The Invisible World

Name:_____

What are your things?

In this activity you are to form a group and write down, as many "things" which you know exists in the following space.

Group Number			
Leader	**Spoke person**	**Scribe**	**Idea's department**

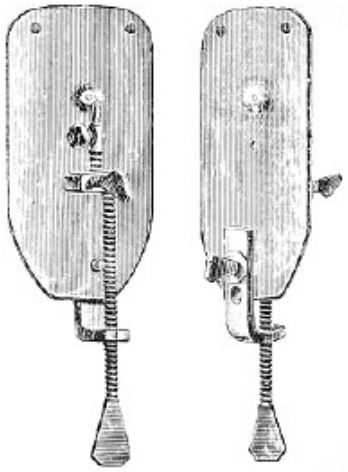
Now place all your "things" in 4 different groups

_____	_____	_____	_____

Tiny things amuse great minds

Every living thing on Earth is made up of cells. Small living things, like bacteria, may be made up of only one cell. Larger living things, such as trees and humans, are made up of billions of cells. Cells are the basic units of life.
There are many different types of cells, but they all have some things in common. Firstly, most cells are very small. Because we can only see them with a microscope, we say that they are microscopic.

Our knowledge of cells has been built up over hundreds of years. However, cells could not have been discovered until the invention of the magnifying glass (lens) and the microscope. These devices gave people the ability to see these tiny objects. Two Dutch spectacle makers, Hans and Zacharias Janssen, probably invented the first microscopes around 1600. An Englishman, Robert Hooke, built the first two-lens microscope in 1665. Hooke's microscope could magnify 30 times. He used this microscope to look at many things including a thin slice of cork. He thought the box-shaped structures looked like the cells (rooms) used by monks in monasteries, so he called them cells. In 1675, another Dutchman, Anton van Leeuwenhoek, used a very simple microscope to find living things in ditch water. He described these living things as 'little beasties'. Today we call these creatures protozoa.



A diagram of Anton van Leeuwenhoek's microscope

Anton van Leeuwenhoek's microscope could magnify 270 times so he was able to see creatures even smaller than protozoa. He found yeast cells and in 1683 he was the first person to observe bacteria. Over the next 200 years many improvements in lenses and microscope design were made. Early scientists began to study plants and animals in detail. They found cells everywhere they looked. Soon scientists began to believe that all living things were made of cells. Around the same time two German scientists published their ideas about cells. Matthias Schleiden and Theodor Schwann developed the **cell theory** after making many careful observations and taking into account the work of other scientists.

The cell theory states that:

- all living things are made up of one or more cells
- Cells are the basic units of structure and function in living things
- all cells come from only other living cells.

By the 1860s Ernst Abbe had designed a microscope that is much the same as the modern microscopes in use today. New techniques to slice very thin sections of living things and colour them with dyes allowed further discoveries to be made. At the same time, Rudolf Virchow showed that 'all cells arise from other cells'.

The invention of the electron microscope in 1931 has allowed the greatest advances in our knowledge of cells. This type of microscope passes electrons instead of light through a very thin slice of an object. The electrons are 'seen' as a picture on a television screen. Another type of electron microscope called the scanning electron microscope was developed in 1965. This allowed objects to be viewed in three dimensions. With these microscopes scientists can study even the smallest details of a cell, and can discover things that have never been seen before.

Activities 1

1 What is the cell theory?

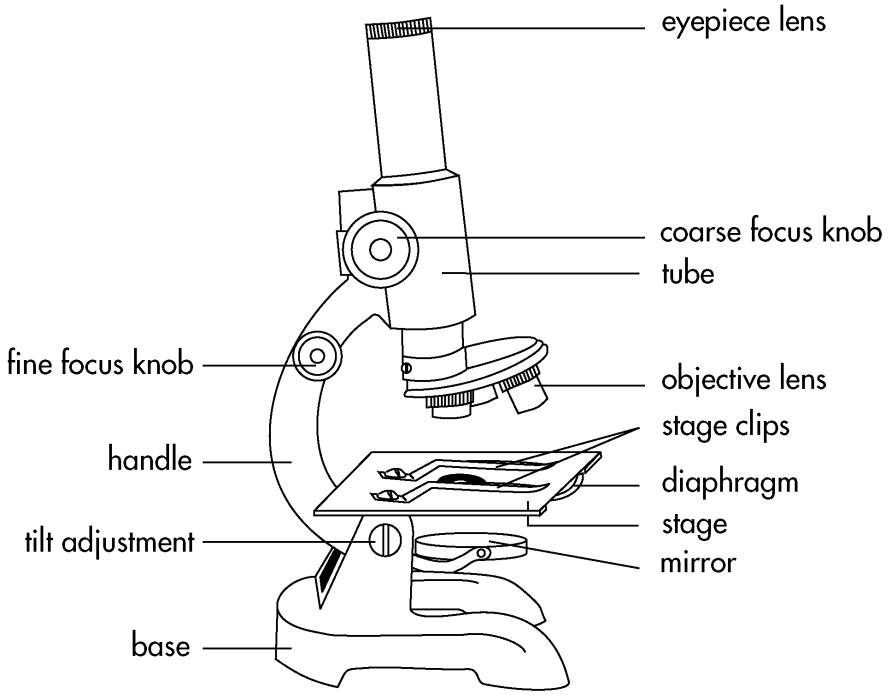
2 How did cells get their name? Who gave them this name?

