Patterns of Inheritance (6.1.2): OCR A Level Biology Exam Questions by T

19 questions · 47 marks · about 56 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Paper 2 · June 2025 · Q17(a) · 1 mark

17 Animals can undergo natural and artificial cloning.

(a) Human identical twins are an example of natural animal clones.

Suggest why human identical twins do not look exactly identical.

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..... **[1]**

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Question 2 · information from earlier in the question

(b) When conditions are not favourable, *Hydra* reproduces sexually. This often happens in the winter.

Cells in the body wall produce sperms and eggs by meiosis.

Large numbers of sperms are released into the water. These sperms can fertilise eggs from different individuals. Each egg forms a tough outer coat, and can lie dormant at the bottom of the water until conditions improve.

17

(i)* Explain how sexual reproduction in *Hydra* leads to genetic variation in the offspring.

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Additional answer space if required.

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Question 2 · A level Paper 2 · November 2020 · Q19(b)(ii) · 1 mark

(ii) Suggest why sexual reproduction in *Hydra* usually occurs in the winter.

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..... **[1]**

Turn over

Question 3 · A level Paper 3 · June 2018 · Q1(c)(i) · 3 marks

(c) The colour of onion bulbs is determined by two genes, **A/a** and **B/b**.

- **A** is a dominant allele and codes for the production of a red pigment.
- Onion bulbs that are homozygous for the recessive allele, **a**, produce no pigment and are white.
- **B** is a dominant allele that inhibits the expression of allele **A**.
- The recessive allele, **b**, allows the production of the red pigment.

A white onion plant was cross-pollinated with a red onion plant. All 15 offspring had the genotype **AaBb**.

(i) Identify the following:

The genotype of the white onion plant .....

The genotype of the red onion plant .....

The phenotype of the offspring .....

[3]

Question 4 · A level Paper 3 · June 2018 · Q1(c)(ii) · 1 mark

(ii) State the type of gene interaction shown by the genes **A/a** and **B/b**.

..... **[1]**

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(ii) Fig. 4 shows the inheritance pattern of agammaglobulinemia in a family.

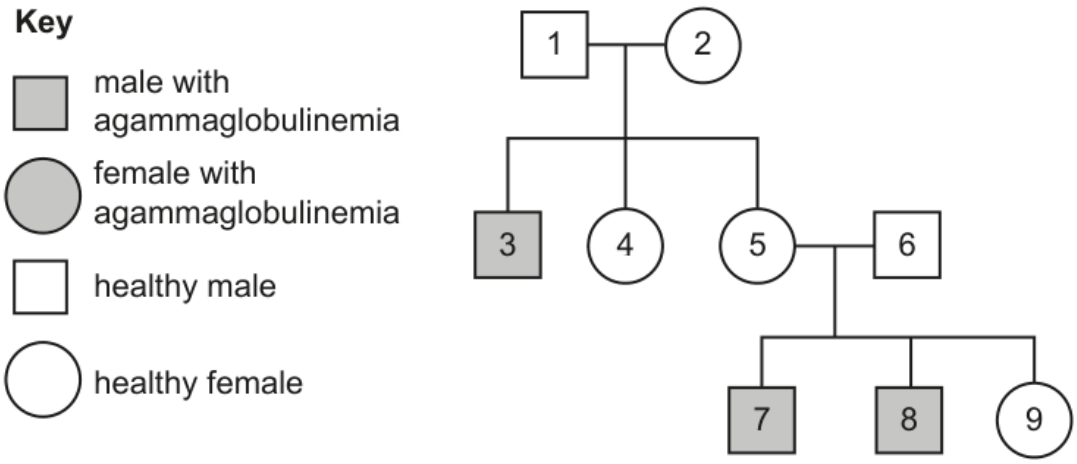


Fig. 4

What conclusions can you draw about the location and nature of the allele responsible for causing agammaglobulinemia? Explain your conclusions.

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..... **[4]**

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Question 6 · information from earlier in the question

19 The inheritance of some alleles depends on the sex of the individual.

(a) In birds, sex is determined by a combination of **Z** and **W** chromosomes.

Male birds have two **Z** chromosomes and female birds have one **Z** chromosome and one **W** chromosome.

