UNIVERSITY OF SWAZILAND
FACULTY OF EDUCATION
FINAL EXAMINATION QUESTION PAPER, MAY 2006

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

INSTRUCTIONS:

1. This examination paper has five questions. Answer any four (4) questions

2. Each question has a total of 25 points. The number of points for each sub-question is indicated in parentheses

3. There is an attachment for one question only

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1. a) J. B. Conant suggests two (2) views of science . Briefly describe each one. [5]

b) Compare and contrast the views of Karl Popper and Thomas Kuhn on how scientific progress occurs. [5]

c) Medawar proposes two (2) conceptions of science. Describe the relationship between the two conceptions. [5]

d) Explain how experiment and theory are dependent on each other. [5]

e) Explain the difference between how scientific research occurs and how it is reported. [5]

2 a) Science has a special place in the school curriculum. It contributes toward the development of the following:
(i) intellectual skills
(ii) scientific methods of investigation
(iii) science process skills.

Explain these [3x5]

b) Discuss two intrinsic and two extrinsic justifications for teaching science in school. [10]

3. The following is the curriculum content for the topic osmosis from the IGCSE biology syllabus, 2007.

Topic	**Core**	**Extended**
Osmosis	**- define osmosis as the passage of water molecules from a region of their higher concentration to a region of their lower concentration, through a partially permeable membrane**	
	- describe the importance of osmosis on the uptake of water by plants, and its effects on plant and animal tissues	**- understand the concept of a water potential gradient**

Use the attached information on osmosis and your own knowledge of the topic to answer the following questions.

a) Write four (4) objectives you would want to achieve in teaching osmosis. [8]

b) Name two (2) process skills you would want to develop and explain how to develop them. [6]

c) What appropriate teaching materials would you use to develop process skills? [5]

d) Identify an appropriate teaching strategy and briefly explain how you would use it. [6]

4. Questioning is a valuable technique in fostering inquiry thinking in students. It can be used in most/all methods of science teaching.

a) i) Name three (3) types of classification of questions. [3]

ii) For each type, give two examples of questions from any biology content that illustrates the classification type, and justify or explain why the question is so classified. [15]

b) How can active participation of students be invoked in a discussion? [7]

5. The demonstration method is frequently used in schools in Swaziland to teach biology.

a) Discuss the value and limitations of using the demonstration method. [12]

b) Briefly explain the guidelines you would use in preparing for a demonstration for a topic in biology. [7]

c) What measures would you take to ensure optimum student participation? [6]

Osmosis

If a dilute solution is separated from a concentrated solution by a **partially permeable** membrane, water diffuses across the membrane from the dilute to the concentrated solution. This is known as **osmosis**.

A partially permeable membrane is porous but allows water to pass through it more rapidly than dissolved substances.

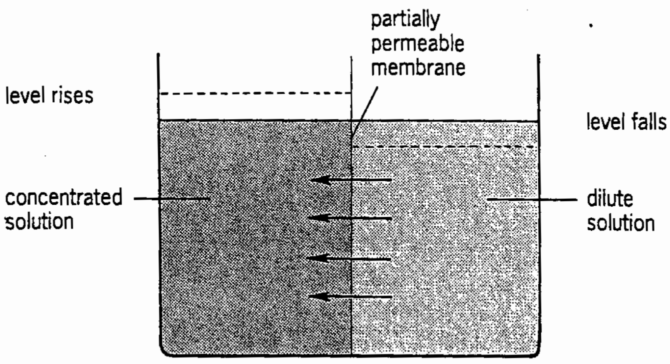


Figure 10 Osmosis. Water will diffuse from the dilute to the concentrated solution through the partially permeable membrane. As a result, the liquid level will rise on the left and fall on the right.

Since a dilute solution contains, in effect, more water molecules than a concentrated solution, there is a diffusion gradient which favours the passage of water from the dilute to the concentrated solution.

In living cells, the cell membrane is partially permeable and the cytoplasm and vacuole (in plant cells) contain dissolved substances. As a consequence, water tends to diffuse into cells by osmosis if they are surrounded by a weak solution, e.g. fresh water. If the cells are surrounded by a stronger solution, e.g. sea water, the cells may lose water by osmosis.

These effects are described more fully on p. 32.

Explanation of osmosis

When a substance such as sugar dissolves in water, the sugar molecules attract some of the water molecules and stop them moving freely. This, in effect, reduces the concentration of water molecules. In Fig. 11 the sugar molecules on the right have 'captured' half the water molecules. There are more free water molecules on the left of the membrane than on the right, so water will diffuse more rapidly from left to right across the membrane than from right to left.

