BIOLOGY

Cells – the Building Blocks of Life

Ideas you have met before

Body systems

We can think of a human body as being made up of different systems.

Each system has a specific purpose in the body.

We have a circulatory system that pumps blood around, a skeletal system that supports us and a digestive system that gets energy from the food we eat.

Reproduction in plants

The flowering plant also has different systems – these are the roots, stems, leaves and flowers.

Flowers enable reproduction in plants, through pollination and seed dispersal. Plants have evolved different ways of carrying out these processes.

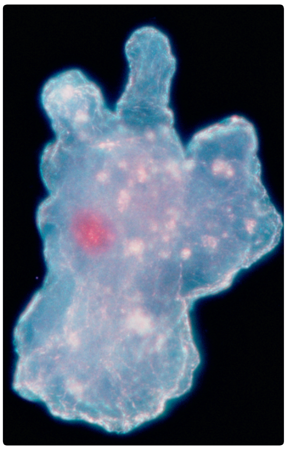
Human development

Humans change throughout their lifetime, from the moment of conception to the time they grow old.

Some changes occur much faster than others. We change fastest during the first few months of our existence.

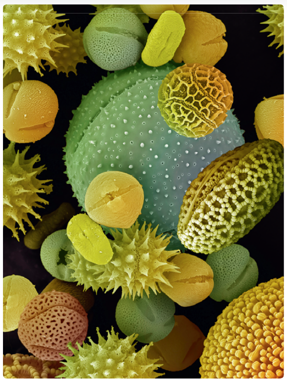
In this chapter you will find out

How cells work for an organism



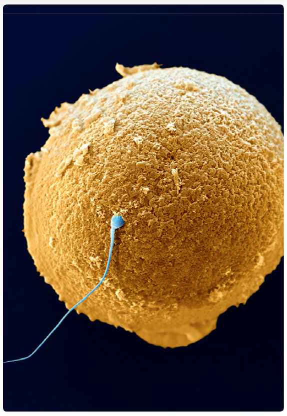
- Cells are the building blocks of life. They contain structures called organelles, which all have specific jobs.
- A human body has a highly organised set of body systems, organs, tissues and cells.
- Many cells, such as muscle cells and nerve cells, are specialised enabling them to carry out a specific task more effectively.
- Some organisms, such as bacteria and protozoa, consist only of a single cell. They can, nevertheless, carry out all seven life processes.

How plants are adapted to reproduce



- Pollen is the male sex cell in plant reproduction.
- Flowers are adapted in many ways to attract pollinators or use the wind to help pollination.
- We rely on bees and other insects to pollinate our crops for food – some of our actions put these organisms at risk.
- Plants have adapted different mechanisms to disperse their seeds, increasing their chances of survival.

Reproduction in humans



- The male and female human reproductive systems are adapted for successful reproduction.
- Boys and girls experience changes during puberty, preparing them for reproduction.
- When an egg is fertilised it develops into a foetus. This grows in the uterus until it becomes a fully grown baby.
- Many factors affect the growth and development of a foetus, including the mother's use of alcohol, cigarettes and drugs.

Historical ideas about living things

We are learning how to:

- Summarise some historical ideas about living things.
- Explain how evidence can change ideas.
- Select evidence to support or disprove ideas.

For many years people believed that living things came from non-living things. Today, water found in meteorites and moons suggests that life could have come to Earth from space.

FIGURE 1.1.2a: Meteorites like this may hold clues to the origins of life on Earth.

Spontaneous generation

From the time of Aristotle (384–322 BCE) to the 1600s, most people believed in the idea of spontaneous generation – that is, they thought that many **organisms** (living things) came from inanimate objects (non-living things). For example, observing mice coming out from a stack of corn, they would draw the **conclusion** that the corn had produced the mice.

1. Do the following observations seem to support or disprove the idea of spontaneous generation?
   a) kittens coming out of a barn
   b) fish swimming in a puddle
   c) lambs being born
2. Can you think of other examples where people might think that animals come from non-living things?

Redi's experiment

In 1668, Francesco Redi set out to disprove this idea. He put the same amount of fresh meat in three jars. He left one jar open, covered the other with a cheesecloth, and sealed the third. After a few days, maggots appeared in the open jar – there were no maggots in the closed jars. The maggots came from flies that had got into the open jar and laid eggs, not from the meat itself.

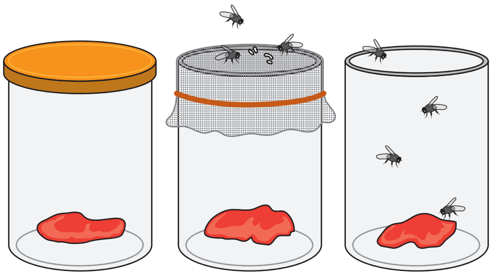


FIGURE 1.1.2b: Redi's experiment to disprove the idea of spontaneous generation.

3. What scientific question was Redi trying to investigate?
4. How did Redi make his experiment a fair test?
5. How did his findings disprove the idea of spontaneous generation?

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Disproving the idea

In 1864, the scientist Louis Pasteur added the same amount of boiled broth to specially designed bottles. He sealed some bottles and removed the tops from the rest, then left them for a long time. He observed no life in any of the bottles that had been sealed, but the open bottles were teeming with life.

With the invention of the **microscope** in 1590, scientists observed that living things were complex structures, which could not have possibly been formed from inanimate objects. From studying samples of cork bark, Robert Hooke discovered that organisms were made from simple building blocks. We call these individual building blocks **cells**. They are too small to be seen with the unaided eye.

Did you know…?

Today, scientists can use special high-power microscopes to study structures within cells to find cures for diseases. Modern-day microscopes are also used to study the structure of crystals and metals. Some can even view atoms.

1938 Ernst Ruska develops the electron microscope to improve the magnification and resolution. Viruses and molecules are studied

1932 Frits Zernike invents a microscope to study transparent and colourless specimens

18th Century improvements in microscopes result in their greater use by scientists

1675 Anton van Leeuwenhoek uses a simple microscope to look at blood, insects and pond water. He was the first person to describe cells and bacteria

1667 Robert Hooke makes a microscope to study various objects

1590 Dutch lens grinders Hans and Zacharias Jansen make the first microscope by placing two lenses in a tube

FIGURE 1.1.2c: The invention of the microscope enabled the discovery of cells.

6. What conclusions would you reach based on the **evidence** from Pasteur's experiment?
7. Which investigation would you trust the most – Pasteur's or Redi's? Give a reason for your answer.
8. Why did it take so long for people to change their ideas after Redi's investigation?
9. What impact do you think microscopes have had on our understanding of living things?

Key vocabulary

organism

conclusion

microscope

cell

evidence

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Biology

Comparing plant and animal cells

We are learning how to:

- Develop models to explain the differences between animal cells and plant cells.
- Record evidence using a microscope.
- Communicate ideas about cells effectively using scientific terminology.

Every cell is a chemical processing factory, with over 500 quadrillion chemical reactions occurring every second! Without these reactions, the organism would die.

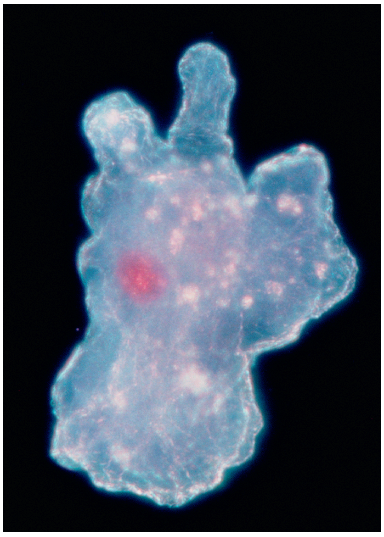

FIGURE 1.1.3a: An amoeba is a single-celled organism.

Cells as building blocks

All living organisms are made of cells – they are the building blocks of life. Cells cannot be seen except under a microscope. This is why it took so long to discover them. Some organisms are made of only one cell; most are made of millions of cells working together.

1. How can we see cells?
2. Is a cell living?

Common structures in animal and plant cells

All plant cells and animal cells have three main structures – the **nucleus**, the **cytoplasm** and the **cell membrane**.

Every cell, except red blood cells, contains a nucleus. The nucleus contains DNA, which controls the reactions inside the cell and is involved in making the cell reproduce.

The cytoplasm is a jelly-like material that makes up the bulk of the cell. All the chemical reactions occur here. Smaller structures within the cytoplasm, called organelles, make new materials to keep the cell and the organism alive.

The cell membrane surrounds the cell and contains the cytoplasm. The cell needs water, oxygen, glucose and nutrients – the membrane lets these in. During the chemical reactions, the cell makes waste products that it must get rid of, including carbon dioxide and urea. The membrane lets these substances out of the cell.

In the cytoplasm, special organelles called **mitochondria** convert glucose and oxygen into a form of energy that the cell can use.

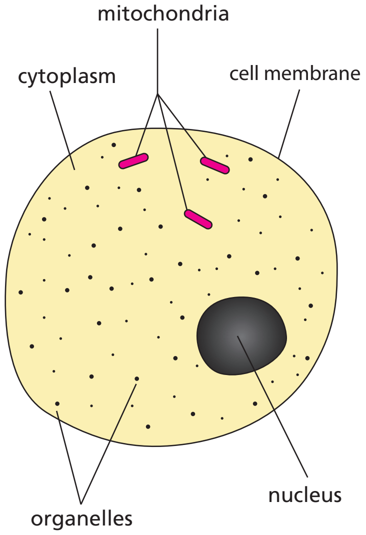

FIGURE 1.1.3b: The main structures of an animal cell

3. Which two parts of the cell are found inside the cytoplasm?
4. What main substances are allowed through the cell membrane?

Differences between animal and plant cells

Animal cells are the simplest type of cell, containing a nucleus, cytoplasm, a cell membrane and mitochondria in the cytoplasm. Plant cells share these parts, but also have other important structures.

The **cell wall** is an extra protective layer outside the cell membrane. It gives the cell shape and strength.

The **vacuole** is a large bubble full of liquid, storing water, sugars, nutrients and salts in the cytoplasm. It provides internal pressure for the cell, keeping it firm and in shape. It also helps to control water movement inside and between cells.

Leaf cells also contain small, round, green organelles called **chloroplasts**. These contain a green pigment called chlorophyll, which absorbs energy from the Sun and helps the plant make glucose.

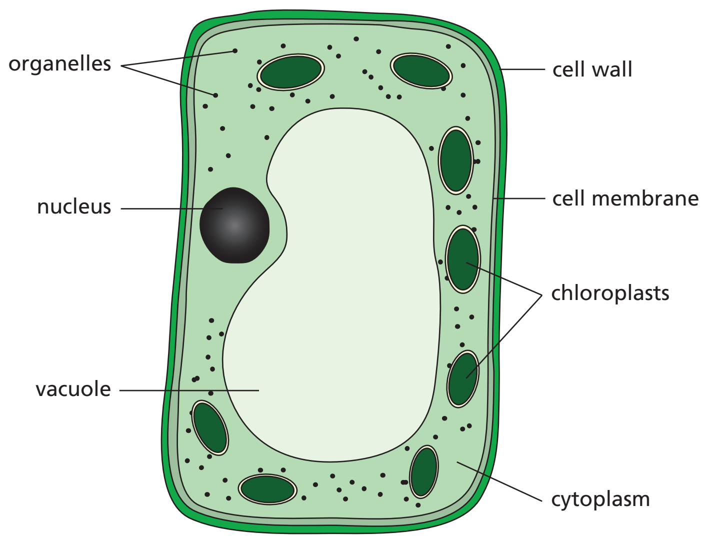

FIGURE 1.1.3c: A plant leaf cell

5. Which two structures give a plant cell its shape?
6. Which cell do you think will be larger – a plant cell or an animal cell? Explain your answer.
7. Why do you think plant cells need extra structures that are not found in animal cells?

