Cambridge Lower Secondary Science Stage 7 and 8 Learners Book

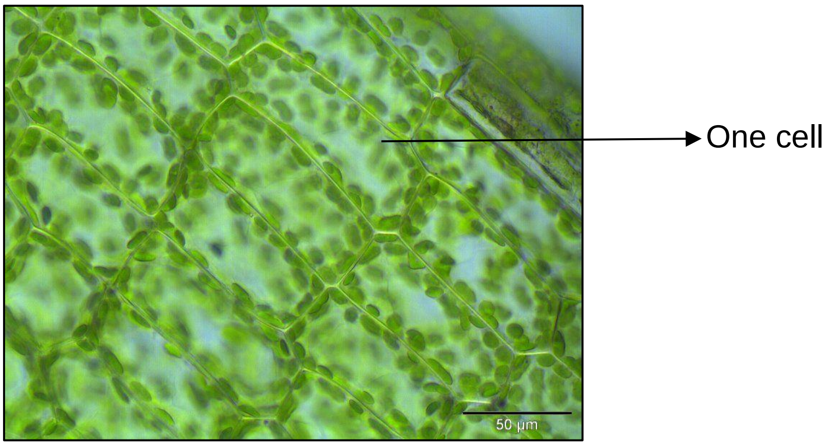
Biology

Stage 7

Unit 1 Cells

1.1 Plant cells

All living organisms are made of **cells**. Cells are so small that you cannot see them with your eyes alone. You need a microscope to see cells. Microscopes magnify the view of cells



Part of a leaf seen through a microscope

Parts of a plant cell

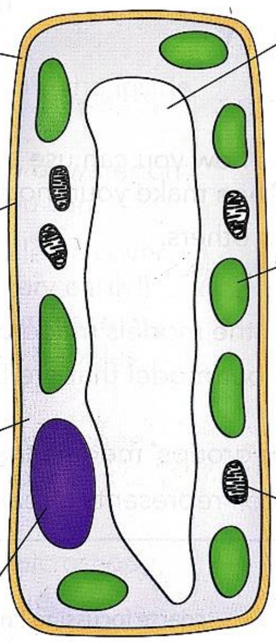
The diagram shows a plant cell from a leaf.

cell wall
Every plant cell has a cell wall. The cell wall is strong and stiff. It holds the plant cell in shape. Plant cell walls are made of a substance called **cellulose**.

cell membrane
All cells have a cell membrane. The cell membrane is very thin and flexible. It is like the thin skin of a soap bubble. It lies along the inner edge of the cell wall. The cell membrane controls what goes in and out of the cell.

cytoplasm
All cells have cytoplasm. Cytoplasm is like clear jelly. Chemical reactions happen inside the cytoplasm. These reactions keep the cell alive.

nucleus
Most cells have a nucleus. The nucleus controls the activities of the cell.



sap vacuole
This is a large, fluid-filled space inside a plant cell. The liquid inside it is a solution of sugars and other svubstances dissolved in water. The solution is called cell sap.

chloroplast
Plant cells that are in the sunlight often contain chloroplasts. This is where plants make their food. Chloroplasts look green because they contain a green substance called **chlorophyll**.

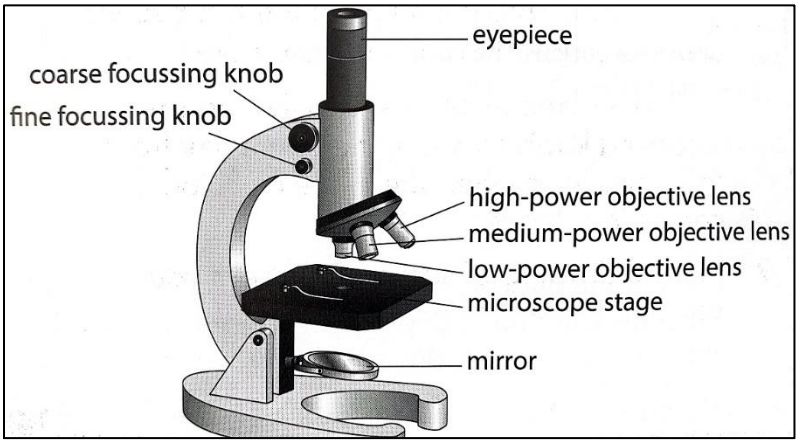
mitochondrion
All plant cells have mitochondria (singular: mitochondrion). Inside mitochondria, energy is released from food.

Questions:

1. Look at the photograph of the plant cells on the previous page. What do you think the little green circles inside the cells are? Why are they green? What happens inside them?
2. Describe four differences between a cell wall and a cell membrane.

Microscopes

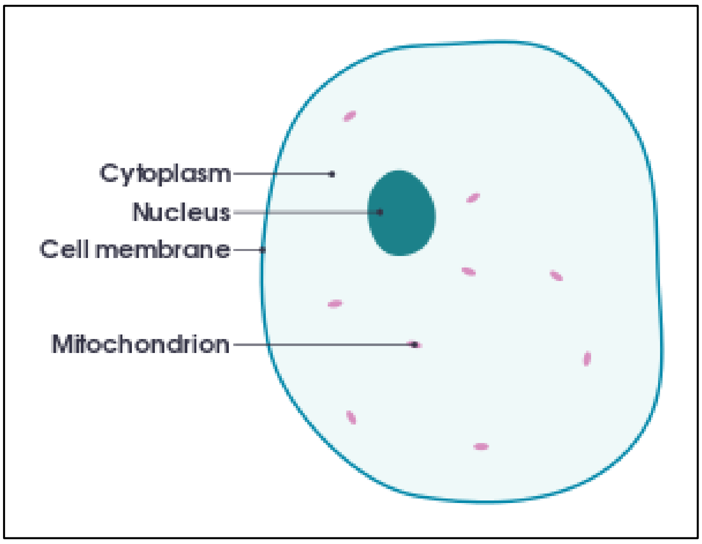
Scientists who study living organisms often use microscopes to help them see very small things. The diagram shows a microscope.



1.2 Animal cells

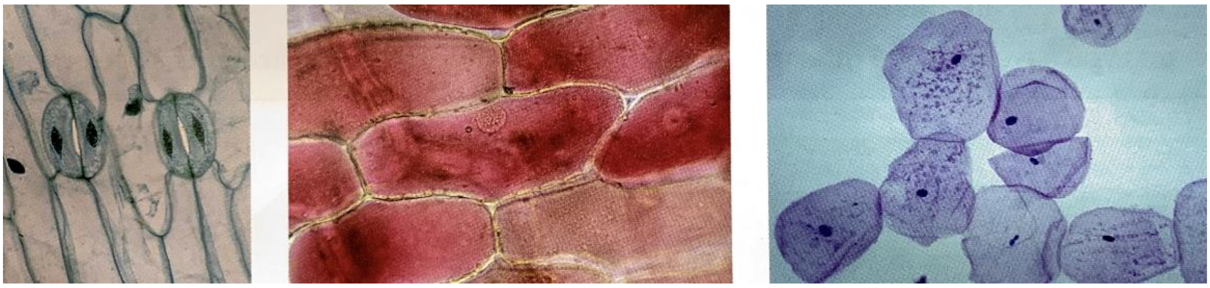
Parts of an animal cell

All animals are made of cells. Animal cells are similar to plant cells, they have a cell membrane, cytoplasm, mitochondria and nucleus.



Questions:

1. The photographs show some cells, seen through a microscope.

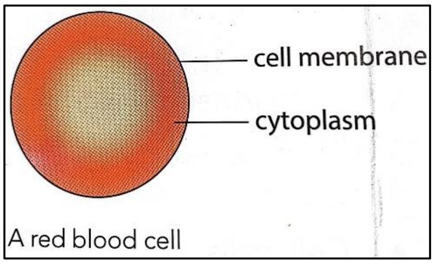


For each photograph, decide whether the cells are plant cells or animal cells. Explain your decision.

1.3 Specialised cells

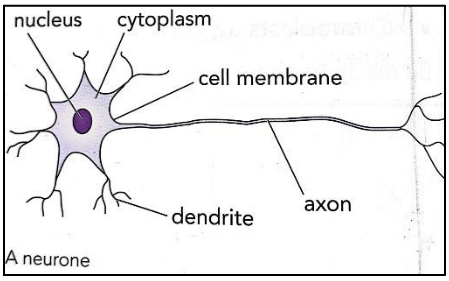
Some specialised animal cells

Not all the cells in your body are the same. There are many different kinds of cells in your body. Each kind of cell has a particular **function.** The function of the cell is the job that it does, or the role that it plays.



A red blood cell

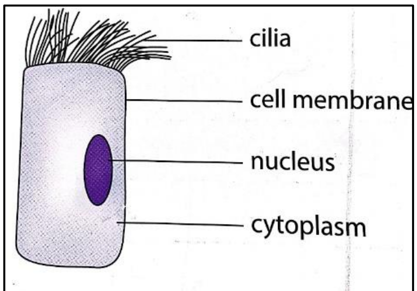
Red blood cells are smaller than most other cells in the body. This allows them to get through tiny blood **capillaries**, so they can deliver oxygen to every part of the body. The cytoplasm contains a red **pigment** (colour) called **haemoglobin**. This carries oxygen around the body. The cell has no nucleus. This leaves more space for haemoglobin.



A neurone

Neurones carry electrical signals from one part of the body to another. They help all the different parts of the body to communicate to each other. For example, they can carry signals from the brain to muscles, to make the muscles move. The **axon** is a very long strand of cytoplasm. Electrical signals can travel along this very quickly. **Dendrites** are short strands of cytoplasm that collect electrical signals from other nearby nerve cells.

Ciliated cells have tiny threads along one edge, like microscopic hairs. These are called **cilia**. The cilia can move. One place in the body that contains ciliated cells is the lining of the tubes leading from your mouth to your lungs. Other cells in this lining make a sticky substance called **mucus**. When you breathe in, the mucus traps dust and bacteria in the air, to stop them from going into your lungs. The cilia sweep the mucus up to the back of your mouth and you swallow it.



A ciliated cell

Questions:

1. List **two** things that red blood cells, neurones and ciliated cells have in common.
2. How can you tell that all of these three cells are animal cells, not plant cells?

Activity 1.3.1 Structure and function in animal cells

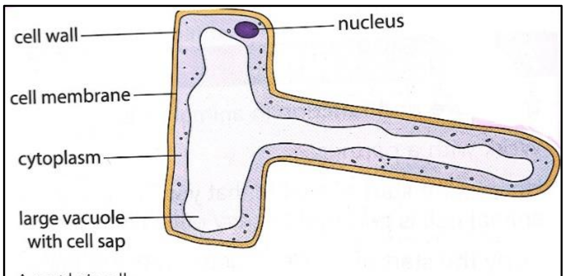
Here is the start of a table that you can use to summarise how each kind of specialised animal cell is adapted to carry out its function. Copy the start of the table into your book. Then complete the entries for the red blood cell. You could include a small drawing of a red blood cell underneath its name in the first column. Next, add entries for a neurone and a ciliated cell. Remember to give your table a title. Complete the rest of the table in your book.

Name of cell	**Function of cell**	**Specialised feature**	**How this helps the cell to carry out its function**
Red blood cell	Transports oxygen	Has haemoglobin in its cytoplasm	Haemoglobin carries oxygen
Neurone			

Some specialised plant cells

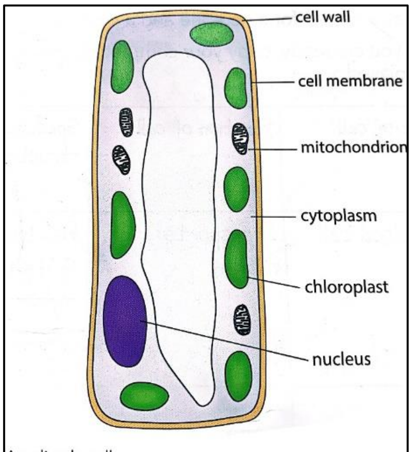
Plants contain specialised cells. Here are two examples.

Root hair cells are found outside the plant roots. Their function is to **absorb** (soak up) water from the soil. Each cell has a long thin extension that allows water to move easily from the soil into the cell.



A root hair cell

Palisade cells are found in the leaves of plants. Their function is to make food by photosynthesis. They have a lot of chloroplasts containing chlorophyll. The chlorophyll absorbs energy from sunlight, which is used to help the plant make food.



A palisade cell

Questions:

3. Suggest why root hair cells do not contain chloroplasts.
4. Water moves through several parts of the root hair cell, as it goes from the soil into the sap vacuole. List these parts in order.

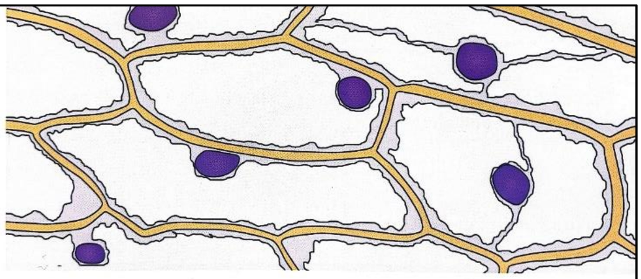
1.4 Cells, tissues, and organs

Tissues

Living things, including animals and plants, are called **organisms**. There are many different kinds of cells in an animal or plant. Most of them are specialised to carry out a particular function. Usually, many cells of the same kind are grouped together. A group of similar cells, which all work together to carry out a particular function, is called a **tissue**.

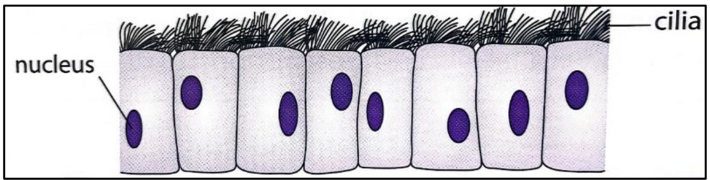
The diagrams show a tissue from a plant, and a tissue from an animal.

This is a diagram of a tissue from inside an onion. It is called an **onion epidermis**. This tissue covers the surface of the layers inside the onion.



Onion epithelium

This is a diagram of **ciliated epithelium**, the tissue that lines the tubes leading down to our lungs. The cilia will all wave together, like grass in the wind.

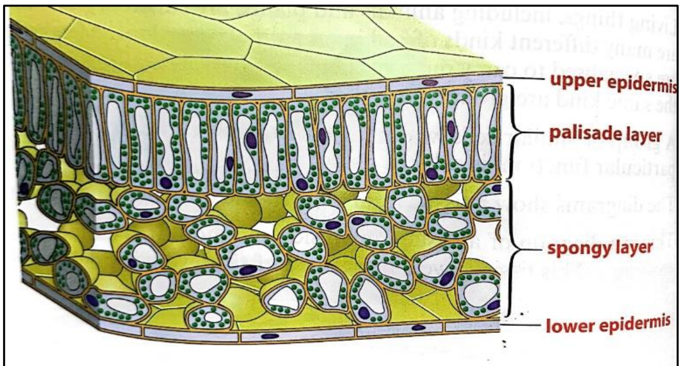


Questions:

1. What is the function of the ciliated epithelium tissue? (Think about the function of a ciliated cell).
2. The word 'tissue' has an everyday meaning and a different scientific meaning. Write two sentences, one using the word 'tissue' with its everyday meaning, and one using its scientific meaning.

Organs and organ systems

The bodies of plants and animals contain many different parts, called **organs**. For example, your organs include your brain, heart, and muscles. Plants' organs include leaves, roots, and flowers. Each organ is made up of several different kinds of tissue, working together. For example, your brain contains neurones, and several other kinds of cells. A plant root contains root hair cells, and several other kinds of cells. Organs also work together. A set of organs that all work together to carry out the same function is called an **organ system**.



This is part of a leaf, cut open. A leaf is a plant organ, and contains several different kinds of tissue.

Questions:

3. Copy and complete each sentence, using words from the list.

   organism   tissue   organ   organ system

   A group of similar cells is called is a ______________________________.

   An _______________________ is a structure made of many different tissues.

   An __________________ is a group of organs that carry out a particular function.

   An ____________________ is a living thing. It may contain many different organ systems, organs, and tissues.

KEY WORDS

- **Cells** – One of the small structures that make up living organisms.
- **Magnify** – Make things look bigger than they really are.
- **Cell wall** – The strong, stiff outer covering of plant cells and bacterial cells.
- **Cellulose** – The substance that makes up cell walls in plants.
- **Cell membrane** – A thin, flexible 'skin' on the outside of every cell, which controls what enters and leaves the cell.
- **Cytoplasm** – The 'background' substance that fills a cell, in which many chemical reactions happen.
- **Nucleus** – A structure found in animal and plant cells, which controls the activity of the cell.
- **Sap vacuole** – The space inside a plant cell containing liquid (sap).
- **Chloroplast** – One of many structures inside some plant cells, which contain the green pigment chlorophyl, where photosynthesis takes place.
- **Chlorophyll** – The green substance in plants that allows them to use energy from the Sun.
- **Mitochondrion –** A small structure inside a cell, where energy is released from food (plural: mitochondria).
- **Limitations** – Weaknesses
- **Function** – The job that something does or the role it plays.
- **Specialised** – Built to do its job well.
- **Adapted** – Having features that help it carry out its function.
- **Red blood cells** – A very small cell with no nucleus that delivers oxygen to every part of the body.
- **Capillary** – The smallest type of blood vessel, which delivers blood close to every cell in the body.
- **Pigment** – A coloured substance; chlorophyll and haemoglobin are pigments.

