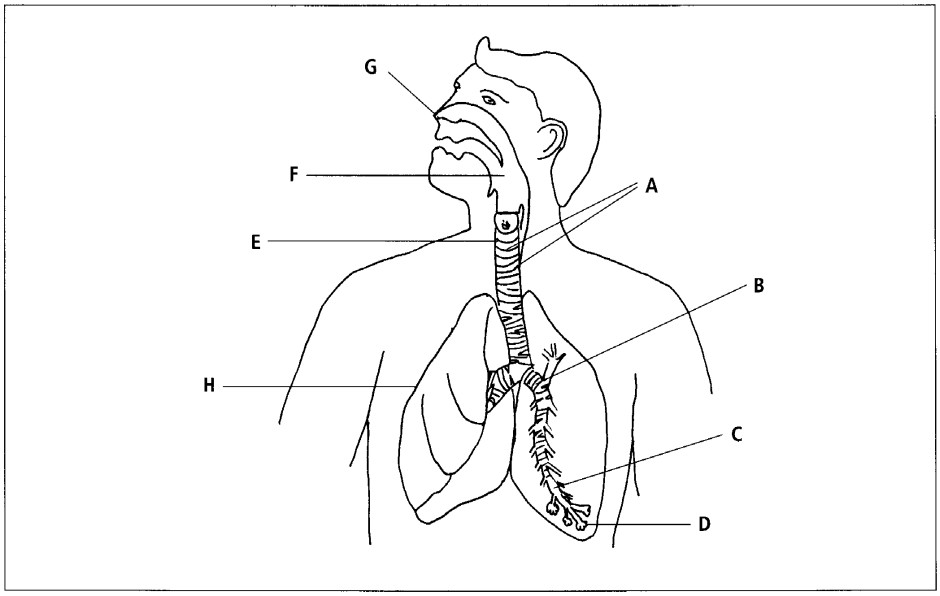


Diagram 1.5
Human respiration system.

- Answer the following questions in your exercise book:

1. Explain the difference between respiration and breathing.
2. Name the two parts of the body that work together during breathing.
3. Describe what happens to the oxygen and carbon dioxide during gas exchange.

Micro-organisms

Bacteria are single-cell organisms that have a cell wall, cell membrane, cytoplasm and genetic material. Some types of bacteria also have capsules and flagella.

Bacteria use binary fission for reproduction. Reproduction can be as quick as once every 20 minutes. Lack of space or food, too much toxic waste and too high or too low temperatures all slow reproduction down.

Bacteria and fungi feed by extra-cellular digestion. They feed on two different types of food sources. Saprophytes feed on dead organic material and parasites feed on living host cells.

Some bacteria carry out aerobic respiration, which means they need oxygen. Other types of bacteria use anaerobic respiration, which means they do not need oxygen.

Agar plates can be used to grow and reproduce a single bacterium into a colony. Colonies become so big that they can be seen as a shiny spot on the agar. Fungi can also be grown on agar. They appear as lumps of threads or furry patches.

Fungi are made up of hyphae, which grow through the food supply. Fungi grow in warm, moist places and reproduce using spores.

Viruses are made up of a protein coat and genetic material. Viruses are always parasites. They reproduce by joining onto a host cell and using the cell to make copies of themselves.

Disinfectants, antiseptics and antibiotics are chemicals used to stop the growth of micro-organisms.

Activity 6 Micro-organisms

Aim: To revise work on micro-organisms.

- Copy the following diagram into your books. Label the letters with the correct name from the following list.

Flagella	Genetic material	Cell membrane
Cell wall	Capsule	Cytoplasm

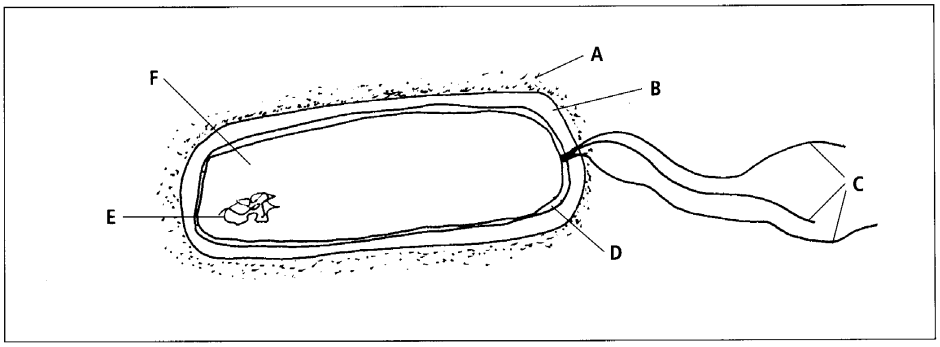


Diagram 1.6
Parts of a bacterium.

- Answer the following questions in your exercise book.

1. What environmental factors stop bacteria from reproducing?
2. Describe the difference between fungi that are saprophytes and those that are parasites.
3. How do viruses reproduce?

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

Plants

1. The main organ in plants are (L _ _ _ _ _).
2. Plants use (P_ _ _ _ _ _ _ _ _ _ _ _ _) to make their own food.
3. The chemical that makes plants green is (C _ _ _ _ _ _ _ _ _ _).
4. The (X _ _ _ _ _ _) forms a series of tubes inside plants.
5. The tubes that transport sugar are called (P _ _ _ _ _).

Cells

1. The chemical in chromosomes is (D _ _).
2. A living thing, made of one or many cells, is an (O _ _ _ _ _ _ _).
3. The part of a cell that controls it is the (N _ _ _ _ _ _).
4. A group of organs that work together is an (O _ _ _ _ S _ _ _ _ _).
5. Tissues and cells that form structures and work together are (O_ _ _ _ _).

Food

1. Food is made up of a variety of substances called (N _ _ _ _ _ _ _ _).
2. To test for starch, add a few drops of (I _ _ _ _ _).
3. To test for glucose, add (B _ _ _ _ _ _ _ '_ S _ _ _ _ _ _ _).
4. Amino acids linked together in long chains form (P _ _ _ _ _ _).
5. Food is used for (G _ _ _ _ _) and (R _ _ _ _ _).

Human Circulation

1. (A _ _ _ _ _ _ _) carry oxygenated blood away from the heart.
2. The oxygen in blood is carried by (H _ _ _ _ _ _ _ _ _ _).
3. The pump in the body is the (H _ _ _ _).
4. Pressure in the arteries is a (P _ _ _ _).
5. The smallest blood vessels in the body are the (C _ _ _ _ _ _ _ _ _ _).

Human Respiration

1. The movement of air in and out of the lungs is (B _ _ _ _ _ _ _ _).
2. The air spaces at the end of the bronchiole are called (A _ _ _ _ _ _).
3. The gas needed for respiration is (O _ _ _ _ _).
4. The gas formed as a waste in humans is (C _ _ _ _ _ D _ _ _ _ _ _).
5. The process that happens in the alveoli is (G _ _ E _ _ _ _ _ _).

Micro-organisms

1. (A _ _ _ _ _ _ _ _) respiration doesn't need oxygen.
2. Bacteria use (B _ _ _ _ _ F _ _ _ _ _ _) for reproduction.
3. Spores are used for reproduction in (F _ _ _ _).
4. Viruses are always (P _ _ _ _ _ _ _ _).
5. Bacteria can be grown on (A _ _ _).

Unit 2: PLANT GROWTH AND REPRODUCTION

Introduction

In this unit, you will learn about how flowering plants grow and reproduce.

Flowering plant life cycles

Most flowering plants grow from seeds. Firstly the seed **germinates**, which means that the small plant **embryo** inside the seed begins to grow. The embryo plant grows into a seedling, and then into an adult plant.

The adult plant is able to flower and make **pollen** and **ovules**. When a pollen and ovule from the same type of plant join together they form an embryo plant. The embryo plant is inside a seed. When the growing conditions are right for the seed it will germinate, and the cycle will continue.

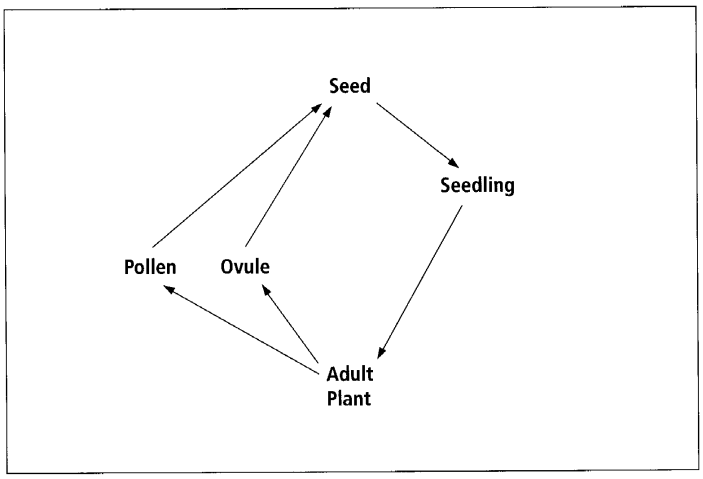


Diagram 2.1
Life cycle of a flowering plant.

Plant reproduction

Plants can reproduce using **sexual** and **asexual** reproduction. **Asexual reproduction** allows plants to reproduce very quickly. All the new plants produced have the same genetic information as the parent plant. This means that if the conditions where the plant is living are good then many new plants can be produced to make use of the good conditions.

Sexual reproduction takes longer and plants use a lot of energy making flowers, pollen and seeds. The offspring from sexual reproduction have a different genetic make up to the parent plants. This means that each plant has slightly different **adaptations** to the environment. This is an advantage to the group of plants. If the conditions of the environment change then there is the possibility that some of the plants are well adapted to grow in the new conditions.

Asexual reproduction

There are many different methods of asexual reproduction. In each method a part of the parent plant grows into a new plant.

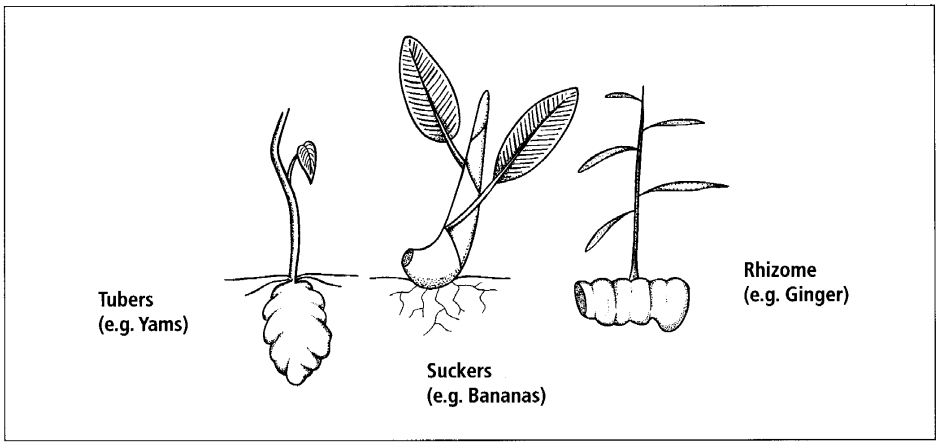


Diagram 2.2
Some methods of asexual reproduction.

Sometimes people use the asexual reproduction of plants by taking cuttings from a plant and placing them in the soil to grow. New hibiscus plants can be grown this way. The fue saina (mile a minute) plant can grow from small pieces that have broken off the plant, which makes it a difficult weed to get rid of. Plant growing techniques, such as tissue culture and grafting, are also methods of asexual reproduction.

Activity 1 Plant Life Cycles

Aim: To record information about the life cycles of flowering plants and asexual reproduction.

- Copy the life cycle of a flowering plant diagram on page 15.
- Choose a plant that grows at your school or home, and add to the diagram a drawing of a seed, seedling and adult plant of the same type of plant.
- Copy the following table and use the information about plant reproduction to complete it.

Type of Reproduction	Is the genetic material the same or different from the parent?	What is the advantage of this type of reproduction?
Asexual		
Sexual		

Activity 2 Asexual Reproduction

Aim: To investigate asexual reproduction.

- List all the names of local plants that use asexual reproduction. Find out and record how each type of plant reproduces.
- Ask a person that uses asexual reproduction to grow crops to describe the steps they use to grow new plants. Write up the steps they describe.
- Find out from the Agricultural Department, USP or Polytechnic how different methods of asexual reproduction, such as tissue culture, are carried out.

Sexual reproduction

There are four processes that are important in sexual reproduction. These are: making **gametes**, **pollination**, **fertilisation** and **dispersal**. Flowers are important in these processes.

When a flower is being formed it is called a bud. **Sepals** cover the outside of the bud to protect the flower as it develops. Sepals are green and look like small leaves.

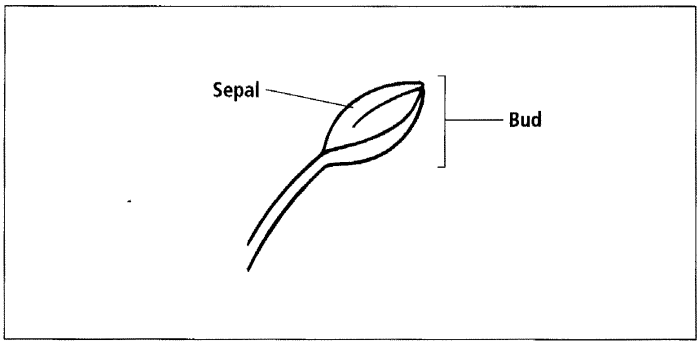


Diagram 2.3
Flower bud.

Although flowers show a lot of differences in size, shape and colour, the parts that make them up are almost identical. Flowers that are wind-pollinated are often small, green and have a different structure to flowers that are animal-pollinated. Flowers have three groups of parts. The female parts called the **pistil**, the male parts called the **stamen**, and finally there are the sepals and petals.

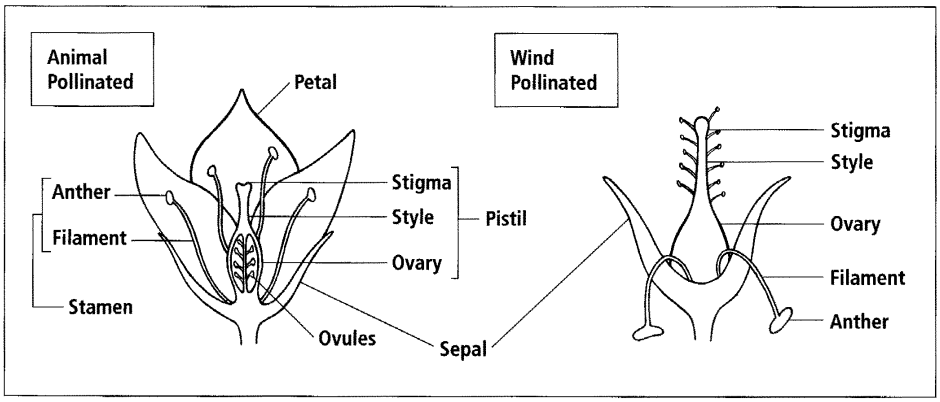


Diagram 2.4
Animal and wind-pollinated flowers. Note that the animal-pollinated flower has been cut in half to show the structures inside.

As the flower is forming, male and female **gametes** are made. **Ovules**, the female gamete, are made in the **ovary**. **Pollen** grains carrying the male gamete are made in the **anther**. Pollen grains are small and round. In wind-pollinated flowers the pollen is smooth so that it can travel easily on the wind. Pollen from animal-pollinated flowers has a rough, often sticky surface, so that it will stick to an animal and be taken from one flower to another.

Pollination is the transport of pollen from the **anther** of one plant to the **stigma** of another plant of the same type. Petals are an important part of flowers that are pollinated by animals. Plants use the bright colour of the petals, the smell of the flower and a sugar solution called **nectar** to attract insects and other animals to the flower. When an insect or small animal goes into the flower to get the nectar some pollen sticks to it. When the animal goes into another flower some of the pollen goes onto the stigma of the new flower. This is how animal-pollination occurs. In wind-pollination the wind carries the pollen from one flower to another.

Cross-pollination occurs when pollen goes from the anther of one flower to the stigma of another. **Self-pollination** is when the pollen goes from the anther to the stigma of the same flower. Some flowers are designed for self-pollination, and others for cross-pollination.

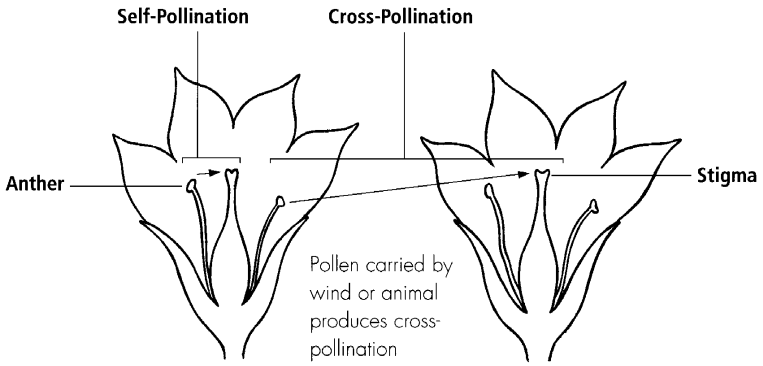


Diagram 2.5
Cross- and self-pollination.

The third process in sexual reproduction is fertilisation. If pollen from the anther of one plant gets taken to the stigma of another plant of the same type, it germinates and grows down the **style** and into the ovary. In the ovary the male gamete in the pollen joins with an ovule to form a **zygote**. This joining is called fertilisation. The zygote will develop into an embryo plant, and the parts of the flower around the zygote will develop into a seed and fruit.

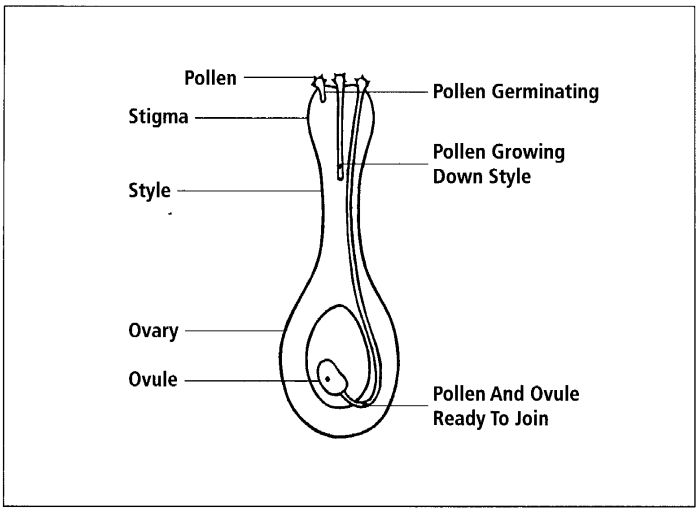


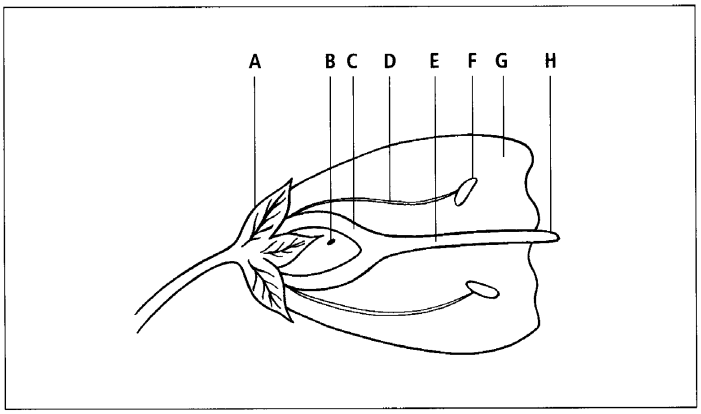
Diagram 2.6
Fertilisation.

