

Collins

BIOLOGY

AQA Biology for A-level Year 1 and AS

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Your A-level students will need increased maths skills and stronger practical skills to successfully tackle the demands of AS and A-level Biology.

Our resources will help you deliver comprehensive support as students build the skills they need. Regular opportunities to consolidate and track progress will build towards confidence in the final examination.

- **Supporting you through the changes** – the change in assessment structure will bring challenges – our coherent structure of Student Books, Teacher Guides and Skills and Practice resources will help you to understand, plan for and master these challenges
- **Assess and progress** – from GCSE and across the linear course with varied skills practice integrated throughout the Student Books, Teacher Guides and Skills and Practice resources on Collins Connect
- **Prepare for practicals** – develop your students' theoretical understanding with advice and explanations of best practice, plus carry out Required Practical effectively with full teacher support
- **Help prepare students for further study and scientific careers** with plenty of stretch and challenge questions that develop higher-order thinking skills

The Student Books
have entered the
AQA approval process

BIOLOGY

Teaching A level Biology, how the resources support you:

Linear assessment

Terminal assessment in the form of three 2 hour papers at A-level and two 1.5 hour papers on the first four topics at AS Level



- Extensive practice questions embedded throughout help build synoptic understanding
- Online resources including video worked examples and downloadable practice papers develop the skills and written techniques that students need for their final assessment

Practicals

Assessment of practical skills will be by written exam only. Practical-based questions will form 15% of the total assessment



- Comprehensive Required Practical sections advise students on apparatus, techniques and how best to avoid common errors
- Detailed support for teachers and technicians in the Teacher Guides
- Practical based assignments and questions integrated throughout the Student Book and Teacher Guides

Maths

10% of assessment marks require the use of Level 2 mathematical skills



- Test and build mathematical skills with signposted Assignments throughout and a dedicated Maths chapter in the Student Book
- Video worked examples in the Skills and Practice resources model mathematical skills

Standalone AS qualification

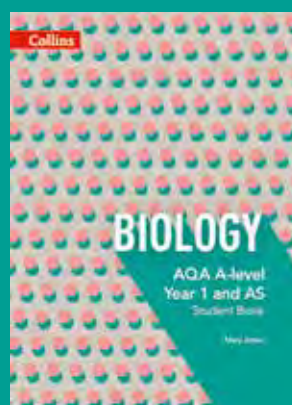
The AS becomes a stand-alone qualification, which doesn't contribute to the A-level grade



- Planning tools in the Teacher Guide and Student Book content matched to the 2015 specification enable you to easily co-teach AS and year one of A-level

Comprehensive Student Support

The complete content coverage that your students will need. Help them build knowledge, application and evaluation skills through clear explanations set in real-life contexts, supported by maths and practical skills-focused assignments. Questions are integrated into every chapter to check knowledge, test skills and consolidate learning. Stretch and challenge questions extend students' understanding, and extensive practice questions help prepare for the final assessment.



Prior knowledge section at the start of each chapter consolidates knowledge from GCSE and gives students a route into the topic

Stretch and challenge questions and activities encourage stronger students to move beyond the specification

2 LIPIDS AND PROTEINS

PRIOR KNOWLEDGE

You have probably learned about the importance of fats (lipids) and proteins in the diet. You might want to remind yourself about hydrogen bonds, and also about monomers and polymers, condensation reactions and hydrolysis reactions.

LEARNING OBJECTIVES

In this chapter, you will build on these ideas to understand how the structures and functions of lipids and protein molecules are related to their roles in the bodies of living organisms.

(3.1.3, 3.1.4)

Everyone knows that they should eat protein as part of their diet. Protein is needed to help us to produce new cells, and to repair damaged tissues. But not everyone is aware of the huge number of different kinds of proteins that exist, and the wide range of different functions they have.