- **Haemoglobin** – A red pigment inside red blood cells, which carries oxygen around the body.
- **Neurone –** A cell that carries electrical signals from one part of the body to another.
- **Axon –** Very long strand of cytoplasm along which electrical signals travel.
- **Dendrite** – A short strand of cytoplasm on a neurone which collects electrical signals from other neurones.
- **Ciliated cell –** A cell with tiny threads called cilia along its edge which can move in a wave-like motion**.**
- **Cilia –** Tiny, hair-like structures that extend from the surface of some cells.
- **Mucus** – Sticky substance made by cells lining the tubes from the mouth to the lungs. Mucus traps dust and bacteria.
- **Root hair cell –** A cell that is found on the outside of plant roots and is specialised to absorb water.
- **Absorb** – Soak up.
- **Palisade cells** – A cell found inside the leaf of a plant; this is where most photosynthesis happens.
- **Organisms** – A living thing.
- **Tissue –** A group of similar cells that work together for a particular function.
- **Onion epidermis** – The tissue on the surface of the layer of an onion bulb.
- **Ciliate epithelium** – Tissue that lines the tubes leading down to the lungs.
- **Organ** – A structure made up of many different tissues, which work together to perform a particular function.
- **Organ system –** A set of organs that all work together to carry out the same function.
- **Upper epidermis –** A tissue made up of cells with no chloroplasts, which covers the top surface of a leaf.
- **Palisade layer –** The tissue made up of many palisade cells arranged side by side in leaf.
- **Spongy layer –** The tissue made of many rounded cells containing chloroplasts, found beneath the palisade layer inside a leaf.
- **Lower epidermis –** The tissue that covers the lower surface of leaves.

Stage 8

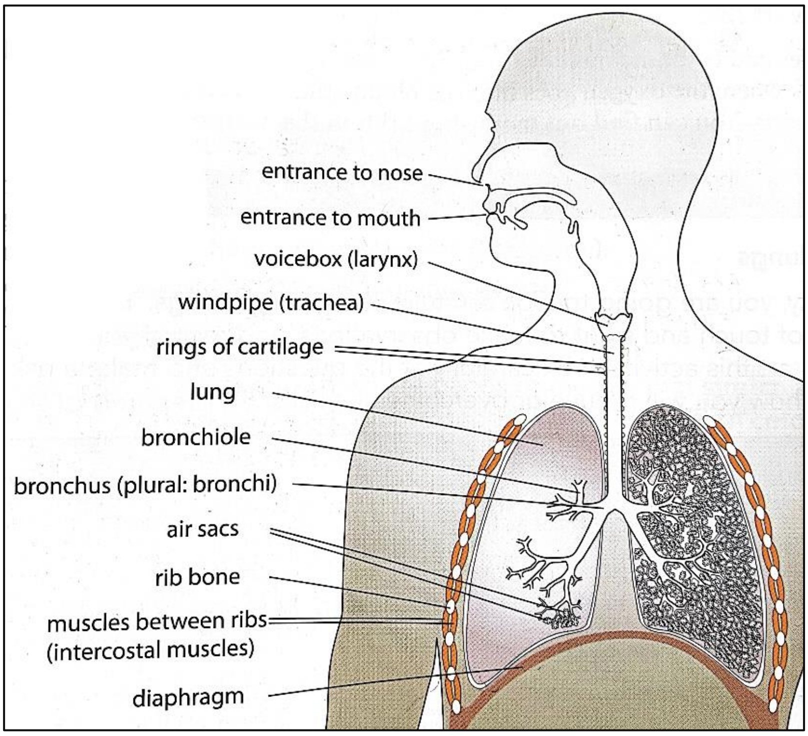
Unit 1 Respiration

1.1 The human respiratory system

One of the characteristics shared by all living things is **respiration**. Respiration is a series of chemical reactions that happens inside every living cell. The kind of respiration that usually happens inside our cells is called **aerobic respiration**. Aerobic respiration uses oxygen. The cells produce carbon dioxide as a waste product. The air around you contains oxygen. When you breathe, you take ai into your lungs. Some of the oxygen from the air goes into your blood. The blood delivers oxygen to every cell in your body, so that the cells can use it for respiration. The blood collects the waste carbon dioxide from the cells, and it takes it back to your lungs. The organs that help you take oxygen out of the air, and get rid of carbon dioxide, make up the **respiratory system**.

The structure of the human respiratory system

This is a diagram of the human respiratory system. The white spaces in this diagram are 'tubes' (bronchi and bronchioles) that air moves through, as it goes into and out of your lungs.



Questions:

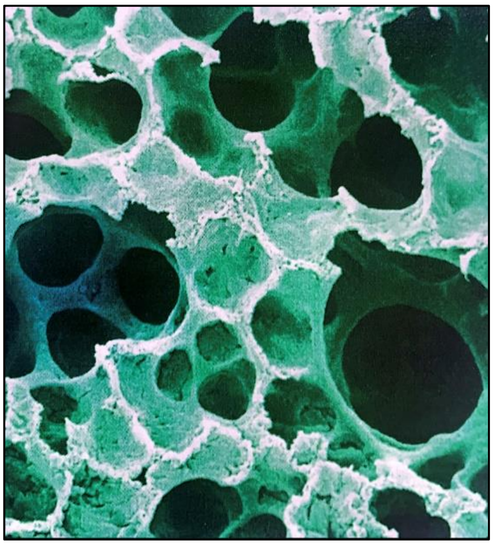
1. Put your finger on the entrance to the nose or mouth in the diagram of the respiratory system. Move your finger along the white space and down into the lungs. Write down the structures that the air passes through, as it moves down into your lungs. Write them in the correct order.
2. Now write the same structures in the order in which the air passes through them as it moves out of your lungs and back into your surroundings.

Air gets into your body through your mouth and nose. You mouth and nose both connect to your **trachea**. The trachea is sometimes called the **windpipe**. It has strong rings of **cartilage** around it. These rings of cartilage keep the trachea open and prevent it collapsing, so that air can keep moving in and out of your body. If you put your fingers on the front of your neck and move them downwards, you can feel the rings of cartilage on your trachea. The trachea branches into two **bronchi** (singular: **bronchus**). The bronchi also have cartilage to support them. One bronchus goes into each lung. Each bronchus carries air deep into your lungs. Each bronchus divides into several smaller tubes called **bronchioles**. The structure of these branches allow air to reach deeper into your lungs. The bronchioles end by branching into many tiny structures called **air sacs**. This is where the oxygen goes into your blood, and the carbon dioxide comes out.

1.2 Gas exchange

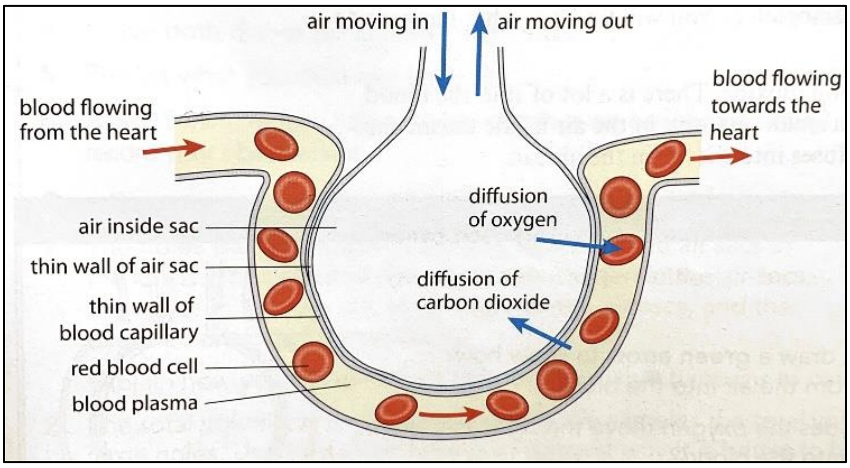
Air sacs

The photograph shows a tiny part of the lungs, seen through a powerful microscope. You can see the lungs are mostly holes. These holes are called air sacs. Another name for them is **alveoli**. There are also lots of tiny blood vessels in the lungs, wrapped around the air sacs. You cannot see them in the photograph, but they are shown in the diagram below. These blood vessels are called capillaries.



The structure of an air sac

This diagram shows one of the air sacs in the lungs. The air sac has a wall made of one layer of cells. These cells are very thin. You can see that there is a blood capillary around the outside of the alveolus. The wall of the capillary is also made of a single layer of very thin cells.



Gas exchange in the air sacs

Inside the air sac, oxygen from the air goes into the blood. Carbon dioxide from the blood goes into the air. The is called **gas exchange**. Think about the blood capillary on the left of the diagram. The blood inside this capillary comes from the heart. Before reaching the heart, if comes from the organs in the body. These organs contain cells that respire, using up oxygen and making carbon dioxide. So, the blood in this capillary contains only a small amount of oxygen, and a lot of carbon dioxide.

Now think about the air inside the air sac. It came from outside the body, where air contains a lot of oxygen and only a small amount of carbon dioxide. Inside the alveolus, this air is very close to the blood. There are only 2 very thin cells between the air and the blood. The oxygen particles in the air are a gas, so they are moving freely. They can easily move from the air, through the thin-walled cells and into the blood. This is called **diffusion**. The oxygen particles move from where there are a lot of them (in the air) to where there are fewer of them (in the blood). When the oxygen gets into the blood, it dissolves. The oxygen goes into the red blood cells where it combines with haemoglobin.

Now think about the carbon dioxide. There is a lot of it in the blood in the capillary, and only a small quantity in the air inside the air sac. So, the carbon dioxide diffuses into the air in the air sac.

Activity 1.2.1 Gases in and out

Copy this diagram.

1. On your diagram, draw a **green** arrow to show how oxygen diffuses from the air into the blood.
2. How many cells does the oxygen move through, as it leaves the air and goes into the blood?
3. On your diagram, draw a **blue** arrow to show how carbon dioxide diffuses from the blood into the air.

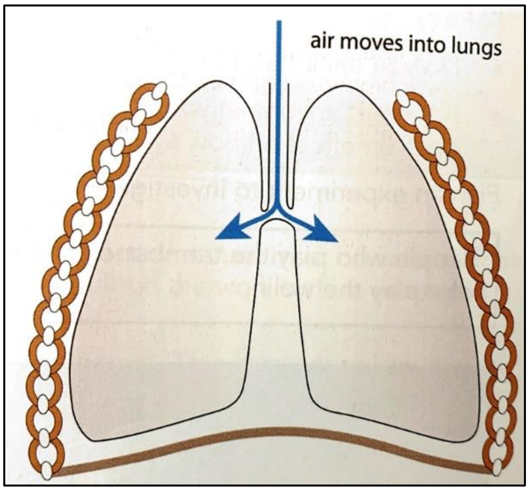
1.3 Gas exchange

Breathing

Remember that air is a gas. The pressure of a gas increases when the volume of its container is decreased.

When you breathe in, these things happen:

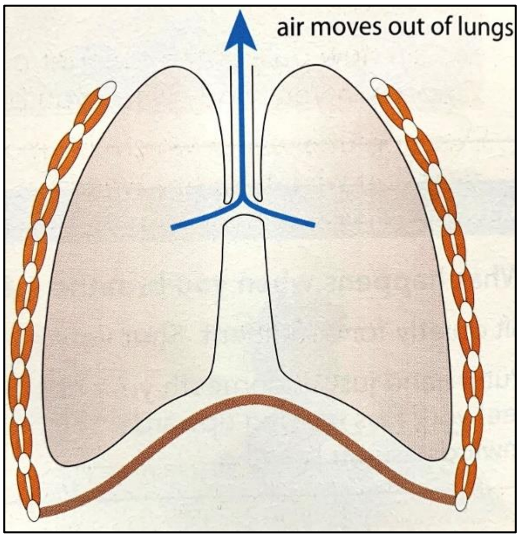
- The intercostal muscles between the ribs contract (get shorter). This pulls the ribs upwards.
- The muscles in the diaphragm contract. This pulls the diaphragm downwards.
- These two movements make more space inside the chest cavity. They increase the volume inside it.
- When the volume increases, the pressure inside the chest cavity and lungs decreases.



- Air moves down through the trachea into the lungs, to fill the extra space.

When you breathe out, these things happen:

- The intercostal muscles between the ribs **relax** (return to normal size). This allows the ribs to drop down into their natural position.
- The muscles in the diaphragm relax. This allows the diaphragm to become its normal, dome shape.
- These two movements make less space inside the chest cavity. They decrease the volume inside it.
- When the volume decreases, the pressure increases. So, air is squeezed out of the lungs.



Questions:

1. Copy and complete the table Use these words: **contract** **relax**

Action	What do the diaphragm muscles do?	What do the intercostal muscles do?
Breathing in		
Breathing out		

2. Copy and complete these sentences. Use these words:

   decrease **increase** **into** **out of**

   a) When we breath in, the muscles in the diaphragm and between the ribs _____________ the volume of the chest.

   b) This makes air move _____________ the lungs.

   c) When we breathe out, the muscles in the diaphragm bd between the ribs _____________ the volume of the chest.

   d) This makes air move _____________ the lungs.

1.4 Respiration

Using energy to stay alive

Our bodies need energy for many different reasons. For example:

We use energy when we move

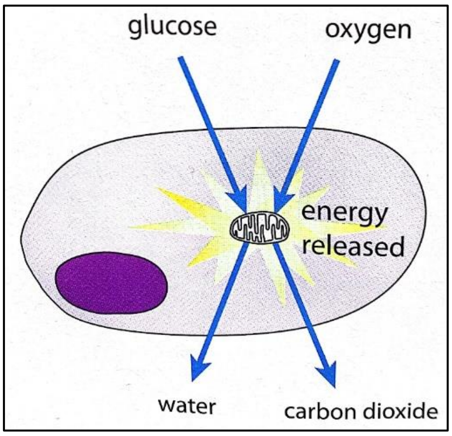
We use energy to send electrical impulses along neurones

We use energy to keep our bodies warm when it's cold

All our energy comes from the food we eat. Carbohydrates are especially good for giving us energy. When we eat food containing carbohydrates, our digestive system breaks down the carbohydrates to a kind of sugar called **glucose**. The glucose goes into our blood. The blood delivers glucose to every cell in the body. The cells use the glucose to get energy that they need.

Releasing energy from glucose

Energy must be changed from one type to another, or be transferred, to do something. The energy in glucose is locked up inside it. Glucose is an energy store. Before your cells can use the energy, it must be released from the glucose. This is done by tiny structures called mitochondria that are found inside cells. Most cells have many mitochondria inside them. Mitochondria release energy from glucose, so that the cells can use the energy. The mitochondria carry out a chemical reaction called aerobic respiration. Aerobic respiration means it uses oxygen, from the air. Here is the word equation for aerobic respiration.



$$\textbf{glucose} + \textbf{oxygen} \rightarrow \textbf{carbon dioxide} + \textbf{water}$$

In this reaction, some of the energy inside the glucose is released. This is done in a very controlled way. Just a little bit of energy is released at a time, just enough for the cell's needs.

Questions:

1. Neurones contain more mitochondria than cheek cells. Suggest why.
2. Look at the word equation for aerobic respiration.
   a) What are the reactants in this reaction?
   b) What are the products of this reaction?
3. Use the equation for aerobic respiration to explain why the air that you breathe out contains more carbon dioxide that the air that you breathe in.

Respiration and heat production

Every time energy is transferred or transformed, some of its energy changes into heat energy. In respiration, chemical energy stored in glucose is transferred to other substances, so that cells can use it. In this process, some of the energy is changed to heat energy. So respiring cells get a little bit warmer than their surroundings.

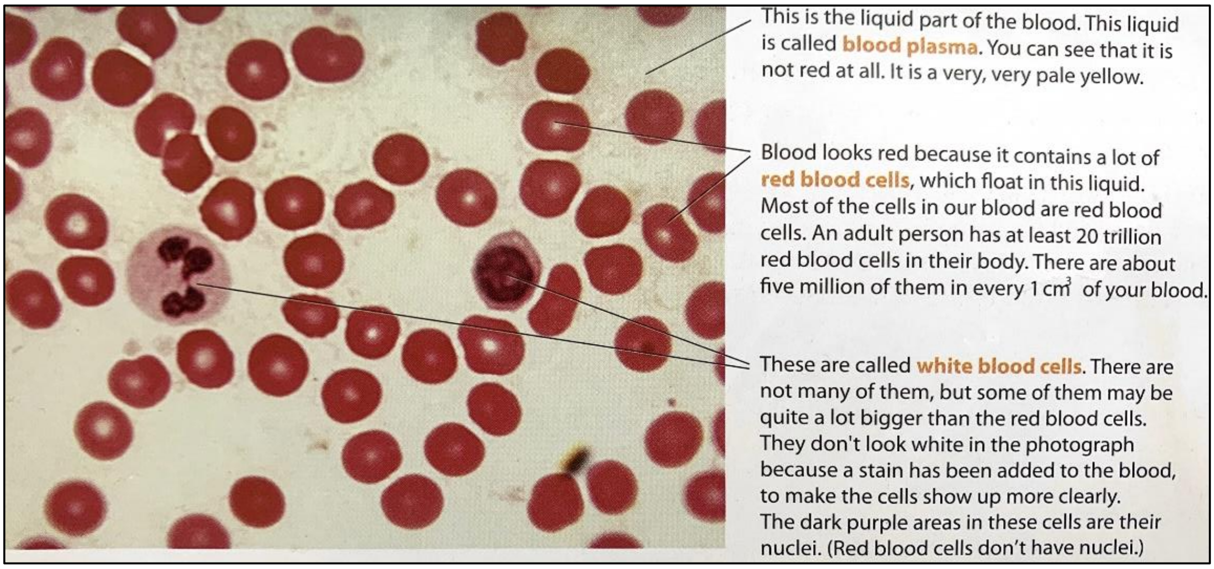
1.5 Blood

Delivering the requirements for respiration in cells

You have seen that all your cells need energy to stay alive. Each cell gets its energy through a chemical reaction called respiration. Every cell in your body needs a good supply of glucose and oxygen, the carbon dioxide and water that the cell makes must be taken away. The delivery and removal is done by the blood. The blood moves around the body inside blood vessels. The heart pumps constantly, to keep the blood moving.

