



National  
Qualifications  
2023

---

**2023 Human Biology**  
**Higher - Paper 2**  
**Finalised Marking Instructions**

© Scottish Qualifications Authority 2023

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

The information in this document may be reproduced in support of SQA qualifications only on a non-commercial basis. If it is reproduced, SQA must be clearly acknowledged as the source. If it is to be reproduced for any other purpose, written permission must be obtained from [permissions@sqa.org.uk](mailto:permissions@sqa.org.uk).



## General marking principles for Higher Human Biology

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

- (a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.
- (b) If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.
- (c) Do not award half marks.
- (d) Where a candidate makes an error in the first part of a question, award marks for subsequent answers that are correct with regard to this original error. Do not penalise candidates more than once for the same error.
- (e) Unless a numerical question specifically requires evidence of working to be shown, award full marks for a correct final answer (including units, if appropriate) on its own.
- (f) Candidates should not use bulleted lists to answer extended-response questions. They must respond to the 'command' word as appropriate and provide extended answers to communicate fully their knowledge and understanding. Candidate responses in the form of bulleted lists may not be able to access the full range of available marks.
- (g) In the detailed marking instructions, if a word is **underlined** then it is essential; if a word is **(bracketed)** then it is not essential.
- (h) In the detailed marking instructions, words separated by / are **alternatives**.
- (i) A correct response can be negated if the candidate includes:
  - an extra, incorrect, response
  - additional information that contradicts the correct response
- (j) Where the candidate is instructed to choose one question to answer but instead answers two questions, mark both responses and award the higher mark.
- (k) Unless otherwise required by the question, the use of abbreviations (for example DNA, ATP) or chemical formulae (for example CO<sub>2</sub>, H<sub>2</sub>O) are acceptable alternatives to naming.
- (l) If a numerical answer is required and units are not given in the stem of the question or in the answer space, candidates must supply the units to gain the mark. If units are required on more than one occasion, do not penalise candidates repeatedly.
- (m) If incorrect spelling is given:
  - If the correct word is recognisable then award the mark.
  - If the word can easily be confused with another biological term then **do not** award the mark, for example glucagon and glycogen.

(n) **Presentation of data:**

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

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

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

Marking instructions for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	(DNA) Nucleotides	1	
		(ii)	Sugar/deoxyribose and phosphate	1	
		(iii)	X or Y	1	
	(b)	(i)	Transcription	1	
		(ii)	Different exons are retained/ removed. <b>OR</b> Different mature transcripts are produced.	1	Any reference to introns being retained or treated as exons negates.
		(iii)	tRNA/it attaches to a specific amino acid. <b>OR</b> tRNA/it carries/brings an amino acid to the ribosome/mRNA. (1)  Anticodon (on tRNA) aligns/joins/ bonds with codon (on mRNA). <b>OR</b> Anticodon is complementary/specific to the codon. (1)  Results in/ensures the amino acid(s) are in the correct order/position. <b>OR</b> tRNA/it detaches/leaves the ribosome and can collect another amino acid/be reused. (1)  Any 2	2	Accept anticodon is specific to an amino acid.  Suggestion of tRNA has codon/mRNA has anticodon negates this mark.

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i)	A (large) molecule/substrate/ substance is broken down (to smaller molecules).  <b>OR</b> Two/multiple (smaller) products/ molecules are formed.	1	
		(ii)	The active site changes shape.  <b>OR</b> The active site changes to (better) fit the substrate.	1	
		(iii)	The products/they have a low affinity/attraction for the active site.  <b>OR</b> The products/they no longer fit the active site.	1	
	(b)		It is the lowest concentration (of tyrosine/substrate) to produce the maximum/highest concentration/ (~)0.010 (mg/cm <sup>3</sup> ) of L-dopa/ product.  <b>OR</b> Raising the concentration of tyrosine above this/5 (mg/cm <sup>3</sup> ) does not increase the concentration of L- dopa/product.  <b>OR</b> By raising the concentration of tyrosine above this/5 (mg/cm <sup>3</sup> ), the concentration of L-dopa/product levels off/is not affected/remains constant/at (~) 0.010 (mg/cm <sup>3</sup> ).	1	Accept: it/5 (mg/cm <sup>3</sup> ) of tyrosine produces the highest concentration of L-dopa/product before the concentration/it levels off/is not affected/remains constant/at (~) 0.010 (mg/cm <sup>3</sup> ).

