Introduction

This document provides guidance on how to construct and mark Higher Biology assessments and should be read in conjunction with the *Higher Biology: Guidance on gathering key evidence in session 2020-21.*

Assessment structure

Approximately 30% of the available marks across the assessment should be targeted at grade A candidates and the remaining marks at grade C candidates. There is no intention of targeting grade B candidates. The probability is that grade B candidates would achieve most grade C marks and some of the grade A marks.

The Higher Biology question paper brief in Appendix 1 gives the structure of the SQA question paper, and the range of marks allocated to scientific problem-solving skills and knowledge and understanding. It gives the abbreviated codes for the knowledge and skills that are assessed. The question paper brief is a useful starting point to ensure that your questions have the correct balance and level of demand for constructing an assessment.

Grade C marks

Questions with grade C marks require candidates to demonstrate successful performance in relation to the skills, knowledge and understanding for the course.

Examples of questions with grade C marks in Paper 1 – Multiple-choice

Example 1 – 2018 Question 15

This question requires candidates to demonstrate their knowledge and understanding through recall of one fact. Candidates are required to state the meaning of cell differentiation.

Each type of human cell has a different structure and function because

A only some of their genes are expressed

B they contain different genes

C some genes are lost during differentiation

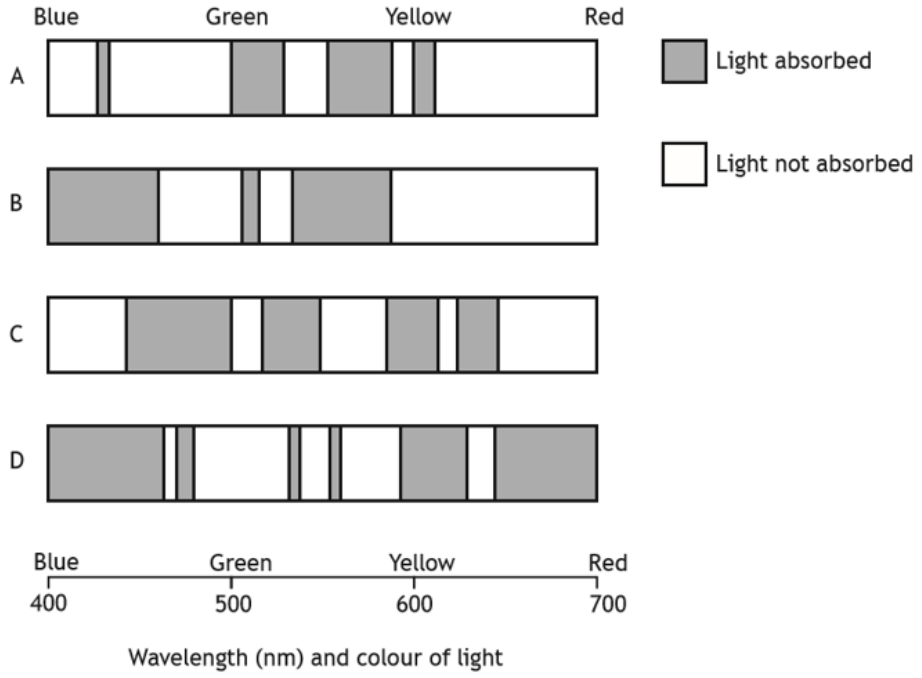
D some genes are gained during differentiation.

Example 2 – 2016 Question 15

This question requires candidates to apply their knowledge and understanding to information in a diagram. They are required to apply the knowledge of photosynthetic pigments to identify the absorption spectrum for chlorophyll.

The following absorption spectra were obtained by testing four different plant extracts.

Which extract contains chlorophyll?



Example 3 – 2018 Question 5

This question requires candidates to consider experimental variables in the design of an investigation and identify the independent variable. This is a planning and designing experiments skill. Most candidates can identify the independent variable.

Yeast cells contain the enzyme catalase which breaks down hydrogen peroxide to produce oxygen. An experiment was carried out into the effect of lead nitrate concentration on the activity of catalase.

Six flasks were set up. Each contained 25 cm^3 of hydrogen peroxide and 10 cm^3 of yeast suspension. 10 cm^3 of a different concentration of lead nitrate was then added to each flask. The volume of oxygen produced after 15 minutes was measured.

Identify the independent variable in this experiment.