Take spider silk, for example. Spider silk is a fibrous protein – one that is made up of long chains of

amino acids that lie side by side, forming long, strong fibres. Like many fibrous proteins, spider silk contains repetitive sequences of amino acids. In this case mostly glycine and alanine. It has tremendous strength – and a thread of spider silk is about five times stronger than steel of the same diameter.

Spiders use silk for many different purposes, including catching prey in webs, wrapping prey to immobilise and store, making shelters and ballooning. For ballooning, a spider produces long strands of fine silk threads which blow in the wind and lift the spider attached high into the air. Ballooning spiders have been found at heights of five kilometres above sea level. This is how they are able to disperse to new areas.

Materials scientists are very interested in spider silk, seeing it as a promising starting point for developing technical materials with a very high strength-to-weight ratio. While people have long kept silkworms (moth caterpillars) to make large quantities of silk, it is not easy to produce spider silk in large amounts. If you try to keep lots of spiders together, they eat each other. Now, DNA sequences that code for making silk have been isolated from spiders and inserted into silkworms. Spider silk synthesised by these genetically engineered silkworms may form the basis of large-scale production of new fibres and materials.

17

Substrate concentration and enzyme activity
Concentration is a measure of the relative proportions of solute and solvent molecules in a solution. A concentrated solution has a large number of solute molecules in a given volume.

Imagine a solution containing enzyme and substrate molecules. All of the molecules are in constant motion. If there are only very few substrate molecules in the solution, then the chance of them hitting an active site is low. If there are a lot of substrate molecules, the chance is much higher. So the rate of reaction is much greater in a concentrated solution containing a high number of substrate molecules than in a dilute solution with a low concentration of substrate molecules (Figure 8).

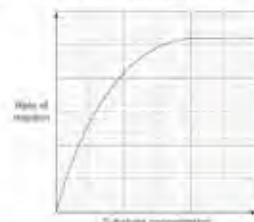


Figure 8 The effect of substrate concentration on enzyme-catalysed reactions

Now imagine that we keep on increasing the substrate concentration, while making no change to the concentration of the enzyme. Eventually, we will reach a point where all the active sites are fully occupied. The enzyme molecules are all working as fast as they can, converting substrates, turning them into products and releasing them. No matter how much more substrate is available the enzyme cannot work any faster. This explains why the curve in Figure 8 levels off at high substrate concentrations.

Enzyme concentration and enzyme activity

If we keep the substrate concentration constant and increase the enzyme concentration, what effect does this have on the rate of the reaction? This is shown in Figure 9. You can see that the shape of the curve is very similar to that in Figure 8. As we increase the enzyme concentration, the chance of an enzyme molecule colliding with a substrate molecule increases, so the rate of reaction increases. However, at high

Factors affecting enzyme activity

3.4

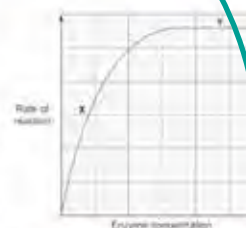


Figure 9 The effect of enzyme concentration on enzyme activity

enzyme concentrations, there may not be enough substrate molecules to keep them all busy all the time, so the rate levels off.

QUESTIONS

10 Explain in terms of active sites why the curve in Figure 9 flattens out.

STRETCH AND CHALLENGE

11 The graph in Figure 9 is labelled with the letters X and Y. Do the following, describing, at each point, what is happening.

- At this point, there is an excess of substrate in the mixture.
- At this point, the enzyme's active sites are saturated with substrate.
- At this point, adding more enzyme could increase the rate of reaction.
- At this point, adding more substrate could increase the rate of reaction.
- At this point, increasing the temperature could increase the rate of reaction.

Worked maths example: Rate of reaction
(MS 1.5, MS 5.2, MS 5.5, MS 5.6, PS 3.1, PS 3.2)

Your friend carried out an experiment to investigate the rate of a reaction with and without an enzyme. Here are his notes.

