A-level
BIOLOGY
7402/1

Paper 1

Mark scheme

June 2021

Version: 1.0 Final

216A7402/1/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

Copyright information

AQA retains the copyright on all its publications. However, registered schools/colleges for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to schools/colleges to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Copyright © 2021 AQA and its licensors. All rights reserved.

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	1. Substrate binds to the active site/enzyme **OR** Enzyme-substrate complex forms; 2. Active site changes shape (slightly) so it is <u>complementary</u> to substrate **OR** Active site changes shape (slightly) so distorting/breaking/forming bonds in the substrate; 3. Reduces activation energy;	3	1. Accept for 'binds', fits

Question	Marking Guidance	Mark	Comments
01.2	Adenosine diphosphate;	1	

Question	Marking Guidance	Mark	Comments
01.3	Mark in pairs, 1 **and** 2 OR 3 **and** 4 OR 5 **and** 6 1. Boil **OR** Add (strong) acid/alkali; 2. Denatures the enzyme/ATP synthase; **OR** 3. Put in ice/fridge/freezer; 4. Lower kinetic energy so no enzyme-substrate complexes form; **OR** 5. Add high concentration of inhibitor; 6. Enzyme-substrate complexes do not form;	2	1. Accept heat at > 50^{o}C OR at very high temperatures 2. Accept for 'denatures', a description of denaturation 4. Accept ES for enzyme substrate complex

Question	Marking Guidance	Mark	Comments
01.4	1. (With) increasing Pi concentration, more enzyme-substrate complexes are formed; 2. At or above 40 (mmol dm^{-3}) all active sites occupied **OR** At or above 40 (mmol dm^{-3}) enzyme concentration is a limiting factor;	2	

Question	Marking Guidance	Mark	Comments
02.1	1. Large(r) organisms have a small(er) surface area:volume (ratio); **OR** Small(er) organisms have a large(r) surface area:volume (ratio); 2. Overcomes long <u>diffusion</u> pathway **OR** Faster <u>diffusion</u>;	2	2. Accept short diffusion pathway 2. Accept for 'faster', more

Question	Marking Guidance	Mark	Comments
02.2	Mark in pairs, 1, **and** 2 OR 3. **and** 4. 1. Water has low(er) oxygen partial pressure/concentration (than air); 2. So (system on outside) gives large surface area (in contact with water) **OR** So (system on outside) reduces diffusion distance (between water and blood); 3. Water is dense(r) (than air); 4. (So) water supports the systems/gills;	2	

Question	Marking Guidance	Mark	Comments
02.3	1. In fish, blood leaving (V) has more oxygen than water leaving (E); 2. (But) in humans, blood leaving (V) has less oxygen than air leaving (E); 3. Difference in oxygen (concentration) between artery and vein is greater in fish than in humans; 4. (So) fish remove a greater proportion from the oxygen they take in;	2 max	

Question	Marking Guidance	Mark	Comments
02.4	1. Blood and water flow in opposite directions; 2. Diffusion/concentration gradient (maintained) along (length of) lamella/filament;	2	Accept for 2 marks, suitably labelled diagram

Question	Marking Guidance	Mark	Comments
02.5	1. and 2. Correct answer for 2 marks, 4.3 (times greater);; Accept for 1 mark, 4.333333333 (correct answer not given to 2 significant figures) **OR** Evidence of 130 ($cm^3\,kg^{-1}$) **and** 30 ($cm^3\,kg^{-1}$) Correct explanation for 1 mark, 3. Provides more oxygen for <u>respiration</u>;	3	

Question	Marking Guidance	Mark	Comments
03.1	1. tRNA brings specific amino acid (to ribosome); 2. Anticodon (on tRNA) binds to codon (on mRNA); 3. Amino acids join by condensation reaction (using ATP) **OR** Amino acids join to form a peptide bond (using ATP);	3	

Question	Marking Guidance	Mark	Comments
03.2	1. Hydrogen bonds form instead of ionic bonds; 2. Changes the tertiary structure (of the crystallin);	2	2. Ignore reference to active site

