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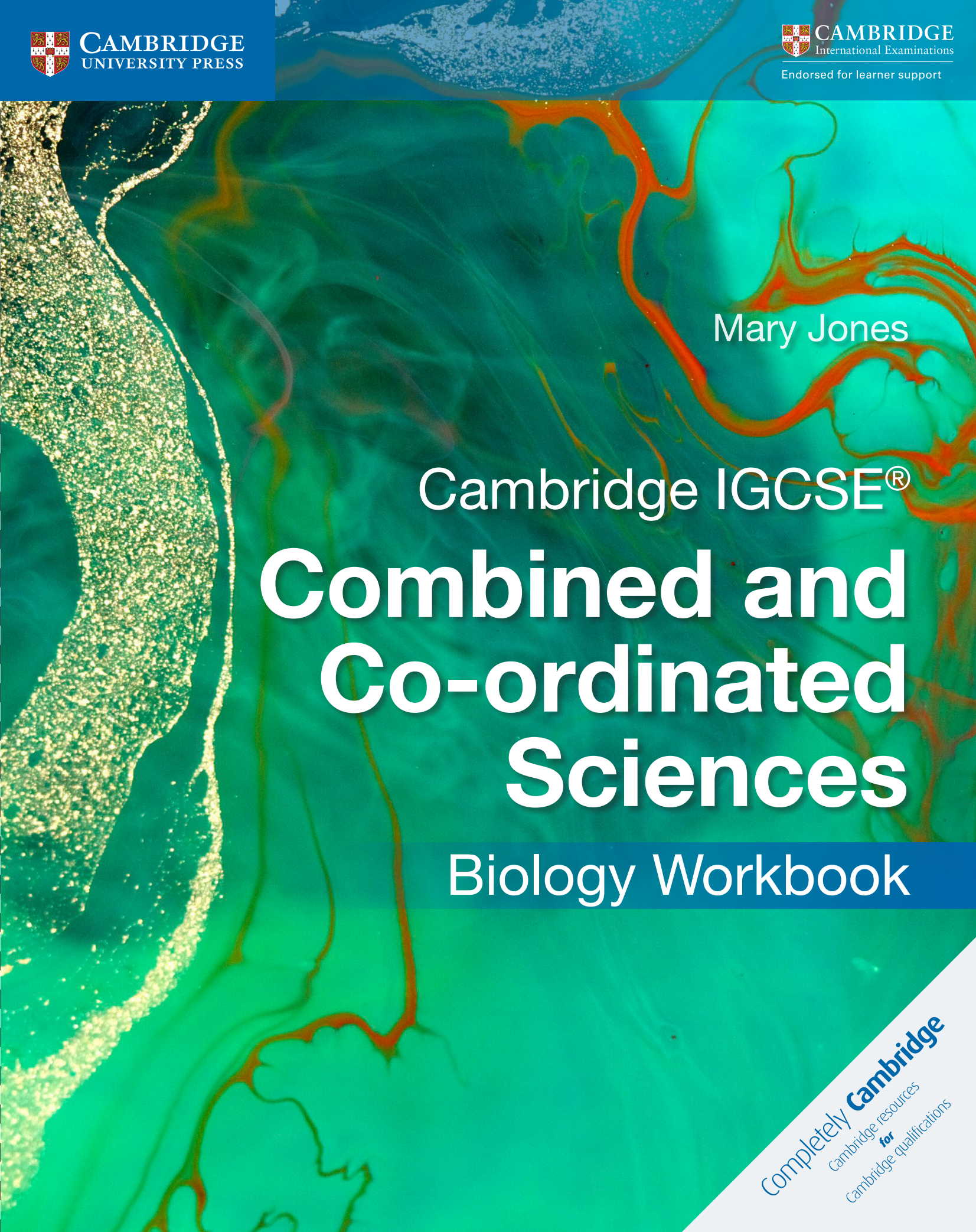

Mary Jones

Cambridge IGCSE®
Combined and Co-ordinated Sciences
Biology Workbook

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Introduction

This workbook covers two syllabuses: Cambridge IGCSE Combined Science (0653) and Cambridge IGCSE Co-ordinated Sciences (0654). Before you start using this workbook, check with your teacher which syllabus you are studying and which papers you will take. You will sit either the Core paper or the Extended paper for your syllabus. If you are sitting the Extended paper, you will study the Core material and the Supplement material for your syllabus.