Exp 1 – enzyme

Time 0.30 40 80 120 160 180 200 240 280 320

Volume of gas 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

41

ENZYMES

Exp 1 – no enzyme

Time 0 30 60 90 120 150 180 210 240 270 300 330 360 390 420

Volume of gas 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

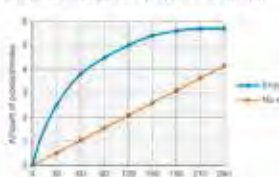
He needs to display his results and calculate the rate of reaction, in mol mol⁻¹ s⁻¹, for both experiments at 60 seconds, and has asked for your help.

First, use his notes to create a table, making sure all the data points are recorded to one decimal place, and each column has a clear heading with the units specified.

Time/seconds	Experiment 1 (no enzyme)	Experiment 2 (with enzyme)
0	0.0	0.0
30	0.0	0.0
60	0.0	0.0
90	0.0	0.0
120	0.0	0.0
150	0.0	0.0
180	0.0	0.0
210	0.0	0.0
240	0.0	0.0

Next, create a graph. Label the y-axis 'Amount of product formed/mole' and the x-axis 'Time/seconds', and choose suitable scales. Give the graph a title (for example, 'Effect of enzyme on rate of reaction').

Then plot the results, and add lines of best fit to both sets of data. Use different coloured lines and label



then 'enzyme' and 'no enzyme' for each experiment.

Experiment 2 (with enzyme)

The orange line is linear, so the rate of reaction is the same at all points in time – it is constant.

rate of reaction = $\frac{\text{change in y}}{\text{change in x}}$

In your friend's experiment, after 120 seconds the amount of product had changed from 0 to 2.0 moles.

rate of reaction = $\frac{2.0}{120} = 0.016 \text{ mol s}^{-1}$

The question asks for the rate in mol mol⁻¹ s⁻¹, so you need to multiply your answer by 50.

rate of reaction = $0.016 \times 50 = 0.8 \text{ mol mol}^{-1} \text{ s}^{-1}$

We can know that this is the same at other points in a linear graph by choosing another time period. For example, between 150 seconds and 210 seconds (a period of 60 seconds) the change in y is: $5.0 - 2.5 = 2.5$ moles.

rate of reaction = $\frac{2.5}{60} = 0.042 \text{ mol s}^{-1} = 2.1 \text{ mol mol}^{-1} \text{ s}^{-1}$

Experiment 1 (no enzyme)

The blue line does not show a straight line, the rate of reaction does over time.

You can calculate the rate of reaction at any point in time by drawing a tangent – a straight line which touches the curve at one point only – and then calculating the gradient of the tangent.

So, since your friend wants to know the rate of reaction at 60 seconds, draw a tangent at 60 seconds.

rate of reaction = $\frac{\text{change in y}}{\text{change in x}} = \frac{(4.4 - 3.2)}{(80 - 40)}$

= $\frac{1.2}{40} = 0.03 \text{ mol s}^{-1} = 1.5 \text{ mol mol}^{-1} \text{ s}^{-1}$



42

In text questions provide opportunities to check understanding and progress, whether learning a topic for the first time or revisiting it as part of revision

Blood vessels

9.4

MATHS ASSIGNMENT 2: ANALYSING THE EFFECTS OF EXERCISE ON BLOOD FLOW

(MS 1.5, MS 3.2, PS 1.2, PS 3.1, PS 3.2)



Figure A2 A runner during exercise

Exercise has been shown to have many effects on the mind, including relief from stress, depression and anxiety, and improved self-esteem. The effects of regular exercise on the body are well documented and include improved cardiovascular performance and increased muscle mass and bone density.

In the short term, exercise has the greatest effect on blood flow. The table shows the volume of blood flowing through different parts of the body when resting and during exercise.