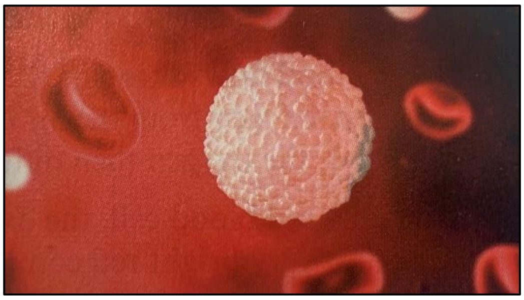
What is blood?

Blood is a red liquid. But if you had to look at some blood through a microscope, you might get a surprise. The photograph shows what you might see.



Questions:

1. Look at the photograph above. Approximately how many times more red blood cells are there than white blood cells?
2. The photograph on the right was taken with a powerful electron microscope. What difference can you see between the red blood cell and the white blood cell.

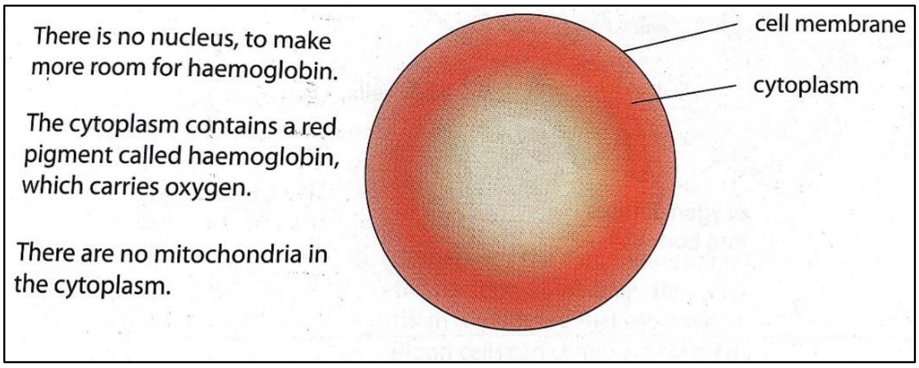


Plasma

Plasma is the liquid part of the plod. It is mostly water. The red and white blood cells are transported around the body in the blood plasma. Plasma also has many other different substances dissolved in it. For example, glucose, dissolved blood plasma, is transported from the digestive system to every cell. You will remember that carbon dioxide is produced in every body cell, by respiration. The carbon dioxide dissolves in blood plasma and is carried away from the cells. The blood takes it to your lungs, where the carbon dioxide diffuses out and is breathed out in your expired air.

Red blood cells

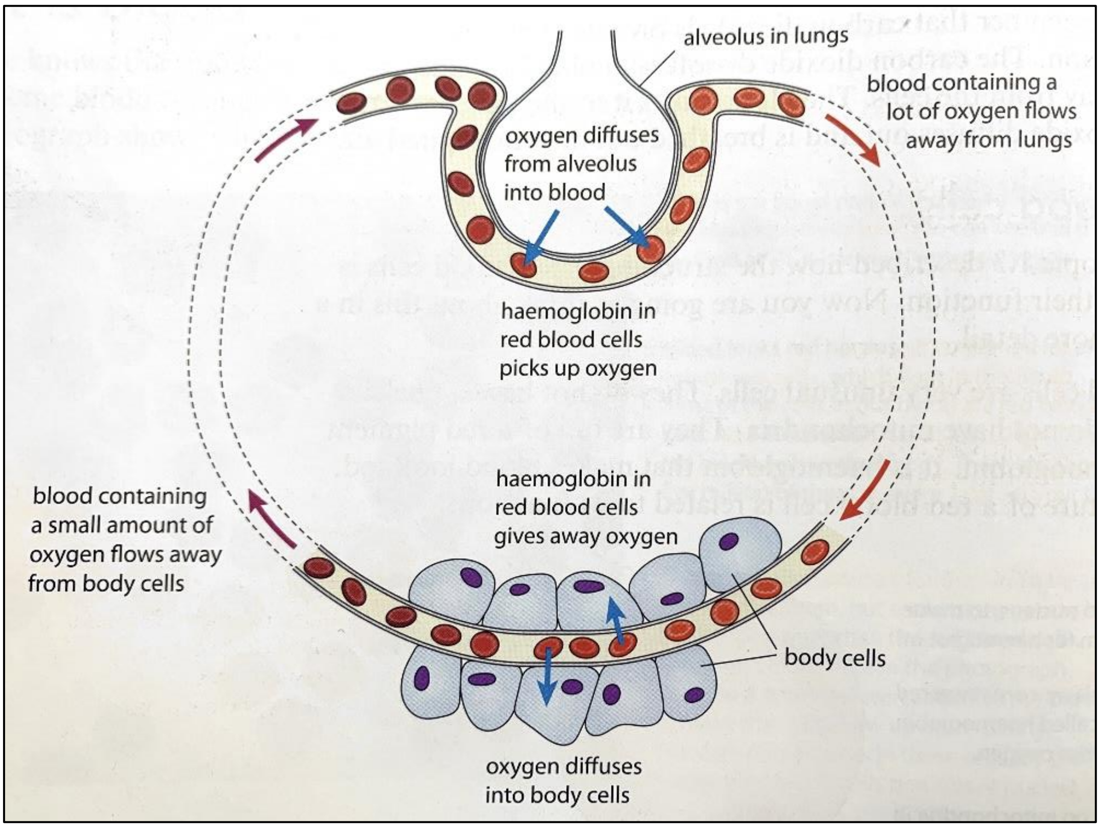
Red blood cells are very unusual cells. They do not have a nucleus and they do not have mitochondria. They are full of a red pigment called haemoglobin. The structure of a red blood cell is related to its function.



The haemoglobin helps the red blood cells to transport oxygen.

- As the blood flows through the tiny capillaries next to the alveoli in the lungs, oxygen from the air diffuses into the blood. Once it is in the blood, the oxygen then diffuses into the red blood cells.
- Inside the red blood cell, the oxygen combines with the haemoglobin. It forms a very bright red compound called **oxyhaemoglobin**.
- As the blood continues its journey around the body, it passes cells that are respiring. The oxyhaemoglobin lets go of its oxygen and gives it to the cells.
- The blood, which has given away most of its oxygen, now travels back to the lungs to collect some more.

This explains why red blood cells have haemoglobin, but why don't they have a nucleus or mitochondria? Scientists think that not having a nucleus makes more space for haemoglobin. They also think that not having mitochondria stops the red blood cells from using up all the oxygen for themselves, instead of delivering it elsewhere.



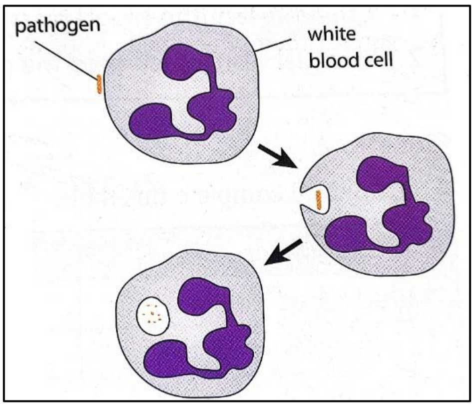
Another way in which red blood cells are adapted for their function is that they are quite a lot smaller than most cells in the body. Being so small helps them to get through the tiny blood capillaries. This means they can get really close to the alveoli in the lungs, and to the respiring cells in the other parts of the body.

Questions:

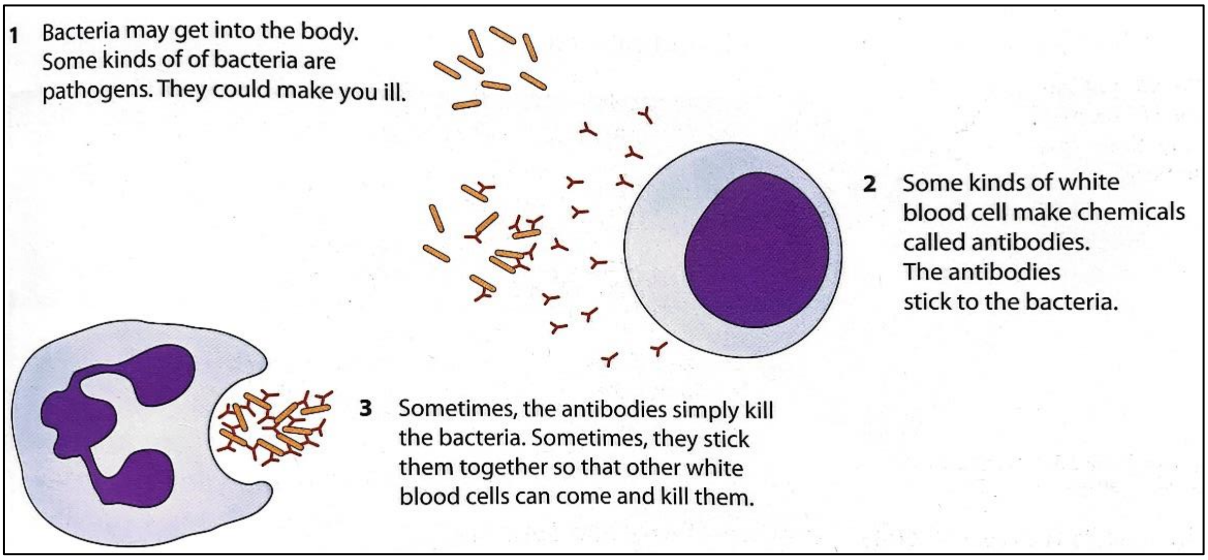
3. Explain why red blood cells might use up oxygen if they have mitochondria.

White blood cells

White blood cells are easily to distinguish from red blood cells. They always have a nucleus, which red blood cells do not have. Some kinds of white blood cell (but not all) are larger than red blood cells. Some bacteria and viruses can cause illnesses when they get into the body. These bacteria and viruses are called **pathogens**. White blood cells help to defend us against pathogens.



Some kinds of white blood cells can change their shape and push their cytoplasm out to make 'fingers' that can capture a pathogen. The white blood cell then produces chemicals that kill and digest the pathogen. Other types of white blood cells produce chemicals that kill pathogens. These chemicals are called **antibodies**. They are shown as little Y-shapes on the diagram below. Different kinds of antibodies are needed for each different kind of pathogen. The antibodies stick to the pathogen. Sometimes, they kill the pathogen directly. Sometimes, they glue lots of pathogens together so that they cannot move. This makes it easy for other white blood cells to capture and kill the pathogen.



Questions:

4. Copy and complete the table.

Component of blood	Appearance	Function
Red blood cell		
White blood cell		
Plasma		

5. Name **three** things that are transported in blood plasma.

KEY WORDS

- **Respiration** – A series of chemical reactions that take place in all living cells, in which energy is released from glucose.
- **Aerobic respiration** – Chemical reactions inside cells, where oxygen is used to break down glucose and release energy.
- **Respiratory system** – The lungs and other organs that help oxygen to enter the body and carbon dioxide to leave it.
- **Trachea** – The tube that carries air from the back of the mouth, down through the neck towards the lungs.
- **Windpipe** – Another name for trachea.
- **Cartilage** – A tough but bendy material, which makes up the supporting rings around the trachea.
- **Bronchus** – One of the tubes that branch from the trachea, and which carry air into the lungs.
- **Bronchiole** – One of the small tubes leading into the lungs from the bronchus.
- **Air sac** – One of the tiny air-filled spaces inside the lungs; also called an alveolus.
- **Alveoli** – Air sacs in the lungs.
- **Gas exchange** – The movement of gases into and out of organisms.
- **Diffusion** – The random movement of particles from an area where they are in high concentration to an area where they are in lower concentration.
- **Contract** – Of a muscle: get shorter.
- **Relax** – Of a muscle: Stop contracting.
- **Glucose** – A sugar that cells break down in respiration to release energy.
- **Blood plasma** – The liquid part of the blood.
- **Red blood cell** – The most common cells in the blood. They contain haemoglobin which transports oxygen from the lungs to body cells.
- **White blood cell** – Blood cells that help to protect against pathogens.
- **Oxyhaemoglobin** – Haemoglobin that is combined with oxygen.
- **Pathogens** – Microorganisms that cause disease, some bacteria and viruses are pathogens.
- **Antibodies** – Chemicals produced by white blood cells, which kill pathogens.

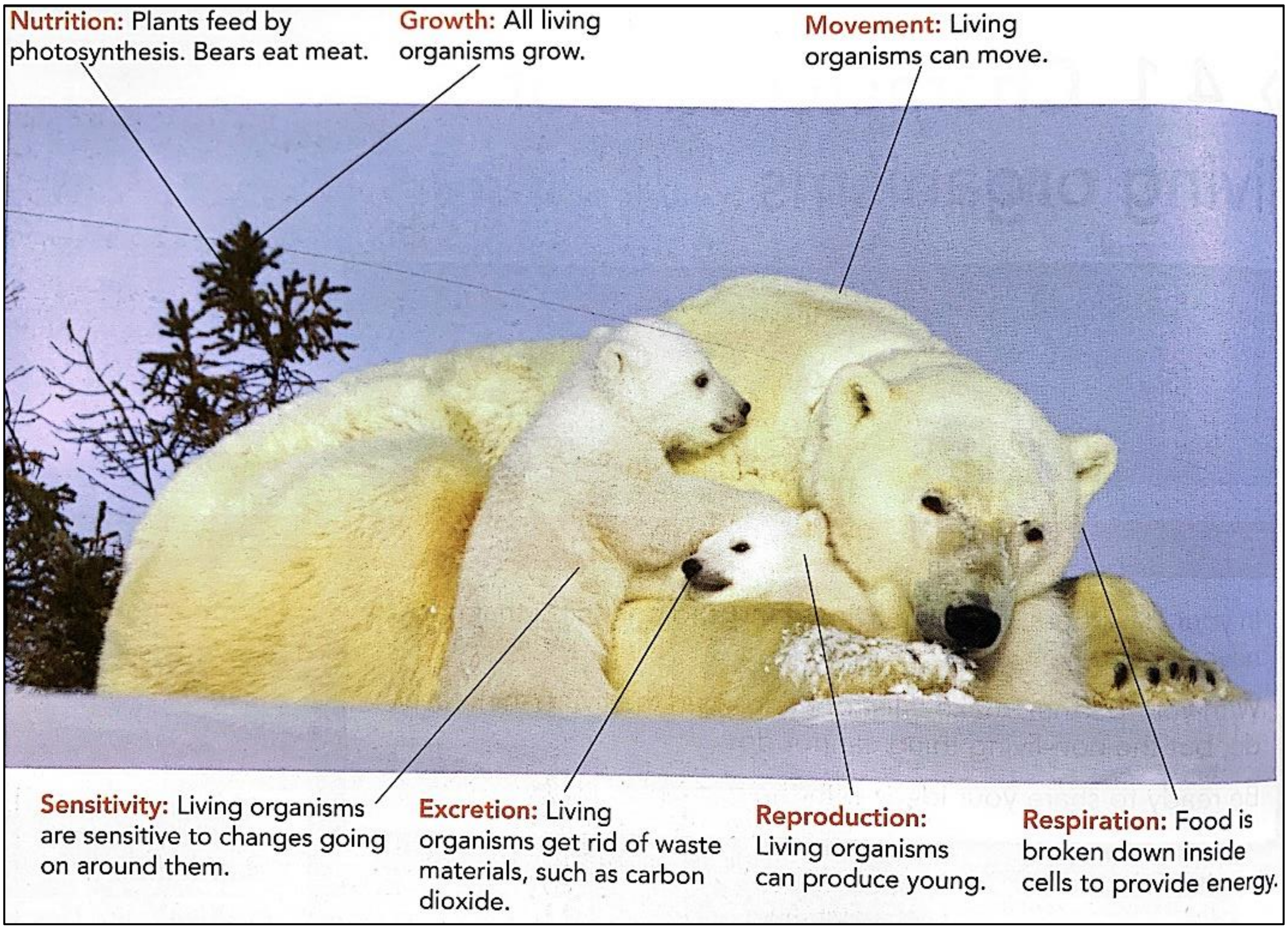
Stage 7

Unit 4 Grouping and identifying organisms

4.1 Characteristics of living organisms

Living and non-living

How do you know when something is alive? If it is a person, you can check to see if they are breathing, or if they have a heartbeat. Plants don't breathe or have hearts, yet they are alive. Living things are called **organisms**. Living organisms have a set of seven characteristics that make them different from non-living things.



Questions:

These questions are about the picture of the polar bears. Copy and complete the sentences. Use these words. You can use each word once, more than once or not at all.

Carbon dioxide chewing feeding growth movement oxygen sight smell reproduce respiration

1. Another word for taking in nutrition is ______________________________
2. Polar bears can sense things in their environment. For example, with their nose they can sense the ______________________________ of meat.
3. All living organisms excrete waste substances. Animals excrete __________ when they breathe out.
4. Living organisms ______________ to make more of the same kind of organism.
5. Young plants and animals get bigger. This is called ____________________.
6. All living organisms break down some of the food they eat, to provide them with energy. This happens in a process called ___________________________.
7. Most living organisms can change the shape and position of their bodies. This is called ____.

Activity 4.1.1 Is a car alive?

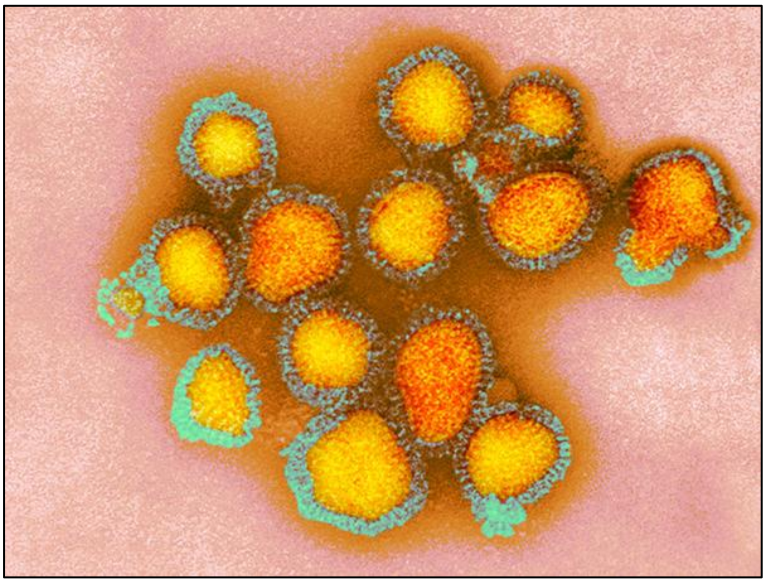
The picture shows a car. Here are some facts about cars.