After seeds have been formed, plants try to spread their seeds as far as possible from themselves. This is called **dispersal**. By spreading its seeds a plant stops its seedlings from competing against itself for nutrients, water, light and space to grow. Coconuts are dispersed by floating on water. When birds and other animals eat fruit, the seeds in the fruit go through the animals' digestive system and are dispersed in the animals' faeces. The seeds of some plants are dispersed by wind, and others are dispersed by getting hooked on the fur, hair or feathers of animals. In some plants the seed pod explodes and sends the seeds through the air.

Activity 3 Sexual Reproduction

Aim: To record information about sexual reproduction.

1. Name the four processes used in sexual reproduction. Use the information on the previous page to explain what happens in each process.
2. Explain why some flowers make nectar.
3. List five methods plants use to disperse their seeds.
4. Explain the difference between cross-pollination and self-pollination.
5. Copy this diagram of a flower and name the parts labelled A to H.



6. Rewrite the following table in your book with the part of the flower matched with its correct function.

Part of 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.

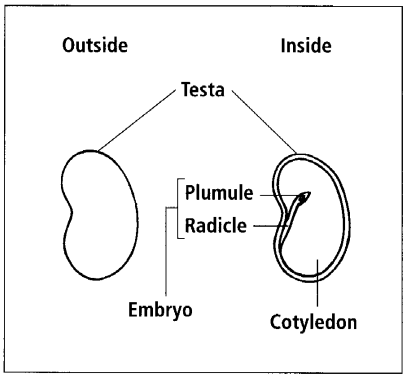
Activity 4 — Flower Structure

Materials needed:
Several flowers;
Knife or blade;
Hand lens or magnifying glass;
Sticky tape.

Aim: To investigate the different sizes and shapes of flowers.

- Collect several different flowers.

1. Draw a diagram of two different flowers and name their parts.
2. Look at the anther and stigma of a flower with a hand lens or magnifying glass. Describe what you see.
3. Cut the ovary in half and look at it with a hand lens or magnifying glass. Draw or describe what you see.
4. Take a flower apart and stick each part into your book. Label the parts.



Seeds
Seeds are composed of an embryo plant, a food store and a hard outside cover. The hard cover, called a **testa**, protects the embryo and stops water from entering the seed. The embryo plant uses the food store, called a **cotyledon**, until it has grown enough to make its own sugars using photosynthesis. The embryo plant is made up of two parts: the **radicle**, which grows to become the root of the plant, and the **plumule**, which grows to become the shoot of the plant.

Diagram 2.7
Seed structure.

Activity 5 — Seed Numbers

Aim: To plan and carry out an investigation to find out the average number of seeds produced by a plant.

1. Choose a plant that produces seeds that are easy to count, *e.g. Coconut, coffee, beans.*
2. Plan how you can find out the average number of seeds produced by a tree, *e.g. Coconut*; or in a group, *e.g. Coffee*; or in a pod, *e.g. Beans.*
3. Carry out your investigation and write up a report showing your results and conclusion.

Germination

After dispersal some seeds are able to stay **dormant** for a number of years. Being dormant means that the life processes of the embryo plant have slowed down, and it doesn't grow. Different types of seeds require different conditions to break the dormancy and begin germination. Some need cooler temperatures, others need their surface to be scratched, and some need water.

Once germination begins the radicle of the embryo begins to grow. It uses the energy from the chemicals in the cotyledon. Then the plumule begins to grow.

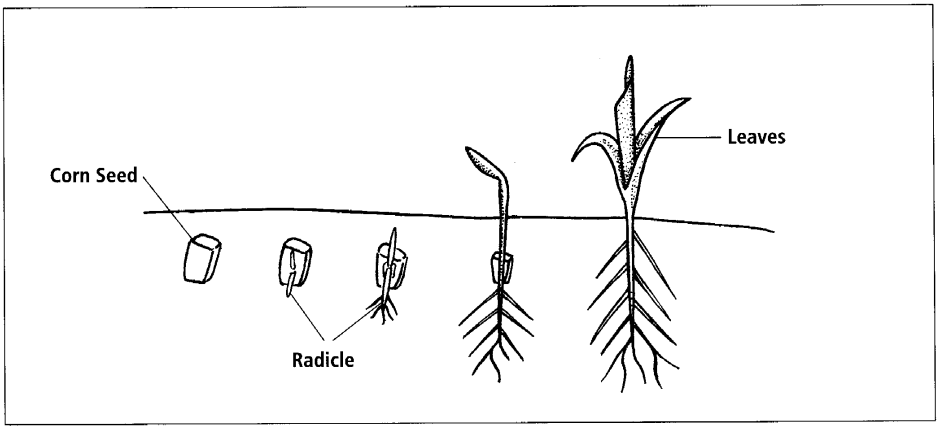


Diagram 2.8
Germination.

Activity 6

Seed Structure

Materials needed:
Bean seeds;
Bean seeds that have been soaked overnight;
Other seeds;
Knife or blade;
Hand lens or magnifying glass.

Aim: To investigate the structure of seeds.

1. Look at the outside of a dry bean seed. Record your observations in drawings and descriptions.
2. Try to remove the testa. Comment on how it protects the seed.
3. Compare the bean seed with other seeds. Draw the sizes and shapes of the different seeds.
4. Compare the soaked and unsoaked bean seeds. Record the differences you observe.
5. Cut open a soaked seed.
6. Draw and label the parts inside the seed.

Activity 7 — Germination Test

Materials needed:
Two plates or saucers;
20 seeds;
Paper tissue or newspaper.

Aim: To work out the germination percentage of seeds.

1. Soak 20 seeds for one hour.
2. Pour three or four spoonfuls of water into a plate or saucer.
3. Wet the paper and place it across the plate.
4. Put 20 seeds on the paper. Space them out evenly.
5. Cover the paper and seeds with the other plate.
6. Leave plates in a safe place and check daily. Add water if needed.
7. After four or five days count the number of germinated seeds and then calculate the germination rate using the formula below.

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated} \times 100}{\text{Number of seeds used}}$$

8. Record your results and write a conclusion.

Activity 8 — Germination Investigation

Materials needed:
Seeds that are quick to germinate and grow (such as beans);
Other equipment needed depends on the students own investigation plan.

Aim: To investigate the best conditions for the germination of a seed.

- Choose a topic for your investigation to test the effect of different conditions on seed germination. Choose topics such as:
  a. The effect of temperature on germination.
  b. The effect of water on germination.
  c. The effect of light on germination.
  d. The effect of soaking on germination — how quickly the plants grow: *e.g. Soaking for 1 hour, 12 hours, 24 hours and 48 hours.*
  e. Comparing the effects of soaking for 24 hours, 48 hours, freezing for two hours, and rubbing with sandpaper, on germination and growth rate.

- Plan your investigation using the questions that follow.

1. What is the investigation called? (*e.g. Germination.*)

2. What is the aim or purpose of this investigation? (*e.g. To find out the effect of temperature on germination rate.*)

3. What variable will be changed? (*e.g. The temperature the seeds are germinated in.*)

4. How will the variable be changed? (*e.g. Some seeds will be put in a hot place, some in a warm place and some in a cold place.*)

5. Which variables will be kept the same? (*e.g. The number of seeds — 10 seeds will be used in each place; light — they will all be covered with thick paper.*)

6. What will be measured or counted? (*e.g. Number of seeds that have germinated then the height of each seedling.*)

7. How will you make sure the results are accurate and reliable? (*e.g. Use 10 seeds in each test* ***or*** *repeat each test three times.*)

- Carry out your investigation.
- Record your results in tables and graphs.
- Interpret the results and write a conclusion.
- Write a discussion to evaluate your investigation and your results.

Plant growth

Plants are able to grow in lots of different ways. They can get taller, wider or grow more branches, leaves and roots. Some of the growth of plants happens by cells getting bigger and other growth happens by more cells being produced.

Did you know?

Project *Call of the Wild* — Sāmoa has a lot of trees that are in danger of becoming extinct because of industrial and domestic use. The challenge is for you and your class to grow seedlings of these endangered trees. Find out from the Forestry Division or an Agriculture Extension Officer about the trees and plants that need to be grown. Get help to collect seeds and set up a seedling nursery.

Unit Summary

- Flowering plants produce seeds that hold an embryo plant. When a seed germinates the embryo plant inside grows into a seedling, and then into an adult plant.
- Asexual reproduction uses part of the parent plant to grow a new plant that has the same genetic make up as the parent. Plants can reproduce very quickly using asexual reproduction.
- Examples of asexual reproduction 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.
  Gamete production — adult plants produce pollen and ovules.
  Pollination — pollen is transferred from the anther to the stigma.
  Fertilisation — the male gamete joins with the female gamete.
  Dispersal — the seeds are spread away from the parent plant.
- Seeds have a hard testa, an embryo plant, and a cotyledon that stores the sugars 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 making new cells, and these cells getting bigger.

Unit 3: CELL PROCESSES

Introduction

In this unit you will learn how cells carry out the processes of **diffusion**, **osmosis**, **photosynthesis**, **respiration** and **mitosis**. These processes show the chemical and energy requirements of plant and animal cells, and the wastes these cells produce.

Living cells need to transport different chemicals from one place to another. Diffusion and osmosis are two ways that chemicals move from place to place.

Diffusion

The particles in gases and liquids are always moving and hitting one another. When sugar is put into hot water the sugar dissolves and its particles move throughout the water. This is called diffusion. Diffusion occurs quickly in hotter water because the particles are moving fast and banging into each other more than in cold water.

In diffusion, a chemical always moves from an area where there is lots of that chemical (high concentration) to an area where there is less of the chemical (a lower concentration). The diagram below shows there is a high concentration of sugar around a lump when first placed in the hot water. There is a low concentration of sugar particles in the surrounding water. After a few minutes the sugar particles have moved from where it was high in concentration to where it was low in concentration. Eventually it is at an even concentration of sugar particles throughout the water.

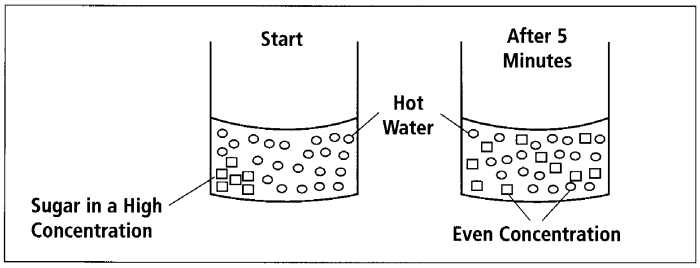


Diagram 3.1
Model of diffusion of sugar in hot water.

Activity 1

Diffusion

Materials needed:
Coloured jelly crystals;
Water at different temperatures — boiling, hot, warm, cold;
Beakers, jars or glasses.

Aim: To investigate the effect of temperature on diffusion.

1. Set up four beakers, each containing water at a different temperature.
2. Place a small amount of jelly crystals in the centre of each beaker. Observe and record what happens in each.
3. Carry out observations and recordings every five minutes, for a total of 20 minutes.
4. Describe your results using the terms — 'high concentration', 'low concentration' and 'even concentration'.
5. Use the information about diffusion on the previous page to explain the difference in the results for the different temperatures.

Osmosis

Osmosis is the movement of water molecules from an area of high water concentration to an area of low water concentration. The water molecules move through a membrane that only lets small chemicals through. Because it lets some chemicals through and not others it is called a **semi-permeable membrane**. Cell membranes are semi-permeable. They let small chemicals like water, oxygen and carbon dioxide through, but stop large chemicals like proteins.

Osmosis occurs when a solution of water is on one side of a semi-permeable membrane and a solution, containing large molecules that can not go through the membrane, is on the other side. This means that some of the water from the water solution will move through the membrane and into the other solution. Water molecules will always move from an area of high concentration to an area of low concentration to try and balance the two concentrations out.

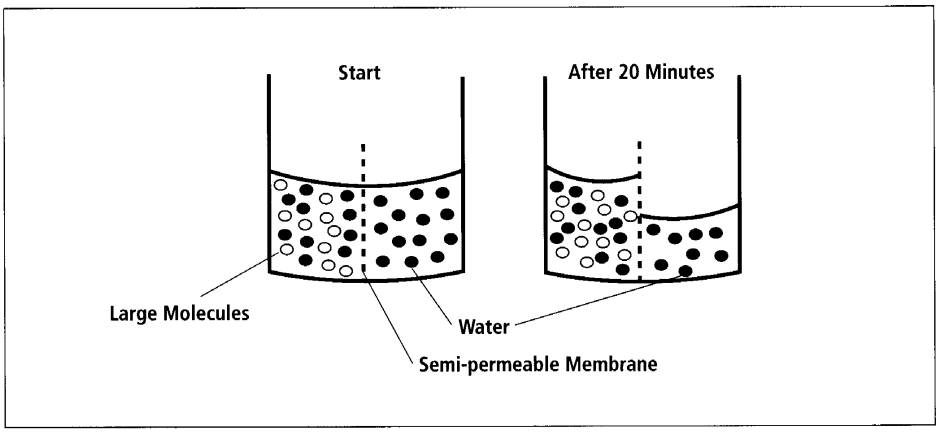


Diagram 3.2
Osmosis.

Activity 2 Diffusion And Osmosis

Aim: To record information on diffusion and osmosis.

- Answer the following questions in your exercise book:

1. Describe what happens to chemicals during diffusion. Draw diagrams to help your description.
2. What happens to water and to chemicals made up of large molecules during osmosis? Draw diagrams to help your description.
3. What does the term 'semi-permeable' mean?
4. What does the term 'low concentration' mean?

Activity 3 Model Of Diffusion And Osmosis

Materials needed:
Dish;
Marbles or ball bearings or stones of two different sizes;
Model semi-permeable membrane that fits across the dish.

Aim: To investigate the effect of a semi-permeable membrane.

Diffusion model

1. Place the small marbles or stones on one side of the dish and the large ones on the other.
2. Gently move the dish from side to side and observe what happens. Record your observations.
3. Start with the small marbles or stones on one side and the large on the other side again. Investigate the effect of moving the dish at different speeds.
4. Record your observations.

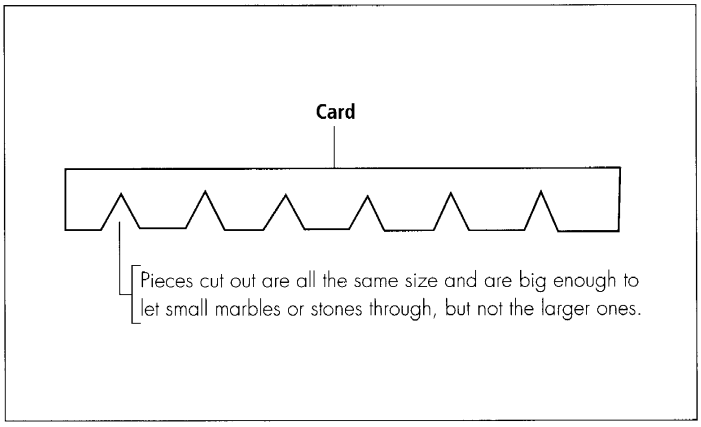


Diagram 3.3
Semi-permeable membrane model.

Osmosis model

1. Place your model of the semi-permeable membrane in the dish with the small marbles on one side of it and the large ones on the other side.
2. Gently move the dish from side to side and observe what happens. Record your observations.
3. Discuss what happened in the models of diffusion and osmosis. How are diffusion and osmosis different? What are the similarities between diffusion and osmosis?

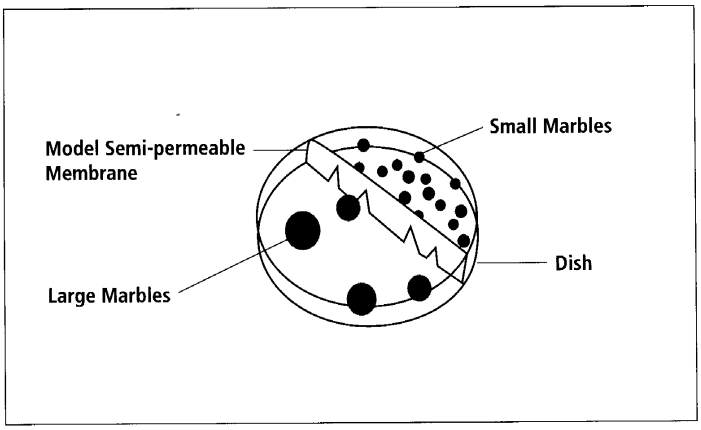


Diagram 3.4
Osmosis model.

Activity 4

Osmosis

Materials needed:
Potatoes, yams or carrots;
Sugar;
Water;
Small beakers;
Scales.

Aim: To investigate osmosis in cells.

Method 1

1. Make up a strong sugar solution by dissolving as much sugar as possible in 100 mL of water.
2. Keep about 10 mL of this solution.
3. Add water to the rest of the strong solution to make three weaker solutions.
4. Cut five equal size cubes of potato and hollow out the centre.
5. Place each cube in a small beaker and add water around the cube.
6. Half fill the hollow of each cube with one of the sugar solutions. Add water to the last cube. Label the beakers.
7. Leave for 24 hours.
8. Observe the amount of solution inside the hollow. Record which way the water has moved. Was it from the sugar solution in the potato to the water in the beaker, or from the water in the beaker to the sugar solution in the potato?
9. Write a conclusion for your results.
10. Use the information about osmosis on the previous pages to explain your results.
11. Explain why water was put into the hollow of one of the potato cubes.

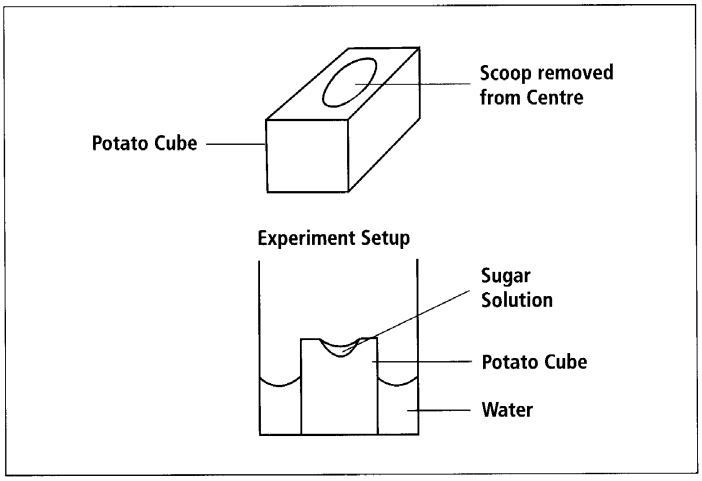


Diagram 3.5
Osmosis through a potato.