Question	Marking Guidance	Mark	Comments
03.3	3 correct = 2 marks;; 2 correct = 1 mark; 0 or 1 correct = 0 marks	2	

mRNA codon for the non-mutant triplet	AGG
Mutated mRNA codon	GGG
Mutated DNA triplet	CCC

Question	Marking Guidance	Mark	Comments
04.1	1. Only use single lines/do not use sketching (lines)/ensure lines are continuous/connected; 2. Add labels/annotations/title; 3. Add magnification/scale (bar); 4. Draw all parts to same scale/relative size; 5. Do not use shading/hatching;	2 max	

Question	Marking Guidance	Mark	Comments
04.2	1. Blood vessel **X** – artery/arteriole **and** Blood vessel **Y** – vein/venule; 2. (Difference in) lumen size **OR** (Difference in) wall thickness;	2	Ignore name of blood vessel, eg. (pulmonary) artery

Question	Marking Guidance	Mark	Comments
04.3	1. Carry/wash sharp instruments by holding handle **OR** Carry/wash sharp instruments by pointing away (from body)/down; 2. Disinfect instruments/surfaces; 3. Disinfect hands **OR** Wash hands with soap (and water); 4. Put organ/gloves/paper towels in a (separate) bag/bin/tray to dispose;	2 max	1. and 2. Accept for 'instruments', a suitable named example, eg. scalpel 2. and 3. Accept for 'disinfect', sanitise OR use antiseptic

Question	Marking Guidance	Mark	Comments
05.1	1. Break open cells/tissue **and** filter **OR** Grind/blend cells/tissue/leaves **and** filter; 2. In cold, same water potential/concentration, pH controlled solution; 3. Centrifuge/spin and remove nuclei/cell debris; 4. (Centrifuge/spin) at high(er) speed, chloroplasts settle out;	4	1. Accept homogenise **and** filter 2. Accept for 'same water potential/ concentration', isotonic 2. Accept for 'pH controlled', buffered

Question	Marking Guidance	Mark	Comments
05.2	Mark in pairs, 1 **and** 2 OR 3 **and** 4 1. DNA; 2. Is not associated with protein/histones **but** nuclear DNA is **OR** Is circular **but** nuclear DNA is linear **OR** Is shorter than nuclear DNA; 3. Ribosomes; 4. Are small**er** than cytoplasmic ribosomes;	2	4. Accept: 70S ribosomes in chloroplast, but 80S ribosomes in cytoplasm

Question	Marking Guidance	Mark	Comments
05.3	Correct answer for 1 mark, 36:1;	1	

Question	Marking Guidance	Mark	Comments
05.4	1. Less (thylakoid) membrane **OR** Fewer/smaller grana; 2. Smaller surface area (of membrane in chloroplast)/less chlorophyll; 3. (Less chlorophyll so) reduced light absorption; 4. (So) slower rate of photosynthesis;	3 max	4. Accept reduced rate of any named biochemical process in photosynthesis; eg. reduced production of ATP/reduced NADP

Question	Marking Guidance	Mark	Comments
06.1	Correct answer for 2 marks, 1.286;; Accept for 1 mark, 1.28571429 (correct answer not to 3 decimal places) **OR** 1.285 (incorrect rounding to 3 decimal places) **OR** Evidence of 0.02142857 **OR** Evidence of 19 **and** 4 **and** 700 **OR** Evidence of 15 **and** 1800 **and** 2500 OR Evidence of 15 **and** 700	2	

Question	Marking Guidance	Mark	Comments
06.2	1. C = prophase **and** D = metaphase **and** E = anaphase; 2. (In) prophase, chromosomes condense; 3. (In) prophase **OR** metaphase, centromeres attach to spindle fibres; 4. (In) metaphase, chromosomes/pairs of chromatids at equator/centre of spindle/cell; 5. (In) anaphase, centromeres divide; 6. (In) anaphase, chromatids (from each pair) pulled to (opposite) poles/ends (of cell); 7. (In) prophase/metaphase/anaphase, spindle fibres shorten;	5 max	**If mark point 1 is not credited = 4 max** Do not carry forward error from 1. Accept letters for stages as indicated in 1. 2. Accept chromatin for 'chromosomes' and for 'condense', shorten and thicken 6. Accept for 'chromatids', chromosomes but reject homologous chromosomes 7. Accept for 'shorten', contract

