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UNIVERSITY OF SWAZILAND
FACULTY OF EDUCATION
FINAL EXAMINATION QUESTION PAPER, MAY 2005

TITLE OF PAPER	:	**CURRICULUM STUDIES IN BIOLOGY I**
COURSE CODE	:	**EDC 278/578**
TIME ALLOWED	:	**THREE (3) HOURS**
INSTRUCTIONS	:	**CHOOSE ANY FOUR (4) QUESTIONS**

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1. a) Thomas Khun refers to progress in science as characterized by a series of 'scientific revolutions' interrupted by periods of 'normal science'. Explain [10]

   b) According to Medawar scientific publications do not give a true reflection of scientific progress and the nature of science. By this he implies that the scientific paper may be a fraud. How can this view be justified? Give specific examples. [10]

   c) Medawar proposes two conceptions of science and scientific inquiry. Name them and explain their attributes. [5]

2. a) The place of science in the school curriculum can be justified on the basis of its intrinsic as well as extrinsic values. Explain and give specific examples of these from biology. [15]

   b) The two statements that follow refer to what may be expected of students who have completed an O'level biology course

   i) Students will have developed a high level of scientific literacy.

   ii) Students will be able to distinguish between aerobic and anaerobic respiration.

   How are these statements 1) similar to and 2) different from each other? [10]

3. 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** types of classification of questions. [3]

   ii) For each type, give two examples of questions from any biology content that illustrate 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]

4. a) Laboratory work is an integral part of learning activities in science. The aim of the activity must be specified. List 2 aims for a biology practical activity and state procedures you will use to evaluate the work. [10]

b) Why is it important to construct a blueprint or grid before construction of an assessment instrument? [10]

c) How does a grid affect content validity? [5]

5. You are preparing to teach a lesson on the topic 'cell structure and function' (plant and animal). Use the attached O'level biology syllabus and information on cells and your own knowledge of the topic to:

a) i) Write 5 (five) objectives, 4 (our) from the cognitive domain and one from the affective domain. 3 (three) objectives should be above knowledge level and one should refer to a science process. [10]

ii) State which one refers to a science process and identify the science process. [2]

iii) How would you determine if the affective objective was achieved by the learners? [3]

b) Describe 2 teaching methods by which this lesson may be taught and state clearly what the students will be doing during your lesson. [10]

SUBJECT CONTENT

1. Cell Structure and Organisation

Content

1.1 Plant and animal cells
1.2 Specialised cells, tissues and organs

Learning Outcomes:

Candidates should be able to:

(a) examine under the microscope an animal cell (e.g. from fresh liver) and a plant cell (e.g. from *Elodea*, a moss, onion epidermis, or any suitable locally available material), using an appropriate temporary staining technique, such as iodine or methylene blue

(b) draw diagrams to represent observations of the plant and animal cells examined above

(c) identify, from fresh preparations or on diagrams or photomicrographs, the cell membrane, nucleus and cytoplasm in an animal cell

(d) identify, from diagrams or photomicrographs, the cell wall, cell membrane, sap vacuole, cytoplasm, nucleus and chloroplasts in a plant cell

(e) compare the visible differences in structure of the animal and the plant cells examined

(f) state the function of the cell membrane in controlling the passage of substances into and out of the cell

(g) state, in simple terms, the relationship between cell function and cell structure for the following:

absorption - root hair cells
conduction and support - xylem vessels
transport of oxygen - red blood cells

(h) identify these cells from preserved material under the microscope, from diagrams and from photomicrographs

(i) differentiate *cell, tissue, organ* and *organ system* as illustrated by examples covered in sections 1 to 12, 15 and 16.

1 CELLS AND TISSUES

Cell structure
How tissues are studied to see cells: taking sections. Cell components. Plant cells.

Cell division and specialization
Cell division and growth. Specialization of cells for different functions.

Tissues and organs
Definitions and examples of tissues, organs and systems.