A Volume of lead nitrate

B Volume of oxygen produced

C Activity of catalase

D Concentration of lead nitrate

Example 4 – 2017 Question 15

This question requires candidates to make a prediction based on information given in a table.

The table shows optimum, maximum and minimum temperatures for the growth of some crop plants.

	Temperature (°C)		
Crop	*Optimum*	*Maximum*	*Minimum*
Maize	22–26	32–34	20–22
Wheat	20–25	36–38	5–7
Rice	30–33	37–40	18–22
Potato	15–20	28–34	12–14
Soyabean	25–28	37–40	10–14

Which of the following predictions is supported by the evidence in the table?

A Maize will grow at lower temperatures than soyabean.

B Rice will grow at higher temperatures than soyabean.

C Rice will grow in a narrower range of temperatures than maize.

D Wheat will grow in a wider range of temperatures than potato.

Example 5 – 2016 Question 3

This question requires candidates to apply their knowledge and understanding and process information using a simple calculation. Candidates are asked to use their knowledge of PCR to calculate the time required to produce a given number of DNA fragments when told how long one cycle of the process takes.

Each cycle of a polymerase chain reaction (PCR) takes 5 minutes.

If there are 1000 DNA fragments at the start of the reaction, how long will it take for the number of fragments produced by the reaction to be greater than 1 million?

A 15 minutes

B 35 minutes

C 50 minutes

D 55 minutes

Examples of questions with grade C marks in Paper 2

Example 1 – 2018 Question 12(a)(i)

This question requires candidates to demonstrate knowledge about single gene mutations. This is a straightforward piece of factual recall for which the candidate has a choice of two correct answers.

Congenital lactase deficiency in humans is caused by very low activity of the enzyme lactase, resulting in individuals being unable to digest lactose in milk. This is caused by a number of different mutations in the lactase gene.

(a) One of the mutations involved causes a frame-shift mutation in the lactase gene.

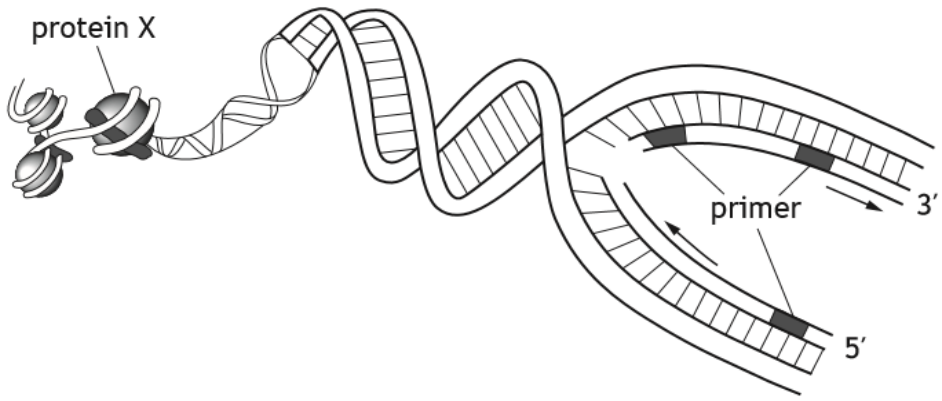
(i) Name a gene mutation which causes a frame-shift. 1

_____

Example 2 – 2019 Question 1(a)

This question requires candidates to demonstrate knowledge from a diagram. They are required to identify a histone from a diagram of a linear chromosome in a eukaryotic cell.

The diagram shows the replication of DNA in a chromosome from a eukaryotic cell. The arrows show the directions of replication.



(a) Name protein X. 1

_____

Example 3 – 2019 Questions 2(a)

This question requires candidates to process information by calculating a simple whole number ratio. Candidates usually have little difficulty with simple whole number ratio calculations.

Three different mutated bacteria, X, Y and Z were studied. Each had a mutation in a different region of its DNA that is transcribed to rRNA.

Protein synthesis was measured in cultures of each mutated bacteria and in a culture of unmutated bacteria.

The results are shown in the table.

Bacterial culture	Protein synthesis (%)
Unmutated	100
X	9
Y	15
Z	90

(a) Calculate the simplest whole number ratio of percentage protein synthesis in cultures X, Y and Z. **1**

Space for calculation

_____ : _____ : _____

Example 4 – 2016 Question 10(b)

This question allows candidates to indicate that they can present information in an appropriate form. Candidates are given readings in a table which they are required to present as a line graph. Higher Biology question papers always contain one question where candidates are asked to draw a graph.

