UNIVERSITY OF SWAZILAND
FACULTY OF EDUCATION
DEPARTMENT OF CURRICULUM AND TEACHING
MAIN EXAMINATION QUESTION PAPER: DECEMBER 2015

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 are 2 attachments: i) SGCSE Biology Syllabus Code 6884, 2015-2016, page 12; ii) Biology for IGSE. Jones, M. (2002) pp. 15 – 24 for one question

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Question 1 is compulsory.

1. a) Scientific theories and experiments have an interactive and interdependent relationship. Illustrate this relationship, providing examples. **[5]**

b) Holton and Roller agree with Medawar regarding how scientific investigations occur and how the findings are subsequently reported. Explain what this means. **[5]**

c) Provide 3 differences between assessment and evaluation. **[6]**

d) Compare and contrast the following: **[4]**
i) Convergent and divergent questions
ii) Inquiry and discovery learning

e) List 3 advantages and 2 disadvantages associated with the use of behavioural objectives. **[5]**

Choose any 3 questions below.

2. a) Discuss the views of Karl Popper, Thomas Kuhn and Peter Medawar about the criterion of demarcation in science, that is, how science is distinct from non-science or pseudo-science . **[12]**

b) The discovery of Homo naledi in caves outside Johannesburg is significant in terms of providing answers to the theory of our evolution (**explaining our past and present**), and indicating if there are any species between Homo naledi and Homo sapiens **(predicting)**. Discuss the role of an existing paradigm or theory (Homo naledi) in scientific research. **[6]**

c) Using the Meiotic Model and Simple Dominance Model, show how scientific models
i) are a set of ideas used to describe a natural process
ii) are used to explain and predict natural phenomena
iii) are constituted by empirical or theoretical *objects* and the *processes* in which they participate **[7]**

3. a) According to the National Science Education Standards, science students must be exposed to and directly experience 5 *essential features of inquiry.* Provide and discuss any 3 essential features of inquiry. **[15]**

b) In Swaziland, learners engage in practical activities but not much scientific inquiry is involved. Critique this statement using the notions of open versus guided inquiry and full versus partial inquiry. **[10]**

4. a) Questioning, as a teaching and learning method and strategy, is important in science classrooms because it can be used with other teaching methods to actively engage learners with conceptually and procedurally. Explain how you would use this method in the following: **[3x4]**
   i) Group discussion
   ii) Demonstration
   iii) Laboratory exercises

   b) Ms Langa, a form 2 science teacher has a daily routine. First, she goes over any homework from previous lessons. Then she introduces the new topic by explaining the concepts to the learners. This is followed by giving the class notes to copy in their notebooks. Then she gives the learners classwork which she moves around checking followed by homework. Occasionally, learners are asked to read passages from the text and very rarely she will perform a demonstration, sometimes asking Vusi to assist her. Her classes are quiet and occasionally show some interest during the demonstrations.

   i) Discuss how this approach is not likely to lead to a conceptual change **[7]**
   ii) Provide 3 ways in which you would motivate the class to be actively engaged in the lessons. **[6]**

5. a) You are assigned to teach Form IV's the following topics during the first four weeks of teaching practice. Syllabus and appropriate content are attached.

   cell structure and organisation; levels of organisation and size of specimens

   i) Show how you would sequence the topics and why. **[5]**

   ii) Prepare a scheme of work for the **first week only** when provided with one double period and two single periods per week for Biology. **[10]**

   b) Research findings indicate that formative assessment results in improved achievement levels of learners. Discuss the implications of these findings for teaching. **[10]**

SGCSE

EXAMS COUNCIL OF SWAZILAND

Swaziland
General
Certificate of
Secondary
Education

BIOLOGY

Subject Code 6884

2015 - 2016 Syllabus

SECTION II - ORGANISATION AND MAINTENANCE OF THE ORGANISM (50% of teaching time)

CORE All learners should be able to:	EXTENDED In addition to what is required in the core, learners taking the Extended paper should be able to:
1. Cell structure and organisation: the cellular nature of all living organisms	
- identify and describe the structure of a plant cell (palisade cell) and an animal cell (liver cell), as seen under a light microscope. - describe the differences in structure between typical animal and plant cells.	- relate the structures seen under the light microscope in the plant cell and in the animal cell to their functions.
2. Levels of organisation	
- define development as an increase in complexity through the differentiation of cells. - define *tissue* as a group of cells of similar structure that work together to perform a special function. - relate the structure of the following to their functions: • palisade mesophyll cells – photosynthesis, • ciliated cells in respiratory tract – movement of mucus, • root hair cells – absorption • xylem vessels – conduction and support, • muscle cells – contraction, • red blood cells – transport. - define: • *organ* as several tissues grouped together to make a structure with a special function, • *organ system* as a group of organs with closely related functions. (Use examples of organs and organ systems, as illustrated by examples covered in Sections II and III.)	
3. Size of specimens	
- calculate magnification and size of biological specimens using millimetres as units.	
4. Movement in and out of cells	
4.1 Diffusion - define *diffusion* as the movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient. - describe the importance of gaseous and solute diffusion, and of water as a solvent.	

