A-level
BIOLOGY
7402/3

Paper 3

Mark scheme

June 2019

Version: 1.1 Final

196A7402/3/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 Assessment Writer.

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

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. High blood/hydrostatic pressure; 2. **Two named** small substances pass out eg water, glucose, ions, urea; 3. (Through small) gaps/pores/fenestrations **in** (capillary) endothelium; 4. (And) through (capillary) basement membrane;	3 max	Ignore references to podocytes 1. Ignore references to afferent and efferent arterioles 1. Ignore 'increasing/higher blood pressure' as does not necessarily mean high 2. Accept correct named ions 2. Accept mineral ions/minerals 2. Accept amino acids/small proteins 2. Ignore references to molecules **not** filtered 3. Accept epithelium for endothelium
01.2	☑ Glucose by facilitated diffusion and active transport and water down a water potential gradient	1	
01.3	17.4;	1	Accept any number of fours after the decimal point.

01.4	1. Thicker medulla means a longer loop (of Henle); 2. (The longer the loop of Henle means) **increase** in sodium ion concentration (in medulla) **OR** (The longer the loop of Henle means) sodium ion gradient maintained for **longer** (in medulla) **OR** (The longer the loop of Henle means) **more** sodium ions are moved out (into medulla); 3. (Therefore) water potential gradient maintained (for longer), **so** more water (re)absorbed (from loop and collecting duct); **OR** More water is (re)absorbed **from** the loop (of Henle) / collecting duct **by** osmosis;	3	2. Must have idea of increase/longer/more 3. Reject water being reabsorbed **into** the loop of Henle 3. Direction is important 3. Accept Ψ for water potential

Question	Marking Guidance	Mark	Comments

02.1	1. (They use enzymes to) decompose proteins/DNA/RNA/urea; 2. Producing/releasing ammonia/ammonium compounds/ammonium ions;	2	1. Accept any named molecule containing nitrogen eg enzymes, NAD, ATP, amino acids 1. Accept digest/breakdown/hydrolyse for decompose 1. Ignore 'nitrogen -containing compounds' unqualified 2. Accept (they) perform ammonification 2. Accept named ammonium compound
02.2	Accept **any** valid method, for example 1. Use of colorimeter; 2. Measure the absorbance/transmission (of light); 3. Example of how method can be standardised eg same volume of water, zeroing colorimeter, same wavelength of light, shaking the sample;	3	Principle is 1. Named apparatus 2. What is measured 3. Standardisation of method 1. Reject calorimeter 2. Reject if samples are filtered unless filtering to remove debris 2. Accept descriptions 3. Ignore references to calibration curves

Question	Marking Guidance	Mark	Comments
03.1	Valve **A** (Left) atrioventricular Chamber **B** Left ventricle;	1	Reject right side in either context Accept mitral/bicuspid for Valve **A**. Reject tricuspid for Valve **A** Ignore AV for Valve **A**
03.2	Accept any **two** suitable safety precautions for 1 mark, eg; Use a sharp scalpel/scissors Wash hands/wear gloves Disinfect bench/equipment Cover any cuts Cut away from self/others/on a hard surface Safe disposal	1 max	Ignore take care with scalpel/scissors or keep away from fingers Ignore goggles
03.3	1. Pressure in (left) atrium is higher than in ventricle/**B causing** valve to open; **OR** (When) pressure above valve is higher than below valve it opens; 2. Pressure in (left) ventricle/**B** is higher than in atrium **causing** valve to close; **OR** (When) pressure in below valve is higher than above valve it closes;	2	1. and 2. Ignore pressure in front of/behind valve 1. and 2. As long as direction of opening/closing of valve is correct, ignore 'semi lunar' 2. Accept cords/tendons prevent valve turning inside out
03.4	1. More impulses/action potentials along sympathetic (nervous system pathway/branch); 2. To SAN increasing the heart rate (seen in **Figure 3**);	2	1. Ignore signals/information/ messages 1. Idea of more impulses/action potentials is required
03.5	73 (this is the *best* answer since all numbers quoted in	1	(73.4375) Accept 73.4 / any

	the question are to 2 s.f.)		correct rounding
03.6	**Group to be given** 1. Sugar solution (only) **OR** A drink with sugar (**and** no caffeine); **Reason** 2. To show/prove that sugar (alone) is not causing the increases (in HR) **OR** To show that sugar does not have an effect;	2	1. Accept 'glucose' for sugar 1. Ignore named drinks unless qualified 1. Ignore 'sugar' by itself 1. Ignore references to use of a placebo tablet 2. Accept 'to see the effect of sugar'