Question		Expected response	Max mark	Additional guidance
2.	(c)	<p>To prevent feedback/end-product inhibition.</p> <p><b>OR</b></p> <p>A high concentration of end-product inhibits the enzyme/lowers the reaction rate.</p> <p><b>OR</b></p> <p>Removal of the product drives/pushes/promotes/causes the reaction to make more product.</p> <p><b>OR</b></p> <p>It prevents build-up/an increase of product, which would reverse the reaction.</p>	1	Accept a description of end-product inhibition.

Question			Expected response	Max mark	Additional guidance											
3.	(a)	(i)	Concentration of enzyme/ dehydrogenase/DCPIP/inhibitor.  <b>OR</b> Temperature/pH of solution/test tubes.	1	Do not accept type of inhibitor.  Accept temperature/pH of contents of tube/named solution.											
		(ii)	Difficult to identify/measure the (exact) time of decolourisation (of DCPIP)/end point.  <b>OR</b> Difficult to make sure all drops (of DCPIP) are consistent/the same volume/size.  <b>OR</b> Adding the DCPIP/it after the reaction starts/enzyme is added.	1												
		(iii)	Repeat (the investigation/ experiment/it) at each (succinate) concentration.  <b>OR</b> Repeat (the investigation/ experiment/it) and take an average.	1												
	(b)	<p>Axes have correct scales and labels. (1)</p> <p>Points correctly plotted and lines drawn. (1)</p> <table border="1" data-bbox="352 1335 818 1592"> <thead> <tr> <th>Concentration of succinate (M)</th> <th>Time to decolourise DCPIP (s)</th> </tr> </thead> <tbody> <tr> <td>0.2</td> <td>94</td> </tr> <tr> <td>0.4</td> <td>48</td> </tr> <tr> <td>0.6</td> <td>24</td> </tr> <tr> <td>0.8</td> <td>14</td> </tr> <tr> <td>1.0</td> <td>8</td> </tr> </tbody> </table>	Concentration of succinate (M)	Time to decolourise DCPIP (s)	0.2	94	0.4	48	0.6	24	0.8	14	1.0	8	2	<p>Any 3 values to establish a linear scale. A number at the origin is not essential.</p> <p>Data can be plotted outwith the numbered scale.</p> <p>Scale breaks are not acceptable. If the axes are transposed do not award the scale mark.</p> <p>Candidates cannot access the scale mark if the plotted points use less than half the graph paper.</p> <p>The line must touch all the points.</p>
Concentration of succinate (M)	Time to decolourise DCPIP (s)															
0.2	94															
0.4	48															
0.6	24															
0.8	14															
1.0	8															

Question		Expected response	Max mark	Additional guidance	
3.	(c)	<p>As the substrate/succinate concentration increases the time of the reaction/to decolourise decreases.</p> <p><b>OR</b></p> <p>The maximum rate of reaction is reached.</p> <p><b>OR</b></p> <p>Increasing substrate concentration reduces/overcomes/reverses inhibition.</p> <p><b>OR</b></p> <p>The time to decolourise DCPIP with inhibitor reaches the same value as without inhibitor.</p>	1	Accept if non-competitive inhibitor is used maximum rate of reaction would not be reached.	
	(d)	(i)	Matrix of mitochondria.	1	
		(ii)	<p>To remove hydrogen ions)/electrons.</p> <p><b>OR</b></p> <p>Pass hydrogen (ions)/electrons to NAD (to form NADH).</p>	1	<p>Accept H<sup>+</sup>/e<sup>-</sup></p> <p>Removal of hydrogen (ions)/electrons from NADH negates.</p> <p>Reference to dehydrogenase transporting hydrogen (ions)/electrons to electron transport chain negates.</p>
		(iii)	Oxaloacetate	1	



