A-level
BIOLOGY
7402/3

Paper 3

Mark scheme

June 2022

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226A7402/3/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Mark scheme instructions to examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information in the 'Comments' column is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for the same mark are indicated by the use of **OR**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the 'Comments' column of the mark scheme) are not penalised.

3.2 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can usually be gained by correct substitution / working and this is shown in the 'Comments' column or by each stage of a longer calculation.

3.3 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.4 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ECF or consequential in the mark scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the mark scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.6 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.7 Ignore / Insufficient / Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

Question	Marking Guidance	Mark	Comments
01.1	**Two** marks for three correct answers, **one** mark for two correct answers;; (Left amino acid) Serine (Middle amino acid) Alanine (Right amino acid) Aspartic (acid)	2 (2 x AO2)	Accept phonetic spellings

Question	Marking Guidance	Mark	Comments
01.2	One mark for each correct row **DNA** / **ATP** / **Reverse transcriptase** / **Phospholipid** (blank) / (blank) / ✓ / (blank) ; ✓ / ✓ / ✓ / ✓ ; ✓ / (blank) / ✓ / (blank) ;	3 (3 x AO1)	

Question	Marking Guidance	Mark	Comments
01.3	Correct answer of 574 (amino acids) = **2 marks**;; 573.99936 = **1 mark** **OR** 146/145.99986 = **1 mark** **OR** 287 = **1 mark** **OR** 292 = 1 mark;	2 (2 x AO2)	

Question	Marking Guidance	Mark	Comments
01.4	Accept curve drawn to the right, following the same pattern **and** starting at Y = 0 and finishing at the same percentage saturation as original curve;	1 (AO3)	

Question	Marking Guidance	Mark	Comments
01.5	1. During exercise **OR** At low pO_2 (in the tissues); 2. (Allowing) **more** oxygen for respiration **OR** (Allowing) **more** aerobic respiration **OR** To delay anaerobic respiration;	2 (2 x AO3)	1. Accept 'high altitude' or 'lack of red blood cells' for 'exercise' 1. Accept when there is a high pCO_2 (in the tissues) 1. Accept at low concentration of O_2 (in the tissues) 2. Accept descriptions of aerobic respiration, eg more oxygen to act as a terminal electron acceptor 2. Accept oxygen can unload/dissociate eas**ier**/**more** readily for respiration

Question	Marking Guidance	Mark	Comments
02.1	**Two** marks for **three** correct structures, **one** mark for **two** correct structures;; P = Capsule/lamella(e) Q = Axon (membrane) R = Schwann cell(s) **OR** R = Myelin (sheath)	2 (2 x AO1)	P – accept connective tissue Q – accept (sensory) neurone Q – accept nerve cell Q – ignore nerve

Question	Marking Guidance	Mark	Comments
02.2	1.27% (second box) ticked;	1 (AO2)	

Question	Marking Guidance	Mark	Comments
02.3	1. The student started to move/close her hand before the ruler was released; 2. The ruler did not fall vertically/was not placed vertically; 3. The ruler stuck to her skin; 4. (Student **B**) held the ruler too high/higher;	1 max (AO3)	1. Accept any descriptions of a pre-emptive strike Ignore answers related to student **A** having their eyes open Ignore student **B** misread the ruler;

Question	Marking Guidance	Mark	Comments
02.4	Correct answer of 12.9 / 13 (m s^{-1}) = **2 marks**;; Use of reaction time of 136 (ms)/0.136 (s) in answer **= 1 mark** **OR** 14.583 (answer including Trial 3) = **1 mark** **OR** 1.29 = **1 mark**	2 (2 x AO2)	For **2 marks** accept any correct rounding of 12.8676471

Question	Marking Guidance	Mark	Comments
02.5	1. Synaptic transmission **OR** Transmission at neuromuscular junction; 2. Time for muscle contraction; 3. Time taken for (stretch-mediated) sodium ion channels to open (in the Pacinian corpuscle); 4. Student may have been distracted/not concentrating; 5. Time taken for coordination/comprehension (by the brain);	3 max (3 x AO3)	Ignore answers relating to the estimate of the length of the nerve pathway involved 1. Accept (involves) synapses For 1 mark, accept correct reference to student conditions/medication eg tiredness, antidepressants

Question	Marking Guidance	Mark	Comments
03.1	1. To break down links between cells/cell walls **OR** To separate cells/cell walls **OR** To break down/hydrolyse cellulose/cell wall; 2. Allowing the stain to pass/diffuse into the cells **OR** Allowing the cells to be (more easily) squashed; 3. To stop mitosis;	2 max (2 x AO2)	1. Ignore references to any bonds 3. Accept to stop cell division/cell cycle

Question	Marking Guidance	Mark	Comments
03.2	1. To create a single/thin layer of cells **OR** To spread out cells; 2. So that light could pass through;	2 (2 x AO3)	