The partially permeable membrane does not act like a sieve, in this case. The sugar molecules can diffuse from right to left but, because they are bigger and surrounded by a cloud of water molecules, they diffuse more slowly than the water.

Artificial partially permeable membranes are made from cellulose acetate in sheets or tubes and used for **dialysis** (p. 36) rather than for osmosis. The pore size can be adjusted during manufacture so that large molecules cannot get through at all.

The cell membrane behaves like a partially permeable membrane. The partial permeability may depend on pores in the cell membrane but the processes involved are far more

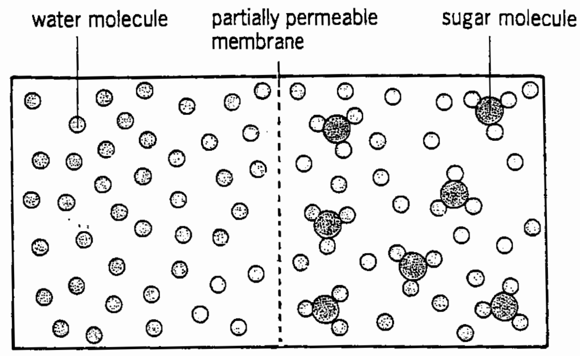


Figure 11 The diffusion gradient for water. There are more free water molecules on the left, so more will diffuse from left to right than in the other direction. Sugar molecules will diffuse more slowly from right to left.

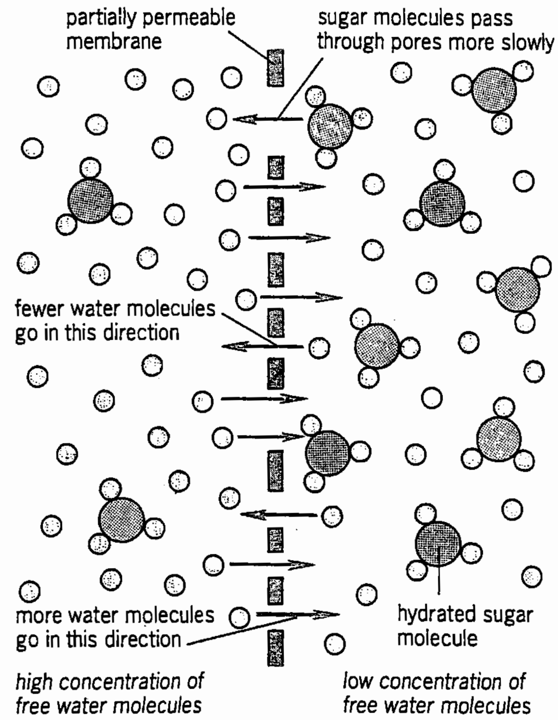


Figure 12 The diffusion theory of osmosis

complicated than in an artificial membrane and depend on the structure of the membrane and on living processes in the cytoplasm (see p. 29). The cell membrane contains lipids and proteins. Anything which denatures proteins, e.g. heat, also destroys the structure and the partially permeable properties of a cell membrane. If this happens, the cell will die as essential substances diffuse out of the cell and harmful chemicals diffuse in.

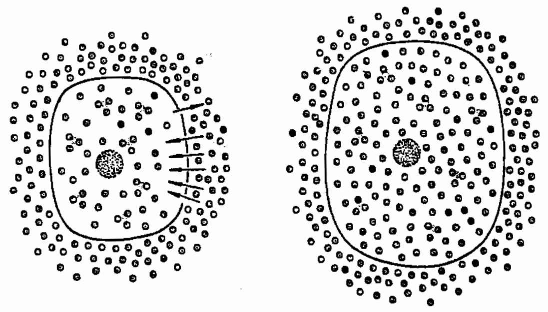
Water potential

The water potential of a solution is a measure of whether it is likely to lose or gain water molecules from another solution. A dilute solution, with its high proportion of free water molecules, is said to have a higher water potential than a concentrated solution, because water will flow from the dilute to the concentrated solution (from a high potential to a low potential). Pure water has the highest possible water potential because water molecules will flow from it to any other aqueous solution, no matter how dilute.

Animal cells

In Fig. 13 an animal cell is shown very simply. The coloured circles represent molecules in the cytoplasm. They may be sugar, salt or protein molecules. The grey circles represent water molecules.

The cell is shown surrounded by pure water. Nothing is dissolved in the water; it has 100 per cent concentration of water molecules. So the concentration of free water molecules outside the cell is greater than that inside and, therefore, water will diffuse into the cell by osmosis.



(a) There is a higher concentration of free water molecules outside the cell than inside, so water diffuses into the cell.