3 Why do you think the history of the microscope is often linked to the history of cell theory?

4 Why do you think the scientists who first saw cells wanted more powerful microscopes?

Compound Microscopes

Most modern microscopes are compound light microscopes, which can magnify to approximately 1000 times. They work by shining light through the object.



For this reason objects viewed under a compound microscope must be very thin and flat. The object is placed on a glass slide, usually in a drop of water, then covered with a very thin piece of glass called a cover slip.

Activities 2

Microscopes come in various shapes and sizes. However, all microscopes are made of the same basic parts.

1 Collect a microscope. Make sure you carry it with both hands, one under the base and the other around the handle. Place the microscope on your bench away from the edge.

2 Examine your microscope carefully and use diagram to find each of the labelled parts. Can you work out what each part is for?

3 The table contains a description and a function for each part of the microscope but they are all mixed up. Cut out the information provided and glue it into the appropriate position.

Name of part	Description	Function
Eyepiece lens		
Objective lenses		
Focus knob		
Base		
Mirror		
Stage		

Using a Microscope Experiment

Materials

- compound microscope
- prepared slide

Method PART A

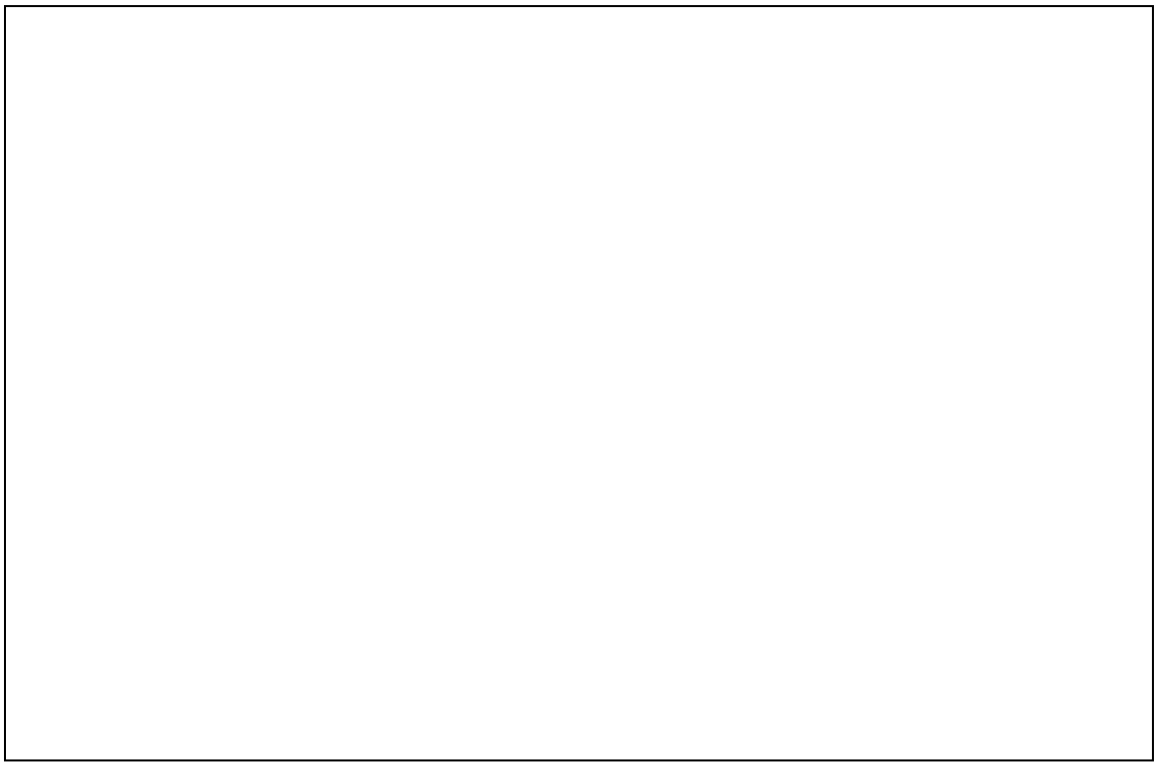
1 Place the microscope near a light source. (Do not place it in direct sunlight.)

