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Avoid common mistakes
*
Get better grades

A-LEVEL Biology

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Suitable for: AQA, Pearson Edexcel, OCR, WJEC, CCEA

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Contents

Introduction

Exam Insights for A-Level Biology is perfect for last-minute revision and practice. This book covers 10 of the trickiest topics where students have dropped marks in recent UK exams. It focuses on the most common misconceptions and the skills that are most difficult to answer. Namely, writing extended responses, using mathematics and demonstrating practical skills.

Throughout the book, you will see different exercises alongside more traditional exam-style questions. These include:

- Worked examples – expert walkthroughs on how best to approach a question and answer it correctly.
- Be the examiner – read through and mark student answers to understand where they went wrong and the common mistakes you should avoid in your own work.
- Improve the answer – demonstrate your knowledge to re-write a student answer and pick up maximum marks.

You may wish to use additional paper for your answers to the extended response questions.

You will also see the following features:

- Recaps – a brief summary of the key knowledge you'll need for each topic.
- Insights – lessons that you can learn from past exams and student answers.
- UpGrades – top tips on how to pick up extra marks and improve your grade.

Fully worked solutions with mark schemes are provided in the book so you can check your answers.

1 Enzyme action

Overview

Knowledge recap

- Enzymes are protein molecules that are biological catalysts. They are synthesised at the ribosomes in the cells of all living organisms.
- Enzymes have a tertiary structure with an active site that is specific and complementary in shape to the substrate molecules on which they act. This allows the substrate molecules to fit into the active site.
- When substrates collide with enzymes, they can bind at the active site and an enzyme–substrate complex is formed. This causes the active site to change shape and put a strain on the bonds within the substrate. This strain makes these bonds easier to break, thus lowering the activation energy. This is called the induced fit model of enzyme action.
- Most enzymes act inside cells and organelles to catalyse important biochemical reactions, including respiration and photosynthesis.
- Some enzymes act outside cells, such as the hydrolytic enzymes which digest food in the gut.
- The rate of an enzyme-catalysed reaction is determined by the number of enzyme–substrate complexes formed (per unit time).
- Factors that affect the rate of enzyme-catalysed reactions do so by increasing or decreasing the number of enzyme–substrate complexes that can be formed.
- These factors include temperature, pH, [substrate], [enzyme] and the presence of inhibitors.

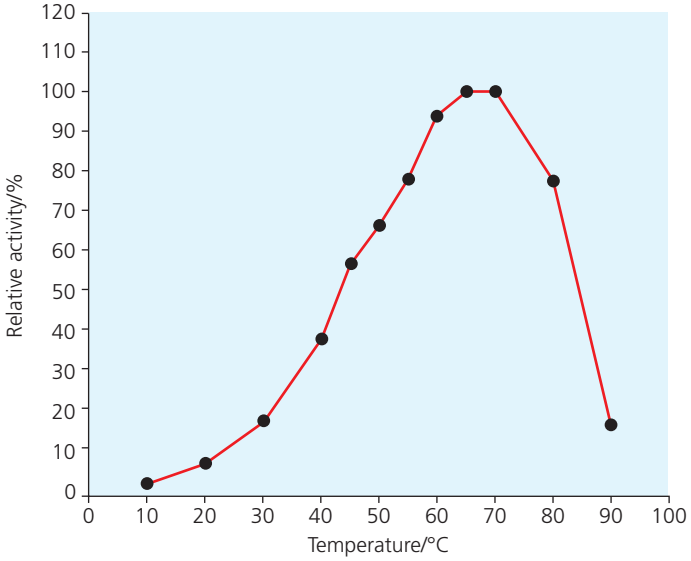
Practice questions

1 Explain why the formation of an enzyme–substrate complex increases the rate of reaction. (3)

Insight

Many students answering this question focus (wrongly) on enzymes and substrates being complementary in shape, rather than explaining the induced fit mechanism of enzyme action.

2 The figure shows the effect of temperature on the activity of an enzyme isolated from a bacterium called *Thermus aquaticus*. These organisms live in the water of hot springs.



UpGrade

Not all organisms function best at the temperatures with which we are more familiar, but the same biological principles apply regardless of how hot or cold is the context.

