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Cambridge International AS and A Level Biology

Coursebook

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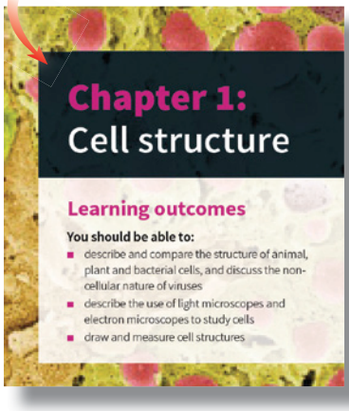
Contents

How to use this book

Each chapter begins with a short list of the facts and concepts that are explained in it.



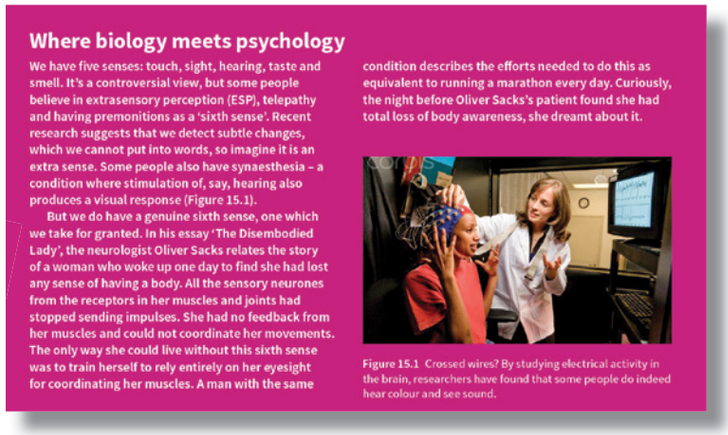
Chapter 1:
Cell structure

Learning outcomes

You should be able to:

- describe and compare the structure of animal, plant and bacterial cells, and discuss the non-cellular nature of viruses
- describe the use of light microscopes and electron microscopes to study cells
- draw and measure cell structures

There is a short context at the beginning of each chapter, containing an example of how the material covered in the chapter relates to the 'real world'.



Where biology meets psychology

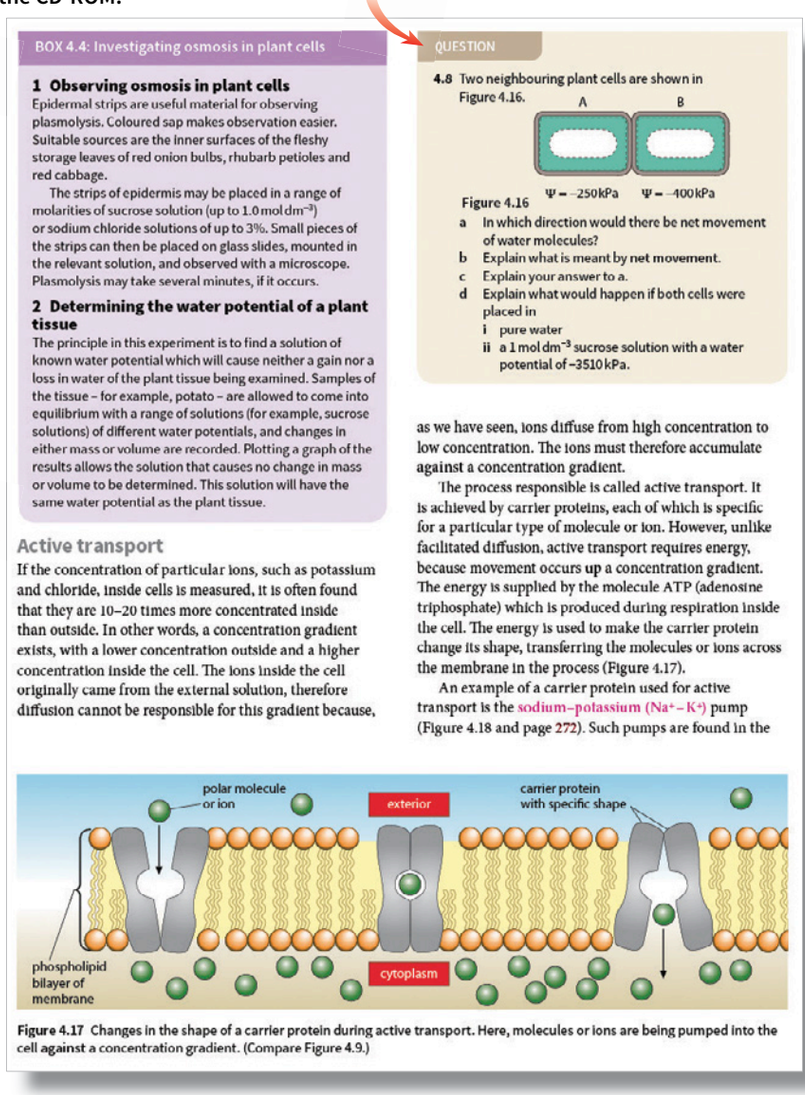
We have five senses: touch, sight, hearing, taste and smell. It's a controversial view, but some people believe in extrasensory perception (ESP), telepathy and having premonitions as a 'sixth sense'. Recent research suggests that we detect subtle changes, which we cannot put into words, so imagine it is an extra sense. Some people also have synaesthesia – a condition where stimulation of, say, hearing also produces a visual response (Figure 15.1).