(i) The chromosomes used to determine sex inheritance are given different letters in birds and mammals.

Identify one **other** way in which the sex determination in birds is different from sex determination in mammals.

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..... **[1]**

Question 6 · A level Paper 2 · November 2021 · Q19(a)(ii) · 4 marks

(ii) A pigeon is a bird. The colour of pigeon feathers is determined by a single gene on the **Z** chromosome.

The feather colour gene has three alleles.
$\mathbf{Z^A}$ = red
$\mathbf{Z^B}$ = blue
$\mathbf{Z^b}$ = brown

$\mathbf{Z^A}$ is dominant to $\mathbf{Z^B}$ and $\mathbf{Z^b}$
$\mathbf{Z^B}$ is dominant to $\mathbf{Z^b}$

The **W** chromosome contains no gene for feather colour.

A pigeon with the genotype $\mathbf{Z^A\ Z^b}$ was crossed with a pigeon with genotype $\mathbf{Z^BW}$.

Complete the answer lines below to show this genetic cross.

Parent genotypes: $\mathbf{Z^A\ Z^b}$ × $\mathbf{Z^BW}$

Parent phenotypes: ....

Gametes: ....

Offspring genotypes: .....

Offspring phenotypes: .....

.....

[4]

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(c) Two characteristics that farmers have selectively bred in maize are colour and kernel (fruit) shape.

Colour is determined by a gene with two alleles:

- Allele **A** is dominant and results in a purple colour.
- Allele **a** is recessive and results in a yellow colour.

Kernel shape is determined by a gene with two alleles:

- Allele **B** is dominant and results in a smooth shape.
- Allele **b** is recessive and results in a wrinkled shape.

The two genes are found on different chromosomes.

Two maize plants are crossed.

- One parent plant is purple and smooth and heterozygous for both genes.
- One parent plant is yellow and smooth and heterozygous for gene **B/b**.

Complete the answer lines below to show this genetic cross.

Parental genotypes: ..... × .....

Gametes: .....

Expected offspring phenotypes: .....

.....

Expected phenotypic ratio: .....

[4]

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Question 8 · A level Paper 2 · June 2025 · Q20(a)(i) · 3 marks

20 Plants are often used to investigate genetic inheritance.

(a) Genetic crosses are used to investigate the inheritance of two genes at the same time. This is known as dihybrid inheritance.

Gregor Mendel investigated dihybrid inheritance in pea plants. When parent plants that were both heterozygous for two different genes were crossed, the ratio of phenotypes in the offspring was 9 : 3 : 3 : 1.

(i) Sweet pea is another species of plant.

- Sweet pea flower colour is coded for by a gene with two alleles: blue (**B**) and red (**b**).
- Sweet pea pollen shape is coded for by a gene with two alleles: long (**L**) and round (**l**).

When parents that were both heterozygous for the two genes were crossed, the ratio of phenotypes in the offspring was **3** (blue and long) : **1** (red and round).

The inheritance of flower colour and pollen shape in sweet pea is not affected by epistasis.

Explain what can be concluded from the phenotypic ratio **not** being the expected 9 : 3 : 3 : 1 for Mendelian dihybrid inheritance.

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..... **[3]**

Question 9 · A level Paper 2 · June 2025 · Q20(a)(ii) · 2 marks

(ii) Explain why epistasis affects the offspring ratio in a genetic cross.

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..... **[2]**

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Question 10 · A level Paper 3 · June 2023 · Q4(b)(i) · 1 mark

(b) The kakapo, shown in **Fig. 4.3**, is an endangered species of flightless bird that lives in New Zealand. The population size of kakapos has experienced a large decrease over the past few hundred years. There are now fewer than 250 kakapos living in the wild.

Fig. 4.3



(i) State the term for a large decrease in population size that reduces the gene pool.

..... **[1]**

Question 11 · information from earlier in the question

(b) The population of cheetahs has been declining for the past 100 years and is estimated to be between 6000 and 7000.

Within the remaining cheetah population, intraspecific genetic diversity is very low.

One isolated population of cheetahs in Iran has fewer than 100 individuals.

(i) State one way in which genetic diversity can be measured.

