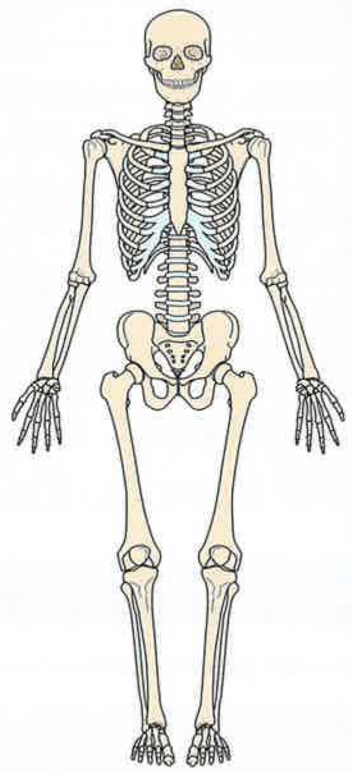
Organisms
Movement *and* Cells

Ideas you have met before

Movement

Humans and some other animals have a skeleton to support and protect them.

Animals with a backbone are called vertebrates.

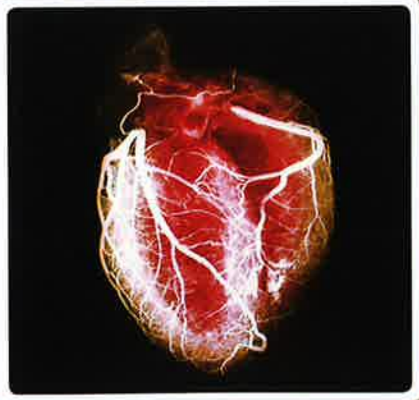


Body systems

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 provides energy from the food we eat.



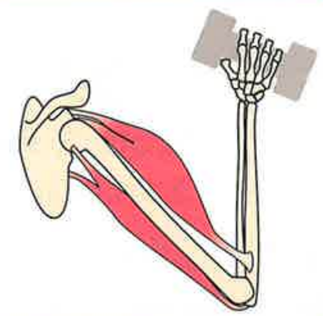
In this chapter you will find out

The skeleton

- The skeleton allows movement at the joints.
- The skeleton also protects some organs.
- Most blood cells are made inside bones.

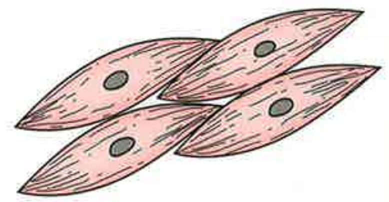
Muscles

- Muscles contract to move bones at the joints.
- Muscles can only contract and relax – they cannot push.
- Many muscles interact and work in pairs to bring about opposite movements.



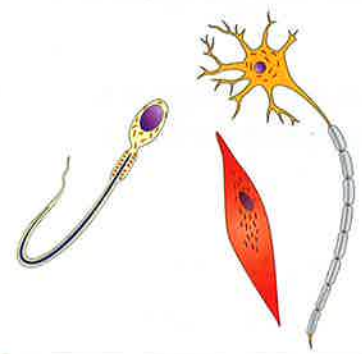
Cells

- Cells are the building blocks of life. They contain structures called organelles, which all have specific jobs.
- Microscopes can be used to observe cells and other structures.
- Some organisms, such as bacteria and protozoa, consist of only a single cell. They can, nevertheless, carry out all necessary life processes.



How cells work for an organism

- A human body has a highly organised set of organ 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.
- Body systems can be affected by certain drugs and by damage to other organs.



Exploring the human skeleton

We are learning how to:

- Identify bones of the human skeleton.
- Describe the roles of the skeleton.
- Explain why we have different shapes and sizes of bones.

There are 206 bones in the human skeleton. Each one contains calcium to make it strong. The smallest bone is found in your ear and is approximately 3 mm long. The largest is your thigh bone. Why do bones vary so much?

Did you know...?

Bones of flying birds are hollow to make the skeleton more lightweight. To increase the strength of the skeleton, more bones are fused together than in humans.

The human skeleton

Bones make up the human **skeleton**.

Look at Figure 1.8.1a and answer these questions.

1. State the scientific name for the:
   - **a)** skull;
   - **b)** collar bone;
   - **c)** shoulder blade;
   - **d)** funny bone.
2. Suggest why you cannot count 206 bones on the diagram of the skeleton in Figure 1.8.1a.
3. Explain why the name 'vertebrates' is suitable for describing animals that have a backbone. **Hint:** look at the bones of the backbone.

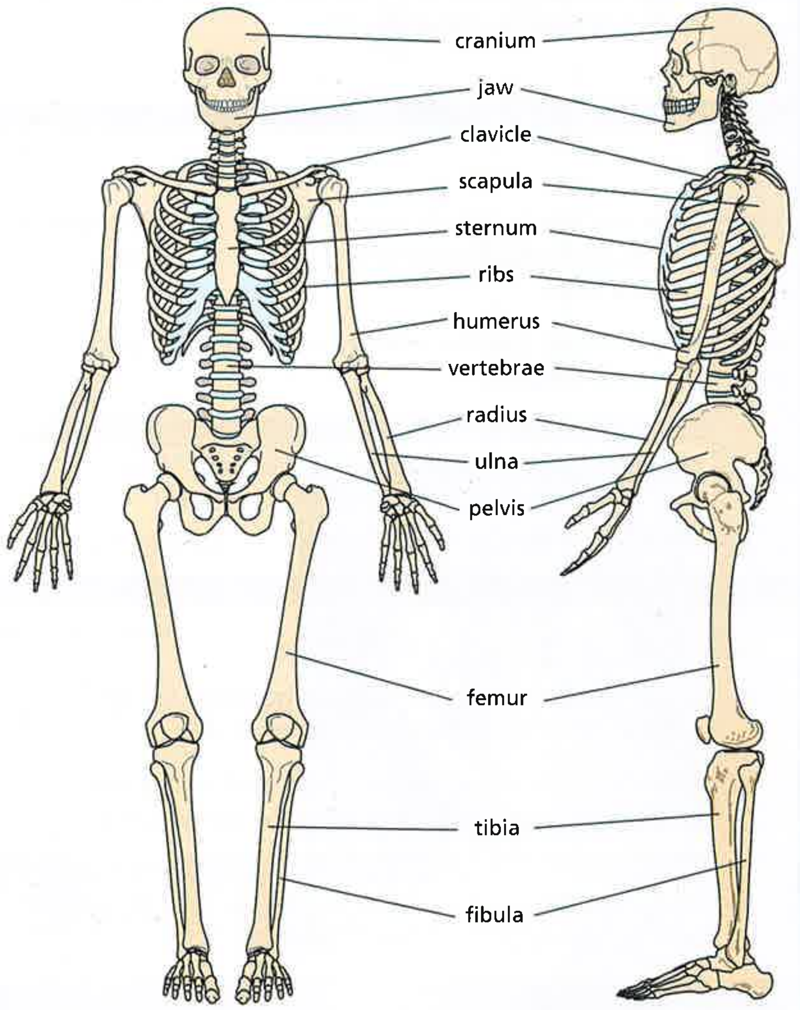


FIGURE 1.8.1a: The main bones of the human skeleton.

