AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 4.1.2.1

Chromosomes

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**7**
Available paper years	**2018–2025**

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.

4.1.2.1 Chromosomes

Answer 01 · Mark scheme June 2018 | 8464/B/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	one X and one Y chromosome and 9 pairs of other chromosomes		1	AO2 4.6.1.6
07.2	any **three** from: • (called) meiosis • DNA / chromosomes replicate **or** DNA makes a copy • two divisions to form 4 cells • so only 1 set of chromosomes per cell • (daughter cells / gametes) are all genetically different	correct spelling only allow cells are haploid ignore half the DNA if no other mark awarded allow **1** mark for forms gametes / cells which are all different **or** only happens in testes and (embryonic) ovaries	3	AO1 4.6.1.2
07.3	(meiosis will not work because) number of chromosomes cannot halve	allow chromosomes cannot form pairs allow chromosomes cannot split up evenly	1	AO2 4.6.1.2
07.4	do not use energy in reproduction so more (energy) available to synthesise proteins	allow converse if clearly describing diploid oysters allow other correct molecules or cell components	1 1	AO2 4.6.1.3 4.4.2.1

4.1.2.1 Chromosomes

Answer 01 · Mark scheme

June 2018 | 8464/B/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	any **two** from: • global warming may be raising temperature of water and killing oysters • pollutants in the water may be toxic and kill the oysters **or** increased acidity of the oceans is killing oysters • new competitors / triploid oysters are using up the normal food source • new pathogens may be causing diseases • new predators eating oysters	allow correctly named pollutant with reason ignore over harvesting	2	AO2 4.7.3.5 4.7.3.2 4.7.1.2 4.7.1.3

4.1.2.1 Chromosomes

Answer 01 · Mark scheme

June 2018 | 8464/B/2H | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.6	**Level 3:** A judgement strongly linked and logically supported by a sufficient range of correct reasons is given.	5–6	AO3
	Level 2: Some logically linked reasons are given. There also may be a simple judgement.	3–4	AO3 AO2
	Level 1: Relevant points are made. They are not logically linked.	1–2	AO2
	No relevant content	0	
	Indicative content **for:** • oysters are available to eat all year **so** eating oysters has become very popular • cheaper to produce **so** more food for expanding population • oysters grow faster **so** more oysters for supermarkets / restaurants or more profit for farmers • stocks are replenished each year **so** more sustainable fishing • they can harvest / sell all year **so** more stable and profitable for oyster farmers **against:** • carcinogen put into environment / oysters **so** may enter the food chain or cause cancer in humans • bigger triploid oysters may outcompete the smaller native diploid oysters **so** upset balance of the ecosystem / cause extinction • people may not buy / eat them because they have used a carcinogenic chemical **so** reduced profit for farmers / suppliers / supermarkets / restaurants • farmers have to buy new seed oysters every time **so** more expensive **other content:** • shouldn't be eating the oysters until they are thoroughly tested • should be looking for alternative ways to get triploid oysters • should stop using triploid oysters until the effect on the (marine) environment is known • would replace lost oyster beds **but** could change the ecosystem • oysters available to eat all year **but** probably do not taste the same or have the same flavour		4.7.3.2 4.7.3.6 4.7.2.1 4.7.1.3 4.7.1.1
Total		**15**	

4.1.2.1 Chromosomes

Answer 02 · Mark scheme

November 2020 | 8464/B/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1			1	AO2 4.6.1.3
01.2	any **one** from: • 2 strands / chains that are twisted / coiled / spiralled • double helix • (long) polymer	allow cross links between 2 strands / chains allow reference to nucleotides or sugars, phosphates and bases	1	AO1 4.6.1.3
01.3	amino acids protein	in this order only allow polypeptide	1 1	AO1 4.6.1.3
01.4	all the genetic material (of an organism)	allow DNA / genes for genetic material ignore chromosomes	1	AO1 4.6.1.3
01.5	tracing how aboriginal people spread across Australia		1	AO2 4.6.1.3
01.6	variation	ignore genetic/environmental	1	AO1 4.6.2.1

4.1.2.1 Chromosomes

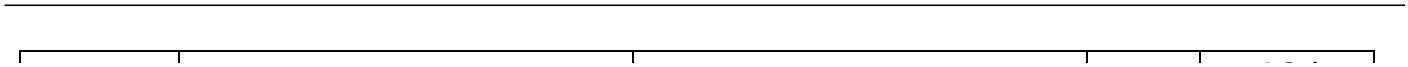
Answer 02 · Mark scheme

01.7	stronger / larger (shell) (so) more likely to (survive and) breed **or** (so) more likely to (survive and) pass on genes **OR** (better) camouflaged (1) (so) less likely to be eaten and will breed more (1)		1 1	AO2 4.6.2.2
Total			**9**	