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..... **[1]**

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Question 11 · A level Paper 2 · June 2018 · Q20(b)(ii) · 2 marks

(ii) It is thought that the modern cheetah population has low genetic diversity because the population, relatively recently, experienced a genetic bottleneck.

Explain why a genetic bottleneck can lead to low genetic diversity.

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..... **[2]**

Question 12 · A level Paper 2 · June 2018 · Q20(b)(iii) · 2 marks

(iii) Scientists are concerned about genetic drift in the remaining cheetah populations.

Explain why genetic drift is likely to be of particular concern in the population of 100 cheetahs in Iran.

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..... **[2]**

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(c) Madagascar is a large island off the coast of Africa that once formed part of the mainland.

The fossa, *Cryptoprocta ferox* is the top predator on Madagascar.

The fossa shares many physical similarities with cats but it is not a member of the family Felidae. It is related to the mongoose.

The mongoose is a much smaller mammal that lives on the African mainland.

Fig. 20.2 shows a fossa and a mongoose.

fossa



mongoose



Fig. 20.2

(i) The mongoose is a smaller mammal and also has proportionally longer fur. State **one** other difference, **visible in Fig. 20.2**, between a fossa and a mongoose.

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..... **[1]**

Turn over

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Question 13 · A level Paper 2 · June 2018 · Q20(c)(ii) · 4 marks

(ii) When the island of Madagascar became separated from the African continent, there were no members of the cat family, Felidae, on the island.

Outline how a fossa could have evolved from a much smaller, mongoose-like ancestor.

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Question 14 · A level Paper 2 · November 2021 · Q20(b)(ii) · 1 mark

(ii) Suggest how *G. fortis* with large beaks could become reproductively isolated from *G. fortis* with small beaks despite living in the same location.

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..... **[1]**

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Question 15 · information from earlier in the question

(c) Lungs are the specialised gas exchange surfaces in mammals. Dogs are mammals.

A disease called canine pulmonary fibrosis (CPF) can affect lung function in dogs. CPF can reduce the tidal volume of a dog's lungs.

(i) The West Highland Terrier develops CPF more often than other breeds of dog.

The lung function of a West Highland Terrier was tested. At rest, its ventilation rate was $1.44\,dm^3\,min^{-1}$ and its breathing rate was 24 breaths min^{-1}.

Calculate the tidal volume of the West Highland Terrier in cm^3.

Tidal volume = ... cm^3 **[1]**

Question 15 · A level Paper 3 · November 2021 · Q1(c)(ii) · 1 mark

(ii) Explain how the high occurrence of CPF in West Highland Terriers could have been a result of artificial selection.

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..... **[1]**

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Question 16 · A level Paper 2 · June 2018 · Q18 · 6 marks

18* For centuries, artificial selection has been used to improve the quality of crop plants used for human consumption.

Explain, with reference to selective breeding, why it is important to maintain viable wild populations of crop plant species.

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3 Students investigated the effect of light on the growth of garden cress seedlings.

- A total of 120 seedlings were divided into 2 groups of 60.
- Group A was grown in darkness for 2 days.
- Group B was grown for 1 day in darkness and then for 1 day in white light using the set-up shown in Fig. 3.1.

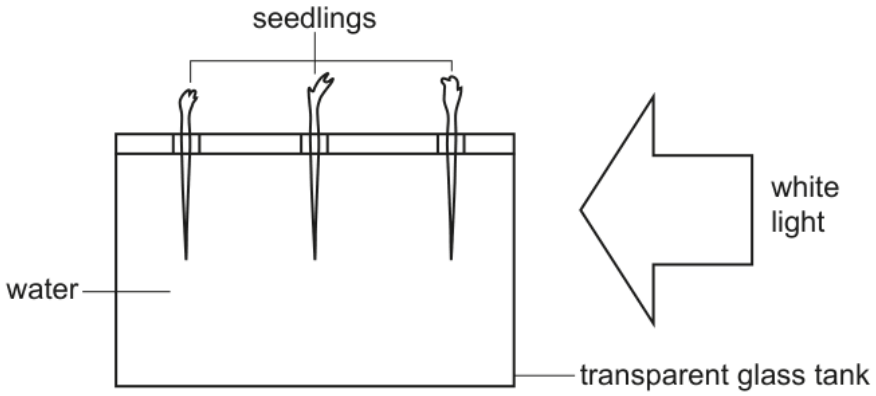


Fig. 3.1

The results of the students' experiment are shown in Tables 3.1 and 3.2.

