National
Qualifications
2023

2023 Biology

Higher – Paper 2

Finalised marking instructions

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

General marking principles for Higher Biology

Always apply these general principles. Use them in conjunction with the 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 CO2, H20) 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, justify,** 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

Question			Expected response	Max mark	Additional guidance
1.	(a)		DNA polymerase.	**1**	**Not acceptable -** polymerase alone
	(b)		Two/multiple primers (attached to strand A). **OR** The primer hasn't bonded to the 5′ end of the DNA strand.	**1**	**Not acceptable -** replicated in fragments alone
	(c)	(i)	One (primer is required) for each strand. **OR** One primer is required for each end of the target sequence/region to be amplified.	**1**	**Not acceptable -** it has a leading and lagging strand.
		(ii)	Any value or any range from 50 to 65 inclusive.	**1**	
	(d)		240	**1**	

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i)	Alternative (RNA) splicing.	**1**	**Not acceptable -** RNA splicing
		(ii)	The order/sequence of the exons has changed.	**1**	
	(b)		Introns retained/included. **OR** Some exons not included. **(1)** Non-functional (protein) **OR** Different/more/fewer amino acids. **OR** Longer/shorter/larger/smaller (protein). **OR** (Protein) will have different shape/structure. **OR** (Protein) not folded correctly. **(1)**	**2**	 **Not acceptable -** no protein is made **Not acceptable -** new/different protein

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i)	Testing drugs/medicine. **OR** Investigate/study cell processes/ division/growth/differentiation. **OR** Investigate/study gene regulation.	**1**	
		(ii)	Can become/differentiate into any/all cell (types). **OR** Pluripotent **OR** All genes in embryonic stem cells can be switched on/expressed. **OR** Can self-renew/divide in the lab/in culture (under the right conditions).	**1**	**Not acceptable -** many cells/cell types **Not acceptable -** multipotent **Not acceptable** – all genes are switched on/expressed
		(iii)	Can find/discover/lead to cures/treatments for disease/ injuries/easing suffering. **OR** Avoids/reduces animal testing.	**1**	**Not acceptable -** cure/treat disease/ease suffering

Question			Expected response	Max mark	Additional guidance
3.	(b)	(i)	(Cell count is) higher/increases faster for medium +cytokines. **OR** Highest (cell count) is 520/day 8 for medium (only) **and** 8200/day 10 for medium+ cytokines. **OR** (Cell count for) medium only was lower at the end/day 10 than the start/day 2 whereas medium + cytokine was higher at the end/day 10 than at the start/day 2. **OR** Medium + cytokines (cell count) increases throughout **and** medium (only) increases then decreases (after 8 days/at day 10. **(Any 2)**	**2**	**Accept - (flask) A** in place of medium throughout. **Accept - (flask) B** in place of medium +cytokines throughout. If figures are quoted these must be correct.
		(ii)	82	**1**	
		(iii)	The cell count decreases in medium (only) after day 8/at day 10. **OR** Medium (only) shows a death phase after day 8/at day 10.	**1**	
4.	(a)	(i)	88	**1**	
		(ii)	6	**1**	
		(iii)	Zebrafish	**1**	
	(b)	(i)	C	**1**	
		(ii)	Inversion	**1**	

Question			Expected response	Max mark	Additional guidance
5.	**A**		1. Prokaryotes have circular chromosomes and plasmids. 2. Prokaryote DNA/chromosomes/plasmids are found in the cytoplasm. 3. Eukaryotes have linear chromosomes. 4.In eukaryotes linear chromosomes/DNA is in the nucleus 5. Linear/nuclear chromosome/DNA packaged with/coiled/wrapped around associated proteins/histones. 6. Eukaryotes have circular chromosomes in mitochondria/ chloroplasts. 7. Yeast is a eukaryote with plasmids. **Max 4 from points 3-7** **(Any 5)**	**5**	**Not acceptable -** circular DNA