The flask was placed in a water bath at 5 °C and left for 10 minutes.

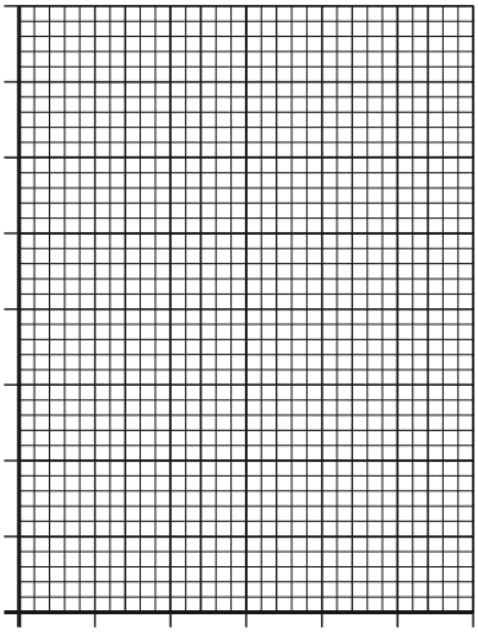
The CO_2 produced per minute was then measured. This procedure was repeated at 10, 15, 20 and 30 °C.

The results are shown in the table below.

Temperature (°C)	*Rate of CO_2 production* (units per minute)
5	300
10	500
15	800
20	1200
30	1600

(b) Plot a line graph to show the results of the investigation. **2**

(Additional graph paper, if required can be found on *Page 31*).



Example 5 – 2018 Question 10(a)(ii)

This question asks candidates to consider variables when planning and designing experiments. They are required to identify variables which should be controlled so that a valid conclusion can be drawn. There are usually several possible correct answers in a question of this type, and it is a skill which most candidates demonstrate successfully.

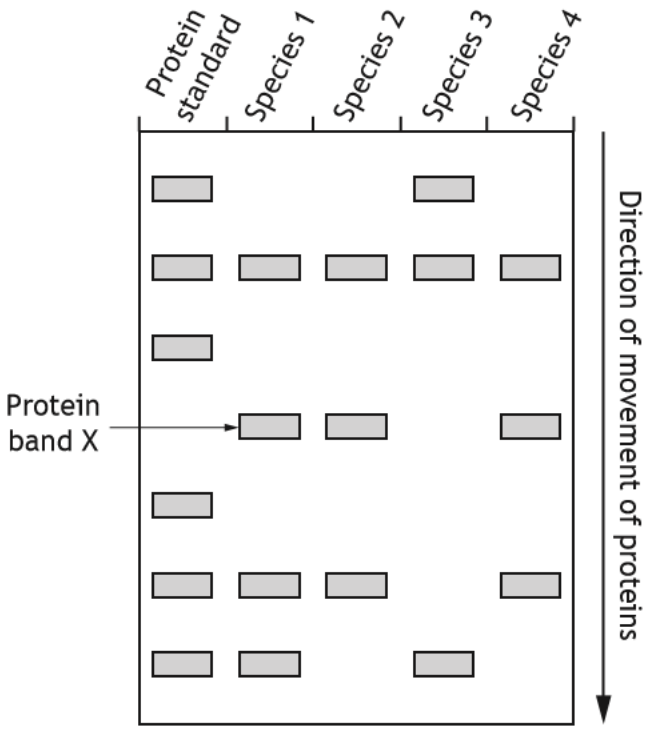
An experiment was carried out to investigate the evolutionary relatedness of four species of fish by comparing proteins extracted from the fish. The more closely related species are, the more proteins they have in common.

A sample of muscle tissue from each species of fish was heated in a solution to extract proteins.

The protein extracts were analysed by gel electrophoresis which separates proteins according to their mass. A protein standard containing proteins of known masses was also analysed.

The results of the gel electrophoresis are shown in the diagram. Each band represents a protein.

Mass of protein in protein standard (kDa)	*Distance travelled* (mm)
16	50
20	38
26	30
44	24
66	15
108	10



(a) (i) Identify **two** variables related to the protein extraction, not already mentioned, which should be kept constant so that a valid conclusion can be drawn. **2**

1 _____

2 _____

Grade A marks

Approximately 30% of total available marks should be targeted at grade A candidates.