Roles of the skeleton

The human skeleton has four main roles:

- it supports the body;
- it protects the organs;
- it allows movement;
- it produces blood cells.

Without a skeleton you would not be able to sit, stand or hold yourself up.

The ribs are curved bones, forming a cavity inside the ribcage. The lungs are positioned inside the ribcage.

The many **joints** in your skeleton allow you to move. For example, the joint at the knee allows your leg to bend.

New blood cells are made in the **bone marrow** (Figure 1.8.1b).

4. Describe the four main roles of the skeleton.
5. Explain which organ each part of the skeleton protects:
   - **a)** ribs;
   - **b)** cranium.
6. Describe three parts of the skeleton where joints are important.

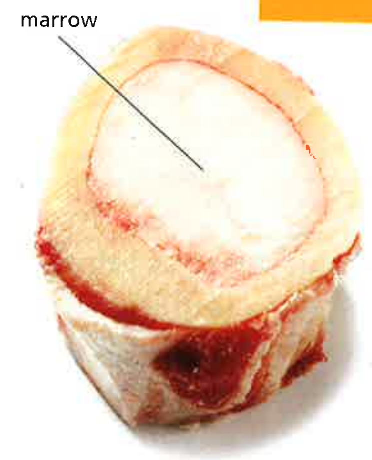


FIGURE 1.8.1b: Bone marrow inside large bones makes blood cells. The red blood cells carry oxygen around the body.

Comparing bones

Bones must be strong to support you. Most of a bone (approximately 70 per cent) is made up of hard minerals, such as **calcium**. The outside of a bone is smooth and hard to provide support. Inside this hard outer layer lies spongy, porous material and inside this layer, in some bones, is bone marrow. This makes your bones lighter than if they were completely solid.

Some bones are long and narrow, such as those in your legs. Some bones are shorter, such as those in your feet. Other bones are flat and wide, such as the scapula (shoulder blade). Each bone is adapted to suit its function. For example, the foot contains many small bones to allow flexibility.

FIGURE 1.8.1c: The femur is a long bone, whereas the scapula is a flat bone.

7. For each of the examples below, describe how the bone shape or structure is well adapted for its function in the body:
   - **a)** femur (thigh bone);
   - **b)** bones of the hand;
   - **c)** ribs.
8. Vertebrae are described as small and irregular bones.
   - **a)** Explain what is meant by an 'irregular' bone.
   - **b)** Suggest why all vertebrae are small and the same size.

Know this vocabulary

skeleton
joints
bone marrow
calcium

Understanding the role of joints and muscles

We are learning how to:

- Describe the roles of tendons, ligaments, joints and muscles.
- Identify muscles used in different movements.
- Compare different joints in the human skeleton.

Bones meet at joints. Some joints, such as those in your cranium, do not allow much movement. However, many joints allow a wide range of movement. Try moving your arm at your elbow, then try at your shoulder. Different joints allow you to move in different ways. Muscles cause these movements at joints by pulling the bones.

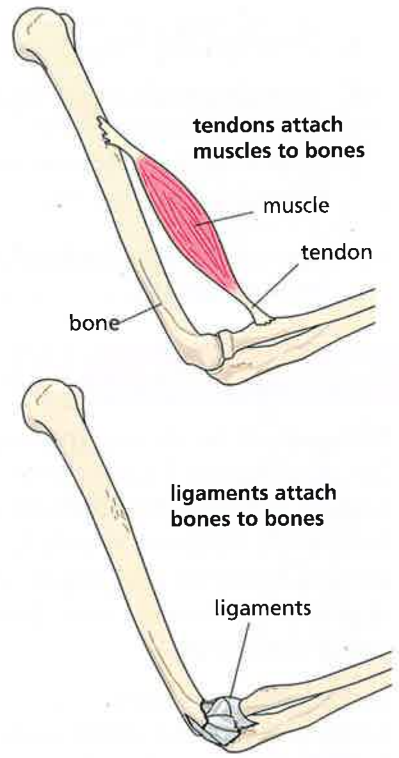


FIGURE 1.8.2a: Tendons join bone to muscle; ligaments join bone to bone.

Tendons and ligaments

The bones of a skeleton are held together by **ligaments**. Bones are connected to **muscles** by **tendons**.

Both ligaments and tendons are made of fibres called collagen. However, the fibres are arranged differently in each. In tendons, they are arranged so that the tendon can move easily as muscles contract. In ligaments, fibres are arranged more tightly to hold bones together securely.

1. Describe the roles of tendons and ligaments.
2. Sportspeople often damage ligaments. Suggest how this can happen.

The main muscles of the body

There are three types of muscle – cardiac muscle in the heart, smooth muscle in the organs, and skeletal muscle attached to the skeleton.

Skeletal muscles (Figure 1.8.2b) allow you to move. They are attached to bones by tendons. As the muscles contract, they pull on tendons, causing the bones around a joint to move. You have over 600 skeletal muscles, which are all involved in moving parts of your body.

The skeletal bones, ligaments, skeletal muscles and tendons are collectively called the **muscular skeletal system**.

Did you know...?

The heart is made of muscle. But this is different from the muscles attached to your skeleton. Heart muscle (cardiac muscle) contracts approximately 70 times every minute for your entire life and it does not tire.

3. State the three types of muscle and where each is found.
4. Name three muscles of the arm.
5. Describe the main muscles that enable you to make these movements:
   - **a)** reaching your arms above your head;
   - **b)** lifting your toes off the floor;
   - **c)** doing a sit-up.

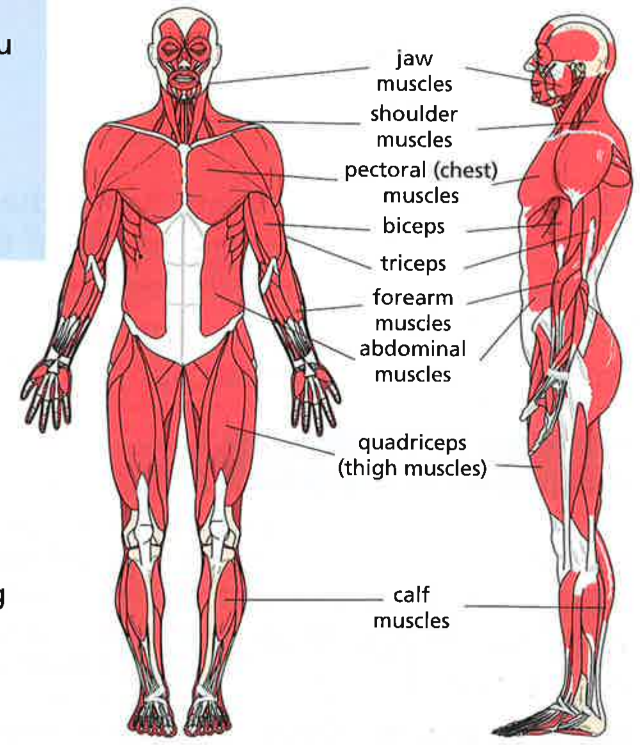


FIGURE 1.8.2b: The main skeletal muscles.