4.1.2.1 Chromosomes

Answer 02 · Mark scheme

November 2020 | 8464/B/2H | Original Q1



4.1.2.1 Chromosomes

Answer 03 · Mark scheme

November 2020 | 8464/B/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(male gametes) X and Y all offspring correct **Female** X X **Male** **X** **XX** **XX** **Y** **XY** **XY**	 allow correct offspring from incorrect gametes	1 1	AO1 AO2 4.6.1.6
05.2	It is (50%) chance if sperm cells which fertilised the egg has X (or Y) chromosome	allow each / every child / baby / pregnancy has a 50% chance of being male or female (so can be all same sex)	1	AO2 4.6.1.6 4.6.1.4

4.1.2.1 Chromosomes

Answer 03 · Mark scheme

November 2020 | 8464/B/2H | Original Q5

05.3	both parents shown as heterozygous derivation correct to show 1 unaffected, 2 carriers and 1 affected offspring. **Woman** T t **Man** **T** **TT** **Tt** **t** **Tt** **tt** **tt** identified as offspring with CF correct ratio / probability from their derivations of **tt** e.g. 1:3, 1 in 4, 25%, 0.25	allow correct derivation from incorrect gametes	1 1 1 1	AO2 AO2 AO2 AO3 4.6.1.5 4.6.1.4
05.4	any **three** from: • does not need IVF which is stressful / invasive • higher chance of successful pregnancy as risk of miscarriage is low compared to (30%) success rate of IVF • the test is freely available • the test can be carried out even once the mother is pregnant	allow method 2 is not available to all couples who want it	3	AO3 4.5.3.5 4.6.1.5

4.1.2.1 Chromosomes

Answer 03 · Mark scheme

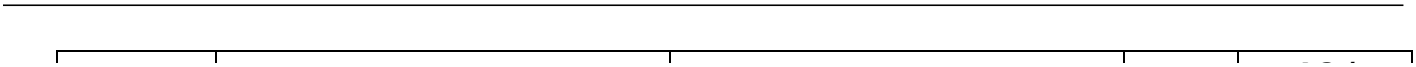
November 2020 | 8464/B/2H | Original Q5

05.5	any **one** from: • child will (definitely) not have CF • do not need to consider termination • it is a way to have a child if couples are having fertility problems		1	AO3 4.5.3.5 4.6.1.5
Total			**11**	

4.1.2.1 Chromosomes

Answer 03 · Mark scheme

November 2020 | 8464/B/2H | Original Q5



4.1.2.1 Chromosomes

Answer 04 · Mark scheme

June 2022 | 8464/B/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	gene chromosome nucleus cell	must be in this order	1	AO1 4.1.1.1 4.1.1.2 4.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	differentiation	ignore specialisation	1	AO1 4.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	4	allow 15	1	AO2 4.1.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	46	allow 23 pairs (of chromosomes)	1	AO2 4.1.2.1 4.1.2.2

4.1.2.1 Chromosomes

Answer 04 · Mark scheme

June 2022 | 8464/B/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	**Stage 1** any **one** from: • (cell) growth • increase in number of sub-cellular structures • DNA replicates • chromosomes double / duplicate / replicate	allow increase in number of organelles / ribosomes / mitochondria allow genetic material for DNA allow DNA doubles / duplicates	1	AO1 4.1.2.2
	Stage 2 any **one** from: • (one set of) chromosomes pulled to each end of cell • two nuclei form	ignore mitosis occurs allow chromosomes line up across the centre of the cell allow chromosomes move to opposite ends of the cell allow nucleus divides / splits (into two)	1	
	Stage 3 any **one** from: • cytoplasm / membrane divides • two identical cells formed	allow cytokinesis	1	

Question	Answers	Mark	AO / Spec. Ref.
02.6	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4–6	AO3
	Level 1: Relevant features are identified and differences noted.	1–3	AO2
	No relevant content	0	

4.1.2.1 Chromosomes

	Indicative content General comparisons: • boys height at birth (slightly) greater than girls height • boys are (slightly) taller than girls up to age 11 • correct height comparisons eg boys are approximately 4 / 5 cm taller than girls up to age 11 • girls and boys are the same height at age 11 • girls are taller than boys between age 11 and age 14 • girls and boys are the same height at age 14 • boys are taller than girls above age 14 • correct height comparisons eg boys are 5 to 18 cm taller than girls above age 14 • boys (eventually) grow taller than girls • boys carry on growing for a longer time than girls • girls stop growing age 13 / 14 / 15 **and** boys stop growing age 17 / 18 Rate comparisons: • rate of growth similar up to age 10 / 11 • girls grow faster than boys between 10 / 11 and 14 allow girls have a greater increase in height between 11 and 14 • growth spurt occurs at a younger age in girls • growth spurt starts age 10 / 11 in girls **and** age 13 / 14 in boys • increased rate of growth in girls aged 10 to 13 /14 **and** in boys aged 13 to 17 / 18 Key points for Level 2 are correct reference to 0-11 year period, 11-14 period and after age 14, with at least one correct reference to rate of growth or use of correct values of height and age to illustrate rate.		4.1.2.2

