AQA GCSE Biology | 8461

SPECIFICATION POINT 4.4.2.3

Metabolism

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**8**
Available paper years	**2010–2022**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.4.2.3 Metabolism

Answer 01 · Mark scheme

Question 3

question	answers	extra information	mark
3(a)(i)	pancreas	allow phonetic spelling	1
3(a)(ii)	(increases movement of) glucose into cells / organs / named	allow (glucose) converted to glycogen / fat allow (glucose) used in (increased) respiration do **not** allow hybrid spellings of glycogen	1
3(b)	**Type of diabetes** / **Treatment** Type 1 → Careful attention to diet only Type 1 → Careful attention to diet **and** injection of insulin Type 2 → Careful attention to diet **and** injection of insulin Type 2 → Injection of insulin only	**1** mark per correct line extra line from a type of diabetes cancels the mark	2
3(c)(i)	protein		1
3(c)(ii)	gene / allele		1

Question 3 continues on the next page

BLY2H

Question 3 continued

question	answers	extra information	mark
3(c)(iii)	any **three** from: • (amino acids) broken down / converted • (amino acids) form / into urea • (break down / convert / urea formed) in liver • (urea / broken down amino acids) removed / filtered by kidney • (urea / broken down amino acids) in urine • (urine / urea / broken down amino acids) stored / held in bladder	max **2** if any one process goes on in the wrong organ	3
Total			**9**

4.4.2.3 Metabolism

Answer 01 · Mark scheme

January 2010 | BLY2H | Original Q3 | Legacy

BLY2H

4.4.2.3 Metabolism

Answer 02 · Mark scheme

June 2012 | BL2HP | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)	any **three** from: • age (of athlete) • gender (of athlete) • starting concentration of glycogen • type / intensity of exercise • length of exercise period • number of training sessions • time interval between exercise sessions • exercise at same time of day	if diet given as answer = max **2** if none of these points gained amount of exercise = **1** mark if last four points not awarded allow time (for exercise) for **1** mark ignore references to amount of energy ignore they are both athletes	3
1(a)(ii)	any **two** from: • intensity of exercise • amount of exercise between sessions • starting concentration of glycogen • fitness / health • metabolic rate / respiration rate • amount / mass of muscle / physique • aspects of diet qualified, eg amount of food eaten	do **not** accept amount of carbohydrate if no other marks awarded allow height / mass / weight for **1** mark	2

4.4.2.3 Metabolism

1(a)(iii)	(B has) less glycogen **or** (B's glycogen) fell more **or** (B's glycogen) built up less	he = B accept use of approximate figures allow other correct observations from graph eg A is lower at end of first session ignore rate of fall	1
1(b)	athlete **A** (no mark) athlete **A** had more glycogen / **B** has less (only if A chosen to complete marathon) (glycogen / glucose) used in respiration (more) energy released / available in athlete **A** **and either** energy used for movement / muscle action / to run **or** (extra) glycogen → (more) glucose	to gain full marks 'more' must be given at least once accept converse argument for **B** ignore anaerobic allow 'energy made'	 1 1 1 1
Total			**10**

4.4.2.3 Metabolism

Answer 02 · Mark scheme

June 2012 | BL2HP | Original Q1 | Legacy

BL2HP

4.4.2.3 Metabolism

Answer 03 · Mark scheme

June 2015 | BL2HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	glycerol		1	AO1 2.5.2f
1(a)(ii)	pancreas / small intestine	accept duodenum / ileum ignore intestine unqualified	1	AO1 2.5.2f
1(b)	any **two** from: • type of milk • volume / amount of milk • vol. bile equals vol. water • volume of lipase • concentration of lipase • temperature	ignore time interval ignore solution unqualified do **not** allow pH ignore starting pH ignore volume / amount of bile / water ignore concentration of bile accept amount of lipase if neither volume nor concentration given	2	AO3 2.5.2f,h
1(c)(i)	fatty acid (production)		1	AO2 2.5.2f,h
1(c)(ii)	faster reaction / digestion (with bile) **or** pH decreases faster (with bile) **or** takes less time (with bile) **or** steeper fall / line (with bile)	allow use of data ignore easier	1	AO3 2.5.2f,h

