AQA GCSE Biology | 8461

SPECIFICATION POINT 4.6.1.4

DNA and the genome

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**7**
Available paper years	**2008–2023**

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.

4.6.1.4 DNA and the genome

Answer 01 · Mark scheme June 2008 | BLY2H | Original Q4 | Legacy

question	answers	extra information	mark
4(a)	any **two** from: • to combine / use amino acids • in specific / particular / correct / right order • to manufacture protein / enzymes / hormones	do **not** allow to make amino acids allow examples of proteins / enzymes / hormones	2
4(b)(i)	(man) B any **three** from: • child gets DNA / bars / lines from mother and father / parents • (child has) mother's 25 / 28 / 30 / 31 **or** child gets 17 / 19 / 22 / 24 from mother • (child has) man B's 10 / 12 / 13 / 14 **or** child gets 18 / 20 / 21 / 23 from B • no bars / DNA / lines from man A correspond to child	no mark for this **but** max **2** marks if A given ignore genes / chromosomes Man B Child Mother 17 — 25 10 — 18 19 — 28 12 — 20 13 — 21 22 — 30 14 — 23 24 — 31 contradictions disqualify 2nd and / or 3rd marking points ignore genes / chromosomes	3
4(b)(ii)	any **two** from: • gametes / eggs / sperm • contain only half of (mother's / father's) DNA / chromosomes / genes / genetic information • due to meiosis		2
Total			**7**

4.6.1.4 DNA and the genome

Answer 01 · Mark scheme June 2008 | BLY2H | Original Q4 | Legacy

COMPONENT NUMBER: BLY2H

COMPONENT NAME: Additional Science / Biology

STATUS: Final

DATE: June 2008

4.6.1.4 DNA and the genome

Answer 02 · Mark scheme

Question 8

question	answers	extra information	mark
8(a)	chromosomes	ignore gene / DNA	1
8(b)	**pros eg** any **two** from: • overcomes shortage of human eggs / rabbits produce lots of eggs • ethical / religious issues with using human embryos • reduces tests on (adult) humans • may provide cure for / cause of disease • embryo not allowed to develop beyond 14 days • no harm to rabbit • 99.5 % human genetic information so very similar to human or will react in the same way **cons eg** any **two** from: • ethical / religious objections to mixture of human and rabbit genes • ethical issues with experimenting with rabbits • ethical / religious objections to killing embryos • 0.5% of rabbit genetic information might affect results • 14 days too short a time to get results	to obtain **3** marks candidates must give **one** reasonable pro **and one** reasonable con ignore all embryos identical allow some people object to using rabbits / cruel to rabbits	max 2 max 2

Question 8b continues on next page

BLY1H

Question 8b continued

	plus **conclusion eg** • possibility of cure does / does not outweigh ethical / religious objections • cure does not justify mixing human and animal genes / killing embryos	**Note:** the conclusion mark cannot be given unless both an advantage and a disadvantage have (already) been given do **not** award the mark if the conclusion only states that advantages outweigh disadvantages	1
Total			**5**

4.6.1.4 DNA and the genome

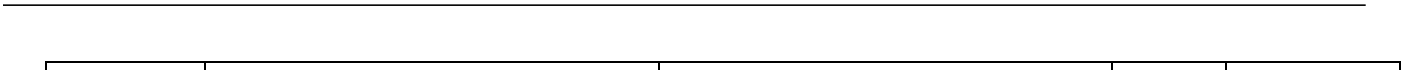
Answer 03 · Mark scheme June 2015 | BL2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)(i)	in the chromosome(s) in the nucleus	ignore genes / alleles allow nuclei allow mitochondria	1 1	AO1 2.7.2f, 2.7.1b
3(a)(ii)	the DNA / chromosomes / genes are replicated / copied / multiplied / doubled / duplicated	allow DNA is cloned ignore same DNA / chromosomes / genes if unqualified	1	AO1 2.7.1a,c,n
3(b)(i)	1 / one		1	AO2 2.7.2c,e, 2.7.3a,c
3(b)(ii)	2 / two		1	AO2 2.7.2c,d, 2.7.3a,b
3(c)	**B**		1	AO3 2.7.2i
Total			**6**	

4.6.1.4 DNA and the genome

Answer 03 · Mark scheme

June 2015 | BL2HP | Original Q3 | Legacy



4.6.1.4 DNA and the genome

Answer 04 · Mark scheme

June 2019 | 8461/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	chromosome(s)	allow gene(s) / allele(s)	1	AO1 4.6.1.4 4.1.2.1
02.2	X = sugar Y = nucleotide Z = base		1 1 1	AO1 4.6.1.5
02.3	double helix		1	AO1 4.6.1.4
02.4	3		1	AO2 4.6.1.5
02.5	any **two** from: • diagnosis of inherited / genetic disorder • gene therapy **or** treatment of inherited disorders • understanding (human) evolution **or** understanding ethnic origins (of a person) **or** understanding ancestry • tracing human migration patterns	allow descriptions or named examples allow research / understand genetic disorders allow other examples – eg identification of criminals (1) paternity determination (1)	2	AO1 4.6.1.4
Total			**8**	