Practical work
Preparing, observing and drawing plant and animal cells.

Cell structure

If a very thin slice of a plant stem is cut and studied under a microscope, it can be seen that the stem consists of thousands of tiny, box-like structures. These structures are called **cells**. Fig. 1 is a thin slice taken from the tip of a plant shoot and photographed through a microscope. Photographs like this are called **photomicrographs**. The one in Fig. 1 is 60 times larger than life, so a cell which appears to be 2 mm long in the picture, is only 0.03 mm long in life.

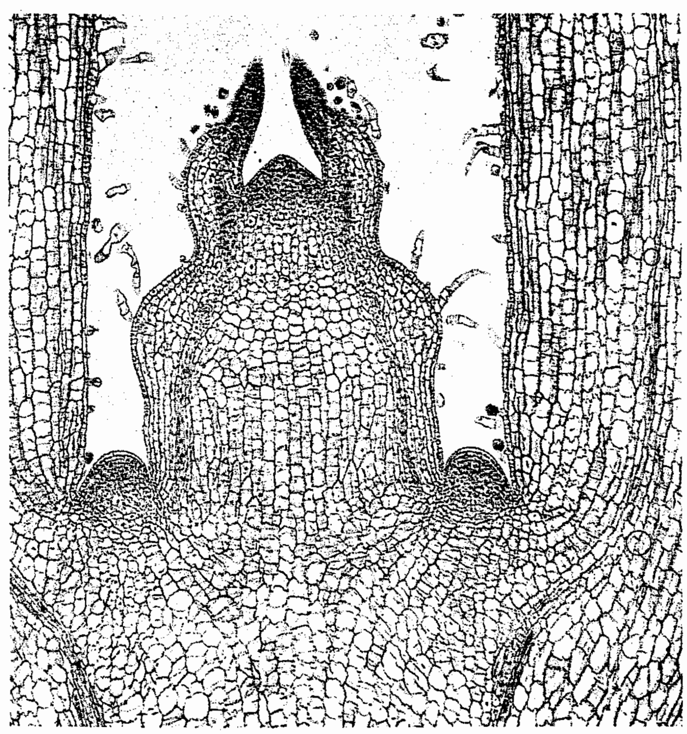


Figure 1 Longitudinal section through the tip of a plant shoot (x60). The slice is only one cell thick, so light can pass through it and allow the cells to be seen clearly.

Thin slices of this kind are called **sections**. If you cut *along the length* of the structure, you are taking a **longitudinal section**. Fig. 1 shows a longitudinal section, which passes through two small developing leaves near the tip of the shoot, and two larger leaves below them. The leaves, buds and stem are all made up of cells. If you cut *across* the structure, you make a **transverse section** (Fig. 2).

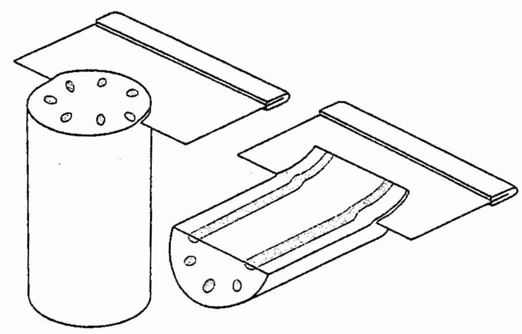


Figure 2 Cutting sections of a plant stem

It is fairly easy to cut sections through plant structures just by using a razor blade. To make a microscopic study of animal structures is more difficult because they are mostly soft and flexible. Pieces of skin, muscle or liver, for example, first have to be soaked in melted wax. When the wax goes solid it is then possible to cut thin sections. The wax is dissolved away after making the section.

When sections of animal structures are examined under the microscope, they, too, are seen to be made up of cells but they are much smaller than plant cells and need to be magnified more. The photomicrograph of kidney tissue in Fig. 3 has been magnified 700 times to show the cells clearly. The sections are often treated with dyes, called 'stains', in order to show up the structures inside the cells more clearly.