Method 2

1. Mix up sugar solutions of:
   a. 3.4 g of sugar and 100 mL of water.
   b. 10.3 g of sugar and 100 mL of water.
   c. 17.1 g of sugar and 100 mL of water.
   d. 23.9 g of sugar and 100 mL of water.
2. Label five small beakers 1, 2, 3, 4 and 5.
3. Cut five equal size pieces of potato.
4. Weigh each piece. Record the weight. Put one piece of potato in each of the sugar solutions and one in water.
5. Leave for 24 hours.
6. Weigh the potatoes again. Record the new weight in your book. Work out which potatoes gained weight and which potatoes lost weight.
7. Write a conclusion for your results.
8. Use the information about osmosis to explain your results.
9. Explain why one of the pieces of potato was placed in water.

Photosynthesis

Photosynthesis is the name of the process by which plants produce sugars. The cells in plants use these sugars as a supply of energy for chemical reactions. The parts of a plant that are green have **chloroplasts**. These are small green coloured organelles that are able to carry out the process of photosynthesis. Chloroplasts are green because they are full of a green substance called **chlorophyll**. Chlorophyll is able to use the energy in light to carry out the chemical reactions that make the sugars.

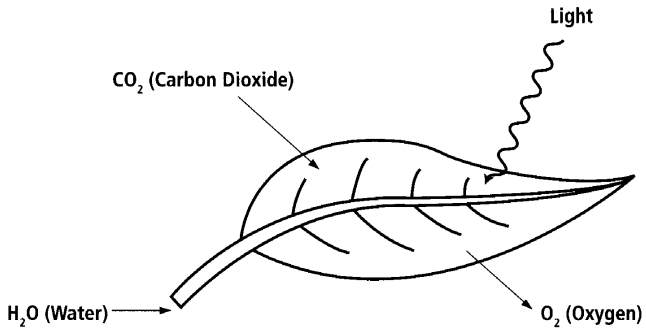


Diagram 3.6
Photosynthesis.

The chemicals needed for photosynthesis are water and carbon dioxide. During photosynthesis oxygen and sugars are produced. The following word equation shows the chemical reaction for photosynthesis.

$$\text{Carbon dioxide + water} \xrightarrow[\text{Chlorophyll}]{\text{Light}} \text{Glucose sugar + oxygen}$$

Light and chlorophyll are written above and below the arrow to show that they are needed in the reaction. Photosynthesis can only happen if light is shining on the plant.

The glucose sugar made during photosynthesis is firstly turned into starch and stored by the plant. The plant can then use the starch and turn it into other chemicals such as proteins, fats, oils and other carbohydrates. When animals eat the plants, they digest these nutrients that have been made by the plant.

Activity 5 Photosynthesis

Aim: To record information about photosynthesis. Answer the following questions and complete the exercise.

1. Why do plant cells carry out photosynthesis?
2. Why can only some plant cells carry out photosynthesis?
3. What causes plants to be green?

- Copy the word equation for photosynthesis.

Activity 6 Photosynthesis Investigations

Materials needed:
Plant with soft leaves that have been destarched by placing the plant in the dark for at least 12 hours;
Plastic bag and string;
Dilute sodium hydroxide solution;
Two test tubes;
Hot plate or boiling water;
Meths;
Dish;
Iodine.

Part A

Aim: To show that carbon dioxide is needed for photosynthesis to occur.

Method

1. Take your plant out of the dark and cover one of the leaves with a plastic bag containing a small amount of dilute sodium hydroxide solution. Be careful not to get any sodium hydroxide on the leaf. The sodium hydroxide solution removes carbon dioxide from around the leaf.
2. Leave the plant under a light source for 24 hours.
3. Remove the plastic bag. Cut off the leaf that was in the plastic bag. Place it in a test tube and cover it with meths. Label the test tube.
4. Remove a second leaf from the plant. Place it in a test tube and cover it with meths. Label the test tube.
5. Boil both the test tubes with leaves in meths in a water bath (never by a flame) for about 10 minutes. This will remove the chlorophyll. Take care — meths fumes burn easily.
6. Rinse the leaves in hot water to remove the meths and soften them.
7. 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.
8. 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.
9. Draw the shapes of the two leaves and mark in the patches of blue-black and brown colour.
10. Write a conclusion and discuss your results.

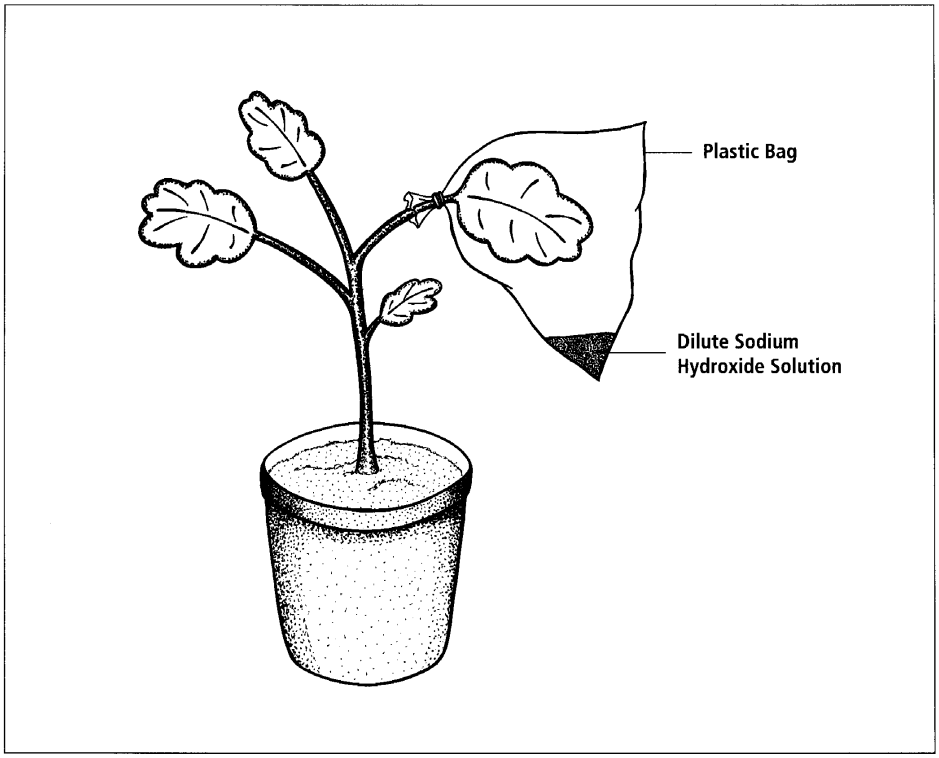


Diagram 3.7
Photosynthesis experiment one (part A).

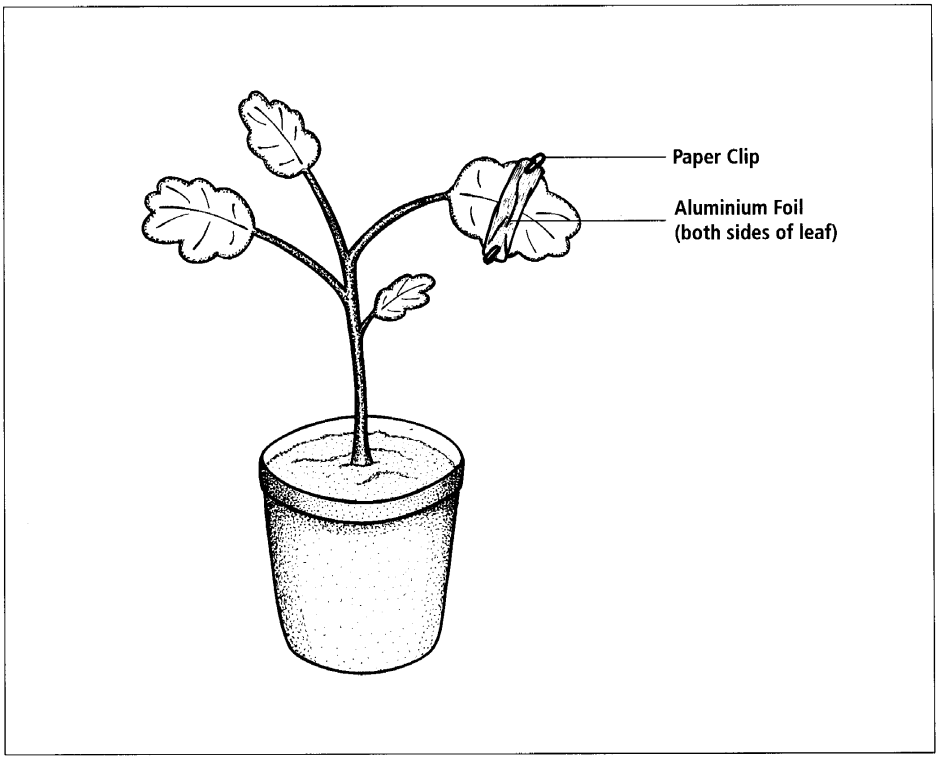


Diagram 3.8
Photosynthesis experiment two (part B).

Materials needed:
Plant with soft leaves that has been destarched by placing the plant in the dark for at least 12 hours.
Aluminium foil;
Test tubes;
Hot plate or boiling water;
Meths;
Dish;
Iodine.

Part B

Aim: To show that light is needed for photosynthesis to occur.

Method

1. Take the plant out of the dark and cover part of one of the leaves with aluminium foil. Make sure the foil covers both sides of part of the leaf.
2. Leave the plant under a light source for 24 hours.
3. Remove the aluminium foil from the leaf and then remove the leaf from the plant.
4. Carry out steps 5 to 10 from Part A to test the leaf for starch.

Materials needed:

Plant with soft variegated leaves. Variegated leaves have white or red patches as well as green. Destarch the plant by placing the plant in the dark for at least 12 hours;

Test tubes;

Hot plate or boiling water;

Meths;

Dish;

Iodine.

Part C

Aim: To show that chlorophyll is needed for photosynthesis to occur.

Method

1. Take the plant out of the dark and leave under a light source for 24 hours.
2. Remove a leaf from the plant.
3. Carry out steps 5 to 10 from Part A to test the leaf for starch.

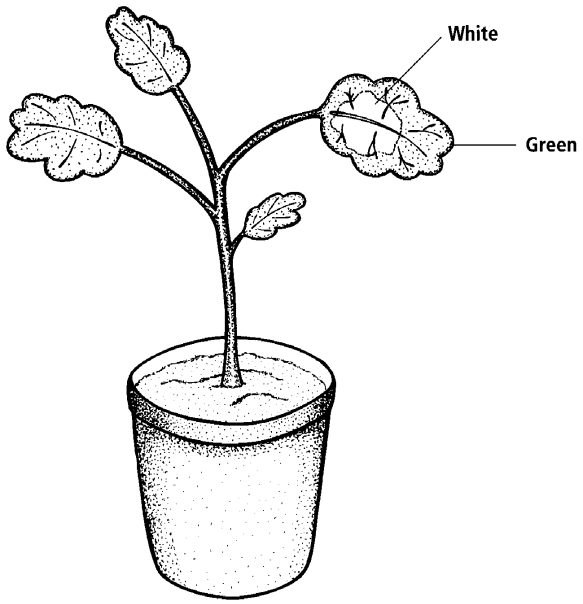


Diagram 3.9
Photosynthesis experiment three (part C).

Respiration

Respiration is the process that cells use to get energy from sugars. The energy is then used in other chemical reactions and processes. Most cells carry out aerobic respiration. This means that they need oxygen for respiration. The following word equation shows the chemical reaction for aerobic respiration.

Glucose sugar + oxygen ⟶ Carbon dioxide + water + energy

Plant cells carry out respiration during the day and the night. Plant cells with chlorophyll in them also carry out photosynthesis when light is shining on the plant during the day. Some of the carbon dioxide produced by plant cells during respiration can be used for photosynthesis and the oxygen from photosynthesis is used for respiration. Plant respiration uses the sugars produced by photosynthesis. Animals must eat either plants or other animals to get the sugars needed for respiration.

Cells sometimes use other chemicals such as proteins, fats and oils for respiration. Before these chemicals can be used for respiration they must be changed into sugars. When a protein is changed into a sugar the part of the protein containing nitrogen and hydrogen atoms is removed. This becomes a waste product that must be removed from the cell and excreted by the organism. Carbon dioxide from respiration and oxygen from photosynthesis, that are not needed by the plant or animal cells, are waste products that are released from the organism.

Activity 7 Respiration And Photosynthesis

Aim: To record information about respiration and photosynthesis. Answer the following questions and complete the exercises.

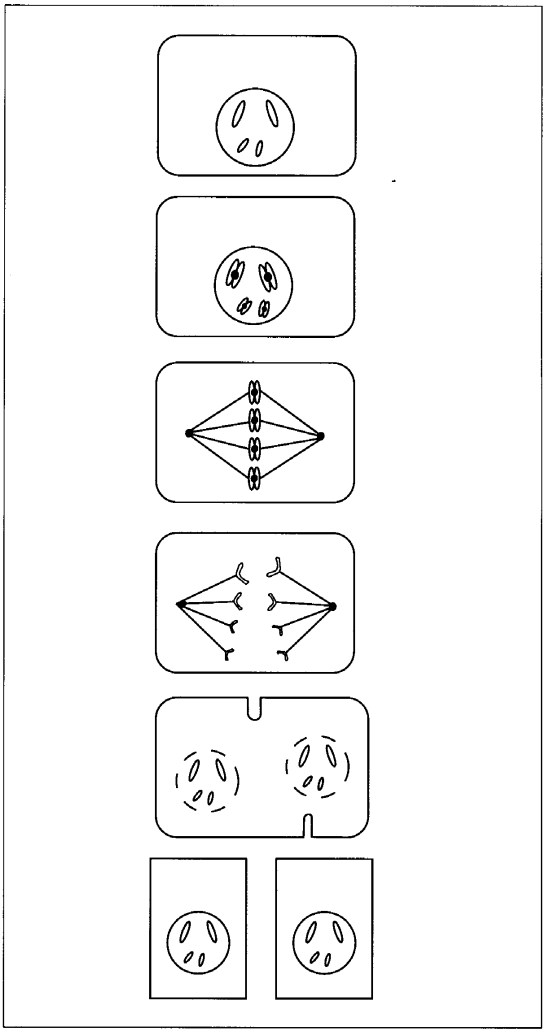
1. Why do cells carry out respiration?
2. What is aerobic respiration?

- Copy the following table. Complete it using the words respiration and photosynthesis to show which of the processes plant and animal cells are carrying out during the day and at night.

Type of cell	**Processes occurring in the cells during the day**	**Processes occurring in the cells during the night**
Animal cells		
Plant cells **with** chlorophyll		
Plant cells **without** chlorophyll		

Mitosis

Living things grow by making new cells, and to some extent, by having existing cells grow bigger. New cells are also needed to replace cells such as skin cells that get worn away, and blood cells that die fighting disease-causing micro-organisms. The type of cell division used to make more cells for growth and repair of the body is called mitosis. During mitosis one cell divides to form two cells and each cell has the same genetic material as the first cell.



This is a fully grown cell ready to divide by mitosis. It has four chromosomes.

Each of the chromosomes is copied, and the copies are held together.

The nuclear membrane disappears and the chromosomes line up across the centre of the cells. Fine threads of protein are formed. The threads are attached to each side of the chromosomes.

The protein threads get shorter and pull the copies of each chromosome to the edges of the cell.

The cytoplasm of the cell then divides and the nucleus forms again.

Two cells are formed from the one cell. Each cell has half of the cytoplasm and a complete set of chromosomes.

Diagram 3.10
Mitosis.

Activity 8 Mitosis

Aim: To record information about mitosis. Answer the following questions and complete the exercise.

1. Why do living things use mitosis?
2. During mitosis each chromosome is copied so that the two cells formed both have a copy of each chromosome. Why is it important that each of the new cells has a copy of each chromosome?

- Copy the following diagrams into your books in the correct order for mitosis — use the notes beside Diagram 3.10 to add notes to describe what is happening in each diagram.

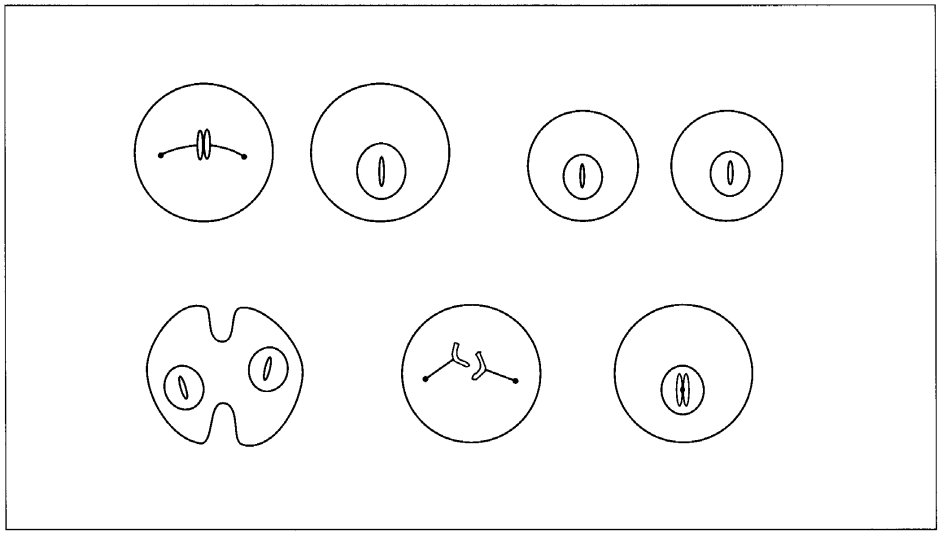


Diagram 3.11
Steps in the process of mitosis.

Activity 9 Requirements And Wastes

Aim: To summarise information about the requirements of, and wastes produced by cells.

- Copy the table below. Use the information about each process to complete the table. The first and last lines have been done for you.

Process	**Chemicals and energy needed**	**Wastes produced**
Diffusion	None	None
Osmosis		
Photosynthesis		
Respiration		
Mitosis	Energy (glucose) needed	Carbon dioxide from respiration

Unit Summary

- Diffusion is the movement of a chemical from where it is in a high concentration to where it is in a low concentration. The movement happens because particles are moving and banging into each other. Diffusion occurs quicker in hot temperatures than in cold.
- Osmosis is the movement of water through a semi-permeable membrane, from where it is in high concentration to where it is in a low concentration.
- Photosynthesis is the process plants carry out to make sugars. Carbon dioxide, water, light and chlorophyll are needed for photosynthesis. Glucose sugar and oxygen are produced. The plant uses the glucose and oxygen for respiration and stores excess glucose as starch.
- Respiration is the process that cells use to get energy from chemicals to use for their life processes. Glucose and oxygen are needed for respiration and carbon dioxide and water are produced.
- Mitosis is the process of cell division — where one cell forms two cells — with copies of the same genetic material in each. The cells are used for growth, repair and replacement of old cells.
- All cells require oxygen and glucose sugar to carry out respiration and get the energy they need to live. During respiration, the waste products carbon dioxide and water are produced. 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.

