UNIVERSITY OF SWAZILAND
FACULTY OF EDUCATION
DEPARTMENT OF CURRICULUM AND TEACHING
SUPPLEMENTARY EXAMINATION QUESTION PAPER, JULY 2016

TITLE OF PAPER	**:**	**CURRICULUM STUDIES IN BIOLOGY I**
COURSE CODE	**:**	**EDC 278**
STUDENTS	**:**	**BEd. II**
TIME ALLOWED	**:**	**THREE (3) HOURS**

INSTRUCTIONS: **1.This examination paper has five (5) questions. Question 1 is compulsory. Then answer any three (3) questions.**

2. Each question has a total of 25 points.

3. There is an attachment: Biology for IGCSE. Jones, M. (2002) pages 15 - 24 for two questions

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Question 1 is compulsory.

1. a) Explain the relationship between hypothesis formulating and hypothesis testing [5]

b) Compare the characteristics of a person who has nominal scientific literacy and one who has functional scientific literacy. [5]

c) Discuss the place of behavioural objectives in the science classroom. [5]

d) Explain why individual laboratory activities are preferable to teacher demonstrations. [5]

e) Science teachers often use the following phrase when learners are engaged in laboratory activities
''You'd better finish your work because I will collect your notebooks at the end of the period''.
i) What is the likely classroom environment that would prompt this kind of reaction from the teacher? [2]
ii) Briefly explain the effect this is likely to have on the learners. [3]

Choose any 3 questions below.

2. a) Scientific knowledge, as a product of scientific inquiry, should meet the requirements of description, explanation, prediction and understanding. Explain what is entailed in any **two** of these requirements, giving specific examples. [10]

b) Medawar suggests 4 types of experiments scientists engage in during the experimental phase of scientific inquiry. Explain what each type entails and the type of activities involved. [10]

c) Compare the roles of an existing paradigm and scientific models in scientific research. [5]

3. a) In Swaziland science teachers very frequently use demonstration to illustrate scientific phenomena while simultaneously developing inquiry skills in the learners. Explain what the use of the following types of demonstrations entails:
Inductive [4 ½]
Deductive [3 ½]
Experimental [2]

b) The learning cycle or 5E instructional model (engagement, exploration, explanation, elaboration and evaluation) can be used to actively engage learners in knowledge construction that results in the desired conceptual change. Select a topic(s) from the attachment *cells, diffusion and osmosis* and illustrate how you would use this model to foster conceptual change in the learners. [15]

4. a) The national science education standards for assessment advocate for *fair* and *accurate* assessment of learner achievement. Provide and explain the forms of assessment that would meet the criteria of fairness and accuracy for achievement in biology. **[15]**

   b) Explain the significance of formative assessment in science. **[10]**

5. Questioning, as a teaching strategy, is advantageous because it allows for inquiry and hence can be used in scientific investigations and discussion. You may refer to the attached topic *cells, diffusion and osmosis* to answer the following questions:

   a) Select a section(s) and formulate two divergent questions that demand the use of critical thinking. **[5]**

   b) If you were to teach a lesson on the selected section(s), explain how the lesson could be taught using discussion method, ensuring that all learners actively participate in the discussion. **[15]**

   c) Write 2 objectives in the **affective** domain that you would wish your learners to attain from the above discussion. **[5]**

Chapter

Cells, diffusion and osmosis

All living organisms except viruses are made of cells. Plant cells have some structures that are not found in animal cells. All cells have a partially permeable cell surface membrane, through which substances may pass into and out of the cell. This may take place by diffusion. Osmosis is a special type of diffusion involving water and a partially permeable membrane.

Cells ▶

The structure of an animal cell

All living organisms are made up of **cells**. Most cells are very small, and a human such as yourself contains around 1 million million cells. However, you can see cells with a microscope (Figure 2.1).

Investigation 2.1

Looking at animal cells

You need to use a microscope for this investigation. You will probably have to share a microscope with several other students, but do make your *own* slide, even if you are sharing a microscope in a group.

