Cambridge Assessment International Education

Interactive

Learner Guide

Cambridge International AS & A Level Biology 9700

For examination from 2022

Cambridge Pathway

Contents

About this guide

This guide explains what you need to know about your Cambridge International AS & A Level Biology 9700 course and examinations.

This guide will help you to:

- understand what skills you should develop by taking this Cambridge International AS & A Level course
- understand how you will be assessed
- understand what we are looking for in the answers you write
- plan your revision programme
- revise, by providing revision tips and an interactive revision checklist (Section 6).

Following a Cambridge International AS & A level programme will help you to develop abilities that universities colleges and employers value highly, including a deep understanding of your subject; higher order thinking skills (analysis, critical thinking, problem solving); presenting ordered and coherent arguments; and independent learning and research.

Studying Cambridge International AS & A Level Biology will help you to develop a set of transferable skills, including the ability to work with mathematical information; think logically and independently; consider accuracy; model situations mathematically; analyse results and reflect on findings.

Section 1: Syllabus content - what you need to know

This section gives you an outline of the syllabus content for this course. If you are taking the AS examination you will follow sections 1 to 11. If you are taking the full A level examination you will take all 19 sections.

AS Content

Content section	Assessment component	Topics included
1 Cell structure	9700/01, 9700/02, 9700/03	Using a light microscope to study cells and tissues. The structure of cells using photomicrographs and electron micrographs. The structure of prokaryotic and eukaryotic cells, and the structure of viruses.
2 Biological molecules	9700/01, 9700/02, 9700/03	The structure and function of carbohydrates, lipids and proteins. Hydrogen bonding and the roles of water in living organisms. Using a variety of reagents to test for the presence of biological molecules.
3 Enzymes	9700/01, 9700/02, 9700/03	How enzymes catalyse reactions. Investigating the affect of different factors on enzyme action by following disappearance of substrate or appearance of product.
4 Cell membranes and transport	9700/01, 9700/02, 9700/03	The fluid mosaic model of membrane structure and the roles of the components of membranes at cell surfaces. Investigating the movement of substances into and out of cells.
5 The mitotic cell cycle	9700/01, 9700/02, 9700/03	The structure of chromosomes and the roles of mitosis in eukaryotic organisms. The events that occur during the cell cycle. Using light microscopy to study the behaviour of chromosomes during mitosis.
6 Nucleic acids and protein synthesis	9700/01, 9700/02, 9700/03	The structure of DNA and its replication during interphase of the cell cycle. Comparing the structure of DNA with RNA. The process of protein synthesis. Different types of gene mutation and their effects on polypeptide structure.
7 Transport in plants	9700/01, 9700/02, 9700/03	Using the light microscope to study the distribution of xylem and phloem in plant organs (roots, stems and leaves). Transpiration and the transport of water in xylem and the transport of assimilates in phloem.
8 Transport in mammals	9700/01, 9700/02, 9700/03	Using light microscopy to study the structure of blood and blood vessels. The structure and function of the heart and five types of blood vessel. The transport of oxygen and carbon dioxide in the blood.
9 Gas exchange	9700/01, 9700/02, 9700/03	Using light microscopy to study the structure of the trachea and the lungs. The structure and function of the gas exchange system.

Content section	Assessment component	Topics included
10 Infectious diseases	9700/01, 9700/02, 9700/03	The pathogens that cause cholera, malaria, tuberculosis and HIV/AIDS and the ways in which these pathogens are transmitted. The factors involved in the prevention and control of these infectious diseases. The action of penicillin. The consequences of antibiotic resistance.
11 Immunity	9700/01, 9700/02, 9700/03	The roles of the cellular components of the immune system. The responses of the immune system to pathogens. The structure and function of antibodies and how monoclonal antibodies are produced and used. How vaccines are used to control infectious diseases.

A Level Content

Content section	Assessment component	Topics included
12 Energy and respiration	9700/04 9700/05	The uses of energy in living organisms and the role of respiration in supplying energy to cells. Using a variety of practical techniques to investigate aspects of respiration.
13 Photosynthesis	9700/04 9700/05	The transfer of energy in photosynthesis. Using a variety of practical techniques to investigate aspects of photosynthesis and the effects of limiting factors on the rate of the process.
14 Homeostasis	9700/04 9700/05	The transfer of energy in photosynthesis. Using a variety of practical techniques to investigate aspects of photosynthesis and the effects of limiting factors on the rate of the process.
15 Control and coordination	9700/04 9700/05	Aspects of the endocrine system, nervous system and muscular system in mammals. Some control methods in plants.
16 Inheritance	9700/04 9700/05	Ways in which genetic information is transmitted from one generation to the next and the roles of genes in determining the functioning and appearance of organisms. Some of the ways that the activities of genes are controlled in prokaryotes and eukaryotes.
17 Selection and evolution	9700/04 9700/05	Aspects of variation and the role of natural selection in evolution. The principles of selective breeding with some plant and animal examples.
18 Classification, biodiversity and conservation	9700/04 9700/05	The ways in which all organisms are classified and the importance of biodiversity. Using field work techniques to investigate biodiversity in one or more ecosystems. Some of the issues involved with conserving species and ecosystems.
19 Genetic technology	9700/04 9700/05	The principles of genetic technology and how various techniques are applied to medicine and agriculture.

Prior knowledge

Learners starting this course should have completed a course in Biology or Co-ordinated Science equivalent to Cambridge IGCSE™ or Cambridge International O Level.

Key concepts

Key concepts are essential ideas that help you to develop a deep understanding of your subject and make links between different aspects of the course. The key concepts for Cambridge International AS & A Level Biology are:

- **Cells as the units of life**

A cell is the basic unit of life and all organisms are composed of one or more cells. There are two fundamental types of cell: prokaryotic and eukaryotic. Understanding how cells work provides an insight into the fundamental processes of all living organisms.

- **Biochemical processes**

Cells are dynamic structures within which the chemistry of life takes place. Biochemistry and molecular biology help to explain how and why cells function as they do.

- **DNA, the molecule of heredity**

Cells contain the molecule of heredity, DNA. DNA is essential for the continuity and evolution of life by allowing genetic information to be stored accurately, to be copied to daughter cells, to be passed from one generation to the next and for the controlled production of proteins. Rare errors in the accurate copying of DNA known as mutations result in genetic variation and are essential for evolution.

- **Natural selection**

Natural selection acts on genetic variation and is the major mechanism in evolution, including speciation. Natural selection results in the accumulation of beneficial genetic mutations within populations and explains how populations can adapt to meet the demands of changing environments.

- **Organisms in their environment**

All organisms interact with their biotic and abiotic environment. Studying these interactions allows biologists to understand better the effect of human activities on ecosystems, to develop more effective strategies to conserve biodiversity and to predict more accurately the future implications for humans of changes in the natural world.

- **Observation and experiment**

The different fields of biology are intertwined and cannot be studied in isolation. Observation, enquiry, experimentation and fieldwork are fundamental to biology, allowing relevant evidence to be collected and considered as a basis on which to build new models and theories. Such models and theories are further tested by experimentation and observation in a cyclical process of feedback and refinement, allowing the development of robust and evidence-based conceptual understandings.

Section 2: How you will be assessed

There are three ways you can gain a Cambridge International Advanced Level qualification.

- take the Advanced Subsidiary (AS) qualification only
- follow a staged assessment route to the Advanced (A) Level by taking the AS Level papers and the A Level papers in different examination sessions. Usually this means taking the AS Level papers at the end of one year of study and the A Level papers at the end of a second year of study.
- take all the examination papers in the same examination session leading to the full A Level.

About the examinations

There are three papers you take to obtain an AS level Biology qualification:

- Paper 1
- Paper 2
- Paper 3

There are two additional papers you take to obtain an A level Biology qualification:

- Paper 4
- Paper 5

About the papers

The table gives you further information about the examination papers:

Component	Time and marks	Questions	Percentage of total mark
Paper 1	1 hour 15 minutes 40 marks	40 multiple-choice questions. Questions are based on the AS Level syllabus content.	31% of the AS Level 15.5% of the A Level
Paper 2	1 hour 15 minutes 60 marks	Structured questions - usually between 5 and 7. Questions are based on the AS Level syllabus content.	46% of the AS Level 23% of the A Level
Paper 3	2 hours 40 marks	2 or 3 questions, which are based on the practical skills in the Practical assessment section of the syllabus.	23% of the AS Level 11.5% of the A Level
Paper 4	2 hours 100 marks	Structured questions. Questions are based on the A Level syllabus content; knowledge of material from the AS Level syllabus content will be required.	38.5% of the A Level
Paper 5	1 hour 15 minutes 30 marks	Structured questions. Questions are based on the practical skills of planning, analysis and evaluation. The context of the questions may be from within the syllabus (topics 1 to 19) or maybe based on topics that are outside the syllabus	11.5% of the A Level

About the practical papers

In Paper 3, you will have to handle familiar and unfamiliar biological material and will be expected to show

evidence of the following skills:

- manipulation (carrying out experimental procedures), measurement (using apparatus such as rulers, pipettes and eyepiece graticules) and making observations
- presentation of data and observations
- analysis, conclusions and evaluation.

When unfamiliar materials or techniques are involved, you will be given full instructions. One question will require the use of a light microscope.

In Paper 5, there will be questions in which you will be expected to design an investigation and write out a plan that you will not carry out, as well as analysing and evaluating experimental data. To do this confidently you need plenty of experience of practical work in the laboratory.

Questions involving an understanding of the use of statistical tests may be set. You will be provided with the formulae for these tests.

Section 3: What skills will be assessed?

The examiners take account of the following skills areas, known as **Assessment Objectives (AOs)**, in the examinations:

- AO1 Knowledge and understanding
- AO2 Handling, applying and evaluating information
- AO3 Experimental skills and investigations

Assessment objectives (AO)	What does the AO mean?
AO1 Knowledge and Understanding	You should be able to demonstrate knowledge and understanding of: • scientific phenomena, facts, laws, definitions, concepts and theories • scientific vocabulary, terminology and conventions (including symbols, quantities and units) • scientific instruments and apparatus, including techniques of operation and aspects of safety • scientific quantities and their determination • scientific and technological applications with their social, economic and environmental implications.
AO2 Handling, applying and evaluating information	Handle, apply and manipulate information in words or using other forms of presentation (e.g. symbols, graphical of numerical) to: • locate, select, organise and present information from a variety of sources • translate information from one form to another • manipulate numerical and other data • use information to identify patterns, report trends and draw conclusions • give reasoned explanations for phenomena, patterns and relationships • make predictions and construct arguments to support hypotheses • apply knowledge, including principles, to new situations • evaluate information and hypotheses • demonstrate an awareness of the limitations of biological theories and models • solve problems.
AO3 Experimental skills and investigations	Demonstrate the ability to: • plan experiments and investigations • plan experiments and investigations • collect, record and present observations, measurements and estimates • analyse and interpret experimental data to reach conclusions • evaluate methods and quality of experimental data and suggest possible improvements to experiments.