Unit 4: VARIATION

Introduction

In this unit you will learn about continuous and discrete variation in the features of living things, and the importance of variation to the survival of different types of living organisms.

Variation

If you look at the leaves from several breadfruit trees, differences in size, shape and colour can be seen. These differences are called **variation**. Some of the variation is caused by **environmental factors** such as the quality or quantity of soil the plant is growing in. If some leaves are smaller than others due to environmental factors, then it is the result of the conditions that the plant is growing in.

Sometimes the variation in a feature is caused by **genetic factors**. This means that the **alleles** of the **genes** that the organism has inherited are the cause of the differences seen. If some leaves are smaller than others due to genetic factors, then the plant has inherited alleles for smaller leaves.

It is often very difficult to tell if environmental factors or genetic factors cause the variation that is being observed. Often the variation is caused by both environmental and genetic factors working together.

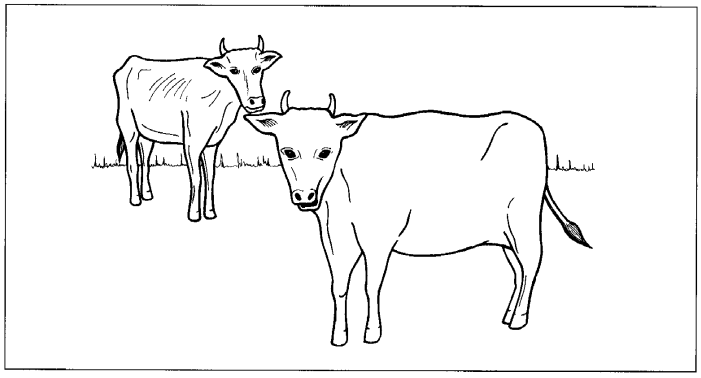


Diagram 4.1
Variation caused by the environment.

Activity 1 Variation

Aim: To record information about variation.

- Answer the following questions in your exercise book:

1. What is variation?
2. Name two factors that cause variation.
3. Explain how the variation shown in these two coconut palms of the same age can be caused by environmental and genetic factors.

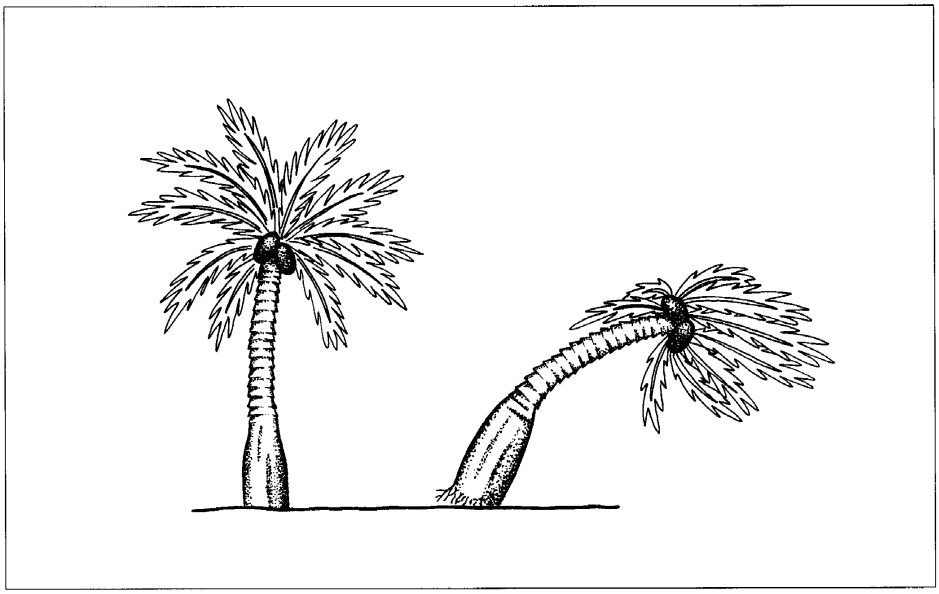


Diagram 4.2
Coconut palm variation.

Continuous variation

Some variation has a range of differences that can be measured. Variation that can be measured is called **continuous variation**. For example people have a range of heights from very short to very tall. This variation is caused by genetic and environmental factors. Continuous variation can be recorded in a **frequency table** and then shown on a graph called a frequency **histogram**.

In the frequency table on the next page the weight ranges, 0–99, 100–199, etc., are called data classes. Each of the data classes used in a frequency table must have an equal number of possible measurements. For example, there are 100 data points between 100 and 199, so each of the classes used in this table must have a range of 100 data points. The number of data

points used has to be carefully selected to show the pattern of variation in the data. If the classes are too large or too small the data gets lumped together and the pattern in the data cannot be seen. When collecting data for a frequency histogram it is important to choose classes that spread the data out to show a pattern. It is also important to collect enough data so that the pattern can be seen. At least thirty samples are recommended.

Weights of Newborn Pigs		
Weight (g)	**Tally marks**	**Frequency**
0 – 99		0
100 – 199	/	1
200 – 299	//	2
300 – 399	𝍸 ///	8
400 – 499	𝍸 𝍸	10
500 – 599	𝍸 𝍸 ///	13
600 – 699	𝍸 𝍸 /	11
700 – 799	///	3
800 – 899	/	1
900 – 999		0
Total		49

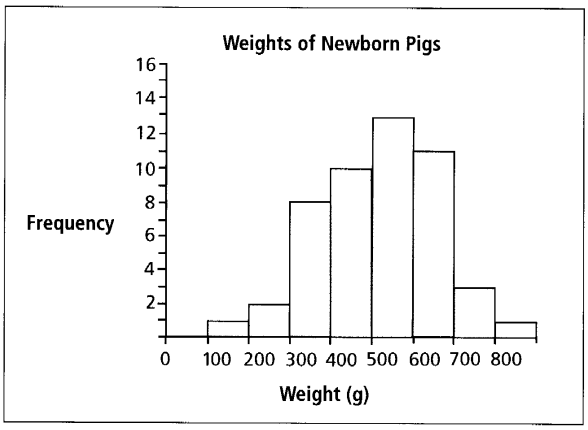


Diagram 4.3
Frequency histogram showing the information from the table above.

Activity 2 Showing The Patterns In Variation

Aim: To look at the effect that size of the data class chosen has on how well the pattern in the data is shown.

- Copy the following frequency table into your book.

Heights of Students in a Class		
Height (cm)	**Tally marks**	**Frequency**
145 – 149		
150 – 154		
155 – 159		
160 – 164		
165 – 169		
170 – 174		
175 – 179		
180 – 184		
Total		

1. Use tally marks to record the data given below into your frequency table.
2. Count up the tally marks for each data class and record the frequency.

155 cm	172 cm	175 cm
150 cm	161 cm	155 cm
167 cm	154 cm	170 cm
168 cm	162 cm	164 cm
160 cm	165 cm	175 cm
163 cm	169 cm	162 cm
176 cm	158 cm	162 cm
163 cm	182 cm	167 cm
165 cm	174 cm	149 cm
170 cm	164 cm	156 cm
168 cm	162 cm	164 cm

3. Copy the frequency charts on the next page, and complete them using the same data above. This will let you look at the effect that the size of the data class chosen has on how well the pattern in the data is shown.

4. Describe the pattern shown in each of the three frequency tables.
5. Describe which table has the best data classes to use and why.

Heights of Students in a Class		
Height (cm)	**Tally marks**	**Frequency**
148 – 150		
151 – 153		
154 – 156		
157 – 159		
160 – 162		
163 – 165		
166 – 168		
169 – 171		
172 – 174		
175 – 177		
178 – 180		
181 – 183		
Total		

Heights of Students in a Class		
Height (cm)	**Tally marks**	**Frequency**
145 – 154		
155 – 164		
165 – 174		
175 – 184		
Total		

Activity 3 Drawing Frequency Histograms

Aim: To practise graph drawing skills to show variation.

- Copy and complete the table below by totalling up the tally marks for each data class.
- Draw a frequency histogram of this data.

Left Foot Length		
Length (cm)	**Tally marks**	**Frequency**
12.0 – 14.9	/	
15.0 – 17.9	///	
18.0 – 20.9	~~////~~ /	
21.0 – 23.9	~~////~~ ~~////~~ /	
24.0 – 26.9	~~////~~ ////	
27.0 – 29.9	~~////~~	
30.0 –32.9	////	
33.0 – 35.9	/	
Total		

Activity 4 Investigating Continuous Variation

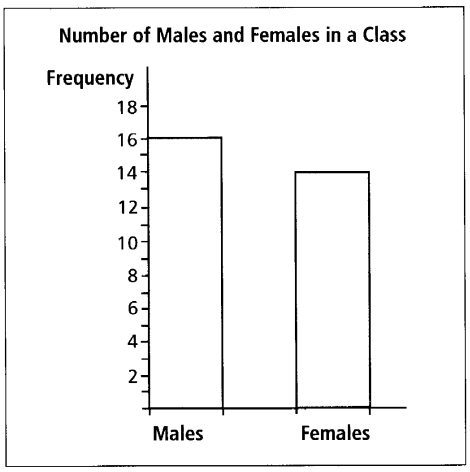
Materials needed:
Rulers.

Aim: To investigate examples of continuous variation.

1. Record the height of each person in the class on the board or a piece of paper.
2. Look at the data and then decide on the data classes that are best to use to show the pattern.
3. Use the chosen data classes and tally marks to record the class height data in a frequency table.
4. Draw a frequency histogram of the data.
5. Describe the pattern of variation shown.
6. Collect data and complete a frequency table and histogram for at least one or two of the following examples of continuous variation.
   a. Length or width of leaves on the same type of plant.
   b. Width of the palm of the hand or hand-span.
   c. Weight of yams, coconuts or any other fruit or nut.
   d. Length of the foot or length of the second toe.

Discrete variation

Some variation between the living things of the same type is a yes/no variation. This means that the organism either has the feature (yes) or doesn't have the feature (no). This type of variation is called **discrete variation**. Discrete variation can be counted, but not measured as continuous variation is. Being male or female is an example of discrete variation. Discrete variation is caused by genetic factors.



Numbers of males and females in a class:

Number of males	16
Number of females	14

Diagram 4.4
Bar graph of discrete variation.

- There are lots of different examples of discrete variation in human genetics. Which one of each of these are you?

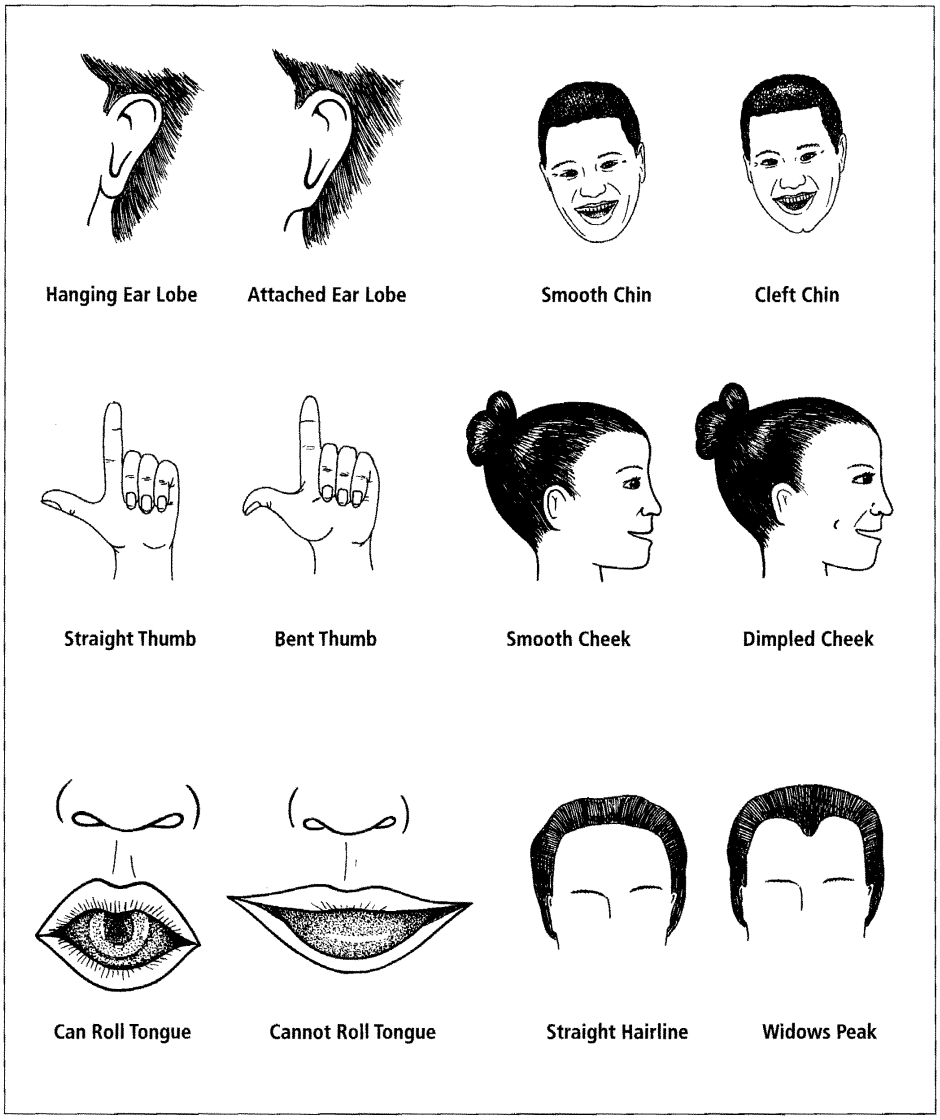


Diagram 4.5
Examples of discrete variation.

Activity 5 Investigating Discrete Variation

Aim: To investigate discrete variation in a number of examples.

1. Develop a method of recording the class information for each of the following examples of discrete variation. A tally table is one way you could record your information.
   a. Male or female
   b. Right handed or left handed
   c. Attached or hanging earlobe
   d. Smooth or cleft chin
   e. Straight or bent thumb
   f. Smooth or dimpled cheek
   g. Tongue roller or non-roller
   h. Straight or widows peak hairline
2. Record the class data in your book.
3. Draw bar graphs for at least three of the examples of discrete variation.
4. Write a discussion of the class results in which you comment on the patterns of inheritance. For example, world wide the number of males and females is equal. The number of people that are right handed is usually about 98%.
5. Explain how continuous variation and discrete variation are different.

Importance of variation

Genetic variation is important in groups of plants and animals. Genetic variation occurs because of mixing of genetic material during sexual reproduction. This means that offspring produced during sexual reproduction have a different genetic make up from their parents. This variation gives each organism slightly different adaptations to the environment. Some adaptations are better than others. This is an advantage to the group of organisms as it increases the chances of survival of the group. If the conditions in the environment change then there is the possibility that some of the group of organisms are better adapted to grow in the new conditions. The advantage that variation gives a group of organisms is so good that individual organisms expend a lot of time and energy to carry out sexual reproduction.

Unit Summary

- Variation refers to the differences in living organisms caused by their environmental or genetic factors. Genetic variation is gained 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. Foot length is an example of continuous variation. Information on continuous variation can be recorded in frequency tables and presented in frequency histograms.
- When using frequency tables and histograms it is important to choose the data classes used carefully. 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. Having a straight thumb or a bent thumb is an example of discrete variation. Information about discrete variation can be recorded in frequency tables and presented in bar graphs.

Unit 5: PATHOGENS

Introduction

In this unit, you will learn about the effects pathogens have on living things, and the methods people use to overcome these effects. You will also learn how people try to control the spread of pathogenic diseases.

Pathogens

Diseases that one can get from another person are called **infectious** diseases. These diseases are caused by organisms called **pathogens**. The bacteria, fungi and viruses you learnt about in Year 9 are common pathogens. Pathogens are **parasites**. This means that they grow, reproduce and feed on, or in, the cells of living things. When they do this they cause damage to the cells and cause the symptoms of disease. The cell or organism that the pathogen is living on is called a **host**. The host can be a plant, an animal, fungus or bacterium.

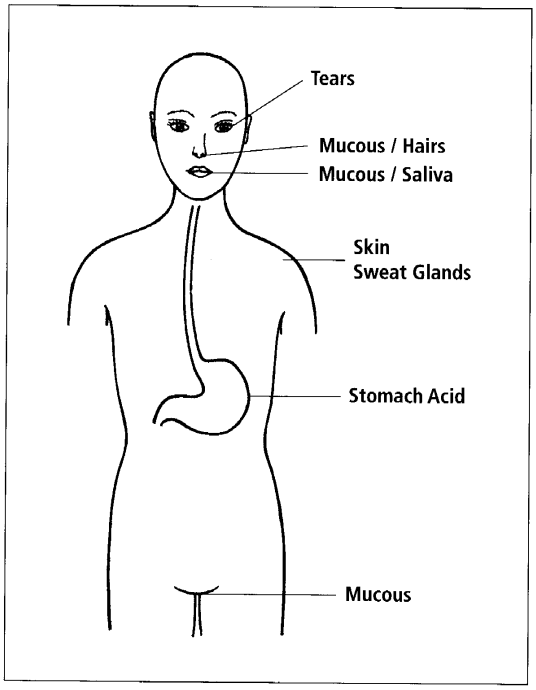


Diagram 5.1
Ways to stop pathogens from entering the body.

Defences against pathogens

Our bodies have a number of ways to stop pathogens from entering, and causing damage to our cells. The skin acts as a barrier to stop pathogens, and each of the openings in the body has fluid that is antibacterial — such as the tears in our eyes, and the mucous in our nose. The hairs in the nose also trap dust and bacteria to stop them from getting into our lungs. Acid in the stomach kills most bacteria and fungi that are in our food. The hepatitis-A virus can survive in stomach acid and get into the body through the digestive system, however. Cuts and scratches cause breaks in the skin that could allow bacteria and other pathogens to enter the body.

Chemicals released from cells damaged by a cut cause an **inflammatory response**. The first step in the inflammatory response is the increase of blood flow to the affected area. Blood brings white blood cells, which go from the capillary into the damaged skin. Chemicals in the blood, and the white blood cells, cause the area to swell and look red. This shows that the body is reacting to pathogens.

White blood cells act as **phagocytes**. They move around the pathogens and eat them. They also clean up the damaged cells around the area that was cut. Some of the white blood cells die. The dead white blood cells form yellow pus around the cut.