- Cars use fuel and oxygen.
- Inside the engine of the car, the fuel and oxygen provide energy to make the car move.
- The engine produces waste gases, including carbon dioxide. These are given off in the exhaust of the car.
- Some cars have sensors. For example, they can sense when it is dark and turn the lights on automatically.

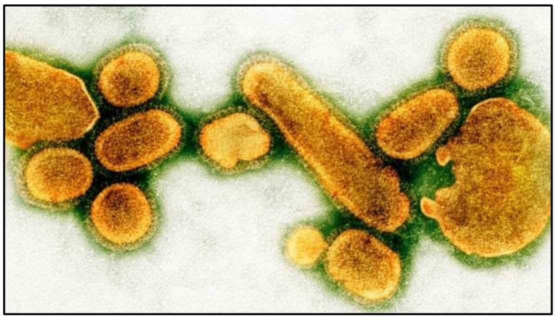
4.2 Viruses

What is a virus?

Viruses are very, very small. A virus is much smaller than one of your cells. You cannot see a virus with the kind of microscope that you use in school. To see a virus, you need to use a special kind of microscope called an **electron microscope**. Viruses are not made of cells. They do not have a cell membrane or cytoplasm. The green-blue outer layer in the photograph is a coat made of **protein**. There are little pegs on the outside of this coat. The orange part inside contains a substance called **RNA**. The RNA is made of little threads that contain a set of coded instructions for making more viruses.



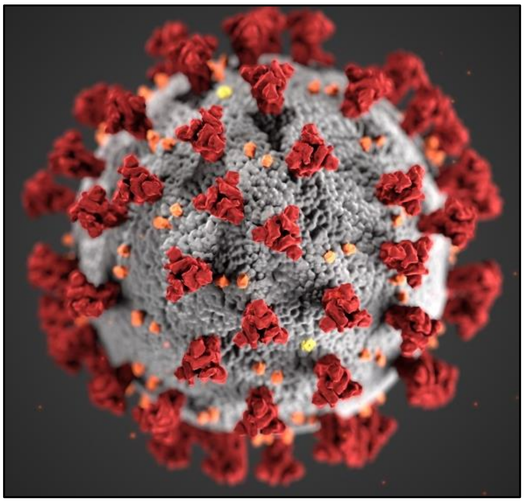
How viruses replicate



Viruses cannot do anything on their own. They do not respire, feed, excrete or grow. They are not sensitive and cannot move. Viruses must get inside a living cell before they can make copies of themselves. The brown viruses in the photograph are H3N2 **influenza** viruses. This kind of virus can invade (get inside) cells of birds, humans, and other mammals.

The viruses get into your body by going up your nose when you breathe in. The little pegs on the virus's coat help it to stick onto one of your cells and then get inside the cell. When the viruses are inside the cell, each virus bursts open. The virus forces the cell to copy the instructions of its RNA and make many new viruses. This is called **replication**. This kills the cell. Then the new viruses burst out of the dying cell, ready to infect more cells. This makes the animals whose cells are infected feel ill.

H3N2 viruses cause a very unpleasant and dangerous kind of influenza (flu). In 1968 – 1969, these viruses killed approximately one million people. These flu viruses are just one of thousands of different kinds of viruses we know about. Each kind of virus has a particular kind of cell that it infects. Some viruses infect plant cells. In 2019, a new virus appeared. We do not know exactly it came from, but scientists think it developed in a wild animal and then spread to humans. The new virus is similar to the viruses that cause flu and colds. Its official name is SARS-CoV-2. The illness it causes is called Covid-19. This stands for coronavirus disease 2019. The virus quickly spread all over the world. Many people get the virus without being ill at all, or just have mild symptoms, but in some people, it causes dangerous illness and even death. Scientists will work hard for many years to find the best ways of preventing this, including vaccination, and drugs to treat Covid-19.



Activity 4.2.1 Are viruses alive?

Some scientists consider that viruses are living organisms. Others think that they are not. Answer this question: Are viruses living organisms? Make a list of reasons for your answer.

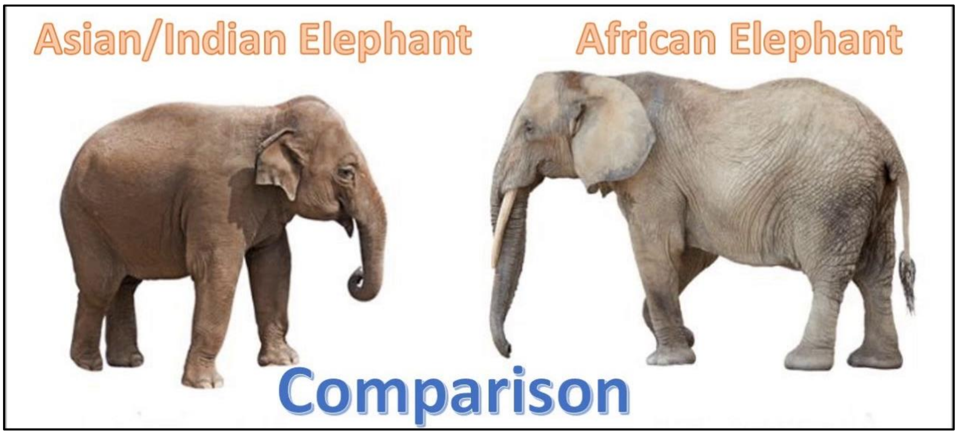
4.3 What is a species?

Species

Scientists group living organisms into different kinds. Each kind of organism is called a **species**.

Activity 4.3.1 Comparing two species of elephant

Look at the two pictures of elephants. These elephants belong to two different species. Make a list of the similarities and differences that you can see between the two species of elephant.



Species and reproduction

All organisms in a species share the same characteristics but they are not all **identical** to each other. For example, some Indian elephants have straighter tusks than others. They have pink markings on their skin in different places. There is **variation** between the individual Indian elephants. Variation between individuals can sometimes make it difficult to decide whether two organisms belong to the same species. To be sure, scientists try to find out if they can reproduce with one another. Indian elephants reproduce only with other Indian elephants. They do not reproduce with Africa elephants. Each species reproduces only with other members of its own species. When they have **offspring** (children), the offspring belong to the same species as their parents. The offspring are **fertile**. This means they can also produce offspring. Organisms that belong to different species cannot usually reproduce with one another.

Very rarely, two organisms from different species do reproduce together. This sometimes happens in a zoo. It can happen if two animals from different species are put into the same enclosure. For example, a male lion and a female tiger in a zoo sometimes reproduce together. They will only do this if they do not have a member of their own species to reproduce with. The young animals that are produced are called ligers. Ligers are healthy animals, but ligers cannot reproduce. They cannot have offspring. They are **infertile**. So, we can describe a species as a group of organisms that can reproduce together to produce fertile offspring.

Male lion

female tiger

liger

Questions:

1. Copy and complete these sentences. Choose from these words:

   bigger **different** **identical** **similar**

   Organisms that belong to the same species usually look ______________ to one another. They look ______________ from organisms belonging to other species.
2. Explain why biologists say that lions and tigers belong to different species, even though they can sometimes reproduce together.

4.4 Using keys

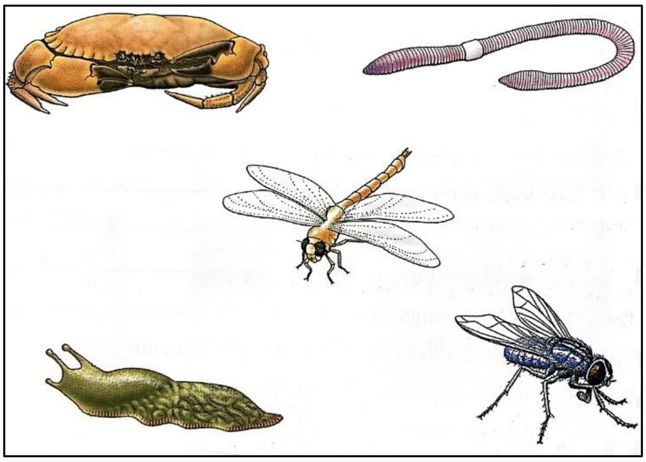
Identifying organisms

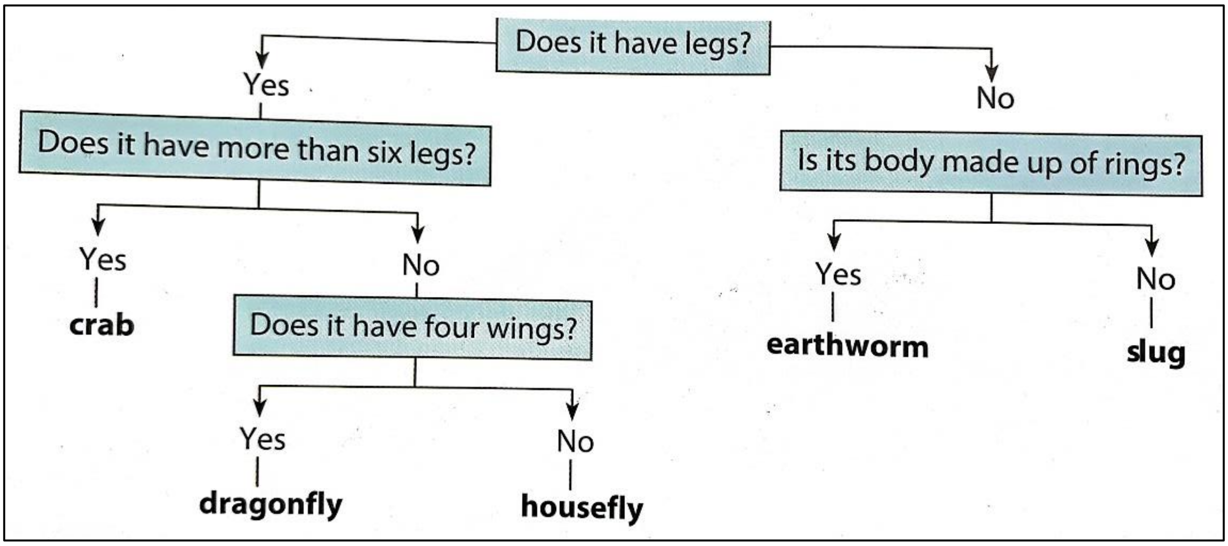
Biologists often want to identify an organism that they have found. A good way to start is to look at pictures in a reference book, or on the internet. The biologist may be able to find a picture of the organism, with its name, but this does not always happen. Biologists also use keys to help identify organisms. A key is a set of questions about the organism you want to identify. The answer to each question takes you to another question. You work through all the questions until you arrive at the name of the organism.

Here is a simple key to help someone identify an organism. It is a dichotomous key. Dichotomous means 'branching into two'. You will have to imagine that you have the whole animal to look at, not just these pictures.

To use the key:

- Choose one organism you want to identify.
- Starting at the top of the key, answer the first question – yes or no?
- Follow the line until you arrive at the name of the organism.





Keys are sometimes arranged differently. Here is the same key set out in a different way. Instead of a question, the key starts with a pair of statements to choose from. Instead of arrows pointing to where you go next, there is a number telling you which pair of statements to go to next.

1. a. It has legs. → Go to 2
   b. It does not have legs. → Go to 3
2. a. It has exactly six legs. → Go to 4
   b. It has more than six legs. → **Crab**
3. a. Its body is made up of rings. → **Earthworm**
   b. Its body is not made up of rings. → **Slug**
4. a. It has four wings. → **Dragonfly**
   b. It has two wings. → **Housefly**

Questions:

1. Using the key above, which steps would you go through to identify the earthworm.
2. Explain why the key is called a dichotomous key.

4.5 Constructing keys

Constructing a key

Look at the photographs of the four learners. Imagine you are going to construct a key to help someone identify these learners.


Deidre


Ben


Elsa


Ari

STEP 1:

Think of a way you can split the learners into two groups. For example, you could split them into male and female. So, your first question could be: Is the learner female?

STEP 2:

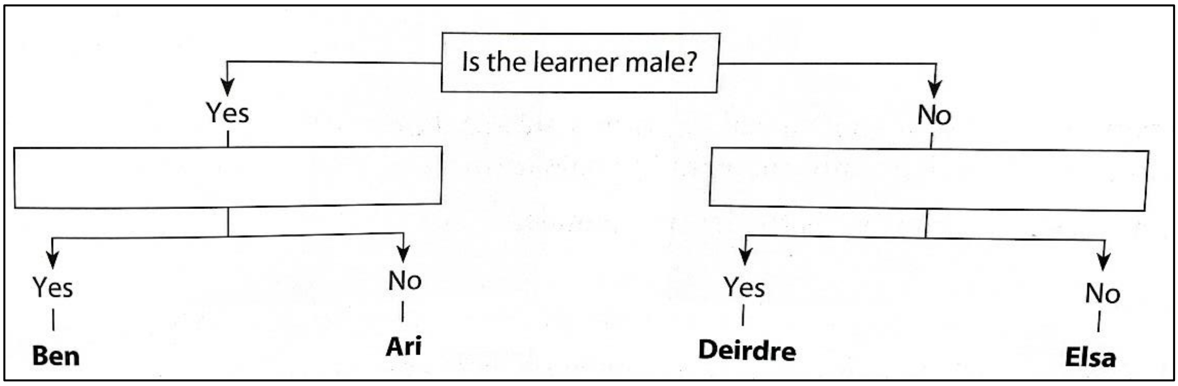
Now look at just one of these groups – the female learners, for example. Think of a way to split these into two. For example, you could use the colour of their hair.

STEP 3:

Repeat step 2 unit you have thought of ways to identify each learner.

Think like a scientist – Making keys to identify four learners

1. Copy this key and complete it, to help someone identify each of the four learners in the photographs.



2. Now write your key in the other style, using pairs of statements, 1a and b, 2a and b and so on. You could use the same pairs of features as your first key, or you could challenge yourself to use different pairs.

KEY WORDS

- **Excretion** – Getting rid of waste materials, such as carbon dioxide.
- **Growth** – A permanent increase in size.
- **Movement** – The ability of organisms to change position.
- **Nutrition** – Feeding; taking in substances that are needed for growth or to provide energy.
- **Organism** – A living thing.
- **Reproduction** – The ability of organisms to produce young.
- **Sensitivity** – The ability of an organism to notice and respond to changes happening around them.
- **Electron microscope** – A very powerful microscope that allows scientists to see viruses and other small things.
- **Influenza** – Flu, a common viral illness that causes fever and headache.
- **Protein** – A chemical that is a necessary part of the cells of all living things.
- **RNA** – A substance inside a virus containing a set of coded instructions for making more viruses.
- **Virus** – An extremely small structure made of a protein coat surrounding RNA (or DNA); viruses can invade cells and cause them to produce new viruses.
- **Fertile** – Being able to produce offspring.
- **Identical** – Exactly the same.
- **Infertile** – Unable to produce offspring.
- **Offspring** – The 'children' of a living organism.
- **Species** – A group of organisms that can reproduce with others in the same species, but not with members of a different species.
- **Variation** – Differences between individuals that belong to the same species.
- **Dichotomous key** – Branching into two.

Stage 8

Unit 4 - Ecosystems

4.1 The Sonoran Desert

A desert in Arizona

The photograph shows the Sonoran Desert in Arizona, in the USA. Deserts are not easy places for animals and plants to live. Deserts do not get much rainfall, so the organisms that live there must have **adaptations** that help them to survive with little water. The tall plants in the photograph are saguaro cacti. They grow very slowly. The ones in the photograph may be more than 100 years old. Their roots spread out widely just underneath the soil, ready to absorb any rain that falls.

Many animals live among the cacti and other desert plants. Gila woodpeckers, make holes in the cacti, to make their nests. Other birds also visit these holes. Cactus wrens often use a different kind of cactus, called a teddy bear cholla, to make their nests. Teddy bear chollas are so spiky that very few other animals will get close to them. So, the cactus wren's eggs and young ones are protected from predators.

During the hot days, lizards, tortoises, and other animals rest in the shade of the plants, or burrow into the soil where it is cooler. At night, when the temperature falls, kangaroo rats come out to feed, wary of their predators such as rattlesnakes and coyotes.

In the Sonoran Desert, it usually rains heavily at least once a year. When the rains come, the desert is transformed. Many plants quickly produce flowers. Insects feed on the **nectar** and **pollen** in the flowers, helping the plants to reproduce by **pollinating** them. At night, bats feed on the nectar from the flowers of agave plants.

Seeds fall to the ground and are collected by ants, to take into their nests to provide a food store. Many months or years later, some of the uneaten seeds may germinate to produce new plants.

Interactions in the Sonoran Desert

As you read the information above, and looked at the photographs, you may have realised that all the different animals and plants depend on each other. They **interact** with each other. The actions of one organism affect another.

Non-living things in the desert

It is not only other organisms that affect the plants and animals in the Sonoran Desert. There are also interactions between the organisms and the non-living parts of their **environment**.