2 Rotate the objective lenses so that the smallest is in place above the stage.

3 While looking down through the eyepiece lens adjust the mirror so that bright light is reflected up into your eye. Your microscope is now ready to use.

Method PART B

1 Place the prepared slide so that the object on it is in the centre of the hole in the stage. Use the stage clips to hold it in place.
2 Watch from the side while you use the coarse focus knob to lower the objective lens over the slide until it almost touches it.
3 Look through the eyepiece lens and turn the coarse focus knob upwards until the object on the slide comes into focus.
4 Adjust the fine focus knob (if your microscope has one) until you have a sharp picture.
5 Draw what you see below.



Activities 3

1 Why are microscopes needed to study cells?

_____

_____

_____

2 What are some of the things microscopes have allowed scientists to discover?

_____

_____

_____

3 Why is it necessary to use both hands to carry a microscope?

_____

_____

_____

4 What could go wrong if you lowered an objective lens downwards while looking through the eyepiece?

_____

_____

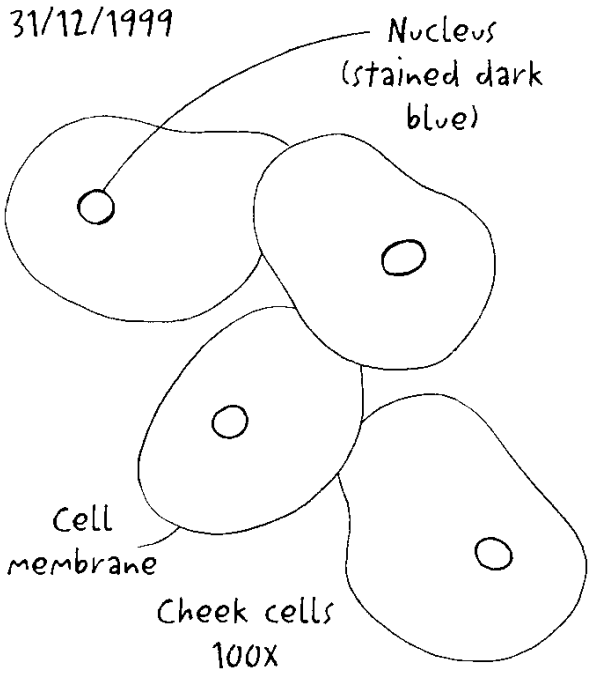
_____

Zooming in on a small world

In this section we are going to learn some of the skill of using a microscope.

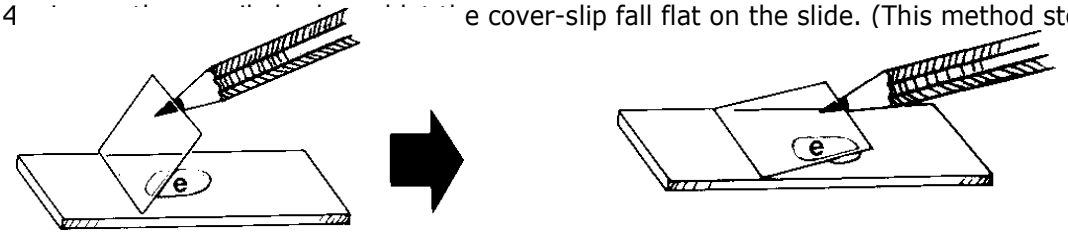
How to sketch what you see under the microscope

1. Use a sharp lead pencil.
2. Draw only the lines that you see and label only the structures that you can identify.
3. Your diagrams should take up about a third to half a page each.
4. Record the magnification next to each diagram.
5. State the name of the specimen and the date of observation.
6. A written description is also often of considerable value.
7. When you are viewing many cells at one time, it is often useful to select and draw only two or three representative cells for each observation.