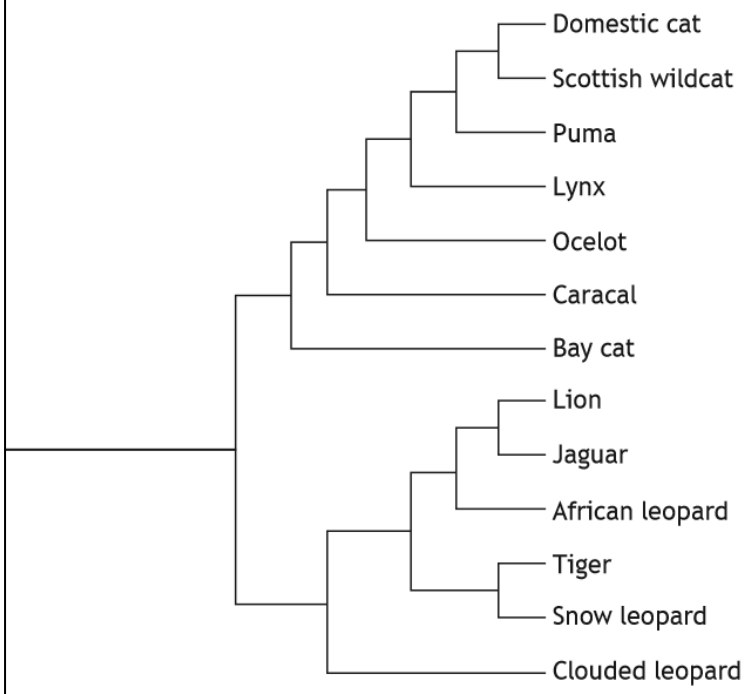
Questions with grade A marks are more demanding and test more complex skills.

Examples of questions with grade A marks in Paper 1 – Multiple-choice

Example 1 – 2016 Question 5

This question requires candidates to apply their knowledge and understanding and select relevant information from a diagram. Candidates have difficulty interpreting phylogenetic trees. Many do not realise that each species shares a common ancestor with all other species in the phylogenetic tree if they go far enough back in time.

The diagram below represents a phylogenetic tree showing the evolutionary relatedness of several species of cat.



With how many species does the African leopard share a common ancestor in this phylogenetic tree?

A 2 only
B 5 only
C 12 only
D 13

Example 2 – 2016 Question 11

This question requires candidates to demonstrate knowledge and understanding of three cell processes involving recall of challenging concepts. They are expected to remember two different events which occur in aerobic respiration and relate these to each of the three stages of aerobic respiration.

Stages of aerobic respiration are shown below.

1 Glycolysis
2 Citric acid cycle
3 Electron transfer chain

Which stage(s) involve(s) **both** phosphorylation of intermediates and generation of ATP?

A 1 only

B 3 only

C 1 and 2 only

D 1 and 3 only

Example 3 – 2018 Question 13

This problem-solving question requires candidates to identify which aspects of an investigation increased reliability of the results. Many candidates find this challenging, and confuse reliability, accuracy, and validity.

An experiment was carried out to investigate the growth rate of pigs. They were put into five groups of eight pigs, each with the same average initial body mass. Each group was fed a diet which contained either 0, 10%, 20%, 30% or 40% faba beans. The pigs were re-weighed each day for 40 days.

Which aspect of the experimental design increased reliability of the results?

A Five groups of pigs were used.

B The pigs were re-weighed each day for 40 days.

C Each group had the same average initial body mass.

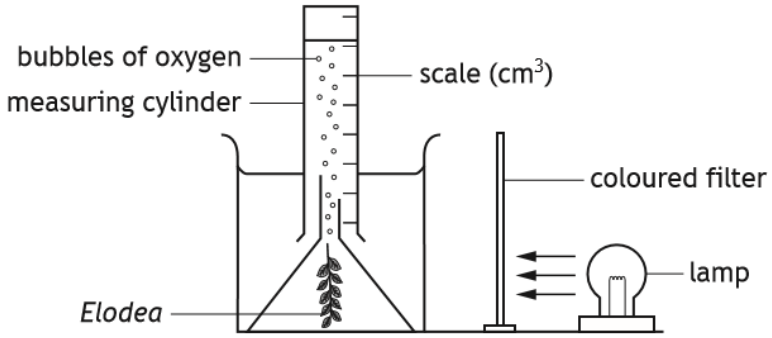
D Each group contained eight pigs.