Question			Expected response	Max mark	Additional guidance
4.	(a)	(i)	(One) thymine/T is replaced by adenine/A. <b>OR</b> The second/one codon has one base/nucleotide different.	1	
		(ii)	The shape/structure of the protein is changed. <b>OR</b> The protein does not fold properly. <b>OR</b> Different bonding occurs (between the amino acids). <b>OR</b> The binding site for oxygen has changed.	1	
	(b)		In a missense mutation only one amino acid is changed/replaced/ altered. (1)  In a frame-shift mutation (the order of) amino acids after the mutation are changed/replaced/ altered. (1)	2	Do not accept production of amino acids.
	(c)	(i)	Both types of haemoglobin are found in their red blood cells. <b>OR</b> Individuals/they have both haemoglobin S and normal haemoglobin. <b>OR</b> Both (haemoglobin) alleles have an equal chance of being expressed. <b>OR</b> Individuals have a mild/less severe form of sickle cell disease.	1	Accept both (haemoglobin) alleles are shown in the phenotype.
		(ii)	Their (red) blood cells could stick together/stick to artery walls and forms clots/blockages. <b>OR</b> Their (red) blood cells block arteries to the brain.	1	
		(iii)	14 700	1	

Question			Expected response	Max mark	Additional guidance
5.	(a)	(i)	4	1	
		(ii)	Corpus luteum.	1	
	(b)	(i)	A lack/decrease in LH/drop in concentration of LH (1)  (Leads to the) degeneration/break down of the corpus luteum. (1)	2	Accept a decrease in LH secretion/production.
		(ii)	Menstruation starts/the endometrium starts to break down/no longer maintained. <b>OR</b> Pituitary (gland) secretes FSH. <b>OR</b> Inhibition of the pituitary (gland) stops/is removed.	1	Accept menstruation.  Accept FSH concentration increases.
	(c)		Prevent the negative feedback/inhibitory effect of oestrogen (on FSH secretion). <b>OR</b> Mimic (the action of) FSH/LH.	1	Do not accept answers referring to the drugs containing FSH/LH.

Question			Expected response	Max mark	Additional guidance
6.	(a)	(i)	<p>1. As the (number of IVF) cycles increases the birth rate (per embryo transfer) decreases. (1)</p> <p>2. As the (number of IVF) cycles increases the average age of the women (undergoing IVF) increases. (1)</p> <p>3. As the average age of women (undergoing IVF) increases the birth rate (per embryo transfer) decreases. (1)</p> <p style="text-align: right;">Any 2</p>	2	
		(ii)	35	1	
	(b)	(i)	99/99.1/99.06	1	
		(ii)	6240	1	
		(iii)	As the number of embryos transferred/used is different/ decreases.	1	
	(c)	(i)	27	1	
		(ii)	<p>The birth rate (per embryo transfer) decreased with age for the women's own eggs but remained constant/did not decrease with age for donor eggs.</p> <p><b>OR</b></p> <p>The difference in birth rate (per embryo transfer) increases with age.</p>	1	
		(iii)	<p>Donor eggs/they may be younger/ come from younger women.</p> <p><b>OR</b></p> <p>Donor eggs/they may have less mutations/abnormalities.</p>	1	Accept donor eggs/they come from women under 35.

Question			Expected response	Max mark	Additional guidance
7.	(a)	(i)	The muscle/connective tissue layer is thicker/larger/wider in X/arteries. <b>OR</b> The lumen is smaller/narrower in X/arteries.	1	Do not accept arteries have thicker walls/veins have thinner walls Accept converse answers relating to veins.
		(ii)	Endothelium/endothelial (cells)	1	Do not accept epithelium/epithelial.
	(b)		1. Pressure filtration (occurs). <b>OR</b> Plasma passes through capillary walls. 2. The plasma becomes tissue fluid. <b>OR</b> Tissue fluid surrounds the cells. 3. Glucose/oxygen moves/diffuses into/is supplied to the cells. <b>OR</b> Carbon dioxide/(metabolic) waste products diffuse/move out of the cells. 4. Tissue fluid moves back into the blood/capillary.  <b>Any 3</b>	3	Accept excess tissue fluid is absorbed/taken in/removed by lymphatic vessels/system.