4.4.2.3 Metabolism

Answer 03 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(c)(iii)	all fat / milk digested **or** same amount of fatty acids present **or** (lower pH) denatures the enzyme / lipase	allow all reactants used up ignore reference to neutralisation allow enzyme won't work at low pH do **not** allow enzyme killed	1	AO2 2.5.2f,h
Total			**7**	

4.4.2.3 Metabolism

Answer 03 · Mark scheme

June 2015 | BL2HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref

4.4.2.3 Metabolism

Answer 04 · Mark scheme

June 2017 | BL3HP | Original Q9 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
9(a)	pancreas releases <u>insulin</u> glucose moves into the cells **or** pancreas stops releasing glucagon glycogen stops being converted to glucose	do **not** allow liver releasing / producing insulin allow glucose is converted to glycogen	1 1	AO1 3.3.3a
9(b)	(exercise) uses up <u>glucose</u> idea of no <u>glucose</u> released into the blood(stream) (because) no available glycogen **or** glycogen cannot be broken down **or** no glycogen stored (and) <u>blood</u> sugar levels fall too low **or** (and) blood sugar levels remain low	 allow glucagon has no effect (on faulty glycogen) **or** glucagon doesn't break down glycogen ignore glycogen does not form properly 	1 1 1 1	AO2 3.3.3b
Total			**6**	

4.4.2.3 Metabolism

Answer 05 · Mark scheme

June 2018 | 8461/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	any **one** from: • respiration • formation of proteins • formation / breakdown of glycogen • breakdown of (excess) protein **or** formation of urea • photosynthesis **or** formation of glucose / starch (in plants)	allow other correct reference to metabolic reactions in cells ignore reference to digestion ignore formation of carbohydrates	1	AO1 4.4.2.3
02.2	males have a higher metabolic rate than females after five years of age the mean metabolic rate of females decreases faster than males up to 25 years of age	each additional tick negates a mark	1 1	AO3 4.4.2.3
02.3	$\frac{17}{53} \times 100$ 32.075472… 32.1	an answer of 32.1 scores **3** marks allow correct rounding of this to at least 4 significant figures allow a correct reduction to 3 significant figures from an incorrect calculation for marking point 2	1 1 1	AO2 4.4.2.3

4.4.2.3 Metabolism

Answer 05 · Mark scheme

June 2018 | 8461/1H | Original Q2

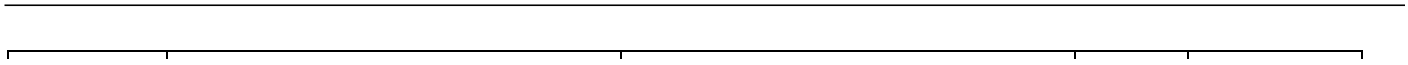
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any **two** from: • (person) R heart rate rose / increased more slowly than (person) S • (person) R heart rate levelled off whereas (person) S continued to increase • (person) R heart rate rose less (overall / after 5 minutes of exercise) than S	allow converse allow correct use of figures eg R increased (overall) by 39 bpm / 65% and S by 54 bpm / 69% ignore lack of units	2	AO3 4.4.2.2
02.5	correct scale and axis labelled all points plotted correctly (to within ± ½ square) line joined point to point or correct curved line of best fit	allow min(s) do **not** accept 'm' the zero is not required on the *x*-axis allow 4 or 5 correct plots for **1** mark	1 2 1	AO2 4.4.2.2
02.6	$\frac{132 - 78}{12}$ 4.5 (minutes) / 4½ minutes / 4 minutes 30 seconds / 4:30	an answer of 4.5 minutes scores **2** marks allow $\frac{54}{12}$ allow sequential deductions of 12 four or five times do **not** accept 4:50 **or** 4 minutes 50 seconds	1 1	AO2 4.4.2.2

Question	Answers	Mark	AO / Spec. Ref.
02.7	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 4.4.2.2
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content • two groups of people - non-smokers and smokers • have at least five people in each group or large groups • get each person to do (named) exercise • controlled variables: - same number of people in each group or large groups - same gender - same level of activity / exercise - same age - no health issues / illnesses - same type of exercise - same time for exercise • record heart rate for each person before and after exercise • calculate increase in heart rate for each person after exercise • compare results for each group for **level 3**, students should refer to at least 5 smokers and 5 non-smokers, carrying out exercise with control variables and a means of determining an increase in heart rate for **level 2**, students should refer to 'groups' of smokers and non-smokers exercising		
Total			**20**