Preparing a wet mount slide

1. Look for a small lower case 'e' in a newspaper. Cut it out and place it on the slide.
2. Add a drop of water to the slide.
3. Place the edge of the cover slip on the slide, and lean it on a pencil.
4 [illegible] e cover-slip fall flat on the slide. (This method stops air bubbles



5. Place the slide on the microscope stage and observe the letter under low power.
6. Is the 'e' the right way up?

_____

7. Move the slide to the left. Which way does the 'e' move when viewed through the microscope?

_____

_____

What x 10 means

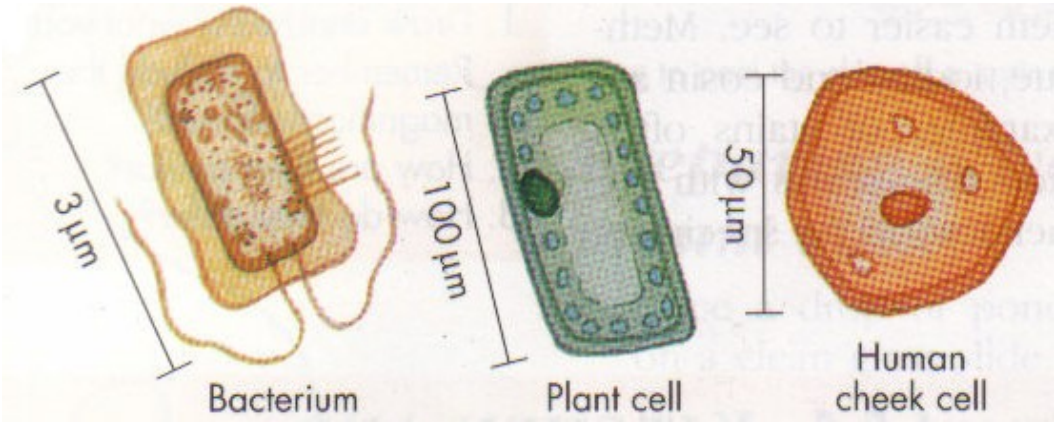
A microscope magnifies things. The eyepiece and the objective lenses have magnifying powers marked on them. Look at the eyepiece lens. You may see the number x 10. This means that the lens magnifies an object to 10 times the original size. The objective lenses are marked in the same way. If the eyepiece is x 10 and the objective is x 10, then the microscope will magnify x 100 times. You will see the object 100 times bigger by using these two lenses.

Staining a Specimen

Many objects are colourless when viewed down the microscope, so specimens are often stained to make them easier to see. Methylene blue, iodine and eosin are some examples of stains often used. Each stain reacts with different chemicals in the specimen.
For example, iodine stains starch a blue-black colour. Take care when using these stains, because they can stain you as well.

How big are cells?

Cells vary in size from the smallest bacteria, which are one-thousandth of a millimetre in diameter, to large nerve cells of over a metre in length. To measure cells, we use a unit called the **micrometre (μm).** One micrometre is one-millionth of a metre, or one-thousandth of a millimetre. Bacterial cells are about 1 micrometre across; human skin cells are about 50 micrometres across. Until microscopes were invented, people knew very little about the cells that make up all living things.



Activities 4

1 Complete the sentences below by choosing the correct word from the box.

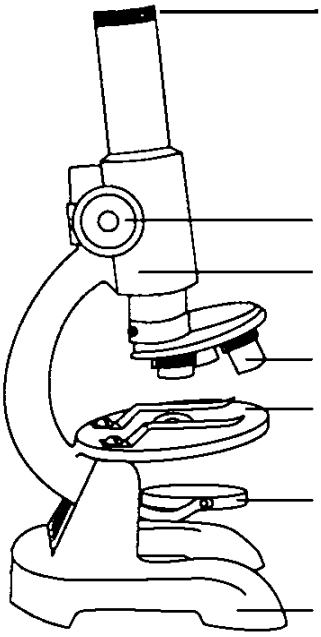
animal	millimetre	electron	micrometres	cells	microscope
small					

Virtually every living thing, or organism, on Earth is made up of _____ .
There are plant cells and there are _____ cells.
Most cells are so _____ that we need a _____ to see them.
We use light microscopes and _____ microscopes to observe cells.
We measure cells in _____ .

One micrometre is one-thousandth of a _____ .

2 Use the words in the box to label the diagram of the microscope.

focus knob	stage	objective lens	mirror
eyepiece lens	base	microscope tube	



Now write the name of each part next to the correct definition below.

_____ The platform on which the microscope is built.
_____ The lens you look through to see the object you are studying.
_____ The platform on which the object you are studying is placed.
_____ The lens that is closest to the object you are studying.
_____ A knob you can turn to bring the object you are studying into focus.
_____ The adjustable tube between the two lenses.
_____ Directs light through the object you are studying.