Question	Marking Guidance	Mark	Comments
04.1	Substitution;	1	Accept inversion or translocation Ignore 'point mutation'
04.2	1. ($VO_{2\ max}$ **and** CS activity) increased for both groups; 2. No statistical test, **so** do not know if **differences** are significant **OR** No statistical test, **so differences** could be due to chance; 3. Only 8 weeks training **OR** Training did not last long; 4. Might not be true for all types of training/exercise/females;	3 max	**Max 2 marks for mark points 2, 3 and 4** 2. Ignore standard deviation 2. Accept correct named statistical test eg t-test
04.3	In Group **C**: 1. Less mitochondrial replication/production; 2. Less transcription (of genes) for mitochondrial proteins/CS **OR** Less translation of (mRNA into) mitochondrial proteins;	2	1. and 2. Accept converse for Group **T** 2. Accept less CS/enzyme is produced

04.4	For (no mark) 1. (From **Figure 5** Group **T** have) increased CS activity for Krebs cycle; 2. (from **Figure 4** Group **T** have) increased $VO_{2\ max}$ **so** more oxygen (available) **OR** (from **Figure 4** Group **T** have) increased $VO_{2\ max}$ **so** more aerobic respiration **OR** (from **Figure 4** Group **T** have) increased VO_{2max} **so** delayed anaerobic respiration; Against (no mark) 3. No correlation between (percentage change in) $VO_{2\ max}$ and CS activity **OR** No correlation on **Figure 6**; 4. It might not be thymine causing the increase **OR** There may be other differences in the control region (of Group **T**) that cause the increase; 5. $VO_{2\ max}$/CS activity not the only measures of ability to exercise for longer;	3 max	**Max 2 marks for mark points 3, 4 and 5** Ignore any answers relating to sample size or duration of investigation Ignore 'correlation does not mean causation' unless qualified 2. Accept 'less lactate' for delayed anaerobic respiration 4. Ignore 'could be due to lifestyle/diet changes' 5. Accept ideas that they did not measure ability to exercise for longer

Question	Marking Guidance	Mark	Comments
05.1	Accept suitable null hypothesis that **includes type of light and behaviour**, eg The type of light has no effect on the behaviour/movement of COTS **OR** There is no difference in behaviour/movement with constant/flashing light;	1	Ignore general null hypotheses, or example 'there is no difference between observed and expected'
05.2	Accept any **two** factors for **one** mark from the list below; Salinity / salt concentration of the water Temperature (of the water) Amount / distribution of food pH (of the water) Oxygen/carbon dioxide concentration Intensity/wavelength of (constant and flashing) light	1 max	List rule applies Ignore humidity Ignore type of coral Ignore depth of water
05.3	Yes (no mark) 1. Movement is away from either type/both types of light **OR** Negative (photo) taxis to both types/either types of light; 2. Significant movement away from constant light **as** p=0.02/<0.05/=2%/<5% **OR** Movement away from constant light is not due to chance **as** p=0.02/<0.05/=2%/<5%; No (no mark) 3. Movement away from flashing light is not significant **as** p=0.69/>0.05/=69%/>5% **OR** Movement away from flashing light is due to chance **as** p=0.69/>0.05/=69%/>5%;	3	2. and 3. Ignore '**results'** in the context of significance or chance

05.4	Correct answer of 3 hours = 2 marks;; Allow 1 mark for distance of 48 000 mm in working 1 max for answer of 185 minutes/3 hours and 5 minutes/3.09 hours 1 max for answer of 1 hour (ie answers that use 564 in their calculation);	2 max	

Question	Marking Guidance	Mark	Comments
06.1	0.1;	1	
06.2	Accept answer in the range of 4.7 to 4.9;	1	
06.3	1. (Trexall acts as a) competitive inhibitor **OR** (Trexall) competes (with folic acid/substrate) for/is able to fit into/binds at <u>active site</u> (on dihydrofolate reductase / enzyme); 2. Less folic acid/substrate attaches **OR** Fewer enzyme-substrate complexes; 3. Fewer/not enough nucleotides available for DNA replication;	3	1. Reject Trexall and folic acid have the **same** shape 2. Accept folic acid/substrate is prevented from binding 3. Accept fewer/not enough nucleotides available during interphase/for semi-conservative replication/to add to (all) template strands/for transcription
06.4	**Percentage change** 1. To allow comparison **as** tumours may differ in volume/size (at the start of the investigation); **Tumour volume** 2. (As) tumours may differ in length/width/shape **OR** (As) volume is (best) indication of the number of cells in tumour;	2	2. Accept 'as tumours are three dimensional' 2. Ignore answers relating to density/thickness

