AQA GCSE Biology | 8461

SPECIFICATION POINT 4.6.1.6

Genetic inheritance

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**25**
Available paper years	**2008–2025**

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.

4.6.1.6 Genetic inheritance

Answer 01 · Mark scheme June 2008 | BLY2F | Original Q8 | Legacy

question	answers	extra information	mark
8(a)	cell membranes		1
8(b)(i)	two recessive / cystic fibrosis / faulty / diseased / the allele(s) / genes from Bob **and** Carol / both parents / the parents	two can be implied by second marking point ignore chromosomes if no other marks awarded 'Carol is a carrier' gains **1** mark	1 1
8(b)(ii)	(inherited) dominant / normal allele / gene from Carol / mother	ignore references to recessive allele / gene from father / Bob if no other marks awarded he has <u>just</u> / <u>only</u> one recessive allele gains **1** mark	1 1
8(c)(i)	reduce number of people with cystic fibrosis (in population) **or** reduce health-care costs **or** expensive to have baby with cystic fibrosis	accept to allow decision / emotional argument qualified eg allows abortion **or** allows people to make choices about termination **or** help to prepare financially / emotionally etc	1

Question 8 continued on next page…

4.6.1.6 Genetic inheritance

Answer 01 · Mark scheme

COMPONENT NUMBER: BLY2F

COMPONENT NAME: Additional Science / Biology

STATUS: Final

DATE: June 2008

Question 8 continued…

question	answers	extra information	mark
8(c)(ii)	any **one** from: • possible damage / risk to embryo / fetus / baby • screening / it is expensive • (may) have to make ethical / moral / religious decisions • right to life	 allow possible harm / risk to mother ignore not natural / playing God / unethical / immoral / religious unqualified	1
Total			**7**

4.6.1.6 Genetic inheritance

Answer 02 · Mark scheme

January 2009 | BLY2F | Original Q3 | Legacy

question	answers	extra information	mark
3(a)	2 and 3		1
3(b)	cell **P** has an X chromosome; cell **R** has a Y chromosome		1
3(c)	any **two** from: • (formed from) different egg / 2 eggs • (formed from) different sperm / 2 sperm • have different genes / alleles / chromosomes / DNA	 allow genetics	2
3(d)(i)	stem cells		1
3(d)(ii)	the cells divide the cells differentiate		1 1
3(d)(iii)	(medical) research / named eg growing organs **or** medical / patient treatment	allow (embryo) cloning do **not** allow designer babies / more babies	1

Question 3 continued on next page…

COMPONENT NUMBER: BLY2F

COMPONENT NAME: Additional Science / Biology

STATUS: Final

DATE: January 2009

Question 3 continued…

question	answers	extra information	mark
3(d)(iv)	any **one** from: • ethical / moral / religious objections • potential harm to embryo	ignore cruel / not natural / playing God allow deformed ignore harm to mother	1
Total			**9**

4.6.1.6 Genetic inheritance

Answer 02 · Mark scheme

COMPONENT NUMBER: BLY2F

COMPONENT NAME: Additional Science / Biology

STATUS: Final

DATE: January 2009

4.6.1.6 Genetic inheritance

Answer 03 · Mark scheme

Question 5

question	answers	extra information	mark
5(a)	chromosomes		1
5(b)	diagram showing four separate chromosomes two long and two short (as in diagram 1)	allow each chromosome shown as two joined chromatids do **not** allow if chromosomes touching each other	1
5(c)(i)	any **two** from: • can grow into any type of tissue / named tissue • used in medical research • used to treat human diseases • large numbers can be grown		2
5(c)(ii)	any **two** from: • expensive • grow out of control / ref cancers • may be rejected • need for drugs (for rest of life)		2
Total			**6**

4.6.1.6 Genetic inheritance

Answer 03 · Mark scheme

June 2009 | BLY2F | Original Q5 | Legacy

BLY2F

4.6.1.6 Genetic inheritance

Answer 04 · Mark scheme

January 2010 | BLY2F | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	sex cells		1
2(a)(ii)	chromosomes		1
2(b)(i)	two		1
2(b)(ii)	recessive		1
2(c)(i)	cell membrane	allow membrane	1
2(c)(ii)	cytoplasm		1
2(d)(i)	A		1
2(d)(ii)	B		1
Total			**8**

4.6.1.6 Genetic inheritance

Answer 04 · Mark scheme January 2010 | BLY2F | Original Q2 | Legacy

BLY2F

Answer 05 · Mark scheme March 2010 | BLY1BP | Original Q3 | Legacy

Three	**A**	genes	**2**
	B	gametes	**1**
	C	characteristics	**4**
	D	nucleus	**3**

4.6.1.6 Genetic inheritance

Answer 06 · Mark scheme

June 2010 | BLY1F | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)(i)	characteristic		1
4(a)(ii)	gene		1
4(a)(iii)	gamete		1
4(b)	sexual asexual clones		1 1 1
Total			**6**