Once you know which paper you will be sitting, you can use the exercises in this workbook to help develop the skills you need and prepare for your examination.

The examination tests three different Assessment Objectives, or AOs for short. These are:

AO1 Knowledge with understanding

AO2 Handling information and problem solving

AO3 Experimental skills and investigations.

In the examination, about 50% of the marks are for AO1, 30% for AO2 and 20% for AO3. Just learning your work and remembering it is therefore not enough to make sure that you get the best possible grade in the exam. Half of all the marks are for AO2 and AO3. You need to be able to use what you've learned in unfamiliar contexts (AO2) and to demonstrate your experimental skills (AO3).

There are lots of activities in your coursebook which will help you to develop your experimental skills by doing practical work. This workbook contains exercises to help you to develop AO2 and AO3 further. There are some questions that just involve remembering things you have been taught (AO1), but most of the questions require you to use what you've learned to work out, for example, what a set of data means, or to suggest how an experiment might be improved.

These exercises are not intended to be exactly like the questions you will get on your exam papers. This is because they are meant to help you to develop your skills, rather than testing you on them.

There's an introduction at the start of each exercise that tells you the purpose of it – which skills you will be working with as you answer the questions.

For some parts of the exercises, there are self-assessment checklists. You can try using these to mark your own work. This will help you to remember the important points to think about. Your teacher should also mark the work and will discuss with you whether your own assessments are right.

There are sidebars in the margins of the book to show which material relates to each syllabus and paper. If there is no sidebar, it means that everyone will study this material.

Use this table to ensure that you study the right material for your syllabus and paper:

Cambridge IGCSE Combined Science (0653)		Cambridge IGCSE Co-ordinated Sciences (0654)	
Core	**Supplement**	**Core**	**Supplement**
You will study the material: Without a sidebar	*You will study the material:* Without a sidebar With a double grey sidebar With a double black sidebar	*You will study the material:* Without a sidebar With a single grey sidebar With a double grey sidebar	*You will study* ***everything****.* *This includes the material:* Without a sidebar With a single grey sidebar With a double grey sidebar With a single black sidebar With a double black sidebar

We would like to thank Cambridge International Examinations for permission to reproduce exam questions.

Chapter B1
Cells

KEY TERMS

excretion: removal from organisms of the waste products of metabolism (chemical reactions in cells including respiration), toxic materials and substances in excess of requirements

growth: a permanent increase in size and dry mass by an increase in cell number or cell size or both

movement: an action by an organism or part of an organism causing a change of position or place

nutrition: taking in of materials for energy, growth and development; plants require light, carbon dioxide, water and ions; animals need organic compounds and ions and usually need water

reproduction: the processes that make more of the same kind of organism

respiration: the chemical reactions in cells that break down nutrient molecules and release energy for metabolism

sensitivity: the ability to detect or sense stimuli in the internal or external environment and to make appropriate responses

magnification: the size of an object in illustration divided by the real size of the object

Exercise B1.01 Observing and drawing organisms

This exercise will help you to improve your observation and drawing skills (AO3.3). You will also practise calculating magnification.

You need:

- **specimens of two different fish**
- **a sharp HB (medium hard) pencil and a good eraser**
- **a ruler to measure in mm.**

a Observe the fish carefully. Look for similarities and differences between them.

b On the blank page following, make a large drawing of one of the fish. You can turn the page sideways if this works better. Leave space around the drawing for labels.

c Label your drawing to point out any interesting features of the fish.