Did you know…?

Each human consists of about 100 trillion cells working together.

Key vocabulary

nucleus
cytoplasm
cell membrane
mitochondria
cell wall
vacuole
chloroplast

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Biology

Describing cells

We are learning how to:

- Classify specialised cells as animal cells or plant cells.
- Describe different specialised animal cells and plant cells.
- Explain the structure and function of specialised cells using models.

All young cells start out exactly the same – these are called stem cells. When they grow, stem cells change their structure to carry out a certain job within the organism. Any stem cell can be made to become any type of specialised cell.

The right cells for the job

Many animal cells look very different from each other, although they contain the same basic structures. Cells become *specialised* so they can carry out a particular job. In an organism, many different jobs need to be done to keep it alive. These include movement, detecting information about the environment, sending messages, carrying chemicals around the body, making chemicals the body needs, reproducing and absorbing food.

1. Where would you find cells that detect:

a) light? **b)** sound? **c)** heat?

Specialised animal cells

Nerve cells have very long extensions of cytoplasm. This enables them to carry messages from one part of the body to another.

Muscle cells are made from protein fibres that can rapidly expand and contract to create movement. They have the most mitochondria of all cells because they need lots of energy.

Sperm cells have tails and huge heads. Their main job is to carry genetic material to an **egg cell**, so that it can be fertilised. Sperm cells have lots of mitochondria because they must swim long distances.

2. Name the animal cells in Figure 1.1.4a.

3. Which cell:

a) transmits electrical messages?

b) contracts and expands to create movement?

c) carries genetic material for fertilisation?

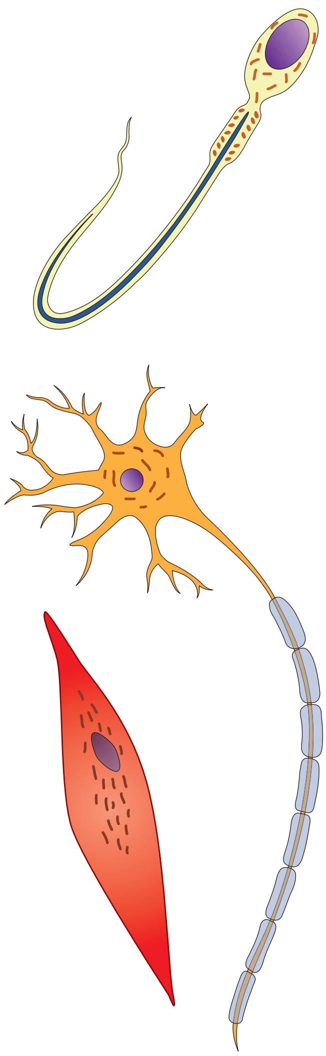

FIGURE 1.1.4a: Can you find the nucleus, cell membrane, cytoplasm and mitochondria of each cell?

Specialised plant cells

Plant cells are also highly specialised. Plants make their own food by a process called photosynthesis. Many of the specialised cells in a plant are linked to this function. Cells collect light and water, and take in carbon dioxide. Specialised leaf cells like the one shown in Figure 1.1.3c in Topic 1.3, use these materials and turn them into sugar.

Specialised plant cells are also linked to the process of reproduction. Pollen cells are the male sex cell in plants. Some are carried by the wind, and others stick to insect or bird pollinators. There are over 300 000 different types of pollen cells.

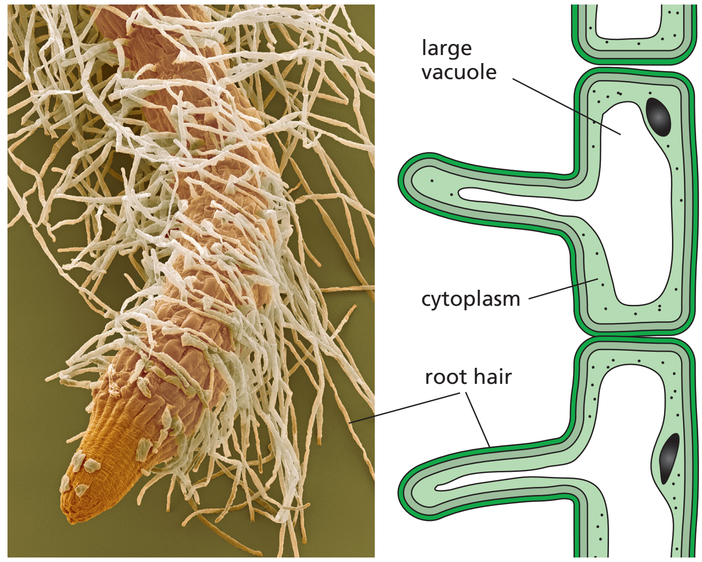

FIGURE 1.1.4b: How are these root hair cells different from the leaf cell shown in Figure 1.1.3c?

4. Look at Figure 1.1.3c showing a leaf cell and at Figure 1.1.4b showing a **root hair cell**. Describe the features of each and suggest how these features enable the cells to carry out their jobs.

5. Compare and contrast the specialisation of a wind-transferred pollen cell and an insect-transferred pollen cell. Look at Figure 1.1.4c to help you.

6. Which is more specialised – a pollen cell or a sperm cell? Give reasons for your answer.

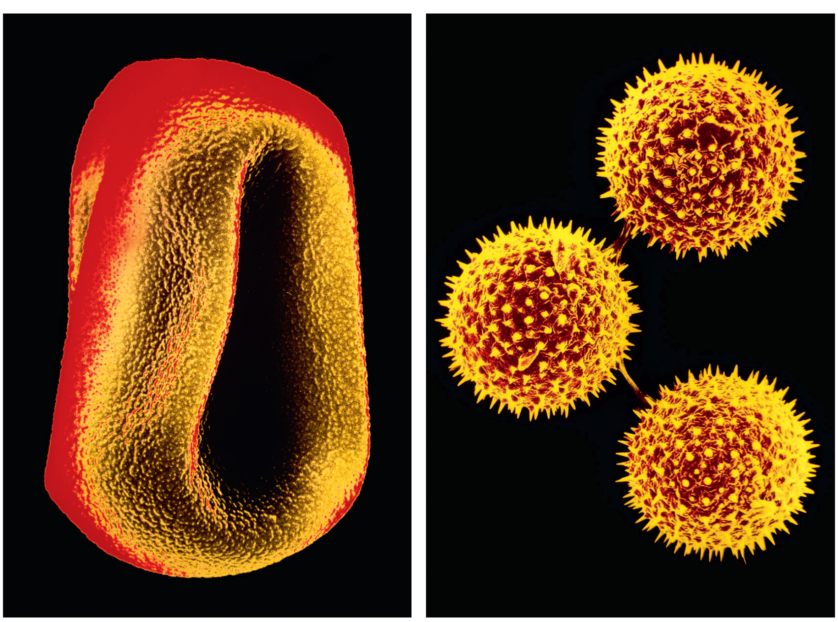
FIGURE 1.1.4c: Wind- and insect-transferred pollen cells.

Did you know…?

There are more than 200 different types of specialised cells in the body. In 2012, a Nobel Prize was awarded for the discovery that specialised cells can be changed to become stem cells.

Key vocabulary

nerve cell

muscle cell

sperm cell

egg cell

root hair cell

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Understanding unicellular organisms

We are learning how to:

- Recognise different types of unicellular organisms.
- Describe differences in unicellular organisms.
- Compare and contrast features of unicellular organisms.

The oldest unicellular organisms were found in rocks dated to 3.8 billion years ago. They used chemicals in the ocean for 'food'. Around 3.5 billion years ago, organisms that could make their own food also evolved. Unicellular organisms were the main form of life on the planet for nearly 2 billion years.

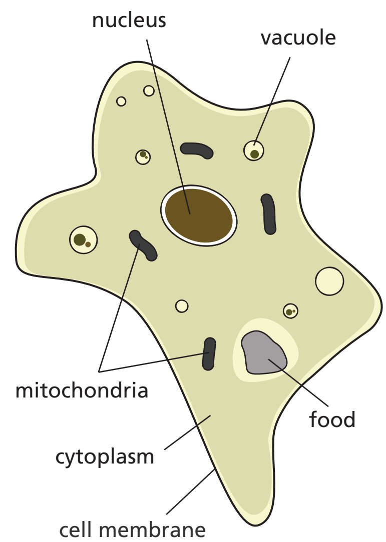

FIGURE 1.1.5a: An amoeba can carry out all life processes.

Unicellular organisms

Unicellular organisms are made up of just one cell. They carry out all the life processes needed to exist independently. They differ from each other in their structure, how they feed and how they move. Algae are plant-like unicellular organisms containing chloroplasts and make their own food. Animal-like unicellular organisms take in food through their cell membrane. Some have developed tiny hairs to help them move, so they can find food or escape from predators. Some are themselves predators and will devour other unicellular organisms. Fungus-like unicellular organisms are called **yeasts**. They have a cell wall but cannot make their own food.

1. Name three different unicellular organisms.
2. List three ways unicellular organisms differ from each other.

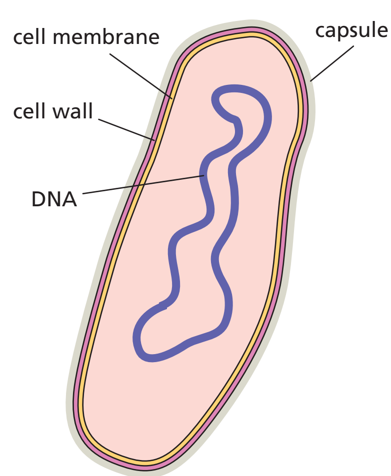

FIGURE 1.1.5b: A bacterium has no nucleus and no mitochondria.

Prokaryotes

Unicellular organisms can be classified into two main groups – **prokaryotes** and **eukaryotes**. Prokaryote means 'before life' – prokaryotes are thought to be the first organisms to live on Earth. They do not have a nucleus, and their genetic material floats within the cytoplasm. They can be up to 200 times smaller than eukaryotes. **Bacteria** are examples of prokaryotes. They come in different shapes and sizes, live in different environments and have a range of food sources. Some bacteria take in chemicals from their environment, such as iron and sulfur, and use these as food. Others contain chloroplasts and use sunlight to make their own food – many can absorb nutrients from their environment. Bacteria can be found in extreme conditions, from under-sea volcano vents to places with temperatures well below freezing.

3. Look at Figure 1.1.5a and Figure 1.1.5b. Which is a prokaryote and which is a eukaryote?

4. What differences can you see between prokaryotes and eukaryotes?

Eukaryotes

Eukaryotes contain a nucleus, surrounded by a nuclear membrane. They also contain many organelles (which prokaryotes do not), including mitochondria, chloroplasts and vacuoles. Examples of eukaryotes are euglena (a type of algae containing chloroplasts), yeast, amoeba, and paramecium – the last two are types of **protozoa**. Eukaryotes can be up to 200 times bigger than prokaryotes and often have external features to help them to survive. The amoeba can move around because its cytoplasm can flow; paramecium has cilia that beat and enable it to move, and the euglena has a flagellum, or tail, to enable it to move.