Group	Mean length (mm)		Mean mass (μg)	
	stem	root	stem	root
A	13	18	102	60
B	25	23	160	120

Table 3.1

	Number of seedlings	
Direction of growth in Group B	**stem**	**root**
Away from light	2	29
Neither away from nor towards light	3	20
Towards light	55	11

Table 3.2

(a) (i)* Describe and explain the results shown in Tables 3.1 and 3.2.

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(iv) Table 3.2 records the direction of growth as:

- away from light
- neither away from nor towards light
- towards light.

The students used the chi-squared test to determine whether the direction of root growth was significantly different from their expectations.

Their null hypothesis was:

There is no difference between the expected direction of root growth and the observed direction of root growth.

The calculated chi-squared value was 8.10.

The students compared their chi-squared value of 8.10 to the values in Table 3.3.

Degrees of freedom	Probability (*p*)		
	0.10	**0.05**	**0.01**
1	2.71	3.84	6.64
2	4.60	5.99	9.21
3	6.25	7.82	11.34
4	7.78	9.49	13.28
5	9.24	11.07	15.09

Table 3.3

11

What can the students conclude about their results based on a chi-squared value of 8.10?

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Question 18 · information from earlier in the question

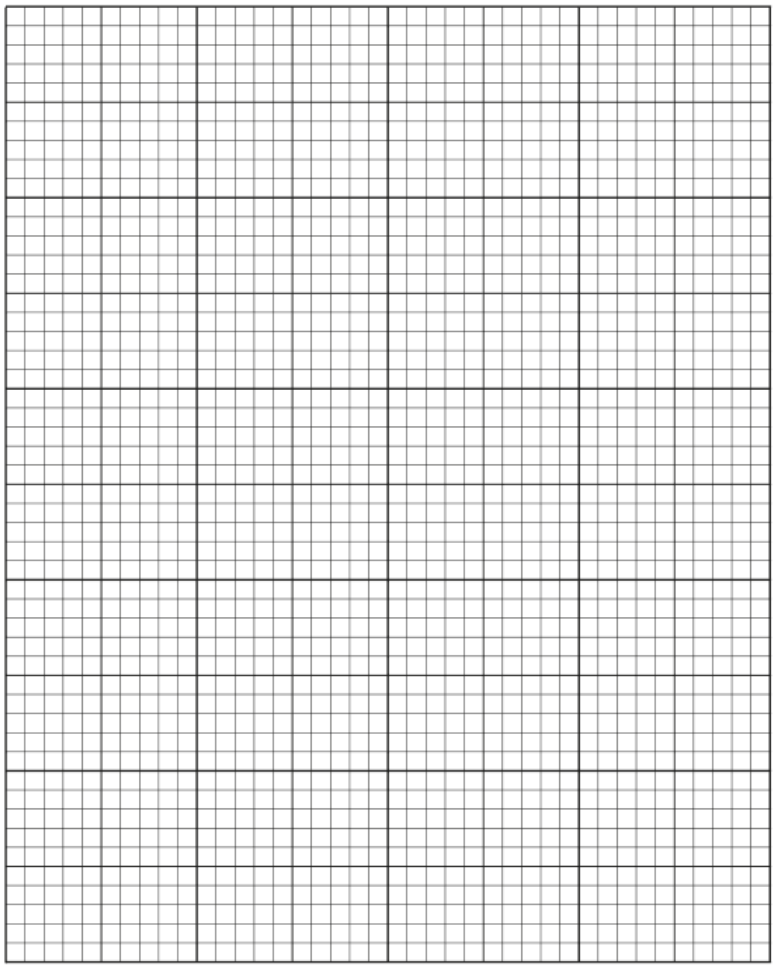
(b) When studying variation, it is sometimes impractical to analyse DNA.

A student was investigating variation between a number of students in their school. They recorded the frequency of students that could and could not roll their tongue.