4.4.2.3 Metabolism

Answer 05 · Mark scheme

June 2018 | 8461/1H | Original Q2



4.4.2.3 Metabolism

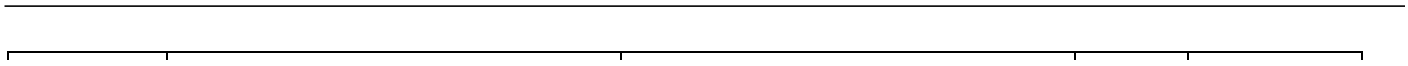
Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	2400 **and** 2280 **or** 500 **and** 380	an answer of 120 scores **2** marks	1	AO2 4.5.3.3
	120		1	
03.2	respiration of glucose		1	AO1 4.4.2.1 4.4.2.3
03.3	(more) sweating	ignore reference to vasodilation / vasoconstriction	1	AO2 4.5.2.4 4.5.3.3
	(because) exercise releases heat **or** need to cool the body **or** need to lose heat **or** need to maintain body temperature	do **not** accept energy being produced	1	
03.4		‘more’ does not need to be stated a second time to gain marking point 1 and marking point 2		AO2 4.5.2.4 4.5.3.3
	more energy needed	do **not** accept energy production do **not** accept energy needed for respiration	1	
	(so) more (aerobic) respiration		1	
	(so) increased breathing (rate / depth) (to supply oxygen **or** remove carbon dioxide / water)		1	
Total			**8**	

4.4.2.3 Metabolism

Answer 06 · Mark scheme

June 2018 | 8461/2H | Original Q3



4.4.2.3 Metabolism

Answer 07 · Mark scheme

June 2018 | 8461/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	3.7		1	AO2 4.7.2.1
08.2	2		1	AO1 4.6.1.6
08.3	(different combinations of alleles cause) many / 22 values **or** in-between values **or** large range of values **or** there are not only two values	allow continuous variation allow there are not only 3 values if 3 is given in question **08.2**	1	AO3 4.6.1.6 4.6.2.1
08.4	different protein made active site changed so substrate does not fit / bind	allow change in shape (of enzyme) or change in 3-D structure ignore denature allow description of substrate allow cannot form E-S complex ignore lock and key description	1 1 1	AO1 4.2.2.1 4.6.1.5
08.5	produces (some) offspring with high-fat milk **or** not all offspring have low-fat milk	ignore reference to alleles	1	AO3 4.6.1.6
08.6	takes less time (to obtain results) **or** more offspring at the same time	allow other sensible suggestion – eg allows screening **or** allow cow 7 to continue to produce eggs **or** avoid injury to cow 7 during mating or giving birth	1	AO3 4.5.3.6

4.4.2.3 Metabolism

Answer 07 · Mark scheme

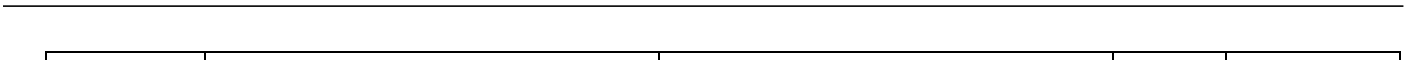
June 2018 | 8461/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.7		**max 3** marks if own symbols used with no key **max 3** marks if alternative diagram to Punnett square used		AO2 4.6.1.6
	male gametes correct: d (and d)		1	
	female gametes correct: D and d	allow **1** mark if gametes are correct but gender not identified	1	
	correct derivation of offspring genotypes from given gametes	allow 2 × 2 **or** 2 × 1 derivation	1	
	Dd identified as low-fat **and** dd identified as high-fat in offspring	if DD offspring are produced, must also identify as low-fat	1	
08.8	find female with low(est) fat in milk **and** high(est) milk yield	allow choose from 7, 9, 12, 13 which has the highest yield	1	AO3 4.6.2.3
	find male whose female offspring have high(est) milk yield **and** low(est) fat in milk **or**	allow choose from 16 or 18 whose female offspring has the highest yield	1	AO3 4.6.2.3
	find female with lowest fat in milk **or** cow 13 (1) **or** find male whose female offspring have high(est) milk yield (1)	allow female with high(est) milk yield allow male whose female offspring have lowest fat in milk / male 16		
	cross the best (for both features) female with the best male		1	AO2 4.6.2.3
	select best offspring (for both features) from each generation and repeat for several generations		1	AO2 4.6.2.3
Total			**16**	