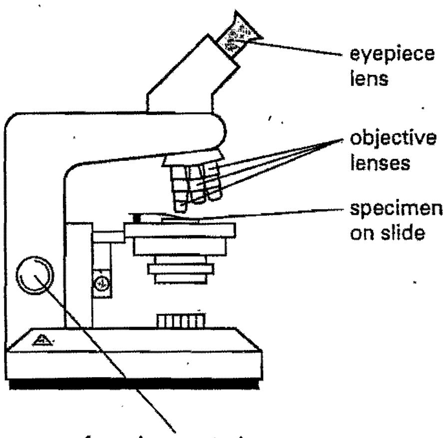
You will need:

- a microscope, a clean slide and a coverslip
- some animal cells, which your teacher will give to you
- a blue stain called methylene blue
- a piece of filter paper or blotting paper for cleaning your slide.

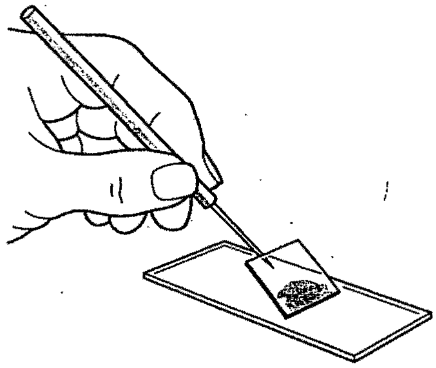
1 Set up a microscope. Make sure that you have the smallest objective lens over the stage, and the light or mirror is arranged so that you can see bright light when you look through the eyepiece.

2 Collect a clean microscope slide. Take it to your teacher, who will give you a few animal cells. You only need a very small amount of cells, and should hardly be able to see anything on your slide.

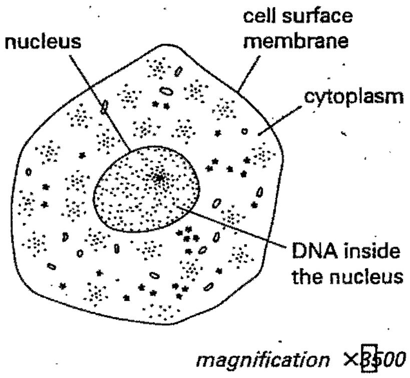
3 Using a dropper pipette, put a few drops of methylene blue onto the cells.



▲ **Figure 2.1**
A microscope.



▲ **Figure 2.2**
How to lower a coverslip on to a slide. If you do it like this, you are less likely to trap air bubbles between the coverslip and the slide.



▲ **Figure 2.3**
A section through an animal cell. This is a liver cell.

4 Very carefully, lower a coverslip onto the drop of stain and the cells. If you do this gently, as in Figure 2.2, you should not trap too many air bubbles under the coverslip. If you do, gently rub across the coverslip with the blunt end of a pencil, to try to squeeze them out.

5 If liquid has escaped from beneath the coverslip, gently remove it with filter paper, so that you will not get any methylene blue on the microscope.

6 Put your slide onto the stage of your microscope. Using the smallest objective lens, focus on the cells. When you have found them, you can try using one of the larger objective lenses.

7 Make a drawing of two or three cells, and label them. Figure 2.3 will help you.

Questions

1 Why do you think it is important to have only a very small amount of cells on your slide?

2 Why is it always a good idea to start off with the smallest objective lens when using a microscope?

3 However careful you were, you probably got a few air bubbles on your slide. What did they look like?

4 Did the methylene blue stain different parts of the cell different shades of blue? If so, explain this in the labels on your diagram – but do not colour it.

If you do investigation 2.1, you should be able to see that these animal cells have cytoplasm, a nucleus, and a cell surface membrane. All animal cells have cytoplasm and a cell surface membrane, and almost all have a nucleus, as shown in Figure 2.3. Red blood cells, however, are very unusual because they do not have a nucleus.