Peel or Squash and stain experiment

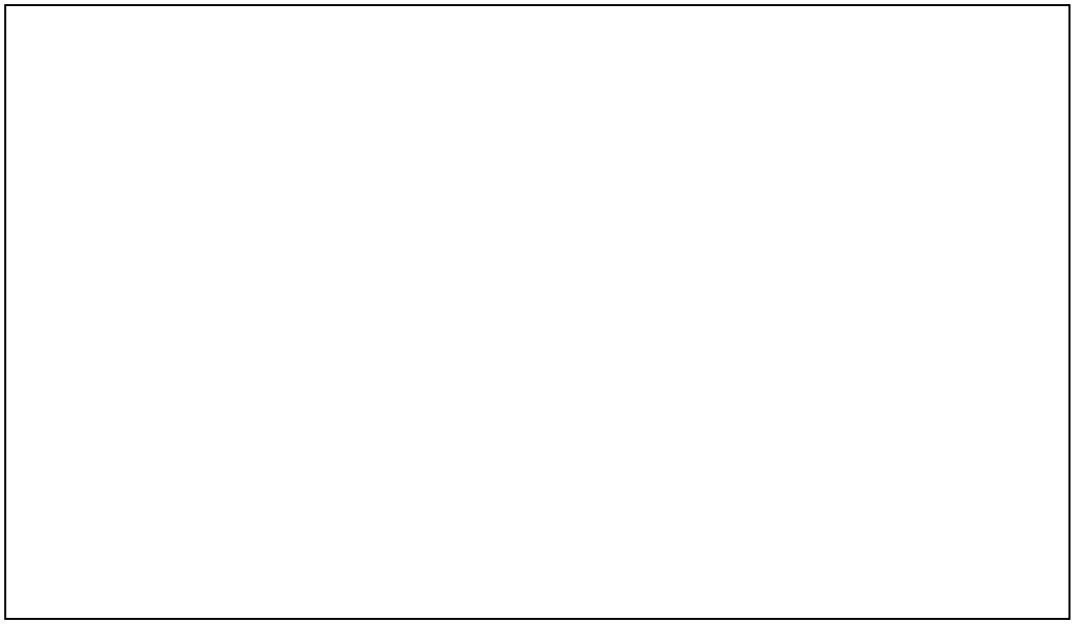
Materials

- light microscope
- cover slips
- microscope slides
- pipette
- onion, banana
- water
- iodine

Method

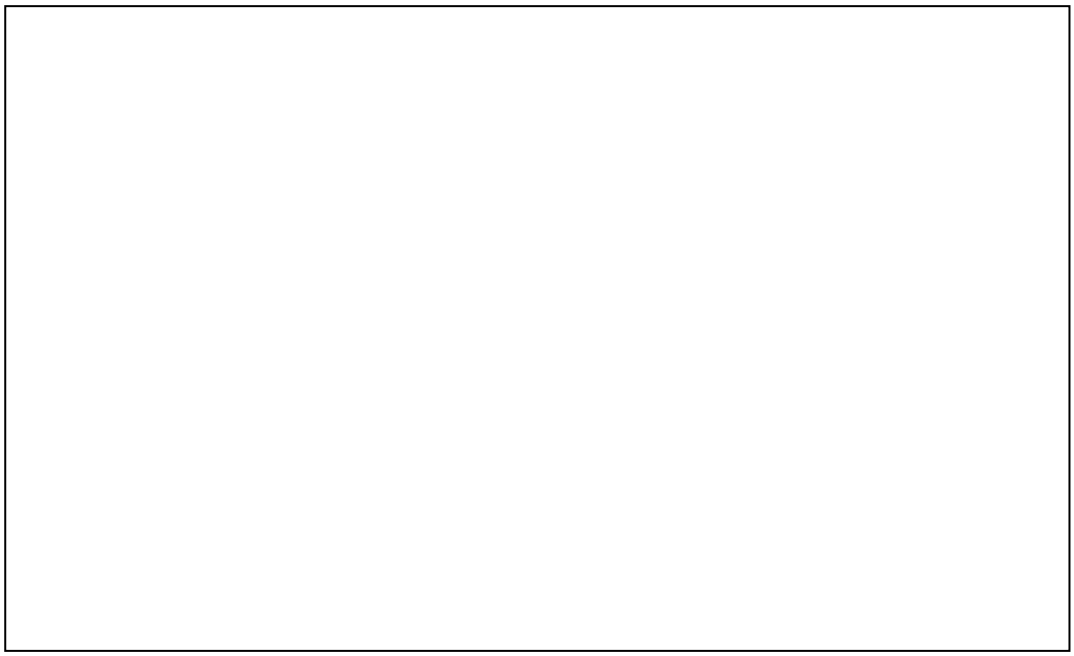
- Peel off a small piece of the clear 'skin[7] found between the layers of an onion.
- Place the piece of skin on a microscope slide and add a drop of iodine. Lower the cover slip on top.
- Look at the cells under the microscope.

1. Record what you see under the microscope. (Labelled diagram and don't forget magnification)



- Prepare a banana, squash on a slide and add a drop of iodine. Carefully use the onionskin and prepare a wet slide.

