Gametes, Fertilisation and Linkage (Topic 3): Edexcel SNAB A Level Biology Exam Questions by Topic

20 questions · 55 marks · about 66 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · AS Paper 2 · June 2016 · Q1(b)(ii) · 1 mark

(ii) Give a reason for the high density of mitochondria found in the midpiece of a sperm cell.

(1)

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Question 2 · information from earlier in the question

5 Egg cells vary in size between different species of animal.

Egg cells from different animals were measured and some further information about each species was recorded. The data are shown in the table.

Animal	Diameter of egg cell	Mass of adult / kg	Site of fertilisation	Site of offspring development
Domestic cow (mammal)	85 μm	540	inside the body	in the uterus
Human (mammal)	150 μm	62	inside the body	in the uterus
American eel (fish)	1.1 mm	6.8	in the sea	floating in the sea
Hermann's tortoise (reptile)	2.3 cm	3.4	inside the body	inside an egg shell, in a nest
Great spotted kiwi (bird)	7.8 cm	2.3	inside the body	inside an egg shell, in a nest

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Question 2 · AS Paper 2 · June 2016 · Q5(b) · 2 marks

(b) The eel egg cell is larger than the human egg cell, yet an adult eel is smaller than an adult human.

Analyse the data in the table to explain why it is advantageous for the eel to have a larger egg cell.

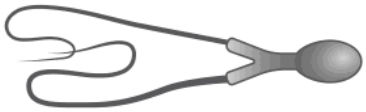
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Question 3 · AS Paper 2 · June 2019 · Q6(a) · 3 marks

6 Teratozoospermia is a condition that causes sperm cells to have an abnormal structure. This condition reduces fertility.

The diagram shows an abnormal sperm cell with two flagella.



(a) Explain why the production of these abnormal sperm cells may reduce fertility.

(3)

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Question 4 · A level Paper 2 · June 2024 · Q6(b) · 3 marks

(b) Explain how a sperm cell is adapted for its role in fertilisation.

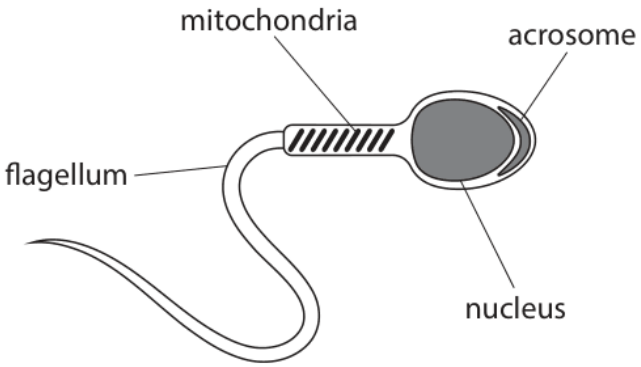
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Question 5 · AS Paper 2 · June 2025 · Q7(a) · 3 marks

7 Sperm cells are gametes produced by animals.

The diagram shows the structure of a sperm cell.



(a) Describe how the structure of the sperm cell allows it to reach the surface membrane of an egg cell.

(3)