4.1.2.1 Chromosomes

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	repair of tissues **or** replacement of cells	ignore growth allow repair of organs ignore repair of cells allow replacement of tissues ignore replacement of organs	1	AO1 4.1.1.4

Total Question 2		**14**

4.1.2.1 Chromosomes

Answer 05 · Mark scheme

June 2023 | 8464/B/2H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	Oncorhynchus	ignore capitals ignore italics do **not** accept *Oncorhynchus keta*	1	AO2 4.6.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	eukaryota	allow eukaryote	1	AO1 4.6.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	select fish that have / get least / less / no (attachment of) sea lice **and** breed (selected fish) together	ignore with desired genes	1	AO2
	select offspring that have least sea lice **and** breed (selected offspring) together	allow select offspring with desired characteristic **and** breed together	1	AO1
	repeat over many generations until all offspring have no sea lice (attached)	do **not** accept idea of repeating with the same parents	1	AO2 4.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	sea lice will not be feeding on salmon (skin / blood)	allow skin less likely to be damaged / infected	1	AO3 4.6.2.3
	(so) salmon grow larger / faster	allow (so) salmon lose less energy allow no / less need for pesticides / insecticides allow (so) not off-putting (to consumers / buyers) allow (so) more (likely to be) sold allow salmon with sea lice cannot be sold	1	
	(so) salmon can be sold for more money	allow more profit allow no need to remove lice	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	all fish genetically similar	allow all fish have many / mostly same genes ignore inbreeding unqualified do **not** accept fish are clones do **not** accept fish are genetically identical	1	AO1 4.6.2.3
	(therefore) all may have (same) inherited disorder / defect **or** (therefore) prone / susceptible to same disease **or** (therefore) lack of variation to survive future environmental change		1	

Total Question 4	**10**

4.1.2.1 Chromosomes

Answer 06 · Mark scheme

June 2024 | 8464/B/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	parents of child with AKU / disorder do not have AKU / disorder **or** child(ren) with AKU / disorder have parents who do not	allow **A** and **B** do not have AKU, but child / **D** does (have AKU) allow **F** and **G** do not have AKU, but child / children / **K** / **L** does (have AKU) allow child(ren) with AKU / disorder have parents who are carriers	1	AO3 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	G		1	AO2 4.6.1.4

4.1.2.1 Chromosomes

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(parental gametes) (female) **a and a** (male) **A and a**	allow **1** mark for **a a and A a** parental gametes reversed	1 1	AO2 AO2
	offspring correctly derived **Aa Aa aa aa**	allow correctly derived offspring from incorrect parental gametes	1	AO2
	offspring phenotype correctly derived **Aa** = no AKU **aa** = AKU	allow correctly derived phenotypes from incorrect parental gametes or incorrect offspring genotypes allow inclusion of **AA** = no AKU, if their cross derives this genotype ignore reference to carriers	1	AO2
	(probability =) 0.5	allow 50% **or** ½ **or** 1 in 2 **or** 1:1 **or** 50:50 probability must match offspring genotype do **not** accept 1:2 **or** 50/50	1	AO3 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(mutation causes) incorrect sequence of amino acids		1	AO2 4.6.1.3
	(which) causes the enzyme to be a different shape	allow (which) causes the active site to be a different shape allow which means the enzyme and substrate cannot bind ignore the enzyme is denatured do **not** accept no enzyme produced	1	

4.1.2.1 Chromosomes

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	FSH **and** LH given / injected (into female) to stimulate maturation of egg(s)		1	AO1 4.5.3.3 4.5.3.5
	(collected) egg(s) are fertilised (in laboratory)	allow (collected) egg(s) fused with sperm (in laboratory) allow sperm is injected into egg (in laboratory)	1	
	fertilised egg undergoes mitosis	allow cell(s) undergo mitosis allow fertilised egg divides / develops to form embryo	1	
	(one or two) embryo(s) inserted into uterus / womb **or** (one or two) ball(s) of cells inserted into uterus / womb		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	any **two** from: • risk to embryo	allow risk of miscarriage do **not** accept risk to embryo due to radiation	2	AO3 4.6.1.5
	• risk to female / mother • stressful process • may lead to termination of the pregnancy	allow may lead to destruction of the embryo		
	• (high) cost (of the screening process) • embryo cannot give consent	allow idea of increased prejudice against other people with (inherited) disorders ignore references to religion / ethics		