The structure of a plant cell

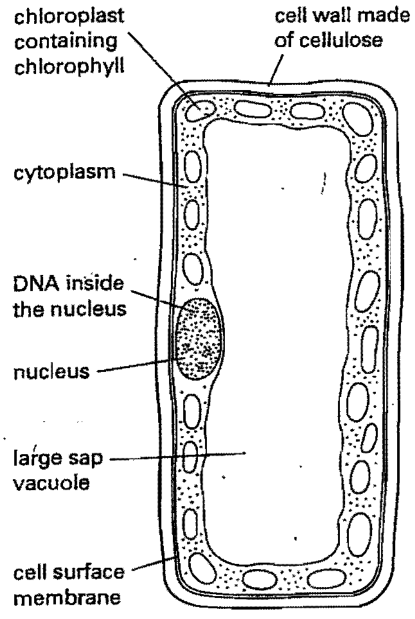
Plant cells have some structures that are never found in animal cells. These are a **cell wall**, and sometimes **chloroplasts** and a large **vacuole containing cell sap**.

Investigation 2.2

Looking at plant cells

You will need:

- a microscope, two clean slides, two coverslips
- a piece of pondweed
- a piece of onion



▲ **Figure 2.4**
A section through a plant cell. This is a palisade cell from a leaf.

- a piece of filter paper or blotting paper to clean your slide.

1 Set up a microscope.
2 Put a drop of water onto one of your microscope slides. Take one small thread of pondweed, and place it in the water drop. Gently lower a coverslip onto it. Clean your slide.
3 Put another drop of water onto your other microscope slide. Take a small piece of one layer from the onion, and cut a square with sides of about 0.5 cm. Carefully peel the very thin, paper-like skin from the inner surface of this square. Place it in the water drop, flatten it if necessary, and then put on a coverslip. Clean your slide.
4 Look at both kinds of plant cells, one at a time, using the microscope.
5 Make labelled drawings of each kind of plant cell. Figure 2.4 will help you with your labels.

Questions

1 Were these plant cells bigger or smaller than the animal cells you looked at? How can you tell?
2 What structures were present in the pondweed, but not present in the onion cells? Can you suggest why the onion cells did not have these structures?

Structures found in all cells

All of the structures which are shown in Figures 2.3 and 2.4 have their own job or **function**.

Note
Function related to cell structure, needed for Supplement, is included in this section.

The **cytoplasm** of a cell is like jelly. It is mostly water – about 70% in many cells – with proteins and other chemicals dissolved in it. Many chemical reactions, called **metabolic reactions**, happen in the cytoplasm.

Every cell has a cell surface membrane. This membrane controls what goes in and out of the cell. It will let some substances go through, but not others, and so it is said to be **partially permeable**. Cell surface membranes are very flexible, so they allow the cell to change shape.

Most cells have a **nucleus**. The nucleus contains a chemical called DNA. The DNA is arranged into **chromosomes**. You will not have seen chromosomes in the cells you looked at, and they are not shown in Figures 2.3 and 2.4. This is because when a cell is not dividing, the chromosomes are very long and thin, and so are invisible with a light microscope. But when a cell divides, the chromosomes get much shorter and fatter, and you can see them with a light microscope. The DNA carries coded instructions for how the cell should behave. The DNA in an organism's cells determines what kind of organism it is, and many other things about it. The DNA in your cells makes you a human, a boy or girl, with dark or light hair, and so on.

Structures found in plant cells only

As we have said, plant cells have structures that are not found in animal cells. Outside its cell surface membrane, a plant cell has a **cell wall**, made of **cellulose**. Unlike the cell surface membrane, the cell wall allows almost any kind of substances to go through it, and so it is said to be **fully permeable.** Its function is to support the plant cell and help to hold it in shape. Animal cells never have cell walls.

Many plant cells contain green structures called **chloroplasts**. Chloroplasts are green because they contain the green substance, or pigment, **chlorophyll.** Chlorophyll absorbs sunlight, and helps the chloroplasts to use this energy to make sugars. This is how a plant feeds. This way of feeding is called **photosynthesis**. Animal cells do not feed by photosynthesis, and so they never have chloroplasts.