Question	Marking Guidance	Mark	Comments
03.3	1. Anaphase; 2. Chromatids moved/pulled **to** opposite poles/ends;	2 (1 x AO1, 1 x AO2)	1. Reject 'Anaphase I (of meiosis)' 2. Accept 'chromosomes' for 'chromatids' 2. Reject homologous chromosomes for chromatids

Question	Marking Guidance	Mark	Comments
03.4	0.1 / 0.13 / 0.128;	1 (AO2)	Accept any correct rounding of 0.128205128205128 Reject answers expressed as a percentage

Question	Marking Guidance	Mark	Comments
03.5	1. (Garlic roots) are a different age **OR** (Garlic) grown in different conditions; 2. (Root tips) from different (garlic) plants/bulbs/species; 3. Single field of view is not representative of a root tip **OR** (Other) students may have looked at more fields of view **OR** (Other) students may have calculated a mean; 4. (Different fields of view are from) different parts of the root tip; 5. Cells/roots undergo mitosis/cell division at different times/rates;	2 max (2 x AO3)	1. Accept suitable descriptions of conditions, eg in different temperatures 3. Accept 'samples' for 'fields of view' 4. Reject different sized fields of view 4. Reject different number of cells (per field of view)

Question	Marking Guidance	Mark	Comments
04.1	**Genome** 1. (The) complete set of genes in a cell/organism **OR** (All) the DNA in a cell/organism; **Proteome** 2. Range of proteins that a cell/organism **can produce** **OR** Range of proteins the genome/DNA **can code for**;	2 (2 x AO1)	1. Accept (all) the genes/alleles/ genetic material/ genetic code in a cell/organism 1. Accept the total number of DNA bases in a cell/organism 1. Reject all the DNA/genes within a species/ population 2. Do not accept number of proteins unqualified 2. Ignore range of proteins that a species/population can produce

Question	Marking Guidance	Mark	Comments
04.2	1. (The) genetic/DNA code is universal **OR** The same triplets/codons code for the same amino acids (in all species); 2. (The mechanism of) transcription is universal; 3. (The mechanism of) translation is universal;	2 max (2 x AO1)	1. Do not accept 'DNA is universal' unqualified 1. Reject the genetic code is degenerate 1. Ignore anything after 'genetic/DNA code is universal' unless incorrect 2. and 3. Accept descriptions of universal, eg transcription/ translation are the same in humans and bacteria 2. and 3. If neither is stated, accept '(the mechanism of) protein synthesis is universal' for 1 mark 3. Accept bacteria have ribosomes, and so could translate (human mRNA)

Question	Marking Guidance	Mark	Comments
04.3	Cannot splice (pre-mRNA), **so** cannot remove introns **OR** Do not have Golgi (apparatus), **so** cannot process/modify (proteins) **OR** Do not have transcriptional factors (required), **so** cannot carry out transcription/produce mRNA;	1 (AO2)	Accept do not have spliceosomes/ spliceozyme for cannot splice Accept 'rough endoplasmic reticulum' for 'Golgi' Accept (human protein) is too complex and bacteria do not have Golgi (apparatus)

Question	Marking Guidance	Mark	Comments
04.4	1. (Region **M**) promoter; 2. (Region **N**) terminator;	2 (2 x AO2)	Accept phonetic spellings

Question	Marking Guidance	Mark	Comments
04.5	Shows that the (antithrombin) gene has been taken up (by cells/embryos/goats) **OR** Shows transgenic/transformed goat cells/goat embryos/goats **OR** Allows detection of genetically modified cells/ organisms/mammals/goats;	1 (AO1)	Accept 'GM' for 'genetically modified'

Question	Marking Guidance	Mark	Comments
04.6	1. Milk/protein/antithrombin is easy to extract from a goat **OR** Extracting milk/protein/antithrombin from a goat does it no harm; 2. If (antithrombin was produced) in their blood, could prevent/affect clotting **OR** (Antithrombin) could damage other cells;	2 (2 x AO3)	

Question	Marking Guidance	Mark	Comments
05.1	Correct answer of 6.0×10^8/6.02×10^8/ 6.0192×10^8 = **3 marks**;;; 601920000 = **2 marks**;; 8.8 × any **two** of 12000 **OR** 95 **OR** 60 = **1 mark** 1.0032×10^7 / 6.336×10^6 / 5.0160×10^4 **= 1 mark**;	3 (3 x AO3)	Correct answer but not in correct standard form = **2 marks**, eg 60.192×10^7 Accept 10032000 / 6336000 / 50160 for **1 mark**

Question	Marking Guidance	Mark	Comments
05.2	1. (This difference) is **not** significant; 2. There is greater than a 0.5 probability that this difference is due to chance **OR** There is greater than a 0.05 probability that this difference is due to chance	2 (2 x AO3)	Reject 'results' for 'difference' once 2. Accept 50%/1 in 2 for 0.5 2. Accept 5%/1 in 20 for 0.05