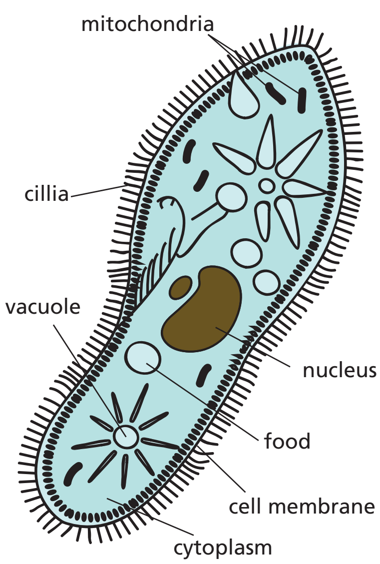

FIGURE 1.1.5c: A paramecium

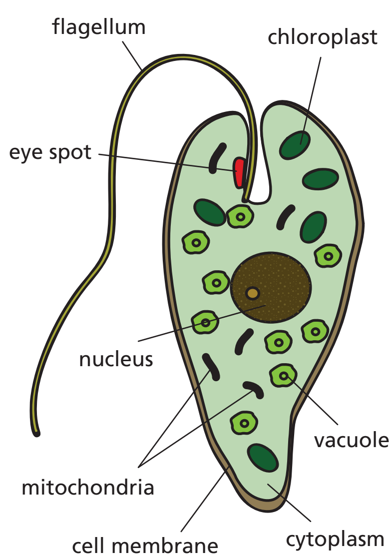

FIGURE 1.1.5d: Euglena

5. Look at Figure 1.1.5d. How does euglena get its food?

6. Which is the most effective form of movement between the three eukaryotes? Justify your choice.

7. Summarise, in a table, the main similarities and differences between unicellular organisms.

Did you know…?

Nummulites are the largest known unicellular organisms. Nummulite fossils as large as 16 cm in diameter have been found, which is about the size of a tennis ball. Some are thought to have lived for over 100 years.

Key vocabulary

yeast

prokaryote

eukaryote

bacterium

protozoa

Understanding diffusion

We are learning how to:

- Describe the process of diffusion and its relation to the cell.
- Plan a fair test investigation to explore the factors affecting diffusion.
- Explain how the different factors speed up or slow down diffusion.

How do substances move from the outside of a cell to the inside of a cell? One answer lies in the process of diffusion. Using this, and other processes, cells allow only the substances they need to enter the cell, and keep themselves safe from unwanted and toxic chemicals.

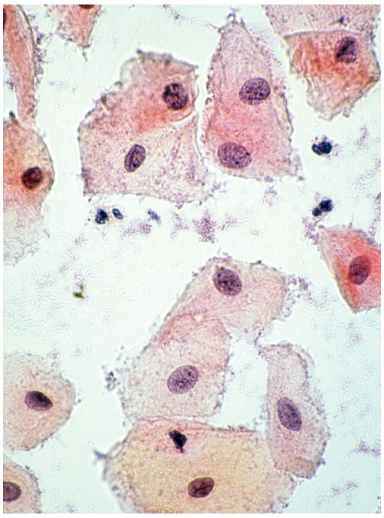

FIGURE 1.1.6a: Substances need to pass in and out of the cell membrane.

Chemicals on the move

All cells require chemicals including **glucose**, oxygen, nutrients and minerals in order to survive. These pass through the cell membrane by **diffusion**, a process by which substances move from an area of high concentration to one of low concentration, until the concentrations are equal. There have to be more particles outside the cell than inside for them to move into the cell.

Cells also produce waste products, such as carbon dioxide and urea. They move out of the cell by diffusion because there are more waste particles inside the cell compared to outside.

1. Look at Figure 1.1.6b. Which way will the particles move?
2. Draw an outline of a cell showing the movement of named substances into and out of the cell.

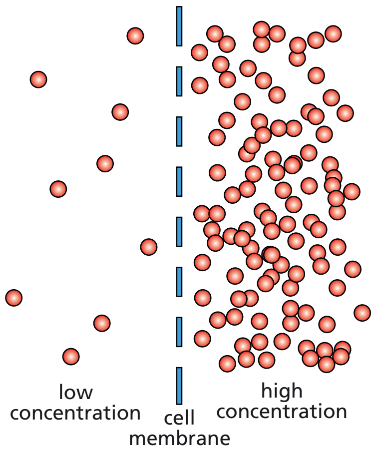

FIGURE 1.1.6b: Particles have a different concentration on either side of the cell membrane.

Factors affecting diffusion

Many factors affect how quickly diffusion occurs. It occurs more rapidly at higher temperatures because the particles have more energy and move faster.

The number of particles in a given volume is called the concentration of a solution. In a highly concentrated solution, there are many particles packed into a small space. The particles try to move away from each other as quickly as possible. If a cell is placed in a high concentration of nutrients, the nutrients diffuse faster into the cell compared to when it is in an area of low concentration.

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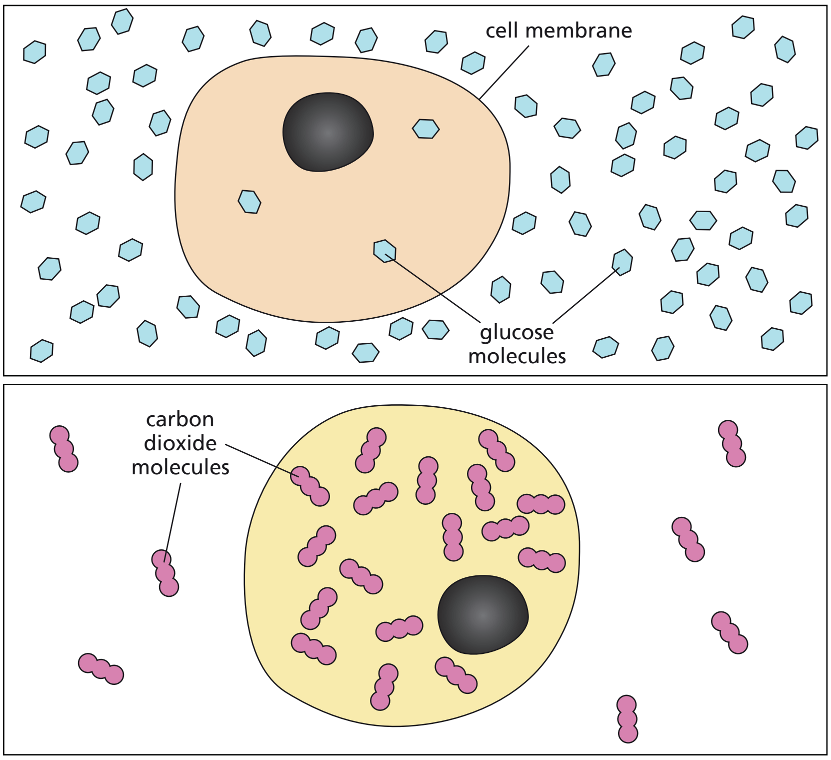

FIGURE 1.1.6c: Diffusion will occur in these ‘cells’. Why will this happen?

3. Draw two identical boxes. Using small circles to represent particles, show a concentrated solution in one and a dilute solution in the other.

4. Suggest and explain whether temperature or concentration has a greater effect on the rate of diffusion.

Effect of surface area

The survival of unicellular organisms depends on the rate of diffusion of chemicals into and out of the cell. The ratio of the **surface area** of the cell to its **volume** affects how quickly diffusion across the cell membrane can occur. With a higher surface-area-to-volume ratio, the rate of diffusion into and out of the cell is faster.

The surface area of a cube can be calculated by working out the area of one side and multiplying this by the number of faces. The volume of a cube is its length × breadth × height. The surface-area-to-volume ratio is worked out by dividing its surface area by its volume.

5. What can you say about the ratio of the surface area to volume as the size of cells increases?

6. Why are most unicellular organisms microscopic?

Did you know…?

The first study of diffusion was performed by Thomas Graham in 1831. Observing gases with different particle sizes, he expected the heaviest to fall to the bottom and the lightest to stay at the top. Instead, they were evenly mixed throughout.

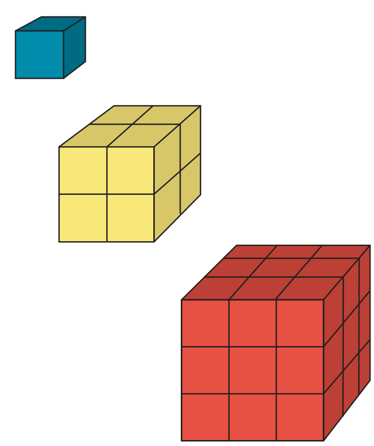
FIGURE 1.1.6d: These cubes represent cells of different sizes.

Key vocabulary

glucose

diffusion

surface area

volume

Understanding organisation in multicellular organisms

We are learning how to:

- Define the terms tissues, organs and organ systems.
- Explain the organisational structure in multicellular organisms.
- Compare the strengths and weaknesses of multicellular organisms and single-celled organisms.

The first simple multicellular organisms are thought to have evolved about 1.2 billion years ago. These eventually increased in organisation and size to form complex multisystem, multicellular organisms. There are 15 different organ systems within human beings, all working together to help us to survive.

Cells, tissues and organs

Groups of similar specialised cells working together are called **tissues**. Examples of human tissues are muscles and bones. Different tissues work together to make up an **organ**. Every organ has a specific job – the eye is an organ made up of many different tissues including a lens and an iris. They work together to enable us to see. Examples of other organs are:

- the heart, which pumps blood to the cells
- the kidneys, which clean the body and balance water in the body
- the brain, which allows us to control all parts of our body quickly.

Organs work together to make **organ systems**. Some of the organ systems in the human body are the circulatory system, the skeletal system, the respiratory system, the digestive system, the reproductive system and the nervous system.

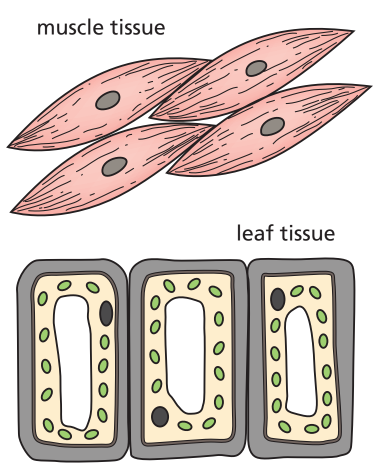

FIGURE 1.1.7a: Two types of tissue as seen under a microscope. What do you notice about the cells in each type of tissue?

1. Name three other organs and describe their functions.
2. The skin is described as an organ, not a tissue. Suggest why.
3. a) Name an organ in each of the six organ systems listed in the text.
   b) State the function of each of these organ systems.

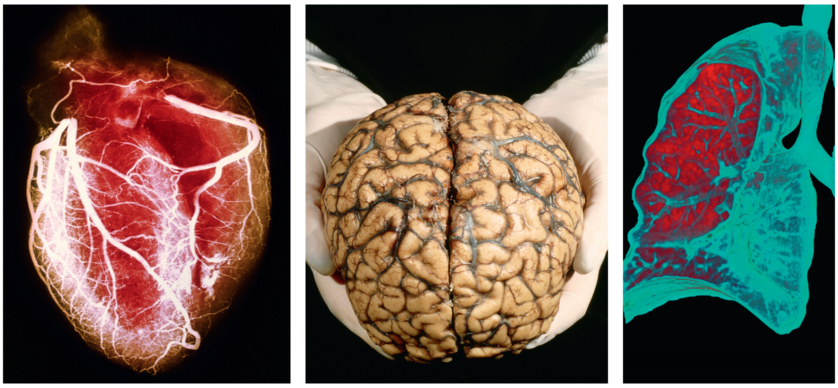

FIGURE 1.1.7b: What do all of these have in common?