(b) The extra water makes the cell swell up. (Note that molecules are really far too small to be seen at this magnification.)

Figure 13 Osmosis in an animal cell

The membrane allows water to go through either way. So in our example, water can move into or out of the cell.

The cell membrane is partially permeable to most of the substances dissolved in the cytoplasm. So although the concentration of these substances inside may be high, they cannot diffuse freely out of the cell.

The water molecules move into and out of the cell, but because there are more of them on the outside, they will move in faster than they move out. The liquid outside the cell does not have to be 100 per cent pure water. As long as the concentration of water outside is higher than that inside, water will diffuse in by osmosis.

Water entering the cell will make it swell up, and unless the extra water is expelled in some way the cell will burst.

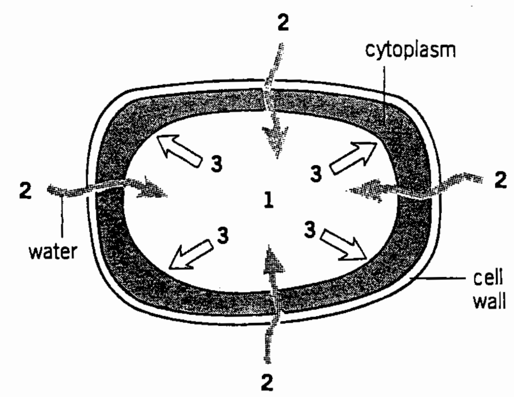
Conversely, if the cells are surrounded by a solution which is more concentrated than the cytoplasm, water will pass out of the cell by osmosis and the cell will shrink. Excessive uptake or loss of water by osmosis may damage cells.

For this reason, it is very important that the cells in an animal's body are surrounded by a liquid which has the same concentration as the liquid inside the cells. The outside liquid is called 'tissue fluid' (see p. 121) and its concentration depends on the concentration of the blood. In vertebrate animals the blood's concentration is monitored by the brain and adjusted by the kidneys, as described on p. 141.

By keeping the blood concentration within narrow limits, the concentration of tissue fluid remains more or less constant (see pp. 124 and 143) and the cells are not bloated by taking in too much water, or dehydrated by losing too much.

Plant cells

The cytoplasm of a plant cell and the cell sap in its vacuole contain salts, sugars and proteins which effectively reduce the concentration of free water molecules inside the cell. The cell wall is freely permeable to water and dissolved substances but the cell membrane of the cytoplasm is partially permeable. If a plant cell is surrounded by water or a solution more dilute than its contents, water will pass into the vacuole by osmosis. The vacuole will expand and press outwards on the cytoplasm and cell wall. The cell wall of a mature plant cell cannot be stretched, so there comes a time when the inflow of water is resisted by the unstretchable cell wall (Fig. 14).

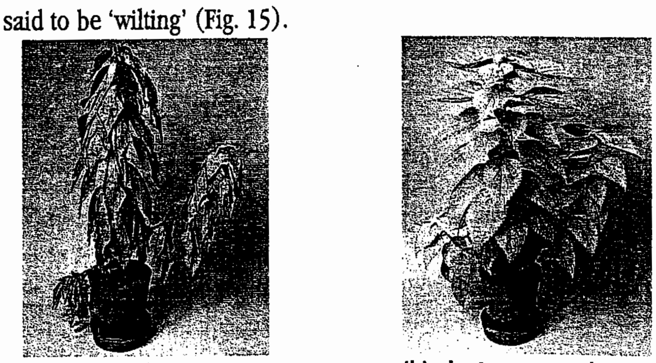


1 Since there is effectively a lower concentration of water in the cell sap
2 water diffuses into the vacuole
3 and makes it push out against the cell wall.

Figure 14 Osmosis in a plant cell

This has a similar effect to inflating a soft bicycle tyre. The tyre represents the firm cell wall, the floppy inner tube is like the cytoplasm and the air inside corresponds to the vacuole. If enough air is pumped in, it pushes the inner tube against the tyre and makes the tyre hard. A plant cell with the vacuole pushing out on the cell wall is said to be **turgid** and the vacuole is exerting **turgor pressure** on the cell wall.

If all the cells in a leaf and stem are turgid, the stem will be firm and upright and the leaves held out straight. If the vacuoles lose water for any reason, the cells will lose their turgor and become **flaccid** (Experiment 3, p. 34). A leaf with flaccid cells will be limp and the stem will droop. A plant which loses water to this extent is said to be 'wilting' (Fig. 15).



(a) plant wilting

(b) plant recovered after watering

Figure 15 Wilting