2–1 Use the figure on the previous page to describe the effect of temperature on the activity of this enzyme. (2)

2–2 Explain the effect of temperature on the rate of this reaction above 70°C. (4)

2–3 The enzymes from *Thermus aquaticus* are described as 'thermostable'. Suggest what is meant by the term 'thermostable'. (1)

2–4 Explain why *Thermus aquaticus* bacteria have thermostable enzymes. (1)

3 Carbonic anhydrase is an enzyme found inside red blood cells that catalyses the following reaction:

carbon dioxide + water → carbonic acid.

Explain why carbonic anhydrase catalyses only this reaction. (3)

4 The ability of an enzyme to catalyse a reaction often depends on the presence of small molecules or ions called co-factors. Chloride ions act as co-factors for amylase. When chloride ions bind to amylase they activate amylase, which can then hydrolyse starch into maltose.

Suggest how chloride ions activate amylase. (2)

5 A change in pH can denature enzymes. Explain why. (3)

6 The most abundant enzyme on Earth is called ribulose bisphosphate carboxylase (RuBisCO). It catalyses one of the reactions involved in photosynthesis. Give the name of an organ, cell and organelle where RuBisCO can be found. (3)

Organ _____ Cell _____ Organelle _____

UpGrade

For questions involving **descriptions** of graphs, you need to include the general pattern of the graph for 1 mark, and include a relevant numerical value from the *x*-axis or *y*-axis for the second mark. No biological knowledge is required for a 'describe' question.

Insight

Some students have difficulty in answering questions that involve temperature ranges with which they are less familiar.

UpGrade

Question 2–2 requires you to apply your biological knowledge of enzymes to **explain why** high temperatures affect the activity of the enzyme.

Insight

Examiner reports show that many students describe the shape of the active site and substrate as 'matching', which implies they are the same shape, which is incorrect – they are **complementary** in shape.

Insight

Reports show that students fail to appreciate that the binding of molecules to enzymes can also increase enzyme activity as well as inhibit activity.

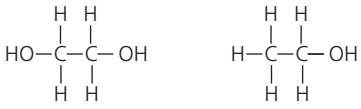
Extended responses

Worked example

1 Drinking the chemical ethylene glycol can be fatal. This occurs because the enzyme alcohol dehydrogenase converts ethylene glycol into oxalic acid, which then leads to kidney failure. Ethylene glycol poisoning can be treated by administering ethanol.

The figure shows the structural formulae of ethylene glycol and ethanol.

Use your knowledge of enzyme action to explain how administering ethanol prevents ethylene glycol poisoning. (6)



Ethylene glycol

Ethanol

UpGrade

In questions like this make sure you identify which molecules are the enzyme, substrate and product. You could label each of them in the stem of the question.

Plan your answer to this question on a separate piece of paper. Start by circling the command words, and then highlight or underline any useful information. When writing your plan, consider numbering your points in the order you would write them.

Here is a sample answer with expert commentary:

Ethylene glycol poisoning occurs when ethylene glycol is converted into oxalic acid to cause the kidneys to fail. Ethanol is the same shape as ethylene glycol and therefore acts as a competitive inhibitor of the enzyme alcohol dehydrogenase because it is also complementary to the shape of the active site. Ethanol therefore binds to the enzyme and stops ethylene glycol from binding and therefore fewer E–S complexes are formed. This means oxalic acid is prevented from being produced so the patient does not die of kidney failure.

This is just a repeat of what is in the stem of the question. This is very common in many answers but is worth no marks.

*Right idea here, but the word 'same' would be incorrect. You need to say that ethylene glycol and alcohol are **similar** in shape. The point that ethanol acts as a competitive inhibitor would gain a mark.*

Unfortunately, this student has dropped a mark by saying that ethanol binds to the enzyme, but a competitive inhibitor binds specifically at the active site.

A strong finish by relating the action of ethanol to fewer E–S complexes, as well as saying how this leads to preventing poisoning.

This answer would get 4/6 because the student has a very good understanding of the process of competitive inhibition. They did not achieve full marks because although they understood the process, they used the wrong terms. Marks are often lost in good answers due to the inaccuracy of terminology rather than the lack of understanding.