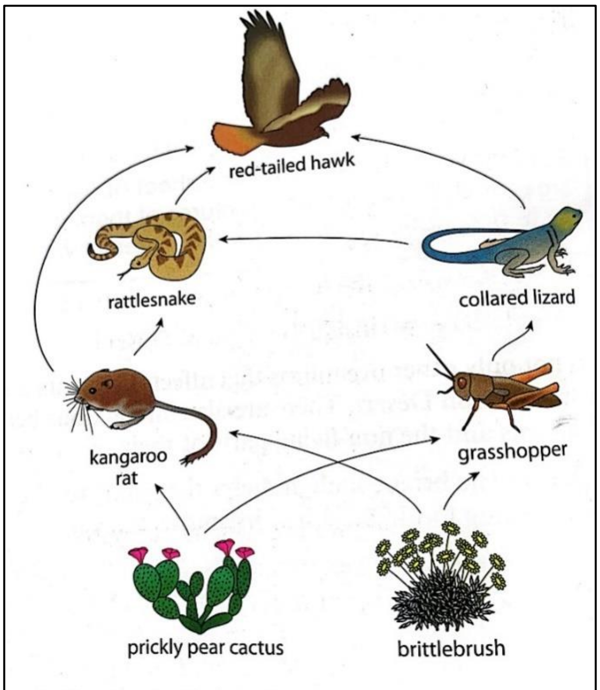
- **Light:** The bright sunlight helps the plants to photosynthesise, producing food that other organisms can eat.
- **Temperature:** The temperature is often very high during the day, but much lower at night. Some animals are **nocturnal**, which helps them to avoid overheating or drying out. It is cooler underneath the soil, so some animals – such as the tarantula in the picture – dig burrows for shelter during the day.

- **Soil:** Rocks and soil provide minerals for plants to grow, as well as building material for ground-nesting birds.
- **Water:** All organisms need water to keep their cells alive. Rain, when it comes, allows them to become more active and to reproduce.
- **Air:** The desert air provides carbon dioxide for the plants to use in photosynthesis, and oxygen for all the organisms to use in respiration.

The organisms also affect their environment. For example, droppings from the kangaroo rats become part of the soil. The gases that they take in and give out affect the composition of the air.

The desert ecosystem

Everything in the desert interacts with everything else. All these interactions make up the desert **ecosystem**. An ecosystem is a network of interactions between all the living organisms and the non-living things around them. Some of the interactions in an ecosystem involve **food webs**. Remember that plants are the producers in a food web. They use energy in sunlight to make food. As animals eat the desert plants and each



A food web in the Sonoran Desert

other, the energy is passed through the desert food web. Food webs are a very important part of the interactions in an ecosystem, but they are not the only interactions. For example, plants may provide places for some of the animals to make nests. Plant roots help to hold the soil together, so that is does not wash away when it rains. Animals help plants to reproduce by pollinating their flowers and spreading their seeds. The interactions in an ecosystem are usually very complicated. The study of ecosystems is called **ecology**. No ecologist would ever claim to have discovered all the different interactions in an ecosystem. There is always something new to find out, even in an ecosystem that scientists have been studying for a long time.

Questions:

1. Name the **two** producers in the diagram of the feed web in the Sonoran Desert.
2. Explain why the food web could not exist without the producers.
3. What do the arrows in a food web represent?
4. Give **two** examples of interactions between organisms in the desert that are **not** to do with feeding.

Habitats in a desert ecosystem

The place where an organism naturally lives is called it habitat. There are many different places to live in a desert.

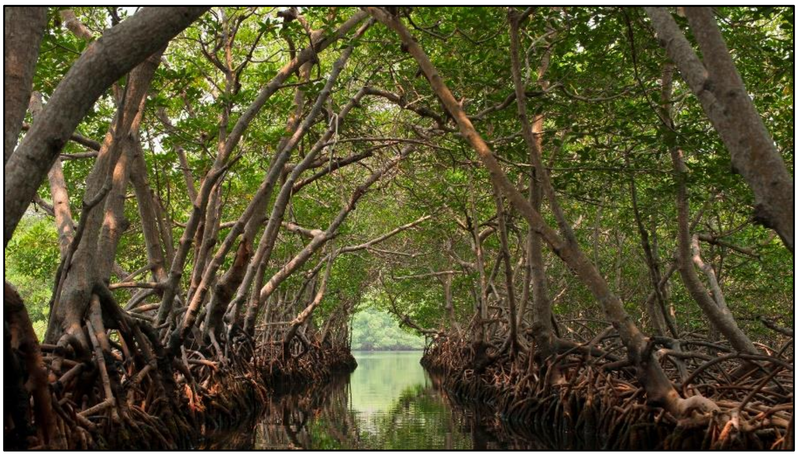
- The habitat of a saguaro cactus is the open desert.
- The habitat of a Gila woodpecker is a saguaro cactus (where it makes its nest) and the air and the ground in the open desert (where it collects food).
- The habitat of a desert ant is underneath the rocks and soil and on the soil surface.
- Termites live at the base of the saguaro cactus.
- Sap beetles live inside the saguaro flowers.
- Kangaroo rats live in burrows and come out to look for food at night.

Question:

5. Explain the difference between an ecosystem and a habitat.

4.2 Different ecosystems

Mangrove forest



- Mangroves are trees that can grow with their roots in sea water. They form forests along the coasts of many tropical countries.
- Young fish live among the mangrove roots, safe from larger fish that might eat them. Mud skippers climb out onto the mud when the tide is out, feeding on whatever they can find.
- As the mangrove leaves fall onto the mud, they are decomposers by bacteria. Prawns and crabs eat the partly decomposed leaves.
- Crab-eating macaques, a type of monkey, climb through the trees and catch crabs on the tree roots and mud.

Sea ice in the Arctic Ocean

- During the winter in the Arctic Ocean, it is so cold that some of the sea water freezes.
- Seals hunt for fish in the water but must come to the surface to breathe air.
- Polar bears patrol the ice, looking for seals to kill and eat. Polar bears are good swimmers and can move from one ice floe to another.
- Enough light passes through the ice to allow tiny algae (single-celled plants) to grow on the underside of the ice floes.
- Tiny shrimp-like organisms eat the algae. Fish eat the shrimp-like organisms.

Rice Paddy

- Not all ecosystems are natural. This area of rice paddies in Malaysia is farmed by people.
- At some times of the year, the paddy fields are flooded with water. Algae grows in this shallow water, and on the mud at the sides of the flooded areas.
- Fish swim into the flooded paddies from the irrigation canals. Frogs and dragonflies breed in the water.
- Because the water is shallow, it heats up quickly during the day, and cools down quickly at night.
- Farmers often add fertiliser to the paddy fields, making not only rice but also the algae grow faster, providing more food for the animals.
- Many birds feed in and around the paddy fields.

4.3 Intruders in an ecosystem

New species in an ecosystem

In your studies of ecosystems, you have seen how all the different organisms interact with each other and their environment. In this topic, you will find out what happens if a new species suddenly arrives. How does the new species fit into the network of interactions? How does this affect the species already there?

Introduced species in New Zealand

New Zealand is a country in the Pacific Ocean. New Zealand became separated from all the other areas of land in the world about 66 million years ago. Because of this separation, the species that developed in New Zealand were different from those elsewhere on Earth. Before humans arrived in New Zealand, there were no predatory mammals there. Many of the **native species** of birds' nest on the ground. There were no predators to eat their eggs, so the eggs and young birds were safe. Even the adults of several species of native bird, such as the kiwi, cannot fly. Nobody knows exactly when humans first arrived in New Zealand, but it was probably about 700 years ago. Humans brought species of animals with them that did not belong in New Zealand. For example, rats stowed away on their boats. Rats now live in most of the country. The rats eat birds' eggs and defenseless young birds. Since then, other species have been introduced to New Zealand. Farmers have brought sheep, to farm for their wool and meat. Rabbits were brought on sailing ships, to use as food. But the rabbits escaped and began to eat grass in the sheep pastures. So, people brought stoats from Europe to control the rabbits. Now the stoats have spread all over New Zealand. They are fierce hunters and breed rapidly. They kill and eat birds much larger than themselves. Stoats have made several species of native bird **extinct**, including the laughing owl and the New Zealand thrush. Stoats eat almost 60% of kiwi chicks. People in New Zealand are now trying to **eradicate** (completely get rid of) stoats, but this is very difficult to do. The best that can be done is to control their numbers. Scientists think that 53 species of native bird in New Zealand have become extinct since humans arrived. The extinctions have been partly caused by people hunting and killing the birds, but mostly because of introduced **invasive species**.

Questions:

1. In your own words, explain what a 'native species' is.
2. Name some native species in your own country.
3. Suggest why it is very difficult to eradicate an introduced species once it has settled into a new place.
4. Buffelgrass is native to Africa, Asia, and the Middle East. It was planted in Arizona in the 1930's, as food for cattle. Now, it is spreading rapidly through the Sonoran Desert. What is the name for a plant, such as buffelgrass, that is growing in an ecosystem where it does not belong?
5. Buffelgrass grows in dense patches. It takes water and nutrients from the soil. Suggest how buffelgrass could affect some of the native species in the desert.

4.4 Bioaccumulation

DDT

DDT is an **insecticide**. This means that is kills insects. DDT was first produced in the 1940s. It was used to kill insects that transmit disease. It was especially useful for killing mosquitoes that transmit malaria, and fleas that transmit a disease called typhus. DDT was also used to kill insects that eat crops. No one thought that DDT could harm organisms other than insects. This old picture was taken in the 1940s. It shows a beach being sprayed with DDT to kill mosquitoes. The people on the beach are being sprayed too. DDT is very good at killing insects. But gradually, people began to realise that it was also harming animals that on one wanted to kill. In 1962, an American author called Rachel Carson wrote a book called *Silent Spring*. She described how DDT was killing not only mosquitoes, but also birds. Her book made many people realise that some insecticides, including DDT, are very harmful to the environment. Scientists now understand how it causes harm to ecosystems.

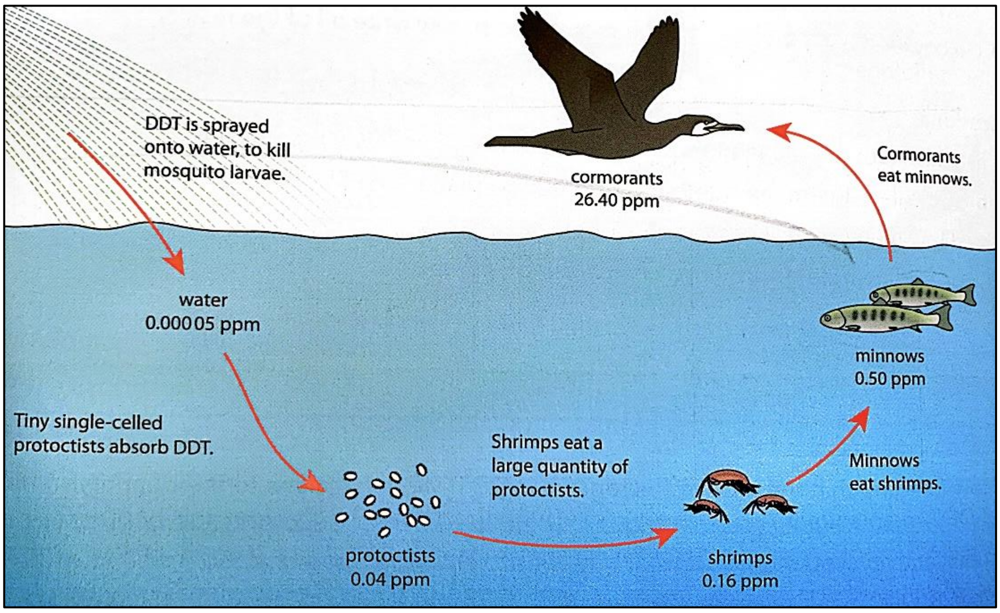
DDT in food chains

We now know that DDT does not break down. It is a **persistent** chemical. It stays in the environment for many years. It is not broken down by decomposers. When DDT is sprayed, some of it is carried up high into the air. It can be blown for very long distances, far away from where it was used. When DDT gets into an animal's body, it stays there for the whole life of the organism, it never breaks down. DDT is very harmful to many kinds of animals. It is **toxic** (poisonous). For example, it makes the shells of birds' eggs very thin and easy to break.

This old photograph shows some eggs of a bird called an ibis. The eggs did not hatch, because the female ibis that laid them had DDT in her body.

Bioaccumulation and biomagnification

Imagine that DDT has been sprayed into some water. Tiny algae take up some of the DDT. Shrimps eat the algae, and fish eat the shrimps. Cormorants (fish-eating birds) eat the fish. All the DDT in all the algae that the shrimp eats over its lifetime **accumulates**, or builds up, in its body. The longer the organism lives, and the more DDT it takes in, the more DDT it gets in its body. This process is called **bioaccumulation**. All the DDT in all the shrimps that the fish eats accumulates in the fish's body. Eventually, all the DDT in all the fish that a cormorant eats in its lifetime accumulates in the cormorant's body. This means that the concentration of DDT in an animal's body increases as you go up the food chain. This is called **biomagnification**. The next diagram shows how the concentration of DDT in the bodies of species in a food chain increases along the chain. The concentration is measured in parts per million (ppm). This is the number of grams of DDT in one million grams of the organisms.



Questions:

1. How many times greater is the concentration of DDT in a cormorant's body than in a minnow's body?

2. Explain, in your own words, why the concentration in the cormorant is greater than in a minnow.

KEY WORDS

- **Adaptations** – Features of the organisms that help them to live and reproduce in their habitat.
- **Ecology** – The study of organisms in their natural habitat.
- **Ecosystem** – A network of interactions between all the living organisms in a habitat, and the non-living things around them.
- **Environment** – Everything around an organism that affects it.
- **Food web** – A diagram showing many interconnected food chains.
- **Habitat** – The place where an organism lives.
- **Interact** – Affect one another.
- **Nectar** – A sugary liquid made by flowers, to attract insects for pollination.
- **Nocturnal** – Active at night.
- **Pollen** – Tiny grains made by flowers, which contain male gametes.
- **Pollinating** – Moving pollen from an anther where it is made, to a stigma.
- **Eradicate** – Get rid of; destroy.
- **Extinct** – No longer existing.
- **Invasive species** – A species that has been introduced onto an ecosystem where it does not belong.
- **Native species** – Types of organisms that are living in their natural habitat.
- **Accumulate** – Gradually increase in quantity.
- **Bioaccumulation** – Gradual increase of a substance in an organism's body; it happens when the substance cannot be broken down inside the body cells.
- **Biodegradable** – Something that can be broken down naturally by bacteria and fungi.
- **Biomagnification** – Increase of the concentration of a substance as you go up in a food chain.
- **Insecticide** – A chemical used to kill insects.
- **Persistent** – A persistent substance stays in the environment for a long time.
- **Toxic** – Poisonous

Stage 7

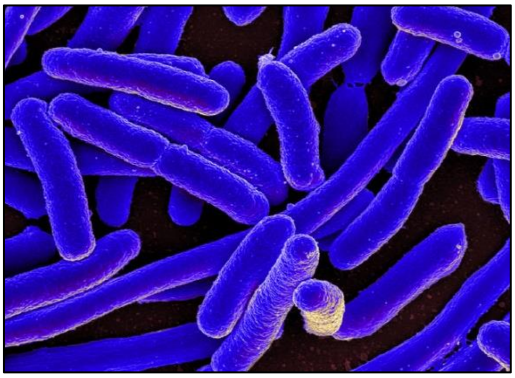
Unit 7 Microorganisms in the environment

7.1 Microorganisms

What is a microorganism?

A **microorganism** is a living organism that is so small that you can only see it clearly by using a microscope. Like all living organisms, microorganisms are made of cells. Many microorganisms are made of only one cell: they are **single-celled**. There are several different kinds of microorganisms. They include **bacteria**, microscopic **fungi**, **protozoa,** and **algae**. Each of these microorganisms is described later in this topic.

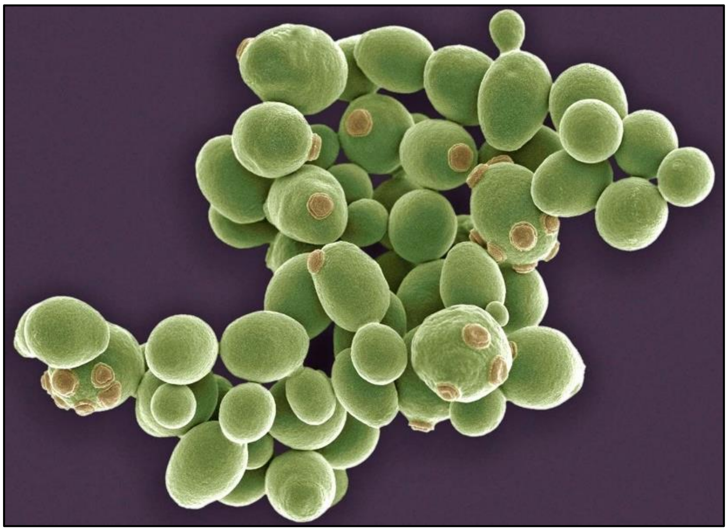
Bacteria



Bacteria are everywhere. Bacteria is a plural word; the singular word is bacterium. Each bacterium is made of a single cell. Cells of bacterium are much smaller than animal cells or plant cells. You could fit 1000 of the bacteria in the photograph, lined up end to end, between two of the millimeter marks on your ruler. Most bacteria are harmless but there are a few kinds that can make you ill.

Fungi

Fungi (singular; fungus) are not always microorganisms. Many fungi, including mushrooms and toadstools, are large and easy to see. **Mushrooms** and **toadstools** are only part of the fungus's body, though, and they only grow at certain times of the year. Most of the time, the fungus is just a tangle of very tiny threads. The threads often grow under the ground, or inside a dead log. The threads are so tiny that they are difficult to see without a microscope. There are also some kinds of fungi that do not produce mushrooms or toadstools. They are made of single cells, not threads, so they are microorganisms. The powdery substance that you sometimes see on the surface of grapes is made up of millions of cells of **yeast**, which is a microscopic fungus.



