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Mary Jones and Geoff Jones

Cambridge IGCSE®

Biology

Workbook

Third edition

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Introduction

This workbook contains exercises to help you to develop the skills you need to do well in your IGCSE Biology examination.

The IGCSE 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 AO3 further and also to develop AO2. 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. The exercises are arranged in the same order as the chapters in your Coursebook. Towards the end of the book, there are some exercises that contain questions covering more than one chapter.

For some parts of the exercises, there are self-assessment checklists. You can try marking your own work using these. 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.

In some exercises, you will see this symbol in the margin:

This indicates that the exercise is intended for students who are studying the Supplement content of the syllabus as well as the Core.

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

1 Classification

Definitions to learn

- **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
- **binomial system** an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species
- **species** a group of organisms that can reproduce and produce fertile offspring

Exercise 1.1 Observing and drawing organisms

This exercise will help you to improve your observation and drawing skills (AO3.3), and also your knowledge of the classification of organisms. 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 check list 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 check list 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.
10–12 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 this table to describe at least **three** differences between the two fish.

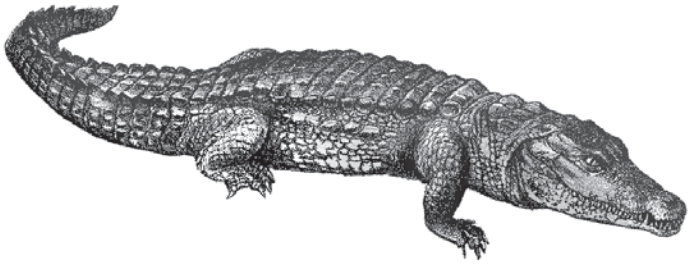
Feature	Fish 1	Fish 2

Exercise 1.2 Using keys

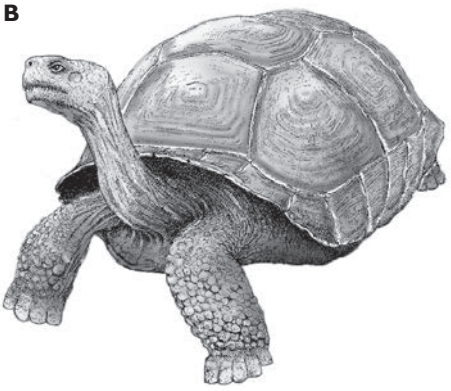
This exercise will help you to improve your observation and drawing skills (AO3.3), and also your knowledge of the classification of organisms. You will also practise calculating magnification.

The drawings show four vertebrates.

A

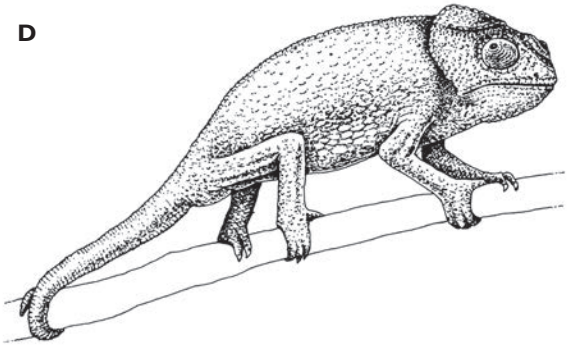


B



C

D



a Use the dichotomous key below to identify each of these four animals.
List the sequence of statements that you worked through to find the name.
Animal **A** has been done for you.

1	**a**	Shell present	*Geochelone elephantopus*
	b	Shell absent	go to **2**
2	**a**	Four legs	go to **3**
	b	No legs	*Ophiophagus hannah*
3	**a**	Scales on back form large plates	*Crocodylus niloticus*
	b	Scales on back do not form large plates	*Chamaeleo gracilis*

A **1b, 2a, 3a** **Crocodylus niloticus**

B .....

C .....

D .....

b **i** What is the correct term for the two-word Latin name of an organism?

.....

ii Explain what the two parts of the name tell you.

.....

c State **one** feature, visible on all of the animals in the drawings, which indicates that they are all reptiles.

.....