06.5	Answer in the range 32 015.93682 to 32 045 = 2 marks **OR** 3.20×10^4 = 2 marks;; Allow 1 mark for correct calculation of volume after treatment in range of 24 011.95261 to 24 034 /2.40×10^4 Allow 1 mark if student uses diameter throughout instead of radius, in range of 256 127 to 256 361/2.56×10^5	2 max	Accept any suitable rounding
06.6	**For (the use of 30 mg)** 1. There is a significantly greater reduction (in tumour size with 30 mg), **as** SD (bars) do not overlap; 2. In some cases (with 30 mg) there was a 100% reduction in size/tumours would have been eradicated; **Against (the use of 30 mg)** 3. There is too much/a lot of variation in effectiveness with 30 mg (in contrast with 20 mg); 4. (No idea of) extra cost of providing 30 mg per week; 5. (Increased risk of) side effects with higher doses;	2 max	Accept converse arguments for all mark points. 1. Accept 'significant difference' for 'significantly greater reduction' 3. Ignore 30 mg has a lot of deviation/large standard deviation' unqualified
06.7	Accept any **two** suitable suggestions for **one** mark, eg; Severity/duration of arthritis Current/other medication Type of arthritis Weight/body mass Ethnicity	1 max	Reject age/health as they are directly in the stem Ignore gender/sex Ignore general answers such as diet/activity/lifestyle

06.8	**For** 1. Pain decreases more with Trexall/Group **R** compared with the control group/Group **S** **OR** Pain decreases by 4.6 with Trexall/Group **R and** by 2 with the control group/Group **S**; **Against** 2. Small sample size/only 12 people/only studied females / effects in males could be different; 3. (Mean score for severity of) pain in control group/Group **S** is (also) lower; 4. No statistical testing, **so** do not know if decrease/difference is significant; 5. Pain is (a) subjective (measurement);	3 max	**2 max for answer only giving reasons against** 1. Ignore numbers stated from **Table 3**, eg 9.7 to 5.1 **and** 9.8 to 7.8 3. Could be subsumed within MP1 4. Ignore 'do not know if **results** are significant' 5. Accept 'patients might lie about pain'

Question 7 Level of response marking guidance

Level of response marking instructions

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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.

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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.

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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	
07.1	**The importance of DNA as an information carrying molecule and its use in gene technologies** • 3.1.5.1 Structure of DNA • 3.1.5.2 DNA replication • 3.2.1.1 DNA in mitochondria (and chloroplasts) • 3.2.1.2 Prokaryotic DNA • 3.2.2 DNA replication in interphase and binary fission • 3.4.1 DNA, genes and chromosomes • 3.4.2 DNA and protein synthesis • 3.4.3 Genetic diversity and meiosis • 3.4.4 Genetic diversity and adaptation • 3.4.7 Investigating diversity • 3.7.1 Inheritance • 3.7.3 Evolution may lead to speciation • 3.8.1 Alteration of the sequence of bases in DNA can alter the structure of proteins • 3.8.2.1 Most of a cell's DNA is not translated • 3.8.2.2 Regulation of transcription and translation • 3.8.2.3 Gene expression and cancer • 3.8.3 Using genome projects • 3.8.4.1 Recombinant DNA technology • 3.8.4.2 Differences in DNA between individuals of the same species can be exploited for identification and diagnosis of heritable conditions • 3.8.4.3 Genetic 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 importance of bonds and bonding in organisms** • 3.1.1 Monomers and polymers • 3.1.2 Carbohydrates • 3.1.3 Lipids • 3.1.4.1 General properties of proteins • 3.1.4.2 Many proteins are enzymes • 3.1.5.1 Structure of DNA and RNA • 3.1.5.2 DNA replication • 3.1.6 ATP • 3.1.7 Water – cohesion • 3.2.2 Mitosis • 3.2.3 Transport across cell membranes • 3.2.4 Cell recognition and the immune system • 3.3.3 Digestion and absorption • 3.3.4.1 Mass transport in animals – haemoglobin • 3.3.4.2 Mass transport in plants • 3.4.2 DNA and protein synthesis • 3.4.3 Mutation and meiosis • 3.5.1 Photosynthesis • 3.5.2 Respiration • 3.5.4 Nutrient cycles • 3.6.2.2 Synaptic transmission • 3.6.3 Skeletal muscles • 3.6.4.2 Control of blood glucose concentration • 3.6.4.3 Control of blood water potential • 3.8.1 Mutations • 3.8.2.2 Regulation of transcription and translation • 3.8.2.3 Gene expression and cancer • 3.8.4.1 Recombinant DNA technology	**[25 marks]**	

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