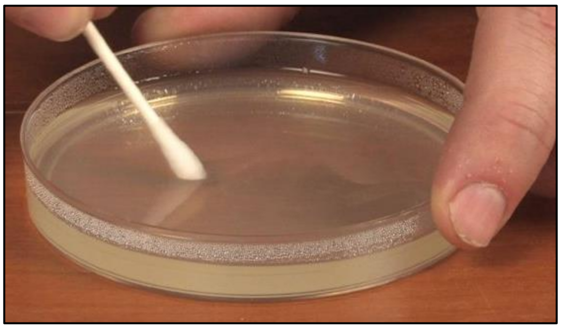
Group of yeast cells seen through a microscope

Questions:

1. Viruses are even smaller than bacteria. Suggest why they are not usually said to be microorganisms.
2. We can see yeast on the surface of fruit. Why is yeast classified as a microorganism?

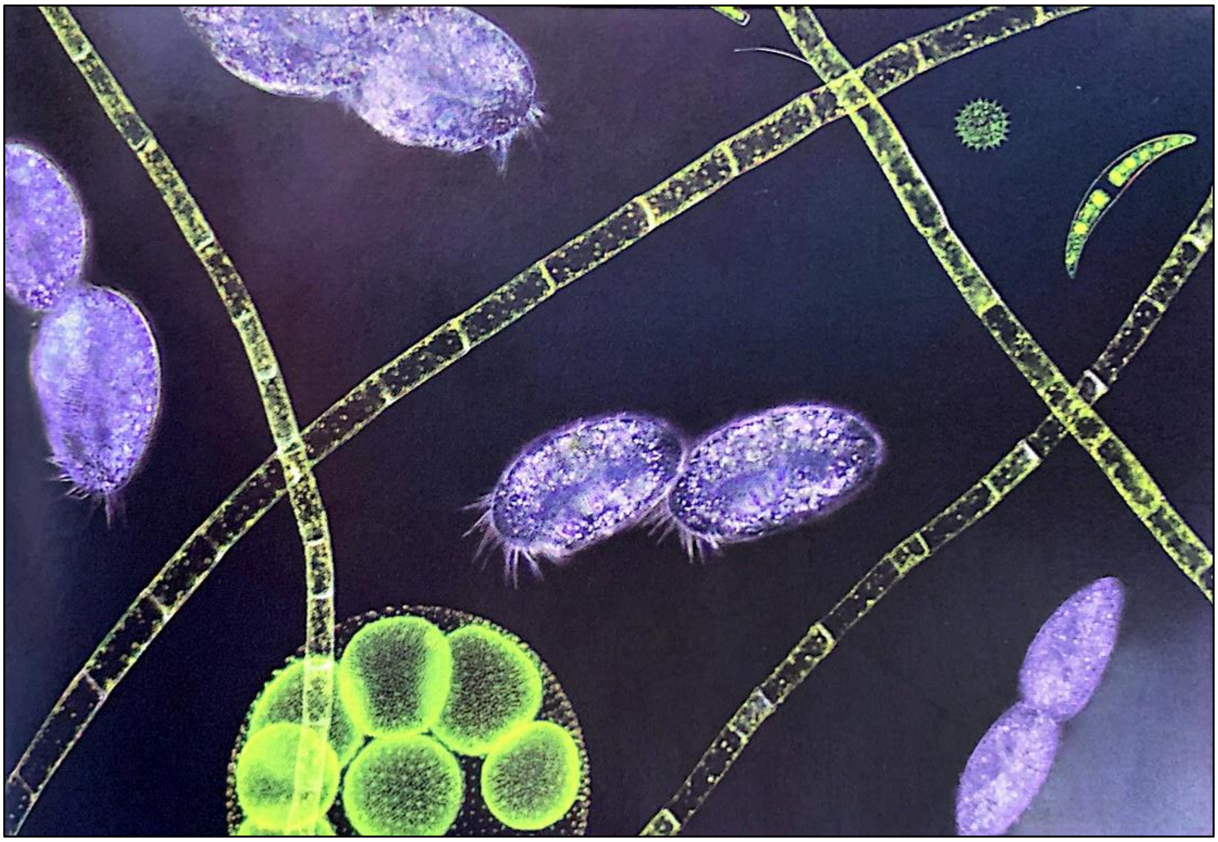
Growing microorganisms

A single microorganism is too small to see without a microscope, but when left to grow, a single cell of a bacterium or fungus divides repeatedly to make a collection of many cells. This collection of cells is called a **colony**. The colonies are big enough for you to see without a microscope. This can be done safely in the laboratory. Scientists let microorganisms grow in a **Petri dish** containing a special kind of jelly, called **agar jelly**. This dish and the jelly must be **sterile**. This means that any living organisms on them must be killed.



Microscopic algae and protozoa

If you look at some pond water through a microscope, you will see many tiny living organisms in the water. Some of them are tiny plant-like organisms, called algae. Some of them are animal-like organisms, called protozoa. The singular forms of these two words are alga and protozoan.



Questions:

3. Some of the microorganisms in the photograph are not single-celled. How are their cells arranged?
4. Some of these microorganisms have cells like animal cells, and some have cells like plant cells.
    a. Make a simple drawing of one of the microorganisms that has cells like animal cells.
    b. Make another simple drawing of one of the microorganisms that has cells like plant cells.
    c. Label your drawings to explain the differences between them.

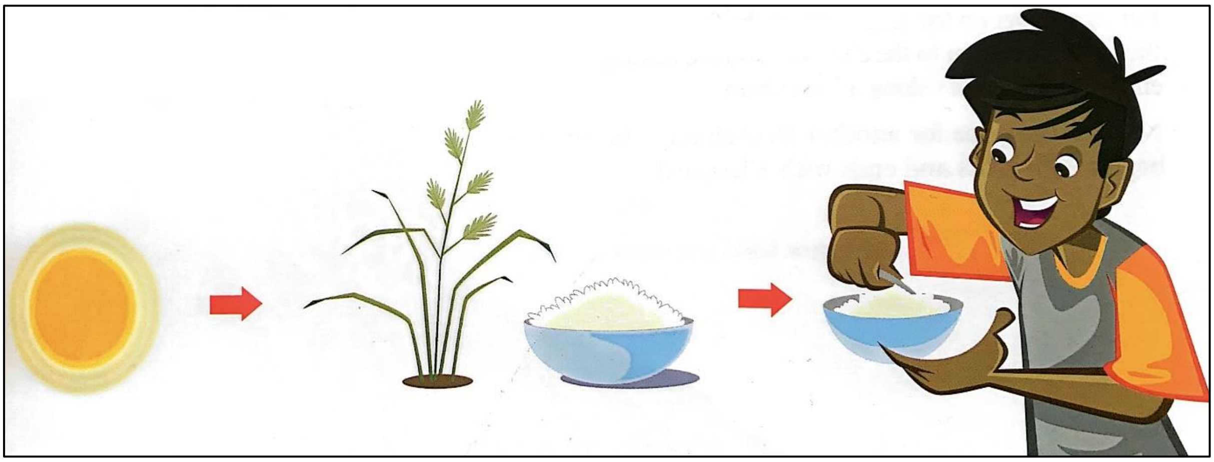
7.2 Food chains and webs

Microorganisms in the environment

The study of organisms in their environment is called ecology. All the different organisms that live together affect one another in some way. For example, one species of animal may eat another animal. A plant may provide shelter for an animal. Microorganisms have important roles to play in the environment. In the rest of this unit, we will look at how microorganisms affect other organisms in their environment, including their importance in **food chains** and food webs. In this topic, you will look at how food chains and food webs describe how energy, in the form of food, is transferred between animals and plants.

Food chains

Arun has chicken and rice for lunch. It gives him a lot of energy. The food you eat gives you energy. How did the energy get into the food? The energy in food begins I the Sun. Energy from the Sun reaches the Earth in sunlight. Plants use energy from sunlight to make their own food. Some of the energy for sunlight goes into the food that the plant stores in its roots, stems, fruits, and leaves. When an animal, such as Arun, eats part of the plant, it eats the food the plant made. This is how the animals gets energy. This is called energy transfer. You can show how the energy passes from the Sun into the rice, and then into Arun's body, by drawing a food chain. The arrows in the food chain show how energy is passed from the Sun to the rice plant, and then is transferred to Arun.



The first organism in a food chain is a **producer**. Plants use energy from the Sun to produce food. All the other organisms in a food chain are **consumers**. Animals are always consumers. They must eat ready-made food to get their energy. They consume (eat) plants or other animals. Consumers that consume only plants are **herbivores**. Consumers that consume other animals are **carnivores**. Animals that catch, kill, and eat other animals are **predators**. The animals that they eat are their **prey**.

Questions:

1. The chicken that Arun ate for lunch ate wheat. Wheat is a plant. Draw a food chain showing how the energy passed from the Sun to Arun when he ate the chicken.
2. Draw a food chain showing how energy from the Sun passes into you when you ate one of the things you had for breakfast or lunch.

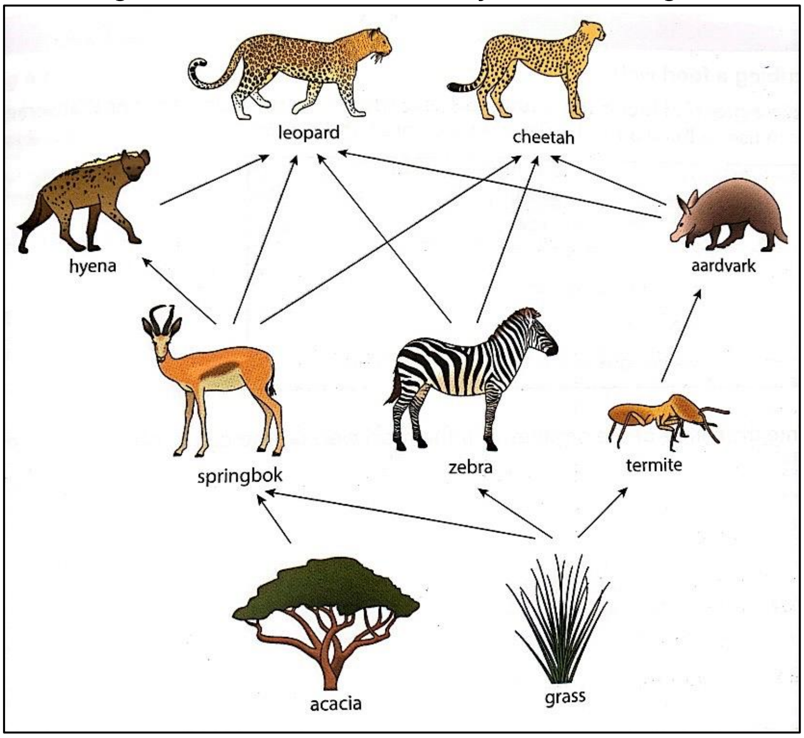
Food webs

Here are two more food chains. These food chains describe part of the feeding network of plants and animals on the African plains.

acacia tree → springbok → cheetah

grass → termite → aardvark → leopard

The diagram below shows how the organisms in these two food chains, and some other organisms, are connected by their feeding habits. This diagram is a food web.



Questions:

3. Write down **two** more food chains that you can find in the food web diagram.
4. Write the names of the **two** producers in the food web.
5. How many consumers are there in the food web?
6. How many herbivores are there in the food web?
7. Write the names of **two** carnivores from the food web.
8. Write the names of **two** predators and their prey, from the food web.

7.3 Microorganisms and decay

Decomposers and decay

The food chains and food webs that you looked at in the previous topic did not include microorganisms. But microorganisms are everywhere. They live in the air, in the soil, in water, on our skin and inside our bodies. The apple in the picture has microorganisms growing on its surface. Each spot in the apple is made up of millions of cells of microscopic fungi. This kind of fungus is sometimes called **mould**. The apple is mouldy. The microorganisms have changed the apple. They have made it **decay**. Organisms that make things decay are called **decomposers**. Many different kinds of microorganisms, including some kinds of bacteria and microscopic fungus, are made the apple rot. decomposers. Apples come from plants, which are living organisms. Any substance that has been made by a living organism is called **organic matter**. So, apples are organic matter. Some microorganisms can break down organic matter when they feed on it. This is what has caused the apple to decay. The microscopic fungi have broken down the crisp, fresh apple and made it become brown and soft. They have made the apple **rot**.

Activity 7.3.1 What can microorganisms decay?

1. Which of these things are made of organic matter?

   bread **water** **leather** **rock** **wood** **fruit**
2. Think of **two** more things that are made of organic matter, and **two** more things that are not made of organic matter.
3. Which of the things in your answer to questions 1 and 2 can be broken down by microorganisms.

Questions:

1. Some microorganisms are decomposers. Explain what this means.
2. Describe **one** way in which decay by microorganisms is not useful.
3. Suggest **one** way in which decay by microorganisms is useful.

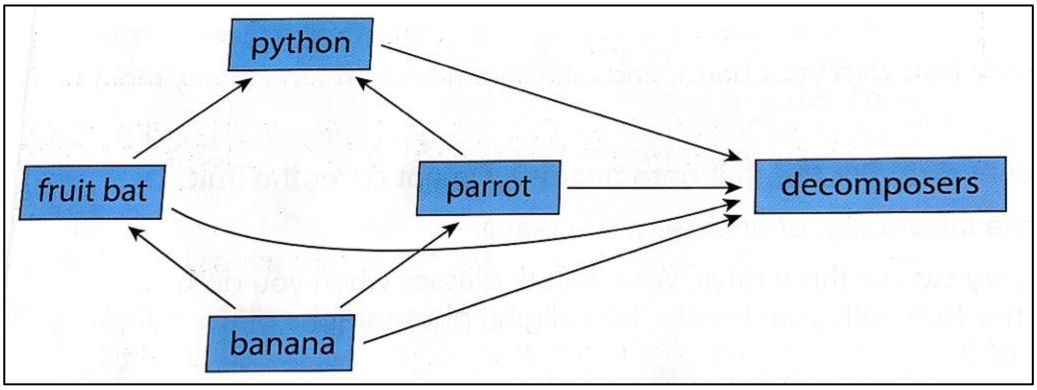
7.4 Microorganisms is food webs

Roles of decomposers

No-one would wat to eat a rotten apple. The microorganisms that make an apple decay have spoiled the food. But most of the time, decay by microorganisms is useful. Microorganisms break down dead bodies and animal waste. They decompose this material. Almost all decomposers are microorganisms. Fungi and bacteria are the most importance decomposers. If the dead bodies and waste are not broken down by decomposers, they would just build up. There would be heaps of dead plants, dead animals, and animal **dung** everywhere. But there is an even more important reason why decomposers are useful. The dead bodies and waste contain substances that living organisms can use to supply them with energy, or to help them grow. These substances are called **nutrients**. When microorganisms decay organic matter, they return the nutrients to the soil. Plants can use the nutrients to help them grow. This is helpful for plants. This also helps animals because there are more plants to eat.

Decomposers in food webs

Decomposers feed on almost every organism after is dies. They also feed on waste from animals. This is how decay microorganisms get their energy. Energy from the dead organisms and their waste is transferred to the decomposers. You can show this by adding decomposers to food chains or food webs. You do not usually do this because you must draw an arrow from every organism in the food chain or food web to the decomposers. This makes it look very complicated. The diagram shows a simple food web with decomposers added to it.



Questions:

1. Write a food chain of your own. Add decomposers to your food chain.
2. Look at the food web above. Are decomposers producers or consumers? Explain your answer.

KEY WORDS

- **Agar jelly** – A think, clear substance made from seaweed, used for growing microorganisms.
- **Algae** – Small, plant-like organisms that grow in or near water (singular: alga).
- **Bacteria** – Organisms made of a very small single cell, with a cell wall but no nucleus (singular: bacterium).
- **Colony** – A group of bacteria or fungi, such as the ones growing on the surface of agar jelly.
- **Fungi** – Organisms such as mushrooms, toadstools, and yeast; they get their energy by decaying organic matter (singular: fungus).
- **Microorganism** – A living organism so small that it can only be seen with a microscope.

- **Mushroom** – A fungus with a round top and a short stem.
- **Petri dish** – A small, clear, round dish with a lid, used for growing microorganisms.
- **Protozoa** – Very small, single-celled, animal-like organisms (singular: protozoan).
- **Single-celled** – Made of only one cell.
- **Sterile** – Completely clean; free from bacteria and other microorganisms.
- **Toadstool** – A fungus with a round top and narrow stem.
- **Yeast** – A microscopic fungus.
- **Carnivore** – Consumers that eat other animals.
- **Consumer** – An organism that cannot make its own food, and therefore relies on food made by plants; all animals and fungi are consumers.
- **Food chain** – A diagram that shows how energy is transferred from one organism to another, in the form of food.
- **Herbivore** – An organism that gets its energy by eating plants.
- **Predator** – An animal that catches, kills, and eats other animals.
- **Prey** – An animal that is killed and eaten by a predator.
- **Producer** – The first organism in a food chain.
- **Decay** – Rot; organic substances can be decayed by microorganisms.
- **Decomposer** – An organism that decays dead plant and animal matter.
- **Mould** – Microscopic fungi that are growing on organic matter.
- **Organic matter** – Any substance that has been made by a living organism.
- **Rot** - Decay
- **Dung** – Solid animal waste.
- **Nutrients** – Substances that living organisms can use to supply them with energy. Or to help them grow.