Use the checklist below to give yourself a mark for your drawing. For each point, award yourself:

- **2 marks if you did it really well**
- **1 mark if you made a good attempt at it and partly succeeded**
- **0 marks if you did not try to do it, or did not succeed.**

Self-assessment checklist for drawing:

Check point	Marks awarded	
	You	Your teacher
You used a sharp pencil and rubbed out mistakes really thoroughly.		
You have drawn single lines, not many tries at the same line.		
You have drawn the specimen the right shape, and with different parts in the correct proportions.		
You have made a really large drawing, using the space provided.		
You have included all the different structures that are visible on the specimen.		
You have drawn label lines with a ruler, touching the structure being labelled.		
You have written the labels horizontally and neatly, well away from the diagram itself.		
Take 1 mark off if you used any shading or colours.		
Total (out of 14)		

12–14 Excellent.

10–11 Good.

7–9 A good start, but you need to improve quite a bit.

5–6 Poor. Try this same drawing again, using a new sheet of paper.

1–4 Very poor. Read through all the criteria again, and then try the same drawing.

d i Measure the actual length of the fish, in mm.

length of real fish = ... mm

ii Measure the same length on your drawing.

length on drawing = ... mm

iii Use your measurements to calculate the magnification of your drawing. Write down the equation you will use, and show your working.

magnification = ...

e Complete Table 1.01 to describe at least three differences between the two fish.

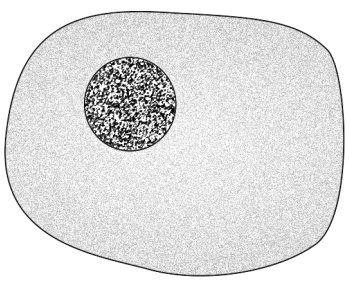
Feature	Fish 1	Fish 2

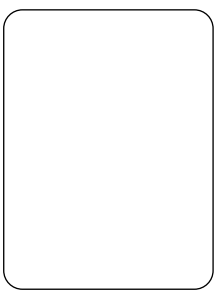
Table 1.01

Exercise B1.02 Animal and plant cells

This exercise will help you to improve your knowledge of the structure of animal and plant cells, and give you more practice in calculating magnification.

The diagram shows an animal cell, and the outline of a plant cell. They are not drawn to the same scale.





a On the animal cell, label the following parts:

cell membrane **cytoplasm** **nucleus**

b Complete the diagram of the plant cell, and then label the following parts:

cell membrane **cytoplasm** **large vacuole containing cell sap** **nucleus**
chloroplast **cell wall** **membrane around vacuole**

c The actual maximum width of the animal cell is 0.1 mm.

i Measure the maximum width of the diagram of the animal cell, in mm ..... .

ii Calculate the magnification of the animal cell diagram. Show your working.

magnification = ...

d The magnification of the plant cell diagram is × 80. Calculate the real height of the plant cell. Show your working.

height = ...

Exercise B1.03 Drawing cells and calculating magnification

This exercise helps you to improve your observation and drawing skills (AO3.3), as well as giving you more practice in calculating magnification.

Look carefully at Image B1.01 in the Cambridge IGCSE Combined and Co-ordinated Sciences Coursebook.

a i In the space below, make a large diagram of the largest cell (the one on the right of the photograph). You cannot see all of the cell, as its ends are out of the picture. Draw only the part that you can see.

ii Label these structures on your diagram. You will have to make a sensible guess as to which structure is the nucleus.

cell wall **position of cell membrane** **chloroplast** **nucleus**

Use the checklist below to give yourself a mark for your drawing. For each point, award yourself:

- **2 marks if you did it really well**
- **1 mark if you made a good attempt at it and partly succeeded**
- **0 marks if you did not try to do it, or did not succeed.**

Self-assessment checklist for drawing:

Check point	Marks awarded	
	You	Your teacher
You used a sharp pencil and rubbed out mistakes really thoroughly.		
You have drawn single lines, not many tries at the same line.		
You have drawn the specimen the right shape, and with different parts in the correct proportions.		
You have made a really large drawing, using the space provided.		
You have included all the different structures that are visible on the specimen.		
You have drawn label lines with a ruler, touching the structure being labelled.		
You have written the labels horizontally and neatly, well away from the diagram itself.		
Take 1 mark off if you used any shading or colours.		
Total (out of 14)		

12–14 Excellent.