Are all joints the same?

We have three types of moveable joint. The type of movement that they allow varies.

Ball and socket joints allow forward, backward and circular movements. The hip joint is a ball and socket.

A hinge joint allows movement like the opening and closing of a door. This type of joint is found at the elbow.

A pivot joint allows rotation around an axis. This type of joint is found at the top of the neck.

There are also fixed joints, such as those in the skull, that do not allow movement.

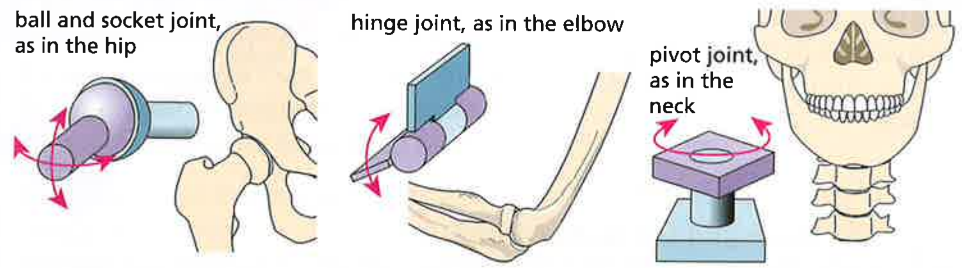


FIGURE 1.8.2c: Types of moveable joints.

At the ends of bones there is smooth, tough tissue called **cartilage**. Cartilage reduces friction between bones and allows them to slide over each other.

6. List the four types of joint in order, starting with the type allowing least movement.
7. Suggest which type of joint is found in the:
   - **a)** shoulder; **b)** knee.
8. Draw a table to summarise the types of joint and the movements they allow.

Know this vocabulary

ligament
muscle
tendon
muscular skeletal system
cartilage

Examining interacting muscles

We are learning how to:

- Describe antagonistic muscles and give examples.
- Explain, using scientific vocabulary, how antagonistic muscles bring about movement.
- Plan an investigation to compare muscle strengths.

The majority of the 600 muscles of the human body work as pairs. As one muscle of the pair contracts, the other muscle relaxes, and vice versa. Without muscles working together in this way we would not be able to move our joints freely.

Muscles working in pairs

When muscles contract, they pull on both a tendon and a bone. If the bone is at a joint, the bone will move. Muscles can only pull, they cannot push. If muscles just worked singly, once pulled the bone would simply stay in that position. To solve this problem, muscles work in **antagonistic muscle pairs**. In the arm, the **bicep** and **tricep** muscles work as an antagonistic pair to control movement at the elbow. To move the forearm up, the bicep contracts and the tricep relaxes. To move the forearm down, the tricep contracts and the bicep relaxes.

Other examples of antagonistic muscles include the quadricep and hamstring muscles in the thigh, which allow bending at the knee, and the shin and calf muscles, which allow movement at the ankle.

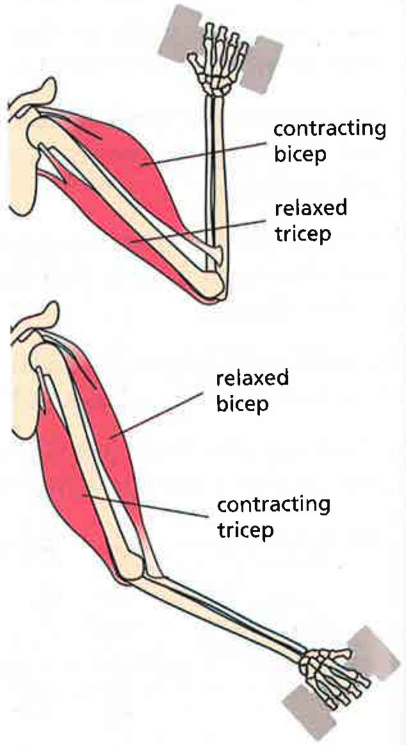


FIGURE 1.8.3a: Which way does the forearm move when the bicep contracts?

1. List some examples of antagonistic muscles.
2. Describe the changes in the bicep and tricep muscles as the forearm moves up and down.
3. Explain why some muscles need to work in pairs.

Movement in a chicken leg

The structure of a chicken leg is similar to the structure of a human leg. When we dissect a chicken leg, we can examine the tissues, including the bones, muscles and tendons. This can help us to understand how our own knee joints work by muscles pulling on the bones to cause movement.

During this dissection, tissue must be removed very carefully. If tissues such as tendons and muscles are damaged during the dissection process, it will be difficult to understand how they work together.

Did you know...?

Antagonistic muscles are at work in our eyes. Pairs of muscles in the coloured part of the eye, the iris, control how big the pupil is. This prevents the eye from being damaged by too much light entering it.

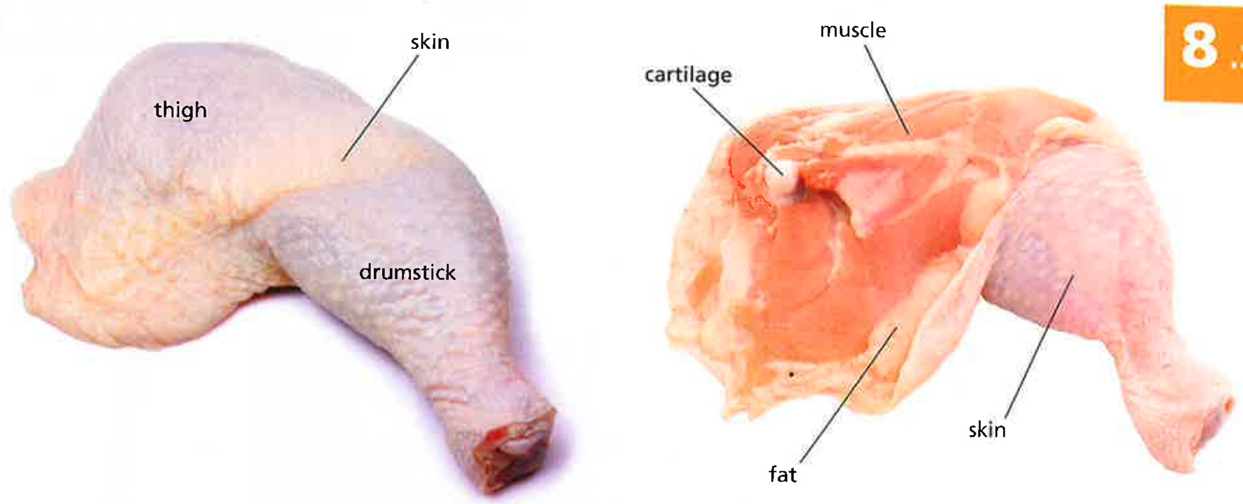


FIGURE 1.8.3b: A chicken leg.