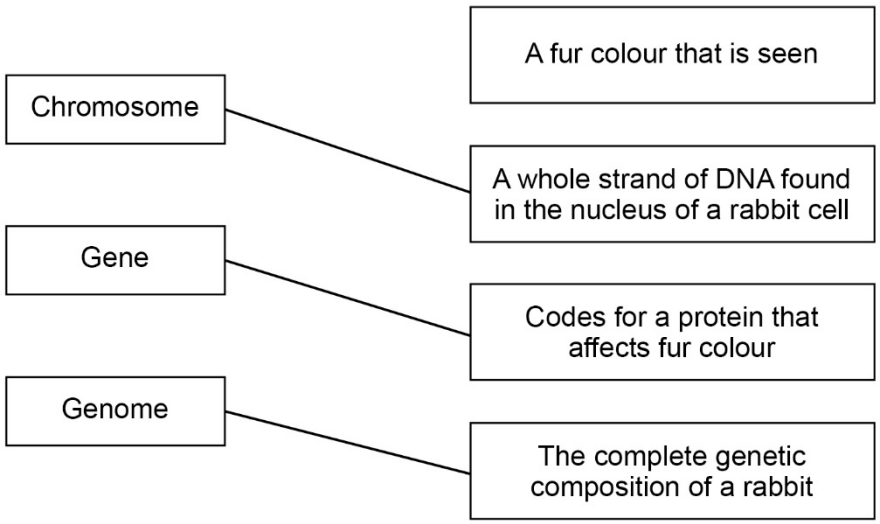
Total Question 3	15

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

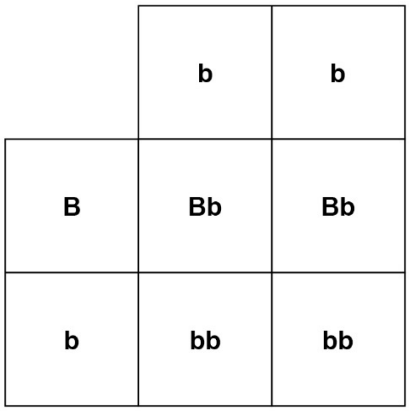
June 2025 | 8464/B/2H | Original Q1

Question 1

Question	Answers	Mark	AO / Spec. Ref.
01.1	Term / Meaning of the term  do **not** accept more than one line from a box on the left	1 1 1	AO1 4.6.1.3 4.6.1.4

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2				
	gametes correct	allow in either position in Punnett square	1	AO2
	offspring genotypes correctly derived	allow correct derivation of offspring genotypes from incorrect gametes allow 3 correctly derived offspring genotypes for **1** mark	2	AO2
	any **bb** offspring identified as having white fur		1	AO2
	0.5	probability must match offspring genotypes if given allow 50% **or** 1 in 2 **or** 1:1 **or** $\frac{1}{2}$ do **not** accept 1:2	1	AO3 4.6.1.4

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3		allow gamete(s) **or** sex cells for sperm throughout		
	sperm have one of each chromosome (pair)	allow sperm have one **set** of chromosomes / genes allow sperm (only) have one allele for each gene allow sperm are haploid allow sperm have half the (number / amount of) chromosomes (compared with a body cell) allow sperm have 23 / 22 chromosomes ignore sperm have one allele ignore sperm have half the DNA / genes	1	AO2
	sperm are produced by meiosis **or** body cells have two of each chromosome	allow body cells have pairs of chromosomes allow body cells are diploid allow body cells have 46 / 44 chromosomes allow **B** and **b** are (alleles) on 2 chromosomes (of the same pair)	1	AO1 4.6.1.1 4.6.1.2 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	44	allow 22 pairs	1	AO2 4.6.1.6

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

June 2025 | 8464/B/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	has two X (chromosomes)	allow XX allow the rabbit is not XY allow the rabbit does not have a Y (chromosome) allow the rabbit only has X (chromosomes) allow both (X) sex chromosomes are the same size	1	AO1 4.6.1.6

Total Question 1	**12**

4.1.2.1 Chromosomes

Answer 01 · Examiner comments

June 2018 | 8464/B/2H | Original Q7

Question 7 (standard, standard / high & high demand)

As expected with this question being higher demand, students generally achieved lower marks. Some excellent answers were seen where students were able to access knowledge from different parts of the specification as well as use information from the question stem and their own wider reading to express complex concepts.

07.1 This was not a straightforward knowledge question as students needed to use logical thinking as well as knowledge of chromosomes to work out the correct alternative. 50% of students arrived at the correct response. Many realised that there would be one X and one Y chromosome but their maths let them down when they computed that only eight more pairs would be needed.

