A-level
BIOLOGY

7402/3

Paper 3

Mark scheme

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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.

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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.

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. Laboratory-raised female (guppies) might not react/behave/choose in the same way (as wild guppies); 2. (Transparent) barrier might not allow for normal (courtship) behaviour/interaction; 3. Do not know if (guppies) have been used in previous experiments; 4. 10 minutes might not be long enough for females to make a (final) choice **OR** Not enough time for females to make a (final) choice;	3 max	Ignore answers relating to sample size 1. Accept laboratory-raised female (guppies) might not be representative of wild females 2. Accept choice might involve chemical/ mechanical signals/interaction 2. Accept colour might not be the only thing females are attracted to 4. Accept descriptions of a choice eg 'show attraction'
01.2	1. (Females with large brains) will mate with males bright in colour; 2. Their (male) offspring would be (more likely to be) bright in colour; 3. (Bright in colour male) offspring could attract larger brained females; 4. The population/offspring could (evolve to) have larger brains; 5. The population/offspring are better at identifying/avoiding predators;	3 max	Accept answers that include references to alleles 4. and 5. Ignore answers relating to females only

01.3	1. **Not** geographically isolated; 2. (Leading to) reproductive isolation **OR** Gene pools kept separate; 3. Changes in allele <u>frequencies</u>; 4. Cannot breed/mate to produce fertile offspring;	3 max	1. Accept are in the same area 2. Accept large brained females will only mate with males bright in colour <u>and</u> small brained females will only mate with males dull in colour 3. Reject gene frequencies 4. Reject inbreeding

Question	Marking Guidance	Mark	Comments
02.1	Interspecific (competition);	1	
02.2	1. Do not provide the livestock/cows/horses/yaks with extra food, **as** their populations will not grow large enough to cause competition **OR** Keep small numbers of livestock/cow/horse/yak, **so** their populations will not grow large enough to cause competition; 2. Do not farm horse/choose animals other than horse to farm, **as** they have the same habitat **and** (very) similar food to the ibex; 3. Keep horses (but) in enclosed/separate areas, **as** they occupy the same habitats as ibex; 4. Farm cows, **as** they have the least similar food **and** (one of the least similar) habitat (to that of the ibex); 5. Farm yaks, **as** despite eating the same food, they live in a very different habitat; 6. (Only) grow crops, **so** no competition;	3 max	Requires suggestion **and** explanation for each mark 2. Accept farm fewer horses **as** they have the same habitat **and** (very) similar food to the ibex 3. Accept descriptions of enclosed areas, eg fenced areas or accept do not let horses out 6. Accept examples of crops

Question	Marking Guidance	Mark	Comments
03.1	1. Mutation in the viral DNA/RNA/genome/genetic material; 2. Altered (tertiary structure of the) viral attachment protein; 3. Allows it/attachment protein/virus to bind (to receptors of other species);	2 max	1. Accept named examples mutations 2. Accept 'antigen' for 'attachment protein' 2. Accept causes antigenic variability 3. Accept descriptions of binding eg is complementary
03.2	For **one** mark, accept any **two** of the following: • The polymerase chain reaction • Genetic/DNA fingerprinting • (Gel) electrophoresis • DNA/genome sequencing;	1	Accept PCR for polymerase chain reaction Accept autoradiography Accept DNA hybridisation Accept compare DNA/base sequence for 'DNA sequencing' Ignore compare mRNA base sequence Ignore compare amino acid sequence Ignore DNA probes
03.3	1. (The scientists) could identify proteins (that derive from the genetic code) **OR** (The scientists) could identify the proteome; 2. (They) could (then) identify potential antigens (to use in the vaccine);	2	2. Reject if answer suggests vaccine contains antibodies

03.4	1. B cell (antibody) binds to (viral) specific/complementary receptor/antigen; 2. B cell clones **OR** B cell divides by <u>mitosis</u>; 3. <u>Plasma cells</u> release/produce (monoclonal) <u>antibodies</u> (against the virus); 4. (B/plasma cells produce/develop) memory cells;	3 max	1. Accept <u>B cell</u> forms antigen-antibody complex 2. Accept B cell undergoes clonal selection/expansion

Question	Marking Guidance	Mark	Comments
04.1	1. (No for aspirin) 1.8 g; 2. (Yes for paracetamol) 3.44 g;	2	Accept for one mark evidence of 1.8 and 3.44 but no/wrong stated units 1. Accept maximum dose of aspirin has 0.6 g less than RDA 2. Accept maximum dose of paracetamol has 1.04 g more than RDA
04.2	**Same** Accept any **two** of the following for **one** mark 1. BMI, age, sex/gender, other/previous medications, ethnicity, diet, exercise, health (issues) **Different** 2. No sodium in the (same) medicine;	2	1. Ignore weight 2. Ignore placebo 2. Ignore 'salt' for sodium 2. Accept concentration of sodium in medicine
04.3	Correct answer of 8513/8514 for **2 marks**;; Allow 1 mark for 61 127(.5401) in answer Incorrect answer but shows sequence of 8513(6) with decimal point in any position = 1 mark	2	
04.4	1. (Sodium ions) lower the water potential (of blood); 2. Water would move into the blood by <u>osmosis</u> (from cells/tissue fluid); 3. Increasing the blood volume;	3	1. Accept make the blood water potential <u>more</u> negative 1. Accept decrease the blood water potential