4.6.1.4 DNA and the genome

Answer 04 · Mark scheme

June 2019 | 8461/2H | Original Q2

4.6.1.4 DNA and the genome

Answer 05 · Mark scheme

November 2020 | 8461/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	many (joined) nucleotides **or** monomers	allow (long) molecule / chain made of repeating units	1	AO1 4.6.1.4 4.6.1.5
04.2	phosphate	ignore phosphorus	1	AO1 4.6.1.5
	(phosphate attached to a) sugar	allow deoxyribose / pentose	1	
		allow **2** marks if position of sugar / phosphate / base is incorrect		
	(which has 1 of 4) base(s) (attached to sugar)		1	
	(bases) are A, C, G **and** T	allow bases are adenine, cytosine, guanine **and** thymine do **not** accept thiamine / adenosine allow description of a pair of nucleotides	1	
04.3		an incorrect answer for one step does not prevent allocation of marks for subsequent steps		AO2 4.6.1.4 4.6.1.5
	$0.34 \times 12\,000\,000\,000$		1	
	$4\,080\,000\,000$		1	
	$\frac{4\,080\,000\,000}{1\,000\,000\,000}$	allow conversion from nm to m at any point in the calculation	1	
	4.08 (m)		1	
	2.04 (m) (divided by 2 due to base pairs)	allow division by 2 at any point in the calculation	1	
04.4	(non-coding parts) can switch genes on / off		1	AO1 4.6.1.5
Total			**11**	

4.6.1.4 DNA and the genome

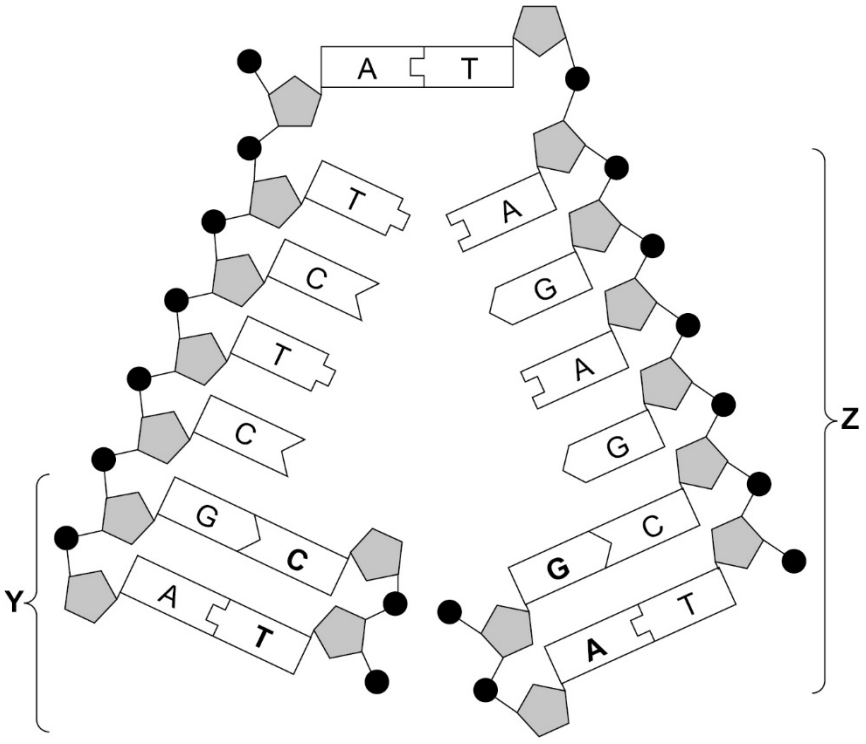
Answer 05 · Mark scheme

November 2020 | 8461/2H | Original Q4

4.6.1.4 DNA and the genome

Answer 06 · Mark scheme

November 2021 | 8461/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	chromosome(s)	allow chromatid(s) / gene(s) / allele(s)	1	AO1 4.6.1.4
01.2	sugar	allow deoxyribose allow pentose do **not** accept ribose	1	AO1 4.6.1.5
01.3	base(s)	allow nitrogenous base(s) allow adenine **and** cytosine **and** guanine **and** thymine	1	AO1 4.6.1.5
01.4		all four required for the mark	1	AO3 4.6.1.5

4.6.1.4 DNA and the genome

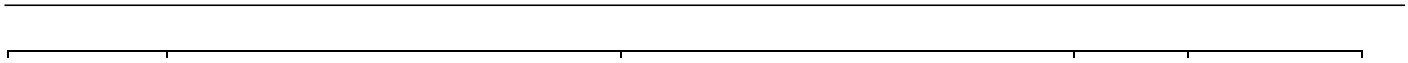
Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	replication		1	AO3 4.6.1.5 4.1.2.2
01.6	protein	allow polypeptide	1	AO1 4.6.1.4
01.7	3×10^{-12} grams		1	AO2 4.6.1.2
01.8	meiosis		1	AO1 4.6.1.2
Total			**8**	