4. Observe or carry out a dissection of a chicken leg. Describe the structure of the chicken leg and the role of each tissue. Try to include the following key words: muscle, skin, cartilage, tendon, fat, bone marrow, femur.
5. Name the type of joint found in the chicken leg and describe the movement that this type of joint allows.
6. Suggest how dissecting animal parts, such as the chicken leg, could help in human medicine.

Measuring muscle strength

By exercising you can increase the strength of muscles. Professional sportspeople consider their training very carefully to ensure that they target specific muscles.

They also test the strength of their muscles frequently to check their progress. These are scientific tests and must be carried out fairly so that measurements can be compared over time. Figure 1.8.3c shows a device to test the strength of the forearm and hand. The person squeezes the handle as hard as they can. The result is then displayed as a **force** (measured in **newtons**).


FIGURE 1.8.3c: A handgrip strength tester.

7. Describe how two rowers could compare hand and forearm strengths using a handgrip tester.
8. A basketball player wants to compare the strength of his forearm with that of a footballer. Predict who would have the most strength.
9. Suggest how you could test the strength of your quadriceps.

Know this vocabulary

antagonistic muscle pair
bicep
tricep
force
newtons

Exploring problems with the skeletal system

We are learning how to:

- Recall some medical problems with the skeletal system.
- Explain how some conditions affect the skeleton.
- Consider the benefits and risks of a technology for improving human movement.

The muscular skeletal system is made up of bones, tendons, ligaments, cartilage and muscles. Medical problems can arise with any of these components, ranging from fractures to genetic conditions that we inherit. The diagnosis and treatment of these problems have changed over time.

FIGURE 1.8.4a: Broken bones can heal in a cast.

Break a leg

With 206 bones in the human skeletal system, it is no surprise that bones are sometimes broken. Bones contain collagen, which allows them to bend a little. However, with a large enough impact bones can splinter, break or shatter.

Bone breaks, or **fractures**, can often be treated by covering the limb with a cast of fibreglass or plaster. This holds the bones in place while new bone knits the broken ends together. More severe fractures require metal pins through the broken bones to hold them in position while healing takes place. An open, or compound, fracture is one in which the skin is broken. This has a much higher risk of infection and usually requires surgery.

1. Suggest how a fracture may happen.
2. Describe how a fracture may be treated.
3. Explain why a compound fracture is often more serious than other fractures.

Figure 1.8.4b: Broken bones can be seen in an X-ray image.

Other problems of the skeletal system

From the age of approximately 35, the density of bones decreases naturally. In some people, the density drops below a healthy level and bones become fragile, making them prone to fractures. This condition is called **osteoporosis**. Treatment for osteoporosis includes taking drugs and calcium supplements to strengthen the bones.

Arthritis is a condition that affects the joints. In one form of arthritis, the cartilage at the end of the bones wears away and bones rub together. This can be very painful. In severe cases, the worn joint is replaced with an artificial joint.

4. Explain why sufferers of osteoporosis are prone to fractures.
5. Explain why arthritis can be so painful.

Did you know...?

On Earth, untreated osteoporosis can typically lead to a loss of 1.5% of bone mass per year. Astronauts can lose 1.5% of bone mass each month!

Medical advances

As technology improves, the diagnosis of fractures by X-rays has become more precise. Surgical techniques have also improved recovery from serious fractures.

As scientists learn more about osteoporosis, they can advise on how to avoid this disease. In the past, all that could be done was to treat the fractures.

As technologies have improved, joint replacements have become much more successful in improving movement and decreasing pain. However, operations such as hip and knee replacements carry risks of infection. There is also the possibility of decreased movement after the operation and the chance that the new joint can become displaced.

FIGURE 1.8.4c: X-ray images of a hip joint before and after the fitting of an artificial joint.

6. Suggest why improvements are likely to continue to be made in medical technology.
7. Explain why some arthritis patients decide not to have joint replacement surgery. Suggest what someone might say to persuade them that surgery would be a good idea.

Know this vocabulary

fracture
osteoporosis
arthritis

Understanding organisation of organisms

We are learning how to:

- Define the terms tissues, organs and organ systems.
- Describe how some recreational drugs affect body systems.
- Suggest the effect of organ damage on other body systems.

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, multi-system, multicellular organisms. There are 15 different organ systems in a human, all working together to help us to survive. What can affect how well these systems work?

Cells, tissues and organs

Groups of similar body cells working together are called **tissues**. Examples of human tissues are muscle and bone. 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 cleanse the blood 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**. An example of an organ system is the circulatory system.

1. Name three other organs and describe their functions.

2. The skin is described as an organ, not a tissue. Suggest why.

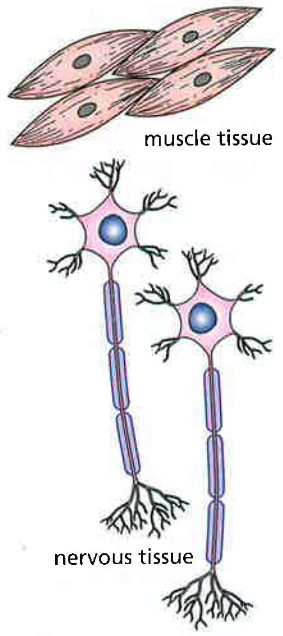


FIGURE 1.8.5a: Two types of tissue as seen under a microscope. What do you notice about the cells in each type of tissue?

Effect of drugs on organs and systems

A drug is any substance that affects the way the body functions. Some drugs are taken to treat medical conditions, such as paracetamol for pain or anaesthetics before an operation. Drugs that are not used for medical reasons are **recreational drugs**.

Drugs can be grouped into four main groups:

- **Painkillers** relieve pain. Examples are paracetamol, codeine and morphine.
- **Stimulants** speed up body systems. Examples are caffeine, nicotine, cocaine, ecstasy and amphetamines.
- **Depressants** slow down body systems. Examples are alcohol, cannabis, tranquillisers (sleeping tablets) and heroin.
- **Hallucinogens** cause us to see things that do not exist. Examples are LSD and psilocybin mushrooms.

Each of these drugs affects the body in different ways. Table 1.8.5 summarises the organ systems that are affected by different drugs:

Did you know...?

Each human consists of about 100 trillion (1×10^{12}) cells working together.

An effect on one organ system by a drug can have a knock on effect on other body systems.

TABLE 1.8.5: Which organ would paracetamol affect?