10–11 Good.

7–9 A good start, but you need to improve quite a bit.

5–6 Poor. Try this same drawing again, using a new sheet of paper.

1–4 Very poor. Read through all the criteria again, and then try the same drawing.

b The magnification of the photograph in Figure B1.6 is × 2000.

i Calculate the real width of the largest cell in the photograph.
Show your working.

width .....

ii Calculate the magnification of your drawing of the plant cell.

magnification = ...

Exercise B1.04 Organelles

This exercise tests your knowledge of the functions of organelles in animal and plant cells.

This list contains organelles that are found in cells.

cell membrane	**cell wall**	**cytoplasm**	**chloroplast**
mitochondrion	**nucleus**	**ribosome**	**vacuole**

Write the name of the organelle beneath its function.

a Contains chromosomes made of DNA, and controls the activity of the cell.

.....

b An extra, strong layer surrounding a plant cell, made of cellulose.

.....

c A jelly-like substance where many metabolic reactions happen.

.....

d Every cell is surrounded by one of these. It controls what enters and leaves the cell.

.....

e Some plant cells have these, but animal cells never do. This is where photosynthesis takes place.

.....

f This is a space inside a cell that contains a liquid, for example cell sap.

.....

Chapter B2
Movement in and out of cells

KEY TERMS

diffusion: the net movement of molecules and ions from a region of their higher concentration to a region of their lower concentration down a concentration gradient, as a result of their random movement

osmosis: the diffusion of water molecules from a region of higher water potential (dilute solution) to a region of lower water potential (concentrated solution), through a partially permeable membrane

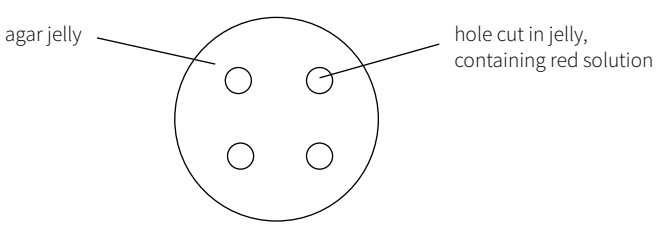
Exercise B2.01 Diffusion experiment

This exercise asks you to handle and interpret data collected during an experiment, and also to think about how the experiment was planned (AO3.4 and AO3.2).

A student did an experiment to test this hypothesis:

The higher the temperature, the faster diffusion takes place.

She took four Petri dishes containing agar jelly. She cut four holes in the jelly in each dish. She placed 0.5 cm^3 of a solution containing a red pigment (coloured substance) into each hole. The following diagram shows the experimental set-up.



The student then covered the dishes and very carefully placed them in different temperatures. She left them for two hours. Then she measured how far the red colour had diffused into the agar around each hole. Table 2.01 shows the student's results.

Dish	Temperature / °C	Distance red colour had diffused into the jelly / mm				
		Hole 1	Hole 2	Hole 3	Hole 4	Mean (average)
A	10	2	3	2	3	
B	20	5	5	6	4	
C	40	9	11	8	10	
D	80	19	21	18	123	

Table 2.01

a Complete Table 2.01 by calculating the mean distances diffused by the red colour in each dish. (Give each distance to the nearest whole number, because this is how the student's measurements were taken.) Write your answers in the table.

b Do the results support the student's hypothesis? Explain your answer.

.....

.....

.....

.....

c State **four** variables that the student kept constant in her experiment, or that she should have kept constant.

1 .....

2 .....

3 .....

4 .....

d Explain why it was a good idea to have four holes in each dish, rather than just one.

.....

.....

e Suggest **two** significant sources of experimental error in this investigation.