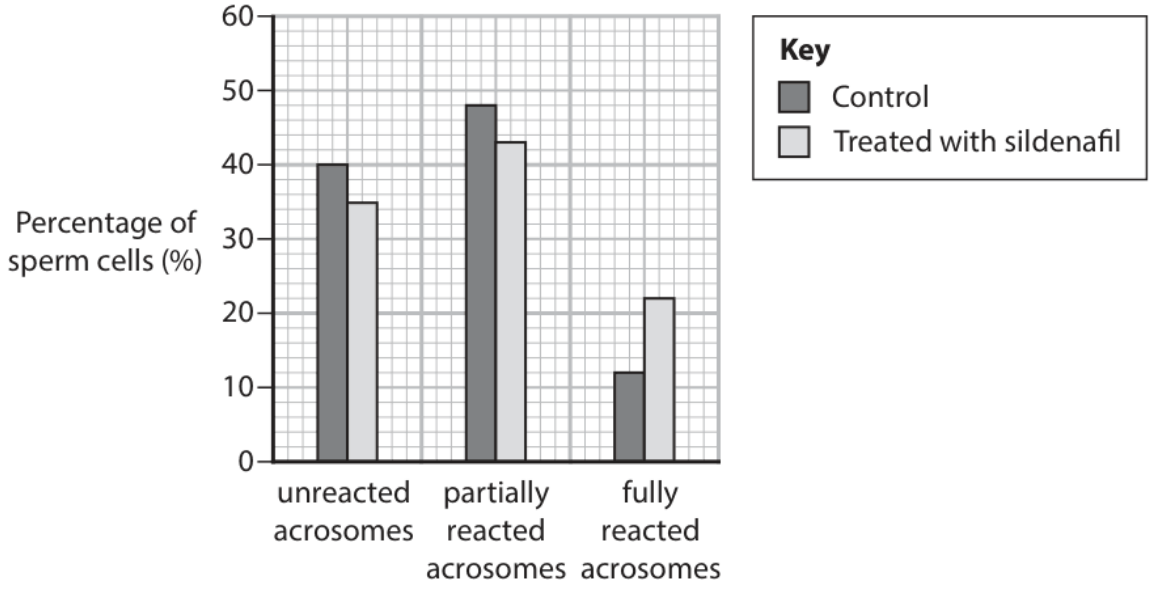
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(b) The effect of the drug sildenafil on sperm cells was investigated.

In one investigation, the state of the acrosome was observed after sperm cells were treated with sildenafil. Unreacted acrosomes had not fused with the sperm cell surface membrane. Partially or fully reacted acrosomes had fused with the sperm cell surface membrane.

The percentage of sperm cells with unreacted, partially reacted and fully reacted acrosomes was calculated. This was compared with sperm cells not treated with sildenafil.

The graph shows the results of this investigation.



Deduce how sildenafil could affect fertility.

(3)

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Question 7 · AS Paper 2 · June 2018 · Q6(a)(ii) · 3 marks

(ii) During fertilisation, only one sperm cell can fertilise an egg cell.

Explain why a second sperm cell cannot fertilise the egg cell.

(3)

Question 8 · AS Paper 2 · June 2023 · Q8(a)(ii) · 4 marks

(ii) Following the fertilisation of an egg cell, the zygote divides to become an embryo.

The embryo develops into a fetus.

Compare and contrast the structure of an unfertilised egg cell with that of a zygote.

(4)

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Question 9 · A level Paper 1 · June 2017 · Q1(b) · 3 marks

(b) Describe the events of fertilisation that occur after the acrosome reaction.

(3)

Question 10 · A level Paper 1 · October 2020 · Q5(a)(i) · 3 marks

5 Reproduction in mammals involves specialised cells called gametes. The production and structure of the gametes can be affected by chemicals in the environment.

(a) (i) A sperm cell contains a specialised lysosome called the acrosome.

Describe the role of the acrosome in fertilisation.

(3)

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Question 11 · A level Paper 1 · June 2022 · Q6(b) · 2 marks

(b) Mitochondrial diseases such as Leigh syndrome are passed on by the mother during fertilisation.

Explain why a fertilised egg cell will contain only maternal mitochondria.

(2)

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7 The photograph shows a stoat, a small mammal living in the UK.



(Source: © Bildagentur Zoonar GmbH/Shutterstock)

Stoats mate once a year and can produce, on average, 12 offspring.

(a) Before fertilisation, the cell membrane of a sperm cell fuses with the egg cell membrane.

(i) Describe the events **after** the fusion of these membranes.