Weighting for assessment objectives

It is important that you know the different weightings (%) of the assessment objectives, as this affects how the examiner will assess your work.

The approximate weightings allocated to each of the assessment objectives are summarised below:

Assessment objectives as a percentage of each qualification

Assessment objective	Weighting at AS Level %	Weighting at A Level %
AO1 Knowledge and understanding	40	40
AO2 Handling, applying and evaluating information	40	40
AO3 Experimental skills and investigations	20	20
Total	**100**	**100**

Assessment objectives as a percentage of each component

Assessment objective	Weighting in components %				
	Paper 1	**Paper 2**	**Paper 3**	**Paper 4**	**Paper 5**
AO1 Knowledge and understanding	50	50	0	50	0
AO2 Handling, applying and evaluating information	50	50	0	50	0
AO3 Experimental skills and investigations	0	0	100	0	100
Total	**100**	**100**	**100**	**100**	**100**

Section 4: Command words

Command words and their meanings help candidates know what is expected from them in the exam. The table below includes command words used in the assessment for this syllabus. The use of the command word will relate to the subject context.

Command word	What it means
Assess	make an informed judgement
Calculate	work out from given facts, figures or information
Comment	give an informed opinion
Compare	identify/comment on similarities and/or differences
Contrast	identify/comment on differences
Define	give precise meaning
Describe	state the points of a topic / give characteristics and main features
Discuss	write about issue(s) or topic(s) in depth in a structured way
Explain	set out purposes or reasons / make the relationships between things evident / provide why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Identify	name/select/recognise
Outline	set out main points
Predict	suggest what may happen based on available information
Sketch	make a simple drawing showing the key features
State	express in clear terms
Suggest	apply knowledge and understanding to situations where there are a range of valid responses in order to make proposals / put forward considerations

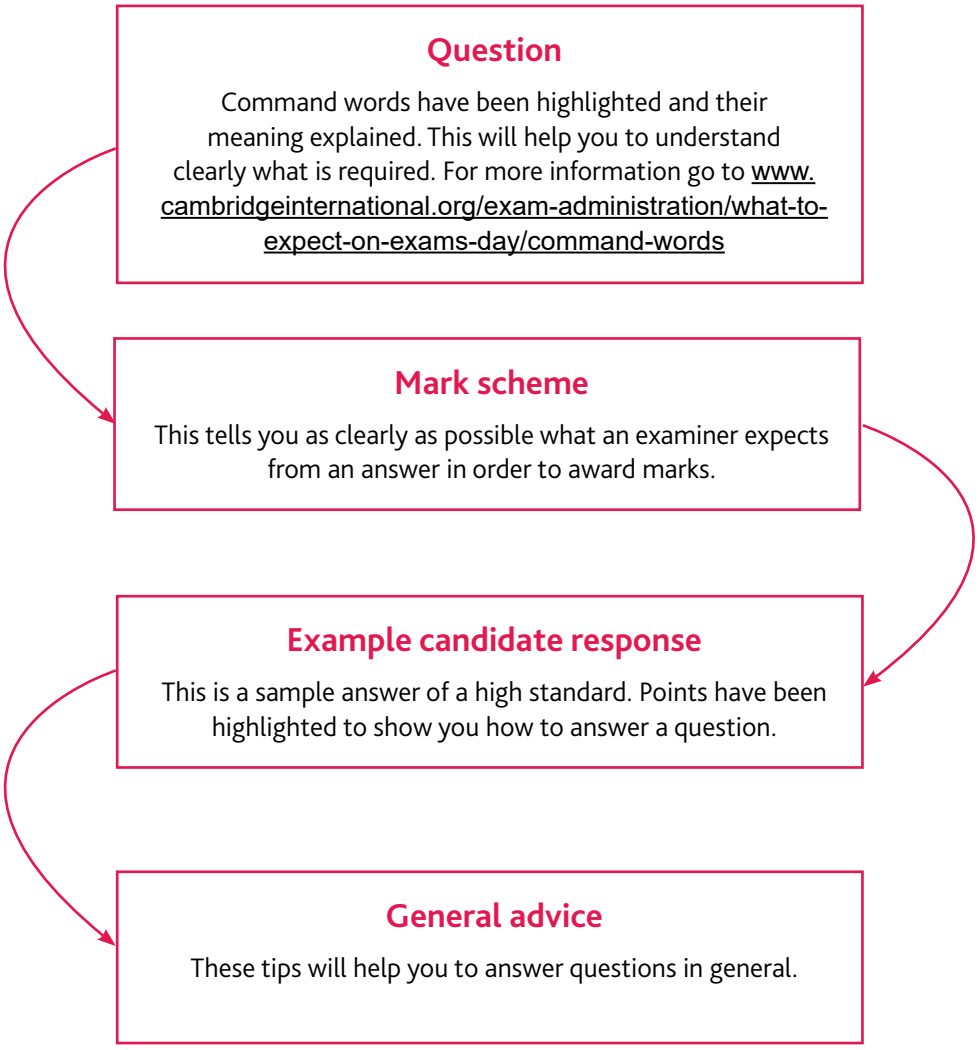
Instructional words may also be used in the assessment of this syllabus, e.g. complete, construct, draw, estimate, list, name, observe, plot, record, select.

Section 5: Example candidate response

This section takes you through an example question and candidate response. It will help you to see how to identify the command words within questions and to understand what is required in your response. Understanding the questions will help you to know what you need to do with your knowledge. For example, you might need to state something, calculate something, find something, show something or analyse and interpret something.

All information and advice in this section is specific to the example question and response being demonstrated. It should give you an idea of how your responses might be viewed by an examiner but it is not a list of what to do in all questions. In your own examination, you will need to pay careful attention to what each question is asking you to do.

This section is sructured as follows:



Question

3 The unicellular fungus *Kluyveromyces lactis* is found in dairy products. It is a safe microorganism to culture for the extraction of the enzyme lactase.

Lactase catalyses the breakdown of lactose, a sugar found in milk.

The reaction catalysed by lactase is summarised in Fig. 3.1.

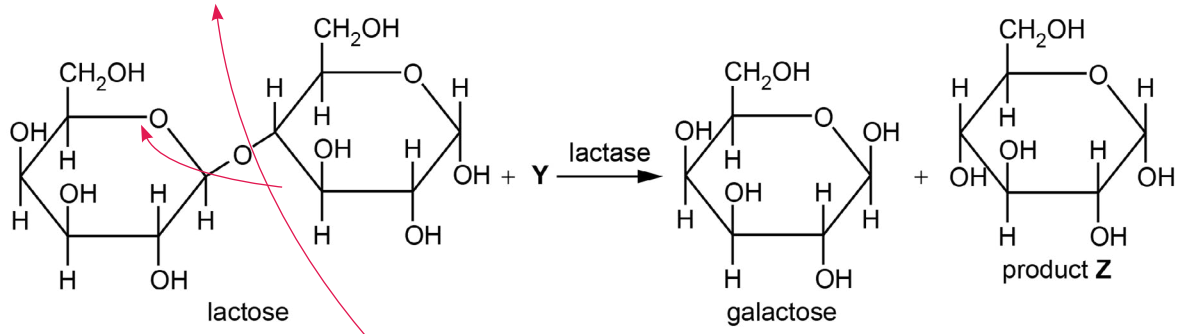


Fig. 3.1

Read through the whole question before you start to write any answers. In this case read the introduction here very carefully and then read through **(a)**, the three part questions in **(b)**, and **(c)**. This will help you appreciate the theme of the question and the parts of the syllabus being tested.

(a) Describe the reaction that is catalysed by lactase. Use Fig. 3.1 to help you.

In your answer, identify **Y** and product **Z**.

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The command word 'describe' means that you should give the main features of the reaction that you can see in Fig. 3.1. You can decide what to write by making some notes on the margin of the exam paper. You could note that lactose is a disaccharide, **Y** is water and **Z** is glucose. Think about the topics that this question is testing - carbohydrates and enzyme reactions. You should know that there are two types of glucose - which one is shown here?

(b) On a commercial scale, immobilised lactase can be used to produce lactose-free milk.

One of the products of the reaction shown in Fig. 3.1 acts as an inhibitor of lactase. This is an example of product inhibition.

(i) Explain why product inhibition is useful in *K. lactis* when lactase is acting as an intracellular enzyme, but can be a disadvantage when extracted lactase is used free in solution for the production of lactose-free milk.

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..... [2]

Explain in this question means give the reason why product inhibition is useful and the reason why it can be a disadvantage. Note that you should have two parts to your answer - an advantage and a disadvantage.

(ii) Suggest how using immobilised lactase for the production of lactose-free milk helps to reduce the problem of product inhibition.

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..... [1]

(iii) The first large-scale production of lactose-free milk with an immobilised enzyme used lactase trapped in cellulose triacetate fibres.

Suggest **one** feature of cellulose triacetate that makes it useful as an immobilising material.

.....

..... [1]

You may not have learnt the answer to questions that use 'suggest' as the command word. Before answering look back over earlier questions for ideas. You should apply your knowledge to the question and make a sensible answer. In **(b)(iii)** the question is asking for one feature so do not give more than one as any extra features you give will not be considered.

(c) When developing an enzyme-catalysed reaction for use in industry, the progress of the reaction is studied.

Outline how the progress of an enzyme-catalysed reaction can be investigated experimentally.

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..... [3]

[Total: 11]

Outline means that you should only give the main points. Detail is not required. When writing about an experiment it is good to write your answer as a set of numbered points.

Mark scheme

Question	Answer	Marks
3(a)	*any four from:* 1 disaccharide to monosaccharides ; 2 **Y** is water / water required ; 3 hydrolysis reaction ; 4 glycosidic bond broken ; 5 **Z** is α-glucose ; 6 detail of enzyme action ; e.g. induced-fit or lock-and-key hypothesis described 7 AVP ; e.g. (β-)1,4(-glycosidic) bond broken **R** if bond type is incorrectly named	**4**
3(b)(i)	*intracellular advantage:* idea of control / maintaining balance / efficient metabolism ; e.g. if, (enough) glucose / galactose / monosaccharides, present then no need for, uptake / breakdown, of lactose avoids osmotic problems as no build-up of monosaccharides *disadvantage:* loss of product / reduced productivity / product required continuously / slows rate of reaction / ref. to enzyme needing to remain active ;	**2**
3(b)(ii)	*any one from:* products and enzyme kept separated / AW ; product removed immediately ;	**1**
3(b)(iii)	*any one from:* inert / unreactive / cannot be digested by lactase / AW ; non-toxic ; insoluble ; long shelf-life ; AVP ; e.g. can create small mesh size suggestion of enzyme attachment to fibres	**1**
	any three from: accept answers in the context of lactase 1 ref. to controlled variables ; e.g. constant, pH / temperature 2 take samples at timed intervals ; **A** regular intervals 3 determine, substrate / lactose, concentration **or** determine, product / glucose / galactose, concentration ; 4 plot graph of, substrate concentration / product concentration, against time ; 5 ref. to rate of disappearance of substrate **or** ref. to rate of appearance of product ; 6 determine initial rate ;	**3**

Now let's look at the example candidate response to the question and the examiner comments.