Question	Marking Guidance	Mark	Comments
05.1	665 (people per month);; Allow one mark for 7980/7981 in working (number of deaths from throat cancer per year)	2	Accept answers not rounded
05.2	1. (EGCG) binds to <u>active site</u> of DNMT; 2. (DNMT) cannot methylate (promoter region of tumour suppressor gene); 3. Transcription(al) factor(s) can bind (to promoter region); 4. RNA polymerase (stimulated/activated);	3 max	1. Ignore active site changes shape 1. Ignore 'forms enzyme-substrate' complex 2. Accept less methylation (of promoter region/tumour suppressor gene)
05.3	1. Only investigated in throat cancer **OR** Might not work for other types of cancer; 2. Not all cancers are caused by (increased) methylation (of a tumour suppressor gene) **OR** There are other causes of cancer; 3. Only a <u>significant</u> reduction with 20/50/above 10 (µmol) 4. Do not know how much EGCG is in green tea; 5. Only reduces growth rate (of cancer cells) **OR** No evidence of cancer being cured; 6. *In vivo* cells/cells in the body might respond (to EGCG) differently (from those grown *in vitro*);	3 max	3. Allow converse, ie no <u>significant</u> effect with 5/10 (µmol)

Question	Marking Guidance	Mark	Comments
06.1	1. Increases dissociation of oxygen; 2. For <u>aerobic</u> respiration at the tissues/muscles/cells **OR** Anaerobic respiration delayed at the tissues/muscles/cells **OR** Less lactate at the tissues/muscles/cells;	2	1. Accept unloading/ release/reduced affinity for dissociation
06.2	1. (Time) 10 minutes; 2. (Ratio) 1.6875(:1); Allow 1 mark for correct ratio calculated from wrong time	2	For the ratio accept any correct rounding
06.3	1. Increase in breathing (rate); 2. Similar/same pCO_2 per breath, but more breaths; **OR** 3. Increase in tidal volume; 4. Similar/same pCO_2 per breath, but increased volume per breath;	2	Award mark points 1 and 2 **OR** 3 and 4 1. Allow more breaths per minute 1. Reject more BPM 3. Accept each breath is deeper
06.4	Second box ticked (Muscle fibres have a limited amount of phosphocreatine.)	1	

06.5	1. More acetylcoenzyme A would enter the Krebs cycle; 2. (So) the Krebs cycle generates (more) reduced coenzymes **OR** (So more) reduced coenzymes pass their electrons to the electron transfer chain; 3. (So more) ATP would be produced; 4. Athletes could build (slow) muscle (fibres) without exercising; 5. (Having more) slow muscle (fibres) would increase endurance;	4 max	1. 2. and 3. idea for more is required once 2. Accept examples of reduced coenzymes 2. Reject production of reduced NADP or NADPH$_2$ 4. Ignore 'develop (slow) muscle (fibres) at rest' as in stem of question 4. Accept description of not exercising, eg without training 5. Accept descriptions of endurance in terms of delayed onset of anaerobic respiration

06.6	1. (EPO) causes blood to thicken; 2. (The thickened blood) could block the coronary arteries **OR** (The thickened blood) slows blood flow **OR** (The thicker blood) could cause clots;	2	1. Accept descriptions of thickening, eg more viscous 2. Reject atheroma/plaque (forms) 2. Accept could cause thrombus/embolus

06.7	1. Some cyclists will gain a bigger advantage/increase **OR** Cyclists with a haematocrit of 50% would not be able to gain an advantage; 2. There are health risks (associated with) taking EPO;	2	1. Accept use of the data, or suitable calculations, eg some may have an 8% increase, others 0% 1. Some cyclists might naturally have a haematocrit over 50% (and so not be allowed to compete) 2. Accept dangerous side-effects of taking EPO, or examples of health risks

Question 7 Level of response marking guidance

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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	
07.1	**The functions of enzymes and their importance in organisms** • 3.1.4.2 Many proteins are enzymes • 3.1.5.2 DNA replication • 3.1.6 ATP • 3.2.4 Cell recognition and the immune system (lysozyme) • 3.3.3 Digestion and absorption • 3.4.2 DNA and protein synthesis • 3.4.4 Genetic diversity and adaptation (penicillinase in bacteria) • 3.5.1 Photosynthesis • 3.5.2 Respiration • 3.5.4 Nutrient cycles • 3.6.2.2 Synaptic transmission • 3.6.3 Muscles • 3.6.4.2 Control of blood glucose • 3.8.4.1 Recombinant DNA technology • 3.8.4.3 DNA fingerprinting	**[25 marks]**	

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	
07.2	**The causes and importance of variation and diversity in organisms** • 3.1.4.1 Proteins have a variety of functions in all living organisms • 3.2.4 Effect of antigen variability on disease and disease prevention • 3.4.3 Genetic diversity from mutation • 3.4.3 Genetic diversity from meiosis • 3.4.4 Genetic diversity and adaptation • 3.4.5 Courtship behaviour • 3.4.6 Biodiversity within a community • 3.4.7 Investigating diversity • 3.5.3 Energy and ecosystems – farming practices • 3.6.3 Slow and fast twitch muscles • 3.7.1 Inheritance • 3.7.2 Populations • 3.7.3 Evolution leading to speciation • 3.7.4 Populations in ecosystems • 3.8.1 Alteration of base sequences • 3.8.2.2 Regulation of transcription and translation • 3.8.2.3 Gene expression and cancer • 3.8.4.1 Recombinant DNA technology • 3.8.4.2 Identification of heritable conditions • 3.8.4.3 Genetic fingerprinting	**[25 marks]**	

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