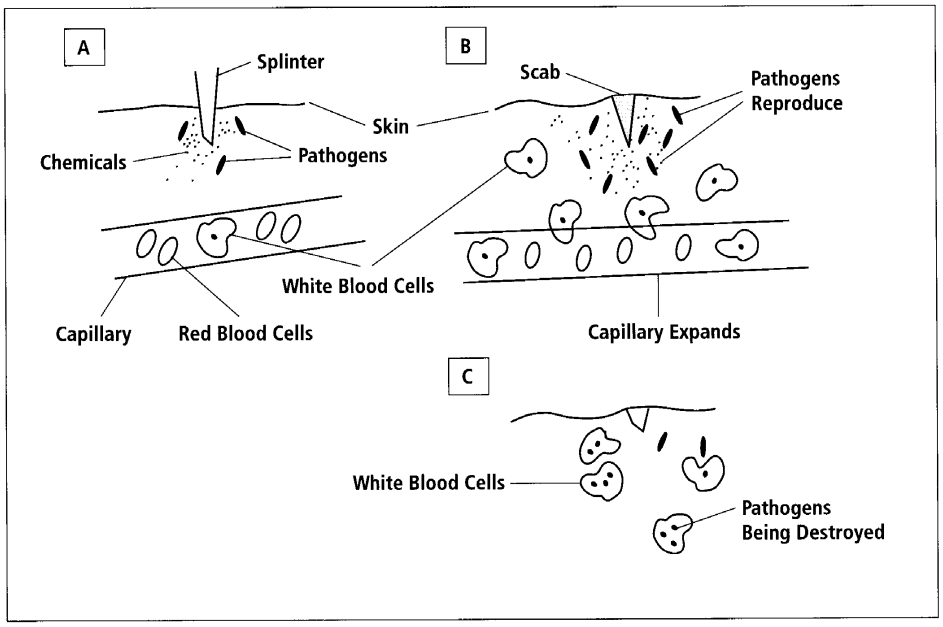


Diagram 5.2
The inflammatory response.

If pathogens get past the skin and the white blood cells then another defence system starts to react. Special types of white blood cells produce proteins called **antibodies**. Antibodies join onto the outside of a pathogen and kill it by bursting its cell wall, stopping it from reproducing, or making it easier for the white blood cells to deal with it. Each different type of pathogen fought requires a different antibody. After the body has made specific antibodies it is able to remember the pathogen. The next time the body becomes infected by the same pathogen it is able to make antibodies against it very quickly. This is called **natural immunity**.

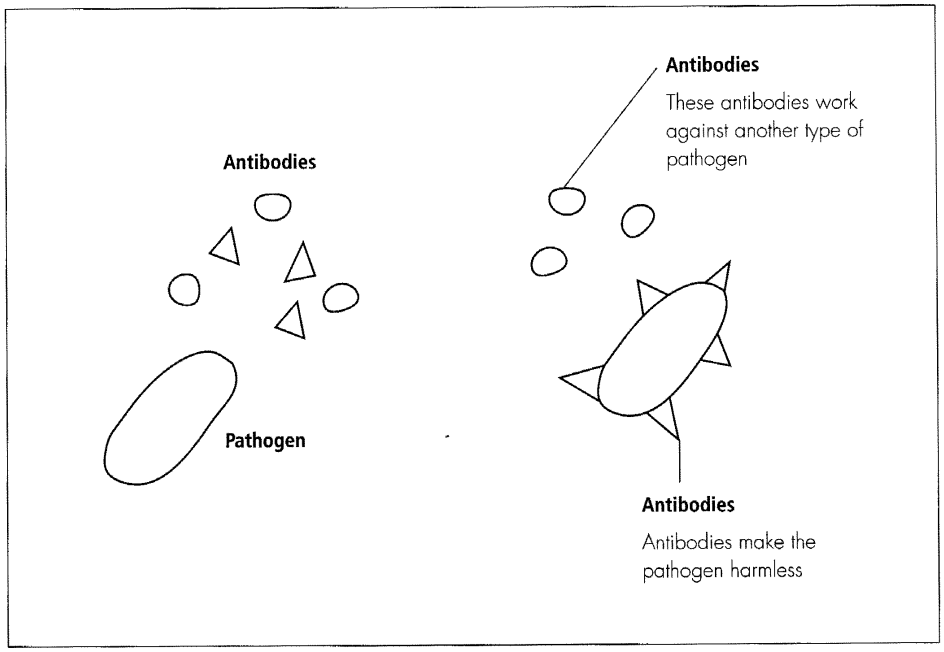


Diagram 5.3
Antibodies working against a pathogen.

People can receive **artificial immunity**. Some injections given by doctors can have ready-made antibodies. These are used when people are already sick. The antibodies work quickly against the infection. This is called **passive immunity**. The body doesn't learn how to make these antibodies the next time it gets the same infection.

Vaccinations and immunisations are injections of dead or weakened forms of the pathogen. The body of the person given the injection makes antibodies against the pathogen. This is called **active immunity**, because the body has to do the work of recognising the pathogen and making the antibodies. The next time the pathogen enters the body it is recognised, and the body starts to make antibodies against it very quickly. Effective vaccinations have been made against infections of polio, rubella, measles and mumps, which are all caused by viruses.

Activity 1 Defences Against Pathogens

Aim: To record information about the body's defence against pathogens.

- Complete the following questions and exercises.

1. How do we get an infectious disease?
2. What is a pathogen?
3. Why are some organisms called hosts?
4. Skin and bodily fluids are often called the body's first line of defence against pathogens. Explain how the skin and bodily fluids stop pathogens from getting into the body.
5. Draw diagrams to show what happens in an inflammatory response to a pathogen in an area that has been scratched.
6. How do antibodies help stop pathogens that get inside our bodies?
7. What is the difference between passive immunity and active immunity?
8. What is the advantage of active immunity?

Effects of pathogens

When a pathogen gets into our lungs or digestive system there is a short time when there are no symptoms of the disease. During this time the pathogens are reproducing, increasing their numbers. While reproducing, the pathogens are beginning to cause damage to the cells of the body. The symptoms of the disease only start to appear when sufficient damage has occurred.

Some pathogens release waste products, called **toxins**, which are poisonous. Toxins cause the white blood cells to release substances that make the body temperature increase. This is called a **fever**. As the body temperature rises, you start to shiver and feel cold, because the body is trying to raise its temperature further. This is called a **chill**. The high body temperature slows the reproduction rate and toxin production of the pathogen. Once toxin levels drop again the body goes back to its normal temperature. The body sweats heavily to lose the extra heat.

The graphs below show the changes in temperature, pulse rate and number of antibodies produced in response to an infection by pathogens. Each graph shows how the responses relate to the number of pathogens.

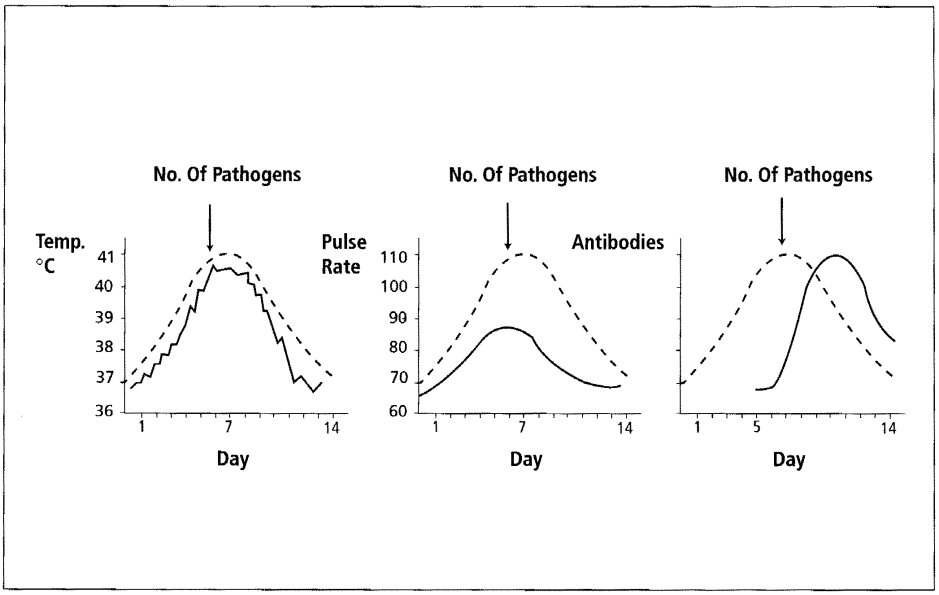


Diagram 5.4
The effects of pathogens on body temperature, pulse rate and antibody production.

The above graphs show that during the first day there are no symptoms of the infection. Day 2 shows the symptoms of the infection appearing. A fever develops and the pulse rate increases. By Day 5 antibody production begins. By Day 7 the fever and antibodies are beginning to control the number of pathogens. Days 8 to 14 show the recovery time — when the number of pathogens keeps getting less and the temperature and pulse rate return to normal.

HIV and AIDS

The human immunodeficiency virus, HIV, is a virus that is causing concern world-wide due to the way it affects the body, and the way it is transferred from one person to another. HIV is transferred by direct transfer of infected cells and this is possible when any blood or body secretions are passed from one person to another. The two main methods of transfer between people are through sexual intercourse and the sharing of needles for intravenous drug use. The transfer of HIV during sex is much less likely if a condom is used.

HIV may pass from mother to child during pregnancy, or in milk when the baby is breast-fed. Blood transfusions used to be a common source of infection, but equipment and procedures have now reduced this method of transfer. The blood-bin rules in international and some local rugby games have been developed as the result of knowledge about the transfer of HIV and hepatitis.

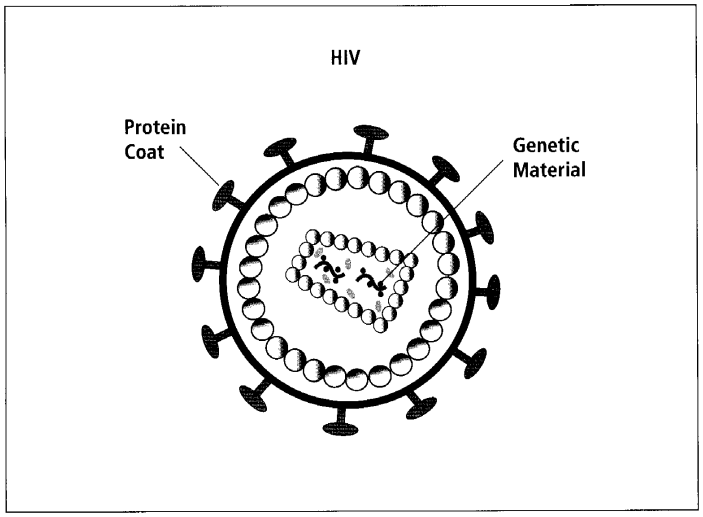


Diagram 5.5
HIV.

HIV attacks the T-cells of the human immune system and reproduces inside them. The virus also damages the lymph nodes, which are areas that produce cells for the immune system and remove damaged cells and pathogens from the blood. AIDS occurs after a time when HIV has damaged the immune system so much that it can no longer stop infections and cancers that would not normally be a problem for the immune system to overcome.

Activity 2 Effects Of Pathogens

Aim: To record information about the effects of pathogens on the body.

1. Combine the three graphs of the effects of pathogens on to one graph. Add a title for the graph.
2. Add the information about the progress of the infection from the paragraph below Diagram 5.4 onto the graph.

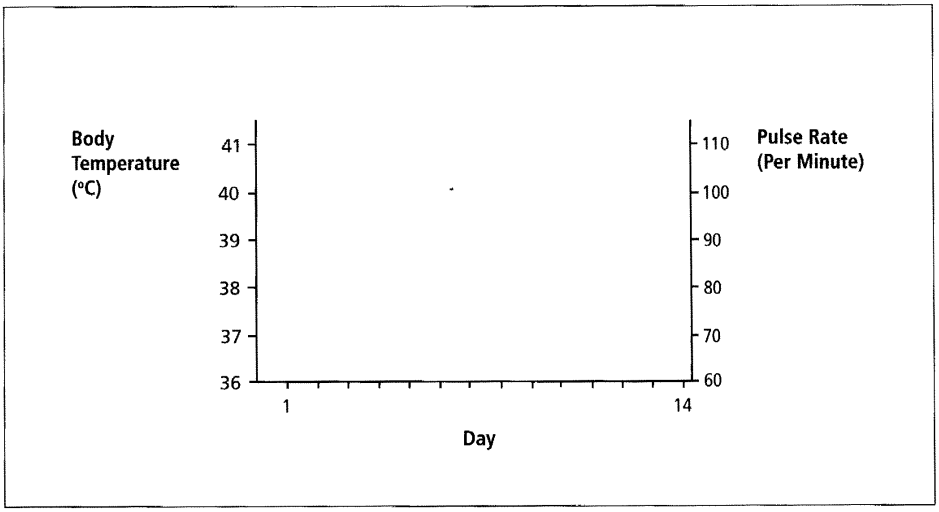


Diagram 5.6
Combination graph.

3. Describe how HIV is transferred from one person to another.
4. Explain why HIV is such a deadly virus.

Medicines

Medicines, such as antibiotics, are chemicals that are used to help the body fight infection. Medicines should only be used when the immune system of the person is not able to stop the infection. Most medicines work by killing the pathogens or stopping them from reproducing.

One of the first antibiotics used was penicillin. Penicillin is made using the Penicillium mould, and used to stop 98% of bacteria from growing. Many more antibiotics have been discovered or developed. Each one is effective against a different range of bacteria. Antibiotics are able to kill the bacteria inside the human body without seriously harming the affected person. A few people have side-effects, and a small number of people can't take antibiotics because they have allergic reactions to them.

In recent years many antibiotics have been used too much. This has produced bacteria that are **resistant** to antibiotics. This means the antibiotic is no longer able to kill the bacteria or stop them from reproducing. Using antibiotics too much can also upset the balance of micro-organisms that normally live inside the human body. Some of these can be pathogenic and they increase in numbers when antibiotics kill other micro-organisms, causing problems for the person. The over use of antibiotics allows the fungus Candida, which causes an infection called thrush, to cause problems.

Antibiotics only work against bacteria and fungi. Once a person has an infection caused by a virus there is no medicine to help them.

People also use painkillers to help with the symptoms of infections. Morphine is a very strong painkiller used by medical staff in hospitals. Aspirin and paracetamol, commonly available painkillers, are often used to control pain from things such as headaches and sore throats.

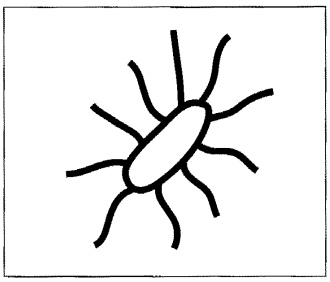
Activity 3 Medicines

Aim: To carry out research about a type of medicine.

1. Choose a common type of medicine. What type of medicine is it?
2. Carry out a survey to find out if people use it, how often they use it and why they use it.
3. Find out about your chosen medicine from a book, or person such as a doctor, nurse, or chemist. Information can also be found on a medicine container.
4. Describe the problems caused by overuse of antibiotics.

Food poisoning

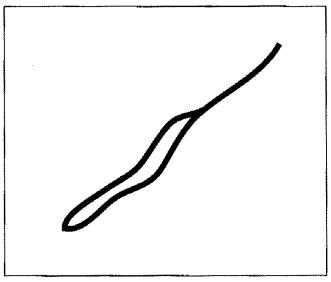
Food poisoning is the term used to describe a range of infections of the digestive system. Pathogens cause infection by producing toxins in food, which poison people when it is eaten, and by infecting the body after being taken in with the food.



Salmonella

Caught from raw eggs and undercooked chicken. The bacteria invade the cells lining the intestine and produce a toxin.

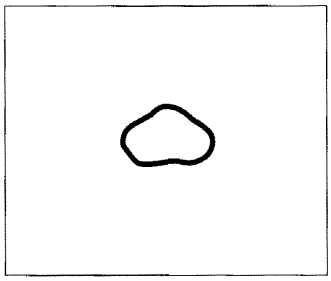
Symptoms begin 24 to 48 hours after ingesting infected food. Symptoms include: fever, diarrhoea, vomiting, dehydration and pain. Symptoms can last several days and can lead to blood poisoning.



Clostridium botulinum

Caught from a variety of sources, including canned fish and yoghurt.

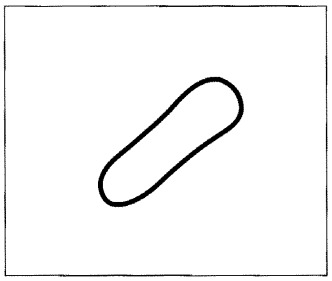
Symptoms can begin after two hours. Symptoms include: vomiting, diarrhoea and muscle paralysis. Infected people can die from failure of the respiratory system.



Staphylococcus aureus

Caught from contaminated dairy products, cooked meats and chicken. Very common.

Symptoms begin after one to six hours. Symptoms include: diarrhoea, vomiting and pain.



Campylobacter

Most common cause of an upset stomach. Caught from undercooked meats, untreated water and milk.

Symptoms begin after one to eleven days. Symptoms include: fever, headache, dizziness, diarrhoea and pain.

Preventing food poisoning

The chance of getting food poisoning can be reduced by using safe food practices. These include:

1. Preventing bacteria getting in food.
   - Always washing hands and cleaning your nails before handling food.
   - Cleaning kitchen equipment with hot, soapy water.
   - Keeping animals, flies and other pests out of the food preparation area.
2. Destroying harmful bacteria in the food.
   - Thoroughly cooking the food, especially meat and meat products.
   - Re-heating food for long enough.
3. Preventing bacteria already on the food from reproducing.
   - All micro-organisms need food, water and warmth to live and reproduce. Some also require oxygen. Bacteria in food that is warm can quickly build up their numbers to levels, which could cause infection. Don't leave food uncovered or at room temperature for a few hours.
4. Store food safely.
   - Store cooked and uncooked meats away from each other.
   - Keep the fridge at less than 4°C.
   - Use food before the 'best before date'.

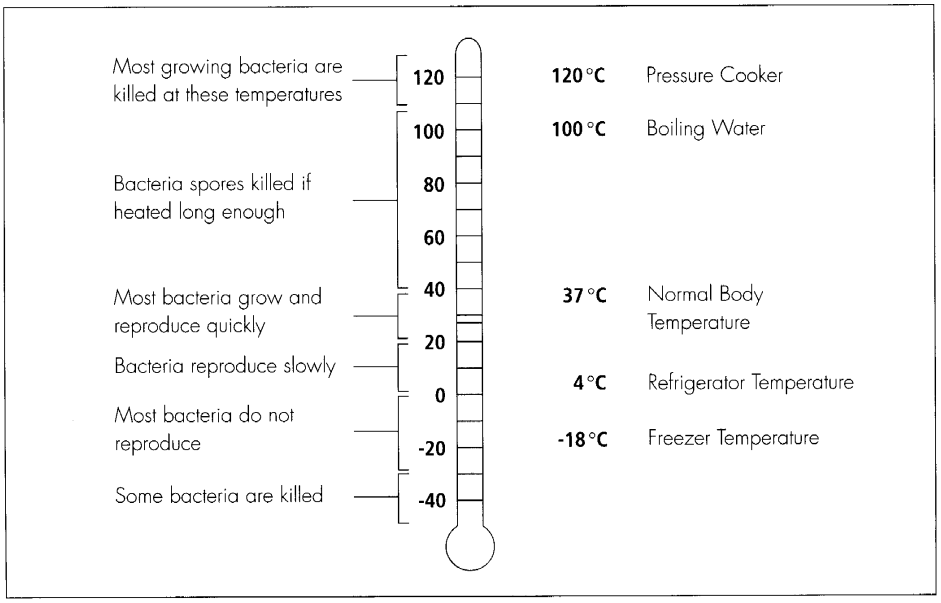


Diagram 5.7
Bacterial activity at different temperatures.