07.2 A large number of students understood meiosis was the type of cell division and many students could not spell it correctly. Being able to understand the differences in mitosis and meiosis is crucial as is being able to correctly spell all keywords. 28% of students achieved two or three marks.

07.3 Students seemed to struggle with the idea that meiosis created four daughter cells from the two divisions, although they did tend to identify that the cells would be haploid. Many just stated the cells would be not identical rather than being genetically different.

The majority of students found it difficult to transfer their knowledge of humans and their 23 pairs of chromosomes to oysters with ten pairs and so their answers were confused. 19% of students achieved the mark here.

07.4 While students were able to note that triploid oysters didn't spend time reproducing, very few related this to energy. Many went down the route of not needing time to look for a mate. The few that did identify energy and reproduction (6% of students) rarely linked the energy available to synthesising proteins, and instead going with vague references to 'growth' which is insufficient at this level.

07.5 Students had the idea that global warming, pollutants, competition or predators could be involved, but rarely gained credit as they did not express this with the necessary high demand biological detail required to explain how it would lead to a reduction in population.

Key points were generally missing such as toxic pollutants and new predators or pathogens. Some students mentioned disease but did not relate it to pathogens. 3% of students achieved full marks.

4.1.2.1 Chromosomes

Answer 01 · Examiner comments

June 2018 | 8464/B/2H | Original Q7

07.6 This 'extended response' question was targeted at grades 6–9. Many students were able to access level 1 (43%) and level 2 (27%). It served its purpose of allowing the higher-attaining students to perform well, while not discouraging lower-attaining students from answering, and very few students made no attempt.

It was felt that students engaged with the opportunity to have an opinion about ideas on whether supermarkets and restaurants should be allowed to stock a product which may have a link to a carcinogen.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.1.2.1 Chromosomes

Answer 04 · Examiner comments

June 2022 | 8464/B/1H | Original Q2

Question 2 (standard demand)

02.1 54% of the students put gene, chromosome, nucleus and cell in order of increasing size.

02.2 Half of the students gave the correct answer, differentiation. Some said specialisation, whilst most students thought the process to produce specialised cells was mitosis, cell division or therapeutic cloning.

02.3 44% of the students correctly calculated the number of cell divisions to form a 16-cell embryo.

02.4 65% of students knew that the cells of a human embryo have 46 chromosomes.

02.5 A quarter of students scored full marks, with 69% scoring at least one mark. Many students scored a mark for Stage 1 by saying that the cell grows or that there is an increase in the number of sub-cellular structures. Some students thought Stage 1 was fertilisation, and they went on to describe the development of an embryo.

A mark for Stage 2 was less often awarded. Many students said mitosis happens, but as this was written on the cell cycle diagram it did not gain credit.

For Stage 3 all the changes listed on the mark scheme were seen, but many students only referred to two daughter cells forming, when reference to two identical cells was required. Reference to specialised cells being formed was seen quite a lot, and was ignored.

4.1.2.1 Chromosomes

Answer 04 · Examiner comments

02.6 The question asked students to compare the growth of boys with the growth of girls, using data from growth curves.

There are three main sections in the graph:

- a section from birth to age 10 or 11, where the height and growth rate of boys and girls is very similar
- a section from age 10 or 11 up to age 14, where girls grow faster than boys
- the section from 14 to 18 years, where boys continue to grow rapidly whilst girls have stopped growing.

Within each section there were several comparisons that could be made.

To score the highest marks reference to all three sections of the graph was required, in addition to at least one comparison of the rate of growth. 30% of students scored four or more marks. More than two thirds of students scored three or more marks.

As the command word was 'Compare' it was important that comparative statements about boys and girls were made. All the statements given in the indicative content are comparisons.

Many responses gave descriptions of what they had learnt about puberty and growth spurts, but if they did not match the data given in the graph they were not credited. Any data given had to be correct.

Common errors in interpreting the graph included:

- boys grow faster than girls up to age 11
- boys grow shorter, or stop growing, at age 11
- girls stop growing at age 18.

02.7 The question asked for one way that mitosis is important in fully grown animals, so saying 'to grow' was not credited. Many students said for growth and repair, which was insufficient. Repair of tissues, organs or wounds all gained credit. Many students said to repair damaged cells, which is incorrect. Replacement of cells or tissues was another acceptable response. Many said mitosis was important for reproduction, which was ignored.

4.1.2.1 Chromosomes

Answer 05 · Examiner comments

Question 4 (Standard, Standard/high and High demand)

04.1 Some students gave the binomial, which was incorrect.

A large number of students were giving incorrect names including the domain / Linnaean classification system (eg Archaea, Eukaryote, Family) or other classification groups (eg Animalia, Vertebrates, Mammal, Fish, Amphibian, Insect).