Example candidate response

3 The unicellular fungus *Kluyveromyces lactis* is found in dairy products. It is a safe microorganism to culture for the extraction of the enzyme lactase.

Lactase catalyses the breakdown of lactose, a sugar found in milk.

The reaction catalysed by lactase is summarised in Fig. 3.1.

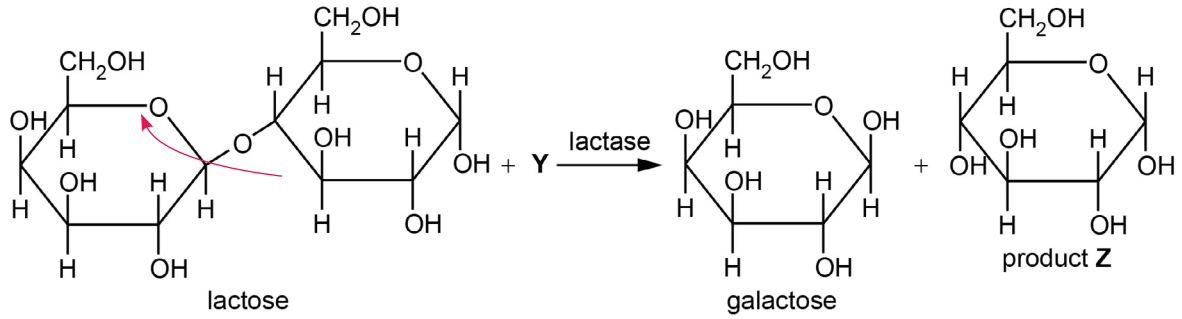

Fig. 3.1

(a) Describe the reaction that is catalysed by lactase. Use Fig. 3.1 to help you.

In your answer, identify **Y** and product **Z**.

The type of reaction shown in the diagram is hydrolysis as it is the breakdown of a compound using water. In this case, lactose is broken down to galactose and glucose <The candidate has not identified Z as α-glucose so mark point 5 cannot be awarded here>. The bond between these two is a glycosidic bond and the part shown by -O- in Fig. 3.1 is broken by the addition of water. This is the reverse of the condensation reaction when lactose is made from the two monosaccharides

[4]

Mark point three awarded

Mark point two awarded

Mark point four awarded

This sentence is not relevant to the question. If the candidate had stated that lactose is a disaccharide then mark point one could have been awarded

Three marks out of four are awarded for part **(a)**.

(b) On a commercial scale, immobilised lactase can be used to produce lactose-free milk.

One of the products of the reaction shown in Fig. 3.1 acts as an inhibitor of lactase. This is an example of product inhibition.

(i) Explain why product inhibition is useful in *K. lactis* when lactase is acting as an intracellular enzyme, but can be a disadvantage when extracted lactase is used free in solution for the production of lactose-free milk.

Useful: if a lot of the product builds up inside the cell then the enzyme stops working. This means that no more of the products are made as there is no need for them and they will not cause any problems such as lowering the water potential in the cell.

Disadvantage: if the enzyme stops working then not all of the lactose will be broken down so the milk will not be lactose-free. [2]

Mark point one awarded

Mark point two awarded

Notice that the candidate has used sub-headings at the start of each answer. This makes it clear to the Examiner which part of the question is being answered.

Full marks are awarded for part **(b)(i)**.

(ii) Suggest how using immobilised lactase for the production of lactose-free milk helps to reduce the problem of product inhibition.

The immobilised lactase is kept separate from the milk and the products shown in Fig. 3.1 The lactase can be kept in a burette and the lactose-free milk collected in a beaker underneath. This stops the product inhibiting the enzyme. [1]

The candidate has given the right idea in the first sentence and has given an example of how the separation may be carried out. The candidate is probably thinking of a practical procedure that involves immobilising enzymes in calcium alginate beads.

The mark is awarded for part **(b)(ii)**.

(iii) The first large-scale production of lactose-free milk with an immobilised enzyme used lactase trapped in cellulose triacetate fibres.

Suggest **one** feature of cellulose triacetate that makes it useful as an immobilising material.

It cannot be broken down by lactase and is not toxic (important in making a food like lactose-free milk). [1]

Mark point one awarded

The question asks for **one** suggestion, but the candidate has given two. Examiners may be told to award the mark for the first response only so giving more than one answer is a waste of time.

The mark is awarded for part **(b)(iii)**.

(c) When developing an enzyme-catalysed reaction for use in industry, the progress of the reaction is studied.

Outline how the progress of an enzyme-catalysed reaction can be investigated experimentally.

1. The solution of lactase (or immobilised lactase) and the milk are kept separate at a fixed temperature (no more than 40 oC).

Mark point one awarded. Temperature is a variable that must be standardised in this experiment. pH is another variable that must also be controlled.

2. Known volumes of lactase and milk are mixed together. This is time = 0.

This is a good point to make and is another way to gain mark point 1 as volumes of enzyme and substrate are other variables that must be standardised.

3. The concentration of glucose in the reaction mixture is determined at intervals by taking small samples.

Mark point two is not awarded here as the intervals are not described as 'timed' or 'regular' intervals. If the candidate had said that the samples are taken every minute, then the mark would have been awarded.

4. A graph is plotted showing the concentration of glucose against time.

Glucose is one of the products of the reaction that the candidate is using as an example, so mark point 4 can be awarded here.

5. The initial rate of reaction can be found by using a tangent to the curve drawn on the graph or by calculating the gradient if there is a straight line.

The mark scheme says 'determine initial rate'. If the graph shows a straight line from time = 0 then the gradient of the line is the initial rate so mark point six is awarded.

Three marks out of three are awarded for part **(c)**.

Examiner's comments

These answers show that the candidate has a good understanding of the topics tested in this question and can use knowledge and understanding to make good responses to parts **(b)(i)**, **(ii)** and **(iii)** that test skills from AO2. Two of these questions begin with the command word 'suggest' which often require plenty of thought about the topics before writing an answer. The candidate has used numbered points when writing the steps of an experimental procedure - in just the same way as they are presented on Paper 3. Note that the candidate did not follow the instructions in part **(a)** as **Y** and **Z** have not been identified. A better answer would start by stating '**Y** is water and **Z** is α-glucose' and would then continue by describing the hydrolysis reaction shown in Fig. 3.1.

General advice

It is always a good idea to read the question carefully, noticing the command words and key instructions (in this case 'Describe', 'Explain', Suggest' and 'Outline'). You may want to underline them to help you think about what they mean. Many candidates start their answer without planning what they intend to write. Read the question first and pause to think about how you should respond so you do not waste time in the examination. If you have made a good attempt at a question and still not managed to finish it, it is best to move on to another question and come back to it later. This will help you to make good use of the time that you have available.

Allow a few minutes at the end of the examination to check your answers. Look carefully at the number of marks available for each question. Ask yourself if you have written an appropriate number of different points in each answer. Also make sure that you have answered all the questions. It is easy to miss the questions that have no answer lines. Questions like this require you to complete a table or add a label or letter to a photograph, diagram or drawing.

Section 6: Revision

This advice will help you revise and prepare for the examinations. It is divided into general advice and specific advice for each of the papers.

Use the tick boxes ☐ to keep a record of what you have done, what you plan to do or what you understand.

General advice

Before the examination

- ☐ Find out the dates of your examinations and plan your revision so that you have enough time for each topic. You should make yourself a revision timetable so that you have enough time to revise effectively for each subject and each examination paper.
- ☐ Find out the length of each Paper, the total number of marks and the number of questions you have to answer. You should aim to have covered half the total marks by half way through each paper.
- ☐ Know the meaning of the command words used in questions and how to apply them to the information given. Highlight the command words in past papers and check what they mean.
- ☐ Make revision notes; try different styles of notes. Discover what works best for you.
- ☐ Work for short periods separated by short breaks. Revise small sections of the syllabus at a time. Set yourself one or more targets for each revision session. Write these targets as 'can do' statements, e.g. 'at the end of this session I will be able to complete a table showing the differences between proteins and nucleic acids'.
- ☐ Build your confidence by practising questions on each of the topics. Past papers are the best source of questions, but there are other equally good sources such as exam-style questions written for text books and revision guides.
- ☐ Make sure that you practise lots of past examination questions so that you are familiar with the format of the examination papers. You could time yourself when doing a whole past paper so that you know how quickly you need to work in the real examination.
- ☐ Look at mark schemes for Papers 2, 3, 4 and 5 to help you to understand how the marks are awarded for each question. Do not memorise these mark schemes as questions are not repeated in exactly the same way.

During the examination

- ☐ Read the instructions carefully and answer **all** the questions.
- ☐ Look for the number of marks for each part question. This helps you to judge how long you should be spend on each response. You don't want to spend too long on some questions and then run out of time at the end.
- ☐ Do not leave out questions or parts of questions. Remember, no answer means no mark.
- ☐ You do not have to answer the questions in the order in which they are printed in the answer booklet. You may start with a later question and then come back to an earlier one later during the examination.
- ☐ Read each question very carefully. Misreading a question can cost you marks:
  - Identify the command words – you could underline or highlight them.
  - Identify the other key words and perhaps underline them too.
  - Try to put the question into your own words to help you understand what it is asking.
- ☐ Read all parts of a question before starting your answer. Think carefully about what is needed for each part.
- ☐ Look very carefully at the information you are given.
  - For each graph, read the introductory text, the labels for the axes and the key (if provided) to find out exactly what is shown.
  - Look carefully at all parts of diagrams and drawings to make sure you understand what is being shown.

- For each table, read the introductory text, column and row headings and the units used to understand the data provided.
- Try using coloured pencils or pens to identify anything that each question asks you about.

☐ **Answer the question set**. This is very important!

- Use your knowledge and understanding.
- Do not just try all the methods you know. Only use the ones you need to answer the question.

☐ Do not start your answer by writing out the question. This is a waste of time and answer lines.

☐ Make sure that you have answered everything that a question asks. Sometimes a question asks for two things, such as advantages **and** disadvantages. It is easy to concentrate on the first and forget about the second one.

☐ When asked to show your working for calculations, make sure that you write this down even if you have completed the whole calculation on your calculator. When you are asked to show working it means that the examiner will award marks for showing the step or steps involved in reaching the answer. Always remember to show the units if these are not given on the answer line. Marks are usually awarded for using correct steps in the method even if you make a mistake somewhere.

☐ Do not cross out any answer until you have replaced it by trying again. If you have made two or more attempts, make sure you cross out all except the one you want marked. If your rewritten answer does not fit on the answer lines continue on any white space on the examination paper and indicate to the examiner where you have completed your answer.

☐ If you need to change a word or a number, or even a sign (+ to – for example), it is better to cross out your work and rewrite it. Don't try to write over the top of your previous work as it will be difficult to read and you may not get the marks.

☐ Use the correct biological terms in your answers when possible.