Question	Marking Guidance	Mark	Comments
07.1	1. Cell ingests/engulfs the antibody/ADC **OR** Cell membrane surrounds the antibody/ADC (to take it inside the cell); 2. Lysosomes fuse with vesicle/phagosome (containing ADC); 3. Lysozymes breakdown/digest the antibody/ADC to release the drug;	3	1. Accept endocytosis for ingest/engulf 3. Accept hydrolytic enzyme for lysozyme

Question	Marking Guidance	Mark	Comments
07.2	1. ADC will bind to non-tumour/healthy cells; 2. Cause death/damage of non-tumour/healthy cells **OR** Cause damage to other organs/systems;	2	1. Reject reference to active site

Question	Marking Guidance	Mark	Comments
07.3	Correct answer for 2 marks, 9.2×10^{-5};; Accept for 1 mark, 0.046 (correct mass injected into 23g mouse) 0.000092 (correct answer but not in standard form)	2	

Question	Marking Guidance	Mark	Comments
07.4	Mice died **OR** Not ethical to continue;	1	

Question	Marking Guidance	Mark	Comments
07.5	1. Tested on other mammals to check for safety/side effects; 2. Tested on (healthy) humans to check for safety/side effects; 3. See if repeat doses stop the tumours regrowing (in Group J); 4. Investigate different concentrations of ADC to find suitable/safe dosage;	2 max	1. Accept named mammal, eg rat 2. Accept: Tested on (healthy) human tissue/cells to check for no side-effects

Question	Marking Guidance	Mark	Comments
08.1	1. **One** glycerol and **three** fatty acids; 2. Condensation (reactions) **and** removal of **three** molecules of water; 3. Ester bond(s) (formed);	3	Accept all marks in suitably labelled diagram OR in a balanced equation

Question	Marking Guidance	Mark	Comments
08.2	Palmitoleic acid is an unsaturated fatty acid represented by diagram **K**;	1	

Question	Marking Guidance	Mark	Comments
08.3	1. To increase accuracy/resolution **because** differences/lengths are small; 2. To increase accuracy **because** reduces risk of human error; 3. To increase accuracy **because** roots are less (likely to be) damaged; 4. To reduce error/uncertainty **because** differences/lengths are small;	1 max	Ignore 'precision'

Question	Marking Guidance	Mark	Comments
08.4	1. Population 1 grew longer roots in warm temperatures **and** population 2 grew longer roots in cool temperatures; 2. Standard deviations do not overlap so difference (in mean) unlikely to be/not due to chance; 3. Population 1 (is better adapted to warm conditions because it) has more saturated fatty acids so more energy available (and more growth); 4. Population 2 (is better adapted to cool conditions because it) has more unsaturated/liquid fatty acids so more lipase activity (and more growth);	4	2. Accept: 'Standard deviations do not overlap showing difference (in mean likely to be) significant' 3. and 4. Accept for 'fatty acids', fat

Question	Marking Guidance	Mark	Comments
08.5	Same species **OR** (If mated) can produce fertile offspring **OR** (It is) genus and species name;	1	

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>09.1</td><td>4 rows correct = 2 marks;;
2 or 3 rows correct = 1 mark;
0 or 1 row correct = 0 marks

<table>
<tr><th rowspan="2">Biological molecules</th><th colspan="4">Element</th></tr>
<tr><th>Carbon</th><th>Nitrogen</th><th>Oxygen</th><th>Phosphorous</th></tr>
<tr><td>Galactose</td><td>✓</td><td></td><td>✓</td><td></td></tr>
<tr><td>Phospholipid</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>RNA</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Sucrose</td><td>✓</td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>2</td><td></td></tr>
</table>

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>09.2</td><td>Correct answer for 2 marks, 0.8376308/0.84/0.8 (hours);;