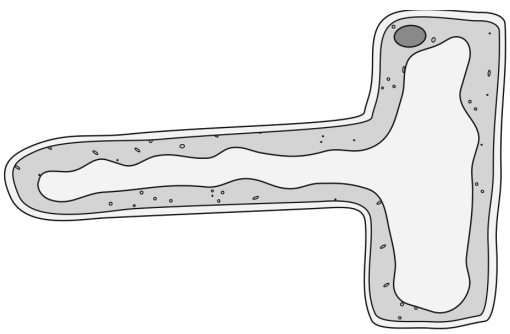
1 .....

2 .....

Exercise B2.02 How plants take up water

This exercise checks that you haven't forgotten about cell structure. It also develops your ability to use your knowledge in a new situation (AO2).

Plants take up water into their roots, from the soil. They have tiny hairs on their roots which help with this. The hairs are called root hairs, and each one is part of a single cell. The diagram shows a root hair cell.



a State **two** structural features of this cell that are typical of plant cells but not animal cells.

1 .....

2 .....

b On the diagram of the cell, label a partially permeable membrane. Use a ruler to draw the labelling line.

c The concentration of the cytoplasm and the cell sap inside the root hair cell is greater than the concentration of the water in the soil around the root hair cell. Use your knowledge of osmosis to explain how water is absorbed into the root hair cell.

.....

.....

.....

.....

.....

d Root hair cells are tiny, and there are hundreds of them on each plant root. Suggest how this helps to increase the rate at which the plant can take up water.

.....

.....

Exercise B2.03 Osmosis and potatoes

In this exercise, you will practise drawing a results chart and recording numerical results in it (AO3.3). You will also construct a graph and evaluate the results (AO3.4). Question d is a good test of your understanding of osmosis, and your ability to use your knowledge in a new situation (AO2).

A student investigated the effect of different concentrations of sugar solutions on some potato cylinders. He took a large potato and used a cork borer to cut out several cylinders, each exactly the same diameter. He trimmed the peel off the ends of the cylinders, and then cut them into exactly 1 cm lengths. He then measured the mass of each piece.

He placed one piece of potato in each of six beakers. He then covered each piece with either water, or one of five different concentrations of sugar solution. He used the same volume of solution in each beaker. The student left the potato pieces in the beakers for 30 minutes. Then he removed them from the beakers, blotted them dry with filter paper and measured their mass again. His results are shown in Table 2.02.

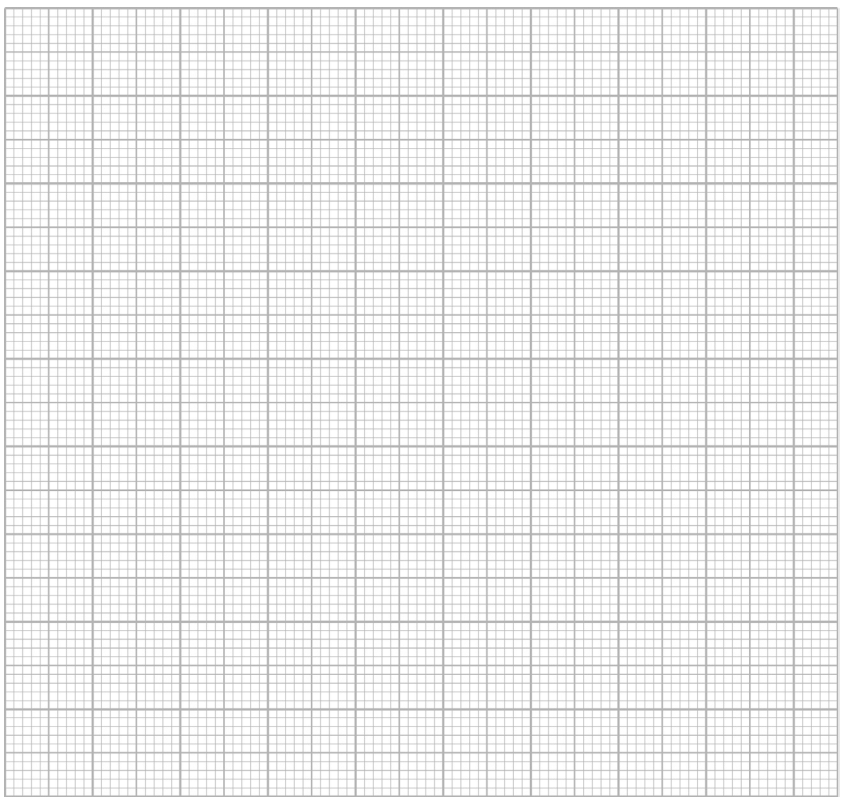
Before	piece A = 5.2 g	piece B = 5.1 g	piece C = 4.9 g
	piece D = 5.0 g	piece E = 5.1 g	piece F = 5.2 g
Solutions	A, distilled water	B, 0.1% sugar solution	C, 0.2% solution
	D, 0.5% solution	E, 0.8% solution	F, 1.0% solution
After	A = 5.5 g	B = 5.2 g	C = 4.9 g
	D = 5.3 g	E = 5.0 g	F = 5.0 g