☐ Annotated diagrams and sketch graphs can help you, and can be used to support your answers. Use them where possible but do not repeat the information in words.

☐ Make sure all your numbers are clear; for example make sure a '1' doesn't look like a '7'.

Advice for Paper 1

☐ You have about one minute to read and answer each question. Each question may test one topic or several topics from different parts of the AS syllabus.

☐ Some questions test what you know and understand (AO1). Some questions test if you can apply what you have learnt to understand new data (AO2). These questions will often have a diagram, graph or table to use.

☐ Some of the choices can be very similar; read carefully and underline words that make each choice distinct from the other three.

☐ Try to decide what the question is testing as you are reading it. The sequence of questions usually follows the sequence of topics in the syllabus. Therefore, you can expect the early questions to ask about Topic 1 on cells and those at the end will be on Topic 11 on immunity.

☐ Do not try to find a pattern in the order of your answers (e.g. A, B, C, D, A, B....). The same letter could be the correct answer for several questions in a row. Letter **A** might be the correct answer for more questions than **B**, **C** or **D**. Or there could be fewer correct answers shown by letter **D** than any of the others. Do not let what you have chosen for the previous questions influence which letter you choose.

☐ Some questions may ask about aspects of practical work, for example about different variables: independent, dependent and controlled.

☐ It is important to understand how to use terminology, e.g. how to apply water potential terminology to problems on cells and osmosis and how to use the appropriate terminology when interpreting graphs showing pressure changes during the cardiac cycle

Advice for Paper 2

☐ This paper has a mix of short answers questions and those requiring slightly longer answers. There is no essay. Always look at the number of marks for each part question to help you decide how much to write. It is a good idea to use each sentence to convey one idea.

- ☐ Look at the number of command words in each question: ask yourself 'do you have to do one or two things?'
- ☐ Use the lines given. Keep to the point and do not write too much. If a question asks for a certain number of answers, do not give more than the number asked. If there are numbered lines, then give one answer per line.
- ☐ There will only be a few parts of questions that need extended writing. These will have four [4] or five [5] marks. These questions will often be related to some information you are given. You will need to write four or five sentences in a logical sequence. You can think of it as "telling a story with a beginning, a middle and an end". Remember to refer to any information you are given if this seems appropriate.
- ☐ Anticipate the different styles of questions. You should have tried many examples of these styles of questions from past papers. Here are some examples:
  - Putting ticks and crosses in a table to make comparisons. For example, comparing the properties of different biological molecules.
  - Completing tables of information by writing in single words, numbers or short phrases, e.g. what happens to the four valves in the heart during different phases of the cardiac cycle.
  - Completing a passage of text with the missing terms. These are known as cloze passages.
  - Writing definitions – make these as concise as you can; there is no need to use any examples unless asked.
  - Making a list – answers should also be concise; detail is not required.
  - Matching pairs from two lists, e.g. matching the names for the stages of mitosis with descriptions of what happens in cells during each stage.
  - Putting stages of a process into the correct sequence, e.g. the stages of protein synthesis.
  - Labelling a diagram – label lines may already be on the diagram or you may have to add them yourself.
  - Describing and/or explaining data from a table or a graph.
  - Explaining aspects of an investigation, e.g. a student investigation that you might have carried out or a piece of research that has been adapted from a scientific paper.
  - Completing a flow chart, e.g. adding information into empty boxes.
  - Writing a flow chart from information that you are given, e.g. drawing a food web from written descriptions of the feeding relationships in a community.
  - Making a drawing from memory or from a photomicrograph or electron micrograph.
  - Drawing a sketch graph.

Advice for Paper 3

Success at Paper 3 requires you to do plenty of practical work during your course and have several attempts at past paper questions to find out how to complete everything in the time available. During the practical exam you will have to make some decisions; if you practice plenty of past questions you will find out what sort of decisions to expect.

- ☐ As you revise, make sure you know exactly how to carry out the practical procedures described in the AS syllabus. You will be assessed on your skills at:
  - manipulating apparatus to collect results and make observations
  - data presentation
  - analysis of results and observations
  - evaluation of procedures and data

  You should be prepared to make decisions about the practical work you will carry out:
  - identify the independent variable and dependent variable
  - decide a suitable range of values to use for the **independent variable** at which measurements of the **dependent variable** are recorded
  - decide the number of different values of the independent variable (a minimum of five) and the intervals between them
  - decide how to change the value of the independent variable
  - decide how the **dependent variable** should be measured
  - decide the number of replicates at each value
  - decide on appropriate controls for the experiment or investigation
  - decide which variables need to be standardised and how to standardise them.

- ☐ Read through the questions carefully, looking to see how many marks are given for each question.
- ☐ Read the instructions to the end; do not start a practical procedure without reading carefully all the steps involved.
- ☐ As you read, make sure that you have the apparatus and materials described. If not alert the Supervisor.
- ☐ Think about the apparatus that you will use for each step and imagine using it in your mind.
- ☐ Follow the instructions for practical methods exactly. If you make a change in the method you can alter the results. Do not take short cuts.
- ☐ Always label test-tubes and other containers to help you identify them.
- ☐ If you are told to "Wash the apparatus thoroughly after each use" make sure you do. If there is anything left in the apparatus the next stage may not work.
- ☐ It is a good idea to put a tick by the side of each instruction when you have completed it. This helps you to find the right place in the instructions, so that you do not leave out a step or repeat a step when it is not required.
- ☐ Keep your exam paper on a part of the bench which you can keep dry. Do not pour liquids or use syringes or pipettes over your exam paper. If you keep your exam paper away from the 'wet' part of your bench you are unlikely to spill anything on it.
- ☐ Make sure that you have a **sharp pencil** to use for making drawings and for drawing graphs and charts. Do **not** draw in ink because you cannot make changes as you can when using a pencil.
- ☐ Make sure you have a good, clean eraser for rubbing out your pencil lines if necessary. Do not press too hard when using a pencil for making drawings, graphs or charts. Sometimes it is difficult for an Examiner to tell which is your final line.

Here is a list of the skills that are assessed when your paper is marked.

Recording your measurements and observations

You are expected to make observations and record them.

- You can record your observations:
  - as statements in writing
  - in tables
  - by using drawings
  - by constructing tally charts.

You will take readings from different apparatus. You must make the measurements as carefully and as accurately as you can. Numerical readings will normally be collected and presented in a table.

- Follow the instructions below about drawing tables.
- Make clear descriptions of colours and colour changes; refer to 'blue', 'orange' and 'purple' when describing reagents used in biochemical tests. You may want to refer to slight differences, so use words like 'pale' and 'dark'.
- Make your measurements as carefully and as accurately as possible.
- Accurate results are close to the actual or 'true' values. If you can take repeat readings, then do so. There is not always enough time to do this.
- You can process your observations by:
  - carrying out calculations, e.g. percentages and percentage changes
  - plotting graphs – line graphs, bar charts and histograms.
- Use all the space available on the paper for your observations.
- Do not write an explanation until the question asks for one.
- Use a sharp HB or B pencil. It can be rubbed out easily if you need to correct a mistake. Use a good eraser so that is clear to the examiner which is your final line.
- Do not forget to include headings for the columns and the rows in tables.

Drawings

These will be made from microscope slides or photographs.

- Read the question carefully, the drawing may have to be an accurate size e.g. twice the original.
- Make each drawing as big as the space allows without writing over the text of the question and making sure that you leave enough space for labels and annotations, if asked for.
- Use a ruler for labelling lines.
- Draw and label in pencil.
- Use one clear continuous outline not an artistic drawing. Do not shade.
- Observe details carefully, such as the relative number of chloroplasts in different cells and the thickness of cell walls in different cells in a vascular bundle. Show these accurately on your drawing.

A plan diagram shows the distribution of tissues in a section. It also shows the proportions of the different tissues. Although called a low power plan diagram you may use high power to identify the different tissues and to be sure you are putting the boundaries of those tissues in the right place. You should not draw any cells in a lower power plan diagram.

When you make a plan diagram, follow these simple rules:

- make the drawing fill most of the space provided; leave space around the drawing for labels and annotations (if required by the question)
- use a sharp HB or B pencil (never use a pen)
- use thin, single, unbroken lines (often called 'clear and continuous lines')
- show the outlines of the tissues
- make the proportions of tissues in the diagram the same as in the section
- do not include drawings of cells
- do not use any shading or colouring.

Add labels and annotations (notes) to your drawing only if you are asked for these in the question. Use a pencil and a ruler to draw straight lines from the drawing to your labels and notes. Write labels and notes in pencil in case you make a mistake and need to change them. You may leave your labels and notes in pencil – do not write over them in ink.

High power drawings should show a small number of cells and they should be drawn a reasonable size so you can show any detail inside them. When you make a high power drawing, follow these simple rules:

- make the drawing fill most of the space provided; leave space around the drawing for labels and annotations (if required by the question)
- use a sharp HB or B pencil (never use a pen)
- use clear, continuous lines (see above)
- draw only what is asked in the question, e.g. three cell types or one named cell and all cells adjoining it
- show the outlines of the cells
- the proportions of the cells in the drawing must be the same as in the section you are drawing
- plant cell walls should be shown as double lines with a middle lamella between the cells; the proportions of cell walls should be drawn carefully.
- show any details of the contents of cells – draw what you see, not what you know should be present; for example, in plant cells you may see nuclei, chloroplasts and vacuoles
- do not use any shading or colouring.

Taking measurements of specimens and photographs

Using an eyepiece graticule

An eyepiece graticule is a glass disc with a printed scale that fits inside the eyepiece on your microscope. It allows you to take measurements of the specimens you view with the microscope. You can measure simply in graticule units, but you may be asked to make an actual measurement which involves calibrating the graticule using a stage micrometer. This is done by lining up the graticule with the divisions on the micrometer.

- Make your measurements as accurately as you can. You will probably be able to measure to the nearest division on the scale on the eyepiece graticule.
- You may be asked to take several measurements and then calculate a mean.

Taking measurements from photographs

You may have to measure an object on a photograph and calculate the actual size of a structure or the magnification of an image.

- Always measure photographs in millimetres, not centimetres.
- If you have to use your measurements in a calculation, write neatly and show your working. The person marking your paper might be able to give you marks for knowing what to do even if you make a mistake or do not finish the calculation.

Presenting data and observations

Tables

Before you start to draw a table, decide what you wish to record. Decide on how many columns and how many rows you will need. Make sure you have read all the instructions before you draw the table outline.

Follow these rules:

- use the space provided, do not make the table too small
- leave some space to the right of the table in case you decide you need to add one or more columns
- make the table ready to take observations or readings so that you can write them directly into the table rather than on another page and then copy them into the table (tables need to show all the raw data you collect)
- draw the table outlines in pencil
- rule lines between the columns and rows
- rule lines around the whole table
- write brief, but informative headings for each column
- columns headed with physical quantities should have appropriate SI units
- when two or more columns are used to present data, the first column should be the independent variable; the second and subsequent columns should contain the dependent variables
- entries in the body of the table should be brief – they should be single words, short descriptive phrases or numbers
- data should be recorded in the table in the order in which it is collected – this is because the table is prepared before the data collection. For example, if the instructions state that results from the highest temperature or highest pH is to be recorded first then these go at the top of their respective columns. It is more usual to arrange the values of the independent variable in ascending order (e.g. from 0 to 100) so that patterns are easier to follow and that is how data in tables for Papers 1, 2, 4 and 5 are usually presented
- numbers written into the body of the table do not have units (units only appear in the column headings).