Type of drug	Effect on body	Organ system affected
painkiller	pain messages blocked; feelings of pain reduced or removed	nervous system
stimulant	increase in alertness and energy, brain activity increased, heart rate increased	nervous system, circulatory system
depressant	relaxed feelings or sleepiness, brain activity decreased, heart rate decreased	nervous system, circulatory system
hallucinogen	sense of reality distorted	nervous system

3. Which organ system do all drugs affect?

4. Ketamine is an animal tranquiliser used by vets for operations. Identify which group of drugs ketamine belongs to and describe which body systems the drug would affect.

Consequences of damage to organs

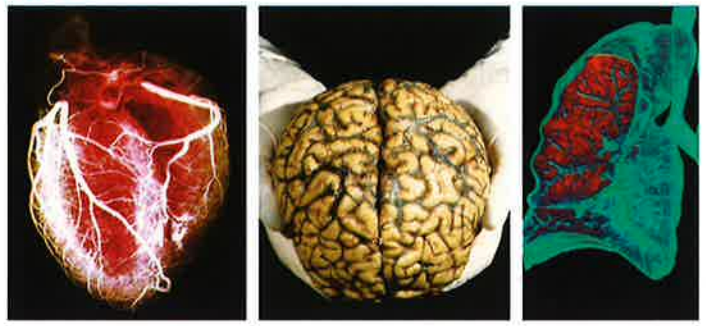


FIGURE 1.8.5b: What would be the consequences of damage to these organs?

Examples of the organ systems in the human body are the **circulatory system**, the **respiratory system**, the **digestive system**, the **reproductive system**, the **immune system**, the **muscular skeletal system** and the **nervous system**. To work effectively, each of these systems relies on more than one organ working together, and on other systems. For example, the respiratory system relies on the lungs to collect oxygen from the air that we breathe (and to remove carbon dioxide from the body). It also relies on the circulatory system to pump the blood carrying the oxygen to all parts of the body (and to pump blood containing carbon dioxide back to the lungs to be breathed out). This oxygen is used to release energy in our bodies.

If a person suffers from a heart condition, ineffective pumping of the heart can result in a lack of oxygen reaching all tissues of the body. So, even if the lungs are working well to bring air into the body and to absorb the oxygen that is needed, the person will feel tired and lack energy.

5. a) State the function of each of the organ systems listed in the text.

b) Name an organ involved in the muscular skeletal system.

6. The nervous system relies on neurons to transmit impulses, carrying information around the body. It also relies on the brain to then interpret the information. Predict the consequences of damage to the brain on the nervous system.

Know this vocabulary

tissue
organ
organ system
recreational drugs
circulatory system
respiratory system
digestive system
reproductive system
immune system
muscular skeletal system
nervous system

Describing animal and plant cells

We are learning how to:

- Describe the structures found in animal and plant cells.
- Explain the function of some of the structures within animal and plant cells.
- Communicate ideas about cells effectively using scientific terminology.

Every cell is a chemical processing factory, with hundreds of thousands of chemical reactions occurring every second. Without these reactions, the organism would die.

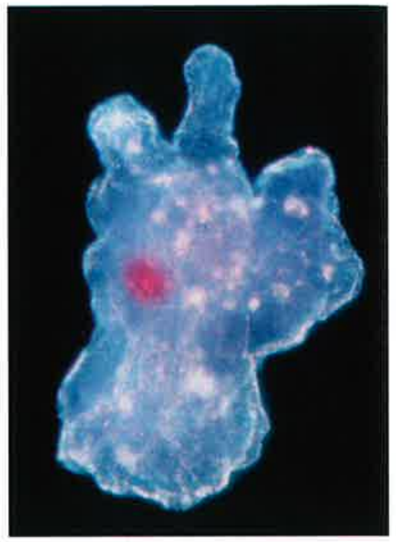


FIGURE 1.8.6a: An amoeba is a unicellular (single-celled) organism.

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. 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.

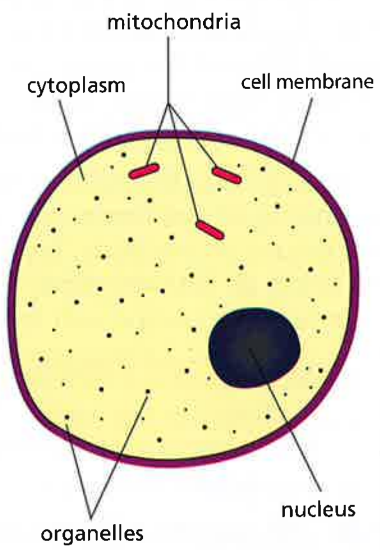


FIGURE 1.8.6b: The main structures of an animal cell.

3. Which parts of the cell are found inside the cytoplasm?
4. What main substances can move 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, made of cellulose. It gives the cell shape and strength.

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

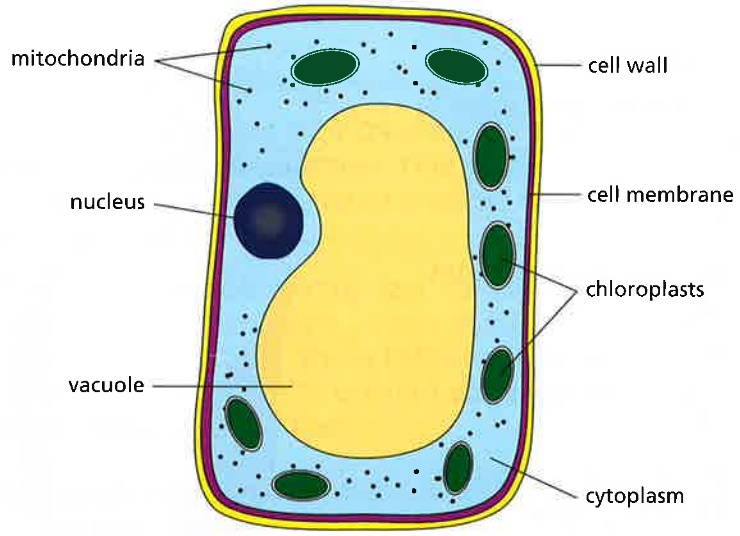


FIGURE 1.8.6c: A plant leaf cell.

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…?

Many scientists believe a theory that mitochondria and chloroplasts evolved from bacterial cells. It is thought that large cells ingested the mitochondria and chloroplasts and they then evolved so that they could no longer exist outside a cell.

Know this vocabulary

cell
nucleus
cytoplasm
cell membrane
mitochondria
cell wall
vacuole
chloroplast

Understanding adaptations of cells

We are learning how to:

- Recall the purpose of specialised cells.
- Identify examples of specialised plant and animal cells.
- Explain the structure and function of specialised cells.

All new cells in an organism 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.

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 impulses, 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)** waves? **c)** heat?
2. Explain why it is important that cells become specialised.

Specialised animal cells

Specialised cells have developed **structural adaptations** that enable the cell to carry out specific functions.

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 large 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.