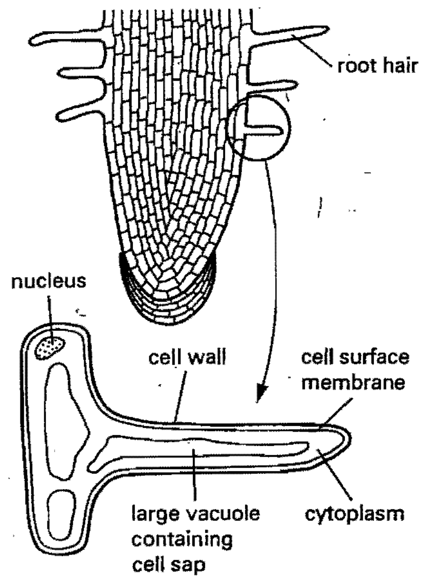
Plant cells often contain a large, liquid-filled space, called a **vacuole**. The vacuole is surrounded by a membrane which keeps its contents separate from the cytoplasm. The liquid inside the vacuole is called **cell sap.** It is mostly water, with sugars, amino acids and other substances dissolved in it. It is a storage area for the plant cell. Animal cells often have small vacuoles, but they are hardly ever as large as the vacuole in a plant cell, and they do not contain cell sap.

Question

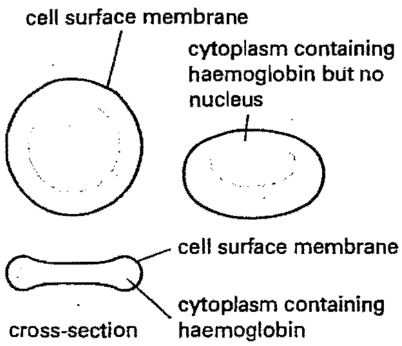
2.1 Make a comparison table to summarise the similarities and differences between plant and animal cells. Draw a table like this:

Structure	Is it found in animal cells?	Is it found in plant cells?	Comment

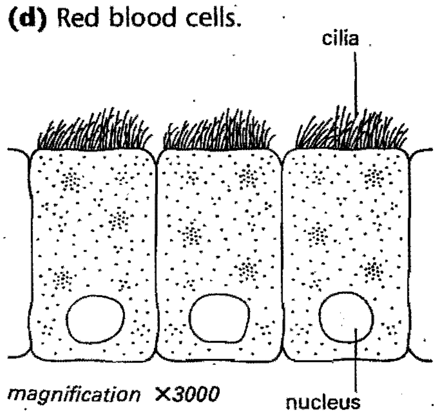
You will need six rows, one each for cell surface membrane, cytoplasm, nucleus, cell wall, chloroplasts and vacuole. Make the 'comment' column wider than the others, so that you can write plenty of information in it.



(a) A vertical section through a root tip. The outer layer of cells, a little way from the tip, forms root hairs. How does a root hair cell differ from the palisade cell in Figure 2.4? Can you explain these differences?



(d) Red blood cells.



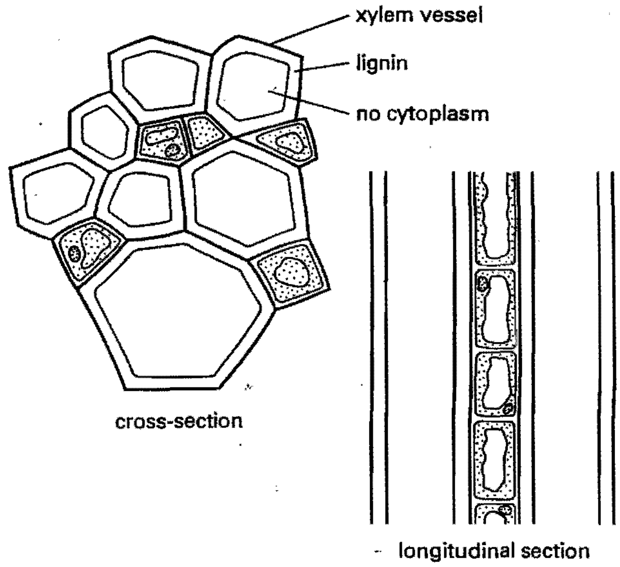
(e) These ciliated cells make up the lining of the trachea.

▲ Figure 2.5
Some different tissues.