2 Cells

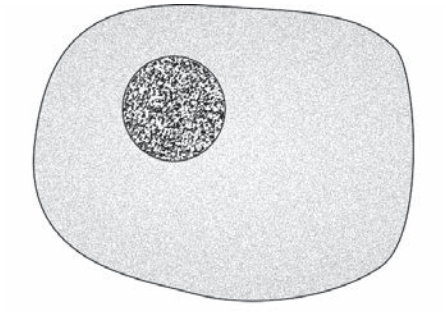
Definitions to learn

- **tissue** a group of cells with similar structures, working together to perform a shared function
- **organ** a structure made up of a group of tissues, working together to perform specific functions
- **organ system** a group of organs with related functions, working together to perform body functions
- **magnification** = $\frac{\text{size of object in illustration}}{\text{real size of object}}$

Exercise 2.1 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 2.2 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 Figure 2.5 on page 20 in your Coursebook.

a **i** In the space below, make a large diagram of the largest cell (the one near the top 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 check list 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 check list 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.
10–12 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 **2.5** 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 2.3 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.

.....

S **g** An organelle in which energy is released from glucose, by aerobic respiration.

.....

h Where proteins are made, by linking amino acids together.

.....

3 Movement in and out of cells

Definitions to learn

- **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
- (S) **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
- **active transport** the movement of molecules and ions in or out of a cell through the cell membrane, against a concentration gradient, using energy from respiration

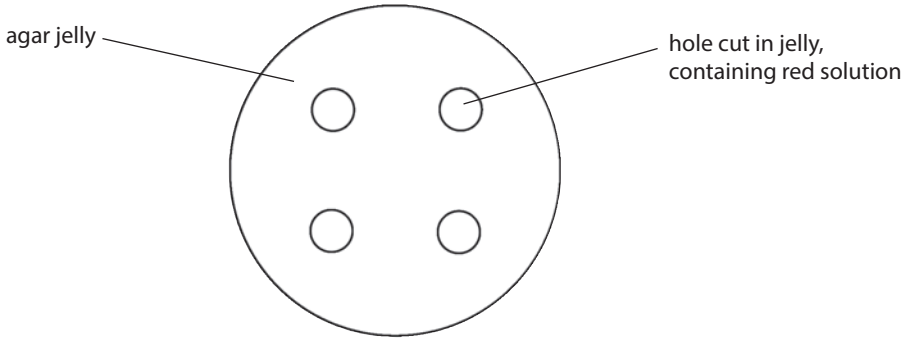
Exercise 3.1 Diffusion experiment

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 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.
The table 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	23	

a Complete the table 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.

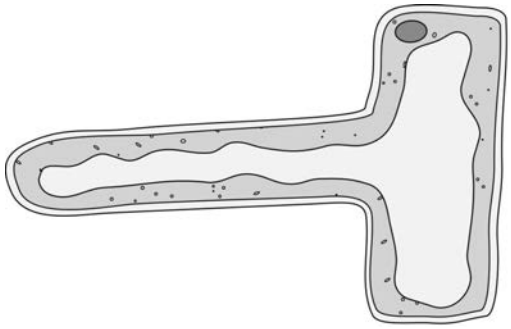
1 .....

2 .....

Exercise 3.2 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.

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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.

.....

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Exercise 3.3 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).