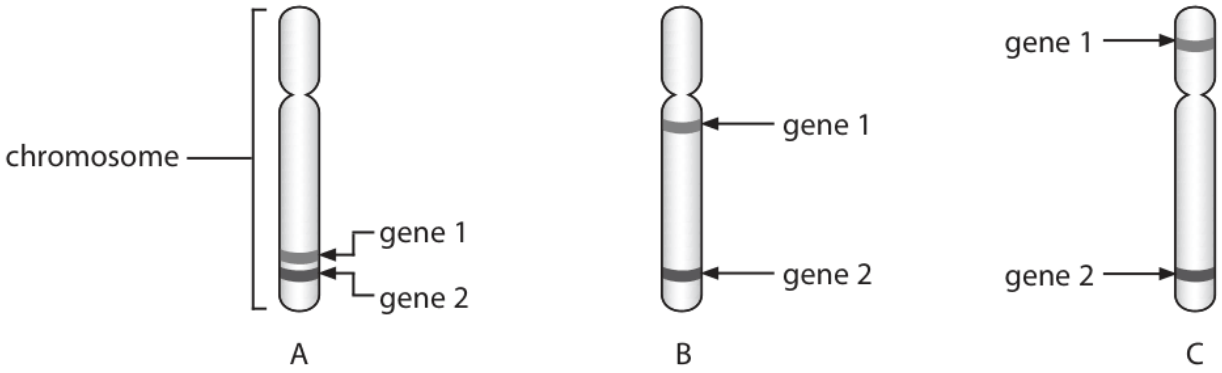
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Question 13 · AS Paper 2 · June 2018 · Q1(a)(i) · 1 mark

1 Linked genes are usually inherited together.

(a) The diagram shows the position of two genes on three chromosomes, A, B and C.



(i) Name the part of a chromosome that is occupied by a gene.

(1)

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Question 14 · AS Paper 2 · June 2018 · Q1(a)(ii) · 3 marks

(ii) Explain which chromosome shows the weakest linkage between genes 1 and 2.

(3)

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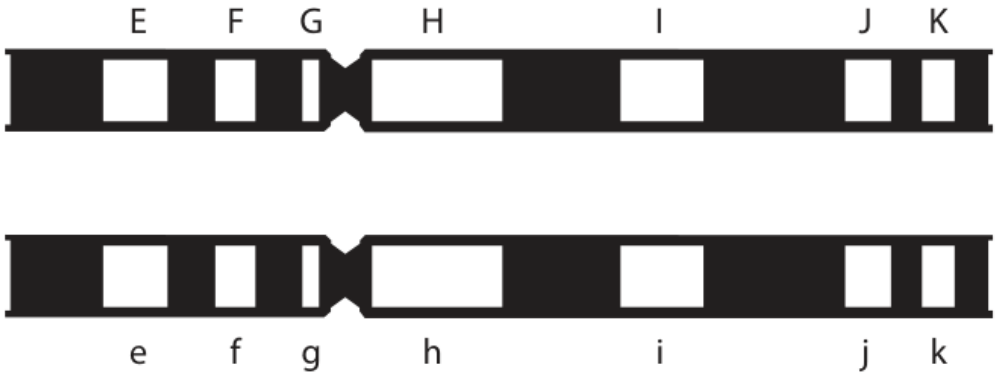
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Questions, mark schemes and examiners' report extracts © Pearson Education Ltd.

Question 15 · information from earlier in the question

8 The diagram shows two homologous chromosomes from a man.



The white regions are the loci of seven genes involved in different phenotypic traits.
The letters E-K and e-k represent the alleles present at each locus.

Questions, mark schemes and examiners' report extracts © Pearson Education Ltd.

Question 15 · AS Paper 2 · June 2016 · Q8(c) · 4 marks

(c) The gametes produced by this man may have different combinations of alleles. Possible combinations of alleles are:

- E and K
- e and K
- h and i
- H and i

Assess the relative chances of this man's gametes containing these combinations of alleles.

(4)

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Question 16 · AS Paper 2 · June 2017 · Q2(b) · 3 marks

(b) Alleles of a gene linked to the development of lupus have been located on the X chromosome.