2. Record what you see under the microscope. (Labelled diagram and don't forget magnification)



3. Describe the similarities and differences between your observations of the banana and the onion cells.

_____

_____

_____

What's in a cell?

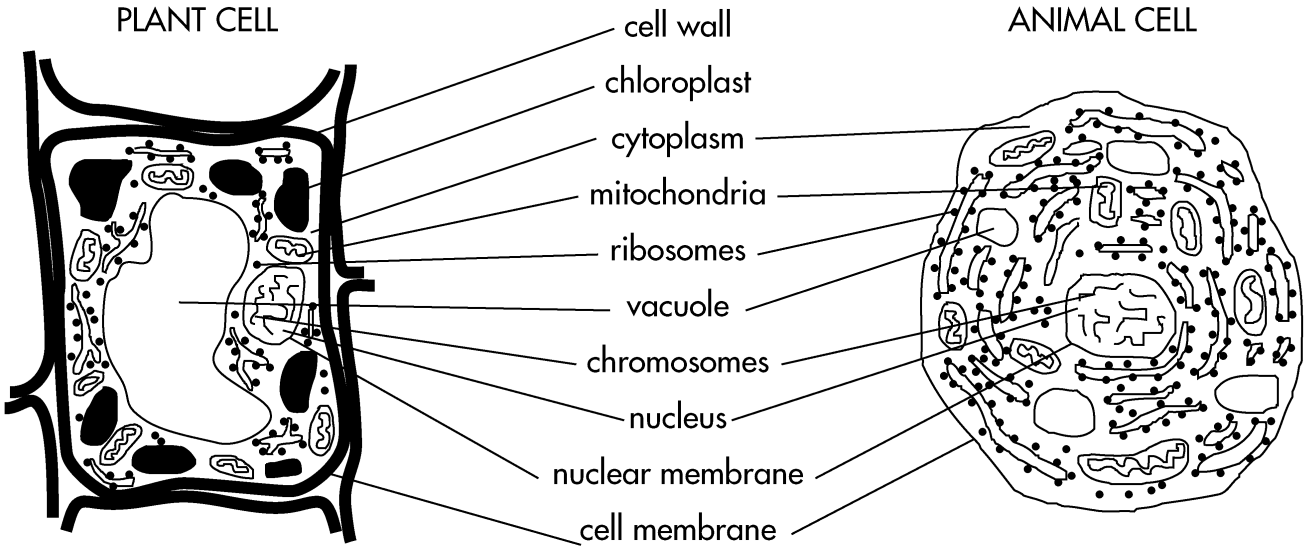
Most cells can be classified as either animal cells or plant cells. Although cells are basically similar, there are some differences between animal and plant cells. This is because animals and plants do some things the same, but do many other things differently.
There are three main parts, or structures, in every cell which can be clearly seen using a light microscope:

- the cell membrane
- the nucleus
- the cytoplasm.

The cell membrane is the thin layer that surrounds each cell. It protects the contents of the cell and gives the cell its shape. A cell membrane controls what enters and leaves the cell.
The nucleus is the 'control centre' of the cell. It is surrounded by a **nuclear membrane** that holds the contents of the nucleus together. Inside the nucleus are **chromosomes.** These chromosomes are made up of smaller units called genes. The genes carry the inherited information that is needed by both the cell and the whole organism.
The cytoplasm is a jelly-like liquid that fills up most of the space in the cell. The cytoplasm contains many smaller structures that carry out special functions in the cell. Ribosomes manufacture complex substances called **proteins.** Storage areas for food, water and wastes in the cytoplasm are called **vacuoles. The mitochondria** are the parts of the cell where energy is produced in a process known as respiration.

Whose cell is that?

Plants make their own food using light, carbon dioxide from the air, and water. This process is called **photosynthesis.** Photosynthesis happens in structures called **chloroplasts** using a green chemical called **chlorophyll.** Plant cells also have tough cell walls surrounding their cell membranes. These **cell walls** give plants the strength to support themselves, since they do not have skeletons like some animals. Cell walls contain a tough, fibrous material called **cellulose.**



Did you know?

Red blood cells do not have a nucleus. This means that they only live for a short time (120-130 days), and die at the rate of 2 000 000 per second. New ones are made at the same rate.

Looking at Plant and Animal Cell

AIM

To compare prepared slides of plant and animal cells under the microscope.

MATERIALS

- microscope
- prepared slides of various animal and plant cells (leaf, root, algae, bladder, blood, intestine)

METHOD

1 Look at two types of plant cells and two types of animal cells under the microscope.
2 Based on the slides you have looked at, and using any pictures in this section, tick the table to indicate the structures that are present in each type of cell.