Question			Expected response	Max mark	Additional guidance
5.	**B**		1. Translation occurs at/in/on the ribosome. 2. tRNA has amino acid attachment site **AND** an anticodon. 3. tRNA collects a specific/correct amino acid. 4. tRNA brings the amino acid to the ribosome/mRNA. 5. anticodon (on tRNA) is complementary/corresponds/binds to codon. 6. (mRNA has) start and stop codons. 7. amino acids joined by peptide bonds **OR** Polypeptide forms **(Any 5)**	**5**	

Question			Expected response	Max mark	Additional guidance
6.	(a)		Glycolysis	**1**	
	(b)		More (ATP) is produced than is used. **OR** 2 (ATP) are used/invested and 4 are produced.	**1**	**Not acceptable -** more energy is **produced** than is used.
	(c)		Carbon dioxide/CO_2	**1**	
	(d)		Mutagenesis/mutation occurs **OR** Causes mutations **OR** Increases mutation rate	**1**	
	(e)		Lactate	**1**	
7.	(a)		As temperature increases oxygen consumption/metabolic rate increases. **OR** Oxygen consumption/metabolic rate is dependent on the temperature.	**1**	If figures quoted these must be correct **Not acceptable - as** oxygen consumption/metabolic rate increases temperature increases. **Not acceptable** – Oxygen consumption/metabolic rate is affected by the temperature.
	(b)		Repeat at each temperature. **OR** Use more lizards/dragons at each temperature. **OR** Repeat/use more dragons **and** calculate an average.	**1**	**Not acceptable -** repeat/use more lizards/dragons
	(c)		0.065 **OR** $6.5x10^{-2}$	**1**	

Question			Expected response	Max mark	Additional guidance
7.	(d)		It results in increased/optimum enzyme activity/rate **OR** Enzymes work faster/more effectively **(1)** (leading to) increased respiration ATP production/rate of (chemical) reactions. **(1)** **OR** It results in increased/optimum diffusion (rate) **(1)** (leading to) more oxygen/glucose/ substrates/metabolites for respiration/(chemical) reactions. **(1)**	**2**	**Not acceptable -** enzymes have an optimum temperature
	(e)		Behavioural **OR** Behaviour	**1**	
	(f)		Regulators have wider/more/larger (range of niches). **OR** Conformers have narrower/fewer/ smaller (range of niches).	**1**	
8.	(a)	(i)	1:5:6	**1**	
		(ii)	January, February, November and December (given in any order) **OR** November – February	**1**	**Accept -** Jan, Feb, Nov, Dec in place of full names. **Not acceptable -** J, F, N, D.
	(b)		Aestivation **(1)** Happens after onset/after start of/ in response to drought/adverse conditions. **(1)**	**2**	**Not acceptable -** happens **after** drought/adverse conditions.
	(c)	(i)	(Daily) torpor	**1**	
		(ii)	Saves/conserves energy. **OR** Less energy used/wasted/needed	**1**	**Not acceptable -** regain/gain energy **Not acceptable -** reduces metabolic costs

Question			Expected response	Max mark	Additional guidance
9.	(a)		Probes measure the (water) temperature (change/increase). **OR** Copper tube has a large surface area. **OR** Insulation reduces/ prevents heat loss. **OR** Copper is a (good) conductor (of heat). **(1)** Metabolic rate can be measured by heat loss/heat production/increase in (water) temperature. **OR** Metabolism/respiration/metabolic reactions give out heat. **(1)**	**2**	**Not acceptable** – probes measure heat produced
	(b)		Intensity of exercise	**1**	**Not acceptable -** type of exercise **Not acceptable -** walking and running

Question			Expected response	Max mark	Additional guidance
9.	(c)		Food/drink intake **OR** Oxygen concentration/level (in the calorimeter) **OR** Temperature of the calorimeter at the start **OR** Flow rate/volume/speed/pressure of water (in the pipe) **OR** Age **OR** Sex **OR** Fitness **OR** Clothing **OR** Mass of individual/person or body size **OR** Thickness/type of insulation **OR** Incline of treadmill **(Any 2)**	**2**	**Not acceptable -** volume of oxygen **Not acceptable -** temperature alone **Not acceptable -** temperature of the water at the start **Not acceptable** – speed/settings of treadmill