You may have to process your results by calculating rates of reaction, changes in length, percentage changes or means of repeat readings. These processed results can appear in the same table with the raw data that you have collected or can be in a separate table with the independent variable.

The solidus or slash (/) meaning 'per' should not be used for compound units. For example, if you have to include concentrations in a table you do not write g per 100 cm^3 as g/100 cm^3 . It should always be written out in full using 'per' or, better, as g 100 cm^{-3}. The negative exponent, cm^{-3} , means 'per'.

Note that the solidus is used to separate what is measured from the unit in which it is measured. You may notice that text books and examination papers use brackets around the units in tables. This is also an accepted convention, but the solidus is the convention used in Cambridge International AS and A Level Biology.

Correct and incorrect ways of showing units in tables and graphs

Correct	Incorrect
either: rate / mm cm^{-3} *or:* rate (mm cm^{-3})	rate mm/cm^3
either: concentration / g 100 cm^{-3} *or:* concentration (g 100 cm^{-3})	concentration g/100 cm^3

A note on the uses of ticks and crosses in tables. Do not use ticks and crosses in tables of results which should show observations, such as the colours obtained in biochemical tests.

Ticks and crosses may be used in tables of comparison if there is a key to explain what they mean, e.g. [✓] = present; [✗] = absent.

You may want to show anomalous results in tables. If so circle them and put a note underneath the table to explain that they are anomalous results.

You may be asked to compare specimens viewed in the microscope and/or in photographs. These comparisons must be organised into a table. Draw your table so that it has a first column for the features that you have observed. You can then present both similarities and differences:

Feature	Specimen **A**	Specimen **B**
	Similarities	

Charts and graphs

Bar charts have separate columns that do not touch – there are gaps in between; histograms have columns that do touch each other. Bar charts are used to show data on discontinuous variables, for example blood groups, eye colour, etc.; histograms are used to show data on continuous variables, e.g. length, mass, speed, volume, etc.

Bar charts

Bar charts should be used if the independent variable is qualitative. If you are investigating the rate of respiration of yeast when given different substrates, the independent variable is the type of substrate, e.g. glucose, maltose, sucrose, etc. In this case there is no continuous scale for the independent variable and a bar chart is the appropriate way to present the results. The dependent variable is continuous as it is the rate of respiration and would be measured in units such as 'rate of carbon dioxide production / $cm^3\ s^{-1}$'

Rules for drawing bar charts:

- use most of the grid provided, do not make the chart too small
- draw the chart in pencil
- bar charts can be made of lines, or more usually, blocks of equal width. There must be space between the lines or bars.
- the intervals between the blocks on the x-axis should be equidistant
- the y-axis should be properly scaled with equidistant intervals; the scale should usually start at 0 and this should be written at the base of the axis. If all the numbers are large a displaced origin may be used but the start number should be clear at the base of the y-axis
- the y-axis should be labelled with the headings and units taken from the table of results
- the lines or blocks should be arranged in the same order as in the table of results
- each block should be identified; there is no need to shade the blocks or colour code them.

Histograms

Do not confuse bar charts with histograms. A histogram is drawn for continuous data that is subdivided into classes. A good example is collecting data on continuous variables, such as linear measurements or mass. Sometimes the intervals can be whole numbers, for example the numbers of seeds in fruits. If you are analysing data then you may wish to draw a frequency histogram to see if the data shows a normal distribution.

First the raw data needs to be organised into classes.

- The number of classes needs to be established. This will largely depend on the type and nature of the data.
- The rule for determining the number of classes is $5 \times \log_{10}$ total number of readings.
- The range within each class needs to be determined; this is usually the total range divided by one less than the number of classes.

- There should be no overlap in the classes, e.g.

  4.01 to 5.20 or 4.01 < 5.21

  5.21 to 6.40 or 5.21 < 6.41 (< = less than)

The data should be organised using a tally chart and using 'five bar gates' to indicate 5, as in *///* = 5

Follow these rules when drawing a histogram:

- use most of the grid provided, do not make the histogram too small
- draw the histogram in pencil
- the x-axis represents the independent variable and is continuous. It should be labelled clearly with an appropriate scale
- the blocks should be drawn touching
- the area of each block is proportional to the size of the class. It is usual to have similar sized classes so the widths of the blocks are all the same
- the blocks should be labelled, e.g. '3.0 to 3.9' which means that 3.0 is included in this class, but 4.0 is not. 4.0 will be included in the next class: 4.0 to 4.9
- the y-axis represents the number or frequency and should be properly scaled with equidistant intervals. It should be labelled with appropriate units.

Line graphs

Line graphs are used to show relationships in data which are not immediately apparent from tables. The term graph applies to the whole representation. The term curve should be used to describe both curves and straight lines which are used to show trends.

Follow these guidelines:

- use at least half the grid provided, do not make the graph too small
- draw the graph in pencil
- the independent variable should be plotted on the *x*-axis
- the dependent variable should be plotted on the *y*-axis
- each axis should be marked with an appropriate scale. The origin should be indicated with a 0. The data should be examined critically to establish whether it is necessary to start the scale(s) at zero. If not, you may have a displaced origin for one or both axes, but this must be made obvious by labelling the displaced origin very clearly
- each axis should be scaled using multiples of 1, 2, 5 or 10 for each 20 mm square on the grid. This makes it easy for you to plot and extract data. Never use multiples of 3
- each axis should be labelled clearly with the quantity and SI unit(s) or derived (calculated) units as appropriate, e.g. time / s and concentration / g dm^{-3}; the axes labels and units must be the same as those in the table
- plotted points must be clearly marked and easily distinguishable from the grid lines on the graph. Dots in circles ([insert a small dot in a circle]) or small, neatly drawn crosses (x) should be used; dots on their own should not. If you need to plot three lines, vertical crosses (+) can also be used
- label each line carefully or use a key. Use a pencil for both lines; do not use a blue or black pen or different colours
- in Paper 3 there are usually five or six results to plot.

After plotting the points you need to decide if any of them are anomalous. Ask yourself the question 'do they fit the trend?'. But what is the trend? You should know something about the theory behind the investigation so you should be aware of the likely trend. If you think one or more of the results are anomalous, then it is a good idea to ring them. Put a circle on the graph away from the line and put a key to state that the circled point(s) represent anomalous result(s).

The next thing to decide is how to present the curve.

- It may be obvious that the points lie on a straight line; for example, the effect of enzyme concentration on the rate of an enzyme-catalysed reaction. If you have a result for the origin (0, 0) then that must be included and you can place a clear plastic ruler on the grid and draw a straight line from the origin making sure that there is an even number of points on either side of the line. If you do not have a result for the origin, then start the line at the first plotted point. Do not continue the line past the last plotted point.
- You should only draw a smooth curve if you know that the intermediate values fall on the curve. You may be expecting the relationship to be a smooth curve and if the points seem to fit on a curve then draw one. Again decide whether the origin is a point and, if not, start at the first plotted point. The curve should go through as many points as possible, but try to make sure there is an even number of points on either side of the line. Do not continue past the last plotted point.

- In the practical examination you may only have five or six results. These are likely to be single results rather than means of replicate results. Therefore you cannot be sure of the relationship and should not draw a straight line or a curve as described above. You should draw straight lines between the points. This indicates uncertainty about the results for values of the independent variable between those plotted.
- If a graph shows more than one line or curve, then each should be labelled to show what it represents.

Bar charts, histograms and line graphs should normally have informative titles. There is no need to give titles in the exam as it is obvious what they are. In all other circumstances give informative titles.

If you have times in minutes and seconds, never use minutes as the unit on a graph. It is very difficult to use a scale with each small square representing 3 or 6 seconds. Always plot results in seconds unless the unit for time is whole minutes.

Analysis, conclusions and evaluation

As part of analysis you should be able to:

- identify anomalous results. Anomalous results are those that do not fit the trend
- process your results to calculate means, percentages, changes in mass or length, calculate percentage changes and rates of reactions
- find unknown quantities by using axis intercepts or estimating from colour standards using known concentrations
- describe the pattern or trend in data as shown in tables, charts and graphs
- make conclusions to consider whether experimental data supports hypotheses or not.

Processing results

You should be prepared to calculate:

- means
- percentages
- percentage changes
- rates of reaction by calculating 1/t or 1000/t; the unit used is s^{-1}

You should know how to use line graphs to:

- find an intercept – where a line you have drawn crosses a key value on the *x*-axis; for example, finding the water potential of a tissue using percentage change in length of plant tissues
- find the rate of a reaction by calculating the gradient of a line you have drawn.

As part of evaluation you should be able to:

- identify systematic and random errors
- identify the main sources of errors in your investigation
- estimate the uncertainty in measurements. The actual error is half the smallest division on the apparatus you are using
- assess how effective you have been at standardising variables
- suggest improvements to the procedure you have followed
- suggest ways in which the investigation might be extended to answer a new question.

Estimating uncertainty in your results

You may have to estimate the uncertainty or error in your results. For particular apparatus, the error is half the smallest graduation on the apparatus, e.g. if the smallest division is 1.0 cm^3 then the uncertainty would be ±0.5 cm^3. So if you start your measuring at 0 the uncertainty applies where you take your measurement – say at 6.3 cm^3 . So the result is expressed as 6.3 ± 0.5 cm^3.

BUT if you have to start at a measurement other than 0 (for example when taking readings from a burette) the uncertainty applies at both ends, so it is multiplied by two as there is an error at each end, e.g. 7.5 ± 1.0 cm^3.

Similarly, if using a ruler then there would be an error at each end unless you start at 0. The same applies to measuring a quantity in a syringe by sucking up from empty. The error would be half the minimum measurement. But when you take two readings from the syringe (say delivering 2.0 cm^3 by moving the plunger from 6.5 cm3 to 4.5 cm^3) the uncertainty is multiplied by two.

Percentage error is calculated as the error expressed as a percentage of the actual reading. For example if the reading is 7.5 ± 1.0 cm^3, then the percentage error is 1.0/7.5 × 100 = 13.3%.

Conclusions

- Conclusions are brief statements supported with explanations using your knowledge from the AS syllabus.
- Use your own results for your conclusions.
- Before planning what to write for a conclusion, turn back to the beginning of the question and read the introduction. You may have forgotten what you were told about the investigation you have just carried out. Think about the theory and apply it to the results you have obtained.
- Sometimes you are expected to make conclusions about some other data, not the data you have collected.
- Do not write the conclusion you have learned from a class experiment or from theory.
- You should also consider the confidence that you have in your conclusions. For this it is a good idea to consider whether:
  - the standardised variables have been kept constant
  - there were any other variables that were not standardised
  - there were any anomalous results
  - any replicate results were similar or not.
- If you are unsure about any aspect of the practical you have carried out, then you can say that you do not have confidence in your conclusions and give a reason or reasons.