4.4.2.3 Metabolism

Answer 07 · Mark scheme

June 2018 | 8461/2H | Original Q8



4.4.2.3 Metabolism

Answer 08 · Mark scheme

June 2022 | 8461/2H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	echidna: 27 to 35 **or** by 8 (°C) **and** human: 36.2 to 37.2 **or** by 1 (°C)	allow a tolerance of ± 0.5 (°C) allow a tolerance of ± 0.1 (°C)	1	AO3 4.5.1 4.5.2.4
	echidna is more variable **or** human fluctuates less	allow echidna is 7 (°C) more variable for **2** marks allow echidna is 8 times more variable for **2** marks	1	

4.4.2.3 Metabolism

Answer 08 · Mark scheme

June 2022 | 8461/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2		do **not** accept energy produced / made / created do **not** accept energy used for respiration		AO2 4.5.2.4 4.5.3.2 4.4.2.1
	loses less energy (from its body)	allow loses / wastes less heat	1	4.4.2.3
	(so) body energy store lasts longer	allow glycogen / fat lasts longer allow stored food lasts longer	1	
	OR			
	lower temperature gradient (between echidna and air) (1)			
	(so) loses less energy (1)	allow loses less heat		
	OR			
	less energy transferred maintaining (higher) body temperature (1)	allow less energy transferred for keeping warm		
	(so) more energy available for processes vital for life (1)	allow more energy for eg heart / brain function ignore metabolism		

4.4.2.3 Metabolism

Answer 08 · Mark scheme

June 2022 | 8461/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	activity / movement requires energy from respiration (and) respiration / metabolism releases heat (which increases body temperature) **OR** respiration / metabolism releases heat (which increases body temperature) (1) (which) increases the rate of chemical reactions **or** increases enzyme activity (1)	do **not** accept energy produced / made / created **once** only	1 1	AO2 4.5.2.4 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	more blood flow near surface (of skin) **or** more blood flow to the skin (so) more heat / energy is lost (from the blood) cools blood which cools the body	do **not** accept blood vessels move nearer to surface of skin ignore cools blood / body unqualified	1 1 1	AO1 4.5.2.4

4.4.2.3 Metabolism

Answer 08 · Mark scheme

June 2022 | 8461/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	$\frac{20\,000 \times 40}{100 \times 2.5}$ **or** $\frac{8000}{2.5}$		1	AO2 4.5.2.4
	3 200 (cm^3)		1	
	3.2 (dm^3)	allow an incorrectly calculated value correctly divided by 1000	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	to replace ions / salt lost (in sweat)	allow named example such as Na^+ allow because ions / salt lost in sweat allow to prevent (muscle) cramp	1	AO2 4.5.2.4 4.5.3.3

Total Question 8		13

Answer 05 · Examiner comments

Question 2 (standard demand)

02.1 By far the most common correct responses referred to either respiration or protein synthesis. Metabolic reactions in plants were rarely given. Students who did not gain this mark often referred to digestion in the alimentary canal, which is extra-cellular, or gave a description of metabolic rate.

02.2 Almost all students managed to identify at least one correct conclusion, from those given in the question, with 85% of students identifying both correct conclusions.

02.3 62% of students achieved all three marks here, often rounding to three significant figures directly from their calculator displays. Incorrect rounding at some point in the calculation occasionally lost a mark. In addition, not recognising that the first 0 after the decimal point counted as a significant figure (giving an answer of 32.08), also cost some students a mark.

02.4 27% of students did not achieve marks because they either didn't describe changes in the heart rates in response to exercise or didn't compare the two people, both of which the question demands. Of these, some students simply compared resting heart rates, or overall heart rates with no reference to the impact the exercise had on the heart rate.

The most common answer given by students satisfied the first marking point. The second marking point was rarely awarded as students did not make the comparison between the two people. They were often able to correctly say that the heart rate for person R levelled off, but did not go on to compare this to the continued increase for person S.

If students calculated the overall increase the figures given were usually correct. A few students calculated the percentage increase, also usually correctly.