Stage 8

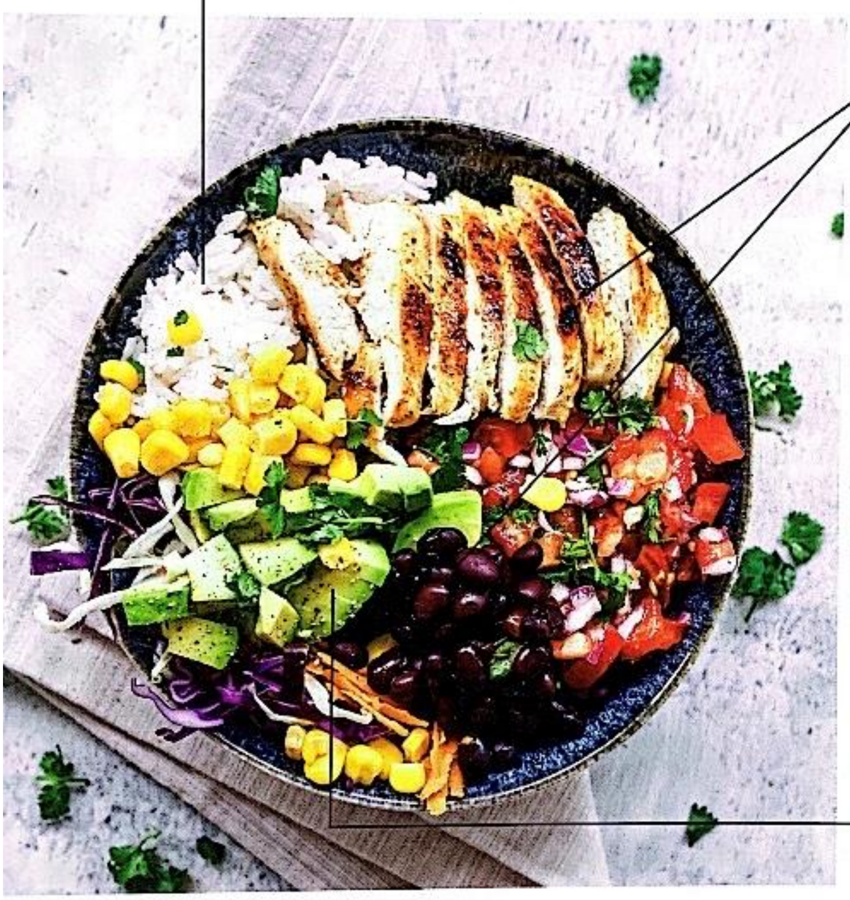
Unit 7 Diet and growth

7.1 Nutrients

Carbohydrates, fats, and proteins

The photograph shows a plate of food. There are several different kinds of food on the plate. How does each of these foods help the body to stay healthy, and to have energy?

The rice contains a lot of **starch**. Starch is a type of **carbohydrate**. After you have eaten starch, the body breaks it down to make a sugar called glucose. You may remember that glucose is the fuel that your cells use for respiration, to release energy. So, starch, sugar and other carbohydrates are needed to give you energy.



The chicken and beans contain a lot of **protein**. Protein is important for making new cells in the body. So, you need protein to help the body to grow, or to repair itself if it gets damaged. Protein is also needed to make haemoglobin and antibodies.

The avocado contains **fats** and **oils**. Fats and oils are very similar but, at normal temperatures, fats are solid and oils are liquid. Fats and oils give you energy. They are also needed to make cell membranes.

Protein, carbohydrates, and fat are nutrients. Nutrients are substances found in food, that you need to stay healthy. These three photographs show some of the kinds of foods that you can eat to get these nutrients.

These foods are good sources of protein

These foods are good sources of starch (a type of carbohydrate)

These foods contain a lot of fat

Energy stores

You do not eat all the time, but you need energy all the time. You get almost all your energy from the carbohydrates and fats that you eat. You can also get energy from protein if you run out of carbohydrates and fats. You store a little bit of carbohydrates, and quite a lot of fat, in your body. These energy stores provide you with energy whenever you need it. You store a small amount of carbohydrates in your cells, especially in your liver and muscles. These are short-term energy stores. For long-term energy stores, your body stores fat in special cells underneath the skin and around some of the body organs. Fat stores in the body also provide heat insulation. Animals that live in cold places, like this seal, have a lot of fat stores underneath their skin, to help to stop them losing heat from their body.

Questions:

1. Copy and complete this table.

Nutrient	Examples of foods that contain a lot of this nutrient	Why the body needs this nutrient
Protein		
Carbohydrate		
Fat		

2. Explain the difference between the meanings of the words 'food' and 'nutrient'.

Vitamins

Vitamins are nutrients that are needed in only small amounts, but if you don't eat them, you can get ill. There are a lot of different kinds of vitamins. Each kind is given a letter.

Vitamin A is needed to help your eyes work well, so that your vision is good. It is particularly important for helping us to see when it is quite dark. People who dint have enough vitamin A in their diet may not be able to see anything at night. It also helps your white blood cells to fight pathogens. You get vitamin A by eating green vegetables, carrots, and squash (such a pumpkin), fruit, food made from milk (such as cheese) and some kinds of fish.

Vitamin C helps the skin to stay strong and to heal quickly if it is damaged. It keeps blood vessels and bones healthy. People who don't eat enough vitamin C can get an illness called scurvy. A person with scurvy feels weak and may have swollen, bleeding gums. You get vitamin C by eating fresh fruits and vegetables. Citrus fruits are particularly rich in vitamin C. Potatoes and colourful berries are also good sources of vitamin C. In the past, before anyone knew about vitamin C, sailors on long sea voyages often got scurvy. This was because they had no fresh fruit or vegetables to eat.

Vitamin D is needed for strong bones and teeth. It helps the body absorb calcium from the food that you eat. There are not many kinds of food that contain vitamin D. Oily fish is probably the best source. But for most people, most vitamin D does not come from food that you eat. Instead, vitamin D is made in the skin when sunlight falls onto it. People who never go outdoors, or who never get any sunlight on their skin, may not get enough vitamin D. This is most likely to happen if you live in a country far from the equator, or where there is not much sunshine. In children, lack of vitamin D can stop their bones growing normally. This illness is called rickets.

Minerals

There are several different kinds of **minerals** that you need to eat. Two of the most important ones are calcium and iron.

Calcium – bones and teeth contain calcium, so you need to eat plenty of calcium to make them strong. Foods made from milk are excellent sources of calcium. Seeds and some types of nuts (such as almonds) also contain a lot of calcium.

Iron – Is needed to make haemoglobin. If you don't eat enough iron, you don't make enough haemoglobin, so not enough oxygen is transported around the body. This causes an illness called **anaemia**, which makes a person feel very tired. Good sources of iron include meat (especially red meat), dark green vegetables, many kinds of fish and shellfish and some nuts and seeds.

Questions:

3. Look back at question 1. Draw a similar table, but include vitamin A, C, D, calcium, and iron instead of protein, carbohydrates, and fats. Then complete your table.
4. Use your knowledge about respiration to explain why a person with anemia does not have much energy.
5. A meal has bell peppers are stuffed with lentils and vegetables and topped with cheese. They contain a lot of iron and calcium. What other nutrients do you think this meal contains? Explain your answer.

Water

There is one more nutrient to add to the list if what you need to take into your body each day. This is water. Water is needed for many different purposes in the body. Cells and blood contain water. Almost 60% of a person's weight is made up of water. Water in cells allows all the different chemicals inside them to dissolve, so that they can react together. These reactions keep us alive. Water in blood allows it to flow easily, transporting substances all over the body.

7.2 A balanced diet

Diet

Your diet is the food that you eat each day. Your diet should provide you with some of all the different kinds of nutrients. It should also give you the right amount of energy. A diet that provides all the different kinds of nutrients, and the right amount of energy, is called a **balanced diet**.

How much energy?

Each day, the energy in the food you eat should be approximately equal to the energy that you use up. Most of your energy comes from the carbohydrates and fat that you eat. Different people use different amounts of energy. For example:

- If you do a lot of sport, or walk or run a lot each day, you use more energy.
- If you don't move around much, you use less energy.
- Some people's genes mean that their body uses up energy more quickly than other people doing the same thing.
- If you are growing fast, you need extra energy to help your cells to divide.
- Tall people use more energy to move their body around than small people.

Different diets

Everyone is different. Different people need different diets. Everyone needs plenty of minerals and vitamins, but people vary in how much protein and carbohydrates they need. Here are some examples.

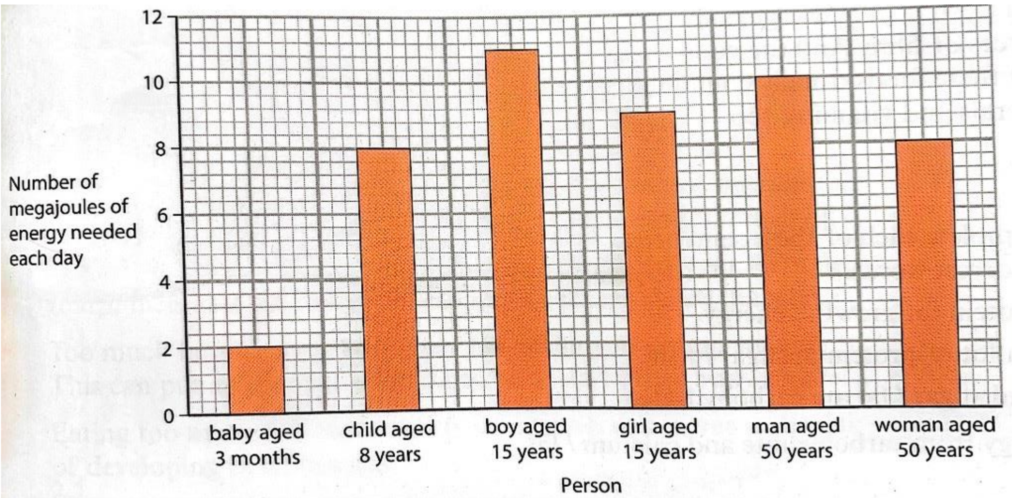
Young people who are still growing need a lot of protein to make new cells. If they use a lot of energy, then they need to eat enough carbohydrates to give them plenty of energy. They need to eat a little bit of fat for energy and making the membranes on the new cells.

People who must sit down for a lot of the day don't use up as much energy as people who are very active. So, they don't need to eat as many carbohydrates or fat as someone who has a job that involves moving around, or who does a lot of sport.

A pregnant woman needs to eat plenty of protein to help to build her growing baby's new cells. She also needs a lot of iron in her diet, to make haemoglobin in her own blood and her baby's blood. She should eat plenty of calcium, for building her baby's bones.

Questions:

The bar chart shows some examples of the energy that different people need each day. A megajoule (MJ) is one million joules.



1. How many MJ of energy does an 8-year-old need, on average?
2. Explain why some 8-year-old children might need more energy that this.
3. Explain why some 8-year-old children might need less energy that this.
4. Suggest why a man aged 50 years needs to take in less energy in his diet than a boy aged 15 years.
5. Suggest why most 15-year-old girls need less energy in their diet than most 15-year-old boys.

Fibre

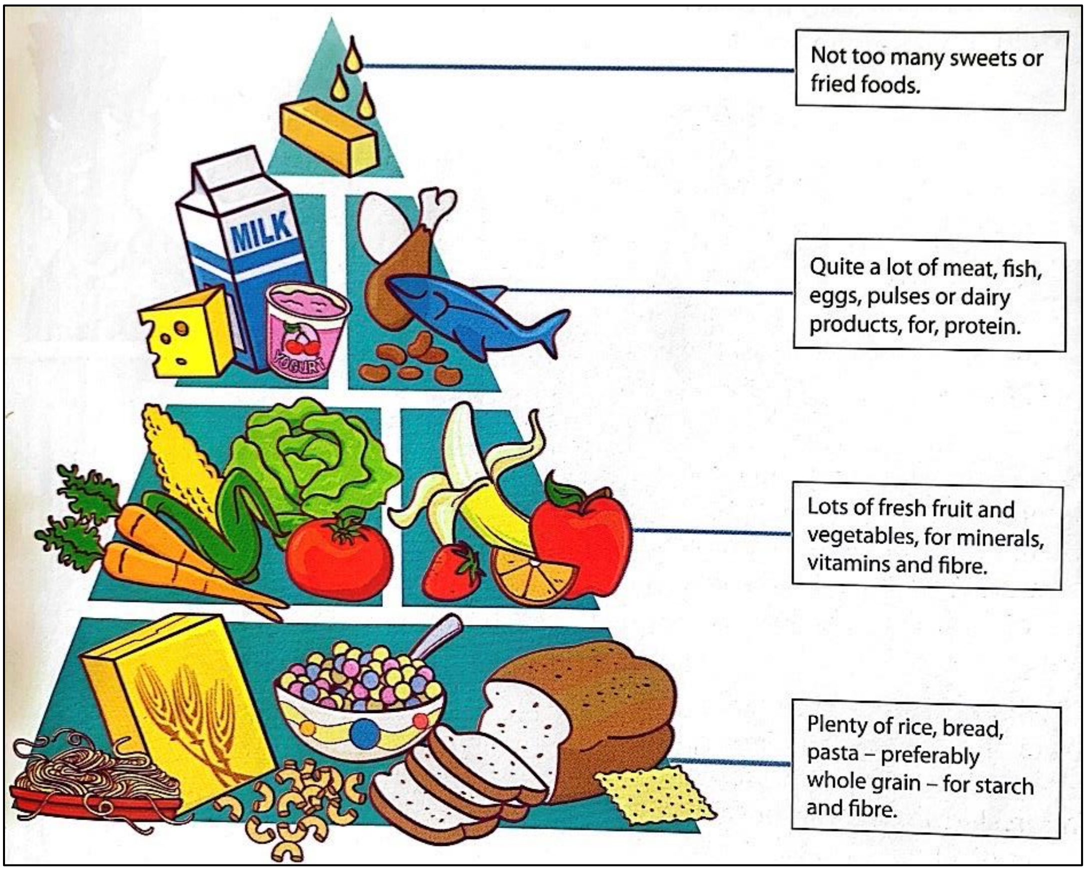
As well as the six nutrients you need in your diet, you also need to eat plenty of **fibre**. Fibre is not actually a nutrient. This is because, when you eat it, you cannot digest it. So, it does not go into the blood or to your cells. Instead, it just travels all the way through the digestive system. It leaves the body as faeces. You might think this means that it is no use to you, but in fact fibre is very important to keep the digestive system healthy. It helps to prevent **constipation**, when the digestive system slows down and faeces collects inside it, instead of being passed out. Fibre is mostly cellulose. Remember that plant cell walls are made of cellulose, so foods made from plants are a good source of fibre. Cereal grains, seeds and fresh fruit and vegetables are all excellent sources of fibre. And the good thing about this is that these foods usually contain lots of different minerals and vitamins, too.

Questions:

6. Copy and complete these sentences. Choose the correct words.
    a. I need protein for **growth / energy**.
    b. There is a lot of protein in **sugar / fish**.
    c. Starch and **sugar / fat** are carbohydrates.
    d. I get energy from carbohydrate and **calcium / fat**.

Food groups

It can be quite difficult to think about which nutrients are in each kind of food that you eat. To make it easier, it sometimes helps to think about food groups. The picture shows some different kinds of foods arranged in a triangle. The bigger the area in the triangle, the greater the proportion of your diet that kind of food should make up.



Not too much

Although, you should try to include every different kind of nutrient in your diet, there are some things that you should not eat too much of.

- Too much sugar (a kind of carbohydrate) can make your teeth decay. It also increases the risk of developing an illness called diabetes.
- Too much fat, oil or carbohydrates can make you put on weight. This can put strain on your joins, heart, and other body organs.
- Eating too many fats that come from animals can increase the risk of developing heart disease.

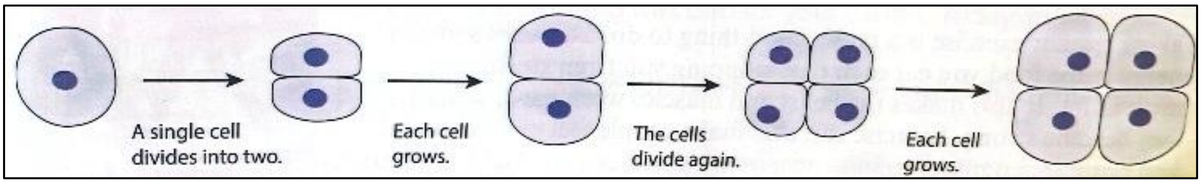
Questions:

7. Look at the picture of the food triangle.
    a. Explain why sweets and fried foods are at the top of the triangle.
    b. Explain why it is better to eat whole-grain bread or brown rice rather than white bread or white rice.
    c. Suggest why you can make sure you get enough protein in your diet, if you don't like eating meat or fish.
8. You little brother's favourite meal is a lamb burger and fries, with a sweet milky drink.
    a. What nutrients does he get from this meal?
    b. What else should he include in his diet?
    c. Explain to him why he should not eat his favourite meal too often.

7.3 Growth, development, and health

Growth

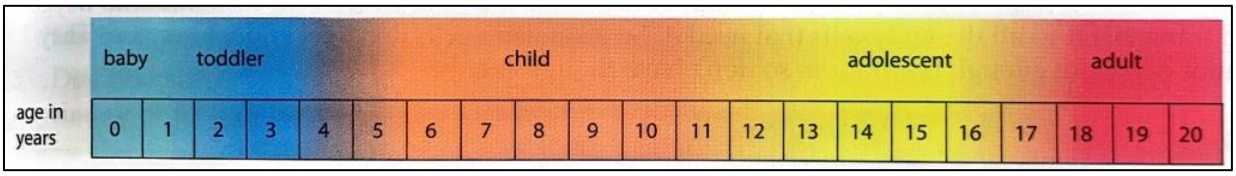
Every person on Earth began their life as a single cell. This cell divided to produce two cells. Each of these cells got bigger, then divided again.



To begin with, the cells are all the same. They produce a little ball of cells called an **embryo**, and eventually a baby. This all happens inside the mother's body. By the time the baby is born, it is a miniature human being. It continues to grow until it is about 18-20 years old. Cells contain a lot of protein. Energy is needed to make cells divide. A pregnant woman and a growing child need plenty of protein in their diet, as well as enough energy to help cells to divide.

Development

The change from a single cell to an adult human involves more than just growth. As the tiny embryo grows into a baby, all its different tissues and organs are formed. As the baby grows into a child, its leg muscles and bones become stronger, so that is can walk and then run. Its brain develops, as it learns to talk and play with toys. These changes are called **development**. Each person is an individual, and everyone grows and develops at different rates, and in slightly different ways. But everyone goes through the same stages of development. These are shown in this chart. Notice that each stage blends gradually into the next one, there are no sharp divisions between them.