The results are shown in the table.

Phenotype	Frequency	
	Females	Males
Tongue-rolling	83	88
Non tongue-rolling	43	34

(i) Represent the data in the table as a bar chart on the grid provided below.



[4]

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Question 18 · A level Paper 2 · November 2020 · Q18(b)(ii) · 3 marks

(ii) Since 1940, people have believed that the ability to roll the tongue is caused by a single gene with two alleles.

R is dominant and allows tongue-rolling.

r is recessive and does not allow tongue-rolling.

The genotype of students who can roll their tongue could be either RR or Rr.

In the results shown in the table opposite

- the total number of students who could roll their tongue = **171**
- the total number of students who could not roll their tongue = **77**.

The Hardy–Weinberg principle allows us to estimate the proportion of each genotype.

Use the Hardy–Weinberg principle to estimate the proportion of heterozygous individuals in the school survey in the table.

Use the equations:

$p^2 + 2pq + q^2 = 1$

$p + q = 1$

proportion = ... **[3]**

Questions, mark schemes and examiners' report extracts © OCR.

Question 19 · information from earlier in the question

(b) In pea plants, flower colour is controlled by two alleles: purple (dominant) and white (recessive).

- 600 pea plants are growing in a large greenhouse.
- 564 of the plants have purple flowers.

(i) Use the Hardy–Weinberg principle to calculate the number of heterozygous individuals in the greenhouse.

Use the equations:

$p + q = 1$

$p^2 + 2pq + q^2 = 1$

Number of heterozygous individuals = ... **[3]**

Question 19 · A level Paper 2 · June 2025 · Q20(b)(ii) · 1 mark

(ii) Estimates made by using the Hardy–Weinberg principle can be inaccurate.

Use the information above to suggest **one** reason why the answer calculated in part **(b)(i)** might be **accurate**.

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..... **[1]**

Turn over

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Mark schemes

Question 1 · A level Paper 2 · June 2025 · Q17(a) · 1 mark

17	**(a)**	(appearance affected by) environment ✓	**1**	**2.1**

ALLOW description of any environmental factors, e.g. different diet / sun exposure / epigenetics

IGNORE mutations

Question 2 · A level Paper 2 · November 2020 · Q19(b)(ii) · 1 mark

(ii)	(some offspring) might survive unfavourable conditions ✓ (some) offspring have useful alleles ✓ (named) unfavourable conditions mean (all) offspring might die (if asexual) ✓		
1 max	2.1	**IGNORE** eggs can lie dormant as stated in question **IGNORE** less susceptible to unfavourable conditions	

Question 3 · A level Paper 3 · June 2018 · Q1(c)(i) · 3 marks

c	**i**	aaBB ✓ AAbb ✓ white / no pigment ✓	**3**	**ALLOW** BBaa / aBaB **ALLOW** bbAA /AbAb **DO NOT ALLOW** colourless

Question 4 · A level Paper 3 · June 2018 · Q1(c)(ii) · 1 mark

ii	(dominant) epistasis ✓	**1**	**DO NOT ALLOW** recessive epistasis **DO NOT ALLOW** complementary epistasis **ALLOW** antagonistic epistasis

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Question 5 · A level Paper 3 · June 2018 · Q4(a)(ii) · 4 marks

ii	(allele is) recessive (because) ✓ healthy parents produce children with the disease ✓ 2 / 5 / 2 and 5 / mothers , heterozygous / carrier ✓ (likely to be) sex-linked / described ✓ (because) on the X chromosome / X linked ✓ only males have the disease/no females have the disease/AW ✓	**4 max**

ALLOW '3 has the disease,
but 1and 2 / parents, do not '
ALLOW '7, or / and, 8, has the disease,
but, 5 and 6 /parents, do not'

ALLOW 'allele found on the sex
chromosomes'

Question 6 · A level Paper 2 · November 2021 · Q19(a)(ii) · 4 marks

(ii)	*Parents' phenotype* red male blue female ✓	**4**	2.1
	Gametes Z^A, Z^b Z^B, W ✓		
	Offspring genotypes Z^AZ^B, Z^BZ^b, Z^AW, Z^bW ✓		
	Offspring phenotypes red male, blue male, red female, brown female ✓		