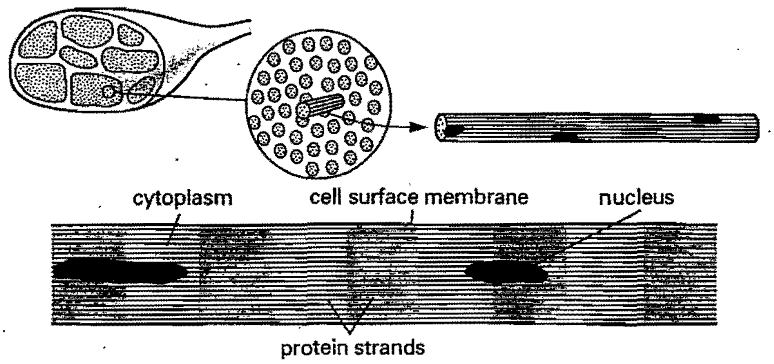
Tissues

When you peeled off the strip of cells from the inside of a piece of onion in investigation 2.2, you were peeling off part of a **tissue**. A tissue is a group of similar cells, all working together to perform the same function.

Figure 2.5 shows cells from two plant tissues and three animal tissues. In all of them, the cells have particular characteristics which help them to carry out their functions.



(b) Xylem tissue is made of many xylem elements, which are dead, and other kinds of living cells arranged between them.



(c) Muscle tissue is made of many muscle cells arranged to form fibres.

Root hair cells, Figure 2.5(a), are found near the tips of roots that are growing through the soil. Their functions are to help to anchor the plant in the soil, and to absorb water and inorganic ions (such as nitrates) from the soil. You can see that each root hair cell has a long thin part reaching out into the soil. This gives the cell a much larger surface area than usual. The large surface area means that a lot of water and inorganic ions can get into the cell quickly.

Xylem vessels, Figure 2.5(b), are found in the roots and stems of plants, and in their leaves. The veins in a leaf contain xylem vessels. Xylem vessels are made up of many long thin cells called elements. The elements are arranged end to end. They are very unusual cells, because they are dead! Their walls contain a very hard, strong substance called **lignin**. Wood is made of xylem vessels, which is why it is so hard and strong. There is nothing alive inside these walls – no cell surface membrane, no cytoplasm and no nucleus. All that the xylem vessels contain is water. This is one of their functions – they carry water from the roots of the plant, up through the roots and stem, and into the leaves and flowers. Their other function is to help to support the plant.

Muscle cells are found in many different animals, including humans. The cells shown in Figure 2.5(c) could be found in the biceps muscle in your arm. Like all animal cells, muscle cells have a cell surface membrane, cytoplasm and a nucleus – but each cell has many nuclei rather than just one. They look stripy because they are made up of many strands of protein arranged in a pattern. The strands of protein can slide between each other, making the cell much shorter. This is how muscles get shorter, or **contract**.

Red blood cells are smaller than most of the other cells in the human body. They have a cell surface membrane and cytoplasm, but no nucleus. The cytoplasm is full of a red protein called **haemoglobin**, which carries oxygen from your lungs to other parts of your body. Red blood cells are small so that they can squeeze through very tiny blood vessels called capillaries, taking the oxygen very close to almost every cell in your body. They are circular with a dent in the middle, which gives them a large surface area for their size. This speeds up the movement of oxygen in and out of the cell.

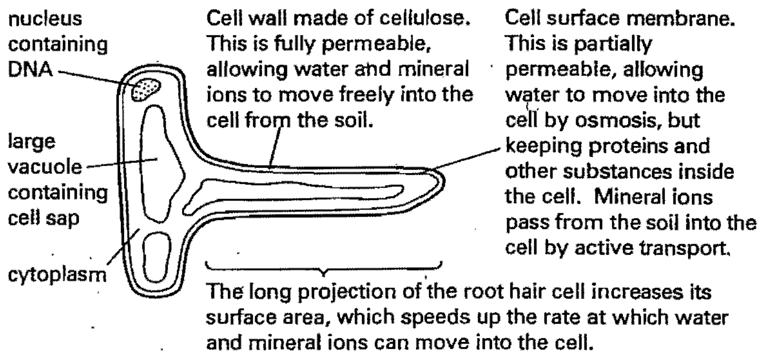
Ciliated cells are found lining some of the tubes inside an animal's body. The trachea and bronchi (tubes that carry air to the lungs) are lined with ciliated cells. So is the oviduct (the tube that carries an egg to the uterus in a female mammal). The cilia are tiny extensions of the cell, covered with a cell surface membrane just like the rest of the cell. The cilia can move, and all the cilia beat together in a rhythmic way so that they look rather like a field of waving grass. They help to sweep fluids along the tube. In the trachea, they help to sweep mucus up to the throat. You can read more about this on page 128.

