AQA GCSE Biology | 8461

SPECIFICATION POINT 4.6.1.5

DNA structure (biology only)

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**9**
Available paper years	**2007–2023**

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.

4.6.1.5 DNA structure (biology only)

Answer 01 · Mark scheme June 2007 | BLY1B | Original Q5 | Legacy

Five	**1**	**1**	**4**	**3**

Answer 02 · 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**

4.6.1.5 DNA structure (biology only)

Answer 02 · Mark scheme

June 2008 | BLY2H | Original Q4 | Legacy

COMPONENT NUMBER: BLY2H

COMPONENT NAME: Additional Science / Biology

STATUS: Final

DATE: June 2008

4.6.1.5 DNA structure (biology only)

Answer 03 · Mark scheme

June 2013 | BL2HP | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	changes code /sequences of bases **or** sequence of amino acids is different		1
	the enzyme has different / wrong shape / structure	allow the active site is changed	1
	so substrate will not fit into enzyme / will not join to enzyme		1
6(b)(i)	46	allow 23 pairs	1
6(b)(ii)	also inherited (from mother) normal chromosome 15 / normal allele / normal gene / boy is heterozygous / **Hh**	allow the boy is a carrier	1
	(allele for) this disorder is recessive **or** the normal allele would give a working enzyme	ignore converse	1
6(b)(iii)	genetic diagram including: Parental gametes: **H** and **h** from both parents	accept alternative symbols, if defined	1
	derivation of offspring genotypes: **HH Hh Hh hh**	allow alternative if correct for student's parental genotypes / gametes	1
	identification of **hh** (having the disorder) if 1 in 4		1
Total			**9**

4.6.1.5 DNA structure (biology only)

Answer 04 · Mark scheme

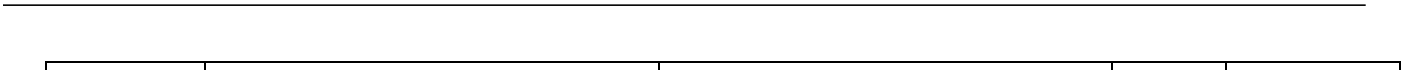
June 2015 | BL2HP | Original Q3 | Legacy

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**	

4.6.1.5 DNA structure (biology only)

Answer 04 · Mark scheme

June 2015 | BL2HP | Original Q3 | Legacy



4.6.1.5 DNA structure (biology only)

Answer 05 · Mark scheme

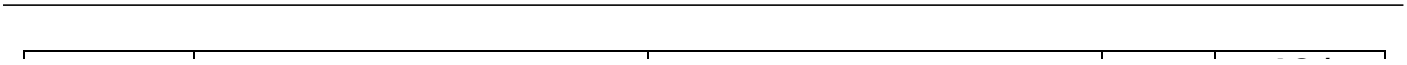
June 2019 | 8461/2H | Original Q2

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**	

4.6.1.5 DNA structure (biology only)

Answer 05 · Mark scheme

June 2019 | 8461/2H | Original Q2



4.6.1.5 DNA structure (biology only)

Answer 06 · 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	
	(which has 1 of 4) base(s) (attached to sugar)	allow **2** marks if position of sugar / phosphate / base is incorrect	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**	