Part	Animal cell 1	Animal cell 2	Plant cell 1	Plant cell 2
Cell wall				
Cell membranes				
Cytoplasm				
Vacuole				
Chloroplast				
Nucleus				
Mitochondria				

Activities 5

1 What cell parts are found in both animal and plant cells?

2 Name two cell parts found only in plant cells.

3 What substance gives plants their green colour? What does this substance do?

4 What is the function of each of the following parts of cells?
   a. mitochondria

   b. ribosomes

c. vacuoles

What do cells do?

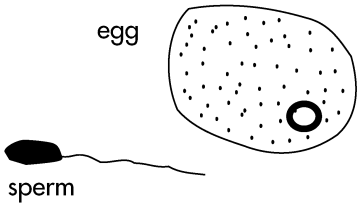
Cells are in fact quite complex things, and they can perform a wide range of tasks. Here is a list of some of the things they do.

- They take in nutrients and carry out chemical reactions.
- They produce waste products.
- They make useful substances such as hair and bone.
- They can reproduce by dividing in two.
- Some special cells can move. For example, muscle cells contract, while sperm cells (and many single-celled organisms) can 'swim'.
- They exchange gases with their surroundings. For example, cells take in oxygen and give out carbon dioxide.

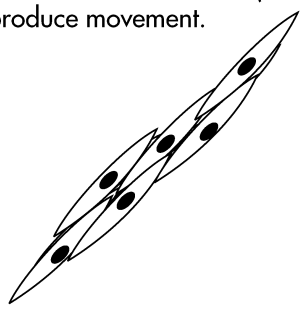
Everything a living organism can do is a result of the activities of its cells.

Most of the animals and plants you can see around you are made up of many, many cells. Some organisms, such as blue whales and kauri trees, contain billions of cells. Living things that are made up of many different types of cells are called multicellular organisms. Different types of cells have different structures that enable them to carry out specialised functions. We say that these cells are specialised.

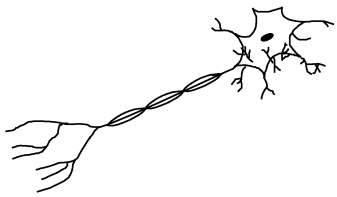
Sex cell
Male sex cells are called sperm. Female sex cells are called eggs or ova. Sex cells combine during reproduction to form a new organism.



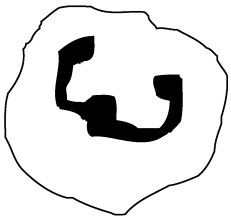
Muscle cell
A muscle cell can contract (shorten) to produce movement.



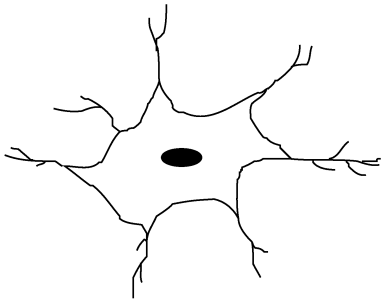
Motor nerve cell
A motor nerve cell controls movement. It passes a message from the brain to a muscle.



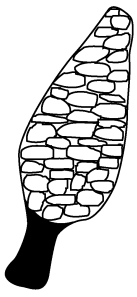
White blood cell
White blood cells help to fight disease. Some move about in the body to 'swallow up' bacteria.



Brain cell
A brain cell makes electrical messages which it passes to other cells through its many connections.



Goblet cell
Goblet cells are shaped like wine glasses, as the name suggests. They make mucus to lubricate and help protect our intestines, stomach and windpipe.



Tissues

In multicellular organisms, similar cells work together in groups called **tissues.** The cells in a tissue all have a similar appearance and function. Animals, for example, have muscle tissue, nerve tissue, skin tissue and blood. In plants, special tissues transport water and minerals, and leaves contain a special skin-like protective tissue.

Organs

An organ is made up of different tissues working together to perform a particular function. For example, the stomach contains muscle tissue and gland tissue (to make the digestive juices), as well as tissues that form the outside lining. There are also blood vessels and nerves in the stomach lining. The brain, heart, liver and intestines are examples of other organs found in animals. Roots, leaves, stem and flowers are examples of the organs found in plants.

Systems

A system is made up of a group of organs that work together to perform a particular function or functions. One example, in animals, is the **circulatory system.** The function of the circulatory system is to move materials through the body. It consists of the heart, blood vessels, and the blood. In plants, a transport system involving the roots, xylem and leaves moves water through the plant.

