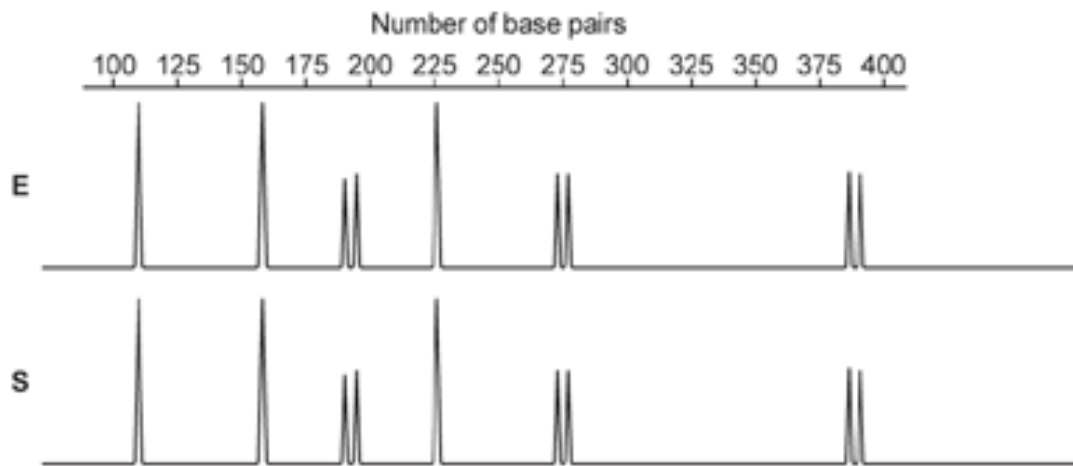


1. DNA profiling is an important technique with many uses.

The steps involved in creating a DNA profile can be outlined as follows:

1. DNA extraction
2. Digestion
3. Separation
4. Analysis

This is part of a DNA profile for six loci from a sample of DNA found at a crime scene (**E**), and DNA from a potential suspect (**S**).



- i. Suggest why some loci have two peaks but some have only one.

[2]

- ii. Using the evidence in the DNA profile it was claimed that suspect **S** had been at the crime scene.

Explain how strongly the evidence supports this claim.

[3]

2. On a biology field trip, some students are studying an area of mixed woodland.

Three tree species dominate the woodland: oak, ash and sycamore.

There are many small herbaceous plants in the woodland, but the students choose to collect data on only one: wood sorrel.

The students choose an oak tree, an ash tree and a sycamore tree and count every individual wood sorrel plant within a 3 m radius of each tree.

The results are shown in the table.

Species	Wood sorrel population (total within 3 m radius)					
Ash	44					
Oak	56					
Sycamore	20					

The null hypothesis of the students' investigation is that the species of tree would not affect the number of wood sorrel growing near it.

The students conclude that the conditions under oak trees are the most favourable of the three trees studied and that conditions under sycamore trees are the least favourable.

- i. Calculate the χ^2 value for the students' data.

Use the equation $\chi^2 = \sum \frac{(O - E)^2}{E}$

You may use the empty columns in the table to help with your calculation.

$\chi^2 = \dots\dots\dots$ [3]

- ii. The critical value for χ^2 in this investigation at $p = 0.05$ is 5.991.

Discuss what can be concluded from the χ^2 calculation in part (i).

[3]

- iii. The teacher suggested that, in order to have confidence in their results, the students should include data from more than one tree for each species.

The students collect all their results on the same day.

Identify **two** other variables the students should attempt to control when carrying out an investigation such as this.

1

2

[2]

3. Variation can be under genetic control.

Which statement about the genetic control of variation **cannot** be true for discontinuous variation?

- A** Variation is controlled by a single gene with multiple alleles.
- B** Variation is controlled by an epistatic interaction between two genes with multiple alleles.
- C** Variation is controlled by many genes on different chromosomes.
- D** Variation is controlled by two genes on the same chromosome.

Your answer

☐

[1]

4. During meiosis, the independent assortment of chromosomes leads to the formation of genetically different gametes.

Gametes of the western clawed frog contain 10 chromosomes.

Calculate the number of genetically different gametes resulting from the independent assortment of chromosomes that would be produced by an individual frog.

Number of different gametes = **[2]**

5(a). Humans have been selectively breeding maize as a crop plant for thousands of years, which has resulted in many different varieties of maize.

Different varieties of maize have different genomes.

Describe how bioinformatics and computational biology can be used to compare the genomes of different varieties of maize.

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

(b).

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: _____ x _____

Gametes: _____

Expected offspring phenotypes: _____

Expected phenotypic ratio: _____ **[4]**

6. The modern pedigree dog breeds have been produced by many years of selective breeding.

Which option does **not** explain why genetic disorders are common in pedigree dogs?

- A** Characteristics that are desirable to humans can be associated with features that are harmful to dogs.
- B** Selective breeding increases the chance of an individual being homozygous for certain characteristics.
- C** Selective breeding increases the chance of mutations.
- D** Selective breeding is associated with inbreeding depression.