Question

2.2 Figure 2.6 is an **annotated diagram** of a root hair cell. An annotated diagram explains something about the functions of what is drawn, as well as its structure.

Using Figure 2.5 as a starting point, make annotated diagrams of a xylem vessel, a muscle cell, a red blood cell and a ciliated cell. Your annotations should explain how the special features of the cell structure help the cell to perform its functions.

Figure 2.6 ▶ An annotated drawing of a root hair cell.



Organs

In an organism such as human or flowering plant, there are many kinds of cells, arranged into many kinds of tissues. Often, different kinds of tissues are arranged together in a particular way to make a structure called an **organ**. An organ is a group of different tissues which work together to perform particular functions.

Figure 2.7 shows a plant organ – a leaf. Leaves have many functions. The main one is to make sugars by photosynthesis. This is done by the cells inside the leaf, in tissues called the **palisade mesophyll** and **spongy mesophyll**. These cells need a supply of water, which is brought to them by **xylem vessels**. Some of the sugar which they make is taken to other parts of the plant in **phloem tubes**. The spongy mesophyll cells are arranged loosely, with air spaces in between. Thin layers of cells on the top and bottom of the leaf, called the **epidermis**, let light through to the mesophyll cells, but stop too much water vapour leaving the leaf, so that it does not dry out. Small openings in the lower epidermis, called **stomata**, allow gases to move in and out of the leaf.

You can find out more about how leaves carry out their functions, and see another diagram of a leaf, in Chapters 6 and 8.

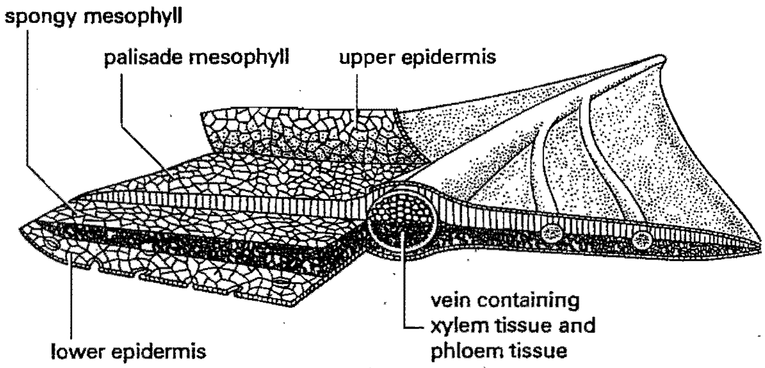


Figure 2.7 ▶
A leaf is an example of an organ. It is made up of many different tissues, arranged in layers. The epidermal tissues at the top and bottom ('epi' means 'outer', and 'dermis' means 'skin') protect the inner layers from drying out. The mesophyll ('middle leaf') tissues photosynthesise. The xylem and phloem tissues transport substances to and from the other tissues in the leaf.

Organ systems

Organs do not work on their own. Many organs work together to help each other to perform particular functions. For example, an eye is one of many organs that make up the **nervous system**. The lungs are part of the **gaseous exchange system**. The stomach is part of the **digestive system**.

Question

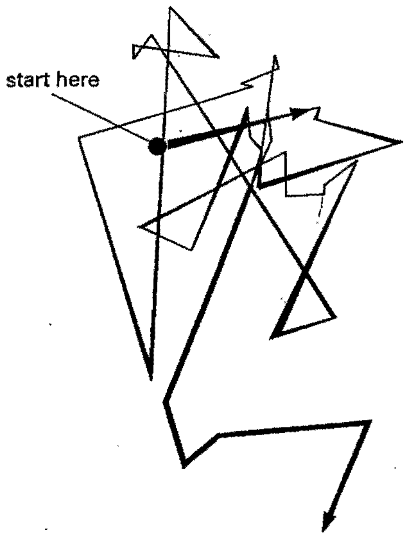
2.3 Using the index, look up the nervous system, gaseous exchange system and digestive system, and make a list of some of the organs in each of these three systems.