04.2 Students found it challenging to name the correct domain.

Common incorrect responses were archaea, prokaryotes, bacteria, insect, kingdom and animals. Some students gave the species or genus name. Many students gave classification groups again (ie Animalia, Mammal, Fish, Amphibian, Insect, Fungus). Some students named roles in a food web such as consumer, prey, predator, tertiary consumer. Some students named the domain as the water/sea/ocean.

Answer 05 · Examiner comments

04.3 There were many responses that were too vague to score marks. In most cases, these repeated the question. References to selecting and breeding fish with the gene were common, and not creditworthy alone.

Some students implied that the parents were being bred repeatedly, rather than the next generation. Few students could describe when the selective breeding would be finished.

Some misconceptions were seen regarding genetic modification.

0 4 . 3 Some salmon have genes that result in fewer sea lice attaching to the skin.

Describe how fish farmers can selectively breed salmon that sea lice **cannot** attach to.

[3 marks]

They can catch the salmon that fewer sea lice attach to. They then bread the fish and breed the offspring until they produce salmon that sea lice cannot attach to.

This response gains marking point 1. It is then unclear that the offspring are being selected before breeding so no further marks were given.

04.4 Generally, students could state some advantage to salmon farmers, but few could give a full explanation.

Responses relating to the fish being 'healthier', 'fresher' or 'higher quality' were insufficient.

04.5 Students found this question challenging. When asked to explain the disadvantage of selective breeding, many students gave responses that could apply to any population (whether selectively bred or not), such as 'may get diseases' or 'may pass on inherited disorders). These were insufficient.

Some students ignored the 'Do not refer to cost or time in your answer' statement in the question and referred to how long selective breeding takes.

For marking point 1 some students incorrectly stated that genes / DNA / gene pool would be the same in all the salmon. So, 'smaller gene pool' / 'similar DNA' were equivalent to the marking point but 'same gene pool' / 'same DNA' did not gain credit.

There were different ways that students could be awarded marking point 2. In option 1 (marking point 2), the idea of an inherited disorder / defect was important, and it needed to be clear that this is across the whole population. Answers of 'all get the same disease' did not gain credit as they miss the idea of it being an inherited condition. An answer of 'one parent can pass on a genetic disorder' would not gain credit as it does not imply all the salmon having it and could apply with or without selective breeding.

4.1.2.1 Chromosomes

Answer 05 · Examiner comments June 2023 | 8464/B/2H | Original Q4

In option 2 (marking point 2), we were looking for the idea is that all salmon would be ‘prone / susceptible to’ ‘the same / a particular’ disease. So, ‘all likely to get the same diseases’ or ‘fish are likely to die from the same disease’ would be equivalent.

Very few students went the option 3 (marking point 2) route, to explain how there would be a lack of variation to survive future environmental change.

Evidence of misconceptions was common, such as the suggestion that salmon are prone to developing genetic diseases. This was stated in terms that suggested genetic diseases are communicable or develop later in life.

References to ethics suggested that students are confused between selective breeding with genetic modification. Some responses referred to the unethical nature of killing fish or sea lice being a disadvantage (despite the whole point of salmon farming being to kill salmon for food). References to mutations implied that some students view any mutation as harmful or negative. Many students gave references to sea lice evolving or becoming extinct. Some misconceptions were seen around selective breeding involving chemicals, resulting in fish not being organic.

Answer 06 · Examiner comments

Question 3 (standard, standard/high & high demand)

03.1 There was only 1 mark available here and for this to be awarded it was essential that reference was made to both parents (without the disorder) and their children (who have the disorder). A common misconception was for students to base their descriptions on the (low) frequency of AKU within the family.

Students should be aware that using 'it' will be treated in terms of how the question is phrased, unless the student clarifies what they mean by 'it'. Please see page 4 of the mark scheme for more guidance on the use of 'it'. Here, 'it' unqualified was considered equivalent to 'AKU'.

No evidence could be obtained from C and D as parents. Answers which described this part of the family tree as evidence gained no credit as it is incorrect biology, even if a student went on to make further correct points.

Examples of answers which were too vague to match the mark scheme included:

- 'D has AKU and this means that his parents are heterozygous' ('Heterozygous' does not clearly suggest that a recessive AKU allele is present but the parents do not have AKU)
- 'A and B don't have AKU but future generations do' ('Future generations' is too vague)
- 'AKU skips generations'.

03.2 Fewer than 50% of students could identify which person is definitely heterozygous for AKU. More students selected the incorrect answer of 'D'.