But we do have a genuine sixth sense, one which we take for granted. In his essay 'The Disembodied Lady', the neurologist Oliver Sacks relates the story of a woman who woke up one day to find she had lost any sense of having a body. All the sensory neurones from the receptors in her muscles and joints had stopped sending impulses. She had no feedback from her muscles and could not coordinate her movements. The only way she could live without this sixth sense was to train herself to rely entirely on her eyesight for coordinating her muscles. A man with the same condition describes the efforts needed to do this as equivalent to running a marathon every day. Curiously, the night before Oliver Sacks's patient found she had total loss of body awareness, she dreamt about it.

Figure 15.1 Crossed wires? By studying electrical activity in the brain, researchers have found that some people do indeed hear colour and see sound.

Questions throughout the text give you a chance to check that you have understood the topic you have just read about. You can find the answers to these questions on the CD-ROM.

This book does not contain detailed instructions for doing particular experiments, but you will find background information about the practical work you need to do in these boxes. There are also two chapters, P1 and P2, which provide detailed information about the practical skills you need to develop during your course.



BOX 4.4: Investigating osmosis in plant cells

1 Observing osmosis in plant cells

Epidermal strips are useful material for observing plasmolysis. Coloured sap makes observation easier. Suitable sources are the inner surfaces of the fleshy storage leaves of red onion bulbs, rhubarb petioles and red cabbage.

The strips of epidermis may be placed in a range of molarities of sucrose solution (up to 1.0 mol dm^{-3}) or sodium chloride solutions of up to 3%. Small pieces of the strips can then be placed on glass slides, mounted in the relevant solution, and observed with a microscope. Plasmolysis may take several minutes, if it occurs.

2 Determining the water potential of a plant tissue

The principle in this experiment is to find a solution of known water potential which will cause neither a gain nor a loss in water of the plant tissue being examined. Samples of the tissue – for example, potato – are allowed to come into equilibrium with a range of solutions (for example, sucrose solutions) of different water potentials, and changes in either mass or volume are recorded. Plotting a graph of the results allows the solution that causes no change in mass or volume to be determined. This solution will have the same water potential as the plant tissue.

QUESTION

4.8 Two neighbouring plant cells are shown in Figure 4.16.

Figure 4.16

a In which direction would there be net movement of water molecules?
b Explain what is meant by net movement.
c Explain your answer to a.
d Explain what would happen if both cells were placed in
i pure water
ii a 1 mol dm^{-3} sucrose solution with a water potential of –3510 kPa.

Active transport

If the concentration of particular ions, such as potassium and chloride, inside cells is measured, it is often found that they are 10–20 times more concentrated inside than outside. In other words, a concentration gradient exists, with a lower concentration outside and a higher concentration inside the cell. The ions inside the cell originally came from the external solution, therefore diffusion cannot be responsible for this gradient because, as we have seen, ions diffuse from high concentration to low concentration. The ions must therefore accumulate against a concentration gradient.