Example 4 – 2018 Question 9

This question requires candidates to evaluate an experiment and suggest improvements which would make the results of the experiment more accurate. Candidates are required to realise that using a smaller diameter measuring cylinder and a scale with more divisions will increase accuracy. As in the previous example, many candidates confuse accuracy, reliability, and validity.

The diagram shows apparatus used in an investigation to measure the rate of photosynthesis in *Elodea* (pondweed) at different wavelengths of light.

Coloured filters were used to change the wavelength of the light. The volume of oxygen collected after 30 minutes was used to measure the rate of photosynthesis.



Suggested improvements to the investigation are shown.

1 Use a measuring cylinder with a narrower diameter.

2 Repeat the experiment several times and take averages.

3 Use a scale with more divisions.

Which of these suggestions would improve the accuracy of the results?

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

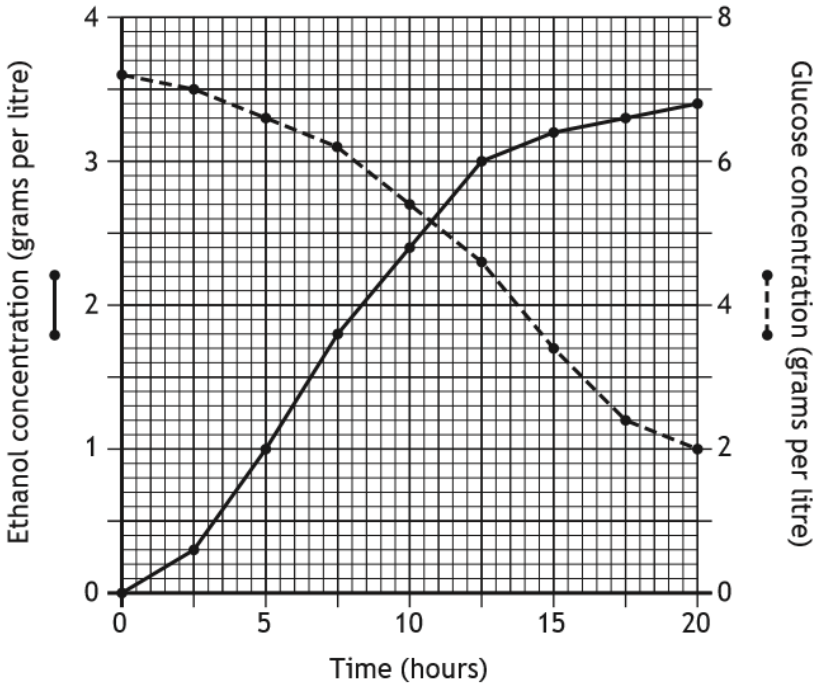
D 1, 2 and 3

Example 5 – 2018 Question 7

This question requires candidates to select information from a graph with two vertical axes with different scales. This is a skill which candidates find challenging as they often read values from the wrong vertical axis. Candidates are expected to have encountered graphs with two vertical axes as Higher Biology question papers usually contain a question of this type.

In an investigation into fermentation, yeast was grown in a flask of glucose solution for 20 hours at 20 °C.

The graph shows the concentrations of ethanol and glucose in the flask over the period of the investigation.



What was the glucose concentration when the ethanol concentration was 3·3 grams per litre?

A 1·2 grams per litre

B 2·2 grams per litre

C 2·4 grams per litre

D 6·6 grams per litre

Examples of questions with grade A marks in Paper 2

Example 1 – 2018 Question 2(a)

This is a processing information question where candidates are asked to calculate an average increase. Candidates are required to calculate the average increase in heart rate across a range of temperatures. Average increase is a calculation which most candidates find difficult. Many candidates simply calculate an average of the five heart rates in the table rather than an average increase.

Daphnia (*Daphnia pulex*) is a species of water flea that lives in fresh water. An investigation was carried out into the effect of water temperature on the heart rate of one Daphnia. The results are shown in the table.