Part of body	Resting blood flow (L min ⁻¹)	During exercise	At rest blood flow (L min ⁻¹)	During exercise
Brain	750	750	750	750
Digestive system	1400	3100	700	300
Heart muscle	250	350	600	1000
Kidneys	1100	300	600	250
Skeletal muscles	1200	4500	1500	22 000
Skin	500	1500	1150	600
Rest of the body	600	400	400	600
TOTAL	5800	9500	1550	1200

Figure 15 summarises the differences in structure between the different types of blood vessel.

Tissue fluid and capillary beds

We have seen that capillaries are tiny vessels that carry blood deep into the tissues of the body. Figure 16 shows the composition of this blood. As the capillaries branch out among the cells in the tissues,

they form a network called a **capillary bed**. The capillaries in the bed then gradually rejoin with each other, eventually forming a **venule**.

Capillary beds are exchange surfaces. Capillaries are leaky, allowing water and other substances with small molecules to seep out of them, into the spaces between the body cells. The fluid that collects between the cells is called **tissue fluid** (Figure 17).

171

Required practicals pages provide comprehensive guidance on apparatus, experimental techniques and how best to avoid common errors

REQUIRED PRACTICAL ACTIVITY 5: APPARATUS AND TECHNIQUES

Dissection of animal or plant gas exchange system or mass transport system or of an organ within such a system

This practical activity gives you the opportunity to show that you can:

- Safely use instruments for dissection of an animal or plant organ (PS 4.1, AT 1)

Apparatus

Dissection is a key skill in biology. It requires you to be observant, patient and to have a steady hand. Safety and the ability to follow instructions are most important.



Figure P1 The girl is dissecting a frog's heart with this scalpel. Working practices given in 4.1.1 apply to this activity.

Apparatus	Use
Scalpel and mounted needle	To probe tissues gently, lift flaps of tissue without tearing, or hold tissues out of the way.
Scissors	For cutting tissues; often more useful than a scalpel on tough tissue.
Forceps	To hold or tease tissues, they may be blunt ended or sharp ended.
Scalpel	To cut tissue - most useful for fine dissection. Note: great care must be taken as many scalpels are surgically sharp (but not surgically clean).
Hand lens	To magnify, and enable you to see more clearly, what you are cutting.
Protective gloves	To keep your hands clean, most commonly used if you are dissecting animal tissues.
Wooden dissection board	Used for large specimens, such as the dissection of a mammalian gas exchange system. Also used when carrying out a whole organism dissection (a rat, for example) as pins can be placed in the wood to hold the organism in place.
Metal tray	Used for smaller specimens, especially those that may contain blood, such as a mammalian heart dissection. Some metal trays have a layer of wax in the bottom which can be used to pin tissues in place when dissecting an earthworm or insect, for example.
White tile	Used for small specimens which are not going to produce significant amounts of fluid when dissecting a plant stem, for example.

Dissecting a plant stem

The transport system of a plant can be investigated by dissecting a stem.

Plant stems (or roots) can be dissected lengthwise to show the xylem and phloem tissues. The plant is usually put in water containing a swimming pool dye for a period of time and this will stain the system tissue as the plant takes up the water. A scalpel is best for this dissection.

If you have access to a binocular microscope or a magnifier of about $\times 15$ you can investigate the detail of xylem tissue. Almost any plant stem can be used, but fleshy stems are the easiest to both dissect and to see the transport vessels.



Figure P2 Common bean stem (cut)



Figure P3 The tissues of a cut plant stem showing the staining tissues.

Dissecting a heart

Dissection of the heart is relatively straightforward, provided you orientate the heart correctly before you start. Do not do any cutting until you have thoroughly examined the outside and determined which is the front. The front of the heart has a diagonal coronary artery running from top right to bottom left. This will enable you to distinguish the left and right sides of the heart.



Figure P4 The coronary artery of a dissected heart.

Dissecting lungs

As with the heart, it is important to get the lungs the right way round. Often the best way is to look for remains of the pericardium (the layer of tissue that surrounds the heart) which will show you where the heart was, and so which is the front. In addition you may be able to orientate your lungs by determining the position of the oesophagus at the back of the trachea.