4.6.1.6 Genetic inheritance

Answer 06 · Mark scheme

June 2010 | BLY1F | Original Q4 | Legacy

BLY 1F

4.6.1.6 Genetic inheritance

Answer 07 · Mark scheme

June 2019 | BLY2F | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)(i)	circle unshaded	mark independently could be in body of script	1 1
4(a)(ii)	(Harriet) dd DD Dd	in first box if another letter is chosen it must be used throughout and upper or lower case must be clear	1 1 1
4(b)(i)	to check for the D allele.		1
4(b)(ii)	any **one** from: • may harm / kill foetus / embryo / baby / mother • immoral / unethical / religion	allow could affect the baby ignore playing God ignore references to unnatural ignore wrong unqualified ignore expense / prejudice unqualified ignore lack of permission ignore results are unreliable	1
Total			**7**

4.6.1.6 Genetic inheritance

Answer 07 · Mark scheme June 2010 | BLY2F | Original Q4 | Legacy

BLY2F

Answer 08 · Mark scheme November 2010 | BLY1BP | Original Q4 | Legacy

Four	**A**	chromosomes	**4**
	B	clones	**1**
	C	gametes	**3**
	D	genes	**2**

4.6.1.6 Genetic inheritance

Answer 09 · Mark scheme

January 2011 | BLY2F | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)(i)	any **one** from: • A • C		1
4(a)(ii)	any **one** from: • B • D		1
4(b)(i)	pig A		1
4(b)(ii)	a gamete		1
4(c)	XY **or** YX X Y XY **or** YX	 in this order only 	1 1 1
Total			7

4.6.1.6 Genetic inheritance

Answer 09 · Mark scheme

January 2011 | BLY2F | Original Q4 | Legacy

BLY2F

4.6.1.6 Genetic inheritance

Answer 10 · Mark scheme

June 2011 | BLY2F | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)(i)	dominant	allow clear indication	1
5(a)(ii)	recessive	allow clear indication	1
5(b)(i)	aa	extra ring drawn cancels the mark	1
5(b)(ii)	Aa	extra ring drawn cancels the mark	1
5(c)	3 purple : 1 yellow	extra box ticked cancels the mark	1
Total			**5**

4.6.1.6 Genetic inheritance

Answer 10 · Mark scheme

June 2011 | BLY2F | Original Q5 | Legacy

BLY2F

4.6.1.6 Genetic inheritance

Answer 11 · Mark scheme

June 2012 | BL2FP | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)(i)	recessive allele		1
7(a)(ii)	carriers		1
7(b)(i)	6	allow nn	1
7(b)(ii)	1 in 4 / 0.25 / ¼ / 25% / 1:3	do **not** accept '3:1' / 1:4 / 1 in 3 / 25	1
7(c)	**advantage:** detect CF qualified – eg at early stage / before becoming pregnant **or** (only) healthy children produced **disadvantage:** some embryos are destroyed / may damage embryo	 allow 'after only 3 days' allow reduces health care costs allow increased risk of miscarriage ignore not natural ignore cost	 1 1
Total			6

4.6.1.6 Genetic inheritance

Answer 11 · Mark scheme

June 2012 | BL2FP | Original Q7 | Legacy

BL2FP

4.6.1.6 Genetic inheritance

Answer 12 · Mark scheme

Question 5

question	answers	extra information	mark
5(a)	Mendel		1
5(b)(i)	**TT**		1
5(b)(ii)	a dominant allele		1
5(c)	1 : 1		1
5(d)	100 short plants		1
Total			**5**

4.6.1.6 Genetic inheritance

Answer 12 · Mark scheme

January 2013 | BL2FP | Original Q5 | Legacy

BL2FP

4.6.1.6 Genetic inheritance

Answer 13 · Mark scheme

June 2013 | BL2FP | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)(i)	1		1
5(a)(ii)	fertilisation / fusion	allow sexual reproduction allow fertilise / fuse ignore joining	1
5(b)(i)	**Dd**		1
5(b)(ii)	**dd**		1
5(c)(i)	1 in 2		1
5(c)(ii)	0		1
Total			**6**

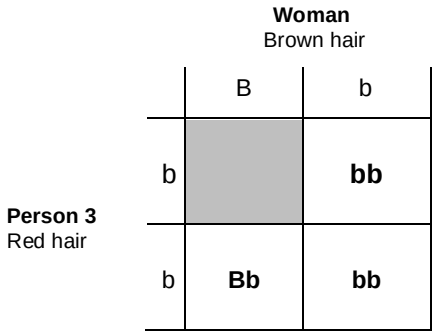
4.6.1.6 Genetic inheritance

Answer 14 · Mark scheme June 2015 | BL2FP | Original Q9 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
9(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
9(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
9(b)(i)	1 / one		1	AO2 2.7.2c,e, 2.7.3a,c
9(b)(ii)	2 / two		1	AO2 2.7.2c,d, 2.7.3a,b
9(c)	**B**		1	AO3 2.7.2i
Total			**6**	