Table 2.02

a In the space below, draw your own results table and fill in the student's results. Include a row or column showing the change in mass. Take care to head each column and row fully, with units.

b Decide if there are any anomalous results. If you think there are, draw a ring around them.

c Display the results as a line graph on the grid below. Put concentration of solution on the *x*-axis and change in mass on the *y*-axis. Remember to include units in your axis labels.



d Use your knowledge of osmosis to explain the results.

.....

.....

.....

.....

.....

.....

.....

.....

e Suggest how the student could have changed his method to make his results more reliable.

.....

.....

.....

f The student's teacher suggested that it would have been better if he had calculated the percentage change in mass of each piece of potato, rather than just the change in mass. Do you agree? Explain your answer.

.....

.....

.....

.....

Use the checklist below to give yourself a mark for your results chart. For each point, award yourself:

- **2 marks if you did it really well**
- **1 mark if you made a good attempt at it and partly succeeded**
- **0 marks if you did not try to do it, or did not succeed.**

Self-assessment checklist for results charts:

Check point	Marks awarded	
	You	Your teacher
You have drawn the chart with a ruler.		
Headings have correct units in each column and row (there are no units inside the cells of the table).		
Your chart is easy for someone else to read and understand.		
If your chart contains readings, all are to the same number of decimal places (for example, 15.5, 9.0).		
Total (out of 8)		

8 Excellent.

7 Good.

5–6 A good start, but you need to improve quite a bit.

3–4 Poor. Try this same results chart again, using a new sheet of paper.

1–2 Very poor. Read through all the criteria again, and then try the same results chart again.

Use the checklist below to give yourself a mark for your graph. For each point, award yourself:

- **2 marks if you did it really well**
- **1 mark if you made a good attempt at it and partly succeeded**
- **0 marks if you did not try to do it, or did not succeed.**

Self-assessment checklist for graphs:

Check point	Marks awarded	
	You	Your teacher
You have drawn the axes with a ruler, and used most of the width and height of the graph paper for the axis labels.		
You have used a good scale for the *x*-axis and the *y*-axis, going up in 1s, 2s, 5s or 10s.		
You have included the correct units with the scales on both axes.		
You have plotted each point precisely and correctly.		
You have used a small, neat cross for each point.		
You have drawn a single, clear line – either by ruling a line between each pair of points or by drawing a well-positioned best-fit line.		
You have ignored any anomalous results when drawing the line.		
Total (out of 14)		

12–14 Excellent.

10–11 Good.

7–9 A good start, but you need to improve quite a bit.

5–6 Poor. Try this same graph again, using a new sheet of paper.

1–4 Very poor. Read through all the criteria again, and then try the same graph again.

Answers

Exercises include questions from past Cambridge exam papers and other questions written by the authors.
Answers to all questions, including past paper questions, have been written by the authors.