Unicellular organisms

Unicellular organisms can live independently of other cells. They have no organ systems, just organelles working together. Because of their small size, they can reproduce very quickly. However, because they are unicellular, there is a limit to how big they can grow and most remain microscopic. If they become too big they cannot obtain the chemicals they need from the environment quickly enough by diffusion. However, being small means they are vulnerable to attack from bigger unicellular, or multilcellular, organisms.

4. Unicellular organisms make up most of the mass of biological material on the planet. What does this say about the success of unicellular organisms?

5. Is being small an advantage or a disadvantage? Give reasons.

How cell types evolved

Some cells evolved to join and work together, forming colonies of cells. An advantage of this was that in times of food shortage, food could be caught, digested and shared more effectively by cells working together. Eventually some of the cells within the colonies became specialised and took on particular jobs. This eventually led to the formation of simple multicellular organisms. These could grow to be much larger than the unicellular organisms and so were better protected and could move further in search of food. However, they needed to evolve complex organ systems in order to become much larger. This requires a lot of energy, and the larger the organism became, the slower the rate of reproduction.

6. What are the advantages of multicellular organisms over unicellular organisms?

7. Why did some cells form colonies?

Did you know…?

Many unicellular organisms live as parasites within multicellular organisms. Most are harmless, but some cause diseases such as malaria and typhoid. The number of bacterial cells living in our gut and on our skin is bigger than the number of our own cells.

FIGURE 1.1.7c: How do these bacterial cells survive better by working together?

Key vocabulary

tissue

organ

organ system

Applying key ideas

You have now met a number of important ideas in this chapter. This activity gives an opportunity for you to apply them, just as scientists do. Read the text first, then have a go at the tasks. The first few are fairly easy – then they get a bit more challenging.

The skin is an organ

The skin is the largest organ in the human body. It is our first line of defence against heat, light, injury, and infecting bacteria and fungi. It also protects us from harmful radiation from the Sun, which can cause cancer. Skin cancer is the most common type of cancer, with over a million new cases reported every year worldwide.

The skin is about 2 mm thick and is composed of three different layers of tissue.

The top layer of skin tissue is called the epidermis. These cells are lost regularly and are replaced every six to eight weeks. We lose about 30 000 to 40 000 skin cells every hour!

The middle layer of tissues is called the dermis. This contains blood vessels, nerve cells and elastic tissue called collagen, which keeps the skin from sagging.

The bottom and thickest layer of tissue is the hypodermis. This layer is responsible for storing fat cells.

Specialised cells in the skin perform different jobs:

- cells that collect information about heat, pain and pressure
- cells that store fat to keep us warm
- pigment-containing cells that protect us from harmful rays from the Sun
- hair follicles that are useful in controlling temperature
- sweat glands that also help to control the body's temperature.

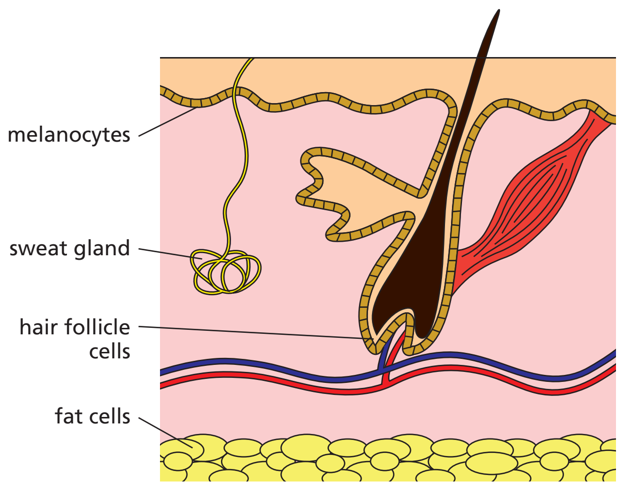

FIGURE 1.1.8a: Specialised skin cells

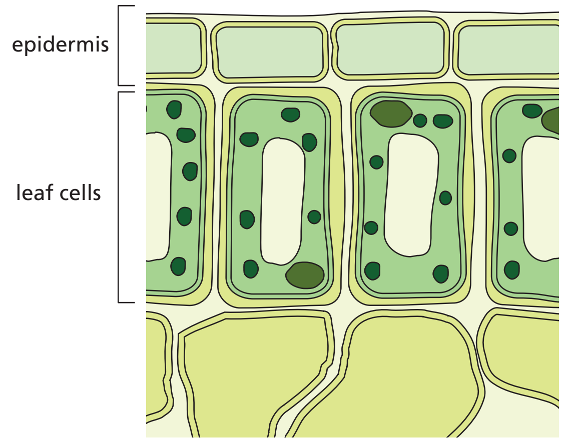

FIGURE 1.1.8b: Plant epidermis

In plants the epidermis is just one cell thick. It is a waterproof layer with a waxy coating. There are far fewer specialised cells here compared with animal skin.

Task 1: Animal cells

Draw a labelled diagram of a non-specialised animal cell in the epidermis of the skin.

Task 2: Plant cells

Draw a labelled diagram of a non-specialised plant cell in the epidermis of a plant. Describe how the animal cells and plant cells are alike and and how they are different.

Task 3: Organisation in multicellular organisms

The skin is an organ composed of tissues and specialised cells. Giving examples, explain what is meant by the terms ‘organ’, ‘tissue’ and ‘specialised cell’.

Task 4: Specialised cells

Explain the features of two specialised cells in human skin. Explain how these features allow them to carry out their jobs.

Task 5: Unicellular organisms

Impetigo is a skin condition caused by bacteria. Athlete’s foot is another skin disorder, caused by a fungus. Use diagrams to explain the differences between bacteria and fungi.

Why might it be hard for paramecium or euglena to live in the epidermis?

Comparing flowering plants

We are learning how to:

- Describe the structures and functions of parts in flowering plants.
- Explain why different plants have such diverse structures.
- Evaluate the differences between wind-pollinated plants and insect-pollinated plants.

The first plants on Earth were mosses. These relied on moisture and touch to transfer pollen. The first flowering plants, using wind and insects to transfer pollen, are thought to have evolved about two-hundred million years ago. Nowadays about 70 per cent of plant species use insects, birds or mammals to transport pollen.

FIGURE 1.1.9a: Which flower is wind pollinated and which is insect pollinated?

Flowers as reproductive organs

Most flowers have male and female parts. The male part is the stamen, consisting of an **anther** and a **filament**. The anther produces **pollen**, which contains the male sex cell. The female part is the carpel. This consists of an **ovary** (with the female sex cells in the ovules), the **style** and the **stigma**, which has a sticky top. The purpose of the flower is to produce pollen in the anther and transfer it to the stigma of a different plant. This process, called pollination, is mainly achieved using wind, insects, birds or bats.

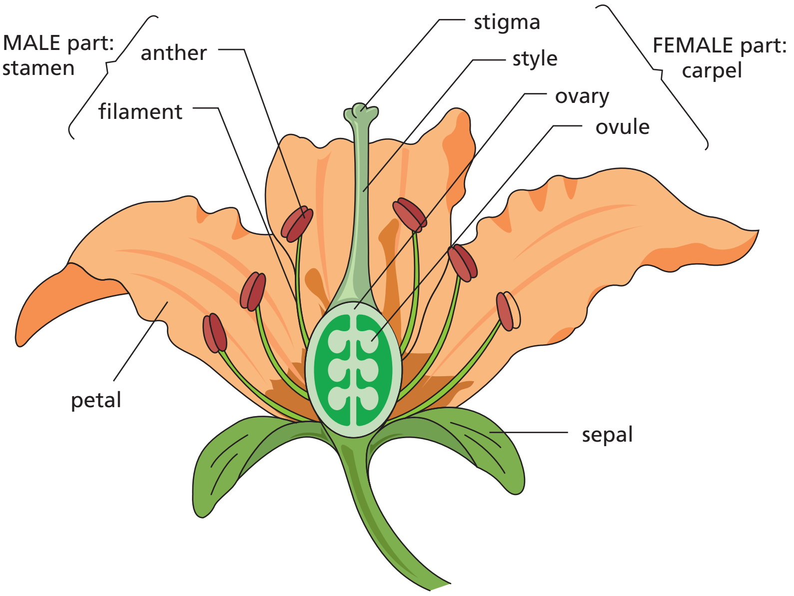

FIGURE 1.1.9b: Male and female parts of a flower

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1. Identify the following parts in the photos in Figure 1.1.9a: anther, filament, stamen, stigma, style, ovary.
2. What differences can you see between the two flowers in Figure 1.1.9a?
3. Why do you think the flowers have the differences you have written in your answer to question 2?

FIGURE 1.1.9c: This orchid mimics the appearance of a female wasp. The male wasp visits the flower and becomes covered in pollen.

Attracting insects

Most insect-pollinated plants produce brightly coloured flowers with sweet smells to attract insects. Many also produce nectar deep inside the flower. This is a sugary fluid that draws insects inside the flower to encourage pollination. Pollinators such as bees collect the pollen as a food source. Plants produce a lot of pollen to increase the chances of successful pollination. Some orchids produce flowers that look like the female of particular wasps.

4. Describe different ways plants encourage insects to visit them.
5. Why do plants use such a diverse range of methods of attracting pollinators?

Wind or insect pollination?

There is no guarantee that the wind will successfully transfer the pollen from one plant to the stigma of another plant, so wind-pollinated plants produce millions of pollen cells to improve their chance of success, even though most cells are wasted. Stigmas evolved to become large and feathery so as to capture pollen floating on the wind. Even so, there is no guarantee that the pollen from the same species will land on the plants.

Insect-pollinated plants produce far less pollen, but use other mechanisms to attract insects. However, some insects eat parts of the flower and plant, so flowers have developed mechanisms to avoid this, such as producing toxins and growing spikes.

6. Discuss the advantages and disadvantages of wind pollination and insect pollination.

Did you know…?

The oldest-known pollen grains were found on the bodies of tiny insects encased in amber. The pollen was thought to be over a million years old. Fossilised pollen has provided evidence of how plant life on Earth has evolved.

Key vocabulary

anther

filament

pollen

ovary

style

stigma

193885_P008_047.indd 25 09/12/2013 15:20

Knowing how pollination leads to fertilisation

We are learning how to:

- Describe the processes of pollination and fertilisation.
- Analyse and present data on the growth of pollen tubes.
- Explain factors that affect the growth of pollen tubes.

The world's chocolate supply depends on midges. These tiny flies are the only insects that can pollinate the cacao plant. Once fertilised, the plant produces seeds, which are used to make coffee and chocolate.

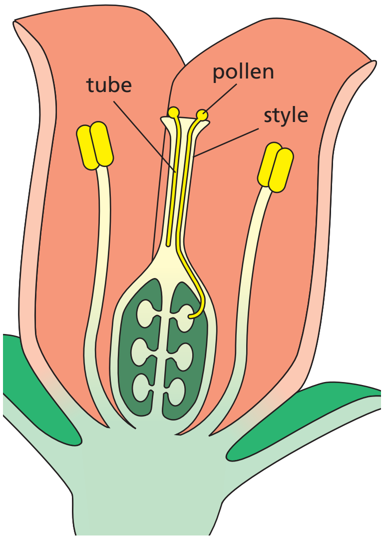


FIGURE 1.1.10a: How do you think a pollen tube is formed, from one cell or many?