Organisms

The systems in an organism work together to help the organism survive. For example, the muscles (muscular system) cannot work unless they receive blood from the circulatory system. The blood supplies the muscles with oxygen, which has been taken in by the lungs (respiratory system). It also supplies nutrients that are used to make energy, and these have been obtained from the digestive system.

Activities 6

1 What is meant by saying a plant or animal is multicellular?

2 In multicellular organisms, cells display specialisation. Explain what is meant by cell specialisation, giving at least one example.

3 What is skin tissue?

4 What is an organ? Give examples.

5 What does a group of organs make up? Give an example.

Bacteria

Bacteria are simple single-celled organisms. Bacteria inhabit almost every place on Earth. They are very small, averaging 1-5 μm (micrometres) across. They can be found in water, in the air, in soil, on most surfaces, as well as on and in the bodies of animals, including us. Most do not cause disease. Once inside the body, bacteria can multiply very quickly. They do this by dividing in two **(binary fission),** and under ideal conditions some can do this every 20 minutes or so. This would mean just one bacterium could become 1 million in under 7 hours!

The Aussie that found Penicillin

Early observations of moulds

For thousands of years people have observed the disease-destroying abilities of moulds without understanding how they worked. Louis Pasteur in the 1870s observed that mould inhibited the growth of anthrax bacteria. Joseph Lister observed that samples of urine contaminated with mould didn't allow bacteria to grow. Then in 1928, Alexander Fleming observed that bacteria growing in a petri dish were killed by mould. The mould had accidentally contaminated the petri dish when the lid had been left off. Fleming hypothesised that the mould produced a chemical that could kill the bacteria. He called the chemical penicillin. No further interest was shown in **penicillin** until Howard Florey decided to investigate its action.

In 1938, Florey gathered a team of scientists to work together on *Penicillium.* Today scientists often work in teams but at that time it was unusual. The team had several problems to solve.

- How could they grow the mould in large quantities?
- How could they extract the antibacterial chemical called penicillin from the mould and purify it.
- How did penicillin work and was it safe to use on patients?

Once the first sample of penicillin was produced they began to test it on living things. One member of the team, Ernst Chain, tested penicillin on eight mice injected with a deadly bacterium. Four of the eight mice were given penicillin. These mice survive but the four untreated mice soon died. Then in 1941, a man suffering from severe blood poisoning was injected with penicillin. At first he showed signs of recovery; however, the team didn't have enough penicillin to keep up the treatment and he died. Other patients, particularly children, showed remarkable recoveries.

Florey realised that penicillin was needed in large quantities. In the middle of World War II he travelled to America in a blacked-out aeroplane to arrange for large-scale production. At first the penicillin was only available for the military and it was used to save the lives of many soldiers. Then in 1944, Australian began manufacturing penicillin and was the first country to make it available to its entire people.

The antibiotic penicillin was a miraculous drug that has saved millions of lives since its development. Howard Florey, Ernst Chain and Alexander Fleming all received the Noble Prize in 1945 for their work on penicillin, one of the greatest medical advances of the 20th century.

Modern antibiotics, antiseptics and disinfectants

The first antibiotics were produced from microorganisms, mainly fungi, but many of the commonly used antibiotics are now synthetically manufactured. Different antibiotics have different actions, but most either stop the bacteria dividing by attacking their cell walls or disrupt their internal functioning.
Today there are many different antibiotics available to treat the range of infections. Antibiotics can be taken in tablet form or given in injections. Unfortunately, however, some types of bacteria have become resistant to certain antibiotics, and so the search for new drugs is always on.
An antiseptic is a substance which can destroy bacteria, and which can be used on the body. It cannot be consumed or injected like an antibiotic. A **disinfectant** is similar to an antiseptic, but is used on surfaces other than the body.

Activities 7

Write the correct word from the box next to each of the definitions below. The first letter has been supplied for you.

antibody	disinfectant	antiseptic	antibiotic
toxin	epidemic	pathogen	

A _____ A substance which can be used on the body to destroy bacteria.

T _____ A poison caused by bacteria.

D _____ A substance which can destroy bacteria but can't be used on the body.

A _____ A chemical that is active against bacteria.

P _____ A bacteria that causes disease.

A _____ A chemical that destroys pathogens.

E _____ An outbreak of disease that affects many people.

Activities 2 (material)

Description	Function
flat bottom surface	holds the slide in place, letting light pass through it
flat platform to sit slide on, has a hole in its centre, may have clip	adjusts the position of the lenses so that the object can be seen clearly; can be coarse or fine
round with a shiny surface	bends the light to make the object appear bigger
knob which can be turned to move the lenses	can be used to get different magnifications
single lens closest to where the eye is placed	supports the microscope
lenses of different lengths which can be positioned above the slide	reflects light up through the slide into the lenses