4.6.1.6 Genetic inheritance

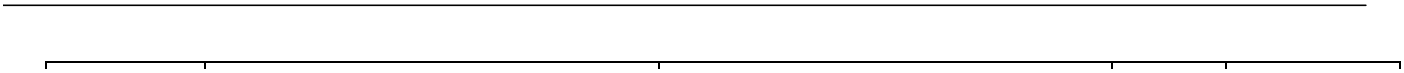
Answer 15 · Mark scheme June 2016 | BL2FP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	When the dominant allele is not present.		1	AO1 2.7.2c/d/e
4(b)(i)	Bb		1	AO2 2.7
4(b)(ii)		3 correct = 2 marks 2 correct = 1 mark 1 or 0 correct = 0 marks allow bB for Bb	2	AO2 2.7
4(b)(iii)	1 in 2	allow ecf from 4bii	1	AO2 2.7
Total			**5**	

4.6.1.6 Genetic inheritance

Answer 15 · Mark scheme

June 2016 | BL2FP | Original Q4 | Legacy



4.6.1.6 Genetic inheritance

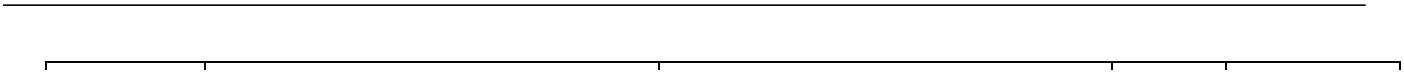
Answer 16 · Mark scheme June 2017 | BL2FP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)(i)	46		1	AO1 2.7.3a 2.7.2b
4(a)(ii)	An allele that shows its effect only if the dominant allele is not present		1	AO1 2.7.2e
4(b)(i)	(top left) **NN** (top right) **Nn** or **nN**		1 1	AO2 2.7 2.7.3a
4(b)(ii)	ring drawn around **nn**	allow alternative indication of **nn**, if unambiguous	1	AO2 2.7 2.7.3a
4(b)(iii)	1 in 4	allow ecf from 4bii	1	AO2 2.7 2.7.3a
Total			**6**	

4.6.1.6 Genetic inheritance

Answer 16 · Mark scheme

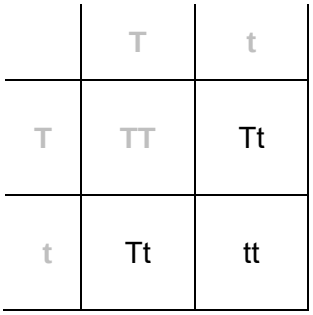
June 2017 | BL2FP | Original Q4 | Legacy



4.6.1.6 Genetic inheritance

Answer 17 · Mark scheme

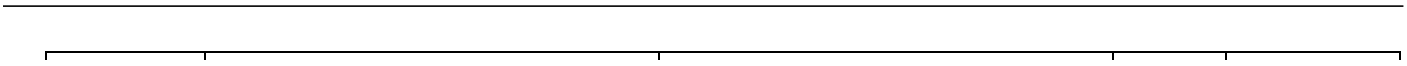
June 2018 | 8461/2F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	Gregor Mendel		1	AO1 4.6.3.3
04.2	DNA		1	AO1 4.6.3.3
04.3	when the dominant allele is not present		1	AO1 4.6.1.6
04.4	tt	allow homozygous recessive	1	AO2 4.6.1.6
04.5		all 3 correct = **2** marks 2 correct = **1** mark 0 or 1 correct = **0** marks allow tT for Tt	2	AO2 4.6.1.6
04.6	circle drawn around either TT or tt on Figure 5	allow circles drawn round both	1	AO2 4.6.1.6
04.7	correct ratio from question **04.5** eg 3 : 1	allow multiples of stated ratio allow 3 : 1 if no answer to question **04.5**	1	AO3 4.6.1.6
Total			**8**	

4.6.1.6 Genetic inheritance

Answer 17 · Mark scheme

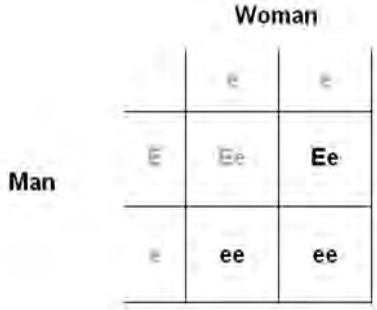
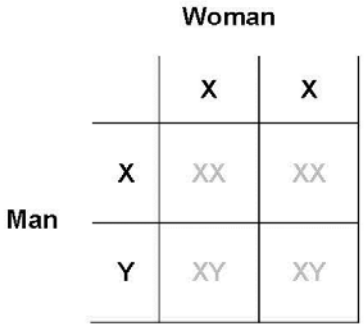
June 2018 | 8461/2F | Original Q4