Suggesting improvements

You may be asked to suggest modifications or improvements that will increase the accuracy and validity of the results. As you carry out the practical procedure you should think critically about it and make some notes. If asked to suggest improvements, then look back to these notes for ideas. You can suggest:

- ways to improve the standardisation of variables, for example by using a thermostatically-controlled water bath
- taking replicate results and calculating means
- using a different way to measure the dependent variable so the results are more accurate
- using a different piece of apparatus to measure the dependent variable and reduce the percentage error (see above)

You may also have to justify your suggested improvements. When you do this, make sure you explain how they will improve the confidence you have in the data and therefore in the conclusion.

Advice for Paper 4

- ☐ The data provided in this paper is often more complex than the data provided in Paper 2. Take time to read all the information given in each question and look carefully at any graphs or tables of data and look for patterns or trends. It is a good idea to annotate the information to help you understand all of it.
- ☐ Expect many of the questions to have information and data that is unfamiliar. Read it very carefully to find clues that will help you find out which topics from the syllabus are being tested.
- ☐ Practise analysing information from tables and graphs and making suitable conclusions.
- ☐ Practice writing out genetic diagrams in full showing the phenotypes and genotypes of parental generations and F1 and F2 generations and the genotypes of gametes. Punnett squares should be used to determine the genotypes of F1 and F2 generations.
- ☐ Practice writing out genetic diagrams of test crosses.

Advice for Paper 5

Remember that this is not a practical paper like Paper 3, but does require a lot of experience of practical work. The paper tests your skills of planning, analysis and evaluation. Each question is based on a practical investigation. You can expect that these investigations will be unfamiliar to you. The advice is the same as for other papers: read the information carefully, underline key words and phrases, annotate any diagrams, graphs and tables that you are given.

Paper 5 differs significantly from Paper 3 in its approach to data presentation. As Paper 5 is a written paper rather than a practical paper you are not required to construct tables and complete them with observations or numerical results. You will be given data and be expected to carry out an analysis, interpretation and evaluation. This means that it is assumed that you understand how data is presented.

In Paper 5 you will be asked to do such tasks as:

- identify anomalous results
- process raw data, for example by calculating means, standard deviations, standard errors, ratios and correlations
- identify and describe patterns and trends
- explain raw or processed data.

In most cases the data is more complex than in Paper 3 and often involves making comparisons.

Complex tables, where variables are being compared may have a different layout to the types of tables used in Paper 3 and you should look carefully for the independent variable. In some cases, the table layout means that the dependent variable is a table heading across several columns and the independent variable is given in a row underneath. You may be asked to plot a graph using figures provided although this is less likely than on Paper 3. In addition to the rules given for Paper 3, you should know how to add error bars to line graphs or bar charts using standard deviation or standard error. You should certainly understand why error bars are added to graphs. In other cases, a graph plotted from the results of an investigation may be given and labels for the axes required. In this case units would be expected which may be in table headings or may have to be deduced from information in the question.

Paper 5 may also use scatter graphs or correlation curves to show the effect of one variable on another. You should know how to interpret these forms of presentation. You should know how to make a sketch graph to predict the results of an investigation. As always, the axes should be orientated with the independent variable as the x-axis and the dependent variable as the y-axis.

Axis labels are expected. Units are not required in sketch graphs unless they are specified in the question.

Planning investigations

One of the questions involves writing a plan for an investigation. You will be given some information about the investigation and this will be enough material for you to write your plan.

The skills that you are being tested on are:

1. Identifying key variables.
2. Describing a workable practical procedure.
3. Selecting appropriate methods for measuring the independent variable.
4. Selecting appropriate methods for varying and measuring the dependent variable.
5. Selecting appropriate methods for controlling other variables.
6. Suggesting a suitable control experiment.
7. Suggesting a quantitative, testable, prediction.
8. Selecting equipment of a level of precision appropriate to ensure accuracy.
9. Planning to collect sufficient replicate results.
10. Describing how results will be recorded.
11. Suggesting how results will be analysed.
12. Risk assessing the practical procedure.

☐ When you read through the information provided on the paper, try to work out three main things:

1. what should be changed – this is the independent variable
2. what is going to be measured – this is the dependent variable
3. what should be kept the same – these are the control variables

☐ You should organise your plan under several headings and then write as concisely as possible. Suitable headings are:

- hypothesis and/or prediction
- variables
- risk assessment
- method
- collecting results
- analysis of results.

- ☐ Some investigations need to have two parts.
  - The experimental – which measures the process being studied and contains the living organism, part of an organism (e.g. a leaf) or enzyme being tested.
  - The control – which will be exactly the same as the experimental except that the living organism will be missing or replaced by something non-living. The control shows that the results are due to the activity of the living organism and is not due to the apparatus or an environmental factor.
- ☐ Make sure you explain carefully how to standardise the control variables; for example, 'put test-tubes in to a thermostatically-controlled water bath' is better than 'keep the test-tubes at the same temperature'.
- ☐ All investigations should be repeated If the same results are achieved (or the results are very similar) then this increases the confidence that can be placed in any conclusions. You can also include the calculation of means and standard deviation in your plan under the heading of analysis of results.
- ☐ Always give quantities in appropriate terms –avoid the use of the word 'amount' as this does not convey precise meaning to any specific quantity. 'Amount' could mean volume, mass or concentration. For example, you can give the volume in cm3, mass in grams and concentration in an appropriate unit, such as grams 100 cm-3.
- ☐ Suggest appropriate volumes and concentrations in your plan. Include instructions on making up dilutions either by serial dilution or proportional dilution. You should have learnt how to do this when preparing for Paper 3.
- ☐ Choose apparatus that will give precise results. For example, if you are measuring using a syringe or measuring cylinder it may be difficult to measure to the nearest cm3. You should think about ways in which the precision can be improved before writing your answer.
- ☐ Write out your method as a list of numbered steps as if you are writing a set of instructions for someone else to follow. Think of your method as a recipe.
- ☐ Carry out a risk assessment on your plan. You should state at least one hazard that is specific to the investigation and a suitable safety precaution.

Analysing data, making conclusions and evaluation

In preparation for Paper 3, you will have learnt how to analyse data, draw graphs, evaluate data and experimental methods, and make conclusions. You will be tested on these skills in Paper 5. In addition, you should know about some statistical methods and apply them to the data provided.

There is always a question that asks you to analyse the data from an investigation. You should know about the following aspects of statistics:

- calculating standard deviation and standard error (formulae will be provided)
- using statistical tests – the chi-squared test, the t-test, and the Pearson and Spearman tests for correlation (formulae for these tests will be provided)
- making a null hypothesis.

You should know when and how to use these methods. There are several different styles of questions that test your understanding of these statistical methods. The best preparation is to look at the way data is presented in past paper questions and see what sort of questions are asked.

Revision checklists

The tables below can be used as a revision checklist: **They don't contain all the detailed knowledge you need to know, just an overview of groups of learning outcomes from each of the topics (1 to 19)**. You must use the syllabus as the source of information about what you should learn and what you should be able to do. For more detail see the syllabus and talk to your teacher.

The table headings are explained below:

Topic	You should be able to	R	A	G	Comments
		You can use the tick boxes to show when you have revised an item and how confident you feel about it. R = RED means you are really unsure and lack confidence; you might want to focus your revision here and possibly talk to your teacher for help A = AMBER means you are reasonably confident but need some extra practice G = GREEN means you are very confident. As your revision progresses, you can concentrate on the RED and AMBER items in order to turn them into GREEN items. You might find it helpful to highlight each topic in red, orange or green to help you prioritise.			You can use the 'Comments' column to: • add more information about the details for each point • add formulae or notes • include a reference to a useful resource • highlight areas of difficulty or things that you need to talk to your teacher about or look up in a textbook.

Cambridge International AS Level Biology consists of Papers 1, 2 and 3

Papers 1, 2 and 3

Topic	You should be able to	R	A	G	Comments
1 Cell structure	• Use the list microscope to study animal and plant cells and tissues. • Recognise organelles and other cell structures in images of eukaryotic cells and outline their functions. • Compare eukaryotic cells with prokaryotic cells and viruses.	☐	☐	☐	
2 Biological molecules	• Describe how to carry out tests for reducing sugars, non-reducing sugars, starch, lipids and proteins. • Describe the structure and functions of carbohydrates, lipids and proteins. • Describe hydrogen bonding and some of the roles of water in living organisms.	☐	☐	☐	
3 Enzymes	• Describe and explain the action of enzymes. • Outline the use of a colorimeter for measuring the progress of enzyme-catalysed reactions. • Describe and explain the effects of factors on the rate of enzyme-catalysed reactions.	☐	☐	☐	
4 Cell membranes and transport	• Describe the fluid-mosiac model of membrane structure. • Describe the roles of the components of cell surface membranes. • Outline the main stages of cell signalling. • Describe and explain the processes by which substances move in and out of cells.	☐	☐	☐	
5 The mitotic cell cycle	• Describe and explain how cells divide during the mitotic cell cycle including the behaviour of chromosomes. • Outline the role of telomeres and stem cells. • Explain how uncontrolled cell division can result in the formation of tumours.	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
6 Nucleic acids and protein synthesis	• Describe the structure of nucleic acids (DNA and RNA).	☐	☐	☐	
	• Describe semi-conservative replication.	☐	☐	☐	
	• Describe the principles of the genetic code.	☐	☐	☐	
	• Describe the processes involved in the production of proteins including transcription, translation and the removal of introns to form mRNA.	☐	☐	☐	
	• Outline the effects of different types of gene mutation on the structure of polypeptides.	☐	☐	☐	
7 Transport in plants	• Describe the distribution of transport tissues (xylem and phloem) in dicotyledonous plants.	☐	☐	☐	
	• Relate the structure of xylem vessel elements and phloem sieve tube elements to their functions.	☐	☐	☐	
	• Describe the pathways and mechanisms of water transport and assimilate transport.	☐	☐	☐	
8 Transport in mammals	• Describe the structure and function of the mammalian circulatory system.	☐	☐	☐	
	• Describe how tissue fluid is formed and state the functions of tissue fluid.	☐	☐	☐	
	• Describe and explain the transport of oxygen and carbon dioxide.	☐	☐	☐	
	• Describe the structure, function and control of the heart.	☐	☐	☐	
9 Gas exchange	• Describe the structure and functions of the mammalian gas exchange system.	☐	☐	☐	
10 Infectious diseases	• State the name and type of pathogen that causes each of the following infectious diseases: cholera, malaria, tuberculosis and HIV/AIDS.	☐	☐	☐	
	• Explain how the four infectious diseases are transmitted and discuss the factors that influence the prevention and control of these disease.	☐	☐	☐	
	• Outline how penicillin acts on bacteria and discuss the consequences of antibiotic resistance.	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
11 Immunity	• Describe the structure and function of the immune system.	☐	☐	☐	
	• Relate the structure of antibodies to their functions.	☐	☐	☐	
	• Outline how monoclonal antibodies are produced and used in diagnosis and treatment.	☐	☐	☐	
	• Describe the differences between active and passive immunity and between natural and artificial immunity.	☐	☐	☐	
	• Explain how vaccination programmes help to control the spread of infectious diseases.	☐	☐	☐	