Water temperature (°C)	*Heart rate* (beats per minute)
2	175
7	184
12	194
17	207
22	219

(a) Calculate the average increase in heart rate per °C between 2 °C and 22 °C. 1

Space for calculation

_____ beats per minute per °C

Example 2 – 2019 Question 7(d)

This question requires candidates to demonstrate knowledge by explaining a difficult concept. Most candidates find it difficult to explain how alternative RNA splicing results in different proteins. Providing explanations is more challenging than simply identifying or naming structures or processes.

(d) In eukaryotes, alternative RNA splicing occurs.

Explain how this results in different proteins being expressed from a single gene. 1

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Example 3 – 2017 Question 7(a)

In this question candidates are required to apply their knowledge of aerobic respiration to a new situation. They are asked to explain why cells carrying out active transport have many mitochondria. This requires them to make the link between ATP production in aerobic respiration and that the mitochondrion is where most ATP is produced.

Sea bass are saltwater fish that can regulate their internal salt concentration. They have specialised cells in their gills with protein pumps in the membrane. These pumps actively transport excess salt from their bodies.

(a) The specialised cells have many mitochondria.

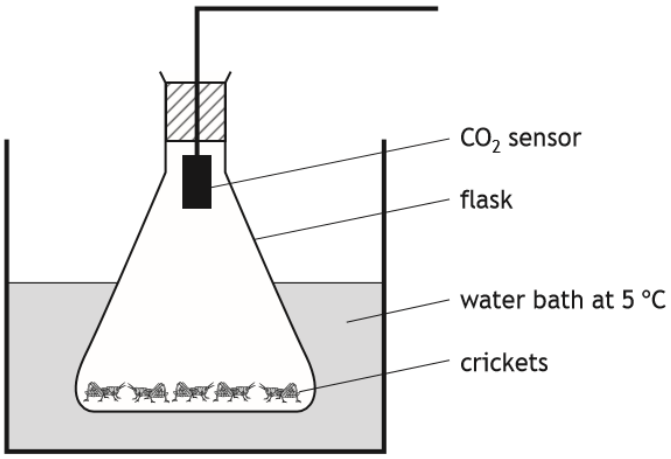
Explain why this is necessary. **2**

Example 4 – 2016 Question 10(c)

This question requires candidates to draw a valid conclusion from a given set of results. The aim of the experiment was to investigate the effect of temperature on metabolic rate and the conclusion should relate to this aim. Many candidates simply restate results and express the conclusion in terms of rate of carbon dioxide production. Candidates should read the stem of the question to identify the aim and then use the results to draw a conclusion.

An investigation was carried out to compare the rate of metabolism in a species of cricket, *Gryllus assimilis*, at different temperatures.

Five crickets were placed in a sealed flask which was fitted with a carbon dioxide (CO_2) sensor as shown in the diagram below.



The flask was placed in a water bath at 5 °C and left for 10 minutes.

The CO_2 produced per minute was then measured. This procedure was repeated at 10, 15, 20 and 30 °C.

The results are shown in the table below.

Temperature (°C)	*Rate of CO_2 production* (units per minute)
5	300
10	500
15	800
20	1200
30	1600

(c) Draw a conclusion from these results. **1**

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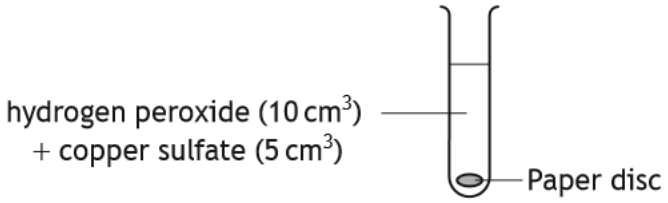
Example 5 – 2017 Question 9(a)(ii)

In this question candidates are assessed in the skill of planning and designing experiments. When asked to describe a suitable control most candidates fail to do this clearly. Many simply suggest leaving out the copper sulfate. They should state that the experiment should be set up the same but the copper sulfate should be replaced with water.

Catalase is an enzyme which breaks down hydrogen peroxide into oxygen and water. Paper discs soaked in catalase sink when placed into hydrogen peroxide solution. The discs rise to the surface when oxygen is produced. The time taken for the discs to rise can be used to measure catalase activity.

An experiment was set up to investigate the effect of copper sulfate concentration on catalase activity.

Six tubes were set up, each containing 10 cm^3 of hydrogen peroxide and 5 cm^3 of a different concentration of copper sulfate. One paper disc was then placed into each test tube as shown in the diagram. The time taken for each paper disc to rise to the surface was recorded.