Lung dissection usually involves cutting down the trachea and following the bronchial tree as far as possible. Scissors are best for this - a scalpel may just bend the cartilage. It's not very sharp. Other investigations may involve inflating the lungs by inserting a rubber tube (do not put the trachea directly in your mouth). You could also see how much air is in the lung by floating a piece of it in water.



Figure P5 A dissected lung showing the bronchial tree.

Dissecting a whole animal

If you are dissecting a whole animal to look at its transport (or gas) exchange system, you will need to use a wider range of dissecting instruments and be especially vigilant with health and safety. Although it is always important to wash your hands after handling biological material, with whole animals there is a greater opportunity for contamination with, for example, *Salmonella*.

Whole animal dissections are not done commonly, but the usual animal used for dissection is a rat. Under no circumstances should you attempt to dissect a dead animal which has been found. Only commercially bred animals should be used.



Figure P6 A dissected rat showing internal organs.

QUESTIONS

Q1 When dissecting a heart, why should you probe the aorta from the left ventricle upwards?

Q2 Why is a stem for dissection put into a dye?

Q3 Why should you never dissect a dead animal you have found?

Boost understanding and mathematical skills with worked maths examples

EXAM PRACTICE QUESTIONS

Figure Q1 shows changes in pressure in different parts of the heart during a period of one minute.

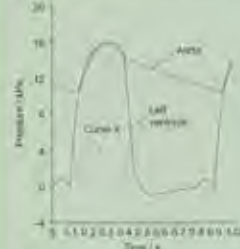


Figure Q1

- At what time do the semilunar valves close?
- Use the graph to calculate the heart rate in beats per minute. Show your working.
- Use the graph to calculate the total time that blood flows out of the left side of the heart during one minute when beating at this rate. Show your working.
- What does curve X represent? Explain your answer.
- The volume of blood pumped out of the left ventricle during one cardiac cycle is called the stroke volume. The volume of blood pumped out of the left ventricle in one minute is called the cardiac output. It is calculated using the equation: $\text{Cardiac output} = \text{stroke volume} \times \text{heart rate}$

After several months of training, an athlete had the same cardiac output but a lower resting heart rate than before. Explain this change.

Figure Q2 shows the oxygen haemoglobin dissociation curves for three species of fish.

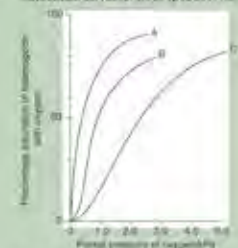


Figure Q2

- Species A lives in water containing a low partial pressure of oxygen. Species C lives in water with a high partial pressure of oxygen. The oxygen haemoglobin dissociation curve for species A is to the left of the curve for species C. Explain the advantage to species A of having haemoglobin with a curve in this position.
- Species A and B live in the same place but B is more active. Suggest an advantage of B of having an oxygen haemoglobin dissociation curve to the right of that for A.

Figure Q3 shows the change in the speed of flow and pressure of blood from the start of the aorta into the capillaries.

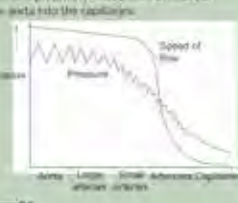


Figure Q3

Extensive end of chapter practice questions help prepare for final assessment

Signposted assignments throughout build confidence in Maths skills, practical skills, extended writing, AO2 and AO3

Comprehensive Teacher Support

Teacher Guides help you deliver a linear course confidently with a clear sequence of learning mapped out in medium and long-term plans. The planning tools also enable you to co-teach AS and A-level. A wealth of differentiated activity sheets provide inspiration for fresh ways to develop students' skills in maths, practicals, analysis and evaluation. These extensive guides also provide support for hands-on practical work with activities, instruction guides and technician notes.