Questions:

1. Growth means getting bigger. Explain what happens as a person grows, to make their body get bigger.
2. Some young children do not get enough protein of energy in their diet. Explain why they may not grow very tall.

Exercise and health

Topic 7.2 described some of the ways in which your diet can affect your health. There are other ways in which the decisions you make about your lifestyle can affect how healthy you are. Taking regular exercise is a good thing to do. This uses some of the energy in the food you eat each day, stopping you from storing too much as fat. It also makes the heart and muscles work hard, so that they become strong. Exercise can also make people feel more cheerful and positive about life.

Smoking

Smoking cigarettes damages the smoker's health. It also damages the health of people around then, who accidentally breathe in cigarette smoke. Tobacco contains many different harmful substances.

Nicotine – Tobacco smoke contains nicotine. Nicotine can help someone stay alert. Nicotine is addictive. This means that it is difficult to manage without it once you are used to smoking. Therefore, smokers find it difficult to stop smoking. Nicotine damages blood vessels in the smoker's body. It makes them get narrower, so it is harder for blood to get through them. Smokers are more likely than non-smokers to develop heart disease.

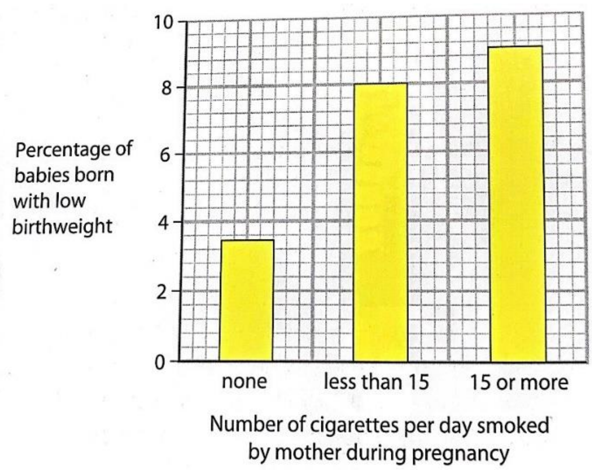
Tar – Tobacco smoke contains a mixture of dark, sticky substances called tar. Some of the chemicals in tar cause cancer. Cancer happens when cells start dividing out of control and spread to other parts of the body. Smoking increases the risk of getting many kinds of cancer, including lung cancer.

Carbon monoxide – This is a poisonous gas. When it gets into the body, it combines with haemoglobin inside red blood cells. This stops haemoglobin doing its normal job, which is to combine with oxygen and transport it to all the body cells that need it. So, a smoker's cells don't get enough oxygen. They cannot carry out enough respiration, so don't get enough energy.

Particulates – Tobacco smoke contains tiny particles of carbon and other minerals, called particulates. They get trapped inside the smoker's lungs. This makes the walls of the alveoli break down. Instead of having millions of tiny alveoli in the lungs, the smoker has a lot of big spaces. This makes it difficult of them to get enough oxygen into their blood.

Questions:

This bar chart shows the percentage of babies with a birthweight lower than normal, born to mothers who smoked different numbers of cigarettes per day while they were pregnant. Use the information in the bar chart to answer these questions.

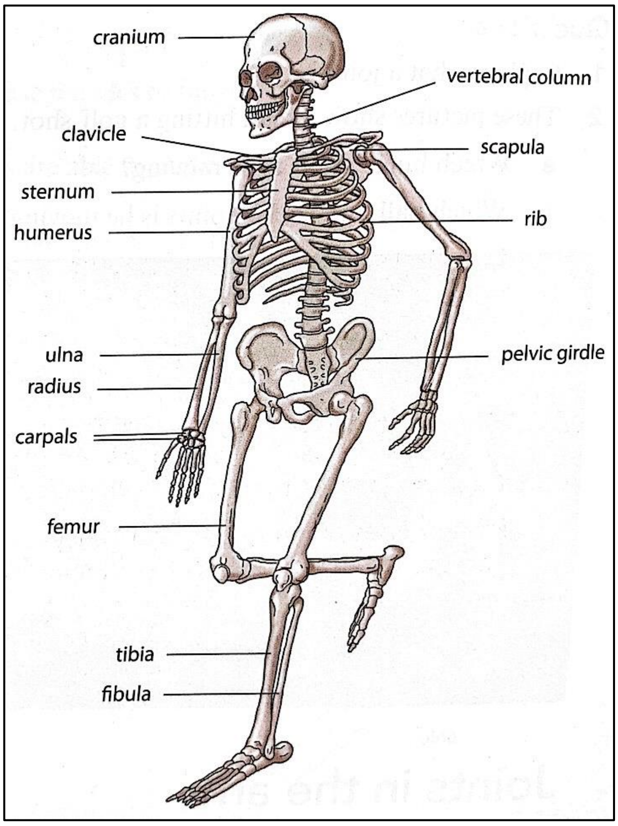


3. What percentage of babies born to mothers who do not smoke have a low birthweight?
4. Calculate the percentage of babies born to non-smoking mothers that do **not** have a low birthweight.
5. Describe how smoking during pregnancy affects the chance of having a baby with a low birthweight.

7.4 Moving the body

The skeleton

Animal's bodies are supported by a **skeleton**. Insects and other arthropods have a skeleton on the outside of their body. This is called an **exoskeleton**. Your skeleton is inside your body. It is made of bones. You do not need to remember the names of all these bones, but you may know some of them already. Bones are hard and strong. They contain a lot of calcium. If you do not have enough calcium in your diet, your bones may not grow properly. Bones contain living cells, so you also need protein in your diet to build strong bones.

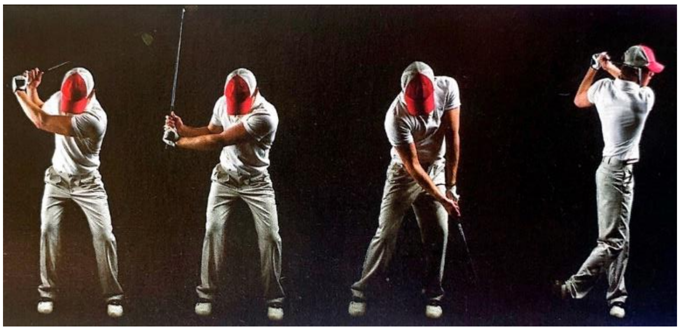


Joints

Bones cannot bend. Movement in the skeleton can only take place where two bones meet one another. These places are called **joints**. Some joints work like the hinges on a door. They let the bones move back and forth in one direction, in the same way that a door opens and closes. These are called **hinge joints**. Some joints let the bones move in a complete circle. At these joints, one of the bones has an end shaped like a ball. The other bone has a cup, or socket, that the ball fits into. These are called **ball-and-socket joints**.

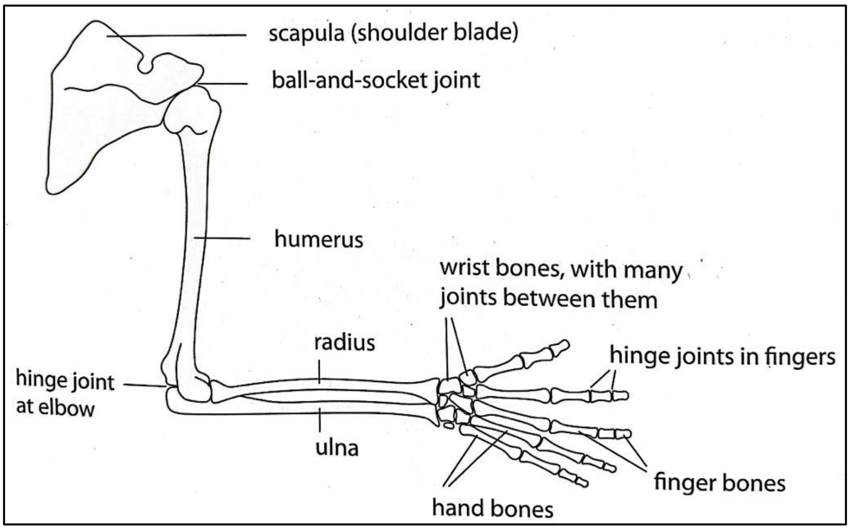
Questions:

1. Explain what a joint is.
2. These pictures show a man hitting a golf shot.
   a. Which hinge joint is he moving?
   b. Which ball-and-socket joints is he moving?



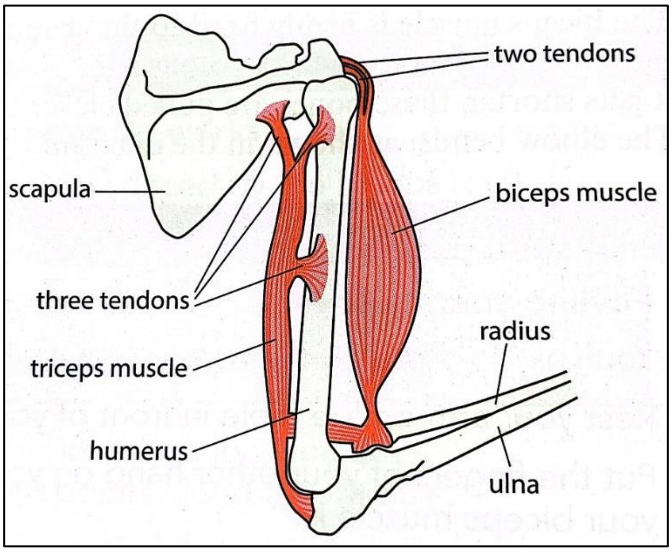
Joints in the arm

You have several different joints in your arms. These include the shoulder joint, the elbow joint, the wrist joint and all the joints in the fingers. The photo is an X-ray of someone's arm. Can you pick out the humerus, radius, and ulna? You should also be able to find the hinge joint at the elbow, and the ball-and-socket joint at the shoulder.



Muscles

Bones and joints cannot move themselves. You use **muscles** to move bones at joints. Muscles are made of specialised cells. These cells can make themselves shorter. This is called **contraction**. Muscles use energy to contract. Like all cells, they get energy from nutrients, especially glucose. The energy is released from glucose by respiration. The more you ask your muscles to contract, the more energy they use, and therefore the more glucose they use. Muscles can produce a strong pulling force when they contract. Many of your muscles are attached to bones, by tough cords called **tendons**. When the muscle contracts, it pulls on the tendon, which pulls on the bone. This makes the bone move at a joint. This diagram shows the muscles that move the arm bones at the elbow joint. First, look at the biggest muscle in the diagram. This is the **biceps** (biceps is an unusual word, because it ends in an s even though it is singular. One biceps, two biceps). 'Bi-' means two. This muscle is called the *biceps* because it has *two* tendons that attach it to the scapula. The longer, thinner muscle in the diagram is the **triceps**.

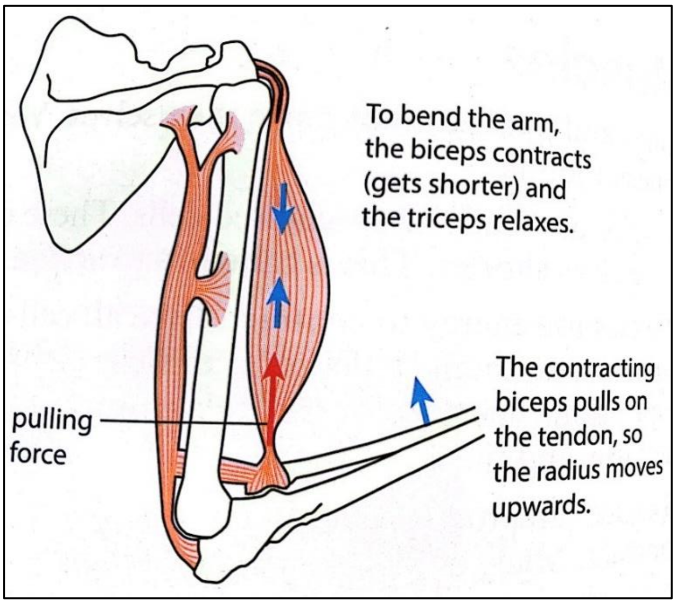


Questions:

3. The biceps is attached to the scapula at one end. Which bone is the other end attached to?
4. Which bone is the triceps attached to?
5. Tri- means three. Suggest why the triceps has this name.
6. Tendons do not stretch. Suggest why not.

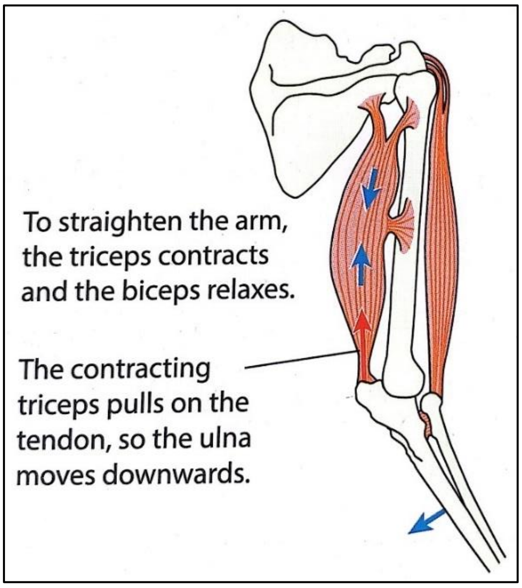
Bending the elbow joint

Think about what happens when you bend your arm at the elbow. When you decide to bend your arm, your brain sends an electrical impulse alone a neurone, to your biceps muscle. The cells in the biceps muscle respond to this electrical impulse by contracting. This makes the whole muscle get shorter. The biceps muscle is firmly fixed to the scapula at one end and the radius at the other end. So, when it gets shorter, these bones are pulled closer together. The elbow bends, as shown in the diagram.



Straightening the elbow joint

Now think about how you straighten your arm at the elbow joint. It's important to remember that muscles can only pull. They cannot push. Muscles can generate a force by getting shorter or contracting. But they cannot generate a force by getting longer. So, the biceps cannot push the arm straight again. You need another muscle to *pull* the arm straight. The muscle that does this is the triceps muscle. This diagram shows how it does this. When a muscle is not contracting, it relaxes. This is all that muscles can do, they can either contract or relax.



Antagonistic muscles

You can see that the biceps muscle and the triceps muscle work as a team.

- To bend the arm, the biceps contracts and the triceps relaxes.
- To straighten the arm, the triceps contracts and the biceps relaxes.

Two muscles that work together like this are called **antagonistic muscles**. When one of them contracts, it moves the bones at a joint in one direction. When the other muscle contracts, it moves the bones in the other direction.

KEY WORDS

- **Anaemia** – Not having enough haemoglobin in the blood, so not enough oxygen is delivered to respiring cells.
- **Carbohydrate** – One of the essential nutrients in the diet; It is broken down to release energy by respiration inside body cells.
- **Fat** – One of the essential nutrients in the diet; it can be broken down to release energy or can be sorted inside cells as an energy reserve.
- **Minerals** – Substances that we need in small quantities in the diet, such as calcium and iron.
- **Nutrients** – Substances in food that are needed in the diet.
- **Oil** – Liquid fat

- **Protein** – One of the essential nutrients in the diet; protein is used to make new cells, and to make substances such as haemoglobin and antibodies.
- **Starch** – A type of carbohydrate, which is often stored inside plant cells.
- **Vitamin A** – A nutrient that we need for good eyesight.
- **Vitamin C** – A nutrient that we need to keep blood vessels and bones healthy.
- **Vitamin D** – A nutrient that we need for strong bones and a good immune system; as well as getting vitamin D in food, the skin can make it when exposed to sunlight.
- **Vitamins** – Substances made by plants and other living organisms, that are required in the diet in small quantities.
- **Balanced diet** – Daily food intake that contains all the different types of nutrients, and the right amount of energy.
- **Constipation** – A condition where the digestive system works too slowly, so that faeces are not passed out regularly.
- **Fibre** – A component of food that cannot be digested; it is mostly made up of cellulose from plants and helps to prevent constipation.
- **Carbon monoxide** – A gas formed from one atom of carbon and one atom of oxygen
- **Development** – Of a human: the gradual changes in the body as a person grows up.
- **Embryo** – A young organism before it hatches or is born.
- **Nicotine** – The addictive substance in tobacco smoke.
- **Particulates** – Tiny solid particle in air or smoke, that cause damage when they get into the lungs.
- **Tar** – A mixture of chemicals found in tobacco smoke that increases the risk of developing many kinds of cancer.
- **Antagonistic muscles** – A pair of muscles that work as a team; When one of them contracts, it moves the bones at a joint in one direction. When the other muscle contracts, it moves the bones in the other direction.
- **Ball-and-socket joints** – A type of joint where one bone has a ball-shaped end that fits into a socket on the other end; it allows a circular movement.
- **Biceps** – A muscle that is attached to the shoulder blade and the radius bone; when it contracts, it makes the arm bend at the elbow.
- **Contraction** – The shortening of a muscle.

- **Exoskeleton** – A skeleton on the outside of the body; insects, for example, have exoskeletons.
- **Hinge joints** – Joints where one bone moves in one plane in relation to the other – like a door moving on its hinges.
- **Joints** – Places where two bones meet.
- **Muscles** – Organs that produce pulling forces when they contract.
- **Skeleton** – A structure that supports an animal's body.
- **Tendons** – Strong, non-stretchy cords that attach muscles to bones.
- **Triceps** – A muscle attached to the scapula and ulna, which straightens the elbow joint when it contracts.

Reference List

- Mary Jones, Diane Fellowes-Freeman & Michael Smyth, Cambridge Lower Secondary Science Learner’s Book 7, Cambridge University Press, 2021
- Mary Jones, Diane Fellowes-Freeman & Michael Smyth, Cambridge Lower Secondary Science Learner’s Book 8, Cambridge University Press, 2021