4.6.1.6 Genetic inheritance

Answer 18 · Mark scheme

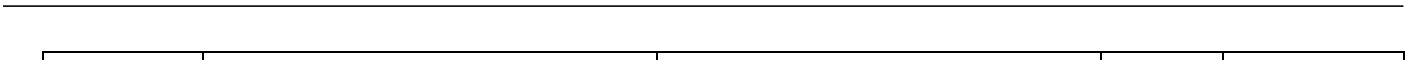
June 2019 | 8461/2F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	an allele expressed even if a person only has one copy of the allele		1	AO1 4.6.1.6
02.2		all 3 correct= 2 marks 1 or 2 correct = 1 mark	2	AO2 4.6.1.6
02.3	correct probability from Figure **4**	if no answer in Question **02.2** allow 0.5	1	AO3 4.6.1.6
02.4		gametes = X + X **and** X + Y allow in incorrect positions X, X, X and Y in correct boxes	1 1	AO2 4.6.1.6 4.6.1.8
02.5	 answer from Question **02.3** × 0.5 answer to calculation in mp1	an answer matching the answer from Question **02.3** × 0.5 scores **2** marks if no answer in Question **02.3**, an answer of 0.25 / ¼ / 1 in 4 / 25% scores **2** marks if no answer in Question **02.3** allow 0.5 × 0.5 if no answer in Question **02.3** allow 0.25 / ¼ / 1 in 4 / 25%	 1 1	AO2 4.6.1.6 4.6.1.8
Total			**8**	

4.6.1.6 Genetic inheritance

Answer 18 · Mark scheme

June 2019 | 8461/2F | Original Q2



4.6.1.6 Genetic inheritance

Answer 19 · Mark scheme

November 2020 | 8461/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	4 / four		1	AO1 4.6.1.2
03.2	23 / twenty three	do **not** accept 23 pairs	1	AO1 4.6.1.2
03.3	a different form of a gene		1	AO1 4.6.1.6
03.4	heterozygous		1	AO2 4.6.1.6
03.5 mark with 3.6 and 3.7	<table><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td>**Dd / dD**</td></tr><tr><td></td><td>**dd**</td><td>**dd**</td></tr></table>	allow 2 correct for **1** mark	2	AO2 4.6.1.1 4.6.1.2 4.6.1.6
03.6 mark with 3.5 and 3.7	ring around any **Dd**	allow ecf from question **03.5**	1	AO2 4.6.1.6
03.7 mark with 3.5 and 3.6	percentage must match answer given to questions **03.5** and **03.6**	if no answer in question **03.5** allow 50 %	1	AO3 4.6.1.6
03.8	mutation / mutated	do **not** accept mutant	1	AO1 4.6.2.1

4.6.1.6 Genetic inheritance

Answer 19 · Mark scheme

03.9	any **one** from: • to help them prepare • to inform whether to consider having an abortion • to find out if they have passed on the disorder	allow to see if the child / embryo has the disorder allow answers referring to genetic disorders, or specific example such as Dupuytren's / cystic fibrosis	1	AO3 4.6.1.7
Total			**10**	

4.6.1.6 Genetic inheritance

Answer 19 · Mark scheme

November 2020 | 8461/2F | Original Q3

4.6.1.6 Genetic inheritance

Answer 20 · Mark scheme

November 2020 | 8461/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	any **two** from: • double • helix • long / thin	allow two strands allow twisted / spiral / coiled	2	AO1 4.6.1.4
07.2	bases		1	AO1 4.6.1.5
07.3	protein		1	AO1 4.6.1.4 4.6.1.5
07.4	nucleotide		1	AO1 4.6.1.5
07.5 **mark with 07.6**	0.34 × 6 000 2040 (million nm)		1 1	AO2 4.6.1.4 4.6.1.5
07.6 **mark with 07.5**	answer from question **07.5** correctly converted	if no answer to question **07.5**, allow 2.04 (m)	1	AO2 4.6.1.4 4.6.1.5
07.7	any **one** of: • to determine if the cancer is genetic (or caused by lifestyle factors) • to inform / help treatment • to allow embryo screening to ensure allele is not passed on • to inform relatives if they have inherited (affected) gene / allele • to detect cancer early **or** before symptoms show • to understand cause of the cancer		1	AO3 4.6.1.7 4.2.2.7
Total			**9**	