Be the examiner

2 Describe and explain the effect that increasing substrate concentration has on the rate of a reaction catalysed by an enzyme. (6)

Read through the sample answer below and comment on what is good and bad about it.

Insight

Students often write about active sites being 'used up'; this would lose them a mark.

As the substrate concentration increases, so does the rate of the reaction because more enzyme–substrate complexes can form, so more product can form in the same period of time. This means that the substrate concentration is the limiting factor, because as it increases so does the rate of the reaction.

However, after a certain substrate concentration all the enzymes will have substrate bound to them, so the reaction will no longer increase in rate as the substrate concentration increases because no more E–S complexes can form. At this point the substrate concentration is no longer the limiting factor, something else is.

Use the mark scheme below to help identify how the student did. Use your comments and what you have checked off to give the answer a mark.

Level descriptors	Marks	
Indicative content • Reference has been made to the overall trend of rate increasing and then plateauing in the response for the description mark. • There has been mention of increased number of collisions between E + S molecules as substrate concentration increases. • The rate of reaction has been related to number of E–S complexes being formed. • There is reference somewhere in the answer to time (because the question is about the rate of reaction). • There is correct description of all active sites being occupied by substrate. • Fully occupied active sites have been linked to an explanation of rate of reaction staying the same. • There are accurate references given to limiting factors.		☐ ☐ ☐ ☐ ☐ ☐ ☐
Level 3: A detailed description and explanation is given which demonstrates a good knowledge and understanding of how increasing substrate concentration affects the rate of an enzyme-catalysed reaction. Correct terminology used in context throughout.	5–6	☐
Level 2: A description and explanation is given which demonstrates a reasonable knowledge and understanding of how substrate concentration affects the rate of an enzyme-catalysed reaction. There may be some inaccurate uses of terms.	3–4	☐
Level 1: A description is given which is not supported by an explanation of how substrate concentration affects the rate of an enzyme-catalysed reaction.	1–2	☐

I would give this _____ /6 because … _____

_____

_____

Practice question

3 Enzymes catalyse reactions inside cells (intracellular reactions) and outside cells (extracellular reactions).

Describe the role of two different enzymes: one that acts inside cells, and one that acts outside. Your answer should include where the enzyme is produced and acts, as well as discussing the substrate and the products of the reaction. (6)

Read through the sample student answer below and make notes on how you would improve it.

The enzyme amylase is produced in the salivary glands and is released into the mouth where it acts on starch in the food. It breaks down the starch into maltose by breaking bonds between glucose molecules. The enzyme ATP synthase is produced in cells that carry out respiration. It produces ATP during the process of oxidative phosphorylation which is part of aerobic respiration.

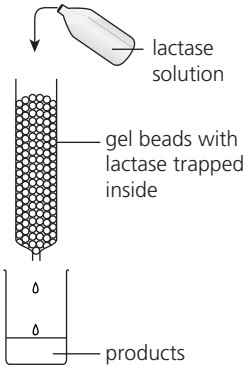
Write an improved response to this question that would get full marks.

Practical Biology

When answering practical questions about enzymes, you may be expected to think about the substrate and products, as well as how the reaction that is being catalysed by the enzyme proceeds from beginning to end. These questions will test your understanding of this area.

Practice questions

1 The figure shows lactase immobilised (trapped) inside gel beads, which are permeable to lactose.



1–1 Explain why lactose can enter the gel beads but lactase remains trapped inside. (1)

1–2 Name the products of the reaction in this experiment. (1)

1–3 Describe a biochemical test you could carry out to determine whether or not the products have been contaminated by the lactase. Explain why you used this test. (3)

1–4 In industry, lactase can be immobilised inside gel beads to produce 'lactose-free' milk. Suggest two advantages of trapping the lactase inside the beads. (2)

1

2

EXAM INSIGHTS

A-LEVEL *Biology*

Boost your grade by using the lessons learnt from previous exams in this write-in workbook.

* Target revision by focusing on the tricky topics and skills students have struggled with in previous exams.
* Know what the examiners are looking for with model answers, commentary and full mark schemes.
* Get exam ready with exam-style questions, tips on how to improve answers and insights from examiners' reports.
* Raise marks in the extended response, practical-based and maths questions with added support.

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