How do we use a key like this? First, choose the insect you want to identify in Figure 1.21. To begin with, look at insect A.

Look at the first pair of descriptions in the key, and decide which one best fits insect A. Insect A has wings, so you are told to go to 2.

Again, choose the description that fits insect A. It has two pairs of wings, so you now go to 4. The wings are transparent, so insect A is a dragonfly.

Check that you could identify all these insects using the key.

Summary

- Living organisms have seven characteristics – nutrition, excretion, respiration, sensitivity, reproduction, growth and movement.
- Organisms are classified into groups. Each species has a two-word Latin name called a binomial, made up of the name of its genus and of its species.
- The five classes of vertebrates are fish, amphibians, reptiles, birds and mammals.
- The largest group of non-vertebrate animals are the arthopods, which have an exoskeleton, a segmented body and jointed legs. They include insects, crustaceans, myriapods and arachnids. Other non-vertebrates include the annelids, nematodes and molluscs.
- Plants can be classified as monocotyledonous or dicotyledonous, according to the number of cotyledons in their seeds.
- Bacteria have cells that are much smaller than those of animals and plants, and these cells have no nucleus.
- Fungi, like plants, have cell walls, but they do not photosynthesise and do not have chloroplasts.
- Viruses do not show all the characteristics of living things, and are not made of cells. They are able to reproduce, but only when inside a living cell.
- A dichotomous key is made up of pairs of questions or statements, which you lead through to the identification of an organism.

Chapter

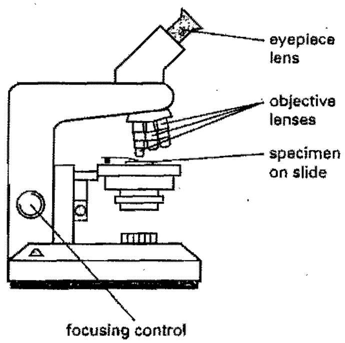
Cells, diffusion and osmosis

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).



▲ **Figure 2.1**
A microscope.

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.

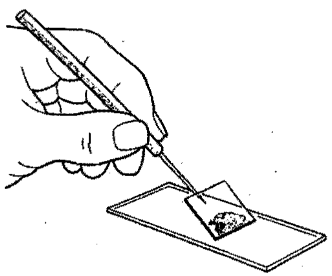
You will need:

- 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.

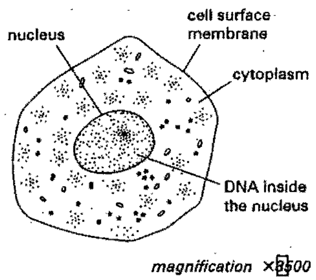
1 Set up a microscope. Make sure that you have the smallest objective lens over the stage, and the light or mirror is arranged so that you can see bright light when you look through the eyepiece.

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 2.2**
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

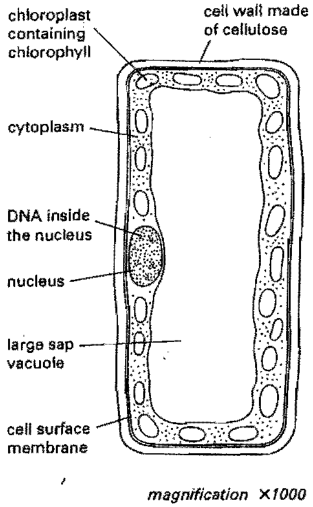
Plant cells have some structures that are never found in animal cells. These are a cell **wall**, and sometimes **chloroplasts** and a large **vacuole containing cell sap**.

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.

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

- 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.**

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.

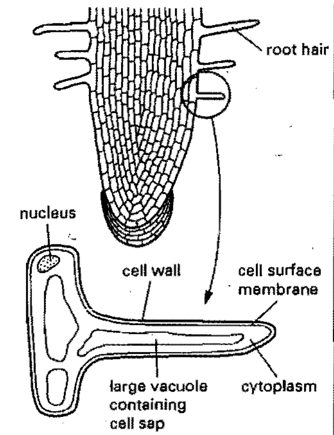
Plant cells often contain a large, liquid-filled space, called a **vacuole**. The vacuole is surrounded by a membrane which keeps its contents separate from the cytoplasm. The liquid inside the vacuole is called cell **sap**. It is mostly water, with sugars, amino acids and other substances dissolved 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

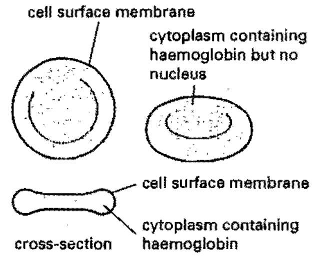
2.1 Make a comparison table to summarise the similarities and differences between plant and animal cells. Draw a table like this:

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

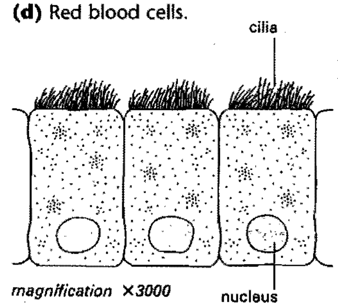
You will need six rows, one each for cell surface membrane, cytoplasm, nucleus, cell wall, chloroplasts and vacuole. Make the 'comment' column wider than the others, so that you can write plenty of information in it.