4.6.1.6 Genetic inheritance

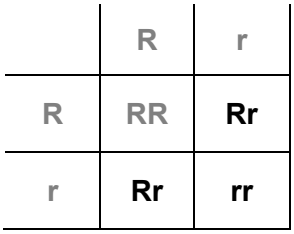
Answer 20 · Mark scheme

November 2020 | 8461/2F | Original Q7

4.6.1.6 Genetic inheritance

Answer 21 · Mark scheme

November 2021 | 8461/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	*Phytophthora*		1	AO2 4.6.4 4.7.5.1
05.2	the fungus can get oxygen from the air		1	AO2 4.4.2.1 4.7.5.1
05.3	the variety of species of organisms in the river		1	AO1 4.7.3.1
05.4	pesticide washed into river pesticide kills (some) organisms / plants / animals in river	allow spray drift allow reference to run-off allow carried by rainfall	1 1	AO2 4.7.3.1 4.7.3.2 4.7.3.6 4.7.5.1
05.5		all 3 correct = **2** marks 2 correct = **1** mark 0 or 1 correct = **0** marks	2	AO2 4.6.1.6 4.7.5.1
05.6	ring drawn around **RR** / **rr** in **Figure 9**	allow around both **RR** and **rr**	1	AO2 4.6.1.6 4.7.5.1
05.7	75%	percentage must match student's answer in **Figure 9** allow 75% if no answer to question **05.5**	1	AO3 4.6.1.6 4.7.5.1

4.6.1.6 Genetic inheritance

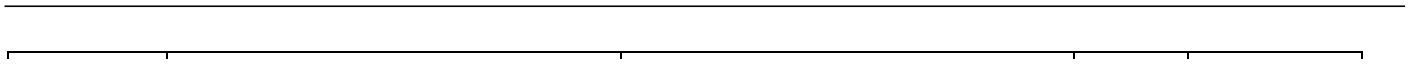
Answer 21 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.8	no fusion of gametes **or** (asexual reproduction involves) mitosis (so) offspring are genetically identical (to parent plant)	allow no fertilisation allow offspring are a clone allow offspring have same DNA allow no mixing of genes / DNA allow no mixing of genetic material allow all offspring inherit **R**	1 1	AO2 4.6.1.1 4.6.1.3 4.7.5.1
Total			**11**	

4.6.1.6 Genetic inheritance

Answer 21 · Mark scheme

November 2021 | 8461/2F | Original Q5



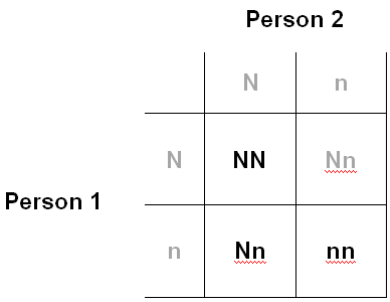
Answer 22 · Mark scheme

June 2022 | 8461/2F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	an allele expressed only if a person has two copies of the allele		1	AO1 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	male with MSUD	allow equivalent statements eg affected male **or** MSUD male **or** man with the disease	1	AO3 4.6.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3 *mark with 01.4, 01.5*		3 correct = **2** marks 2 or 1 correct = **1** mark	2	AO2 4.6.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4 *mark with 01.3, 01.5*	does not have MSUD	allow equivalent statements – eg normal **or** not affected **or** healthy ignore carrier	1	AO2 4.6.1.6 4.6.1.7

Answer 22 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5 *mark with 01.3, 01.4*	correct percentage from **Figure 2**	if no answer in question **01.3** allow 25%	1	AO3 4.6.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	dominant		1	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	DNA	allow deoxyribonucleic acid allow nucleotide(s)	1	AO1 4.6.1.4 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.8	proteins		1	AO2 4.6.1.4

Total Question 1		**9**

4.6.1.6 Genetic inheritance

Answer 23 · Mark scheme

June 2023 | 8461/2F | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	any **one** from: • variation of a named / described (desirable) characteristic • not all susceptible to the same disease / pathogen • maintain / increase gene pool	allow eg different flavour / colour allow different customer preferences	1	AO2 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	any **one** from: • they have the same named /(desirable) characteristic(s) • they grow at the same rate • they ready to harvest at same time	allow eg all high yield **or** all disease-resistant **or** same (desirable) flavour	1	AO2 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	(a group of) cells are grown (into a new organism)	ignore clones	1	AO1 4.6.2.5

Answer 23 · Mark scheme

June 2023 | 8461/2F | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	any **one** from: different • water • minerals / ions • light • herbivores • disease • plant density • soil pH	 allow rain allow named example ignore nutrients ignore sun unqualified allow named example allow named example allow different temperature allow different environmental conditions	1	AO2 4.6.2.1 4.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	male gametes = **X** + **Y** female gametes = **X** + **X** offspring genotypes correctly derived from gametes	if neither mark awarded, allow **1** mark for male = **X** + **X and** female = **X** + **Y** allow correct for chromosome assignment in mp1 & mp2	1 1 1	AO1 AO1 AO2 4.6.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	any **one** from: • half are XX and half are XY • equal probability of X or Y sperm fertilising an egg • (the Punnett square shows) 50% (chance of) male / female		1	AO2 4.6.1.8