Making sections is not the only way to study cells. Thin strips of plant tissue, only one cell thick, can be pulled off stems or leaves (Experiment 1, p. 9). Plant or animal tissue can be squashed or smeared on a microscope slide (Experiment 2, p. 10) or treated with chemicals to separate the cells before studying them.

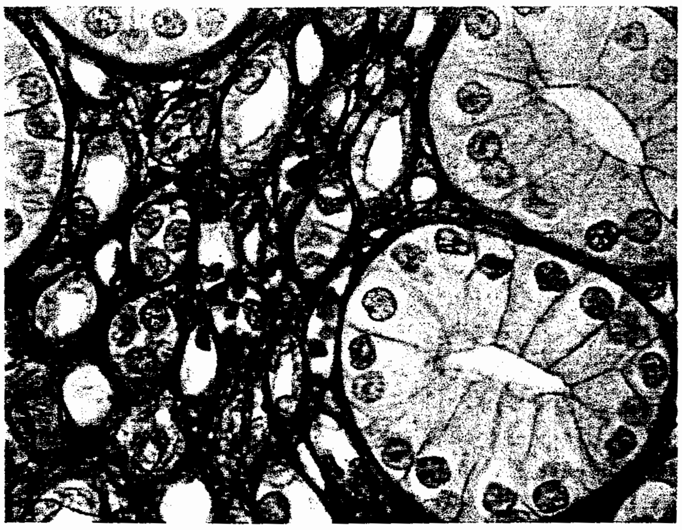


Figure 3 Transverse section through a kidney tubule (×700). A section through a tube will look like a ring (see Fig. 12(b) on p. 6). In this case, each 'ring' consists of about 10 cells.

There is no such thing as a typical plant or animal cell because cells vary a great deal in their size and shape depending on their function. Nevertheless, it is possible to make a 'generalized' drawing like Fig. 4 to show features which are present in most cells. *All cells* have a **cell membrane** which is a thin boundary enclosing the **cytoplasm**. Most cells have a **nucleus**.

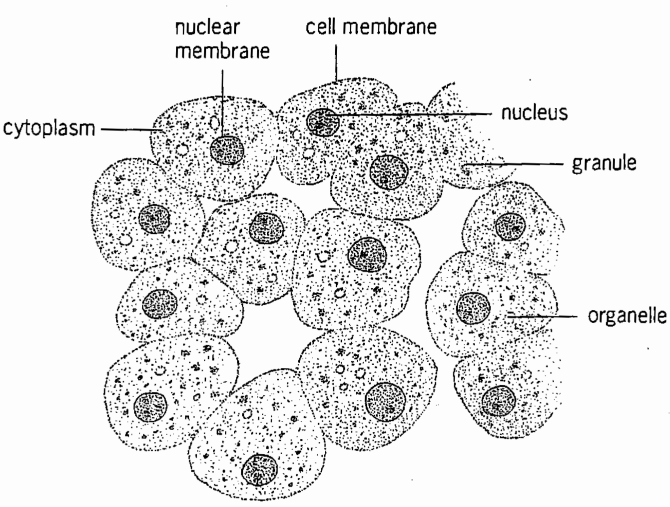


Figure 4 A group of animal cells, e.g. cells from the lining of the cheek

Cytoplasm

Under the ordinary microscope (light microscope), cytoplasm looks like a thick liquid with particles in it. In plant cells it may be seen to be flowing about. The particles may be food reserves such as oil droplets or granules of starch. Other particles are structures which have particular functions in the cytoplasm. These structures are the **organelles**. Examples are the **ribosomes** which build up the cell's proteins (see p. 11) and the **mitochondria** which generate energy for the cell's living processes (see p. 20).

When studied at much higher magnifications with the **electron microscope**, the cytoplasm no longer looks like a structureless jelly but appears to be organized into a complex system of membranes and vacuoles.