Accept for 1 mark,

Evidence of 4 x 10^6 and 3 x 10^9 (written in any format, for correct readings from graph)

OR

Evidence of 9.550746785 (correct number of generations)

OR

Evidence of 1.1938443348 (correct generations/ hour)

OR

Evidence of 50.26 (correct generation time in minutes)

_____

Incorrect reading of graph, 3 x 10^6 and 2 x 10^9

Accept for 1 mark, calculation carried out correctly

Evidence of 9.380821784 (correct calculation of number of generations)</td><td>2</td><td>Accept correct rounding to any number of decimal places</td></tr>
</table>

	OR Evidence of 1.172602723 (correct calculation of generations/ hour) **OR** Evidence of 51.16822503 (correct calculation of generation time in minutes) **OR** Evidence of 0.8528037505 (correct calculation of generation time in hours) Incorrect reading of graph, $10^{6.4}$ **and** $10^{9.3}$ **OR** $10^{6.3}$ **and** $10^{9.2}$ Accept for 1 mark, calculation carried out correctly Evidence of 9.633591475 (correct calculation of number of generations) **OR** Evidence of 1.204198934 (correct calculation of generations/ hour) **OR** Evidence of 49.82565445 (correct calculation of generation time in minutes) **OR** Evidence of 0.8304275742 (correct calculation of generation time in hours) **OR** Evidence of 0.83, with no other working		

Question	Marking Guidance	Mark	Comments
09.3	1. (Model) Q **and** (Name) Semi-conservative (replication); Explanation 2. (Model) **P** (is unsupported because) There should be two peaks in generation 1 **OR** (Only) one peak is shown in generation 1 **OR** There should be 3:1 (ratio) of peaks in generation 2 **OR** There should **not** be an intermediate/^{15}N ^{14}N peak in generation 1/2/3 **OR** The original/generation 0/^{15}N peak should be in generation 1/2/3; 3. (Model) **R** (is unsupported because) There should be >2 peaks in generation 2/3 **OR** There should be one wide/overlapping peak in generation 3;	3	Accept answers 2. and 3. in either order Accept for 'peak', density OR distribution 3. Accept for '>2', many OR several

Question	Marking Guidance	Mark	Comments
10.1	1. Polymer of nucleotides; 2. Each nucleotide formed from deoxyribose, a phosphate (group) and an organic/nitrogenous base; 3. Phosphodiester bonds (between nucleotides); 4. Double helix/2 strands held by hydrogen bonds; 5. (Hydrogen bonds/pairing) between adenine, thymine **and** cytosine, guanine;	5	1. Accept 'Polynucleotide' 1. Accept for 'phosphate'. phosphoric acid

Question	Marking Guidance	Mark	Comments
10.2	1. (Simple) diffusion of small/non-polar molecules down a concentration gradient; 2. Facilitated diffusion down a concentration gradient via protein carrier/channel; 3. Osmosis of water down a water potential gradient; 4. Active transport against a concentration gradient via protein carrier using ATP; 5. Co-transport of 2 different substances using a carrier protein;	5	For any answer accept a correct example If no reference to 'small/ non-polar' for 1. accept this idea from 'large/charged' given in description of 2. 2. Reject if active rather than passive 5. For 'carrier protein' accept symport OR co-transport protein

Question	Marking Guidance	Mark	Comments
10.3	1. Magnification (figures) show **A** is bigger than **B**; 2. **A** has a nucleus whereas **B** has free DNA; 3. **A** has mitochondria whereas **B** does not; 4. **A** has Golgi body/endoplasmic reticulum whereas **B** does not; 5. **A** has no cell wall whereas **B** has a murein/glycoprotein cell wall; 6. **A** has no capsule whereas **B** has a capsule; 7. **A** has DNA is bound to histones/proteins whereas **B** has DNA not associated with histones/proteins **OR** **A** has linear DNA whereas **B** has circular DNA; 8. **A** has larger ribosomes;	5 max	Accept in all marking points, animal/eukaryote for A and prokaryote/ bacterium for B 5. Accept peptidoglycan