Fertilising plants

Pollen contains the male sex cell. The female sex cell, the egg cell, is found in the ovule. The pollen travels down the style to reach the ovule by growing a long tube. Once it has reached the ovule, the nucleus of the male sex cell joins with the nucleus of the egg cell – this is **fertilisation**. The result is a new seed, which will eventually become a new plant.

1. Describe how pollination and fertilisation differ.

Pollen tubes

Look at Figure 1.1.10b. When a pollen grain lands on the stigma of another plant, the tube cell uses stored nutrients and sugars to grow a **pollen tube** down to the ovule. The concentration of sugar affects the ability of the pollen grains to grow tubes.

2. Plot a graph of the data in Table 1.1.10a.

3. Describe the pattern shown by the data.

TABLE 1.1.10a: The effect of sugar on the growth of pollen tubes

Sugar concentration (%)	5	10	15	20
growth of pollen tubes (micrometres)	250	350	450	200


FIGURE 1.1.10b: Why might pollen from different species grow best in different concentrations of sugar solution?

193885_P008_047.indd 26 09/12/2013 15:20

Factors affecting the growth of pollen tubes

Many factors affect the growth of pollen tubes. The pollen grain is dry when it lands on the stigma. Chemicals in the stigma enable water to enter the pollen grain so it can grow. These include sugar. In some plants, if pollen lands on the stigma of the same plant, chemicals prevent it from growing pollen tubes so it cannot fertilise itself. If the temperature is hotter, pollen tubes grow faster. Once the tube has formed, chemicals in the stigma direct the pollen tube to the ovule. Only one pollen cell fertilises the egg.

4. Look at the data in Table 1.1.10b and highlight any anomalous results.

TABLE 1.1.10b: The growth of pollen tubes in different sugar concentrations

Sugar concentration (%)	5	10	15	20
Growth of pollen tubes (micrometres) – experiment 1	225	345	200	213
Growth of pollen tubes (micrometres) – experiment 2	250	350	450	207
Growth of pollen tubes (micrometres) – experiment 3	275	355	450	250

5. Ignoring the anomalous values, calculate the average values in Table 1.1.10b.

TABLE 1.1.10c: The effect of temperature on pollen tube growth

Temperature (°C)	15	20	25	30	35	40
Growth of pollen tubes (micrometres)	0	200	420	700	800	100

6. From the data in Tables 1.1.10b and 1.1.10c, draw two graphs – one showing the effect of sugar concentration and the other showing the effect of temperature on pollen tube growth.

7. Which has the bigger effect on pollen tube growth, from these data? Why do you think this?

8. Which data would you trust more – explain why.

Did you know…?

Pollen that does not land on a stigma remains in the environment. It is the primary cause of hay fever and allergies. Pollen counts are made by counting how much pollen lands on a greasy spinning rod over a 24-hour period.

Key vocabulary

fertilisation

pollen tube

Understanding the challenges facing pollinators

We are learning how to:

- Describe the role of insects in crop production, using suitable data.
- Explain why bee populations are declining.
- Make suggestions for increasing insect populations, and hence crop production.

Honey bees used to pollinate 70 per cent of the UK's insect-pollinated crops. Today, it is less than 30 per cent. However, the growth of some crops has risen, suggesting that other insects have been taking the place of honey bees. Pollinators must be protected to make sure we don't lose crops.

Important pollinators

Most cereal crops are wind-pollinated. However, insect, bird and bat pollinators are responsible for 35 per cent of global crop pollination, including pollination of fruits, nuts, seeds, beans, coffee, oilseed rape, onions, almonds and tomatoes. Butterflies and bees are among the most important pollinators. Bees collect pollen from plants to make honey. They are usually specially **adapted**, with a furry body, so they can collect the maximum amount of pollen. Some of this lands on other plants as they move from plant to plant.

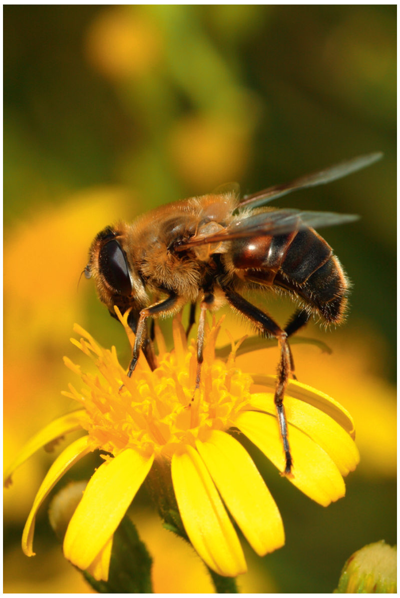


FIGURE 1.1.11a: The world's most important pollinator

1. Name three other crops we rely on insects to pollinate.
2. Why are bees so useful as pollinators?
3. If a plant relies on one species of pollinator, what will happen if the pollinator dies out?

Confused bees

Since 2005, more than ten million bee colonies have been wiped out by **colony collapse disorder (CCD)**, possibly caused by **pesticides**. Bees become weak and confused, and can't find their way back to the hive. This results in a reduction in the size of the colony, a shortage of food for the remaining bees and the inability to reproduce successfully. Many bees have also shown signs of increased viral disease.

4. Draw a flow chart to show how CCD occurs and its effect on a bee colony.

193885_P008_047.indd 28 09/12/2013 15:20

Developing explanations for CCD

Theories about the causes of CCD include:

- Pesticides such as **insecticides** are sprayed on crops to prevent insects and fungi from attacking them. Unfortunately it is not possible to target specific insects, and others may be affected. Some contain nicotine, which is thought to cause confusion in the brain of the bee.
- The number of wild flowering plants has reduced as more land is used for development and agriculture, leading to less variety of pollen and a narrower range of nutrients for bees.
- Farmers rent out hives to pollinate crops. This can disorientate bees, which find their way around by locating routes back to their hives. Also, disease can be spread more widely because hives from different locations come into close contact, which would not occur naturally.
- Climate change means that some plants are flowering earlier, before bees can fly.
- Bees are more susceptible to virus attacks because other factors have made them weaker.

FIGURE 1.1.11b: What are the problems with industrial pollination?

5. What do you think is the most likely cause of CCD?

6. Describe three steps that could be taken that would increase bee **populations**.

Did you know …?

In the USA, bees are the only pollinators of almond trees. Farmers are completely dependent on an active bee population for a good crop.

FIGURE 1.1.11c

Key vocabulary

adapted

colony collapse disorder (CCD)

pesticide

insecticide

population

193885_P008_047.indd 29 09/12/2013 15:20

Understanding how seeds are dispersed by the wind

We are learning how to:

- Recognise the variety of different structures shown by different seeds.
- Describe the need for plants to disperse their seed.
- Plan an investigation into seed dispersal by wind.

The largest seed in the world is 50 cm in diameter. It comes from the palm tree called Coco de Mer, found only in the Seychelles islands in the Indian Ocean. Another large seed is the coconut – it can be carried by the sea and germinate in a new place. Plants have developed many ingenious ways to be dispersed and to colonise new areas.

FIGURE 1.1.12a: Coco de Mer seed – the largest on the planet

Plants on the move?

Plants cannot move. They colonise new areas by moving their **seeds** in a process called **dispersal**. Seeds can be dispersed by:

- wind
- water
- exploding pods that release seeds on touch or with moisture
- being carried inside animals that eat the fruit
- hooking onto the fur or skin of passing animals.

1. Look at Figure 1.1.12b, and identify how each of these seeds is dispersed.
2. Give reasons for all of your answers to question 1.

Ways of travelling

Seeds dispersed by wind have many shapes and sizes. The dandelion has parachute-like seeds, and the sycamore has seeds like helicopters. Peas and pansies have pods that explode when they have dried out or are touched by an animal, causing the seeds to fly out. Some plants produce fruits that animals eat but cannot digest. These pass through the animals, allowing the seed to **germinate** in another place using nutrients from the animals' dung. Burdock seeds have tiny hooks that catch on the fur of passing animals.

FIGURE 1.1.12b: Why have plants developed such variety in types of seed?

Seeds need to be dispersed as far away from the parent plant as possible, where there could be more light, nutrients and water – thereby increasing the chance of successful growth. Seeds are packed with nutrients to help the germinating plant to grow. Smaller seeds have fewer nutrients but may travel further. Larger seeds have bigger stores of food and can last much longer.

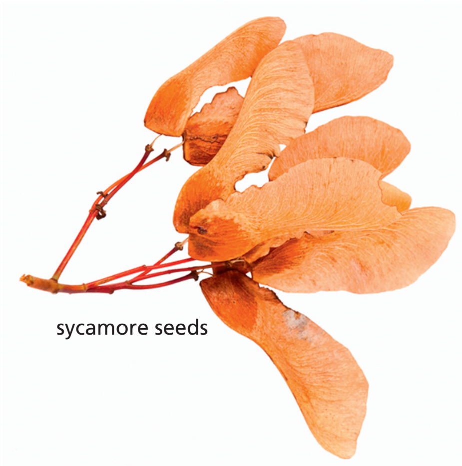


FIGURE 1.1.12c: How are these seeds dispersed?

3. Why are the seeds from trees in forests most likely to be dispersed by the wind?

4. What are the advantages and disadvantages of a seed growing near the parent plant?

Did you know…?

The seeds of the *Alsomitra* vine tree were the inspiration in the development of the first gliders and airplanes. With a wing span of up to 13 cm, they are the largest wind-pollinated seeds in the world.

Surveying and sampling seeds

Botanists carry out surveys to try to find out how seeds are dispersed and how successful different plants are at germinating the seeds they make. They might do this by sampling many plants of the same species in a particular habitat. First they count the number of seeds made. Then, after the seeds have dispersed, they sample the habitat again to make an estimate of the number of seedlings that have germinated. By estimating the percentage of seedlings germinated compared to seeds made originally, they can judge how successful the seed dispersal mechanism is.

5. What is the **independent variable** in this survey?

6. What factors need to be controlled in such a survey?

7. How would you ensure the evidence collected was **reliable**?

8. Why might it be important to find out how successful plants are at dispersing and germinating seeds?

Key vocabulary

seed dispersal

germinate

independent variable

reliable

193885_P008_047.indd 31 09/12/2013 15:20

Understanding how fruits disperse seeds

We are learning how to:

- Describe how fruits are used in seed dispersal.
- Compare evidence about seed dispersal by wind and by fruit formation.
- Use data to evaluate different seed dispersal mechanisms.

Without animals to disperse their seeds, some plants would become extinct. The seeds of the *Astrocaryum* palm used to be dispersed by dinosaurs. Now, small rodents called agoutis disperse the seeds. Agoutis steal each other's seeds, increasing the distance of dispersal.

FIGURE 1.1.13a: Where are the seeds in these plant products?

Plants exploiting animals

Plants use **fruits** to disperse seeds. A fruit is the **ovary** of a plant after fertilisation. The fruit is a nutritious treat surrounding the seed, mainly made of sugars and tasty nutrients to attract animals. Examples include nuts, tomatoes and cucumbers. The seed cannot be digested, so passes through the intestines and out with the faeces. Some seeds, such as mango seeds, are too large to be eaten. When they land in soil, they can germinate to make new plants.

1. What is a 'fruit'?
2. Which of the objects in Figure 1.1.13a is not a fruit?
3. What is the main advantage of fruits dispersing seeds?