4.6.1.6 Genetic inheritance

Answer 23 · Mark scheme

June 2023 | 8461/2F | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.7	any **two** from: • temperature • type / amount of food • light • whether chickens are kept indoors or outdoors • amount of movement / space (allowed) • time of year	 allow (volume / amount of) water allow same stocking density allow same number of each type ignore same number unqualified allow mass at start allow age of chicken(s) allow same medication **or** all healthy	2	AO2 4.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.8	any **one** from: • (more) valid / representative **or** reduce the effect of anomalies • (more) accurate mean	 allow can calculate a valid mean allow (more) accurate results allow (more) reliable mean / results	1	AO2 4.6.2.3

4.6.1.6 Genetic inheritance

Answer 23 · Mark scheme

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.9	breed best of **A** and **B** (together)	allow cross / mate best of **A** and **B**	1	AO2
	select offspring with highest egg numbers **and** heaviest / fastest growing	allow select the best offspring for both desired characteristics	1	AO1
	breed (these) offspring together		1	AO1
	repeat over many / several generations	do **not** accept reference to repeated breeding of the original parents	1	AO1 4.6.2.3

Total Question 9	**15**

4.6.1.6 Genetic inheritance

Answer 24 · Mark scheme

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Question 8

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.1	**r r**	allow homozygous recessive	1	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.2	male gametes correct: **R** and **r** all four offspring genotypes correctly derived from gametes (given)	 allow **1** mark for 2 or 3 correct	1 2	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.3	correct ratio from **Figure 11**	allow 3 : 1 if no answer to **08.2**	1	AO3 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.4	having (two) different alleles (of a gene)	ignore example(s) do **not** accept having two different genes	1	AO1 4.6.1.6

4.6.1.6 Genetic inheritance

Answer 24 · Mark scheme

June 2024 | 8461/2F | Original Q8

Question	Answers	Extra information	Mark	AO / Spec Ref.
08.5	any **two** from: • other scientists not aware of his work **or** work published in obscure journal • other theories accepted at the time • not considered to be a scientist **or** not eminent **or** not respected • Mendel's (mathematical) approach was novel concept • peas gave unusual results compared with other species • new discoveries made Mendel's work relevant	allow work lost for many years allow eg theory of blending inheritance ignore religion allow he was **only** a monk allow he was not believed allow his work was not understood **or** no other scientist had similar ideas allow his results were not corroborated (at the time) allow Mendel only worked on pea plants allow insufficient results / research allow specific discoveries	2	AO2 4.6.3.3

Total Question 8	8

4.6.1.6 Genetic inheritance

Answer 25 · Mark scheme

June 2025 | 8461/2F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	an allele expressed when a rabbit has only one copy of the allele		1	AO1 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	**hh**		1	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	<table><tr><td></td><td>**H**</td><td>**h**</td></tr><tr><td>**H**</td><td>HH</td><td>Hh</td></tr><tr><td>**h**</td><td>Hh</td><td>hh</td></tr></table> male gametes correct all three offspring genotypes correctly derived from gametes	 allow **1** mark for 2 correct	 1 2	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	(on **Figure 2**) ring drawn around **HH** and / or **hh**		1	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	3	answer must be consistent with genotypes in question **01.3** if given allow 3 if question **01.3** is not answered	1	AO3 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	1		1	AO1 4.6.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	2 / two	allow half / ½ (of them) ignore ratios	1	AO2 4.6.1.8

Total Question 1	**9**

4.6.1.6 Genetic inheritance

Answer 19 · Examiner comments November 2020 | 8461/2F | Original Q3

Question 3 (low & standard demand)

This question was about meiosis, chromosomes and an inherited disorder in humans. A little over one-third of students gave the correct answer of '4' cells being formed by meiosis in **03.1**. There were many other alternatives offered: '2' was, not unexpectedly, a common incorrect response and other suggestions included '8' and as many as '50 million' as these last students presumably either misread the question or misunderstood the process of meiosis.

For **03.6** most students ringed an appropriate offspring genotype although a significant minority (about 1 in 15) did not answer this question. The most likely reason for this is that students missed the question, rather than not understanding what they had to do. The lack of answer lines, spaces or boxes to tick should not be seen by students to mean that nothing needs to be done. Students should be reminded to read all of the words on the paper and respond accordingly. Those students who gave incorrect responses often ringed contradictory genotypes, showing a lack of understanding of genetic principles.