In the cytoplasm, a great many chemical reactions are taking place which keep the cell alive by providing energy and making substances that the cell needs (see pp. 11 and 20).

The liquid part of cytoplasm is about 90 per cent water with molecules of salts and sugars dissolved in it. Suspended in this solution there are larger molecules of fats (lipids) and proteins (see pp. 11–12). Lipids and proteins may be used to build up the cell structures, e.g. the membranes. Some of the proteins are **enzymes** (p. 13). Enzymes control the rate and type of chemical reactions which take place in the cells. Some enzymes are attached to the membrane systems of the cell, others float freely in the liquid part of the cytoplasm.

Cell membrane

This is a thin layer of cytoplasm round the outside of the cell. It stops the cell contents from escaping and also controls the substances which are allowed to enter and leave the cell. In general, oxygen, food and water are allowed to enter; waste products are allowed to leave and harmful substances are kept out. In this way the cell membrane maintains the structure and chemical reactions of the cytoplasm.

Nucleus (plural = nuclei)

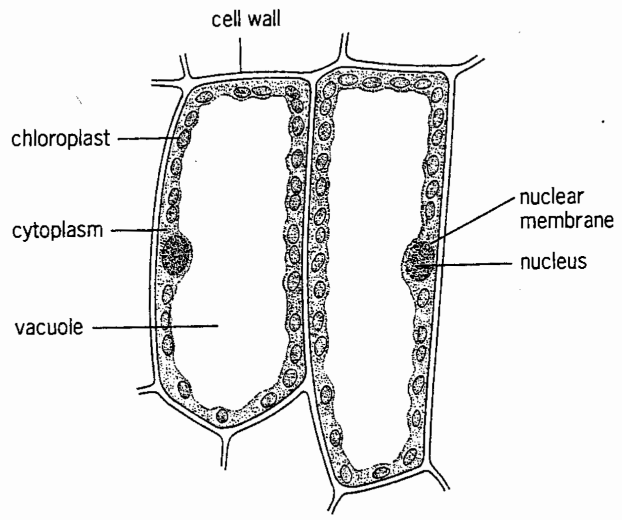
Most cells contain one nucleus, usually seen as a rounded structure enclosed in a membrane and embedded in the cytoplasm. In drawings of cells, the nucleus may be shown darker than the cytoplasm because, in prepared sections, it takes up certain stains more strongly than the cytoplasm. The function of the nucleus is to control the type and quantity of enzymes produced by the cytoplasm. In this way it regulates the chemical changes which take place in the cell. As a result, the nucleus determines what the cell will be, e.g. a blood cell, a liver cell, a muscle cell or a nerve cell.

The nucleus also controls cell division as shown in Fig. 8. A cell without a nucleus cannot reproduce. Inside the nucleus are thread-like structures called **chromosomes** which can be seen most easily at the time when the cell is dividing. (See p. 198 for a fuller account of chromosomes.)

The term **protoplasm** is sometimes used to describe the cytoplasm, nucleus and cell membrane together.

Mitochondria

The mitochondria are tiny organelles present in plant and animal cells. They may be spherical, rod-like or elongated. They are most numerous in regions of rapid chemical activity and are responsible for producing energy from food substances (see 'Respiration', p. 20).



Plant cells

A few generalized animal cells are represented by Fig. 4, while Fig. 5 is a drawing of two palisade cells from a plant leaf (see p. 55).