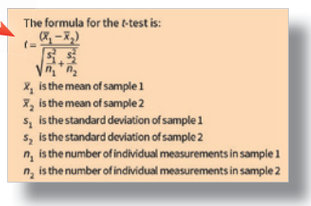
The process responsible is called active transport. It is achieved by carrier proteins, each of which is specific for a particular type of molecule or ion. However, unlike facilitated diffusion, active transport requires energy, because movement occurs **up** a concentration gradient. The energy is supplied by the molecule ATP (adenosine triphosphate) which is produced during respiration inside the cell. The energy is used to make the carrier protein change its shape, transferring the molecules or ions across the membrane in the process (Figure 4.17).

An example of a carrier protein used for active transport is the sodium–potassium (Na^+ – K^+) pump (Figure 4.18 and page 272). Such pumps are found in the

Figure 4.17 Changes in the shape of a carrier protein during active transport. Here, molecules or ions are being pumped into the cell against a concentration gradient. (Compare Figure 4.9.)

The text and illustrations describe and explain all of the facts and concepts that you need to know. The chapters, and often the content within them as well, are arranged in the same sequence as in your syllabus.

Important equations and other facts are shown in highlight boxes.



The formula for the *t*-test is:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$\bar{x}_1$ is the mean of sample 1
$\bar{x}_2$ is the mean of sample 2
s_1 is the standard deviation of sample 1
s_2 is the standard deviation of sample 2
n_1 is the number of individual measurements in sample 1
n_2 is the number of individual measurements in sample 2

Wherever you need to know how to use a formula to carry out a calculation, there are worked example boxes to show you how to do this.

WORKED EXAMPLE 2

Calculating the magnification of a photograph or image

To calculate *M*, the magnification of a photograph or an object, we can use the following method.

Figure 1.9 shows two photographs of a section through the same plant cells. The magnifications of the two photographs are the same. Suppose we want to know the magnification of the plant cell labelled P in Figure 1.9b. If we know its actual (real) length we can calculate its magnification using the formula

$$M = \frac{I}{A}$$

The real length of the cell is 80 µm.

Step 1 Measure the length in mm of the cell in the photograph using a ruler. You should find that it is about 60 mm.

Step 2 Convert mm to µm. (It is easier if we first convert all measurements to the same units – in this case micrometres, µm.)

1 mm = 1000 µm

so 60 mm = 60 × 1000 µm

= 60 000 µm

Step 3 Use the equation to calculate the magnification.

$$\text{magnification, } M = \frac{\text{image size, } I}{\text{actual size, } A} = \frac{60\,000\ \mu\text{m}}{80\ \mu\text{m}} = \times 750$$

The multiplication sign in front of the number 750 means 'times'. We say that the magnification is 'times 750'.

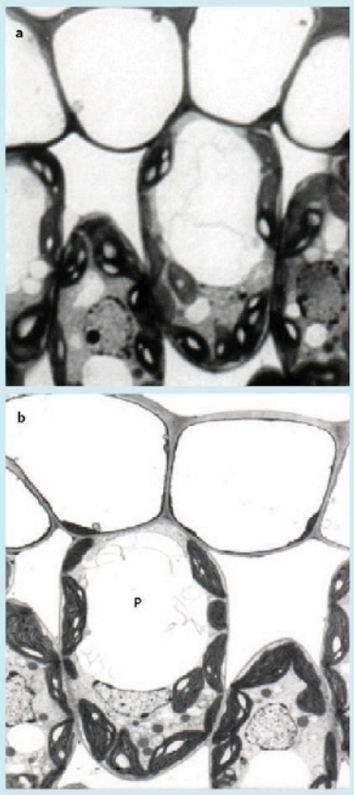


Figure 1.9 Photographs of the same types of plant cells seen a with a light microscope, b with an electron microscope, both shown at a magnification of about × 750.

Definitions that are required by the syllabus are shown in highlight boxes.

A **macromolecule** is a large biological molecule such as a protein, polysaccharide or nucleic acid.

A **monomer** is a relatively simple molecule which is used as a basic building block for the synthesis of a polymer; many monomers are joined together to make the polymer, usually by condensation reactions; common examples of molecules used as monomers are monosaccharides, amino acids and nucleotides.