Paper 3 - Advanced Practical Skills

Topic	You should be able to	R	A	G	Comments
Cell structure	• Make temporary preparations of cellular material suitable for viewing with a light microscope.	☐	☐	☐	
	• Draw cells from microscope slides and photomicrographs.				
	• Calculate magnifications of images and actual sizes of specimens from drawings, photomicrographs and electron micrographs (scanning and transmission).	☐	☐	☐	
	• Use an eyepiece graticule and stage micrometer scale to make measurements and use the appropriate units, millimetre (mm), micrometre (μm) and nanometre (nm).	☐	☐	☐	
	• Recognise organelles and other cell structures found in eukaryotic cells in microscope slides, photomicrographs and electron micrographs.	☐	☐	☐	
	• Describe and interpret photomicrographs, electron micrographs and drawings of typical plant and animal cells.	☐	☐	☐	
	• Compare the structure of typical plant and animal cells by listing similarities and differences between them.	☐	☐	☐	
Biological molecules	• Carry out the Benedict's test for reducing sugars, the iodine test for starch, the emulsion test for lipids and the biuret test for proteins.	☐	☐	☐	
	• Carry out a semi-quantitative Benedict's test on a reducing sugar solution by standardising the test and using the results (time to first colour change or comparison to colour standards) to estimate the concentration.	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
	• Carry out a test to identify the presence of non-reducing sugars, using acid hydrolysis and Benedict's solution.	☐	☐	☐	
Enzymes	• Investigate the effects of the following factors on the rate of enzyme-catalysed reactions: – temperature – pH – enzyme concentration – substrate concentration – inhibitor concentration.	☐	☐	☐	
	• Investigate the difference in activity between an enzyme immobilised in alginate and the same enzyme free in solution.	☐	☐	☐	
Movement into and out of cells	• Investigate simple diffusion and osmosis using plant tissue and non-living materials, including dialysis (Visking) tubing and agar.	☐	☐	☐	
	• Investigate the effect of changing surface area to volume ratio on diffusion using agar blocks of different sizes.	☐	☐	☐	
	• Investigate the effects of immersing plant tissues in solutions of different water potentials, using the results to estimate the water potential of the tissues.	☐	☐	☐	
The mitotic cell cycle	• Interpret photomicrographs, diagrams and microscope slides of cells in different stages of the mitotic cell cycle and identify the main stages of mitosis.	☐	☐	☐	
Transport in plants	• Draw plan diagrams of transverse sections of stems, roots and leaves of herbaceous dicotyledonous plants from microscope slides and photomicrographs.	☐	☐	☐	
	• Draw and label xylem vessel elements, phloem sieve tube elements and companion cells from microscope slides, photomicrographs and electron micrographs.	☐	☐	☐	
Transport in mammals	• Recognise arteries, veins and capillaries from microscope slides, photomicrographs and electron micrographs and make plan diagrams showing the structure of arteries and veins in transverse section (TS) and longitudinal section (LS).	☐	☐	☐	
	• Recognise and draw red blood cells, monocytes, neutrophils and lymphocytes from microscope slides, photomicrographs and electron micrographs.	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
Gas exchange	• Recognise cartilage, ciliated epithelium, goblet cells, squamous epithelium of alveoli, smooth muscle and capillaries in microscope slides, photomicrographs and electron micrographs. • Recognise trachea, bronchi, bronchioles and alveoli in microscope slides, photomicrographs and electron micrographs and make plan diagrams of transverse sections of the walls of the trachea and bronchus	☐	☐	☐	

In addition to the content from the syllabus you will be tested on the skills that you have developed during your course.

Skill	You should be able to	R	A	G	Comments
Manipulation, measurement and observation					
	• Identify the independent variable and dependent variable. • Decide a suitable range of values to use for the independent variable at which measurements of the dependent variable are recorded. • Decide the number of different values of the independent variable (a minimum of five) and the intervals between them. • Decide how to change the value of the independent variable. • Decide how the dependent variable should be measured. • Decide the number of replicates at each value. • Decide on appropriate controls for the experiment or investigation. • Decide which variables need to be standardised and how to standardise them.	☐	☐	☐	
Collection of data and observations					
	• Follow instructions to collect results. • Consider the hazards of the procedure, including the use of any solutions and reagents, and assess the risk as low, medium or high. • Take readings to obtain accurate data (quantitative results) or observations (qualitative results).	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
Presentation of data and observations					
	• Record raw results (unprocessed) and calculated results (processed) in an appropriate table with: – descriptive headings, including any required units (no units in body of table) – heading for the independent variable to the left of (or above, if the table is in rows) the dependent variable.	☐	☐	☐	
	• Record quantitative data to the number of decimal places that is appropriate for the measuring instrument used.	☐	☐	☐	
	• Record qualitative observations using clear descriptions.	☐	☐	☐	
	• Record calculated values (processed results) in an appropriate table.	☐	☐	☐	
Layout of data and observations	• Display data as a graph (continuous data), bar chart (discontinuous or categoric) or histogram (frequency data).	☐	☐	☐	
	• Draw a graph, bar chart or histogram clearly and accurately with: – the independent variable on the x-axis and the dependent variable on the y-axis – axes labelled to match the relevant table headings, including units where appropriate – a scale where both axes should use most or all of the grid available and allow the graph to be read easily to within half a square – all graph points plotted accurately using a sharp pencil, as a small cross or a small dot in a circle, with the intersection of the cross or centre of the dot exactly on the required point – the plotted points of a graph connected with a clear, sharp and unbroken line, either as a line of best fit, a smooth curve or with ruled straight lines joining the points – no extrapolation of graph lines unless this can be assumed from the data – all bars on a bar chart or histogram plotted accurately, with clear, unbroken lines that are drawn with a sharp pencil and ruler.	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
Analysis, conclusions and evaluation					
Interpreting data and observations	• Calculate an answer with the correct number of significant figures using quantitative results or data provided. (The correct number is the same as, or one more than, the smallest number of significant figures in the data used in a calculation.)	☐	☐	☐	
	• Use a graph to find unknown values.	☐	☐	☐	
	• Estimate the concentrations of unknown solutions from qualitative results.	☐	☐	☐	
	• Identify the contents of unknown solutions using biological molecule tests.	☐	☐	☐	
	• Identify anomalous results and suggest how to deal with anomalies.	☐	☐	☐	
	• Describe patterns and trends using the data provided in tables and graphs.	☐	☐	☐	
	• Evaluate the confidence with which conclusions might be made.	☐	☐	☐	
Drawing conclusions	From results, observations or information provided, you should be able to: • summarise the main conclusions	☐	☐	☐	
	• state and explain whether a hypothesis is supported	☐	☐	☐	
	• make predictions from the patterns and trends in data	☐	☐	☐	
	• suggest explanations for observations, results, patterns, trends and conclusions.	☐	☐	☐	
Identifying sources of error and suggesting improvements	Within an investigation, you should be able to: • identify systematic or random errors in an investigation, understanding that systematic errors may not affect	☐	☐	☐	
	• the trend in results whereas a random error may affect the trend	☐	☐	☐	
	• identify the main sources of error in a particular investigation	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
	• suggest improvements to a procedure that will increase the accuracy of the observations or measurements, including: – using a more effective method to standardise relevant variables – using a more accurate method of measuring the dependent variable – using smaller intervals for the values of the independent variable – collecting replicate measurements so that a mean can be calculated	☐	☐	☐	
	• suggest how to extend the investigation to answer a new question, for example by investigating a different independent variable or applying the method to a new context	☐	☐	☐	
	• describe clearly, in words or diagrams, improvements to the procedure or modifications to extend the investigation.	☐	☐	☐	
When using the light microscope and photomicrographs					
Decisions relating to measurements and observations	• set up a light microscope to view and observe specimens	☐	☐	☐	
	• follow instructions to find and draw particular tissues in plant and animal specimens and label the drawings appropriately	☐	☐	☐	
	• follow instructions to find and draw particular cells and structures within the cells	☐	☐	☐	
	• make a temporary slide of stained cells or tissues	☐	☐	☐	
	• calculate actual sizes of tissues or cells from measurements of photomicrographs, using magnifications, scale bars or representations of eyepiece graticules and stage micrometers	☐	☐	☐	
	• estimate the number of cells or cell organelles in a given area using a sampling method, such as grids or fields of view.	☐	☐	☐	
Collection of data and observations	• draw plan diagrams to show the distribution of tissues in a specimen, with no cells drawn and the correct proportions of layers of tissues	☐	☐	☐	
	• draw the observable features of cells in a specimen showing: – the correct shapes – the thicknesses of cell walls where applicable (drawn with two lines or drawn with three lines where two cells touch) – the relative sizes and proportions – observable cell contents only	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
Recording data and observations	• record the fine details of the specimen, including drawing the detailed shapes of layers or outlines of specimens in plan diagrams and drawing the shape and position of observable cell organelles in cells. • make drawings, using a sharp pencil to give finely drawn lines that are clear and unbroken • make drawings that use most of the available space and show all the features observed in the specimen, with no shading • organise comparative observations, showing differences and similarities between specimens.	☐	☐	☐	
Interpreting data and observations	• calculate an answer with the correct number of significant figures using quantitative results or data provided • compare observable features of specimens of biological material including similarities and differences between specimens on a microscope slide and specimens in photomicrographs.	☐	☐	☐	
Identifying sources of error and suggesting improvements	• See above	☐	☐	☐	

Cambridge International A Level Biology consists of the three AS papers and Papers 4 and 5.

Paper 4

You should also revise Topics 1-11 before taking Paper 4.