Chapter B1 Cells

Exercise B1.01 Observing and drawing organisms

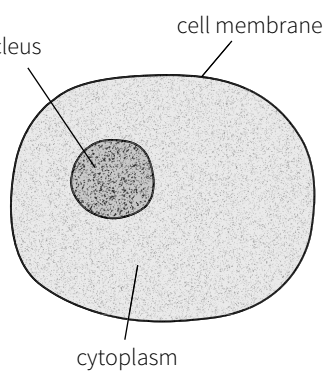
a, b, c Use the self-assessment checklist to assess the drawing and labelling.

d Check the measurements and calculation against the student's drawing.

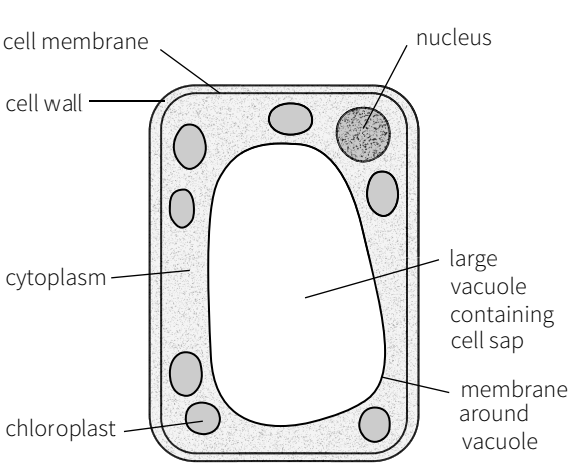
e Look for clear, comparable points opposite each other.

Exercise B1.02 Animal and plant cells

a



b

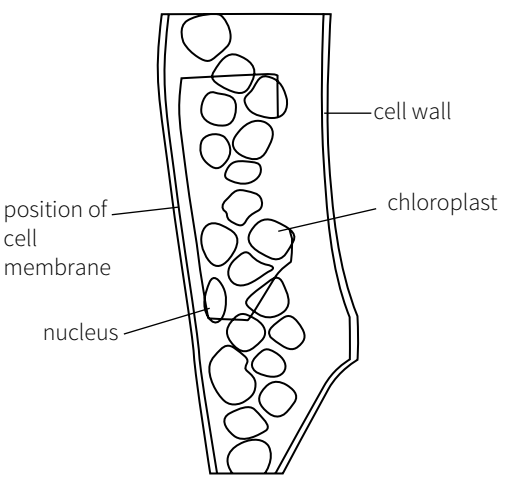


c Answer provided when we know the final size of the image

d Answer provided when we know the final size of the image

Exercise B1.03 Drawing cells and calculating magnification

a



Use the self-assessment checklist to assess the drawing and labelling.

b i Answer provided when we know the final size of the image

ii Answer provided when we know the final size of the image

Exercise B1.04 Organelles

a nucleus

b cell wall

c cytoplasm

d cell membrane

e chloroplasts

f vacuole

Chapter B2 Movement in and out of cells

Exercise B2.01 Diffusion experiment

a See Table A2.01

Dish	Temperature / °C	Distance red colour diffused into jelly / mm				
		Hole 1	Hole 2	Hole 3	Hole 4	Mean (average)
A	10	2	3	2	3	**3**
B	20	5	5	6	4	**5**
C	40	9	11	8	10	**10**
D	80	19	21	18	23	**20**

Table A2.01

b Yes. As temperature increased, the distance the red colour diffused through the jelly increased. As the dishes were all left for the same period of time, this must mean the colour was moving faster in the warmer dishes. A doubling of the temperature caused the distance diffused by the colour to roughly double.

c The four most important variables to be controlled are: concentration of the solution of red pigment; size of hole in the jelly; depth of jelly in the dish; volume of solution placed in the hole.

d This allowed for a mean to be calculated. It improves the reliability of the results.

e Measurement of the distance diffused, because the 'edge' between the colour and the uncoloured jelly will not be very distinct. Some dye may have got into the jelly before the dishes are transferred to their final temperatures (especially as they were carried). Time taken for the dye and jelly in each dish to reach their final temperature – the dye won't have been at the correct temperature for the entire duration of the experiment.