ALLOW ECF if no sexes given for mp1 or mp4 but colours correct

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Question 7 · A level Paper 3 · June 2023 · Q3(c) · 4 marks

3	(c)	(parental genotypes) AaBb and aaBb ✓ (gametes) AB Ab aB ab **and** aB ab ✓ purple & smooth : purple & wrinkled : yellow & smooth : yellow & wrinkled ✓ (ratio =) 3:1:3:1 ✓	4	2.6 2.5

If incorrect symbols used throughout = **max 3**

ALLOW ECF for mp2-4 if incorrect genotypes used

ALLOW mp2 if gamete line is incomplete (e.g. only one parental genotype given - AB, Ab, aB, ab) **but** Punnett square is correct for both sets of gametes

If AA /aa / BB / bb / Aa / Bb given as gametes no further mp's awarded as incorrect biology

	AB	Ab	aB	ab
aB	AaBB purple & smooth	AaBb purple & smooth	aaBB yellow & smooth	aaBb yellow & smooth
ab	AaBb purple & smooth	Aabb purple & wrinkled	aaBb yellow & smooth	aabb yellow & wrinkled

ALLOW mp2 and mp3 from a Punnett square

all four phenotypes should be listed (in any order)

ALLOW ratio of 6:2:6:2

ALLOW phenotypes and ratio in a different order for mp3 and mp4, providing they correctly correspond.

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Question 8 · A level Paper 2 · June 2025 · Q20(a)(i) · 3 marks

20	(a)	(i)	**1** autosomal linkage / (both) genes are on the same chromosome ✓ **2** no independent assortment ✓ **3** short / AW , distance between loci ✓ **4** no crossing over (so no recombinants) ✓ **5** alleles / BL and bl , are inherited together ✓

3 max	**1 x 3.1** **2 x 2.5**	**IGNORE** alleles on same chromosome / alleles linked **ALLOW** genes / loci , are linked **ALLOW** loci close together / genes located close to each other on chromosome **DO NOT ALLOW** crossing over rarely occurs **ALLOW** so, BL and bl, end up in the same gamete **IGNORE** genes inherited together

Question 9 · A level Paper 2 · June 2025 · Q20(a)(ii) · 2 marks

20	(a)	(ii)	gene interaction ✓ phenotype / AW , affected by , more than one gene ✓ (expression / allele of) one gene , affects / masks / prevents , expression of other gene ✓
Question			**Answer**

2 max	**1.2**	**IGNORE** any reference to dominant and recessive **ALLOW** two genes affect the phenotype **IGNORE** references to genes being switched on or off **Note:** The product of one gene masks the expression of another, therefore changing the phenotype = MP2 and MP3
Mark	**AO**	**Guidance**

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Question 10 · A level Paper 3 · June 2023 · Q4(b)(i) · 1 mark

4	**(b)**	**(i)**	(genetic) bottleneck ✓	**1**	1.1	**ALLOW** population bottleneck

Question 11 · A level Paper 2 · June 2018 · Q20(b)(ii) · 2 marks

(ii)	(many) <u>alleles</u> lost (when population dropped) ✓ **ora** (modern population) descended from few survivors / AW ✓	**2**

ALLOW few alleles were left after drop in population

ALLOW cheetahs still alive descended from a small gene pool
IGNORE founder effect unqualified

Question 12 · A level Paper 2 · June 2018 · Q20(b)(iii) · 2 marks

(iii)	*idea that* one individual or allele has proportionally higher effect on small population ✓ (more likely that) <u>alleles</u> will be lost from population ✓ (population) more vulnerable / likely to become extinct due , to environmental change / AW ✓	**2 max**

IGNORE founder effect unqualified

ALLOW example of environmental change
E.g. might become extinct because of (new) disease
IGNORE event

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Question 13 · A level Paper 2 · June 2018 · Q20(c)(ii) · 4 marks

(ii)	1	allopatric speciation ✓	**4 max**
	2	different , selection pressure / environmental conditions (from mainland) ✓	
	3	(random) mutation ✓	
	4	(fossa-like) individuals with , mutation / (new) feature , survive / reproduce ✓ **ora**	
	5	beneficial / AW , <u>alleles</u> passed on ✓	
	6	<u>directional</u> selection ✓	