Answer 20 · Examiner comments November 2020 | 8461/2F | Original Q7

Question 7 (low & standard demand)

This question was about DNA. In **07.1** many students knew the term 'double helix' and gained both of the available marks. Other students attempted to describe the figure lower down on the page, but usually did so in terms of the labelled components of the structure. Various acceptable terms were used as synonyms for 'helix'.

For **07.5** all sorts of mathematical manipulations were carried out with the two numbers in the question. Although these often correctly involved multiplication, the values were sometimes written down incorrectly or the million in the question was interpreted as thousands or billions or anything in between. Consequently, the correct answer was not commonly given. The answer line showed that it was unnecessary to expand the millions in the question, although many attempted to do so. In **07.6** many students carried out further calculations with no reference to the answer they had given in the previous part, introducing all sorts of numbers with no evidence as to their origin. Some multiplied by a factor of 10^9, whilst others omitted the millions in question 07.5 and simply divided what they had written by 10^9.

4.6.1.6 Genetic inheritance

Answer 22 · Examiner comments — June 2022 | 8461/2F | Original Q1

Question 1

This question was about the inheritance of a human genetic condition.

01.1 Just over half the students correctly selected the option that a recessive allele was one expressed only if a person has two copies of the allele.

01.2 Most students were able to identify the correct phenotype for the given symbol in terms of both sex and having the condition maple syrup urine disease (MSUD). A small proportion simply copied one of the other phenotypes from the key.

01.3 A large proportion of students completed the Punnett square correctly. Of those who didn't, it was common for them to give offspring genotypes as single alleles.

01.4 Identification of the phenotype for the heterozygous genotype was poorly done, with many students not referring to MSUD in their answers. Almost one in five made no attempt at all.

01.5 Those students who gave correct answers in question 01.4 were frequently able to give the correct answer to this question. However the number who gained all four marks across this

Answer 22 · Examiner comments — June 2022 | 8461/2F | Original Q1

and the two previous questions was not high (fewer than one-fifth). Students seemed to be somewhat confused by MSUD being the recessive allele and often gave 75%, even when their Punnett square was correct.

01.6 Most students correctly selected *dominant* as the term that described the allele **N** for not having MSUD.

01.7 Although a quarter of students gave the correct answer, DNA (with a small number giving the full chemical name), a considerable number offered all manner of substances, organelles or whole organisms. It was evident that some students either ignored the word 'substance' in the question or lacked the understanding of what a substance is.

01.8 Just over half knew that proteins are made of amino acids.

Answer 23 · Examiner comments — June 2023 | 8461/2F | Original Q9

Question 9

This was the third of the three questions common to both the Foundation and Higher Tier papers. The topic was reproduction and selective breeding.

09.1 The most common advantage given for growing genetically-different tomatoes was that some might be less susceptible to disease, although others, such as producing different-sized tomatoes, were also given. Just over one-third of students gave a suitable answer.

Answer 23 · Examiner comments June 2023 | 8461/2F | Original Q9

09.2 Deciding on an advantage for growing genetically-identical tomatoes proved more problematic and only one-fifth could suggest a feature such as all growing at the same rate or all having the same named desirable feature such as high yield, disease resistance or flavour.

09.3 Very few students could successfully describe what is meant by tissue culture. Use of tissue as the starting material was deemed inadequate and required amplification in terms of cells being grown. Only around 2 percent gave an appropriate answer.

09.4 Almost half of all students were able to suggest why genetically-identical tomatoes growing in a garden might not all attain the same height – for example, due to variations in light intensity, ions, water or temperature in different areas of the garden.

09.5 This question was about sex determination in dogs. Students had to use the symbols X and Y to complete a blank Punnett square. Most knew that the male dog would produce gametes containing either an X or a Y chromosome, and that all the female gametes would contain an X chromosome, and over a quarter were successful in the completion of all aspects of the Punnett square.

09.6 The explanation of why a litter of six puppies might be expected to consist of three males and three females was straightforward for only a minority of students: either in terms of the expected 1:1 ratio of males and females or the inheritance of a Y chromosome by only half of the offspring (as demonstrated in a correct answer to the previous question).

09.7 This question was about the breeding of chickens for meat production and egg production. Given the results of an investigation in Figure 5 which showed that chicken variety A had high egg production while variety B grew more quickly, students had to suggest two control variables for the investigation. Many answers were rather vague – such as the same ‘living conditions’ / ‘environment’. More specific conditions, such as temperature, lighting, amount or type of food, all being kept indoors or all outdoors, were required. The most common correct answer related to the chickens’ food. Fewer than half of the students could suggest at least one suitable control variable, and only 1 in 8 could give two.

09.8 The data in the investigation had come from 500 chickens of each variety and students had to give a reason why such a large number had been used. Acceptable answers included the idea this would be more representative, or would give a more valid mean, or would reduce the effects of any anomalies (and not that it would ‘eliminate’ anomalies). A little over one-third of students were successful.

