

10.2 Inheritance

Question Paper

Course	DP IB Biology
Section	10. Genetics & Evolution (HL Only)
Topic	10.2 Inheritance
Difficulty	Hard

Time allowed: 70
Score: /55
Percentage: /100

Question 1a

a)

An investigation on fruit flies, *Drosophila melanogaster*, was carried out to determine the relationship between body colour and wing length.

Scientists found the genes controlling these characteristics are inherited on different autosomal chromosomes. Fruit flies are either black or grey and have either long or short wings.

A homozygous fruit fly with a black body and long wings was crossed with a homozygous grey fruit fly with short wings. All of the offspring produced had black bodies with long wings.

Using this information and a genetic diagram, show how these offspring were produced. Use **B/b** and **L/l** to represent the alleles.

[3 marks]

[3 marks]

Question 1b

b)

The offspring from part (a) were crossed with grey bodied fruit flies with short wings. Use a genetic diagram to show the expected ratios of the phenotypes expected from this cross.

[3 marks]

[3 marks]

Question 1c

c)

The scientists determined the offspring phenotypes from the cross in part (b) and the data collected is shown in the table below:

Phenotype	Observed Numbers	Expected Numbers
Black body and long wings	83	
Grey body and long wings	78	
Black body and short wings	85	
Grey body and short wings	74	

Complete the table to show the expected number of offspring for each phenotype.

[1 mark]**[1 mark]****Question 1d**

d)

The scientists claimed that independent segregation had taken place. The chi-squared test can be used to determine the significance of the data. The critical value for this data is 7.82.

The formula below can be used to determine the value of chi-squared.

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

i)

Calculate the value of chi-squared (χ^2), using the above formula.

[2 marks]

ii)

Comment on the scientists claims, using the chi-squared value calculated at part (d)(i).

[3 marks]**[5 marks]**

Question 2a

a)

When investigating variation scientists often study sets of twins, both identical and non-identical.

Suggest the advantages of studying twins when investigating variation.

[3 marks]

[3 marks]

Question 2b

b)

A scientific study in 2013 investigated whether academic achievement was influenced by genetics or the environment.

11,117 pairs of twins participated in the study, which found that around 55% of the outcomes in core GCSE subjects (English, maths, and science) were explained by genetic influence, 25% by shared environmental influences, such as parental support, and the remaining 20% by environmental influences that were not shared between the two twins, such as teacher quality and class grouping.

Using this information, evaluate the statement "intelligence is caused by genetics".

[3 marks]

[3 marks]

Question 2c

c)

Twin studies tend to be run using two main assumptions:

- That the identical twins in the study share 100% of their DNA
- That all twins are raised in exactly equal environments at home

Suggest whether it is correct to make these assumptions about twin studies.

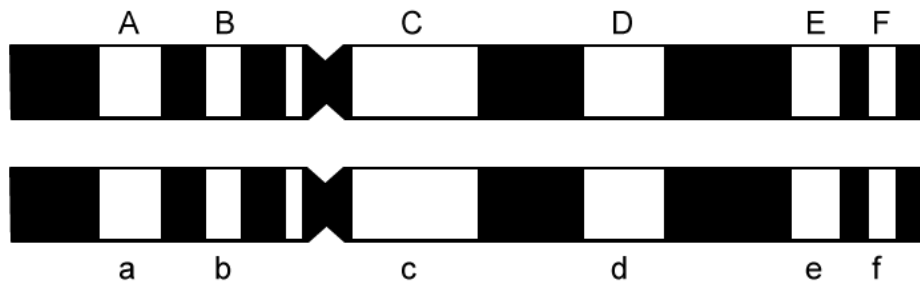
[2 marks]

[2 marks]

Question 3a

a)

The diagram below shows two homologous chromosomes of the fruit fly *Drosophila melanogaster*.



The white regions are the loci of seven genes involved in different phenotypic traits.

The letters A-F and a-f represent the alleles present at each locus.