Preserving food

People use a number of ways to stop bacteria from spoiling food.

Method	How It Works	Foods Used On
Pickling	Soaking in acids such as vinegar — stops bacteria from reproducing.	Fruit and vegetables.
Curing	Salt is put on the food, drawing the water from the food and any bacteria on it.	Meat and fish.
Smoking	The food is covered in chemicals that stop bacteria from growing.	Meat, fish and cheese.
Chemical preservatives	Chemicals such as sulfur dioxide stop bacteria from growing.	Soft drinks, fruit juices and sausages.
Irradiation	Radiation kills bacteria.	Fruit and grain.
Vaccum packing	Removing air from around food means that bacteria cannot respire. It also stops some bacteria from feeding.	Poultry, meats and fish.
Cooking/chilling	Heat kills bacteria and chilling stops them from reproducing.	Prepared meals and stored food.

Activity 4 Food Poisoning

Aim: To record information about food poisoning.

1. List the names of the four pathogens involved in food poisoning and give examples of the food that they are likely to be found in.
2. List some of the symptoms of food poisoning.
3. Explain why older people and very young people are often affected more severely by food poisoning.
4. Copy Diagram 5.7 into your book.
5. Record the four ways the chances of food poisoning can be reduced.
6. Think about the times when you are involved in food preparation, handling and storage. What things could you do to reduce the risk of food poisoning?
7. Complete the mind map below, to show how each method of preserving stops bacteria from growing or reproducing on the food.

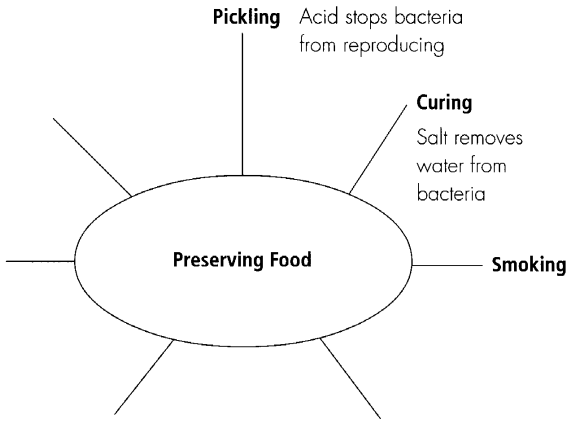


Diagram 5.8
Mind map.

Unit Summary

- Infectious diseases are caused by pathogens that can be transferred from one person to another. The pathogen then grows and feeds on the host or reproduces in host cells.
- The skin and fluids such as tears, stomach acid and mucous are the body's first defense against pathogens.
- If the pathogens get into the body the second defense is the white blood cells that are phagocytes. Phagocytes feed on the pathogens and the cells they have damaged. The inflammatory response is a series of steps that the body uses to help fight pathogens.
- The third line of defense against pathogens is the making of antibodies. This happens about five days after the pathogen has entered the body. Antibodies are proteins that join onto the outside of the pathogen and burst it, stop it from reproducing or make it easier for the white blood cell to eat.
- The production of antibodies against a pathogen is called natural immunity. Passive artificial immunity is given by injecting antibodies into the person. Active artificial immunity is produced by injecting a healthy person 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 a disease that the normal healthy immune system could stop.
- The pathogens that cause food poisoning harm their host by infecting the digestive system and producing toxins.
- Food poisoning can be reduced by careful handling, cooking and storage of foods. Foods can be preserved by a number of ways that stop the bacteria from growing and reproducing in the food.

Unit 6: DIGESTIVE SYSTEM

Introduction

In this unit, you will learn about the parts of the digestive system and how they work together to process the food you eat. You will also carry out research to find out about the diseases and malfunctions that affect an organ system.

Parts of the digestive system

The **digestive system** forms a long tube that goes from the mouth to the anus. Each part of the digestive system has a job to do as the food moves through the body. The digestive system carries out the four processes of **ingestion**, **digestion**, **absorption** and **egestion**.

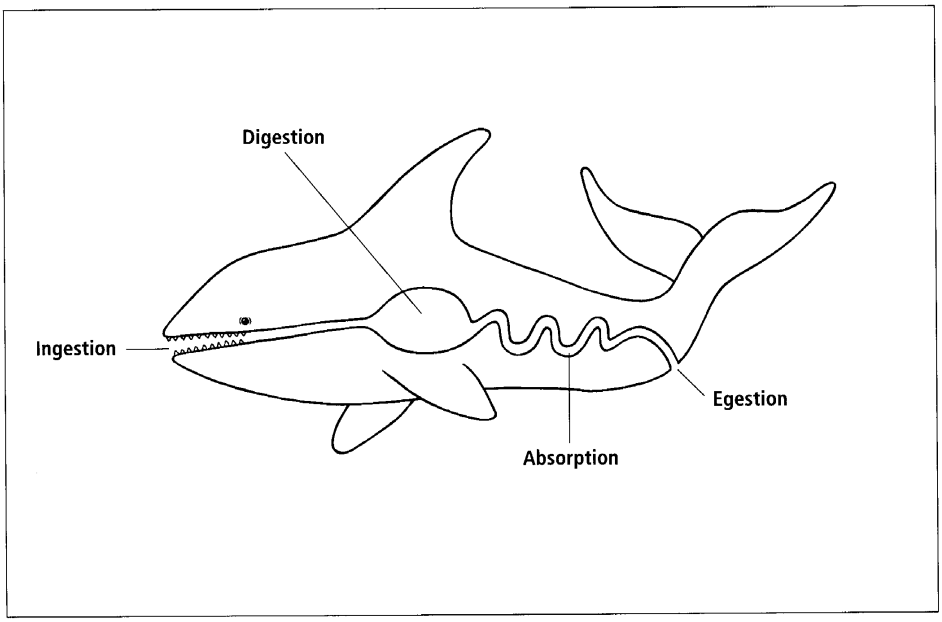


Diagram 6.1
Stages in digestion.

Ingestion

Ingestion is the stage when food is taken into the body. The incisor teeth at the front of the mouth cut the food so the pieces are small enough to go into the mouth. Some animals, such as cattle and butterflies, use their tongues to ingest food. The **oesophagus** carries the food to the stomach.

Digestion

Digestion is the stage when food is broken down. The food we eat is often made up of pieces that are too large for our bodies to use. The first step in digestion is to physically make pieces of food smaller. This is called **physical digestion**. The mouth is the part of the digestive system that ingests food and starts physical digestion. The molar teeth are used to grind food into smaller pieces. After food has been swallowed the **stomach** carries on physical digestion by churning and mixing the food with an acid solution, so it becomes a thick liquid.

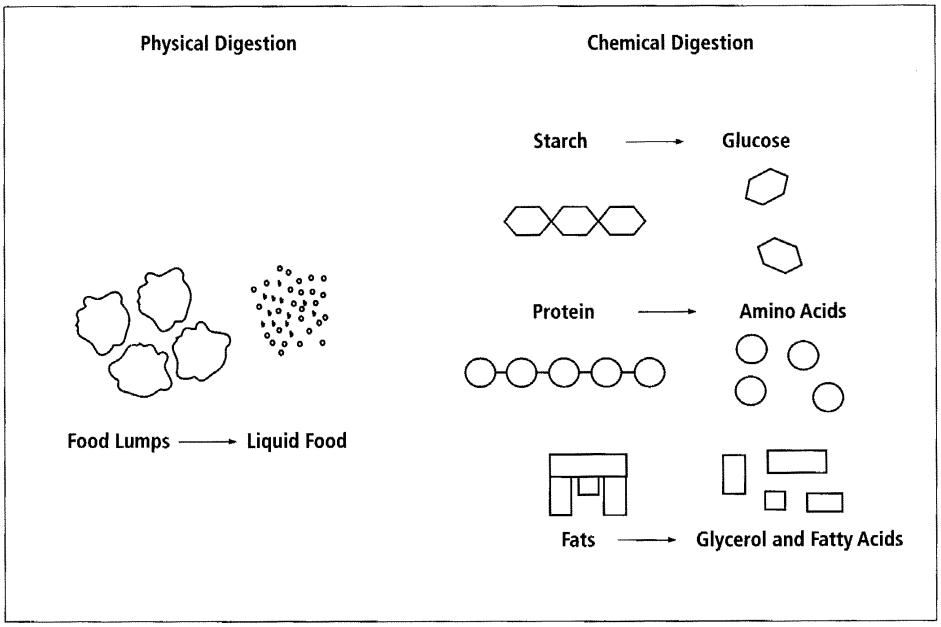


Diagram 6.2
Physical and chemical digestion.

Once the pieces of food are made smaller **chemical digestion** can begin. During chemical digestion large chemicals in food are broken into smaller chemicals so that they are small enough to be absorbed into the blood. Chemical digestion starts in the mouth when a liquid called **saliva** is mixed with food as it is chewed. Saliva is made in the **salivary glands**. Chemicals in saliva, called **enzymes**, break large chemicals into smaller ones. Enzymes are chemicals that help living things carry out chemical reactions such as digestion. Enzymes break starch into glucose and proteins into amino acids.

Chemical digestion also occurs in the stomach and **small intestine** as more enzymes are added to the food. Enzymes used in the **duodenum**, part of the small intestine, are made in the duodenum, **liver** and **pancreas**. The different organs of the digestive system add enzymes that digest different chemicals in food.

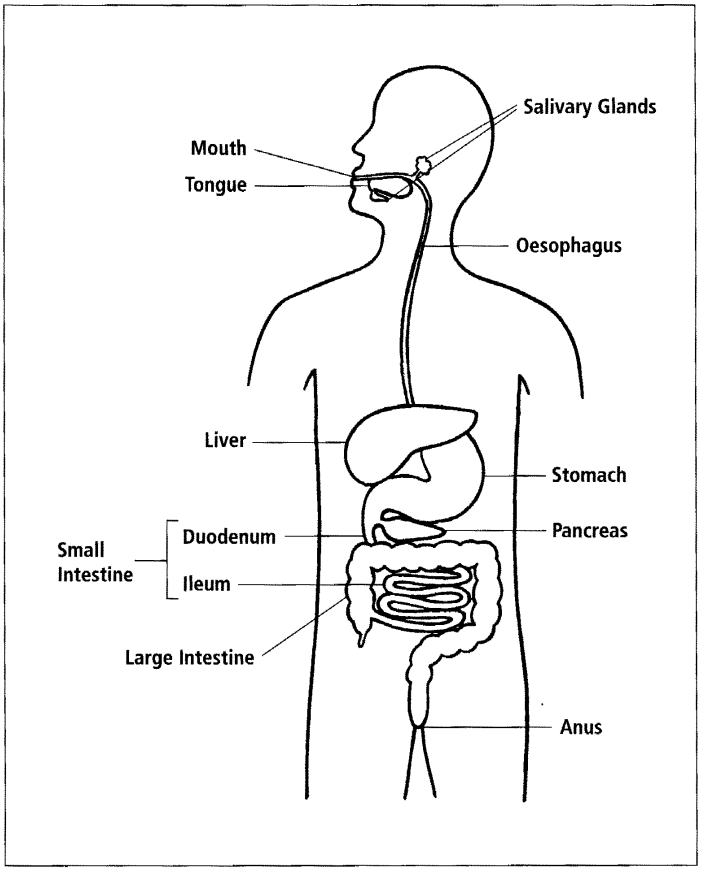


Diagram 6.3
Human digestive system.

- The following table shows the main food chemical digested by each organ.

Organ	Main enzyme	Main food chemical digested by organ
Mouth	Amylase	Starch
Stomach	Pepsin	Protein
Small intestine	Amylase and lipase	Carbohydrates and fats

Absorption

During absorption small digested food chemicals, called **nutrients**, are taken from the digestive system and transported into the blood (nutrients include glucose, amino acids, and fatty acids). Absorption happens in the **ileum** of the small intestine. The inside layer of the ileum wall is folded to form **villi**. Villi create a large surface area for the absorption of nutrients. Water is the main chemical absorbed by the **large intestine**.

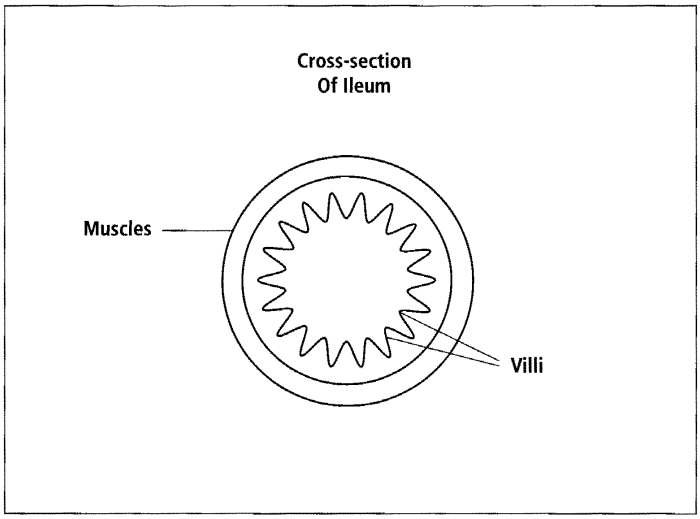


Diagram 6.4
Ileum wall.

Egestion

Egestion is the act of getting rid of undigested waste material through the **anus**. Fibre in plant material is not able to be digested but forms an important part of our diet as it helps to keep the digestive system working correctly. It is egested once it has passed through the digestive system.

Activity 1 The Digestive System

Aim: To record information about the parts of the digestive system.

- Ingestion, digestion, absorption and egestion are processes carried out by the digestive system. Describe what happens during each process.
- Explain the difference between physical and chemical digestion.
- Copy and complete the following table using the information on pages 68–70.

Organ	**Description of the shape and location of the organ**	**Function of the organ in the digestive system**
Mouth		
Salivary gland		
Stomach		
Liver		
Pancreas		
Duodenum		
Ileum		
Large intestine		
Anus		

Digestive systems of animals

The digestive systems of animals are very similar. Plant material has a lot of fibre and is very difficult to digest, so plant eating animals often have parts of their digestive system that are full of mirco-organisms which help digest the plant material for the animal. Mice and rats have a large **caecum** that holds micro-organisms. Cattle are called **ruminants** because they have a four-chambered stomach that holds the micro-organisms that help them digest plant material.

Birds need to be light in weight to fly, so they have some differences in their digestive system. Birds have no teeth. The food is swallowed whole and stored in a **crop** at the base of the neck. The food is then passed to the stomach where enzymes are added. It then goes into a **gizzard**, which has thick muscle walls. In the gizzard the food is ground up. Fine stones the bird has swallowed also help to grind the food in the gizzard. The food then goes to the small intestine where it is digested, and the nutrients are absorbed. The **caeca** at the start of the large intestine help with digestion of plant material. Water and some nutrients are absorbed by the large intestine.

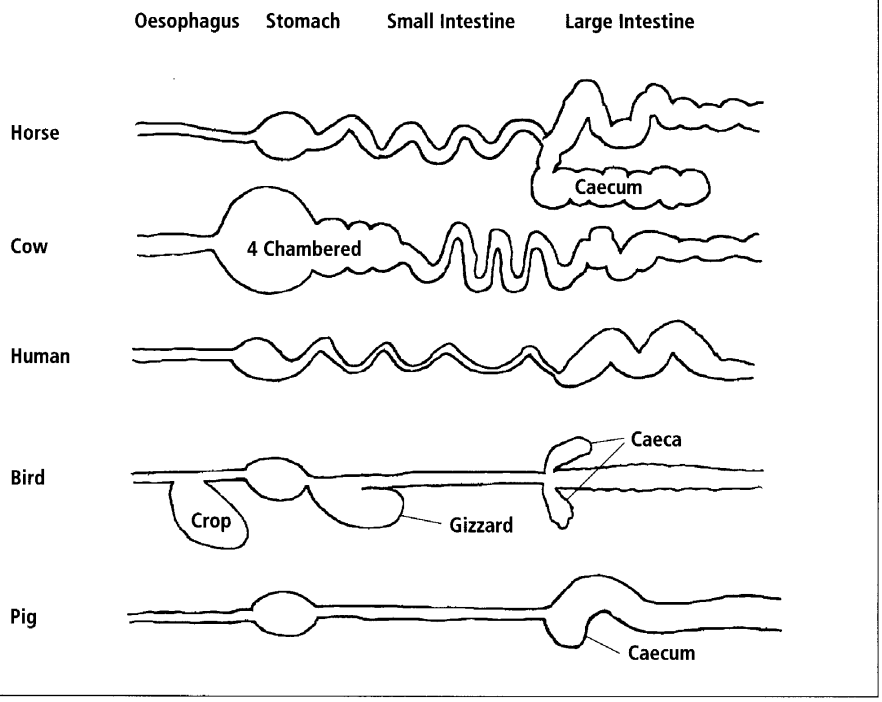


Diagram 6.5
Digestive systems of animals.

Activity 2

Animal Digestive Systems

Materials needed:
A gut of a bird, fish, pig, or cattle, or diagrams of an animal's digestive system.

Aim: To investigate the structure of the digestive system in different organisms.

- Compare the digestive systems of animals with the human digestive system. Comment on the similarities and differences.
- If you have a gut from an animal try to identify all the parts and then measure the length and width of the organs. Record this information and sketch the organs in your book.

Diseases and malfunctions of organ systems

Sometimes things go wrong with the functioning of an organ system. The problem may be a disease caused by a mirco-organism. If the problem is caused by something going wrong with the way the organ works then it is called a malfunction. Diseases and malfunctions have different effects on the health of people. The effect on the health of a person depends upon which organ is affected and how the functionality of the organ is changed.

Disease or malfunction	Description	Symptoms
Tooth decay	Bacteria on the teeth change sugars into acid, which dissolves the covering on the teeth.	Pain.
Ulcers	Stomach acids digest the lining of the digestive system.	Pain, blood in the faeces.
Hepatitis	Inflammation of the liver — as a result of viral or bacterial infection. Aggravated by alcohol.	Nausea, diarrhoea, pain, fever, chills and jaundice.
Staphylococcal food poisoning	When food is cooked at low temperatures, or left in warm conditions for too long, bacteria in the food can produce large amounts of toxins. Reheating the food kills the bacteria, but the toxins remain.	Nausea, vomiting one to six hours after eating contaminated food.
Salmonellosis	Bacteria are ingested in contaminated food — usually meat, chicken, or milk. The bacteria grow in the digestive system. Symptoms can take up to 48 hours to appear.	Nausea, fever, abdominal pain and diarrhoea.
Typhoid fever	Caused by a type of Salmonella bacteria. The bacteria can move from the digestive system to other organs.	Severe fever, headaches and diarrhoea.
Cholera	Bacteria infect the small intestine. They cause the loss of nutrients and water.	Diarrhoea — leading to dehydration and/or death.
Hookworms	Hookworms attach to the intestine wall and feed on the wall and on blood.	Anaemia and lack of energy.