Question			Expected response	Max mark	Additional guidance
9.	(d)	(i)	Axes correctly labelled and scale correct **(1)** Points correctly plotted and joined **(1)**	**2**	Scale: • Any 3 values to establish a linear scale. • Scale **must** match line already plotted. • Data can be plotted out with the numbered scale. • Scale breaks are not acceptable. • If the axes are transposed do not award the scale mark. Plot: • The line must go through all points.
		(ii)	1.7	**1**	
	(e)		As the intensity of exercise increases, the metabolic rate increases	**1**	**Not acceptable -** the intensity of exercise increases as the metabolic rate increases. **Not acceptable -** metabolic rate is higher when running than walking.

Question			Expected response	Max mark	Additional guidance
10.	(a)	(i)	Vector	**1**	
		(ii)	To transfer/ carry large(r)/ long(er) sequences/sections/ fragments/strands of DNA. **OR** To transfer/carry large(r)/long(er) genes.	**1**	
	(b)		(So the gene and artificial chromosome have) complementary/ same/matching sticky ends **OR** complementary bases/base pairs/ DNA sequences	**1**	
	(c)		(DNA) ligase	**1**	
	(d)		Culture P/they have picked up the artificial chromosome. **OR** Culture P/ they have been transformed/modified. **(1)** Culture P/they could make/ synthesise leucine/amino acid **and** grow or make/synthesise protein. **(1)** **OR** (Culture) Q have not picked up the artificial chromosome. **OR** (Culture) Q have not been transformed/modified. **(1)** (Culture) Q could not make leucine/amino acid **and** did not grow or make/synthesise protein. **(1)**	**2**	**(culture) P (cells)/yeast (cells) = they** **(selectable) marker gene = artificial chromosome** **Do not negate** for inclusion of wrong selectable marker gene eg antibiotic resistance

Question			Expected response	Max mark	Additional guidance
11.	(a)		(Electrons) become excited **OR** Transferred/moved/carried through/ to/along the electron transfer/ transport chain	**1**	
	(b)		Photolysis **(1)** ATP synthase **(1)**	**2**	
	(c)	(i)	Increases to 175 (units) **(1)** Then remains constant/levels off. **(1)** **Award** 1 mark for increases then remains constant.	**2**	**NOT-** increase to 1500 (g of dry mass per m^2) alone If values are given these must be correct.
		(ii)	CO_2 (concentration) **(1)** more to react/combine with RuBP **(1)** **OR** Temperature **(1)** Increased or optimum enzyme/ RuBisCO activity/rate **(1)** **OR** pH **(1)** When it is at optimum enzymes/ RuBisCO will work faster/more effectively/have increased activity. **(1)** **OR** Water/moisture **(1)** More hydrogen (ions)/NADPH for the conversion of 3PG to G3P. **(1)**	**2**	Explanation **must refer** to environmental factor given. **NOT-** RuBisCO/enzymes have an optimum (temperature) **NOT-** RuBisCO/enzymes have an optimum pH **NOT-** rain/precipitation

Question			Expected response	Max mark	Additional guidance
12.	(a)		Species richness **OR** Number/variety of (different) species (in an ecosystem) **(1)** Relative abundance **OR** Proportion of (each) species (in an ecosystem) **(1)**	**2**	**Not acceptable -** abundance/population size of species
	(b)		There is a reduced/small population. **(1)** Inbreeding can result in poor reproductive rates. **(1)** Cannot evolve/adapt in response to environmental change. **(1)** **Any 2**	**2**	**Accept** – correct description of population eg number of individuals in a species **Accept-** description of poor reproductive rates eg fail to breed/ reproduce
	(c)	(i)	Habitat corridors	**1**	
		(ii)	Allows movement between fragments. **(1)** Increasing access to/more food/ mates. **OR** Allows/increases gene flow between fragments. **OR** Allows recolonisation of fragments after (local) extinctions. **(1)**	**2**	