09.9 In this question, students had to describe how selective breeding of the two chicken varieties might produce a new variety of chicken that was good for both meat production and egg production. Many answers lacked precision: thus it was not often evident that only the best from varieties A and B would be mated and that the best (for both qualities) from the offspring would then be selected and mated, and that this would be continued over several generations. Often, it was impossible to tell from students’ answers which generation of chickens was being used: the original parents, the first generation offspring or subsequent generations of offspring. The term ‘repeat’ was often used in an ambiguous context. Thus only 1 in 500 students scored all 4 marks, and only 1 in 25 gained at least half-marks.

Mark Ranges and Award of Grades

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

Answer 24 · Examiner comments

June 2024 | 8461/2F | Original Q8

Question 8 (low and standard demand)

08.1 Half of students correctly interpreted the information given in the question and correctly used the given symbols to write the required genotype of 'rr'. Very occasionally the written terms of 'homozygous recessive' were seen, which was credited.

Some students gave only 'recessive' or only 'homozygous' which were insufficient in isolation.

08.2 Almost 50% of students gained all three marks for a correct Punnett square. Plenty of correct Punnett squares seen with some going on to also give the correct ratio. The most common mistake was using 'RR' for the male (although rr was also seen). Marking points 2 and 3 could still be gained for correct derivation of the offspring genotypes.

Some students incorrectly gave 2 alleles for the male gametes and/or 1 for each offspring. There were quite a lot of students who overwrote the letters or drew additional Punnett squares. In some cases, it was very difficult to determine which one they intended as their final answer. Students should be encouraged to cross out an incorrect answer and write another beside it if they change their mind.

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Answer 24 · Examiner comments

June 2024 | 8461/2F | Original Q8

08.3 35% of students were able to give the correct ratio from their Punnett square in question 08.2. Many students did not realise that the offspring would all be round so gave an incorrect ratio of 1:1, 2:2 or even 50:50. Credit was still given if a sensible assumption could be made about the phenotype of offspring from incorrect Punnett squares using single alleles for the offspring, or even two alleles for the parent genotypes.

08.4 This question was not answered well and almost 20% of students did not attempt to answer it. Some students showed an understanding that there was some sort of difference, however, many found it different to express. Those that had a clear understanding often wrote the answer 'two different alleles', but others became confused and described different genes/chromosomes/parents, or that it was related to being female, none of which was creditworthy. Just under 20% of students gained this mark.

08.5 Fewer than 10% of students gained full marks in this question, with just over 35% gaining one mark. The question was well attempted, but many student responses were vague and did not quite reach the clarity necessary for credit. The most common reasons given for why Mendel's work had not being recognised was 'he was not believed' and 'not enough evidence'. Quite a few students referred to 'technology having not advanced at the time' which did not answer the question and was too vague for credit. Some pupils referred to scientific terms or discoveries that did not relate to the time period and thus could not be credited. A few said that Mendel was 'only a monk' or 'not a scientist' which earned them the mark. The other bullet points on the mark scheme were seen less frequently.

Answer 25 · Examiner comments

Question 1 (Low demand)

01.1
45% of students knew the definition of a dominant allele.

01.2
Three quarters of students correctly identified 'hh' as the genotype of the white rabbit.

01.3
Three quarters of students successfully identified the correct male gametes and used them to derive the offspring, demonstrating a secure understanding of fundamental genetic principles. A small number of students incorrectly provided diploid or no gametes, preventing them from earning marks for the Punnett Square portion. However, it is worth noting that some of these students were still able to gain marks in subsequent questions, indicating an understanding of other aspects of the problem despite the initial error. Similarly, other students who provided incorrect gametes still managed to pick up some marks elsewhere in their answers.

A common issue observed was students overwriting their letters, making it challenging to distinguish between 'H' and 'h'. For future assessments, students should be advised to clearly cross out any incorrect letters and rewrite their intended answer close to it, to ensure legibility.

01.4
60% of students correctly drew a ring around one homozygous offspring. A little over 10% of students did not attempt this question - even those who gained full marks on **01.3**. Students are reminded to check all question parts, including those without lines or space for an answer. There were a few students who drew a ring around two offspring, and of those that did some drew a ring around both homozygotes, so still gained the mark. A minority were unable to score because they drew a ring around a gamete.

01.5
Only 50% of students were able to identify how many of the offspring would be Himalayan rabbits from their genetic cross. Some students gave '3' as their answer even when this did not match their Punnett Square suggesting they were giving a learnt response rather than one matching their previous answers.

01.6
A pleasing two thirds of students knew that male rabbits have one X chromosome in each body cell.

01.7
Almost three quarters of students correctly predicted the number of female offspring expected - although a range of numbers was seen – including some that were higher than 4. The most common incorrect answers were 1 and 3.