A **polymer** is a giant molecule made from many similar repeating subunits joined together in a chain; the subunits are much smaller and simpler molecules known as monomers; examples of biological polymers are polysaccharides, proteins and nucleic acids.

Key words are highlighted in the text when they are first introduced.

An example of a carrier protein used for active transport is the sodium–potassium ($Na^+ - K^+$) pump (Figure 4.18 and page 272). Such pumps are found in the

You will also find definitions of these words in the Glossary.

sodium–potassium pump a membrane protein (or proteins) that moves sodium ions out of a cell and potassium ions into it, using ATP

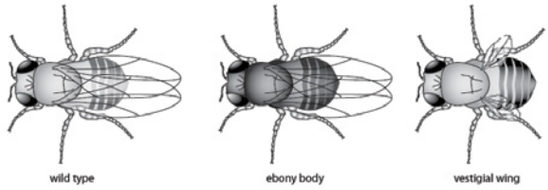
There is a summary of key points at the end of each chapter. You might find this helpful when you are revising.

Summary

- The basic unit of life, the cell, can be seen clearly only with the aid of microscopes. The light microscope uses light as a source of radiation, whereas the electron microscope uses electrons. The electron microscope has greater resolution (allows more detail to be seen) than the light microscope, because electrons have a shorter wavelength than light.
- With a light microscope, cells may be measured using an eyepiece graticule and a stage micrometer. Using the formula $A = \frac{I}{M}$ the actual size of an object (A) or its magnification (M) can be found if its observed (image) size (I) is measured and A or M, as appropriate, is known.

Questions at the end of each chapter begin with a few multiple choice questions, then move on to questions that will help you to organise and practise what you have learnt in that chapter. Finally, there are several more demanding exam-style questions, some of which may require use of knowledge from previous chapters. Answers to these questions can be found on the CD–ROM.

11 a The fruit fly, *Drosophila melanogaster*, feeds on sugars found in damaged fruits. A fly with normal features is called a wild type. It has a grey striped body and its wings are longer than its abdomen. There are mutant variations such as an ebony-coloured body or vestigial wings. These three types of fly are shown in the figure.



Wild-type features are coded for by dominant alleles: A for wild-type body and B for wild-type wings.

Explain what is meant by the terms **allele** and **dominant**. [2]

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Introduction

This fourth edition of *Cambridge International AS and A Level Biology* provides everything that you need to do well in your Cambridge International Examinations AS and A level Biology (9700) courses. It provides full coverage of the syllabus for examinations from 2016 onwards.

The chapters are arranged in the same sequence as the material in your syllabus. Chapters 1 to P1 cover the AS material, and Chapters 12 to P2 cover the extra material you need for the full A level examinations. The various features that you will find in these chapters are explained on the next two pages.

In your examinations, you will be asked many questions that test deep understanding of the facts and concepts that you will learn during your course. It's therefore not enough just to learn words and diagrams that you can repeat in the examination; you need to ensure that you really understand each concept fully. Trying to answer the questions that you will find within each chapter, and at the end, should help you to do this. There are answers to all of these questions on the CD-ROM that comes with this book.

Although you will study your biology as a series of different topics, it's very important to appreciate that all of these topics link up with each other. Some of the questions in your examination will test your ability to make links between different areas of the syllabus. For example, in the AS examination you might be asked a question that involves bringing together knowledge about protein synthesis, infectious disease and transport in mammals. In particular, you will find that certain key concepts come up again and again. These include:

- cells as units of life
- biochemical processes
- DNA, the molecule of heredity
- natural selection
- organisms in their environment
- observation and experiment

As you work through your course, make sure that you keep on thinking about the work that you did earlier, and how it relates to the current topic that you are studying. On the CD-ROM, you will also find some suggestions for other sources of particularly interesting or useful information about the material covered in each chapter. Do try to track down and read some of these.

Practical skills are an important part of your biology course. You will develop these skills as you do experiments and other practical work related to the topic you are studying. Chapters P1 (for AS) and P2 (for A level) explain what these skills are, and what you need to be able to do to succeed in the examination papers that test these skills.