Skill	You should be able to	R	A	G	Comments
12 Energy and respiration	• Outline the need for energy in living organisms and describe the features and role of ATP as the universal energy currency. • Explain the relative energy values of respiratory substrates and explain how the respiratory quotient (RQ) is calculated. • Describe investigations to determine the respiratory quotients of seeds or small invertebrates. • Describe the four stages of aerobic respiration. • Outline lactate fermentation and ethanol fermentation and compare the energy yields with aerobic respiration. • Describe investigations using redox indicators to determine effects of temperature and substrate concentration on rate of respiration of yeast.	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
13 Photosynthesis	• Describe the structure and function of chloroplasts.	☐	☐	☐	
	• Outline the roles of pigments in photosynthesis.	☐	☐	☐	
	• Outline the light-dependent stage and light-independent stage of photosynthesis.	☐	☐	☐	
	• Describe how chromatography is used to separate and identify photosynthetic pigments.	☐	☐	☐	
	• Describe investigations to determine the effects of limiting factors (light intensity, carbon dioxide concentration and temperature) on the rate of photosynthesis.	☐	☐	☐	
14 Homeostasis	• Explain the term *homeostasis* and explain the principles of homeostasis and negative feedback with reference to osmoregulation and the control of the concentration of glucose in the blood.	☐	☐	☐	
	• Describe the processes involved in excretion in mammals.	☐	☐	☐	
	• Describe the principles of cell signalling using the example of glucagon effects on live cells.	☐	☐	☐	
	• Explain the principles of operation of test strips and biosensors for measuring the concentration of glucose in blood and urine.	☐	☐	☐	
	• Explain the role of stomata in homeostasis in plants.	☐	☐	☐	
15 Control and coordination	• Describe the features of the endocrine system and nervous system.	☐	☐	☐	
	• Describe and explain the transmission of nerve impulses along axons across synapses.	☐	☐	☐	
	• Describe the structure of striated muscle and explain the sliding filament model of muscular contraction.	☐	☐	☐	
	• Describe and explain the rapid response of the Venus fly trap.	☐	☐	☐	
	• Explain the roles of auxin and gibberellin in aspects of plant growth.	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
16 Inheritance	• Explain the role of meiosis in life cycles of eukaryotes.	☐	☐	☐	
	• Describe the events that occur during meiosis.	☐	☐	☐	
	• Explain how meiosis and the random fusion of gametes at fertilisation are responsible for variation in offspring.	☐	☐	☐	
	• Interpret and construct genetic diagrams including Punnett squares to explain and predict the results of monohybrid, dihybrid and test crosses using appropriate terminology.	☐	☐	☐	
	• Use the chi-squared test to test the significance of differences between observed and expected results.	☐	☐	☐	
	• Explain the relationship between genes, proteins and phenotype.	☐	☐	☐	
	• Describe and explain some of the methods used to control gene expression in prokaryotes and eukaryotes.	☐	☐	☐	
17 Selection and evolution	• Describe different types of variation within species and explain the roles of genetic and environmental factors on the phenotype.	☐	☐	☐	
	• Use the *t*-test to compare the means of two different samples.	☐	☐	☐	
	• Explain the role of natural selection in evolution	☐	☐	☐	
	• Use the Hardy-Weinberg principle to calculate allele and genotype frequencies in populations.	☐	☐	☐	
	• Describe the principles of selective breeding as applied to examples of animal and plant breeding.	☐	☐	☐	
	• Outline the theory of evolution and discuss how DNA sequence data can show evolutionary relationships between species.	☐	☐	☐	
	• Explain how speciation may occur.	☐	☐	☐	
18 Classification, biodiversity and conservation	• Describe how prokaryotes, eukaryotes and viruses are classified.	☐	☐	☐	
	• Outline the characteristic features of the three domains and the five kingdoms of the Eukarya domain.	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
	• Explain the importance of biodiversity.	☐	☐	☐	
	• Describe various methods to study the biodiversity of one or more ecosystems.	☐	☐	☐	
	• Use Spearman's rank correlation and Pearson's linear correlation to analyse the relationships between two variables.	☐	☐	☐	
	• Use Simpson's index of diversity (D) to calculate the biodiversity of and area and state the significance of values of D.	☐	☐	☐	
	• Explain why populations and species can become extinct and outline the need to maintain biodiversity.	☐	☐	☐	
	• Outline ways to maintain biodoversity, including conserved areas, zoos, botanic gardens, 'frozen zoos' and seed banks.	☐	☐	☐	
	• Explain the reasons for controlling alien species.	☐	☐	☐	
	• Outline the roles of the International Union for the Conservation of Nature (IUCN) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).	☐	☐	☐	
19 Genetic technology	• Describe and explain the principles of genetic technology including gene editing and the polymerase chain reaction.	☐	☐	☐	
	• Describe how gel electrophoresis is used to separate DNA fragments.	☐	☐	☐	
	• Outline the use of microarrays in the analysis of genomes and the expression of genes.	☐	☐	☐	
	• Outline the benefits of using databases of DNA sequences, amino acid sequences and protein structures.	☐	☐	☐	
	• Explain the use of genetic technology in genetic screening, gene therapy and food production.	☐	☐	☐	
	• Discuss the social and ethical considerations of using genetic screening and gene therapy in medicine and using genetically modified organisms in food production.	☐	☐	☐	

Paper 5 - Planning, Analysis and Evaluation

Skill	You should be able to	R	A	G	Comments
Planning					
Defining the problem	• state a relevant prediction, either in words or in the form of a sketch graph showing the expected result, and link this to an underlying hypothesis • identify the independent and dependent variables • identify which key variables must be standardised in order to test a hypothesis.	☐	☐	☐	
Methods	• describe how to vary the independent variable • describe how to measure the values of the independent and dependent variables accurately and to an appropriate precision • describe how to standardise each of the other key variables • describe, where appropriate, suitable volumes and concentrations of reagents. Concentrations may be specified in % (w/v), or mol dm–3 • describe how different concentrations would be prepared by serial dilution or proportional dilution • describe appropriate control experiments • describe, in a logical sequence, the steps involved in the procedure, including how to use the apparatus to collect results • describe how the quality of results can be assessed by considering: – the occurrence of anomalous results – the spread of results including the use of standard deviation, standard error and/or 95% confidence intervals (95% CI) • describe how to assess the validity of the results by considering both the accuracy of the measurements and the repeatability of the results • prepare a simple risk assessment of their plans, taking into account the severity of any hazards and the probability that a problem could occur • describe the precautions that would need to be taken to minimise risks where possible	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
Analysis, conclusions and evaluation					
Dealing with data	From provided data, candidates should be able to: • use tables and graphs to show the key points in quantitative data • sketch or draw suitable graphs, displaying the independent variable on the x-axis and the dependent variable on the y-axis including, where required, confidence limit error bars • decide which calculations are necessary in order to draw conclusions • carry out appropriate calculations to simplify or explain data, including means, percentages and rates of change • carry out calculations in order to compare data, including percentage gain or loss • use values of standard deviation or standard error, or graphs with standard error bars, to determine whether differences in mean values are likely to be statistically significant • choose and carry out statistical tests (limited to those described in the Mathematical requirements section of the syllabus) appropriate to the type of data collected and justify use of these tests • state a null hypothesis for a statistical test • recognise the different types of variable and the different types of data presented.	☐	☐	☐	
Conclusions	• summarise the main conclusions from the results • identify key points of the raw data and processed data, including graphs and statistical test results • discuss the extent to which a given hypothesis is supported by experimental data and the strengths and weaknesses of the evidence • give detailed scientific explanations of the conclusions • make further predictions and hypotheses based on the conclusions.	☐	☐	☐	

Skill	You should be able to	R	A	G	Comments
Evaluation	• identify anomalous values in a table or graph of data and suggest how to deal with anomalies	☐	☐	☐	
	• suggest possible explanations for anomalous readings	☐	☐	☐	
	• assess whether the results have been replicated sufficiently	☐	☐	☐	
	• assess whether the range of values of the independent variable and the intervals between the values were appropriate	☐	☐	☐	
	• assess whether the method of measuring is appropriate for the dependent variable	☐	☐	☐	
	• assess the extent to which selected variables have been effectively controlled	☐	☐	☐	
	• make informed judgements about: – the validity of the investigation – the extent to which the data can be used to test the hypothesis – how much	☐	☐	☐	
	• suggest how an investigation could be improved to increase confidence in the results.	☐	☐	☐	

Section 7: Useful resources

The websites listed below are useful resources to help you study for your Cambridge International AS & A Level Biology.

http://www.biozone.co.uk
This is an excellent gateway to many other websites with useful material to support topics in both AS and A2. Click on Biolinks on the home page.

http://www.cellsalive.com
An interactive website with lots of good images and animations to help you with cell biology, microscopy, microbiology and the immunity section in AS.

http://www.dnaftb.org
DNA from the beginning: on-line tutorials on the structure of DNA , genetics and genetic organisation and control. 41 different topics in all.

https://learn.genetics.utah.edu
Learn.Genetics from the University of Utah. A website full of resources on many aspects of molecular biology and genetics.

http://www.phschool.com/science/biology_place
The Biology Place: find tutorials, animations and tests on a variety of topics including common A level Biology practicals.

http://www.who.ch
The World Health Organization. Use this website to find up-to-date information on the infectious diseases and the progress of vaccination programmes in the AS syllabus.

www.cdc.gov
This is the website of the Centers for Disease Control in the USA. You can also use this website for up-to-date information about diseases.

https://www.cites.org
The Convention on International Trade in Endangered Species of Wild Fauna and Flora. Essential reading for the conservation topic in the A level syllabus.

https://www.iucnredlist.org
The International Union for Conservation of Nature. Use the IUCN database for information on endangered animals and plants when studying conservation.

https://www.youtube.com/channel/UCxUHVv2k31uTOiCm4njuRfQ
Animations from the American publisher McGraw Hill.

http://www.johnkyrk.com/
Animations on various aspects of Cell and Molecular Biology.

http://www.chemguide.co.uk
This is a site that supports Cambridge International AS and A Level Chemistry. You may find this useful for Topic 2 on biological molecules if you are unsure about some basic chemistry.

https://www.rsb.org.uk/education/teaching-resources/secondary-schools/chemistry-for-biologists
Chemistry for Biologists from the Royal Society of Biology which will also help you with Topic 2 on biological molecules.

https://www.biotopics.co.uk
Many useful resources, especially for those starting AS Biology with little or no background in the subject.

www.bozemanscience.com/science-videos
You will find many videos on biological topics on YouTube; this site has video lessons that support Advanced Placement (AP), but are just as suitable for A Level.

www.yourgenome.org
This is the educational website of the Wellcome Trust's Genome Campus in Cambridge, UK. This will bring you up-to-date on many aspects of your course.

Practical Biology

Investigative practical work

http://www.saps.org.uk/
Science and Plants for Schools (SAPS)

http://www.ncbe.reading.ac.uk/
National Centre for Biotechnology Education (NCBE)

http://www.nuffieldfoundation.org/practical-biology
A site devoted to practicals in AS/A courses

http://www.mystrica.com/
The web site of a company that sells colorimeters. The site has much useful information on practical investigations using enzymes.

Microscopy

http://www.histology.leeds.ac.uk/
The Histology Guide (University of Leeds)

http://www.drjastrow.de/WAI/EM/EMAtlas.html
Electron microscopic atlas of cells, tissues and organs. This site has many excellent transmission electron micrographs – all in black and white, not false colour as in many textbooks. Electron micrographs in examination papers are always printed in black and white and you should get used to interpreting them.

www.bu.edu/histology/m/index.htm
The Histology Learning System has many electron micrographs of animal cells (see the section called Ultrastructure of the Cell) and photomicrographs of tissues.

http://botit.botany.wisc.edu/Resources/Botany/
University of Wisconsin (see cells and tissues, plant cell, meiosis, etc.)

Mathematics and Statistics

Handbook of Biological Statistics, John H. McDonald
http://www.biostathandbook.com/

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