(ii) Describe a suitable control for this experiment. 1

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Additional information

Extended-response questions

Each assessment should contain two or three extended-response questions of 10–15 marks in total. At least one of these questions should include a choice of topic. In Higher Biology the last question in Paper 2 is a large extended-response question, which contains a choice and has at least three grade A marks. The smaller extended-response question can contain a choice and has at least one grade A mark. The task of linking together a large number of sentences on a topic is a challenging one and grade C candidates typically do not manage to cover enough points to gain full marks.

The subject matter of the question can determine the level of demand, increasing the number of grade A marks.

The following table shows the extended-response questions from SQA past papers and the topics covered.

Year	Question	Topic	Marks
2015	13A	Gene expression	9
	13B	Some content no longer in Higher Biology	9
	5A/B	Hearts/Enzyme inhibitors	4
2016	14A/B	Crop protection/Social behaviour	8
	7A/B	Anabolism and catabolism/Conformers and regulators	4
2017	15A/B	Citric acid cycle/Adverse conditions	7
	10A/B	Primate behaviour/Invasive species	4
2018	14A/B	DNA organisation and PCR/Structure and function of RNA and RNA splicing	9
	11A/B	Biodiversity/Parasitism	4
2019	16A/B	Photosynthesis/Bottleneck effect, habitat fragmentation and habitat corridors	7
	3A/B	Electron transport chain/Enzyme inhibition	4

Large data-handling question

Each assessment should contain one large data-handling question of 5-9 marks. This style of question should have at least one grade A mark.

Large experimental design question

Each assessment should contain one large experimental design question of 5-9 marks. This style of question has at least one grade A mark.

The following table shows the large data-handing, and large experimental design questions from SQA past papers and the topics covered.

Key

DH Data-handling

ED Experimental Design

Year	Question	Topic	Marks
2015	DH – 9 ED – 11	Fertiliser level PCR	9 8
2016	DH – 4 ED – 10	Meristems Metabolic rate	8 6
2017	DH – 5 ED – 9	Phylogenetic tree Enzyme inhibitor	6 8
2018	DH – 6 ED – 10	Squirrel populations Gel electrophoresis	5 8
2019	DH – 7 ED – 12	Genomes Yeast	6 8

The data analysis grids, published separately, provide the structure of the questions in the SQA Higher Biology past papers (2015-2019) by knowledge/skill; key area; maximum mark, and tags questions that performed as grade A. It also indicates where content is no longer part of the Higher Biology course as a result of the revisions to national qualifications (RNQ). The annual course report gives further detail on how specific questions performed.

Marking reliably

Teachers and lecturers should be familiar with the general marking principles for Higher Biology (see Appendix 2) and the published marking instructions that accompany SQA past papers, as these demonstrate the required marking standard.

It is recommended that centre-devised marking instructions follow the same format and standard as those published by SQA. It is good practice to prepare the marking instructions at the same time as the assessment is constructed. Marking instructions can then be refined in light of candidate responses.

Some common marking issues include:

- Inaccurate or inconsistent application of the marking instructions.
- Arithmetical errors when totalling marks.
- Missing marks or allocating marks twice in extended response questions: using numbered ticks helps to identify where marks are allocated; it is important to be consistent in the approach to marking these, and that the marks are totalled correctly.

Marks should only be allocated based on the written response and not what the response infers.

Marking instructions should be agreed between all markers and applied consistently. Cross-marking of a sample of each markers work should occur to ensure the marking instructions have been applied accurately and consistently.

Using cut-off scores

The notional cut-off scores for course assessment are:

70% A grade
60% B grade
50% C grade
40% D grade

Cut-off scores should be appropriate to the instrument of assessment. They should be amended to reflect any differences between centre assessments and SQA question papers.

Such differences could include:

- an assessment being split over a number of sessions rather than a single sitting
- assessments with an insufficient number of grade A marks
- assessments that do not adequately sample the skills, knowledge and understanding of the course, eg they focus on one or two units only
- assessments that do not adequately integrate the skills, knowledge and understanding of the course, eg they focus on knowledge from one unit.

You should raise the cut-off scores above notional difficulty to reflect such differences.