Effects of disease or malfunction on the person

Any disease that affects the digestive system causes a reduction of the intake of nutrients the body needs for everyday life. This is likely to cause a lack of energy to carry out everyday activities, and the affected person may become dehydrated from a lack of water.

Activity 3

Diseases And Malfunctions

Materials needed:
Books, people and other resources that have information on diseases and malfunctions that affect organ systems.
Page 89 has information on diseases or malfunctions of the skeleto-muscular system.

Aim: To research the diseases and malfunctions that affect one of the body's organ systems.

- Select an organ system from the list below:

circulatory system	digestive system
reproductive system	skeleto-muscular system
respiratory system	excretory system
nervous and endocrine system	

- Carry out research from a wide range of sources to answer the following questions.

1. What is the function of the organ system you have chosen?
2. What are the key organs in the organ system?
3. What are the most common diseases or malfunctions that affect the organ system?
4. Which of these diseases or malfunctions are common in Sāmoa?

- Choose *two* of the common diseases or malfunctions from your research, then answer the questions that follow.

5. What causes each disease or malfunction?
6. What happens in the organ system during each disease or malfunction?
7. What are the effects on the life of the person with each disease or malfunction?

Unit Summary

- The digestive system ingests, then digests food. The small digested food nutrients are then absorbed into the blood stream and the undigested waste material is egested. Each part of the digestive system carries out one or more of the processes of ingestion, digestion, absorption and egestion.
- Physical digestion is the breaking down of lumps of food until it becomes a liquid. Physical digestion occurs in the mouth and stomach.
- Chemical digestion is the breaking down of the large chemicals in foods into smaller ones that can be absorbed as nutrients into the blood. Enzymes are needed to carry out chemical digestion. The mouth, stomach, small intestine, liver and pancreas produce different enzymes to digest different foods.
- Different species of animals have slightly different digestive systems depending on the type of food they eat and how they use micro-organisms to digest the fibre in plant material.
- The digestive systems in birds has some special features related to their way of life. For example, the lack of teeth gives them a lower weight which helps with flight.
- A number of diseases and malfunctions cause the digestive system to not function correctly. When the digestive system is not working properly the body does not get the nutrients it needs and the affected person will lack the energy needed to carry out everyday activities.

Unit 7: SKELETO-MUSCULAR SYSTEM

Introduction

In this unit you will learn about the parts of the skeleto-muscular system and how they work together to provide support for the body and allow us to move from place to place.

Skeletons

The skeleto-muscular system is made up of the **skeleton** as well as **muscles**, **tendons** and **ligaments**. Some animals have their skeletons on the inside of their bodies. This is called an **endoskeleton**. Birds, fish, turtles, frogs and mammals are groups of animals with an endoskeleton.

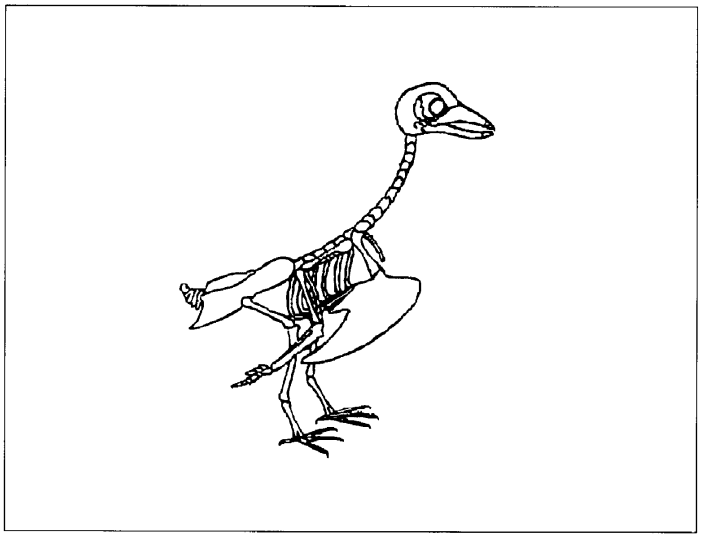


Diagram 7.1
Skeleton of a bird.

Some animals have their skeleton on the outside of their bodies. This is called an **exoskeleton**. All the muscles are on the inside of the exoskeleton. Insects, crabs and animals such as vaga and ula sami have exoskeletons.

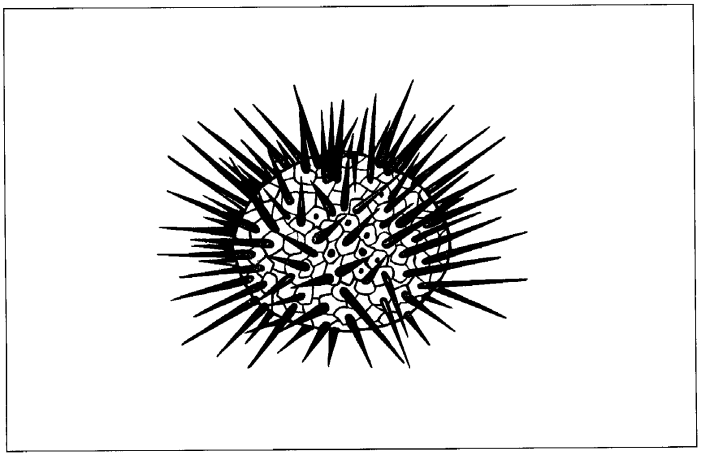


Diagram 7.2
Exoskeleton of satula showing the protective spines.

Functions of the skeleton
The skeletons of animals have many functions.

- The skeleton gives the body shape and support. For example the skull shapes the face of a person. The skeleton gives support by providing a solid structure for muscles, tendons and ligaments to attach to.
- The muscles attach to the skeleton and work with the skeleton to allow the animal to move.

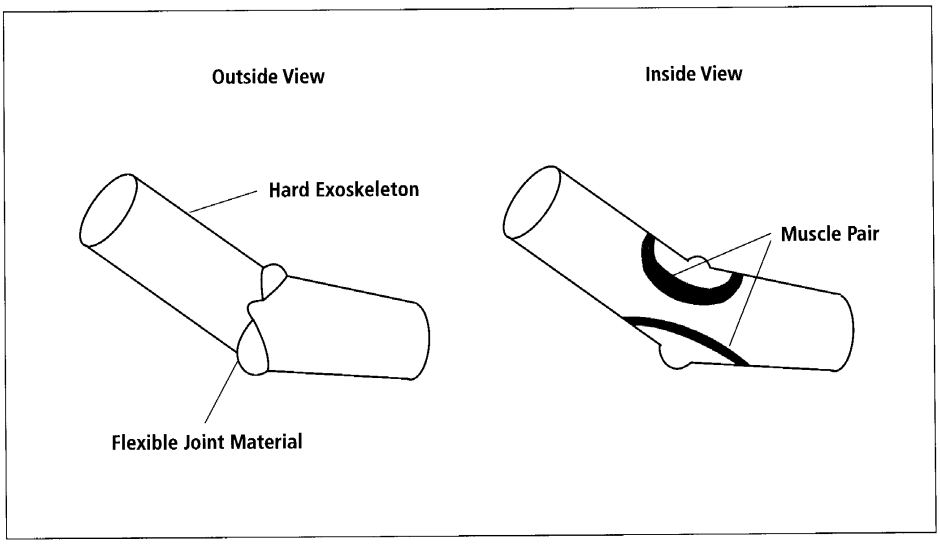


Diagram 7.3
Structure of a crab leg.

- The skeleton protects the organs. Animals with an exoskeleton often have spines on it to protect themselves. Our ribs protect our heart and lungs.
- Some of the large bones in animals have bone marrow inside them. Bone marrow makes red blood cells and some types of white blood cells.
- Bones act as a store of calcium and phosphorous minerals. If the body is short of calcium, some of it can be taken out of the bones and used by the body tissues.
- Many animals, such as humans, have three very small bones in their ears that allow them to hear sounds. These bones are called the hammer, anvil and stirrup.

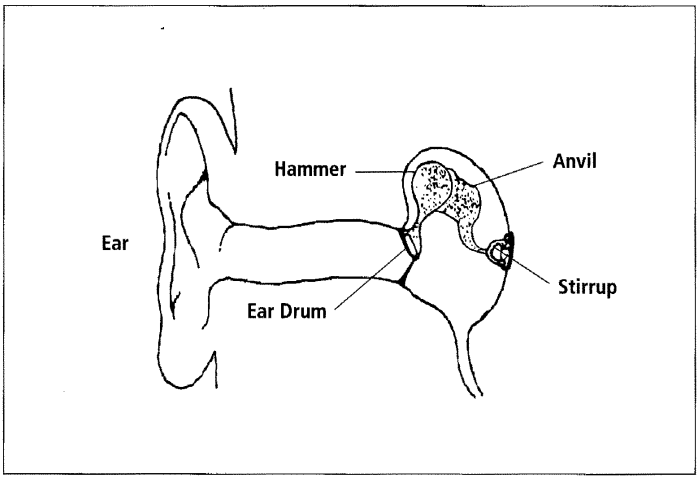


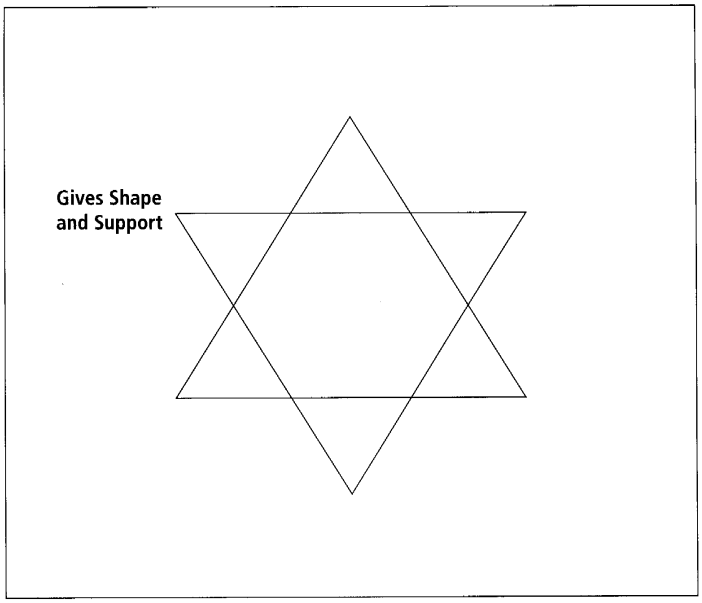
Diagram 7.4
Bones inside the ear.

Activity 1 Skeletons

Aim: To record information about skeletons.

- Complete the following questions in your exercise book.

1. Explain the difference between an endoskeleton and an exoskeleton.
2. Name five animals with an endoskeleton.
3. Name five animals with an exoskeleton.
4. Draw a six-pointed star in your book. Use the information on the previous pages to write one function of the skeleton beside each point of the star. The first one has been done for you.



Human skeleton

The human skeleton is made up of 206 bones of different shapes and sizes. Humans have an endoskeleton. The skeleton is made up of four main parts. These are the vertebral column, rib cage, skull and limbs.

Activity 2 Human Skeleton

Aim: To record information about the human skeleton.

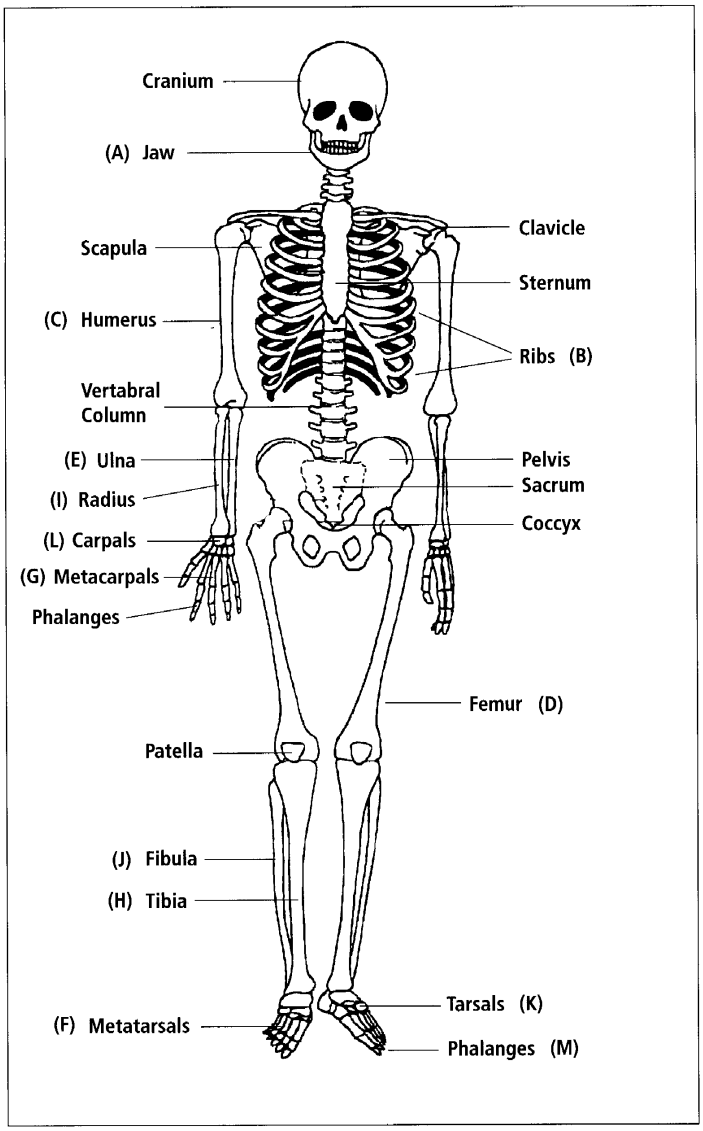


Diagram 7.5
Bones in the human skeleton.

1. Draw or trace the diagram of the human skeleton into your book.
2. Copy and complete this table.

Bones of the skeleton	
Name of bone	**Part of the skeleton the bone is in (arm, hand, foot, ribcage, etc.)**
A.	
B.	
C.	
D.	
E.	
F.	
G.	
H.	
I.	
J.	
K.	
L.	
M.	

3. Count how many ribs in a human skeleton and record this information in your book.
4. Should teeth be classed as part of the skeleton? Give reasons for your answer.
5. Humans have the same bones in their skeleton as other mammals do but the size and shape of the bones makes some of the bones look different. Write the letters A to F in your book. Then use the labels on the human skeleton to name the bones labelled A to F on the skeleton of a cow (next page).

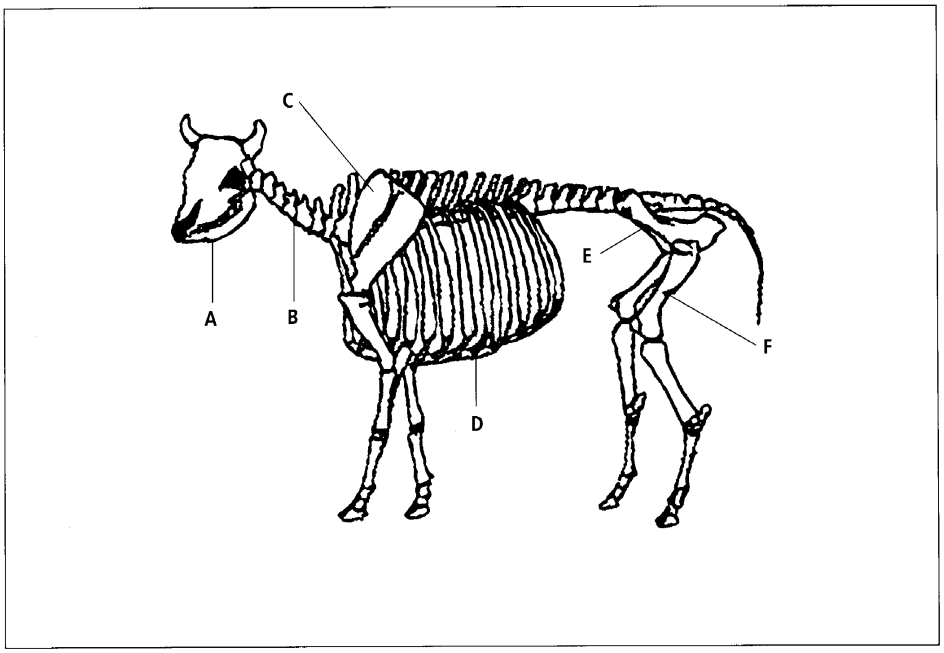


Diagram 7.6
Skeleton of a cow.

Bones and tendons

Bones are made up of bone cells growing between protein fibres and crystals of calcium phosphate. Bones also have arteries, veins and capillaries inside them. These are needed to keep the bone cells alive. The main bones in the arms and legs are not solid bone as they have **bone marrow** inside them. This makes them light but still strong enough so that they don't get damaged when the muscles pull on them. Muscles are joined onto bones by tough flexible tendons.

Activity 3

Bones

Materials needed:
A dried out femur or humerus bone from an animal such as a pig or cow;
Hacksaw.

Aim: To investigate the structure of bones.

1. Collect a dried out femur or humerus bone. If this is not available then a fresh bone can be used.
2. Use a hacksaw to carefully cut the bone in half longways.
3. Draw a diagram of the shape and structure of the inside of the bone. Compare the inside of the bone with the diagram below.

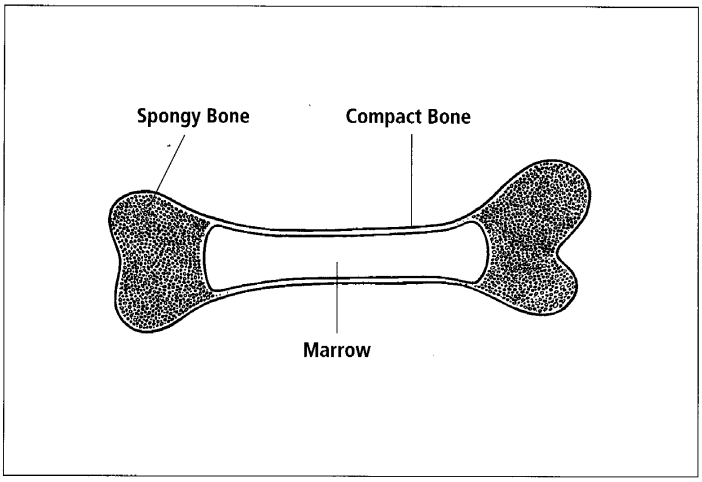


Diagram 7.7
Inside structure of a bone.

Activity 4

Tendons

Aim: To find out about the structure of the Achilles tendon.

The largest tendon in your body is the Achilles tendon at the back of your heel.

- Feel how the tendon joins your calf muscle on the back of your leg to your heel.
- Try to find other tendons in your legs and arms.