4.6.1.5 DNA structure (biology only)

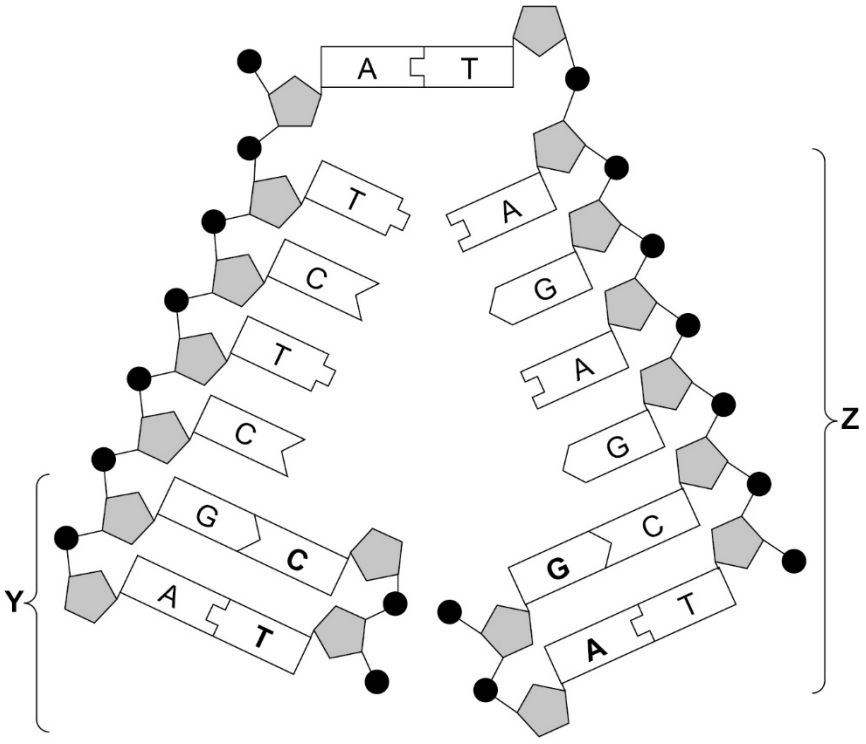
Answer 06 · Mark scheme

November 2020 | 8461/2H | Original Q4

4.6.1.5 DNA structure (biology only)

Answer 07 · 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

4.6.1.5 DNA structure (biology only)

Answer 07 · Mark scheme

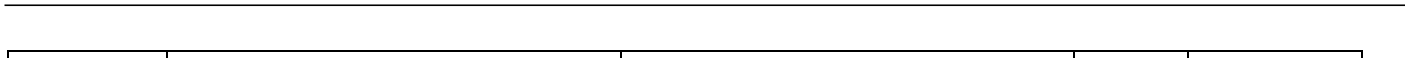
November 2021 | 8461/2H | Original Q1

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**	

4.6.1.5 DNA structure (biology only)

Answer 07 · Mark scheme

November 2021 | 8461/2H | Original Q1



4.6.1.5 DNA structure (biology only)

Answer 08 · Mark scheme

June 2023 | 8461/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec Ref.
05.1	vector		1	AO1 4.3.1.5

Question	Answers	Extra information	Mark	AO / Spec Ref.
05.2	any **three** from: • protist / it has mitochondria • protist / it has (a) nucleus **or** protist DNA / genetic material is not free in the cytoplasm • protist / it does not have a single loop of DNA / genetic material • protist / it does not have <u>plasmid</u>s • protist / it does not have a cell wall	allow converse for prokaryotic cells allow eukaryotic for protist if neither mark awarded, allow **1** mark for protist has membrane-bound structures ignore genetic information ignore genetic information do **not** accept eukaryotic cell does not have a cell wall allow protist / it does not have a slime capsule ignore cilia / flagellae / ribosomes ignore size / shape	3	AO2 4.1.1.1 4.3.1.5

4.6.1.5 DNA structure (biology only)

Answer 08 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
05.3	less oxygen carried (in blood)	allow less oxygen carried (to cells) ignore reference to number of red blood cells unqualified do **not** accept no oxygen carried	1	AO2 4.4.2.3 4.4.2.1 4.2.2.3
	less energy released from respiration	do **not** accept energy produced / made / created	1	

Question	Answers	Mark	AO / Spec Ref.
05.4	any **three** pairs from: **Sexual reproduction** / **Asexual reproduction** involves two parents / involves one parent involves gametes joining / fusing / **or** involves fertilisation / involves no (fusion of) gametes / **or** does not involve fertilisation there is mixing of genetic material / information / **or** there is genetic variation / **or** offspring are genetically different / there is no mixing of genetic material / information / **or** there is no genetic variation / **or** offspring are genetically identical ignore reference to clones involves (only) meiosis / involves mitosis **or** does not involve meiosis more energy required / less energy required slower / faster if no other mark awarded allow **1** mark for asexual reproduction produces many offspring pairs of answers can be in any order	3	AO1 4.6.1.1 4.1.2.2