Scientists tested 13 different alleles of the IRAK1 gene, which is located on the X chromosome. Five of these alleles were associated with lupus.

If these five alleles are recessive, explain how this could affect the ratio of males to females who develop lupus.

(3)

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Question 17 · A level Paper 2 · June 2017 · Q5(a)(ii) · 2 marks

(ii) Explain why genes found on the sex chromosome pair have a pattern of inheritance that is different from genes found on other chromosome pairs.

(2)

Question 18 · A level Paper 2 · November 2021 · Q2(c) · 3 marks

(c) Variation between children and their parents is affected by linkage of genes.

Explain why some genes show linkage and others show sex-linkage.

(3)

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Question 19 · information from earlier in the question

9 It is difficult to tell the sex of young chickens. This can be overcome by breeding programmes that allow the sex of the chicken to determine the visible features.

In birds the sex chromosomes are Z and W. Males are ZZ and females are ZW.

Head colour in chickens is a sex-linked characteristic carried only on the Z chromosome.

The dominant allele gives bar-headed chickens and the recessive allele gives black-headed chickens.



(Source: © Dimarion/Shutterstock)

Bar-headed chicken



(Source: © Muskoka Stock Photos/Shutterstock)

Black-headed chicken

Question 19 · A level Paper 1 · June 2023 · Q9(a)(ii) · 3 marks

(ii) A bar-headed female chicken was crossed with a black-headed male chicken.

Draw a genetic diagram to show the genotypes and phenotypes of the offspring produced by this cross.

(3)

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Question 20 · AS Paper 2 · June 2024 · Q3(b)(i) · 3 marks

(b) The gene for red-green colour deficiency is found on the X chromosome.

The allele for normal colour vision is dominant (B).

(i) Explain the ways that a mother with normal colour vision could have a child with red-green colour deficiency.

(3)

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Mark schemes

Question 1 · AS Paper 2 · June 2016 · Q1(b)(ii) · 1 mark

Question Number	Answer
1(b)(ii)	An answer making reference to the following point: • { energy / ATP } for movement of flagellum (1)

Additional Guidance	Mark
ALLOW (to release) energy for the sperm to swim ALLOW **provide** energy IGNORE 'move' alone NOT **produce** energy NOT energy **for** respiration	(1)

Question 2 · AS Paper 2 · June 2016 · Q5(b) · 2 marks

Question Number	Answer
5(b)	An explanation that makes reference to the following: • a larger egg will contain more lipid droplets (1) • therefore will provide more energy for the development of the embryo (1) • the eel's larger egg is a bigger target for sperm to hit, aiding fertilisation in open water (1)

Additional Guidance	Mark
ALLOW more resources for the embryo ALLOW greater chance of fertilisation	(2)

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Question 3 · AS Paper 2 · June 2019 · Q6(a) · 3 marks

Question Number	Answer
6(a)	An explanation that makes reference to the following: • (presence of two flagella) would affect {motility / ability of sperm to propel itself} (1) • this may prevent sperm from reaching the egg (1) • preventing fertilisation (1)

Additional Guidance	Mark
ALLOW would affect ability of sperm to {swim / move} / affect direction of movement	**(3)**

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Question 4 · A level Paper 2 · June 2024 · Q6(b) · 3 marks

Question Number	Answer
6(b)	An explanation that makes reference to three of the following: • acrosome to release {digestive / hydrolytic} enzymes to {digest / form a channel through / penetrate / break through } the zona (pellucida) (1) • mitochondria { to supply ATP / to carry out aerobic respiration } (1) • flagellum allows movement of sperm towards the egg (cell) (1) • haploid (nucleus) to produce a {2n / diploid} {number of chromosomes / zygote } at fertilisation (1)

Additional Guidance	Mark
ALLOW acrosome contains digestive enzymes to { get through the zona (pellucida) / reach the egg cell membrane } IGNORE to re-establish the {full/correct} complement of chromosomes	3

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Question 5 · AS Paper 2 · June 2025 · Q7(a) · 3 marks