03.3 Most students were able to correctly identify the gametes for both parents, although where one of these marks was not awarded it was often because students presumed that the female with AKU had the genotype AA rather than aa and therefore were struggling to tell the difference between recessive and dominant despite being told AKU was recessive earlier in the question.

Almost all students were able to derive the offspring in the Punnett square and were awarded marking point 3.

For marking point 4, very few students attempted to identify the offspring phenotypes, and when there was an attempt at this, the mark wasn't awarded if only the phenotype 'having AKU' was indicated rather than the phenotype for both having AKU and not having AKU. Many students drew circles around offspring genotypes in the belief that this would be sufficient to suggest a phenotype of 'having AKU', but this was not creditworthy. Another frequent mistake was referring to the phenotype of Aa offspring as being 'heterozygous' or 'a carrier'. Although not incorrect descriptions, these are not actual phenotypes.

Giving the probability of having AKU was, in the majority of cases, done correctly and was usually given as a percentage or a fraction. This was very rarely given as a ratio. When incorrect gametes were given, a common mistake made when working out the probability was that offspring with Aa or AA would have AKU.

Other, more occasional, errors included giving an incorrect probability, such as 1:2 or 50/50 or 50 and using symbols other than those (A and a) directed in the question.

© 2024 AQA and its licensors. All rights reserved.

4.1.2.1 Chromosomes

Answer 06 · Examiner comments June 2024 | 8464/B/2H | Original Q3

It was noted that quite a few students changed their minds when answering this question and made alterations to the gametes and genotypes they originally opted for. If students do this, they must make sure that the changes are unambiguous and, if necessary, rewrite their choices. It was sometimes very difficult for examiners to decide what the student intended to be marked.

0 3 . 3 A female who has AKU and a male who is heterozygous for AKU plan to have a child.

Determine the probability that the child will have AKU.

You should:

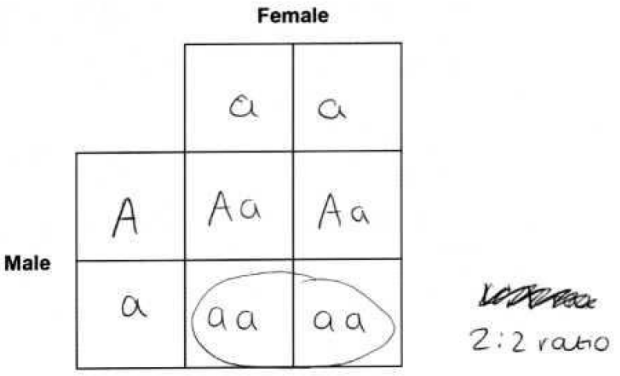
- complete **Figure 4**
- identify the phenotype of each offspring genotype
- use the symbols:

  A = dominant allele

  a = recessive allele.

[5 marks]

Figure 4



Probability that the child will have AKU = 50%

In a typical response, as shown above, students gave the correct parental gametes, and derived offspring genotypes correctly. The student has not indicated the phenotype of each offspring genotype, therefore marking point 4 was not awarded. However, the probability is acceptable, so 4 marks could be awarded.

© 2024 AQA and its licensors. All rights reserved.

4.1.2.1 Chromosomes

Answer 06 · Examiner comments June 2024 | 8464/B/2H | Original Q3

03.4 Students found this question difficult with very few gaining both marks. They struggled to make appropriate connections between the mutation and the non-functioning enzyme.

Answers were often too general and repetitive of information given in the question to be adding any value, such as 'a mutation could change the cell's DNA to stop producing functioning enzymes' or 'if the gene has changed it will mean that the enzyme has changed'.

In other cases, students clung to the familiarity of terms in the question but created their own, inappropriate, narratives around them. So, 'mutation' triggered reference to 'random changes', incidence in the family tree, links to cancer and 'uncontrollable cell division'; 'protein' prompted discussions of ribosomes, protein digestion by protease, proteins being needed for growth and repair; 'enzyme' opened the way to details of denaturation.

Misconceptions were quite frequently seen, such as:

- 'DNA is made of amino acids'
- 'DNA a protein'
- 'genes make amino acids that code for a protein'
- 'the enzyme is 'mutated'
- 'the enzyme changes shape and can then no longer fit the active site'.

Overall, marking point 2 was seen far more frequently than marking point 1. Students clearly felt more comfortable discussing why enzymes might not be functioning rather than the reason behind this (the immediate consequence of the mutation).

03.5 This question was set at high demand. It closely reflects the specification content for the use of hormones in the treatment of infertility. Answers were often confused and poorly sequenced. Appreciation of the distinctions between 'egg', 'fertilised egg' and 'embryo' and between 'ovary' and 'uterus' was often lacking.