A few students attempted to explain the differences in terms of fitness, rather than simply describe the differences.

02.5 Completion of the graph was generally well done with 69% of students achieving all four marks. Where marks were lost it was often due to incomplete labelling of the *x*-axis, such as omission of part, or all, of the label, or giving the unit as 'm', rather than an appropriate unit.

Incorrect plotting was rare; although some appeared to have plotted the values at 3 and 4 minutes on 118 and 128 this was accepted as in tolerance.

A significant minority of students did not draw a graph at all and simply added a scale and label, achieving only one mark.

4.4.2.3 Metabolism

Answer 05 · Examiner comments

June 2018 | 8461/1H | Original Q2

02.6 This calculation was worked out either by subtracting the two heart rates and dividing by 12 or by sequential deductions of 12 from the higher heart rate.

A substantial number of students arrived at the correct answer by one of these methods, but the most common mistake was to arrive at 4 or 5 minutes (rather than 4.5) by the deductions method and not factor in the correct subtraction of half a minute's heart rate decrease. Some students rounded up to 5 minutes having reached the correct answer initially despite not being told to give the answer as a whole number.

Some students divided 132 by 12 without accounting for the fact that the heart rate only had to fall to 78, not to 0.

02.7 It is important that students understand the need for investigation designs to provide **valid** outcomes. In this case, the use of only one or two individuals of each type will not do this and those students who went down this route could not reach level 3. Furthermore, repetition with the same individuals is not equivalent to having large numbers of participants.

There were many good answers with students identifying several control variables, other than those involved directly with the exercise. Most students recognised the need to measure heart rate before and after exercise (and often all the way through as well) but then did not make it clear how they would use that data to calculate the increase in the heart rate. Many simply suggested calculating a mean without specifying what they would be taking a mean of.

Some suggested plotting the data on a graph and comparing the gradient from a smoker with a non-smoker which is a valid way of comparing an increase without subtracting starting rate from end rate.

4.4.2.3 Metabolism

Answer 08 · Examiner comments — June 2022 | 8461/2H | Original Q8

Question 8

This question compared temperature regulation in a primitive mammal, the echidna, with that of a human.

08.1 Since a comparison of temperature variation in the echidna and the human was required, using data from the graphs in **Figures 11** and **12**, it was essential to quote or manipulate numbers from the graphs and to state which variation was the greater. Fewer than a quarter of students were completely successful. Some misread the figures on one or both graphs, others selected the cold-weather data for the echidna whereas warm weather had been asked for, and others did not state which organism's variation was the greater.

08.2 Many students struggled to understand why a low body temperature for hibernation in cold weather would benefit the echidna. Although just over half appreciated the animal would lose less energy, or heat, from its body, few could go on to explain that this was because of the lower temperature gradient between the echidna and its environment or explain that its body energy stores would last longer as a result.

08.3 Two different approaches to answering this question were given credit: to explain how activity could cause an increase in body temperature or to explain why an increase in body temperature would enable the animal to be more active. Either of these hinged on the vital point that energy was released by *respiration*, which was not mentioned by many students and thus only one-third scored any marks.

08.4 Explanations of how dilation of blood vessels in the skin could result in a decrease in body temperature were generally deficient in two respects: a misunderstanding of vasodilation and the omission of how cooling the blood in the skin resulted in a lowering of the temperature of the rest of the body. Some just stated that more blood flowed through dilated vessels or stated incorrectly that the vessels rose up through the skin. Hardly any students could explain that blood cooled at the skin would flow round the rest of the body

Answer 08 · Examiner comments — June 2022 | 8461/2H | Original Q8

and so remove heat from the other parts of the body. The one point generally scored was that more heat would be lost from the blood through the skin.

08.5 This proved to be a straightforward calculation for three-quarters of students, who scored full marks. A common error was the failure to convert correctly an answer in cm^3 to dm^3, even with the fact, given in the question, that 1000 cm^3 equalled 1 dm^3. Some left their answers as 3200 cm^3 of sweat lost by the athlete per day, others incorrectly coverted this to the somewhat improbable answer of 3 200 000 dm^3 per day.

08.6 The need to take salt tablets was related to replenishment of the salt lost in sweat by fewer than half of the students. Many thought that the extra salt in the blood would help to retain water in the body.