Why seeds are dispersed

In producing fruit a plant uses energy, which is transferred to the animals that eat the fruit. The advantage for the plant is that it does not need to produce as many seeds, and most are carried away from the parent plant and land in nutritious soil.

Plants that use wind to disperse seeds usually produce thousands of much smaller seeds, to increase the chance of successful germination. Their small size and aerodynamic features allow them to be dispersed over much larger areas, but with no guarantee of landing in nutritious soil.

The rubber plant and witch hazel have exploding pods that burst open when the seeds are ripe. This mechanism guarantees dispersal, though rarely very far from the parent plant, increasing **competition** and reducing the chance of successful germination. Coconuts are large and buoyant and so can be tranported by seas. They are packed with nutrition so the seed can survive a long time.

4. Which type of dispersal mechanism requires more seeds? Why is this?

FIGURE 1.1.13b: How are these seeds adapted for their dispersal method?

Methods of seed dispersal

TABLE 1.1.13: Different methods of seed dispersal

Name of plant	Type of dispersal mechanism	Approximate number of seeds made per plant	Average dispersal distance
ragwort	parachute	10 000	over 100 m
ash tree	helicopter	1000	over 100 m
Alsomitra vine tree	glider	40 000	1–2 km
witch hazel	exploding pod	100	10 m
pea	exploding pod	100	a few metres
blackcurrant	fruit	300	variable
melon	fruit	500	variable
coconut	water	50	hundreds of miles

Table 1.1.13 summarises the types of seed dispersal mechanisms used by a variety of plants.

5. If you were a plant, which dispersal mechanism would you choose and why?

6. What can you say about the different dispersal mechanisms from the data?

7. Show the data from the table in a graphical form. Choose a good way to represent the data so that mechanisms can be evaluated.

Did you know…?

Avocados are thought to be the most nutritious fruit with over 25 essential nutrients, including vitamin C, iron, magnesium and potassium. Eating plenty of different fruit can reduce the risk of cancer, heart disease, strokes and Alzheimer's disease.

Key vocabulary

fruit

ovary

competition

Understanding the male reproductive system

We are learning how to:

- Describe the structure and function of different parts of the male reproductive system.
- Compare plant and human male reproductive structures.
- Summarise the strengths and weaknesses of the human and plant male reproductive systems.

The human reproductive system is controlled by chemicals. In the male, one chemical is testosterone, which controls the growth and development of the organs and sperm cells. Sperm cells take four to six weeks to mature, and live for about 36 hours once released inside the female.

Male and female

The purpose of a **reproductive system** is to produce offspring and so keep the species alive. In some species, such as plants, the male and female organs are on the same organism. Most vertebrates have separate male and female organisms, with specially adapted reproductive systems. The purpose of the human male reproductive system is to make millions of male sex cells (sperm) and to transport them inside the female to fertilise an egg cell and so produce a baby.

1. Name the male sex cells and female sex cells in humans.
2. What is the purpose of the male reproductive system?

Naming the parts

The **testes** are two organs where human sperm cells are made. They are protected inside the **scrotal sac**. A tube called the **sperm duct** carries the sperm to a large organ called the prostate gland. Here, a liquid called **semen** is produced and mixed with the sperm cells, to supply them with nutrients for their long journey. They leave the male through a tube called the **urethra**, inside the organ known as the **penis**. This occurs during the act of sexual intercourse.

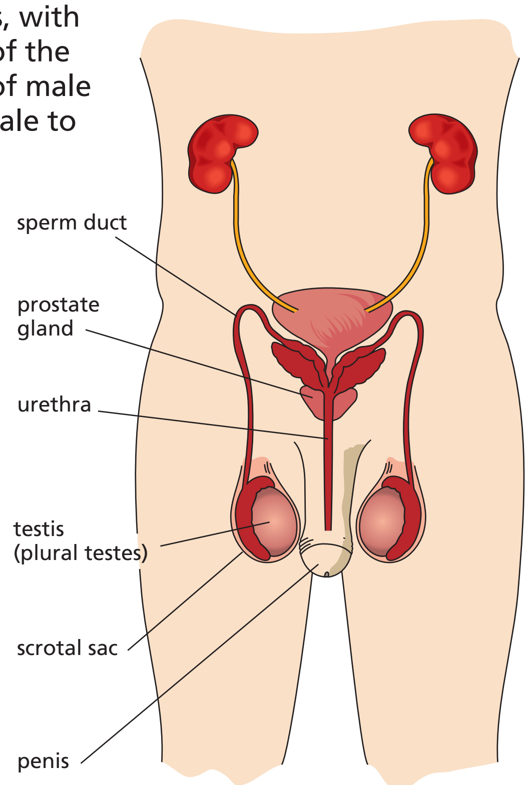


FIGURE 1.1.14a: The male reproductive system

193885_P008_047.indd 34 09/12/2013 15:21

3. List one cell and two organs in the male reproductive system.
4. Draw the journey of a sperm cell, labelling the parts of the male reproductive system that it passes through.

Transfer of the male sex cell

The human male reproductive system has the same purpose as the stamen in a flower. The anther makes pollen (the male sex cells of the plant), just as the testes make sperm cells. The anther releases the pollen to be transported to the stigmas of other plants using external influences such as insects or the wind.

Humans carry out internal fertilisation. In sexual intercourse, the penis is inserted inside the vagina – its movement stimulates the release of sperm from the testes. In this way, sperm are guaranteed to be placed directly inside the female. Both the anther and the testes produce millions of male sex cells to maximise the likelihood of successful fertilisation. However, plants produce pollen only when the stigmas are likely to be ready for fertilisation.

FIGURE 1.1.14b: The human male sex cell is adapted to carry out its job. How is it different from a pollen cell?

5. Which parts make the male sex cells in plants and in humans?
6. What additional features does a plant reproductive system have that a human reproductive system does not have? Why does it need them?
7. What advantage(s) does the plant male reproductive system have over the human male reproductive system?
8. Which system do you think is more effective – the stamen or the human male reproductive system? Give reasons for your answer.

Did you know …?

A human sperm is the smallest cell in the body. 5000 sperm cells would fit into one millimetre. The egg cell is the largest – about the size of a full stop.

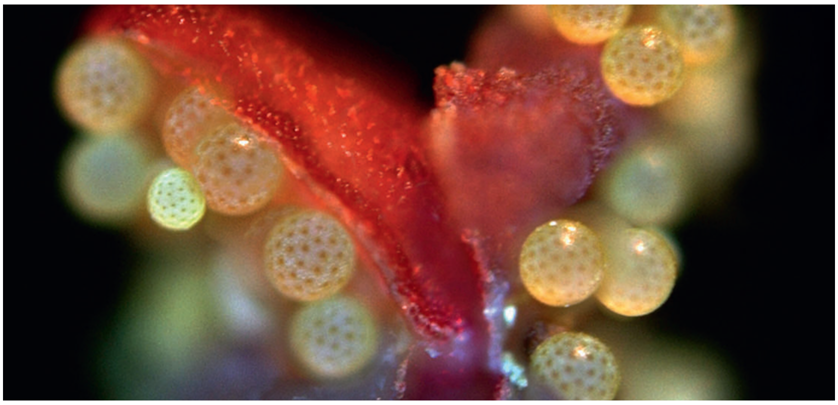


FIGURE 1.1.14c: Pollen on the stamen of a flower. Compare this with the human male reproductive system.

Key vocabulary

reproductive system
testes
scrotal sac
sperm duct
semen
urethra
penis

Understanding the female reproductive system and fertility

We are learning how to:

- Describe the structures and functions of different parts of the female reproductive system.
- Explain the process of fertilisation.
- Explain problems of infertility and how they might be treated.

The human female reproductive system receives sperm and enables the fertilised egg to develop until it is ready to be born. The uterus, or womb, is where the foetus grows and develops. The uterus increases to up to 20 times its original size during pregnancy.

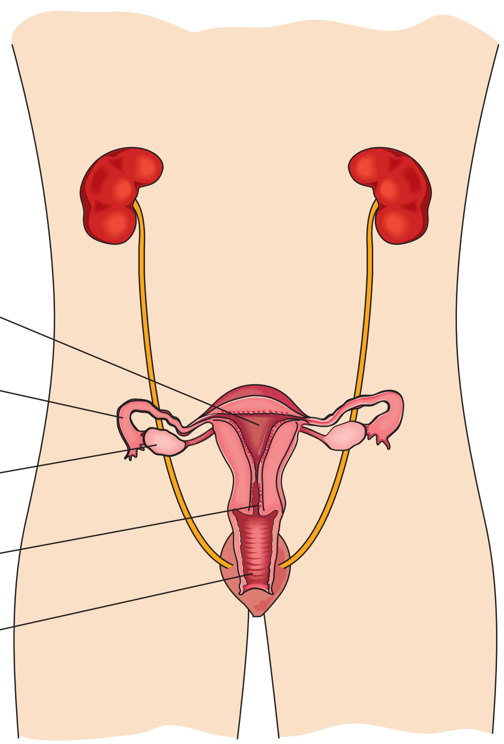


FIGURE 1.1.15a: The female reproductive system

The functions of female organs

The human female reproductive system has two main purposes – to produce egg cells that may be fertilised by the male sperm, and to provide an environment for the growing foetus.

The main female organs are the **vagina**, **cervix**, **uterus**, **oviduct** and **ovary**. Table 1.1.15 summarises the structure and function of each of these.

TABLE 1.1.15: Female reproductive organs

Vagina	Muscular tube, 8 to 12 cm long, that extends up to the uterus and can stretch to allow a baby to pass
Cervix	Narrow opening from the vagina to the uterus with thick walls – can extend wide enough to allow a baby to pass
Uterus or womb	Pear-shaped cavity with thick muscular walls – where fertilisation occurs and the developing baby grows
Oviduct (Fallopian tube)	The tube that carries the egg from the ovary to the uterus
Ovary	Where eggs cells are made and then released into the oviduct

1. Where are female sex cells made?
2. Why do you think the uterus has muscular walls?

193885_P008_047.indd 36 09/12/2013 15:21

Fertilisation

One egg matures each month in the ovary and is released into the oviduct – this process is called **ovulation**. The lining of the oviduct contains specialised cells with tiny hairs that beat causing the egg to move down to the uterus, where for up to 24 hours it may be fertilised by a sperm cell. Only one sperm penetrates the egg cell, losing its tail as it does so. The nucleus of the sperm fuses with the nucleus of the egg, combining the genetic material of both. The fertilised egg is the start of a new life.

3. Why does the egg need to move from the ovary to the uterus?

4. Why do you think the egg cell is so much bigger than the sperm cell?

5. Explain the difference between ovulation and fertilisation.

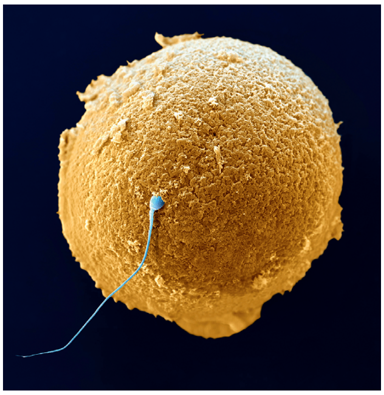


FIGURE 1.1.15b: Fertilisation occurs when one sperm cell penetrates the egg cell and their nuclei fuse.