Question			Expected response	Max mark	Additional guidance
13.	(a)		Increases from 750 thousands of hectares (in 1950) to 2350 in 1980. **OR** Increases from 750 thousands of hectares (in 1950) by 1600 to 1980. **(1)** Decreases to 1150 thousands of hectares (in 2000). **OR** Decreases by 1200 thousands of hectares (by 2000). **(1)** Award one mark for: Increases until 1980 then decreases.	**2**	Any description that includes values from 1930/1940 negates first mark. To achieve 2 marks units must be used once. If additional values are given these must be correct.
	(b)		3	**1**	
	(c)		15	**1**	
	(d)		11 740	**1**	
	(e)		Poultry/pigs will have a lower feed conversion ratio **(1)** Less food/barley is needed for poultry/pigs (than cattle). **OR** The same mass of food produces more (mass of) poultry/pigs than cattle **(1)**	**2**	If values are included these must be correct.

Question			Expected response	Max mark	Additional guidance
14.	(a)	(i)	Parasitism/parasitic	**1**	
		(ii)	Dodder benefits/gains while the blueberry is harmed/is disadvantaged/loses **(1)** by gain/ loss of nutrients/sugar/ energy/food **(1)**	**2**	**Not acceptable -** parasite benefits and host is harmed. **Not acceptable -** (gain or loss of) resources
	(b)	(i)	30 150	**1**	
		(ii)	To show the decrease in yield/ effect was due to dodder/infection/ parasite. **OR** To show the effect of the dodder/ infection/parasite on the blueberry (yield). **OR** To compare with dodder/infection/ parasite. **OR** To show what the yield would be without dodder/infection/parasite.	**1**	**Not acceptable -** for comparison alone
		(iii)	Eliminates/avoids/removes/reduces bias	**1**	

Question			Expected response	Max mark	Additional guidance
15.	**A**	(i)	1. Relatives are bred (for several generations). 2. (this) eliminates heterozygosity or increases homozygosity or population breeds true 3. inbreeding depression occurs 4. Inbreeding depression is an accumulation of deleterious, homozygous, recessive alleles. 5. inbreeding depression reduces reproductive success/reduces fertility/leads to poor reproductive rates. **(maximum 3)**	**9**	**Accept -** alternatives to deleterious eg harmful, disadvantageous.
		(ii)	a. cross breeding is breeding different breeds/cultivars/ varieties. b. results in F1 hybrid. c. offspring have improved/ desirable characteristics/traits/ alleles **OR** offspring have characteristics from each parent. d. new alleles introduced. e. crossbreeding produces a (uniform) heterozygous F1. f. F1/hybrid/crossbreed has hybrid vigour. **OR** F1/hybrid/crossbreed has increased vigour/disease resistance/growth rate/yield. g. F1/hybrids/crossbreeds are not usually bred together as F2/offspring are too varied. h. parent breeds maintained to produce more crossbreeds. **(maximum 6)**		**Not acceptable -** breeding different species

Question			Expected response	Max mark	Additional guidance
15.	**B**	(i)	1. donor is harmed/at risk (of harm). 2. recipient benefits/gains. 3. In reciprocal (altruism) roles reverse. **OR** In reciprocal (altruism) animal helps/feeds another in the hope/expectation that favour will be returned. 4. (altruistic behaviour) occurs between relatives/kin/family. 5. (this is) kin selection. 6. (kin selection) increases chances of/ensures shared genes/alleles surviving/being passed on to offspring. **(maximum 4)**	**9**	
		(ii)	a. have a social hierarchy with a rank order/dominant and subordinates. b. long period of parental care. c. (this allows time to) learn/teach complex (social) behaviour/skills. d. ritualistic display/behaviour by dominant (animals). e. appeasement display/behaviour by subordinate (animals). f. Naming - ritualistic display/behaviour **AND** appeasement display/behaviour (only award if neither d or e awarded). g. Ritualistic/appeasement display/behaviour reduces conflict/ tension/aggression. h. alliances formed to increase/ maintain social status/rank. **(maximum 5)**		**Not acceptable -** removes/prevents/avoids conflict/tension/aggression **Not acceptable -** reduces threat

[END OF MARKING INSTRUCTIONS]