3. Name the types of animal cell in Figure 1.8.7a.

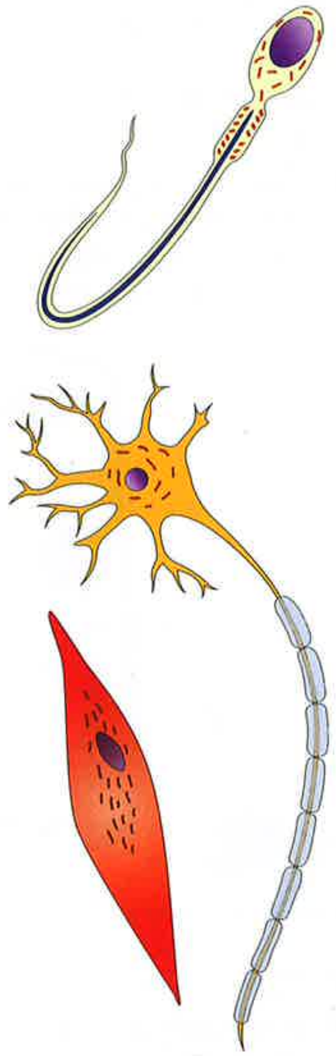


FIGURE 1.8.7a: Can you find the nucleus, cell membrane, cytoplasm and mitochondria of each of these specialised cells?

4. Which type of cell:
   a) transmits electrical messages?
   b) contracts and expands to create movement?
   c) carries genetic material for fertilisation?

Specialised plant cells

Plant cells are also highly specialised. Plants make their own food by a process called photosynthesis. Cells need to collect light and water, and take in carbon dioxide, and they produce a sugar, glucose. Many of the specialised cells in a plant are linked to this function.

Look at the leaf cell shown in Figure 1.8.6c. Chloroplasts trap sunlight needed for photosynthesis.

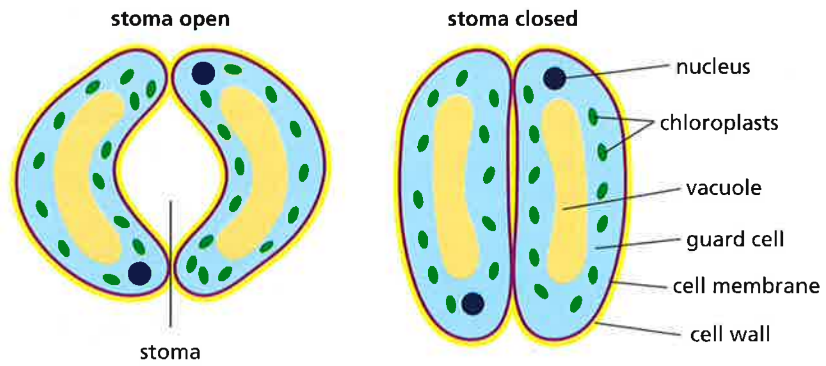


FIGURE 1.8.7b: Leaves have specialised cells called guard cells.

Root hair cells (Figure 1.8.7c) have a long, thin extension called the root hair. This root hair provides a large surface area for water to be absorbed into the roots.

Other specialised cells in the leaf, called guard cells, are adapted to allow carbon dioxide into the leaf, Figure 1.8.7b. These cells can change shape to allow a space to open up so that the gas can move into the leaf.

5. Explain why it is important that plant cells are specialised.
6. Suggest why leaf cells contain lots of chloroplasts compared to other plant cells, such as root hair cells.
7. Look at Figure 1.8.6c showing a leaf cell and at Figure 1.8.7c showing a root hair cell. Describe the features of each and suggest how these features enable the cells to carry out their jobs.

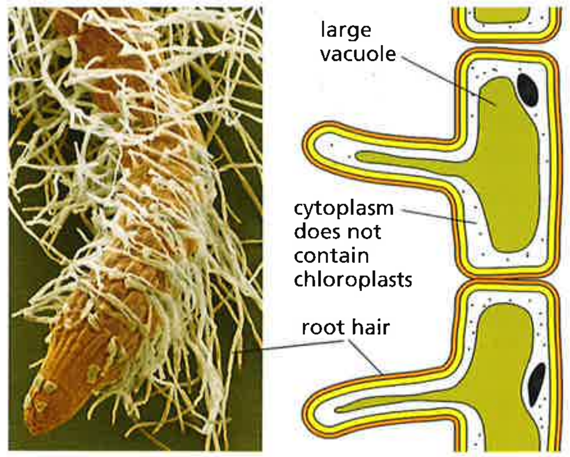


FIGURE 1.8.7c: How are these root hair cells different from the leaf cell shown in Figure 1.8.6c?

Did you know...?

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

Know this vocabulary

specialised cell
structural adaptations

Exploring cells

We are learning how to:

- Observe cells using a microscope and record findings.
- Explain how to use a microscope to identify and compare cells.
- Explain how developments in science can change ideas.

For many years, people believed that living things spontaneously appeared from non-living things. The invention of microscopes allowed scientists to observe cells and to understand how complex, but also structured, living things are.

Discovering cells

In 1590, the first **microscope** was developed and this allowed objects to be magnified. Robert Hooke developed this technique and, in 1667, he observed cells for the first time. From studying samples of cork bark, Robert Hooke discovered that organisms were made from simple building blocks, or cells. They are too small to be seen with the unaided eye.

1. State why we need a microscope to observe cells.
2. What is meant by 'magnified'?

Did you know...?

Robert Hooke used the word 'cells' to describe what he saw under the microscope because he thought that the building blocks of the cork he was using looked like the cells of a monastery where monks lived.

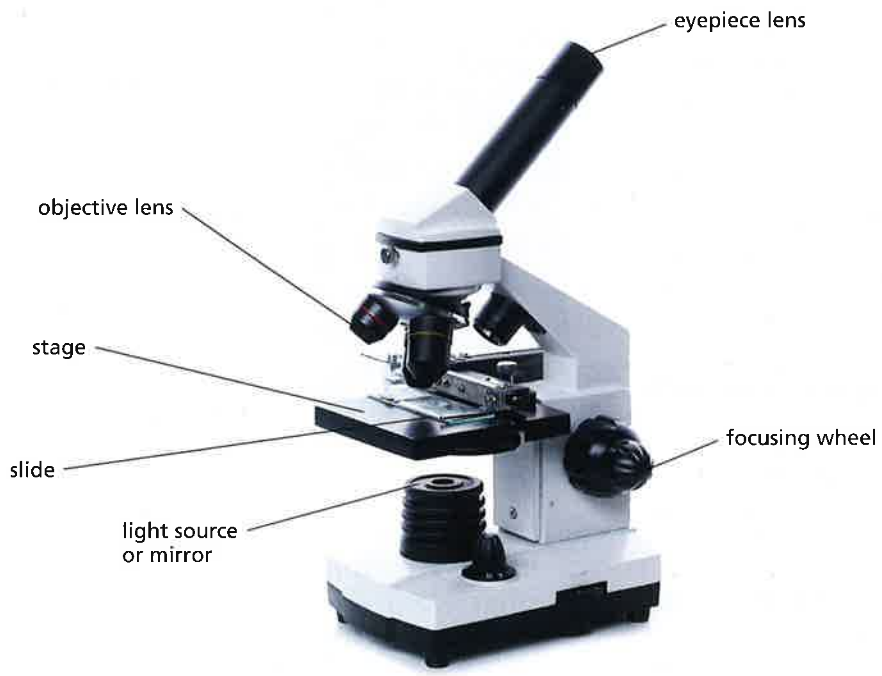


FIGURE 1.8.8a: A light microscope.