Discuss the relative chances of this fly's gametes containing these combinations of alleles:

- A and F
- A and f
- c and d
- c and D

[4 marks]

[4 marks]

Question 3b

b)

In a potential scenario where crossing over does not occur between the two genes, the fly in part (a) reproduces with another fly who is homozygous for the dominant A and B alleles.

Predict the genotypes of the offspring, with relation to these two genes.

[2 marks]

[2 marks]

Question 3c

c)

Drosophila melanogaster is a useful organism to use in studies on inheritance patterns. Female fruit flies can lay up to 400 eggs, developing into adults between 7 and 14 days. They have simple nutrient requirements.

Using the information provided, explain **two** reasons why *Drosophila melanogaster* is a useful organism to use in studies of inheritance patterns.

[2 marks]

[2 marks]

Question 4a

a)

Mendel studied many characteristics of pea plants during his time investigating inheritance. Two such characteristics were seed colour and flower colour. Seed colour can either be yellow, encoded by the dominant allele Y , or green encoded by the recessive allele y . Flower colour can either be purple, encoded by the dominant allele P , or white encoded by the recessive allele p .

A student is unsure whether the two genes are linked. In order to try and work it out they decided to do some breeding experiments.

Outline a method they could use to determine whether the two genes are linked.

[6 marks]

[6 marks]

Question 4b

b)

As part of this process, the student bred together two plants that were heterozygous for both traits.

Draw a genetic diagram of the the expected results from this cross, using the correct notation as if the two genes are located on the same chromosome.

[3 marks]

[3 marks]

Question 4c

c)

On the genetic diagram you produced in part (b), highlight all the recombinants.

[1 mark]

[1 mark]

Question 4d

d)

Upon further research, the student found that the two genes are located on the same chromosome, chromosome one of the pea plant.

When Mendel was researching these traits he found that all of his crosses produced a 9:3:3:1 ratio of phenotypes, and there was no evidence of any 'non-Mendelian' inheritance ratios.

Suggest a possible reason for this.

[2 marks]

[2 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

a)

When looking at buildings built over 100 years ago it is often a notable feature that the door frames are a lot shorter than modern day doors.

A student observed this and made the conclusion that humans must have evolved to become taller over the years since the door frames were built.

Suggest some reasons explaining why the student is most likely incorrect with their conclusion.

[4 marks]

[4 marks]**Question 5b**

b)

Describe how Morgan and his associates were able to produce a genetic map of a chromosome using breeding experiments in *Drosophila*.

[4 marks]**[4 marks]**

Question 5c

c)

Pollen from a pure-bred tomato plant with white flowers and yellow fruit was transferred to the stigmas of a pure-bred plant with yellow flowers and red fruit. All the F_1 generation had yellow flowers and red fruit.

Pollen from the F_1 generation was transferred to pure-bred plants with white flowers and yellow fruit. The ratio of phenotypes expected among the offspring of a dihybrid test cross such as this is 1:1:1:1.

Seeds from the plants were collected and grown, giving plants with the following phenotypes:

- Yellow flowers and red fruit: 59
- Yellow flowers and yellow fruit: 56
- White flowers and red fruit: 40
- White flowers and yellow fruit: 45
- Total number of plants in the four categories: 200

A chi-squared (χ^2) test can be carried out to check whether the numbers of each phenotype of offspring resulting from the test cross are in agreement with a 1:1:1:1 ratio.

The chi-squared (χ^2) equation and distribution is as follows:

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

Degrees of freedom	Probability (p)				
	0.10	0.05	0.02	0.01	0.001
1	2.71	3.84	5.41	6.64	10.83
2	4.61	5.99	7.82	9.21	13.82
3	6.25	7.82	9.84	11.35	16.27
4	7.78	9.49	11.67	13.28	18.47

Use this information to produce a statistical conclusion about the difference between the expected and actual results in the tomato breeding experiment.

You must show your working in your answer.

[7 marks]

[7 marks]