Support progress with a clearly signposted sequence of learning

Chapter 3: Enzymes

Lesson plan 3.2

Lesson 3.2 How enzymes work

LEARNING OUTCOMES

- Describe and explain how enzymes work by the induced fit model
- Compare and contrast the lock and key and induced fit models of enzyme action

THE JOURNEY SO FAR

Students may remember that protein molecules are made up of amino acid monomers and that the protein chains are folded to produce a specific shape. They are most probably aware that the shape of an enzyme molecule is vital to its function. Students may have come across the 'lock and key' theory of enzyme action at KS4.

POSSIBLE BARRIERS TO PROGRESS

Some students may find it difficult to differentiate between the lock and key model and the induced fit theory of enzyme action. Some students may believe that the substrate has an active site, rather than the enzyme.

LESSON OUTLINE

Engage and remind

Ask students to work in pairs to discuss how enzymes work. Provide pairs with large sheets of paper and pens and ask them to represent their discussions in images. They could use the specific example from Lesson 3.1 of the enzyme catalase catalysing the decomposition of hydrogen peroxide. Ask each group to describe, briefly, what their images show to assess understanding of how enzymes work.

Core activities

Use verbal questioning to recap the definitions of primary, secondary and tertiary structure of proteins. Show computer generated images of enzymes and substrates. Use these images to demonstrate the globular nature of enzymes and the active site of enzymes as an indent in the structure. Use *Biology Student Book 1, Section 3.3, Figure 5* to discuss how enzymes catalyse reactions using the induced fit model. (Students are likely to be familiar with the lock and key model of enzyme action from KS4 so it is important that they understand that the shape of the active site is changed, induced by the enzyme.)

Students complete *Activity sheet 3.2.1 Models of enzyme action, Tasks 1 and 2*. Display annotated diagrams produced (Task 2, question 01) and allow students time to compare each. Students should then add to or amend their own annotations.

Reflect on the discussions that took place during *Engage and remind* about students' original perceptions of enzyme action. Point out those models that were based on the lock and key model and ask students to comment on the similarities and differences between the lock and key and induced theories. Students complete *Activity sheet 3.2.1 Models of enzyme action, Task 3*.

Consolidate and look ahead

Ask students to complete questions 1 and 2 from *Biology Student Book 1, Section 3.3*.

BUILDING ON THE OUTLINE

Students could search computer-generated images to show induced fit theory.

Students could research how theories about enzyme action developed and changed over time.

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Chapter 3: Enzymes

Activity sheet 3.3.1

Planning an investigation of enzyme activity

THE INVESTIGATION

Describe your investigation using the sentence stem below:

We are investigating the effect of ...

HYPOTHESIS

Make a prediction about your investigation.

Use scientific knowledge to support your prediction.

EQUIPMENT AND MATERIALS

You will be provided with reagents to use in the investigation.

List these and any other equipment that you will use.

VARIABLES

Identify the variables in the investigation:

- Independent variables
- Dependent variables
- Control variables

TRIAL EXPERIMENTS

Carry out some trial experiments to test the range of values that you will use for your independent variable and the volumes of reagents that you will use.

Keep a rough record of your findings and use these to help you to decide on the procedure for the investigation.

PROCEDURE

Write a method for the investigation as a numbered list of instructions.

Ensure that these instructions could be followed by a peer to carry out the investigation in exactly the same way as you will.

HEALTH AND SAFETY

Use the health and safety information provided with each reagent to identify any health and safety guidance that should be given to anyone carrying out this investigation.

Consider any other guidance that would be useful to ensure that the procedure is carried out safely.

RESULTS

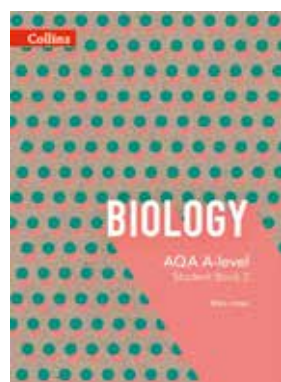
Plan how you will record your results and design a table (or similar) prior to the investigation.

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