How substances move in and out of cells ▶

Diffusion

All substances are made up of small particles called **atoms**. In some substances, these atoms have lost or gained one or more electrons, to become **ions**. In other substances, the atoms are grouped together to form **molecules**.

Atoms, ions and molecules are always moving. In a solid, each particle has a fixed position in relation to the others, and just vibrates in this position. In a liquid, the particles move more freely around each other, but stay in fairly



▲ **Figure 2.8**
A particle in a liquid or gas moves around randomly. When it bumps into another particle, it changes direction.

close contact. In a gas, the particles are much further apart from each other, and move around very freely.

Imagine the lid being taken off a bottle of ammonia solution. Molecules of ammonia gas move out of the bottle. Each molecule moves entirely randomly – it is just as likely to go in one direction as another. The molecules bump into each other, and into other molecules in the air, such as oxygen or nitrogen molecules. When a molecule bumps into another molecule, both of them change course. Figure 2.8 shows the path one ammonia molecule might take.

When the lid of the ammonia bottle is first taken off, there are a lot of ammonia molecules inside the bottle. We say that there is a **high concentration** of ammonia inside the bottle. There are probably almost no ammonia molecules in the air on the other side of the room – here there is a **low concentration** of ammonia molecules. But as the ammonia molecules bump randomly around, some of them move erratically further and further away from the bottle. After a while, some will have moved right into the far corner of the room. The ammonia molecules have **diffused** across the room.

It is important to realise that the ammonia molecules do not head purposefully across the room from the bottle. Each molecule just bumps randomly around. It is just by chance that some of them end up a long way from the bottle. Some of them might even go back into the bottle. But, after a while, these random movements result in there being more ammonia molecules out in the room, and fewer inside the bottle. After a long time, you would probably end up with the ammonia molecules spread evenly all over the room.

The overall or **net result** of diffusion is that particles spread out evenly. They tend to spread out from a place where they are in a high concentration, to a place where they are in a low concentration. We say that they spread out down a **concentration gradient**. Diffusion can be defined as *the net movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient.*

Investigation 2.3

How quickly does ammonia diffuse?

Your teacher will probably carry out this investigation, but you can collect your own set of results. The apparatus is shown in Figure 2.9.

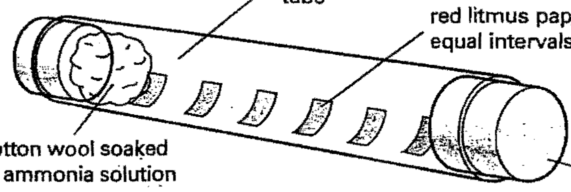


Figure 2.9 ▶ Apparatus for Investigation 2.3.

A piece of cotton wool soaked in ammonia solution is placed in one end of the tube, and quickly sealed inside with a rubber bung. (This is to stop too many ammonia molecules escaping – they do not smell very nice!) A stopwatch is started as the cotton wool goes into the tube. Ammonia turns red litmus paper blue. The time at which each piece of litmus paper turns blue is recorded.

Questions

1 Write up the method of this investigation. Include details of any problems that came up, and how these were solved.
2 Draw up a results chart to show the results of the investigation. Make sure that someone who had not seen the experiment would be able to read your results and understand exactly what they mean.
3 Draw a line graph to show these results.
4 Write a sentence summarising what the investigation has shown.
5 Discuss whether you think the results you obtained were really accurate. Suggest some possible improvements to the investigation that could make the results more valid.
6 Suggest how you could use this apparatus to test the hypothesis (suggestion) that ammonia diffuses more rapidly at high temperatures than at low temperatures. Think about how you could make your experiment a fair test.

Diffusion and living organisms

Diffusion is very important to all living organisms, including humans. You will meet several examples as you continue your Biology course. For the moment, we shall look at one example of diffusion in animals, and one in plants.