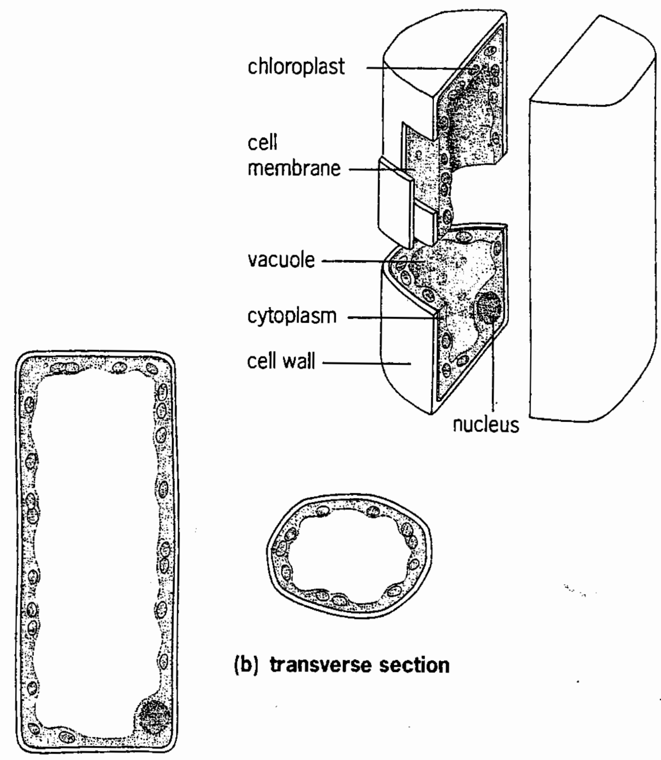
Plant cells differ from animal cells in several ways:

1 Outside the cell membrane they all have a **cell wall** which contains cellulose and other compounds. It is non-living and allows water and dissolved substances to pass through. The cell wall is not selective like the cell membrane. (Note that plant cells *do* have a cell membrane but it is not easy to see or draw because it is pressed against the inside of the cell wall. See Fig. 6.)

   Under the microscope, plant cells are quite distinct and easy to see because of their cell walls. In Fig. 1 it is only the cell walls (and in some cases the nuclei) which can be seen. Each plant cell has its own cell wall but the boundary between two cells side by side does not usually show up clearly. Cells next to each other therefore appear to be sharing the same cell wall.

2 Most mature plant cells have a large, fluid-filled space called a **vacuole**. The vacuole contains **cell sap**, a watery solution of sugars, salts and sometimes pigments. This large, central vacuole pushes the cytoplasm aside so that it forms just a thin lining inside the cell wall. It is the outward pressure of the vacuole on the cytoplasm and cell wall which makes plant cells and their tissues firm (see p.32). Animal cells may sometimes have small vacuoles in their cyotplasm but they are usually produced to do a particular job and are not permanent.

3 In the cytoplasm of plant cells are many organelles called **plastids** which are not present in animal cells. If they contain the green substance **chlorophyll**, the organelles are called **chloroplasts** (see p. 40). Colourless plastids usually contain starch which is used as a food store.



(a) longitudinal section

Figure 6 Structure of a palisade cell. It is important to remember that, although cells look flat in sections or in thin strips of tissue, they are in fact three-dimensional and may seem to have different shapes according to the direction in which the section is cut. If the cell is cut across it will look like (b); if cut longitudinally it will look like (a).

The shape of a cell when seen in a transverse section may be quite different when the same cell is seen in a longitudinal section and Fig. 6 shows why this is so. Figs 10(b) and (c) on p. 57 show the appearance of cells in a stem vein as seen in transverse and longitudinal section.

QUESTIONS

1 **a** What structures are usually present in all cells, whether they are from an animal or from a plant?
b What structures are present in plant cells but not in animal cells?
2 What cell structure is largely responsible for controlling the entry and exit of substances into or out of the cell?
3 In what way does the red blood cell shown in Fig. 1 on p.116 differ from most other animal cells?
4 How does a cell membrane differ from a cell wall?
5 Why does the cell shown in Fig. 6(b) appear to have no nucleus?
6 **a** In order to see cells clearly in a section of plant tissue, would you have to magnify the tissue **i** ×5, **ii** ×10, **iii** ×100 or **iv** ×1000?
b What is the approximate width (in mm) of one of the largest cells in Fig. 3?
7 In Fig. 3, the cell membranes are not always clear. Why is it still possible to decide roughly how many cells there are in each tubule section?