For the first mark, students had to refer only to FSH and LH being given to the female to stimulate maturation of eggs. Incorrect answers included ideas of the hormones 'increasing the chances of fertilisation', 'making the eggs more fertile', 'strengthening the eggs'. Students occasionally suggested that FSH and LH production was stimulated through treatment rather than the hormones being given directly. No credit was given for this.

The second marking point was the most commonly awarded mark. Credit was not given, however, for vague references such as the eggs and sperm were 'combined' or 'joined together'. The term 'fertilisation'/'fusion' was required or a suitable description of sperm being injected into eggs (ICSI). No mark was given when the student described fertilisation 'in the woman'.

Very few students achieved marking point 3. Words that were too vague such as 'growing'/'forming'/'turning into' were used instead. Mention of 'mitosis' was exceptionally rare. No credit was given if it was implied that embryo development only happened at a later stage within the uterus.

For the fourth mark, many students did not state that the embryo was inserted into the uterus. Answers which said that the embryo was 'put back into the woman' were insufficient. Reference to anything other than the 'embryo' or the 'ball of cells' at this stage, such as 'fertilised egg'/'baby', was incorrect. Some students wrongly suggested that the embryos were inserted into ovaries.

© 2024 AQA and its licensors. All rights reserved.

4.1.2.1 Chromosomes

Answer 06 · Examiner comments June 2024 | 8464/B/2H | Original Q3

03.6 This was generally well answered. The most commonly awarded marks were for bullet point 4 and bullet point 5, as students clearly understood the high cost of the process and that it might lead to parents choosing to terminate their pregnancy. Some students attempted bullet point 1 but did not understand the process and wrote about the embryo being harmed due to the radiation used in the process, which was incorrect.

Some students simply wrote 'ethics' without giving details on why some people might think this and there were often references to 'designer babies', which was incorrect. Some students appeared to be talking about IVF, such as 'not always successful', with some confusion about what embryo screening involves.

Some students described ideas of prejudice against people with inherited disorders. This was described in a variety of ways and was creditworthy.

Answer 07 · Examiner comments

June 2025 | 8464/B/2H | Original Q1

Question 1 (Standard demand)

01.1 The most common incorrect answer was a gene linked to 'a fur colour that is seen'. Students seemed to have a better understanding of the meaning of the term genome.

01.2 88 % of students on Higher tier gained 4 or 5 marks.
Those students who were able to put the gametes given in the question stem correctly into the Punnet square generally also achieved 2 marks for the correct derivations. Many students failed to identify the offspring that would have white fur and consequently could not be awarded marking point 4. However, the probability mark was often seen and was awarded if it was correct for the student's derivations.
Some students used the Punnet square incorrectly, with gametes given on the outside of the square and more than four derivations.

The most common error was students using both parent genotypes as Bb.
A number of 50/50 answers were seen despite this being highlighted in previous examiner reports as not being an equivalent probability to 0.5 or 50:50. Some students incorrectly gave the probability as 50, rather than 50% and therefore could not be awarded marking point 5.

01.3 This proved a challenging question with only 25% of students on Higher tier gaining one or two marks. Commonly, students tried to answer in terms of dominant and recessive alleles or genotypes, described the inheritance of alleles from parents, or described the different roles of sperm cells and body cells. Few made any reference to chromosomes, and even fewer mentioned meiosis.

A frequently seen misconception was that 'sperm contain half a chromosome', illustrating that some students struggle with the abstract concepts relating to this part of the specification. Incorrect use of terminology was frequent, such as 'body cells are heterozygous, but sperm cells are homozygous'. Another occasional misconception was the idea that body cells contain maternal and paternal genes or chromosomes, but that sperm cells only contain paternal chromosomes or genes.

0 1 . 3 A male rabbit is heterozygous for fur colour.

The rabbit's body cells have the genotype **Bb**.

One of the sperm cells from the rabbit has the allele **b**.

Explain why the alleles in the rabbit's body cells and the allele in the sperm cell are different.

[2 marks]

The sperm cell only contains half of the genetic material needed for an offspring. The egg will contain the other half.

This student has given a typical response that did not contain sufficient detail to gain either mark.

© 2024 AQA and its licensors. All rights reserved.

4.1.2.1 Chromosomes

Answer 07 · Examiner comments June 2025 | 8464/B/2H | Original Q1

01.4 Just over 25% of students correctly gave an answer of 44, and very few gave the correct equivalent answer of 22 pairs. The most common incorrect answers were 21, 22 and 42, although those also frequently seen included 1, 2, 11, 23 and 46.

01.5 This question asked for evidence from the figure that the rabbit was female. This was answered very well with many students stating that there were 2 X chromosomes. A few students did not gain the mark because they stated '2 X genes' or '2 X alleles'. Some students recognised the absence of the Y chromosome which also gained the mark.