Past-paper walk-through

Passage of information from parents to offspring ▪ 16.1

eXercise

Questions in this set

- 9700/41 N25 Q1 ▪ 9 marks
- 9700/41 N25 Q4 ▪ 11 marks
- 9700/42 N25 Q5 ▪ 14 marks
- 9700/44 N25 Q2 ▪ 10 marks
- 9700/44 N25 Q5 ▪ 12 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 1

9700/41 N25 ▪ Q1 ▪ 9 marks

1 Guinea pigs, *Cavia porcellus*, vary in the length and colour of their fur.

Fig. 1.1 shows a guinea pig with short black fur.

Fig. 1.1

Question 1

Two genes that determine the length and colour of the fur occur at the **A**/**a** locus and the **B**/**b** locus. These two gene loci are on separate autosomal chromosomes.

- The allele **A** results in short fur.
- The allele **a** results in long fur.
- **A** is dominant to **a**.

- The allele **B** results in black fur.
- The allele **b** results in chocolate fur.
- **B** is dominant to **b**.

(a) **(i)** List **all** the possible genotypes of a guinea pig with short black fur.

Question 1

(ii) A test cross could be used to determine the genotype of a female guinea pig with short black fur.

Describe the **phenotype** of the male guinea pig that could be used to carry out this test cross.

Question 1

(b) A black guinea pig with long fur that was homozygous at both loci was crossed with a chocolate guinea pig with short fur that was homozygous at both loci. The F1 offspring of this cross had short black fur. F1 offspring were mated together to produce the F2 offspring.

Complete the Punnett square to:

- show the cross between the F1 offspring
- predict the F2 offspring genotypes.

You should include the gametes in your answer.

State the ratio of F2 offspring phenotypes. You should include a key to link phenotypes to genotypes.

Question 1

Question 1

ratio of F2 offspring phenotypes:

Question 1

Question 1

[4]

(c) Some genes in guinea pigs are structural genes and some are regulatory genes.

Describe the difference between a structural gene and a regulatory gene.

Question 1

[Total: 9]

Solution 1

(a)(i)

Mark scheme

- AABB AABb AaBB AaBb ; ;
- 2

(a)(ii)

Mark scheme

- long chocolate ;
- 1

Solution 1

(b) Mark scheme

- ;
- AB
- Ab
- aB
- Ab
- AB
- AABB
- AABb

Solution 1

- AaBB
- AaBb
- Ab
- AABb
- AAbb
- AaBb
- Aabb
- aB
- AaBB
- AaBb

Solution 1

- aaBB
- aaBb
- Ab
- AaBb
- Aabb
- aaBb
- aabb ;
- F2 offspring phenotype number ratio:
- 9 : 3 : 3 : 1 ;
- short short long long

Solution 1

- black chocolate black chocolate ;
- Mp 4 need phenotypes linked to genotypes by colour, symbol or initials
- 4

Solution 1

(c) Mark scheme

- 1
- structural gene codes for, (named) structural / functional, protein / polypeptide ;
- 2
- regulatory gene codes for, transcription factor / repressor protein
- or
- regulatory gene, controls / helps / restricts, expression of (other) genes ;
- 2
- A

Solution 1

- b
- A
- B
- a
- B
- a
- b
- A
- b
- A

Solution 1

- B
- a
- B
- a
- b
- 9700/41
- October/November 2025

Question 4

9700/41 N25 ▪ Q4 ▪ 11 marks

4 The wolf, *Canis lupus*, lives in North America. Wolves may have a grey or a black coat colour. The colour of an individual wolf depends on the DNA it inherits at the *CPD103* gene locus.

- Wolves inherit two copies of *CPD103*, one from each parent.
- Wolves that inherit one copy of the black form of the *CPD103* gene have a black coat.

(a) State the term used to describe:

Question 4

Question 4

- a form of a gene that gives a phenotypic

Question 4

[3]

In addition to producing black coat colour, the protein coded for by the *CPD103* gene also defends against infectious lung disease.

Canine distemper virus (CDV) causes serious lung disease in wolves. Wolves that have been previously infected by CDV have antibodies against CDV (anti-CDV antibodies) in their blood.

(b) CDV can be passed from domestic dogs to wolves.

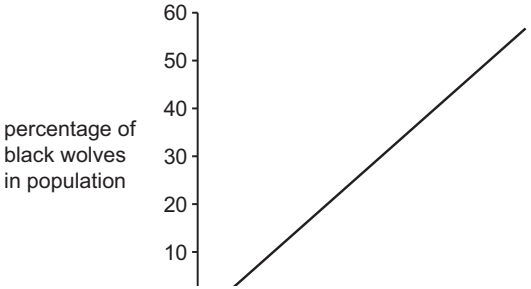
- Domestic dogs are more numerous in the southern part of the area occupied by wolves.
- Domestic dogs are less numerous in the northern part of the area occupied by wolves.
- The relative frequency of black wolves compared to grey wolves increases from the north to the south of the area they occupy.