4.6.1.4 DNA and the genome

Answer 06 · Mark scheme

November 2021 | 8461/2H | Original Q1



4.6.1.4 DNA and the genome

Answer 07 · Mark scheme

June 2023 | 8461/2H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.1	(A) → E → D → C → B → (F)	must be in this order	1	AO3 4.6.1.2 4.1.2.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.2	(start) 16	allow 8 pairs	1	AO3
	(end) 8	the answer must be half the value of the number at the start	1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.3	(meiosis) forms gametes	allow (meiosis) forms sex cells allow (meiosis) forms eggs **and** sperm	1	AO1 4.6.1.2
	(two gametes) fuse / fertilise		1	
	(so) keeps chromosome number constant (from generation to generation) **or** (so) prevents doubling / increase in chromosome number (in each generation) **or** (so) gives normal / correct chromosome number (for embryo / new cell)	allow gives correct chromosome number (for offspring)	1	

Answer 07 · Mark scheme

June 2023 | 8461/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.4	random chromosome from each pair (of chromosomes) moves to one end of the cell **or** goes into each new cell **or** gamete	ignore half the chromosomes ignore half the DNA allow other processes for creating variation ignore mutation	1 1	AO1 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.5	base(s)	allow organic / nitrogenous base(s) ignore adenine / cytosine / guanine / thymine	1	AO1 4.6.1.5

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.6	12 / twelve	allow 6 pairs **or** six pairs	1	AO3 4.6.1.5

Total Question 8	**10**

4.6.1.4 DNA and the genome

Answer 05 · Examiner comments — November 2020 | 8461/2H | Original Q4

Question 4 (standard, standard/high & high demand)

This question was about DNA. **04.3** is a five-step calculation, which differentiated very well between students. Most were able to multiply the number of nucleotides in the cell (given as 1.2×10^{10}) by the length of one pair of nucleotides (given as 0.34 nm) – although some divided these. The main errors came from attempts to convert nanometres to metres (as required by the question) and in not realising that the answer had to be divided by 2 as the nucleotides came in pairs. Many students wrote out long strings of zeros in their calculations and consequently made transfer errors from one line to the next in their calculation; others did not know how many nanometres there are in a metre and used factors of a thousand or a million to interconvert the units (this being covered by the 'Working Scientifically' section of the Specification, part 4, WS4.4 and 4.5). An eighth of students scored all 5 marks, although nearly 60% scored 3 marks and above. It was also evident that some students had little concept of the sizes of molecules and cells and, although the correct answer was 2.04 m of DNA per cell, the most extreme was 1.76×10^{17} m.

Answer 06 · Examiner comments — November 2021 | 8461/2H | Original Q1

Question 1 (standard demand)

This question was about DNA and its replication. Answers to most parts of this question were satisfactory, with most students knowing that DNA was found in chromosomes, recognising the term replication with respect to a diagram showing this process, being able to assign symbols for bases on the same diagram, and knowing that meiosis was the type of cell division used in sperm production.

The names of specific parts of the DNA molecule (sugar and base) and the substance coded for by a gene (protein) were less well known – but success here might have been limited by the fact that the questions were open rather than being multiple choice.

More than half of the students were able to deal with numbers in standard form, showing understanding that a sperm cell has half the usual amount of DNA and that half of 6×10^{-12} is 3×10^{-12}.

One-fifth of the students did not attempt **01.4**. This was probably due to there being no answer lines, and the answer having to be written on the diagram (Figure 2).

4.6.1.4 DNA and the genome

Answer 07 · Examiner comments — June 2023 | 8461/2H | Original Q8

Question 8

This question was about meiosis and DNA structure.

08.1 Given the identity of the first and last diagrams in Figure 13, two-thirds of students were able to put the remaining four in the correct sequence to show the process of meiosis.

08.2 However, in this question, the vast majority did not follow the instruction to give the number of chromosomes per cell in Figure 13 but decided to use human chromosome numbers. Thus, the most common answer for the number of chromosomes at the start of meiosis was 46 and, at the end, 23. Various other numbers were given and, as long as the end number was half the starting number, 1 mark out of 2 was scored. Only 3 percent gave the correct values of 16 and 8 from Figure 13.

08.3 Fewer than a quarter of students were able to give a 3-mark answer explaining why it was necessary for the number of chromosomes at the end of meiosis to be different from that at the start. Many made just two points – either for meiosis producing gametes which could

Answer 07 · Examiner comments — June 2023 | 8461/2H | Original Q8

fuse at fertilisation or for stating that fertilisation would restore the correct chromosome number. Some students simply described the process of meiosis, while others gave a comparison of meiosis and mitosis, both of which were not relevant to the question.

08.4 Most students found it very difficult to describe how meiosis produces cells that are genetically different and so scored no marks. Some described how random fertilisation causes genetic differences which was not relevant. Very few students could describe that one chromosome from each **pair** of chromosomes would separate **randomly** to opposite ends of the cell or into each of the gametes.

08.5 Nearly three-quarters of students knew that the four substances labelled A, C, G or T in Figure 14 were bases. Common errors included ‘amino acids’, ‘proteins’ and ‘nucleotides’.

08.6 Two-thirds evidently knew the meaning of the term nucleotide and successfully counted twelve of them in the portion of DNA shown in Figure 14.