Question			Expected response	Max mark	Additional guidance
8.	(a)	(i)	Coronary artery.	1	
		(ii)	Muscle/cells/tissue are deprived of oxygen/glucose.	1	
	(b)		Statins/they reduce (blood) cholesterol (levels/build up).  <b>OR</b>  Prevents synthesis of cholesterol (by liver cells) (1)  (Statins) reduce atherosclerosis/the chances of a clot/thrombus/atheroma/embolism. (1)	2	
	(c)	(i)	Accept any value from 30 to 31	1	
		(ii)	115.992/115.99/116	1	

Question		Expected response	Max mark	Additional guidance
9.	(a)	Glucose tolerance (test).	1	
	(b)	114	1	
	(c)	<p>There is a decrease in the number / sensitivity of insulin receptors.</p> <p><b>OR</b></p> <p>The cells develop insulin resistance/become less sensitive to insulin. (1)</p> <p>This means that liver cells/they can take in less glucose/do not remove glucose from the blood.</p> <p><b>OR</b></p> <p>(So) less/no glucose is converted to glycogen. (1)</p>	2	Accept receptors develop insulin resistance.
	(d)	<p>The endothelium/ (small) blood vessels/capillaries are damaged.</p> <p><b>OR</b></p> <p>(Small) blood vessels/capillaries burst/haemorrhage/leak blood.</p>	1	Do not accept arteries/veins for blood vessels.

Question			Expected response	Max mark	Additional guidance
10.	(a)	(i)	Axon	1	
		(ii)	It increases the speed of impulses.	1	Answer must indicate an increase.
		(iii)	Glial	1	
	(b)		<p>They have less myelin/myelination is incomplete and impulses are slower.</p> <p><b>OR</b></p> <p>They have less myelin/myelination is incomplete and they cannot move their muscles as quickly/control their muscles as well.</p>	1	Do not accept they have no myelin.
	(c)		<p>Impulse(s)/neurotransmitters can be sent to more than one destination/neuron.</p> <p><b>OR</b></p> <p>More than one muscle/effector/destination/neuron can be stimulated.</p> <p><b>OR</b></p> <p>(It allows) fine motor control/coordination of movement.</p>	1	Accept examples of fine motor control like writing/threading a needle.

Question		Expected response	Max mark	Additional guidance
11.	(a)	Central Nervous (System)/CNS.	1	
	(b)	(i) Antagonistic	1	Do not accept antagonist(s)
		(ii) Increased heart rate:  Increases blood flow to muscles/the body/cells.  <b>OR</b>  Increases glucose/oxygen to muscles/cells.  <b>OR</b>  Increases glucose/oxygen for respiration. (1)  Vasoconstriction of arteries:  Decreases blood flow to small intestine/digestive system/gut.  <b>OR</b>  Increases blood flow to skeletal/working/exercising muscles. (1)	2	Accept blood is diverted to the muscles/other areas.



Question		Expected response	Max mark	Additional guidance
12.	(a)	1. (Same) person reading out the words/volume/tone of person (reading words) 2. (Same) gender balance/ratio. 3. Speed of words read out/time between each word/time allowed to write down the words/time between listening and writing. 4. Order of words/the same words. 5. Hearing ability/level of alertness/IQ/literacy level/first language of participant. 6. Volume of music/background noise/distance from music source/speakers  <p style="text-align: right;"><b>Any 2</b></p>	2	3. Accept time taken to read the words.  If candidate lists three or more variables and at least one is correct award 1 mark.  If all answers are correct award 2 marks.
	(b)	1	1	
	(c)	No (background/rock) music.	1	
	(d)	(Listening to background) rock music decreases the ability to recall/remember words.	1	
	(e)	Words/they may still be in short term memory/STM.  <b>OR</b>  Words/they will not have been displaced/decayed from short term memory/STM.	1	

Question			Expected response	Max mark	Additional guidance
13.	(a)	(i)	105	1	
		(ii)	125	1	
		(iii)	<p>The muscle/cells do not get enough oxygen.</p> <p><b>OR</b></p> <p>Oxygen debt occurs/the electron transport chain cannot occur. (1)</p> <p>Pyruvate is converted to lactate/ lactate is not converted back to pyruvate. (1)</p> <p>Lactate production allows the regeneration of NAD/ glycolysis to continue/some ATP to be produced. (1)</p> <p><b>Any 2</b></p>	2	
	(b)		Eating/sex.	1	<p>Accept laughter.</p> <p>Accept eating any named food.</p> <p>Do not accept injury/stress/pain.</p>
	(c)	(i)	7:10	1	
		(ii)	<p>Fitness levels have no effect on endorphin concentrations/levels.</p> <p><b>OR</b></p> <p>Endorphin concentrations/levels increase to the same extent in both fit and unfit individuals.</p> <p><b>OR</b></p> <p>Endorphin concentrations/levels in both fit and unfit individuals are the same/similar.</p>	1	