Question number	Answer
7(a)	A description that makes reference to the following: • flagellum moves to propel sperm (1) • mitochondria provide {energy / ATP} for movement (1) • enzymes in acrosome { digest / break down} the zona pellucida (1)

Additional guidance	Mark
ALLOW movement of flagellum allows sperm to swim / motility ALLOW acrosin for the enzyme	(3)

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Question 6 · AS Paper 2 · June 2025 · Q7(b) · 3 marks

Question number	Answer
7(b)	An answer that makes reference to three of the following: • reduces fertility (1) • increases number of (sperm cells with) fully reacted acrosomes (1) • correct use of data from graph (1) • fewer sperm with intact acrosome to allow sperm to break down zona pellucida (1) • no acrosome reaction at ovum surface so { no entry of male nucleus / no fertilisation} (1)

Additional guidance	Mark
e.g. 10% more sperm with reacted acrosome, 5% fewer with intact acrosome	(3)

Question 7 · AS Paper 2 · June 2018 · Q6(a)(ii) · 3 marks

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	An explanation which makes reference to the following: • cortical reaction / fusion of cortical granules with egg cell (surface) membrane (1) • resulting in { thickening / hardening } of the zona pellucida (1) • therefore (other) sperm cells cannot reach egg cell (surface) membrane (1)		(3)

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Question 8 · AS Paper 2 · June 2023 · Q8(a)(ii) · 4 marks

Question Number	Answer
8(a)(ii)	An answer that makes reference to the following: Similarities • both contain a named organelle found in the cytoplasm other than the nucleus (1) • both possess {cell membrane / cytoplasm} (1) Differences • (unfertilised) egg cell has a haploid nucleus whereas the zygote has a diploid nucleus (1) • unfertilised egg cell contains cortical granules and the zygote does not (1)

Additional guidance	Mark
e.g. rER, sER, Golgi apparatus, lysosomes, mitochondria ALLOW 23 chromosomes in egg cell compared to 46 chromosomes in zygote ALLOW idea of cortical granule enzymes not released from the unfertilised egg	(4)

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Question 9 · A level Paper 1 · June 2017 · Q1(b) · 3 marks

Question Number	Answer
1(b)	A description that makes reference to three of the following: • fusion of sperm cell (membrane) with egg cell membrane (1) • cortical granules release contents (into zona pellucida) (1) • contents of cortical granules react with the zona pellucida / zona pellucida { thickens / hardens } (1) • fusion of { sperm and egg / haploid } nuclei (1)

Additional Guidance	Mark
ALLOW sperm cell binds to egg cell membrane	3

Question 10 · A level Paper 1 · October 2020 · Q5(a)(i) · 3 marks

Question Number	Answer
5(a)(i)	A description that makes reference to the following • it fuses with the cell (surface) membrane of the sperm cell (1) • (digestive) enzymes are released (1) • to break down the zona pellucida (1)

Additional guidance	Mark
DO NOT ALLOW lysozyme	(3)

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Question 11 · A level Paper 1 · June 2022 · Q6(b) · 2 marks

Question Number	Answer
6(b)	An explanation that makes reference to the following • only the nucleus of the sperm enters the ovum (1) • (therefore) all the mitochondria come from the egg cell (1)

Additional guidance	Mark
ALLOW during fertilisation only the head of the sperm cell enters the egg ALLOW mitochondria from sperm cell do not enter the egg	(2)

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Question 12 · A level Paper 1 · June 2025 · Q7(a)(i) · 3 marks

Question Number	Answer
7(a)(i)	A description that makes reference to three of the following: • enzymes released by lysosomes (of the egg cell) / cortical granules release contents (1) • cause the zona pellucida to {thicken / harden} (1) • the sperm nucleus enters the {ovum / egg cell} (1) • sperm cell nucleus fuses with egg cell nucleus / the two nuclei fuse (1)