(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.



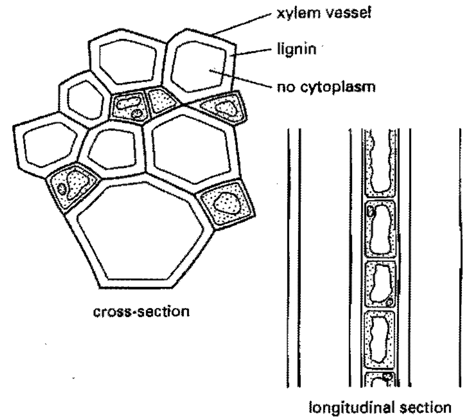
(e) These ciliated cells make up the lining of the trachea.

▲ **Figure 2.5**
Some different tissues.

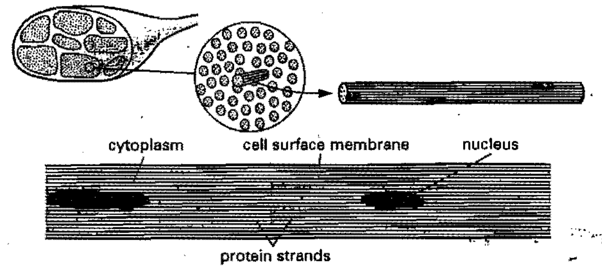
Tissues

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.

Questions

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.

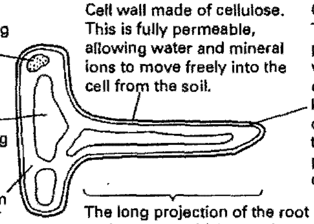


Figure 2.6 ▸ An annotated drawing of a root hair cell.

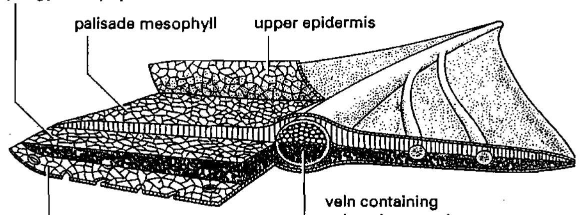
Organs

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

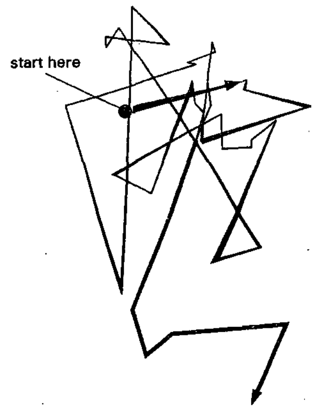
2.3 Using the index, look up the nervous system, gaseous exchange system and digestive system, and make a list of some of the organs in each of these three systems.

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



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

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.

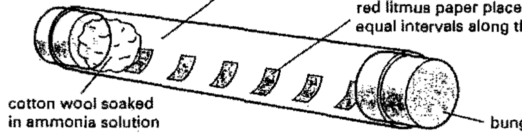


Figure 2.9 ▶ Apparatus for Investigation 2.3.

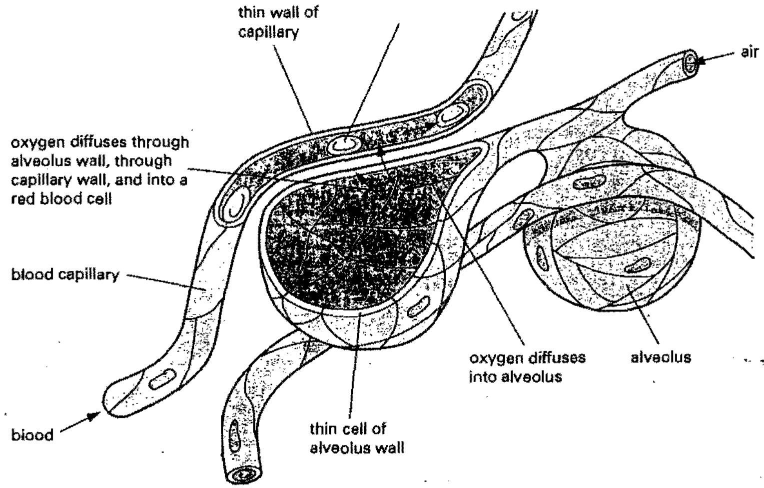
A piece of cotton wool soaked in ammonia solution is placed in one end of the tube, and quickly sealed inside with a rubber bung. (This is to stop too many ammonia molecules escaping – they do not smell very nice!) A stopwatch is started as the cotton wool goes into the tube. Ammonia turns red litmus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



▲ Figure 2.10
In the lungs, oxygen diffuses from an alveolus into the red blood cells.

Diffusion of gas molecules takes place in plants too. In daylight, the palisade and spongy mesophyll cells in a plant leaf photosynthesise. They use carbon dioxide and water to make sugars. These sugars may be turned into starch in the leaf. Where does the carbon dioxide come from, and how does it get to these cells?