3 ALLOW pre-existing genetic variation

4 IGNORE best adapted / fittest

Question 14 · A level Paper 2 · November 2021 · Q20(b)(ii) · 1 mark

(ii)	*idea that* individuals choose to mate only with other individuals with similar sized beaks ✓	**1**	1.2

CREDIT sexual selection
ALLOW different , mating seasons / courtship rituals

Question 15 · A level Paper 3 · November 2021 · Q1(c)(ii) · 1 mark

ii	inbreeding / AW, reduces genetic diversity ✓
	(more) homozygous recessive alleles (for CPF) ✓
	idea of allele for CPF linked to gene for desirable trait (so inherited together) ✓

1 max	2.5	**ALLOW** 'inbreeding creates smaller gene pool' **ALLOW** 'more homozygous recessive genotypes (for CPF)' **ALLOW** (leads to) inbreeding depression e.g. 'CPF gene on same chromosome as (named) desirable trait '

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Question 16 · A level Paper 2 · June 2018 · Q18 · 6 marks

18	***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* ○ *award the higher mark where the Communication Statement has been met.* ○ *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.***			
	Level 3 (5–6 marks) Provides a detailed explanation of the benefits to selective breeding of maintaining a viable wild population. *The answer contains well-developed lines of reasoning which are clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is broadly relevant.* **Level 2 (3–4 marks)** Provides an explanation of the benefits to selective breeding of maintaining a viable wild population. *The answer contains some reasoning, structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1–2 marks)** Lists at least one benefit to selective breeding of maintaining a viable wild population. *The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms or substantial irrelevant material.* *0 marks* *No response or no response worthy of credit.*	**6**	1.2	**Indicative points** *These could be described in terms of problems associated with selective breeding and solutions offered by maintaining a wild population* • genetic variation • genetic resource / gene bank • source of useful alleles • can be cross bred with crop varieties • allows introduction of different traits • unknown future requirements • potentially useful in changing climate • prevention of inbreeding depression • promotion of hybrid vigour • prevent dwindling gene pool • source of replacement if cultivated population is in danger • plausible example(s) of any of the above

Question 17 · A level Paper 3 · November 2020 · Q3(a)(iv) · 3 marks

iv	**3 max** 8.10 is greater than 5.99 (at 2 degrees of freedom) ✓ (therefore) significant (difference) at (p =) 0.05 ✓ not significant at (p =)0.01 ✓ (indicates greater than 95% probability that) difference is not due to chance ✓ null hypothesis can be rejected (at p = 0.05) ✓

3.2	**ALLOW ECF for mp2 ,4 and 5 if 9.49 or 11.07 value used from table for max 2 marks** **ALLOW** 'students chi-squared value greater than critical value for 2 degrees of freedom' **ALLOW** 'there is a significant difference between the observed and expected results' **ALLOW** 'less than 5% probability that difference is due to chance'

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Question 18 · A level Paper 2 · November 2020 · Q18(b)(ii) · 3 marks

(ii)	**FIRST CHECK ON ANSWER LINE** **If answer = 0.5 or 0.49 or 0.493 or 0.494 award 3 marks** $q^2 = 77/248 = 0.31$ ✓ $q = \sqrt{0.31} = 0.557$ ✓ $p = 1 - 0.557 = 0.443$ $2pq = 2 \times 0.443 \times 0.557 = 0.494$ ✓	3

2.4	**IGNORE** sig. figs for working marks **If answer incorrect, ALLOW** either half of working equations for 1 mark each up to a maximum of 2. **ALLOW e.g.** '$q^2 = 77/248$' or '$77/248 = 0.31$'

Question 19 · A level Paper 2 · June 2025 · Q20(b)(ii) · 1 mark

Question	Answer	Mark	AO	Guidance
20 (b) (ii)	no , migration / emigration / immigration / gene flow ✓ (600 is a) large population (size) ✓	1	3.2	**ACCEPT** descriptions of migration / gene flow **ALLOW** isolated from other populations / plants in closed environment **IGNORE** no mutations

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