Question		Expected response	Max mark	Additional guidance
14.	(a)	Pathogen	1	
	(b)	They/phagocytes engulf bacteria/it (into a vacuole). (1)  Lysosomes release/contain enzymes (1)  Enzymes destroy/digest/break down the bacteria/it. (1)  Any 2	2	Accept lysozyme for enzyme.  Do not accept lysosome for enzyme.
	(c)	Attract/signal (more) phagocytes/lymphocytes/white blood cells (to the wound).	1	Accept cause an accumulation for attract.
	(d)	Prevents/reduces the release/crossing of neurotransmitters.  OR  Prevents/reduces the fusion of vesicles.  OR  Increases the reuptake of the neurotransmitters.	1	
	(e)	Tetanus/it is not spread from person to person/from an infected individual.	1	Accept tetanus/it is contracted by contact from soil not people.

Question		Expected response	Max mark	Additional guidance
15.	A	<p>a. (Recreational drugs can act as) agonists which stimulate receptors. <b>OR</b> Agonists mimic (the action of) neurotransmitters.</p> <p>b. (Recreational drugs can act as) antagonists which block receptors. <b>OR</b> Antagonists block the action/ binding of neurotransmitters.</p> <p>c. (Recreational drugs) affect neurotransmission/receptors/ synapses in the reward pathway.</p> <p>d. (Some recreational drugs) inhibit reuptake of neurotransmitters/ inhibit the enzymes that degrade neurotransmitters.</p> <p style="text-align: right;"><b>Maximum 2 marks</b></p> <p>1. Recreational drugs alter (an individual's) mood/cognition/ perception/behaviour.</p> <p>2. (Drug) addiction is caused by (repeated/continual use of) antagonists.</p> <p>3. Antagonists increase the number/sensitivity of receptors.</p> <p>4. An increase in number/sensitivity of receptors causes sensitisation.</p> <p>5. (This leads to) addiction as the individual craves (more of) the drug.</p> <p>6. (Drug) tolerance is caused by (repeated/continual use of) agonists.</p> <p>7. Agonists decrease the number/ sensitivity of receptors.</p> <p>8. A decrease in number/sensitivity of receptors causes desensitisation.</p> <p>9. (This leads to) tolerance where an individual must take more of the drug to get an effect.</p> <p style="text-align: right;"><b>Maximum of 6 marks</b></p>	8	<p>c. Accept (recreational drugs) activate/stimulate the reward pathway</p> <p>1. Accept description of these terms.</p>

Question		Expected response	Max mark	Additional guidance
15.	B	<p>a. Vaccines contain antigens from (infectious) pathogens.</p> <p>b. Vaccines contain inactivated pathogen toxins/dead pathogens/parts of pathogens/weakened pathogens.</p> <p>c. (These are usually) mixed with/contain an adjuvant.</p> <p>d. An adjuvant makes the vaccine more effective/enhances the immune response.</p> <p style="text-align: center;"><b>Maximum of 2 marks</b></p> <p>1. Clinical trials are used to make sure vaccines/drug are safe.</p> <p>2. Subjects/individuals are divided/placed into groups in a randomised way.</p> <p>3. Characteristics/age/gender are controlled/similar.</p> <p>4. (In a clinical trial) one group/some people receives the vaccine/drug while the second group/some people receive a placebo.</p> <p>5. Using a placebo ensures valid comparisons/results.</p> <p>6. In a double-blind trial neither the subjects/participants nor the researchers/doctors know which group subjects are in/treatment is given.</p> <p>7. Bias is prevented/reduced through randomised allocation/ double-blind (trial) (to increase validity).</p> <p>8. Groups must be of a suitable/ large size to reduce experimental error/increase reliability.</p> <p>9. The results are compared to determine any (statistically) significant differences.</p> <p style="text-align: center;"><b>Maximum of 6 marks</b></p>	8	<p>Accept bacteria/virus for pathogen.</p> <p>Use of accuracy does not negate.</p> <p>2. Accept an example of randomisation (eg names out of a hat/computer generated).</p> <p>5. Use of reliability negates.</p> <p>6. Accept a description of the groups/treatment (eg which group/who receives vaccine/ placebo).</p> <p>7. Accept a description of protocol(s).</p> <p>7. Use of reliability negates if not already penalised in point 5.</p> <p>8. Use of validity negates.</p>

[END OF MARKING INSTRUCTIONS]