The roles of genes in determining the phenotype

Question Paper 2

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Inherited change
Sub Topic	The roles of genes in determining the phenotype
Booklet	Theory
Paper Type	Question Paper 2

Time Allowed : **68 minutes**

Score : **/ 56**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 In mice, the intensity of pigmentation of the fur is controlled by multiple alleles of a single gene.

The alleles are listed below in order of dominance, with **C** as the most dominant.

- **C** = full colour
- $\mathbf{C^{ch}}$ = chinchilla
- $\mathbf{C^{h}}$ = himalayan
- $\mathbf{C^{p}}$ = platinum
- $\mathbf{C^{a}}$ = albino

(a) Explain how multiple alleles arise.

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(b) Eye colour in mice is controlled by two alleles of a single gene, **B**/**b**:

- allele **B** codes for black eyes
- allele **b** codes for red eyes.

A mouse with full colour fur and black eyes was crossed with a mouse with himalayan fur and black eyes. One of the offspring was albino with red eyes.

Using the symbols above, draw a genetic diagram to show the genotypes and phenotypes of the offspring of this cross.

[6]

2 **(a)** Sometimes a gene has more than two alleles, termed *multiple alleles*.
The ABO blood group system in humans is controlled by a gene with three alleles, I^A, I^B and I^o. Alleles I^A and I^B are codominant and I^o is recessive to both.

The blood group **AB** is the result of codominance.

Explain what is meant by *codominance*.

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(b) In humans, a gene that codes for the production of a protein, called factor VIII, is located on the X chromosome. The dominant allele for this gene produces factor VIII, but the recessive allele does not produce factor VIII.

A person who is unable to make factor VIII has haemophilia in which the blood fails to clot properly.

Explain why a man with haemophilia cannot pass haemophilia to his son but may pass haemophilia to his grandson.

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(c) A gene for feather colour in chickens is carried on an autosome. This gene has two alleles, black (C^B) and splashed-white (C^W). When a male chicken with black feathers is mated with a female chicken with splashed-white feathers, all the offspring have blue feathers. This also occurs when a male chicken with splashed-white feathers is crossed with a female with black feathers.

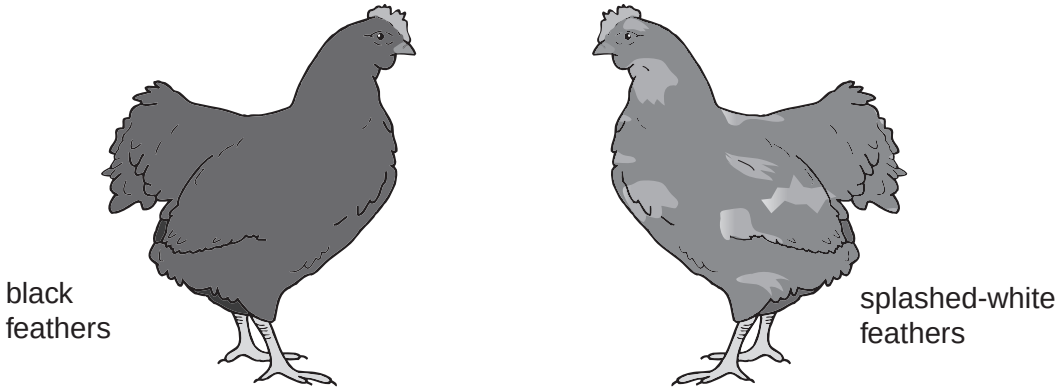

Fig. 7.1

Another gene may cause stripes on feathers (barred feathers). This gene is carried on the X chromosome. The allele for barred feathers (X^A) is dominant to the allele for non-barred feathers (X^a).

In chickens the male is homogametic and has two X chromosomes while the female is heterogametic and has one X chromosome and one Y chromosome.

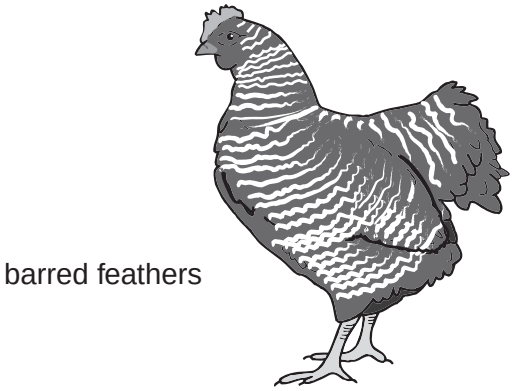

Fig. 7.2

(i) A male chicken with black, non-barred feathers was crossed with a female chicken with splashed-white, barred feathers. All the offspring had blue feathers, but the males were barred and the females were non-barred.

Using the symbols given above draw a genetic diagram to show this cross.

parents' phenotype	male, black, non-barred feathers.	female, splashed-white, barred feathers.
genotype		
gametes		
offspring genotypes		
phenotypes	male, blue, barred feathers.	female, blue, non-barred feathers.

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(ii) Explain how a farmer could use a breeding programme to find out the genotype of a male chicken with blue, barred feathers.

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[Total: 14]

3 **(a)** Describe the role of natural selection in evolution. [8]

(b) Explain, using **named** examples, how mutation can affect phenotype. [7]

[Total: 15]

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4 Coat colour in cats is determined by a sex-linked gene with two alleles, black and orange. When black cats are mated with orange cats, the female offspring are always tortoiseshell, their coats show black and orange patches of various sizes, while the male offspring have the same coat colour as their mothers.

(a) Using the symbols $\mathbf{X^B}$ for black and $\mathbf{X^O}$ for orange, draw genetic diagrams to account for both these crosses.

black female X orange male

orange female X black male

(b) List the genotypes and their phenotypes of the offspring that may result from mating a tortoiseshell female with a black male.

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(c) Suggest an explanation for the tortoiseshell coat in terms of the activity of the X chromosomes.

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[Total: 9]

5 **(a)** Distinguish between phenotype and genotype.

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(b) Describe how artificial selection differs from natural selection.

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(c) Define the terms

(i) *gene;*

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(ii) *allele.*

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[Total : 10]