It is important to note that sometimes intended grade A marks perform as relatively straightforward marks. The overall performance of the cohort should therefore be reviewed after all candidates' assessments have been marked. If the grade A marks did not perform as intended, you should consider why this might be and whether the grade cut-off score should be adjusted to reflect candidate performance. For example, if after reviewing candidate answers, a grade A question was deemed too straightforward, you could raise the grade A boundary by 1 mark to reflect this.

A question that is considered as relatively straightforward may yield responses that are significantly different to the marking instructions, suggesting that the wording of the question caused confusion, or that the question was too challenging. Grade cut-off scores may need to be adjusted to reflect this. For example, if after reviewing candidate answers a grade C question was deemed too demanding, you could lower the grade C boundary by 1 mark to reflect this.

Appendix 1 – Higher Biology question paper brief

	Marks		
Component	**Knowledge and understanding**	**Skills**	**Total**
Question papers	85+/-5	35+/-5	120

Knowledge and understanding/skills	**Range of marks**
♦ demonstrating knowledge and understanding of biology by making statements, describing information, providing explanations and integrating knowledge (dKU)	min 30
♦ applying knowledge and understanding of biology to new situations, interpreting information and solving problems (aKU)	min 30
♦ planning and designing experiments/investigations (PLAN)	30–40
♦ selecting information from a variety of sources (SEL)	
♦ presenting information appropriately in a variety of forms (PRES)	
♦ processing information/data (using calculations and units, where appropriate) (PROC)	
♦ making predictions and generalisations based on evidence/information (PRED)	
♦ drawing valid conclusions and giving explanations supported by evidence/justification (CONC)	
♦ evaluating experiments/investigations and suggesting improvements (IMPR)	

Additional information

Two or three extended-response questions: 10–15 marks in total. At least one of the extended-response questions will include a choice of topic.
One large data-handling question: 5–9 marks.
One large experimental design question: 5–9 marks.
Grade A marks: approximately 30%.

Appendix 2 – General marking principles for Higher Biology

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

(a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.

(b) If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

(c) Do not award half marks.

(d) Where a candidate makes an error in the first part of a question, award marks for subsequent answers that are correct with regard to this original error. Do not penalise candidates more than once for the same error.

(e) Unless a numerical question specifically requires evidence of working to be shown, award full marks for a correct final answer (including units, if appropriate) on its own.

(f) Candidates should not use bulleted lists to answer extended-response questions. They must respond to the 'command' word as appropriate and provide extended answers to communicate fully their knowledge and understanding. Candidate responses in the form of bulleted lists may not be able to access the full range of available marks.

(g) In the detailed marking instructions, if a word is underlined then it is essential; if a word is (bracketed) then it is not essential.

(h) In the detailed marking instructions, words separated by / are alternatives.

(i) A correct response can be negated if the candidate includes:

- an extra, incorrect, response
- additional information that contradicts the correct response

(j) Where the candidate is instructed to choose one question to answer but instead answers two questions, mark both responses and award the higher mark.

(k) Unless otherwise required by the question, the use of abbreviations (for example DNA, ATP) or chemical formulae (for example CO_2, H_20) are acceptable alternatives to naming.

(l) If a numerical answer is required and units are not given in the stem of the question or in the answer space, candidates must supply the units to gain the mark. If units are required on more than one occasion, do not penalise candidates repeatedly.

(m) If incorrect spelling is given, sound out the words.

- If the correct word is recognisable then award the mark.
- If the word can easily be confused with another biological term then do not award the mark, for example glucagon and glycogen.

(n) Presentation of data:

- If a candidate provides two graphs, in response to one question, mark both and award the higher mark.
- If a question asks for a particular type of graph/chart and the candidate gives the wrong type, do not award full marks. Candidates cannot achieve the plot mark but may be able to achieve the mark for scale and label. If the x and y data are transposed, then do not award the scale and label mark.
- If the graph uses less than 50% of the axes, then do not award the scale and label mark.
- If 0 is plotted when no data for this is given, then do not award the plot mark — candidates should only plot the data given.

(o) Only award marks for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify**, **name**, **give** or **state**, they need only answer or present in brief form
- **describe**, they must provide a statement as opposed to simply one word
- **explain**, they must provide a reason for the information given
- **compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between topics being examined
- **calculate**, they must determine a number from given facts, figures or information
- **predict**, they must indicate what may happen based on available information
- **suggest**, they must apply their knowledge and understanding to a new situation