Infertility

Most women below the age of 36 have little trouble in having babies. However, **infertility** affects about 3.5 million women in the UK. There are a number of causes:

- External factors – such as excessive alcohol, drugs, long-term smoking, stress and sexually transmitted diseases.
- Problems with ovulation – the release of eggs is controlled by chemicals called hormones; an imbalance may result in eggs not being made or released.
- Endometriosis – cells from the lining of the oviduct may start to grow around the ovary and cause cysts to appear, making it hard for the eggs to be released.
- Blockages in the oviduct – these can prevent an egg from reaching the uterus and becoming fertilised.

In men, infertility may be caused by a low number of healthy sperm or sperm that can't swim well because of disease.

6. For each of the female infertility problems, suggest a possible solution.

Did you know ...?

The ovaries of new-born girls have about 600 000 immature eggs. However, an adult woman is capable of giving birth to a maximum of 35 babies.

Key vocabulary

vagina
cervix
uterus
oviduct
ovary
ovulation
infertility

193885_P008_047.indd 37 09/12/2013 15:21

Biology

Learning about changes in puberty

We are learning how to:

- Recognise changes in male and female bodies during puberty.
- Describe the process of menstruation.
- Explain how some problems with menstruation occur.

Puberty refers to the period when physical changes occur that enable a person to reproduce. It can start from any age between 8 and 16 years. All the changes are controlled by chemicals called hormones, which work together.

Changes during puberty

During **puberty** in girls:

- the hips widen, preparing for childbirth
- there is a height spurt
- breasts become bigger to prepare for breastfeeding
- **menstruation** (**periods**) start
- hair develops in the armpits and around the reproductive organs.

During puberty in boys:

- the shoulders broaden to give a strong appearance
- the voice deepens to attract females
- there is a height spurt
- the penis and testes grow
- sperm is produced and released during 'wet dreams' to prepare for intercourse
- hair develops in the armpits and around the reproductive organs.

1. What changes in puberty occur in *both* boys and girls?

When the changes happen

The changes that occur during puberty, and the ages between which they usually occur, are shown in Table 1.1.16.

Event in puberty	Age range for start of event (years)
height spurt in girls	8.5 – 14.0
development of breasts	8.0 – 13.0
first menstruation period	10.5 – 15.5
height spurt in boys	10.5 – 16.5
growth of penis	10.5 – 14.5
growth of testes	9.5 – 13.5
growth of voice box (larynx)	10.5 – 14.0

FIGURE 1.1.16a: Individuals experience changes at different ages.

TABLE 1.1.16: Age ranges for the start and end of changes in puberty

193885_P008_047.indd 38 09/12/2013 15:21

2. Look at the data in Table 1.1.16. What are the youngest ages at which a girl and a boy can start puberty?
3. Is there any order in which particular events occur in puberty? Give evidence for your answer.

Menstruation

Menstruation occurs in a cycle lasting about 28 days and is controlled by hormones. Some women experience problems:

- Amenorrhea (absence of periods) is caused by hormonal problems, defects in the ovary, stress or anorexia.
- Menorrhagia (excessively heavy bleeding) is caused by hormonal imbalances or infection in the uterus.
- Dysmenorrhea (period pain) is also caused by hormone imbalances.

Did you know…?

Apart from humans, only primates, elephant shrews and some bats undergo menstruation. In other mammals, the lining is reabsorbed by the body so that nutrients are not lost.

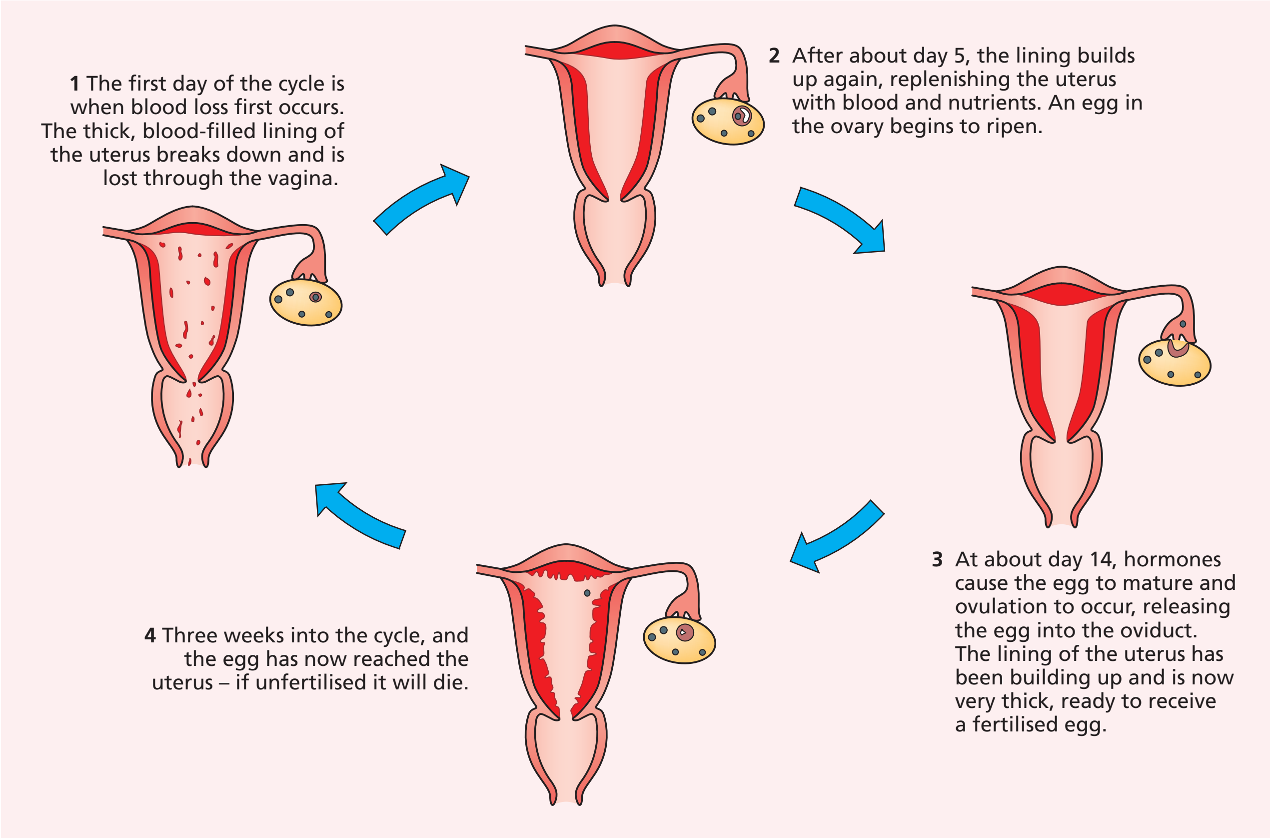


FIGURE 1.1.16b: The menstrual cycle

4. What part do hormones play in normal and abnormal periods?
5. Look at Figure 1.1.16b. Explain the problems that may occur at different stages of the cycle.

Key vocabulary

puberty
menstruation
period

Biology

Learning how a foetus develops

We are learning how to:

- Recognise the process of growth.
- Use data to show how the embryo grows during gestation.
- Compare and contrast the pregnant uterus with the non-pregnant uterus.

A human foetus takes 38 weeks to grow from one fertilised cell into a complete baby ready to be born. Dogs take just two months, whereas elephants take up to two years. The mother provides the developing foetus with all the nutrients and oxygen it needs, as well as removing all waste products.

Cell division

When an egg cell has been fertilised, it divides into two cells. These cells further divide to make four cells, which divide again to make eight cells. This **cell division** continues until there are several thousand cells. This is the process of growth, where cells divide to make new cells and the overall size of the organism increases. Within the first two to three weeks the cells are all the same – they are called **stem cells**. Stem cells have the ability to become any specialised cell in the body.

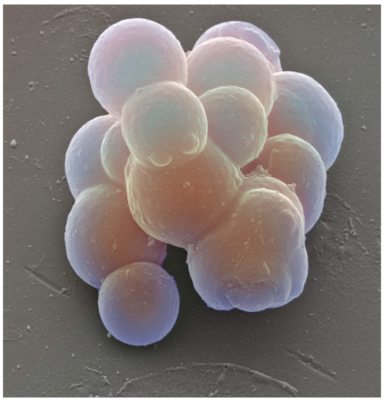


FIGURE 1.1.17a: Stem cells

1. What is 'growth'?
2. What is special about stem cells?

Development of the foetus

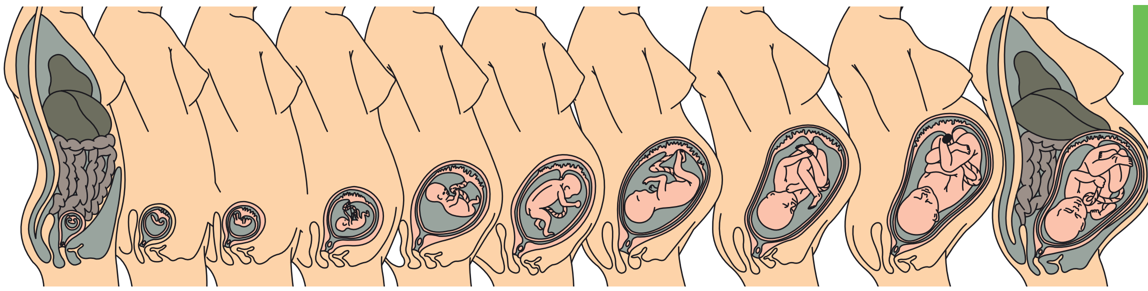
Once the ball of stem cells reaches a certain size, the cells begin to differentiate and become specialised cells. Some cells will develop into the organs and tissues of the developing baby. At this stage when the cells begin to differentiate, the ball of cells is called an **embryo**. Once it reaches about 8 weeks old, when most of the main organs are formed, including the heart which is now beating, it is called a **foetus**.

Figure 1.1.17b shows the different stages of development of a human foetus. Ultrasound is used to make images of the foetus at different stages to monitor its development and identify any problems. The height of the foetus can be measured using these images.

3. When is the fastest period of growth of the developing foetus? Explain your answer.

Did you know…?

The taste buds of a foetus develop at 14 weeks; it can hear at 24 weeks and track objects with its eyes at 31 weeks. At 28 weeks, a foetus is likely to survive if born.



weeks of gestation	9	12	16	20	24	28	32	36	40
size (length) of foetus	50mm	90mm	140mm	190mm	230mm	270mm	300mm	340mm	380mm

FIGURE 1.1.17b: Foetuses at different stages of development

Supporting structures

During pregnancy, other cells from the original ball of cells will become structures that connect with the mother – the **placenta**, amnion, amniotic fluid and **umbilical cord**. These structures are shown in Figure 1.1.17c.