Exercise B2.02 How plants take up water

a cell wall, large vacuole

b Label line to the cell surface membrane, or to the membrane around the vacuole.

c Water molecules move randomly. There is a greater concentration of them outside the cell than inside, so more will (by chance) move into the cell than out of it, through the partially permeable cell surface membrane. The solutes in the cell cannot get out through the partially permeable membrane. (Some students may answer in terms of water potential. The water potential of the solution outside the cell is higher than that inside, so water moves down its water potential gradient.)

d This provides a large surface area, so more water can pass across the surface at any one time.

Exercise B2.03 Osmosis and potatoes

a The table should have rows or columns for the percentage concentration of the solution, and rows or columns for the mass of potato pieces, with the unit g in the heading. Students should also calculate the change in mass. The following is an example of a suitable results table (see Table A2.02).

Percentage concentration of solution	Mass / g		
	Before soaking	After soaking	Change
0.0	5.2	5.5	+0.3
0.1	5.1	5.2	+0.1
0.2	4.9	4.9	0
0.5	5.0	5.3	+0.3
0.8	5.1	5.0	−0.1
1.0	5.2	5.0	−0.2

Table A2.02

b The mass of the potato piece soaking in 0.5% solution has increased, but it would be expected to decrease. This does not follow the pattern of the other results and so is anomalous.

c Look for the following features on the graph:

- Percentage concentration of solution' on the *x*-axis, and 'Change in mass / g' on the *y*-axis
- suitable scales
- all points plotted correctly (allow 0.5 mm tolerance) as crosses or as encircled dots
- either a best-fit line, drawn as a smooth curve with equal numbers of points above and below the line, or points joined with straight lines drawn with a ruler; the anomalous result should be ignored.

d The 0 and 0.1% solutions had a higher water potential than inside the potato cells, so water moved in by osmosis and made the cells increase in mass. The 0.2% solution had a water potential equal to that of the potato cells, so there was no net movement of water into or out of the cells (the same amount went in as came out) so there was no change in mass. The solutions with higher concentrations than this had water potentials lower than that of the potato cells, so water moved out of the cells by osmosis and their mass therefore decreased.

e Have several pieces of potato in each solution, and calculate a mean change in mass for each.

f Yes, this would have been better because the original masses of the potato pieces were not identical. Calculating percentage change would give a fairer comparison between the pieces – it would avoid discrepancies caused by this uncontrolled variable.

Chapter B3 Biological molecules

Exercise B3.01 Carbohydrates

a Look for a single ruled table (see Table A3.01) with fully headed rows and columns.

Food	Result of test with iodine	Result of test with Benedict's	Conclusion
A	brown	orange-red	contains reducing sugar but not starch
B	black	blue	contains starch but not reducing sugar

Table A3.01

Students might decide to have two separate columns for the conclusions, one for starch and one for reducing sugar, which would be fine.

b See Table A3.02

Type of carbohydrate	Example	Role in living organisms
sugar	glucose	provides energy; released by respiration; also the form in which carbohydrates are transported in mammalian blood
	sucrose	the form in which carbohydrates are transported in plants
polysaccharide	starch	the form in which plants store energy
	glycogen	the form in which animals store energy

Table A3.02

Exercise B3.02 Testing a hypothesis

a Add dilute sodium hydroxide (or potassium hydroxide) and very dilute copper sulfate solution to the milk. A purple colour indicates the presence of protein. (Alternatively, biuret reagent could be added.)

b **i** The variable to be changed is the type of milk – cow's milk and goat's milk.

ii The most important variables to be controlled are: the volume of milk, the age of the milk, the temperature of the milk, the volume and concentration of reagents added to it, the time left before the intensity of the colour is assessed.

iii The quantity to be measured is the intensity of the colour produced after the biuret test has been carried out on the milk.

iv This could be measured by comparing the colours visually.

v If the hypothesis is correct, the purple colour formed in the cow's milk will be more intense than the colour in the goat's milk.