Question	Marking Guidance	Mark	Comments
05.3	1. Less ATP **and** reduced NADP produced; 2. Less GP/glycerate 3-phosphate reduced/converted to triose phosphate; 3. Less triose phosphate to regenerate/make RuBP **OR** Less RuBP is regenerated/made; 4. Less RuBP to react with carbon dioxide;	4 (2 x AO2, 2 x AO3)	Need idea of less at least once Reject **no** once If mark points 2, 3 and 4 are not present, allow 1 mark for less light independent reactions **OR** fewer Calvin cycles. 1. Accept $NADPH/NADPH_2$ for reduced NADP 1. Reject less reduced NAD/NADH for reduced NADP 2. and 3. If triose phosphate is not mentioned, **reject TP once**

Question	Marking Guidance	Mark	Comments
05.4	1. 3.5875×10^{-3}; 2. kg m^{-2} h^{-1};	2 (2 x AO2)	1. Accept any correct rounding eg 4×10^{-3} 2. Accept per m^2 **and/or** per hour 2. Accept $kg/m^2/h$ 2. Accept kg h^{-1} m^{-2} 2. Reject kg^{-1} 2. Reject m^{-2} h^{-1} kg **OR** h^{-1} m^{-2} kg

Question	Marking Guidance	Mark	Comments
05.5	1. (In the shade, so) **less/slower rate of** photosynthesis; 2. (Slow-growing, so) would take a long time to replace (mature leaves) **OR** **Leaves** more likely to reach maturity **OR** **Leaves** take a long time to mature; 3. Plants can maintain (a large enough) surface area for photosynthesis **OR** Plants can absorb enough light;	2 max (2 x AO3)	1. Accept any named aspect of photosynthesis that uses light, eg LDR, photoionisation 2. Accept would take a long time to make cellulose or any other correct named compound

Question	Marking Guidance	Mark	Comments
05.6	Yes (no mark) 1. The most recently evolved species/asterids produce more than the mean concentration; 2. The least recently evolved species/ferns produce less than the mean concentration; No (no mark) 3. The highest concentration was **not** in the most recently evolved species/asterids **OR** The highest concentration was in magnoliids **OR** Magnoliids produce more than more recently evolved species/basal angiosperms/rosids/ asterids; 4. The lowest concentration was **not** in the least recently evolved species/ferns **OR** The lowest concentration was in monocots **OR** Monocots evolved more recently but produce a lower concentration than ferns; 5. The least recently evolved species/ferns have the same concentration as more recently evolved species/basal angiosperms/rosids; 6. Basal angiosperms and rosids have the same concentration but evolved at different times;	2 max (2 x AO3)	Ignore answers relating to no statistical testing Accept 'newest species' for most recently evolved species/asterids Accept 'oldest species' for least recently evolved species/ferns

Question 6 Level of response marking guidance

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity, you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level, you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

21–25	Extended Abstract Generalised beyond specific context	Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question. Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained. No significant errors or irrelevant material. For top marks in the band, the answer shows evidence of reading beyond specification requirements.
16–20	Relational Integrated into a whole	Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained. Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology. Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.
11–15	Multistructural Several aspects covered but they are unrelated	Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.
6–10	Unistructural Only one or few aspects covered	Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.
1–5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question.	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. 'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (eg importance) at A-level standard.

Question	Marking Guidance	Mark	
06.1	**The uses and importance of ATP in organisms** • 3.1.5.2 DNA replication • 3.1.6 ATP • 3.2.2 All cells arise from other cells (mitosis) • 3.2.3 Active transport • 3.3.3 Digestion and absorption – co-transport • 3.3.4.2 Mass transport in plants • 3.4.2 DNA and protein synthesis • 3.4.3 Meiosis • 3.5.1 Photosynthesis • 3.5.2 Respiration • 3.5.4 Nutrient cycles – nitrogen fixation • 3.6.2.1 Nerve impulses – resting potential • 3.6.2.2 Synaptic transmission • 3.6.3 Myofibril/muscle contraction • 3.6.4.2 Control of blood glucose concentration (2nd messenger model) • 3.6.4.3 Control of blood water potential	**[25 marks]** (13 x AO1, 12 x AO2)	

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

Question	Marking Guidance	Mark	
06.2	**The importance of cycles in biology** • 3.1.1 Monomers and polymers • 3.1.4.2 Many proteins are enzymes • 3.1.5.2 DNA replication • 3.1.6 ATP • 3.2.2 All cells arise from other cells • 3.3.2 Gas exchange – mechanism of breathing • 3.3.4.1 Cardiac cycle and blood circulation and 3.6.1.3 Control of heart rate • 3.4.3 Meiosis • 3.5.1 Photosynthesis – light independent reaction • 3.5.2 Respiration – Krebs cycle and electron transport chain • 3.5.4 Nutrient cycles • 3.6.2.1 Nerve impulses • 3.6.2.2 Synaptic transmission • 3.6.3 Muscle contraction • 3.6.4.1 Negative feedback • 3.6.4.2 Control of blood glucose concentration • 3.6.4.3 Control of blood water potential • 3.7.4 Populations in ecosystems – predation • 3.8.4.1 Recombinant DNA technology – PCR	**[25 marks]** (13 x AO1, 12 x AO2)	

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