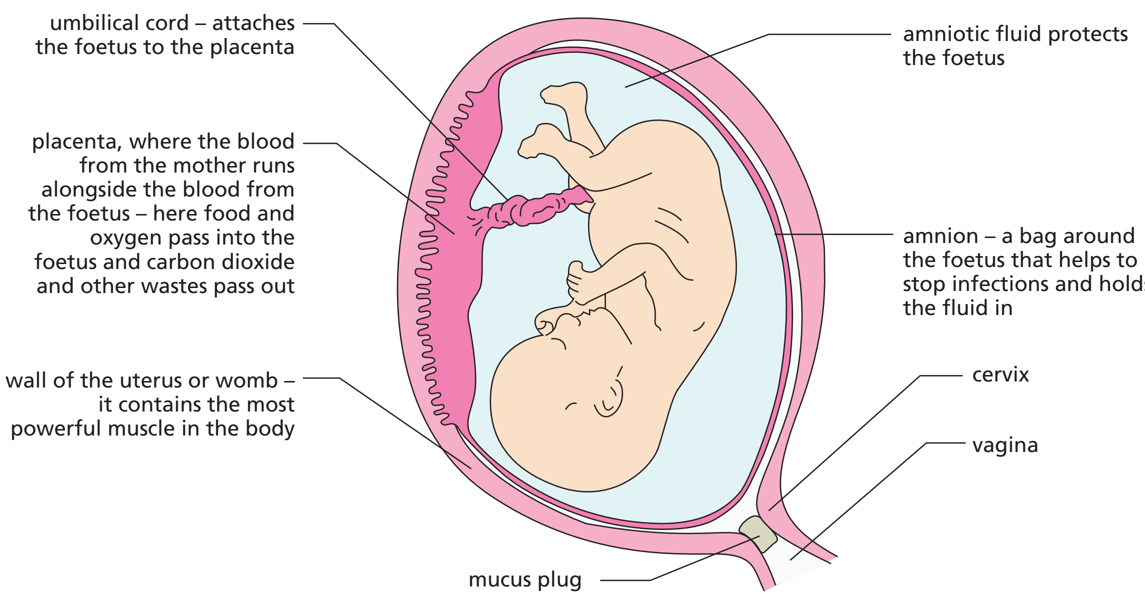


FIGURE 1.1.17c: The developing foetus in the uterus

4. Why does a foetus need the placenta?
5. Why is it important for the baby to be surrounded by fluid?
6. Summarise the different ways in which a pregnant uterus is different from a normal uterus.

Key vocabulary

cell division
stem cells
embryo
foetus
placenta
umbilical cord

Biology

Understanding factors affecting a developing foetus

We are learning how to:

- Describe the effects of different factors on a developing foetus.
- Evaluate the strength of data.

A foetus can't take in its own food or oxygen and relies on the mother to supply it with essential chemicals and nutrients. The placenta allows substances to pass from mother to baby.

The role of the placenta

The placenta allows oxygen, glucose, digested proteins and fats, vitamins and minerals to enter the foetus – it also removes carbon dioxide and waste products, such as urea. Harmful substances can also cross the placenta including alcohol, nicotine, carbon monoxide, cocaine, insecticides, lead and mercury.

1. How might the harmful substances come to be at the placenta?
2. What would happen to a foetus without the placenta? Explain your answer.

FIGURE 1.1.18a: An ultrasound scan of a foetus enables its development to be checked.

Effects of substances on the foetus

Scientific studies have established how different substances affect a developing foetus. Foetal size and movements can be tracked and the heartbeat measured. Tests have found out that some substances affect the foetus – see Table 1.1.18.

TABLE 1.1.18: Substances that affect a developing foetus

Alcohol	Higher rate of stillbirth, lower birth weight, lower IQ; baby slower to move and think, more likely to be dependent on alcohol in adulthood.
Smoking – nicotine and carbon monoxide	Much higher risk of stillbirth, **premature** delivery and low birth weight resulting in poor development; greater likelihood of developing asthma.
Drugs – marijuana, cocaine	Higher rate of stillbirth, premature birth, low birth weight, learning difficulties and likely addiction to the drug.
Nutrition – folic acid	Good for the development of the brain and spinal cord; supplements should be taken as soon as pregnancy is recognised.

3. What are the common factors that badly affect the development of a foetus?
4. What advice can you give to pregnant mothers to help them have a healthy baby?
5. How confident can you be about the evidence produced by ultrasound scans? Explain your answer.

Validity and reliability in research

Researchers need to ensure that their investigations produce **valid** and **reliable** evidence. 'Valid' means that the evidence collected answers the question being investigated. It must take account of all possible variables. The evidence should also be reliable. This can be done through repeat readings or, in the case of a survey, using a large **sample size**.

Did you know...?

A woman may not realise she is pregnant until about 8 weeks after conception. The embryo's brain starts to develop after just 2 to 3 weeks and is highly influenced by chemicals coming through the placenta.

6. Comment on the validity and reliability of the following studies:
   a) The first research on the effects of alcohol was conducted on 127 babies born to alcoholic mothers in France in 1968. The babies were found to have lower birth weights and lower intelligence.
   b) In a study on the effect of smoking, the ultrasound scans of 65 mothers who smoked were compared with the scans of 36 mothers who were non-smokers.
   c) In a study on the use of folic acid, the mothers of 85 per cent of Norwegian children born between 2002 and 2008 completed a questionnaire. Researchers found that 0.1 per cent of mothers who took folic acid had autistic children, compared to 0.21 per cent who did not take folic acid.

FIGURE 1.1.18b: Possible consequence of smoking during pregnancy

Key vocabulary

premature

valid

reliable

sample size

Checking your progress

To make good progress in understanding science you need to focus on these ideas and skills.

☐ Recognise and label basic and specialised animal cells and plant cells; use a microscope to make observations.	☐ Describe the functions of the nucleus, cell membrane, mitochondria, cytoplasm, cell wall, vacuole and chloroplast.	☐ Compare and contrast the similarities and differences between specialised animal cells and plant cells.
☐ Describe unicellular organisms – including yeast, bacteria, euglena, paramecium and amoeba – as being either prokaryotes or eukaryotes.	☐ Describe the function of specialised parts of different unicellular organisms.	☐ Explain how different structures help organisms to survive.
☐ Recognise the role of diffusion in living organisms.	☐ Describe the process of diffusion, and name the materials needed by the cell and those removed from the cell.	☐ Explain the factors that affect diffusion.
☐ Put the terms cell, tissue, organ and organ system in order of hierarchy, naming some common tissues, organs and organ systems in humans.	☐ Explain the terms cell, tissue, organ and organ system and the function of all the main organ systems in the body.	☐ Describe some benefits and disadvantages of multicellular organisms compared to single-celled organisms.
☐ Describe the role of different parts of a flowering plant in reproduction.	☐ Explain the differences in wind-pollinated and insect-pollinated plants.	☐ Discuss the strengths and weaknesses of wind-pollinated and insect-pollinated plants.

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Recognise different seed-dispersal methods and relate these to the structures of the seeds.	Identify key variables that need to be controlled when investigating the effect of seed design on seed dispersal.	Explain the advantages and disadvantages of different seed-dispersal mechanisms.
Name the main parts of the male and female human reproductive systems.	Describe the structures and functions of the main parts of the male and female human reproductive systems; describe how fertility problems may arise.	Explain how the male and female reproductive structures are designed for fertilisation; describe methods to combat infertility.
Recognise changes that occur during adolescence.	Describe how the menstruation cycle works.	Explain how and why some problems occur with menstruation.
Identify substances passed on from a mother that will either help or harm her developing foetus.	Describe the structures and functions of different parts of a pregnant uterus, describing how substances pass into and from a developing foetus.	Explain how a pregnant uterus is different from a normal uterus, including the impact of different substances on the health and development of a foetus.

Questions

Questions 1–7

See how well you have understood the ideas in the chapter.

1. Which of the following is a unicellular organism? [1]

a) nerve cell **b)** cytoplasm **c)** amoeba **d)** flowering plant

2. Where in the cell would the most diffusion take place? [1]

a) nucleus **b)** cell membrane **c)** chloroplast **d)** cell wall

3. Which structure is not directly linked to fertilisation? [1]

a) egg cell **b)** ovary **c)** stigma **d)** pollen grain

4. Which of the following will not pass from a mother to her developing foetus across the placenta? [1]

a) carbon dioxide **b)** carbon monoxide **c)** alcohol **d)** glucose

5. Using an example, describe the theory of ‘spontaneous generation’. [2]

6. Describe the events after pollination that lead to fertilisation. [2]

7. Outline what happens in the menstruation cycle. [4]

Questions 8–14

See how well you can apply the ideas in this chapter to new situations.

8. Some plants live in conditions of low light on the floor of thick forest. Which of the following features are likely to help them to survive? [1]

a) They will have brightly coloured petals.
b) Their leaves will be dark green, packed with more chloroplasts than ordinary leaves.
c) They will have fewer root hair cells.
d) Their seeds will have parachutes so they can be blown by the wind.

9. Cells in the lining of the human lung need to transfer oxygen quickly from the lungs to the blood. How are the cells likely to be adapted to carry out their job? [1]

a) They will contain chloroplasts to collect sunlight.
b) They will contain cilia to remove bacteria.
c) They will have a thin cell membrane and lots of mitochondria.
d) They will have a large surface area and a thin cell membrane.

10. Insect populations in towns are declining. What can be done to increase these populations? [1]

a) Grow a greater variety of wild flowers. **b)** Use more pesticides.
c) Grow more crops for food. **d)** Build more roads and buildings.

11. Seeds are dispersed by a variety of mechanisms. Some are shown in Figure 1.1.20a. Which type of seed is likely to disperse the furthest if the plant was growing on an island? [1]

	Type of seed
a)	Avocado stone
b)	Coconut
c)	Dandelion head
d)	Burdock seed

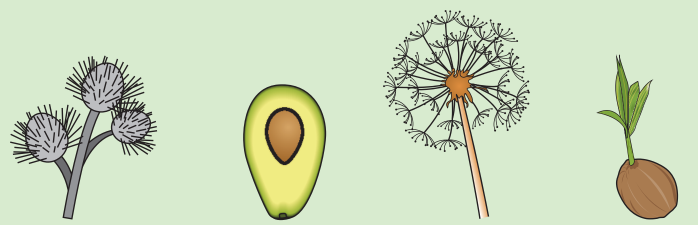

FIGURE 1.1.20a

12. Some scientists discover a new unicellular organism. What features would enable them to classify it as algae? [2]

13. A sixteen-year-old girl has not yet begun to menstruate. What two reasons could there be? [2]

14. Bees in Australia are not affected by colony collapse disorder. Explain why this might be so. [4]

Questions 15–16

See how well you can understand and explain new ideas and evidence.

15. Figure 1.1.20b shows the percentage of motile (moving) sperm in men according to whether they are smokers and/or fertile. What information would you want to know about this study before you could trust the data? [2]

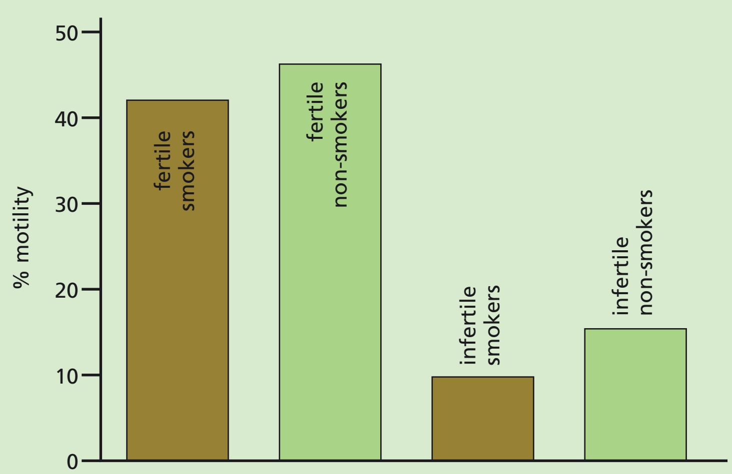

FIGURE 1.1.20b: How smoking affects motility of sperm
(Source: Bethany R. Brookshire, Ph.D scientopia.org/blogs/scicurious/)

16. Sketch a graph to show how the weights of foetuses from smoking mothers compare to those from non-smoking mothers. Give reasons for the differences. [4]