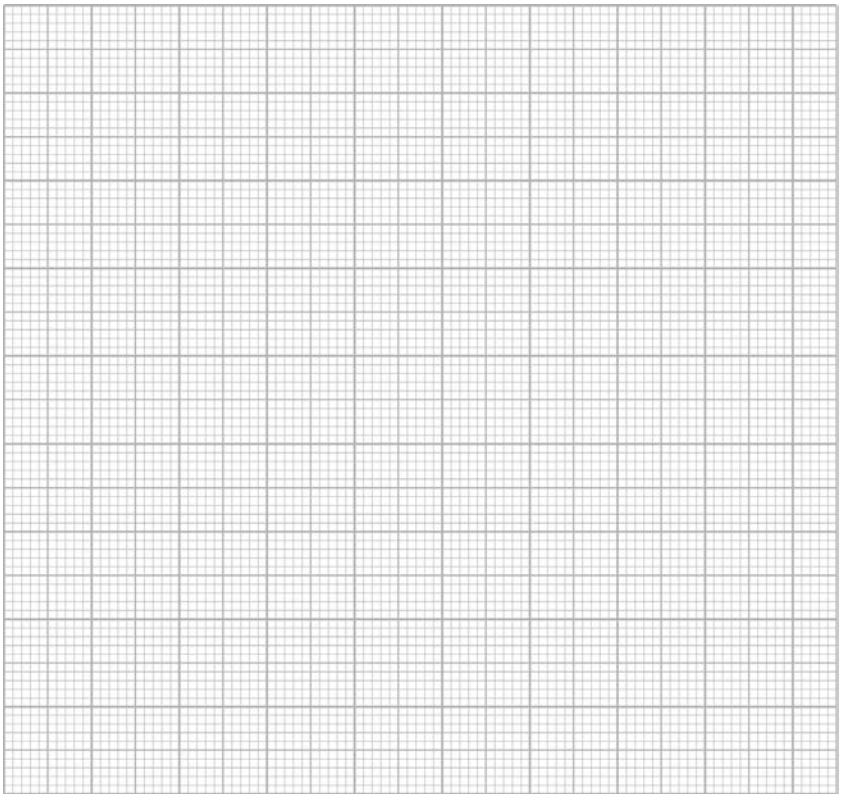
A student investigated the effect of different concentrations of sugar solutions on some potato cylinders.
He took a large potato and used a cork borer to cut out several cylinders, each exactly the same diameter. He trimmed the peel off the ends of the cylinders, and then cut them into exactly 1 cm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

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**

a In the space below, draw a 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.

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

.....

.....

.....

S **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 check list 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 check list 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 check list 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 check list 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 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.

S

Exercise 3.4 Diffusion and active transport

This is quite a tough exercise, but if you are hoping for a Grade A or B you should be able to cope with it. It tests your ability to analyse data and then use your knowledge to draw conclusions, and also to make predictions (AO2).

The table shows the concentrations of three different ions inside the cells in a plant root and in the water in the soil.

Ion	Concentration in plant root cells /mol per dm^3	Concentration in soil water /mol per dm^3
A	0.5	0.5
B	1.0	0.4
C	0.6	0.8

a Which ion has moved into the root hair by diffusion? Explain your answer.

.....

.....

.....

b Which ion has been moved into the root hair by active transport? Explain your answer.

.....

.....

.....

c Which ion has been moved out of the root hair by active transport? Explain your answer.

.....

.....

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d If the soil in which the plant is growing becomes waterlogged, the roots can no longer get sufficient oxygen. Suggest how this would affect the concentrations of ions **A**, **B** and **C** in the root cells. Explain each of your suggestions.

.....

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.....

4 The chemicals of life

Definitions to learn

There are no specific definitions to learn in this chapter.

Exercise 4.1 Carbohydrates

This exercise will give you practice in constructing results charts (AO3.3) and drawing conclusions (AO3.4), as well as helping you to remember important facts about carbohydrates.

A student carried out tests on two foods. This is what she wrote in her notebook.

Starch test – food A went brown, food B went black

Benedict's reagent – food A went orange-red, food B went blue

a Construct a results table and complete it to show the student's results. Think carefully about the best way of showing what she did, what she was testing for, what results she obtained and what these results mean.

b Complete this table about carbohydrates.

Type of carbohydrate	Example	Role in living organisms
sugar	glucose	
		the form in which carbohydrates are transported in plants
polysaccharide		the form in which plants store energy
	cellulose	
	glycogen	

Exercise 4.2 Proteins

This exercise will help you to learn about the importance of proteins in the body. It is also very good practice in finding and sorting information (AO2) and cutting a large amount of information down to just a very short summary of the most important points. Not easy!

There are hundreds of different proteins in the human body, each with its own particular role to play.
Use the internet or other resources to find out about each of the proteins listed below. Make notes, and then shorten them so that you eventually write down just two or three sentences about each protein, each sentence packed with information about it.

a haemoglobin

.....

.....

.....

.....

b keratin

.....

.....

.....

.....

c collagen

.....

.....

.....

.....

d antibodies

.....

.....

.....

.....