Explain how natural selection causes this trend in the distribution of black wolves.

Question 4

(c) Several different populations of wolves were compared.

Fig. 4.1 shows the relationship between the percentage of wolves in a population that have anti-CDV antibodies in their blood and the percentage of wolves in that population that are black. The line of best fit was calculated after comparing the different populations of wolves.



Question 4

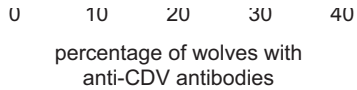


Fig. 4.1

With reference to Fig. 4.1, state the relationship between the percentage of wolves with anti-CDV antibodies and wolf coat colour, **and** suggest reasons for this relationship.

Question 4

[Total: 11]

Solution 4

(a) Mark scheme

- 1
- diploid ;
- 2
- allele ;
- 3
- dominant (allele) ;
- 3

Solution 4

(b) Mark scheme

- any four from:
- 1
- CDV acts as a selection pressure ;
- 2
- DNA / allele, for black (coat) gives resistance to CDV
- or
- DNA / allele, for black (coat), gives (selective) advantage / is selected for, if / when, CDV is common / dogs are

Solution 4

- common ;
- in the south (context must be established at least once):
- 3
- more CDV (infection) in wolves ;
- 4
- black wolves, more likely to survive / have selective advantage / are selected for ; ORA greys
- 5
- black wolves more likely to, breed / reproduce ; ORA greys
- 6

Solution 4

- pass on / increase the frequency of, allele for black coat ; ORA grey
- 4

Solution 4

(c) Mark scheme

- 1
- positive (linear) correlation / positive relationship / direct relationship / directly proportional
- or
- as % with (anti-CDV) antibodies increases the % of black wolvesincreases ;
- plus any three from:
- 2
- wolves that survive CDV will, later / as a result, have antibodies ;

Solution 4

- 3
- high % of antibodies show population with high level of CDV ;
- 4
- in population with high % antibodies, grey wolves have died / more black wolves are left ;
- 5
- gene / DNA / allele / protein, that gives black coat, helps survival / gives resistance to CDV / defends against CDV ;
- 6
- AVP ;
- 4

Solution 4

- 9700/41
- October/November 2025

Question 5

9700/42 N25 ▪ Q5 ▪ 14 marks

Metachromatic leukodystrophy (MLD) is a genetic disease that affects the nervous system.

MLD is caused by mutations in the *ARSA* gene located on chromosome 22. The *ARSA* gene, which is 3150 base pairs (bp) in length, includes 8 exons and is shown in Fig. 5.1.

A genetic test using DNA sequencing is available to identify mutations associated with MLD in the *ARSA* gene. The sequencing method can only work if a DNA fragment size is less than 1000 bp.

The test involves a number of different stages:

Question 5

- Genomic DNA is extracted from a blood sample.
- Polymerase chain reaction (PCR) using 5 pairs of primers selects 5 different DNA fragments of the *ARSA* gene.
- Gel electrophoresis is carried out on the DNA fragments.
- The DNA fragments are sequenced and analysed for mutations.

Table 5.1 shows the length of the DNA fragments and the exons present in each DNA fragment.
Table 5.1

fragment number	DNA fragment length / bp	exons in DNA fragment
1	405	1
2	737	1-2
3	706	2-4
4	860	5-7
5	916	7-8

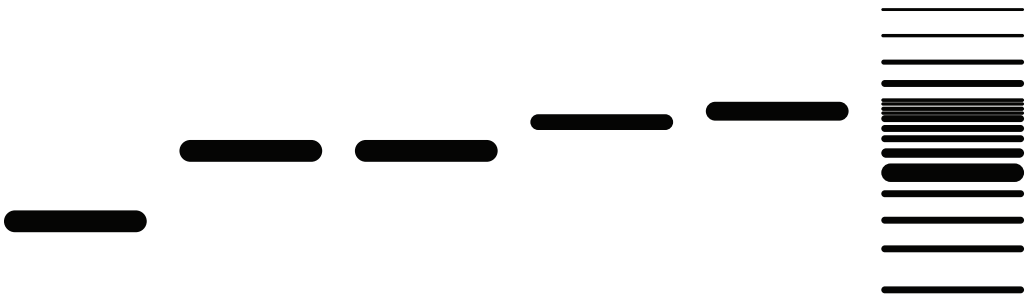
Question 5

(a) Genomic DNA and primers are added to the PCR machine.
Name **two** other substances that are added to the PCR machine, **and** explain why each substance is added. **[4]**

Question 5

fragment number	DNA fragment length / bp	exons in DNA fragment
1	405	1
2	737	1-2
3	706	2-4
4	860	5-7
5	916	7-8

Question 5



Question 5