Additional guidance	Mark
ALLOW cortical reaction IGNORE release of cortical granules ALLOW formation of fertilisation membrane ALLOW egg cell nucleus completes meiosis / zygote undergoes mitosis	(3)

Question 13 · AS Paper 2 · June 2018 · Q1(a)(i) · 1 mark

Question Number	Answer	Additional Guidance	Mark
1(a)(i)	• locus (1)	ALLOW loci	**(1)**

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Question 14 · AS Paper 2 · June 2018 · Q1(a)(ii) · 3 marks

Question Number	Answer
1(a)(ii)	An explanation which makes reference to the following: • (diagram / chromosome) C (1) • because the genes are furthest apart (1) • more likely { to be separated during crossing over / chiasmata forming between the two genes } (1)

Additional Guidance	Mark
ALLOW genes are further apart	(3)

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Question 15 · AS Paper 2 · June 2016 · Q8(c) · 4 marks

Question Number	Answer
8(c)	An answer making reference to four of the following points: • combination on same chromosome more likely (1) • but { e+K / H+i } can result from crossing over (1) • H+i are closer together than e+K (1) • greater distance between loci gives greater likelihood of { crossing over / e+K } (1) • the relative chances, from most likely to least likely, are: h+i, E+K, e+K, H+i (1)

Additional Guidance	Mark
ALLOW converse ALLOW E+K / h+i > e+K / H+i	(4)

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Question 16 · AS Paper 2 · June 2017 · Q2(b) · 3 marks

Question Number	Answer
2(b)	An explanation that makes reference to three the following: • males are more likely (to have lupus) **(1)** • (because) females have two X chromosomes and males only one **(1)** • therefore males would only inherit one copy of the gene **(1)** • males only need one recessive allele to have lupus **(1)**

Additional Guidance	Mark
ALLOW converse statements ALLOW males more likely to develop sex linked recessive condition ALLOW females XX and males XY	**(3)**

Question 17 · A level Paper 2 · June 2017 · Q5(a)(ii) · 2 marks

Question number	Answer
5(a)(ii)	An explanation that makes reference to two of the following points: • X chromosome carries { genes / loci } not present on the Y chromosome (1) • males have only one { copy / allele } of some genes (1) • (if only one allele inherited) it will be expressed (1)

Additional guidance	Mark
ALLOW Y chromosome does not carry { a copy /alleles } of some genes	(2)

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Question 18 · A level Paper 2 · November 2021 · Q2(c) · 3 marks

Question Number	Answer
2(c)	An explanation that makes reference to the following: • there are more genes than there are chromosomes (1) • linkage relates to genes (for different characteristics) located on the same (non-sex) chromosome (1) • sex-linkage relates to genes on the {sex / X / Y} chromosome (1)

Additional guidance	Mark
ALLOW many genes on each chromosome	**(3)**

Question 19 · A level Paper 1 · June 2023 · Q9(a)(ii) · 3 marks

Question Number	Answer
9(a)(ii)	An answer that makes reference to the following • diagram shows (female) gametes Z^B and W, (male) gametes Z^b and Z^b (1) • diagram completed to show correct genotypes of offspring (1) • phenotypes (Z^bW) black-headed females and Z^BZ^b) bar-headed males (1)

Additional guidance	Mark
Z^BZ^b and Z^bW	(3)

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Question 20 · AS Paper 2 · June 2024 · Q3(b)(i) · 3 marks

Question number	Answer
3(b)(i)	An explanation that makes reference to three of the following: • mother is {heterozygous / $X^B X^b$} (1) • (to pass on red green colour deficiency) the child must inherit the recessive allele from its mother (1) • if father has {recessive allele / genotype $X^b Y$} can produce a daughter with { red green colour deficiency / genotype $X^b X^b$} (1) • a son (with red green colour deficiency) would have the genotype $X^b Y$ (1)

Additional guidance	Mark
Marks can be awarded from correct genetic cross diagrams ALLOW mother has a dominant allele and a recessive allele/ mother is a carrier	(3)

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