Observing cells

Figure 1.8.8a shows a light microscope. A specimen is placed on a glass slide on the stage. This is illuminated from beneath and two lenses (the objective lens and the eyepiece lens) then magnify the image. There is a selection of different objective lenses to allow a range of **magnifications.** The specimen is often stained with a dye to ensure that the features of the cells can be seen.

Cheek cells can be collected using a sterile cotton bud. These cells can then be rubbed onto a glass slide and methylene blue stain added. The slide is then placed on the stage and the objective lens with the lowest power used initially. The image is focused by gently moving the stage. Figure 1.8.8b shows an image of cheek cells viewed in this way. Figure 1.8.8c shows onion cells observed using iodine solution as a stain.

3. Explain why stain is often used on microscope specimens.
4. Describe what cheek cells and onion cells appear like under the microscope, and explain the function of the structures observed.
5. Compare the images in Figure 1.8.8b to the drawings of an animal and plant cell in Figures 1.8.6b and 1.8.6c.

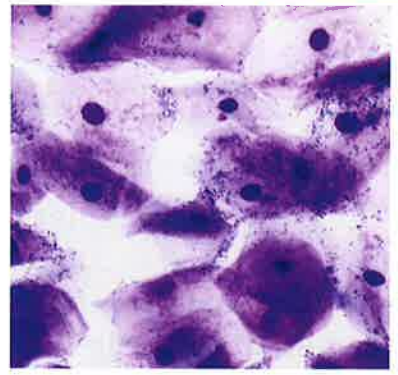


FIGURE 1.8.8b: Cheek cells stained with methylene blue viewed with a light microscope.

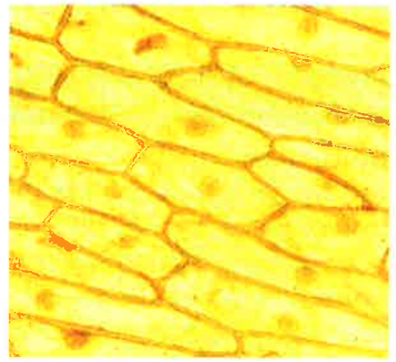


FIGURE 1.8.8c: Onion cells stained with iodine viewed with a light microscope.

Advances in observing cells

Microscopes have advanced hugely since Hooke's version in 1667. However, many are based on the same principles. As microscopes have improved, scientists are able to see smaller cells and smaller structures within cells. These advances have helped scientists to understand how cancer changes cells, for example. Understanding the changes caused is an important step in working out how to treat cancer.

Another type of microscope is the electron microscope. This uses a beam of electrons to form an image of a specimen. Electron microscopes allow greater magnification than light microscopes and have allowed scientists to see images of viruses (Figure 1.8.8d).

6. Describe two differences between a light microscope and an electron microscope.
7. Suggest the importance of improving and developing microscope techniques and technologies.

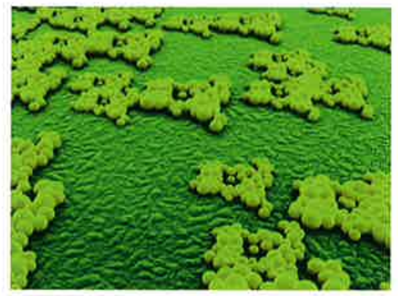


FIGURE 1.8.8d Image of a staphylococcus virus infection produced using an electron microscope.

Know this vocabulary

microscope
magnification

Understanding unicellular organisms

We are learning how to:

- Recognise different types of unicellular organisms.
- Explain how unicellular organisms are adapted to carry out functions.
- Compare and contrast features of different 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, unicellular organisms that could make their own food evolved. Unicellular organisms were the main form of life on the planet for nearly 2 billion years.

Unicellular organisms

Unicellular organisms are made up of just one cell. Each cell carries 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, such as the amoeba (Figure 1.8.9a), 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. What is a unicellular organism?
2. Name three different unicellular organisms.
3. List three ways in which unicellular organisms differ from each other.

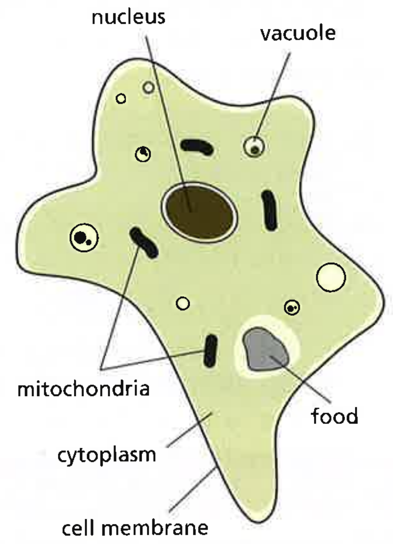


FIGURE 1.8.9a: An amoeba can carry out all life processes.

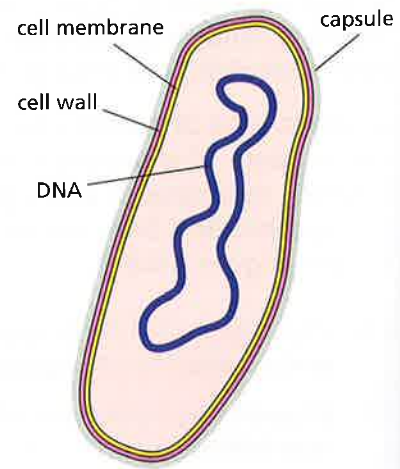


FIGURE 1.8.9b: A bacterium has no nucleus and no mitochondria.

Prokaryotes

Unicellular organisms can be classified into two main groups – **prokaryotes** and **eukaryotes**. Prokaryotes are thought to have been the first organisms to live on Earth. They do not have a nucleus, and their genetic material floats within the cytoplasm. They have no, or few, organelles. **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 chlorophyll and use sunlight to make their own food. Some can absorb nutrients through their cell membrane by **diffusion**. Bacteria can be found in extreme conditions, from under-sea volcano vents to places with temperatures well below freezing.

4. Look at Figure 1.8.9a and Figure 1.8.9b. Which is a prokaryote and which is a eukaryote? Explain your answer.
5. Describe how some prokaryotes are adapted to:
   a) carry out photosynthesis;
   b) absorb nutrients from the environment.

Did you know…?

Nummulites are fossils of the largest known unicellular organisms. Nummulite fossils as large as 16 cm across have been found. Some are thought to have lived for over 100 years.