4.6.1.5 DNA structure (biology only)

Answer 08 · Mark scheme

June 2023 | 8461/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec Ref.
05.5	(no bases so) DNA replication cannot occur	allow copying / duplicating / doubling for replication ignore cannot make DNA unqualified	1	AO2 4.1.2.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
05.6	(after DNA replication) one set of chromosomes is pulled to each end of the cell	allow one (member) of each pair of chromosomes is pulled to each end of the cell ignore (half the) chromosomes are pulled to each end of the cell	1	AO1 4.1.2.2
	nucleus divides	allow two (new) nuclei form	1	
	cytoplasm **or** cell membrane divides to form two cells	allow cytokinesis	1	

Question	Answers	Extra information	Mark	AO / Spec Ref.
05.7	having disorder **S** reduces incidence / percentage of malaria	allow having disorder **S** reduces chance of getting malaria allow having disorder **S** protects against malaria	1	AO3 4.2.2.5 4.3.1.5
	as age increases a lower percentage of children with disorder **S** get malaria until age 10, then the percentage increases	allow protection against malaria increases with (increasing) age until age 10, then it decreases	1	

Total Question 5	15

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	

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**

4.6.1.5 DNA structure (biology only)

Answer 06 · 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 07 · 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).

Answer 08 · Examiner comments — June 2023 | 8461/1H | Original Q5

Question 5 (Standard, standard/high and high demand)

05.1 The majority of students answered this question correctly with just over 68% of students gaining credit. A number of students referred to 'communicable disease' or 'carrier' which were not creditworthy.

4.6.1.5 DNA structure (biology only)

Answer 08 · Examiner comments

June 2023 | 8461/1H | Original Q5

05.2 Students were told in the stem of the question that the malarial protist is a eukaryotic cell, and clearly most students processed this information and just under 95% of student gained some marks. Incorrect responses were seen often when students mixed up protist and prokaryote structures or had misconceptions regarding prokaryote structure suggesting a lack of cell membrane or cytoplasm.

05.3 Most students gained credit for stating that lesson oxygen could be carried by the blood, if red blood cells burst. Only around 20% of students linked this idea to respiration and energy release for the second marking point. Some students suggested that as a result 'no oxygen would be carried' which was not creditworthy. We again this year saw the usual incorrect idea of energy being produced or created which lost students this second marking point.

05.4 Over 70% of students were able to gain some marks on this question, with 8% gaining the full 3 marks available. Many students knew that sexual reproduction involved 'gametes' but they failed to include the idea of fusion and missed out on the first marking point. A pleasing number of students gave the idea of genetic variation for the second marking point, but when 'genetic' was omitted or students simply referred to 'clones' credit was not awarded. The full array of possible creditworthy ideas were seen, as well as the fallback mark.

05.5 Only around 37% of students gained this mark. Those that did not, often lacked detail in their answer. Students were required to specifically refer to DNA, and terms such as 'chromosome' or 'genetic material' were ignored. Furthermore, references to DNA 'multiplying' or 'reproducing' did not gain credit.

05.6 This was a high demand question, and in particular the first marking point proved a good discriminator with very few students referring to 'one set of chromosomes' being pulled to each end of the cell, and instead giving vague references to 'chromosomes pulling apart', or 'DNA halves' which are insufficient at this level. While the process of mitosis is undoubtedly familiar to most students, they struggled to articulate their ideas clearly in their responses. Less than 3% of students gained all 3 marks as a result. Almost 37% gained 1 mark for references either the 'nucleus dividing' or 'the cell membrane / cytoplasm dividing' to form 2 cells.

05.7 The majority of students got muddled with the data in this question or misinterpreted it due to misreading the information provided in the stem informing them that 'the incidence of malaria in children with disorder S was calculated as a percentage of the incidence in children without disorder S'. Consequently, most students concluded that that having disorder S *increased* the chances of children getting malaria and therefore only a minority gained credit, with only 1% of students gaining 2 marks. The trend was however described correctly by around 27% of students for the whole age range obtaining 1 mark.

4.6.1.5 DNA structure (biology only)

Answer 09 · 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 09 · 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.