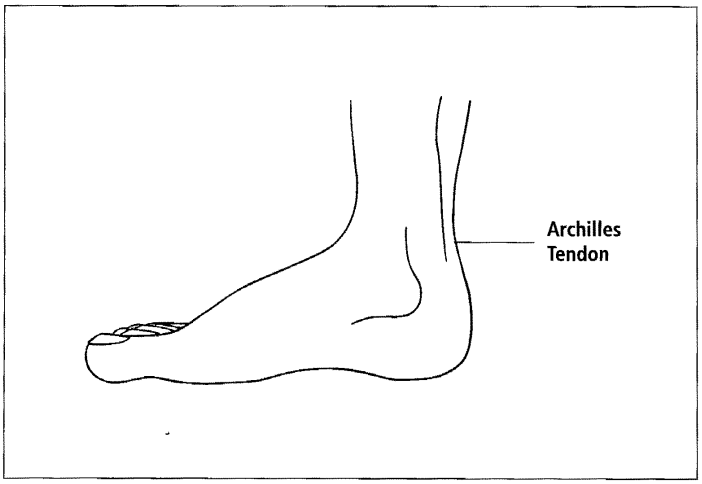
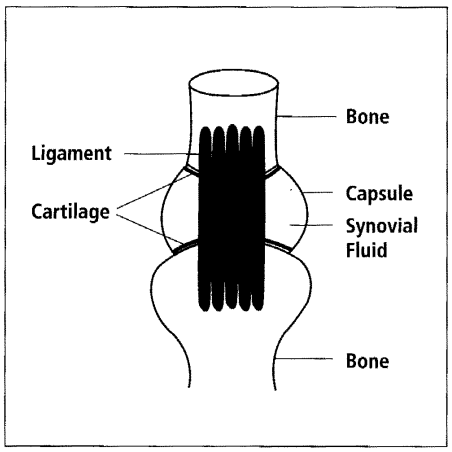


Diagram 7.8
Achilles tendon.



Joints

A **joint** is formed where two bones meet. Some joints, such as the ones between the bones in the skull, are **fixed joints**. This means that the bones cannot move. Most joints are movable joints. The bones in moveable joints are held together by strong **ligaments**. The ends of the bones are covered with **cartilage**. Cartilage is a smooth covering that allows bones to move over each other easily. The whole joint is covered by a **capsule** that holds a lubricating **synovial fluid** around the joint. Muscles that are joined onto the bones on either side of the joint are able to make the joint move.

Diagram 7.9
A joint.

There are different types of joints. The two main types are:

1. **Hinge joints**, such as the knee, elbow and finger joints. A hinge joint lets the bones move up and down.
2. **Ball and socket joints**, such as the hip and shoulder joints. This type of joint lets the bones move in many directions.

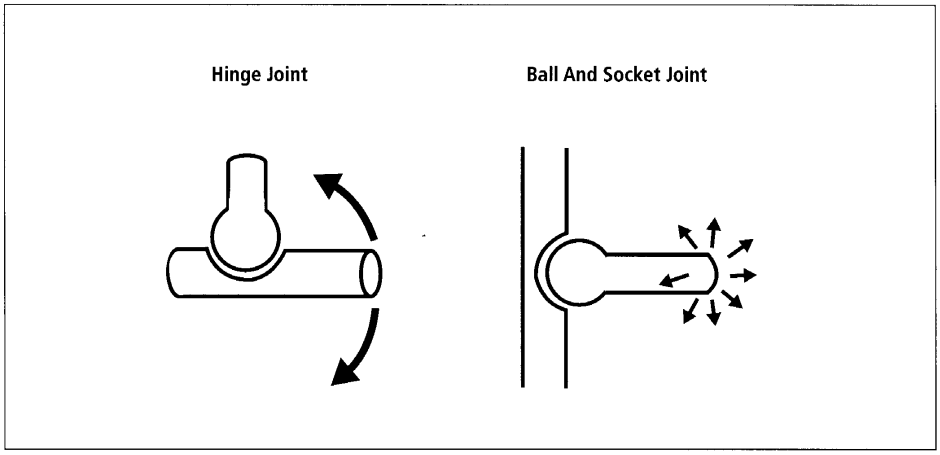


Diagram 7.10
Two main types of joints.

Muscles

Muscles are made up of fibres. The fibres have proteins inside them. Muscles work by **contracting** and **relaxing**. When a muscle contracts the proteins in the muscle fibres slide over one another closer and the muscle gets shorter and thicker. When a muscle contracts it pulls on the bones that it is attached to. When a muscle relaxes it goes back to its original size. Nerves bring messages from the brain to tell the muscle when to contract.

Muscles often work in pairs — called **antagonistic pairs**, because when one of the pair is contracted the other is relaxed. The triceps and biceps in the top of your arm are an antagonistic pair of muscles. At the shoulder end, the biceps are attached to the **scapula** and the triceps are attached to both the scapula and the **humerus**. At the other end the biceps attach to the **radius** and the triceps attach to the **ulna** at the back of the elbow.

When the biceps muscle contracts, the triceps muscle is relaxed and the arm moves up. When the triceps muscle contracts, the biceps relaxes and the arm is lowered.

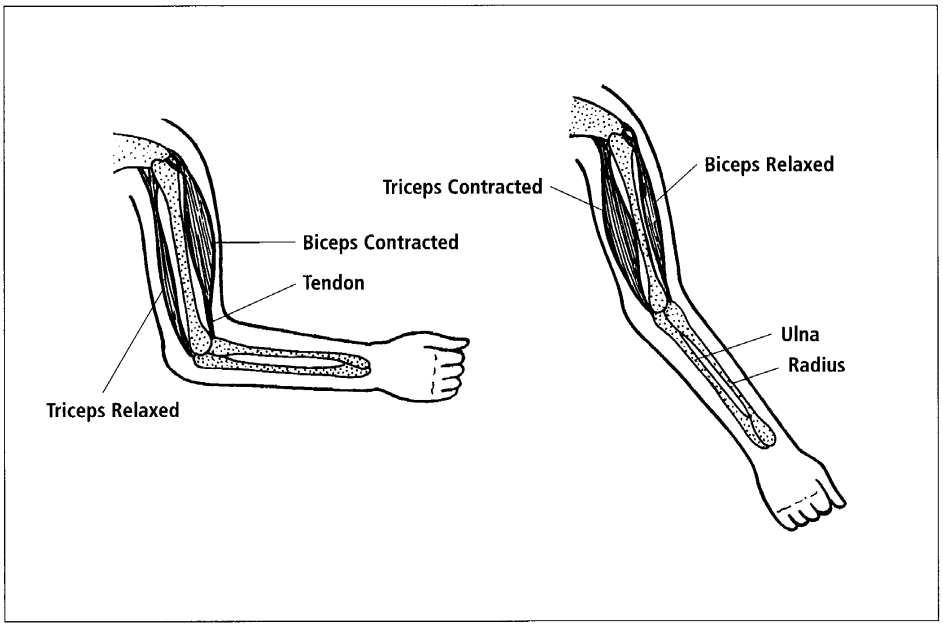


Diagram 7.11
Antagonistic muscles in the arm.

Activity 5 Muscles

Aim: To investigate the way muscles work.

1. Stand or sit beside a table or desk.
2. Place one hand under the edge of the table or desk and gently pull up against it. At the same time feel the muscles in the top of your arm. Which muscle is contracted and which is relaxed? Record your results on a table like this.

Activity	Biceps Muscle	Triceps Muscle
When pulling up		
When pushing down		

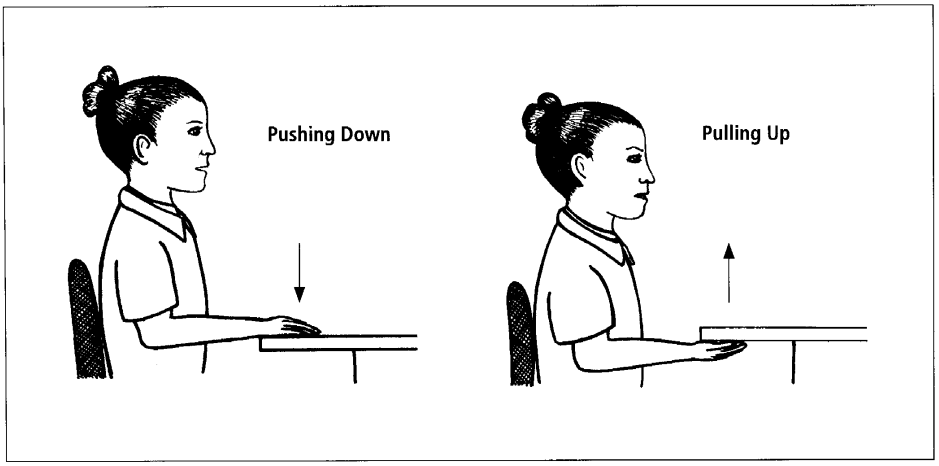


Diagram 7.12
Pulling up and pushing down on a desk or table.

3. Now place your hand on top of the table or desk and push down. Again feel your biceps and triceps and record your results.
4. What type of joint is the elbow joint? Record your thoughts in your book.
5. Draw diagrams and write notes to explain how the triceps and biceps work together to move the arm.

Muscles and energy

During activities such as exercise, muscles need energy to be able to contract. To start, the energy comes from a carbohydrate called **glycogen**, which is stored in the muscles and used in aerobic respiration. After all the available glycogen is used up glucose and oxygen are transported to the muscle cells via the blood.

If exercise continues for a long time the blood will not be able to supply oxygen quickly enough. The muscle then has to start using **anaerobic respiration** to continue contracting. During anaerobic respiration a chemical called **lactic acid** is formed. Lactic acid builds up in the muscle and causes muscle fatigue. As **muscle fatigue** gets worse the affected person will feel pain and cramps, and finally the muscle will stop contracting until the blood removes some of the lactic acid. Most of the lactic acid is eventually taken to the liver, where it is changed into glycogen.

Activity 6 Muscle Fatigue Investigation

Materials needed:
Depends on the investigation design each student wants to use. Some may need a clock or watch.

Aim: To find out about muscle fatigue in your hands.

- Plan and carry out an investigation into muscle fatigue in the muscles in the hands. Hand clasps, where the hands are repeatedly opened and closed, could be used in the investigation. You could test one of the following questions:
  1. How long before I get muscle fatigue and can not do any more hand clasps?
  2. How many hand clasps can I do in a minute? Does this change as muscle fatigue occurs?
  3. Are right handed people able to do more clasps each minute with their right hand?
  4. Are left handed people able to do clasps for longer with their left hand?
  5. How long after muscle fatigue can I start doing hand clasps again? How many or how long can I go before having to stop again?
  6. Can I do hand clasps for longer if I do them slowly?
  7. Can some people do hand clasps for longer than others?
- Use tables and graphs to present the data from the investigation.
- Use your results to write a conclusion about the effect of muscle fatigue on the number of hand clasps you can do.
- Use the information above on muscle fatigue to explain what is happening in the muscles to give the results you got in your investigation.

Diseases and malfunctions of the skeleto-muscular system

Disease or Malfunction	Information about Disease or Malfunction	Symptoms
Fractures	Broken bones. Bone cells are able to make more bone to fix the break.	Pain. In serious breaks the bone can pierce the skin.
Sprains	Twisting a joint badly can tear the tendons, ligaments or muscles that surround it. In serious sprains the ligaments can tear completely off the bone, and muscles and tendons can be ripped in half.	Pain. With serious injuries the affected area cannot be used.
Slipped disc	This happens when one of the discs of cartilage between the vertebrae in the spine splits. The cartilage pushes on the nerves. Keeping a straight back when lifting heavy objects can help prevent this type of injury.	Very painful back.
Inflamed joints	Injury or overuse of a joint can cause it to make too much synovial fluid. Tennis elbow and water on the knee are two common forms of inflamed joints.	Painful, swollen joints.
Arthritis	Osteo-arthritis occurs in older people. It happens when the cartilage in joints has worn away, and they no longer move smoothly. Rheumatoid arthritis is genetic, and can happen at any age. Bone-like material grows inside the joint and can join bones together.	Painful, swollen joints. Sometimes the joints no longer move.
Rheumatism or lumbago	This is an ache in the muscles that occurs mainly in older people. It is worse in cold, damp conditions.	Painful muscles.

Unit Summary

- Bones, muscles, tendons and ligaments make up the skeleto-muscular system.
- Some animals have an exoskeleton on the outside of their bodies and some have an endoskeleton on the inside of their bodies.
- The functions of the skeleton are to give shape, support and protection. Muscles join on to the skeleton in ways that allow us to move. Bones make blood cells and store calcium and phosphorus. Bones inside ears allow animals to hear sounds.
- The four main parts of the human skeleton are vertebral column, rib cage, skull and limbs. These parts are made up of bones of different sizes and shapes.
- 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. Ligaments link the bones together and cartilage makes the ends of the bones 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.
- Muscles are made up of fibres with proteins inside them. These proteins are able to make the muscle contract or relax. 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.
- Muscles need energy to contract. This comes first from aerobic respiration, but if exercise continues and there is not enough oxygen available the muscles use anaerobic respiration. Lactic acid is a waste product of this respiration. The amount of lactic acid in the muscle builds up and causes muscle fatigue.

YEAR 10 GLOSSARY

Word/Phrase	Meaning
Absorption	The process where small digested food chemicals from inside the digestive system are taken into the blood.
Active immunity	Immunity in which the body makes its own antibodies.
Adaptations	Differences between organisms that provide the best chance of survival for groups in varying environments.
Aerobic respiration	Respiration that uses oxygen.
Anaerobic respiration	Respiration that occurs without oxygen.
Antagonistic pairs	A pair of muscles that cause movement. When one muscle is contracted, the other is relaxed.
Anther	Where pollen is produced in the flower.
Anus	The part of the digestive system through which waste material is egested.
Artificial immunity	Immunity gained by injection.
Asexual reproduction	Reproduction using parts from only one organism.
Ball and socket joints	Joints that let bones move in all directions.
Bone marrow	The material inside bones that makes red blood cells and some types of white blood cells.
Caeca, Caecum	Found at the start of the large intestine. Micro-organisms in it help with the digestion of plant material.
Capsule	Holds the synovial fluid around the joint.
Cartilage	Tough, smooth material on the ends of bones that allow them to slide over each other. Also forms rings in the trachea to hold it open.
Chemical digestion	The process of breaking down large chemicals in food into smaller chemicals.
Chill	Shivering caused by the body to increase its temperature during a fever.
Continuous variation	A variation, such as heights of people, that can be measured.
Contracting	When the ends of a muscle pull towards each other and the muscle becomes thicker and shorter.
Cotyledon	The food store in a seed, used by the embryo plant.
Crop	Part of the digestive system at the base of the neck of a bird. It stores food.
Cross-pollination	When pollen from one flower goes to another flower of the same type of plant.
Data classes	The range of data in a frequency table.

YEAR 10 GLOSSARY

Word/Phrase	Meaning
Diffusion	Evenly spreading through another substance.
Digestion	The breaking down of food.
Discrete variation	Variation, such as being male or female, that is counted data.
Dispersal	The spreading of seeds away from the parent plant.
Dormant	When life processes have slowed down and a living thing stops growing.
Duodenum	First part of the small intestine.
Egestion	Getting rid of undigested wastes.
Embryo (plant)	Plant in a seed before it germinates.
Endoskeleton	A skeleton on the inside of a body.
Environmental factors	Conditions in the environment, such as soil conditions or availability of food, that affect the growth and survival of plants and animals. Cause of some of the variations between members of the same species.
Enzymes	Chemicals that break large chemicals into smaller chemicals.
Exoskeleton	A skeleton on the outside of a body.
Fertilisation	The joining of the male and female gametes.
Fever	Increase in body temperature.
Fixed joints	Joints that do not allow the bones to move, such as the joints in the skull.
Frequency histogram	The type of graph continuous variation is recorded on.
Frequency table	Where continuous variation is often recorded.
Gametes	Male and/or female sex cells.
Genetic factors	The alleles of the genes that the organism has inherited. These account for variations not caused by environmental factors.
Germinate	When the small plant embryo inside a seed begins to grow.
Gizzard	Part of the digestive system of a bird that grinds up food.
Glycogen	A carbohydrate stored in the muscles that is used to supply energy.
Hinge joints	Joints that only let the bones move up and down such as the elbow and knee.
Host	The cell or organism a pathogen is living on.
Ileum	The part of the small intestine where absorption takes place.
Infectious disease	Disease that a person can get from another person.
Inflammatory response	The series of steps the body uses to help fight pathogens.
Ingestion	Taking food into the digestive system.

YEAR 10 GLOSSARY

Word/Phrase	Meaning
Joint	Where two bones meet.
Lactic acid	The acid produced from anaerobic respiration in the muscles.
Large intestine	Last large part of the digestive system. Water is absorbed into the blood by this tube.
Ligaments	The material that holds together the bones in movable joints.
Liver	A large organ that produces enzymes used in the duodenum.
Medicines	A group of chemicals used to help the body fight infections.
Mitosis	The type of cell division used to make more cells for growth and repair of the body.
Mouth	The organ food is put into when it is ingested.
Movable joints	Bones linked together that are able to be moved.
Muscle fatigue	When muscles become tired and eventually stop working due to a build-up of lactic acid.
Natural immunity	Immunity that comes from having a disease and producing antibodies to fight it.
Nectar	A sweet sugar solution in flowers.
Oesophagus	The organ that carries food down to the stomach.
Osmosis	Movement of water molecules through a semi-permeable membrane — from a high water concentration to a low water concentration.
Ovary	The female organ that holds the ovules.
Ovules	The female gamete in plants.
Pancreas	Enzymes used in the duodenum are made here and in the liver.
Parasite	An organism that grows, reproduces and feeds on, or in, cells of living things.
Passive immunity	Immunity gained by being injected with antibodies.
Pathogens	Disease causing organisms.
Phagocytes	White blood cells that eat bacteria.
Photosynthesis	A chemical reaction in plants that makes sugar.
Physical digestion	Making lumps of food smaller.
Pistil	The female organs of a flower.
Plumule	Grows from an embryo to become the shoot of a plant.
Pollen	The male gamete in plants.
Pollination	When pollen is transferred from an anther to a stigma.
Radicle	Grows from an embryo to become the root of a plant.

YEAR 10 GLOSSARY

Word/Phrase	Meaning
Resistant	A micro-organism that is no longer affected by an antibiotic.
Respiration	The process that cells use to get energy from sugars.
Ruminants	Organisms, such as cows, that have four chambered stomachs.
Saliva	The liquid added to food in the mouth that breaks down starch.
Salivary glands	The glands where saliva is produced.
Self-pollination	When the pollen goes from the anther to the stigma of the same flower.
Semi-permeable membrane	The membrane through which osmosis occurs. It lets small chemicals pass through but not large ones.
Sepal	Part of a plant that protects the bud.
Sexual reproduction	Reproduction where male and female sex cells join.
Small intestine	Part of the digestive tract after the stomach, where more enzymes are added to help break down the food.
Stamen	The male organs of a flower.
Stomach	The organ that churns and mixes food while adding an acidic solution to it.
Synovial fluid	The lubrication around a joint.
Tendon	Muscles are joined onto bones by tendons.
Testa	The hard layer on the outside of the seed.
Tongue	Organ in the mouth.
Toxins	Poisonous substances.
Variation	A difference in a physical feature, such as height, length, weight, and so on.
Villi	Small folds in the small intestine wall that increase the surface area for absorption.

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