Your answer ☐

[1]

7. What step could be taken to reduce the occurrence of genetic disorders in pedigree dogs?

- A Breeding only with individuals that meet the official breed descriptions.
- B Broadening the official descriptions of pedigree dog breeds.
- C Increased use of somatic gene therapy.
- D Regular cross-breeding with the wild ancestor of domestic dogs.

Your answer

☐

[1]

8. Scientists crossed two plants that were heterozygous for two different genes. Both plants had the same genotype, AaBb.

The genotypes and ratios of the offspring resulting from this cross were:

AABB		AaBb		aabb
1	:	2	:	1

Which option could explain these observations?

- A Autosomal linkage
- B Crossing over
- C Epistasis
- D Mutation

Your answer

☐

[1]

9. The Hardy-Weinberg principle can be used to calculate allele and genotype frequencies in populations.

The common morning glory plant, *Ipomoea purpurea*, has a range of flower colours.

Two colours, purple and pink, are determined by a single gene.

The allele, **F**, coding for purple flowers is dominant to the allele, **f**, coding for pink flowers.

A field contained 600 *I. purpurea* plants, 150 of which had pink flowers.

Using the Hardy-Weinberg principle, calculate the number of plants that had a homozygous dominant (FF) genotype.

Use the equations:

$$p + q = 1$$

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

Number of plants with genotype FF = [2]

10. Body plan is important in multicellular organisms.

Complete the following sentences about control of body plan using the most appropriate terms.

Body plan is under genetic and control. Internal and external..... can influence the expression of genes that regulate the cell cycle. Such genes can promote or inhibit programmed cell death, known as During programmed cell death digest the cell contents and the products are removed by so that they do not damage the surrounding tissues.

[5]

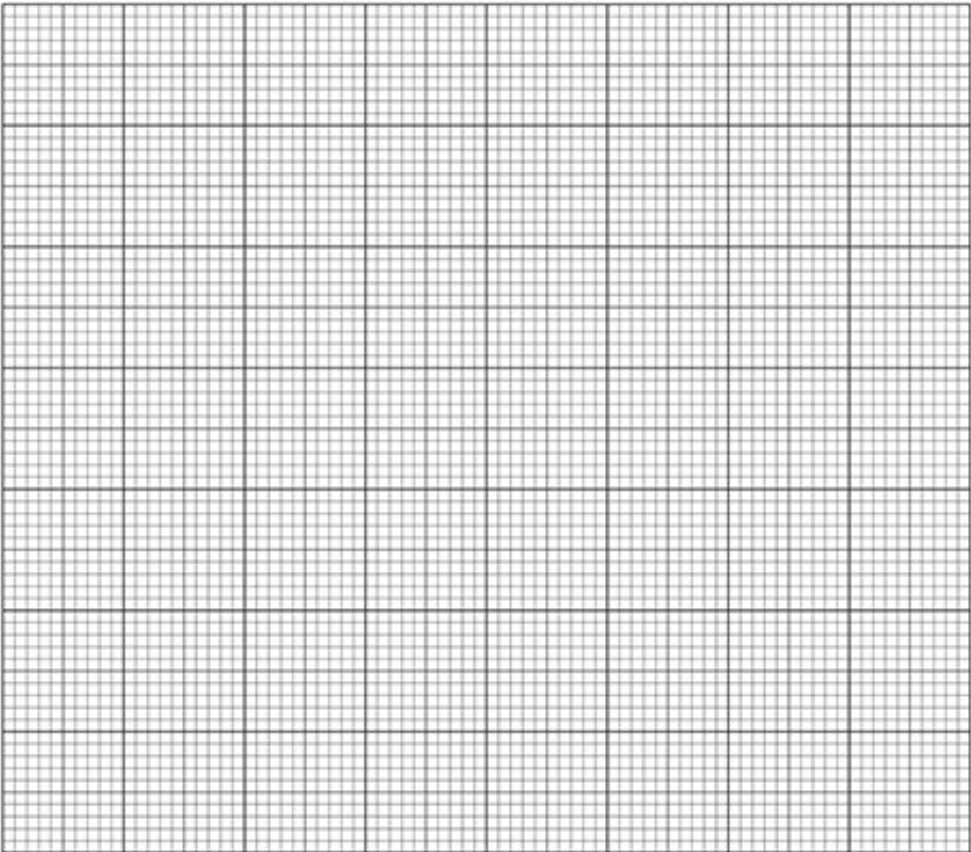
11. The Atlantic cod, *Gadus morhua*, is a large fish that is often eaten by humans.

The body length of Atlantic cod varies between individuals.

The table below shows some data on the size of cod caught in one area of the Atlantic Ocean during one survey.

Body length (mm)	Frequency
$100 \leq x < 200$	10
$200 \leq x < 300$	48
$300 \leq x < 400$	121
$400 \leq x < 500$	130
$500 \leq x < 600$	119
$600 \leq x < 800$	46

- i. In the space provided, plot the results from the table as a suitable graph.



[5]

- ii. Variation can be caused by genetic and environmental factors.

Explain why your graph shows that at least some of the variation in body length in Atlantic cod is caused by environmental factors.

[2]

END OF QUESTION PAPER