Eukaryotes

Eukaryotes contain a nucleus, surrounded by a nuclear membrane. They also contain many organelles, including mitochondria, chloroplasts and vacuoles.

Examples of eukaryotes are euglena (a type of alga containing chloroplasts), yeast, amoeba, and paramecium.

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; the paramecium has cilia that beat and enable it to move, and the euglena has a flagellum, or tail, to enable it to move.

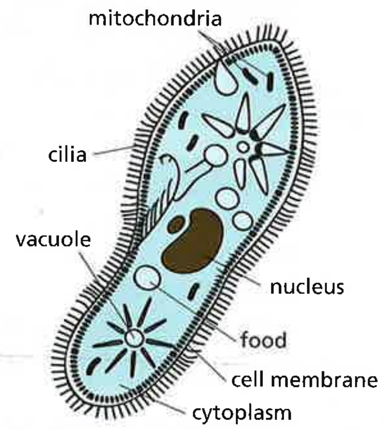


FIGURE 1.8.9c: Paramecium.

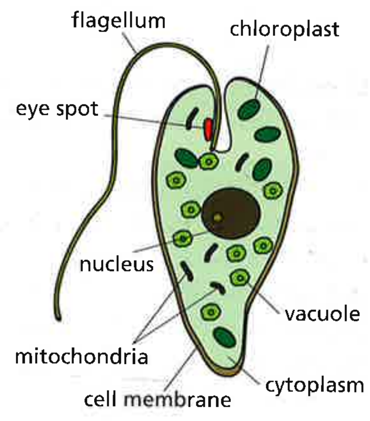


FIGURE 1.8.9d: Euglena.

6. Look at Figure 1.8.9d. How does the euglena get its food?
7. Describe three different ways in which unicellular organisms move.
8. Summarise, in a table, the main similarities and differences between unicellular organisms – compare prokaryotes, paramecium (eukaryote) and euglena (eukaryote).

Know this vocabulary

unicellular
prokaryote
eukaryote
bacteria
diffusion

Checking your progress

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

☐ Identify the main bones of the skeleton.	☐ Describe the functions of the skeleton.	☐ Explain how different parts of the skeleton are adapted to carry out particular functions.
☐ Describe the role of skeletal joints.	☐ Identify some different joints and explain the role of tendons and ligaments in joints.	☐ Compare the movement allowed at different joints and explain why different types of joints are needed.
☐ Recall that muscles contract to move bones at joints.	☐ Identify muscles that contract to cause specific movements.	☐ Explain how muscles work antagonistically to bring about movement, and evaluate a model.
☐ Recognise and label basic and specialised animal cells and plant cells.	☐ 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.
☐ 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 some of the main organ systems in the body.	☐ Explain the relationship between different organs of the body and predict the consequences of damage to specific organs.
☐ Recall that a microscope magnifies an image and allows us to see objects not visible to the naked eye.	☐ Describe and demonstrate how to observe animal and plant cells under the microscope and explain observations.	☐ Explain the importance of the development of microscopy techniques, using examples.

Questions

KNOW. Questions 1–7

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

1. Identify the femur in Figure 1.8.11a. [1]

2. What are the small bones that make up the backbone called? [1]

- **a)** ligaments
- **b)** joints
- **c)** vertebrae
- **d)** tendons

3. How does the ribcage protect the lungs? [2]

4. Explain how muscles cause bones to move. [2]

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

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

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

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

7. Explain why stain is often used on cell samples before observing with a light microscope, and give an example. [2]

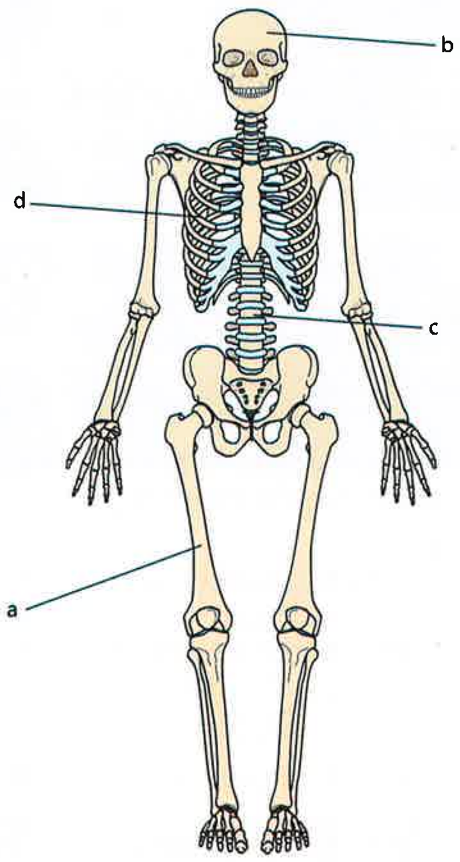


FIGURE 1.8.11a

APPLY. Questions 8–12

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

8. When a muscle underneath the toe contracts to move the toe down, its antagonistic muscle is: [1]

a) contracting; **b)** relaxing;
c) neither contracting nor relaxing; **d)** pushing.

9. Describe how movement at the elbow joint would be different if it were a ball and socket joint. Explain your answer. [2]

10. A sample of cells is observed under a microscope. Each cell has a cell wall, cell membrane and nucleus, but no chloroplasts. Suggest whether this cell is from a plant or an animal, giving reasons. Which part of the organism might these cells have been taken from? [4]

11. 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 small mass so they can be blown by the wind.

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

EXTEND. Questions 13–16

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

13. A bodybuilder has strained his tricep muscles and has been advised to rest his arm. He asks if he could carry on using hand weights to build up his biceps while still resting his triceps. Explain why this is not possible. [4]

14. Imagine that a strange skeleton of an unknown animal is found at an archaeological dig. The backbone of the skeleton is one long bone. Suggest what this tells us about movement of the animal, compared to the movement of humans. [2]

15. Look at Figures 1.8.11b and 1.8.11c. Identify which is from a light microscope and which is from an electron microscope. Explain your answer. [2]

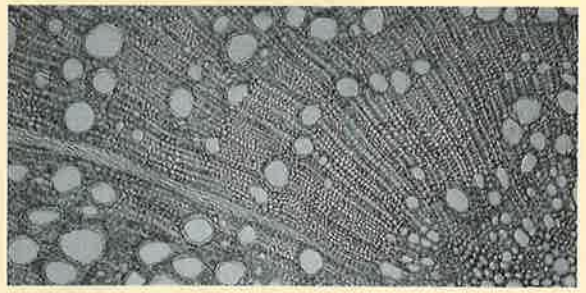


FIGURE 1.8.11b


FIGURE 1.8.11c

16. Table 1.8.11 shows the surface area and volume measured for three different unicellular organisms. Suggest which of the organisms is likely to be more efficient at absorbing nutrients from its environment and explain why. [2]

TABLE 1.8.11

Organism	Surface area (cm^2)	Volume (cm^3)	SA/volume ratio
A	12	6	2:1
B	10	2	5:1
C	12	4	3:1