10.1 Meiosis

Question Paper

Course	DP IB Biology
Section	10. Genetics & Evolution (HL Only)
Topic	10.1 Meiosis
Difficulty	Hard

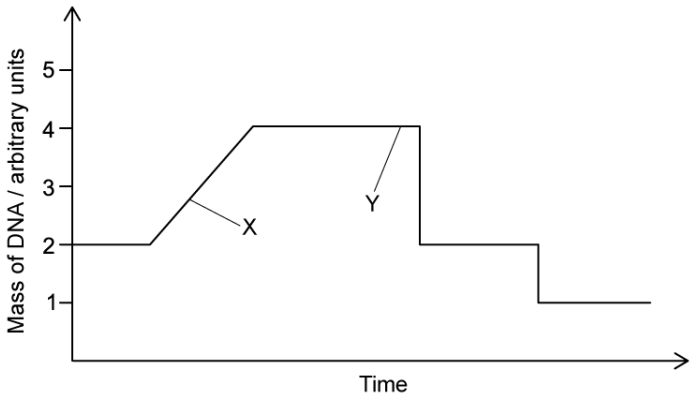
Time allowed: 70

Score: /55

Percentage: /100

Question 1a

a)
The graph below shows changes in the mass of DNA over the course of a cell cycle.



Explain the role of the process, represented by this graph, in living organisms.

[3 marks]

[3 marks]

Question 1b

b)
Annotate the graph in part a) to show the approximate points at which the following events are taking place:

i)
G2

[1 mark]

ii)
Cytokinesis I

[1 mark]

iii)
Metaphase II

[1 mark]

[3 marks]

Question 1c

c)
Variation is introduced at the points labelled **X** and **Y** in the graph in part a).

Identify processes that could introduce variation at points **X** and **Y**.

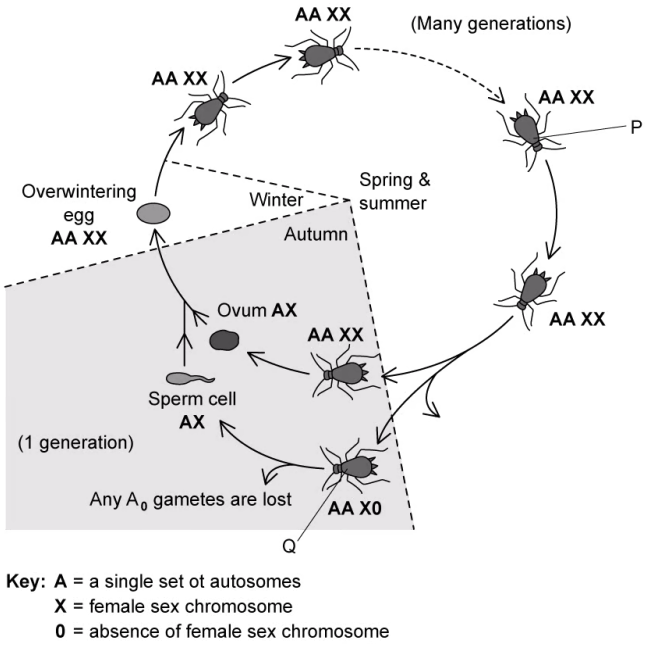
[2 marks]

[2 marks]

Question 2a

a)

The diagram below illustrates the life cycle of the pea aphid, *Acyrthosiphon pisum*. Note that the term **autosome** refers to any chromosome that is not a sex chromosome.



Identify the biological sex of the individuals labelled **P** and **Q**.

[1 mark]

[1 mark]

Question 2b

b)

The diagram in part a) shows that aphids use a different type of reproduction in the spring and summer to the type used in the autumn.

i)

Identify the type of reproduction used by aphids in the spring and summer, and in the autumn.

[1 mark]

ii)

Explain your answer to part i).

[2 marks]

iii)

Suggest the advantage to the aphids of switching their method of reproduction in the autumn.

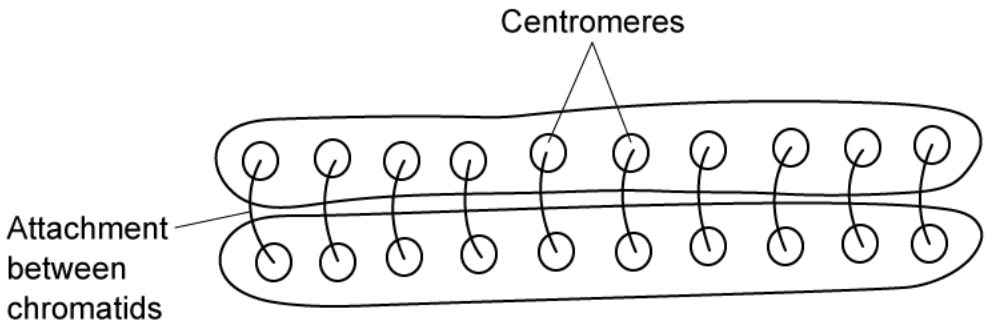
[1 mark]

[4 marks]

Question 2c

c)

Most eukaryotic chromosomes are described as being monocentric. Aphids have unusual chromosomes known as **holocentric** chromosomes. A holocentric chromosome after DNA replication is shown in the diagram below.



Contrast holocentric chromosomes with normal monocentric chromosomes.

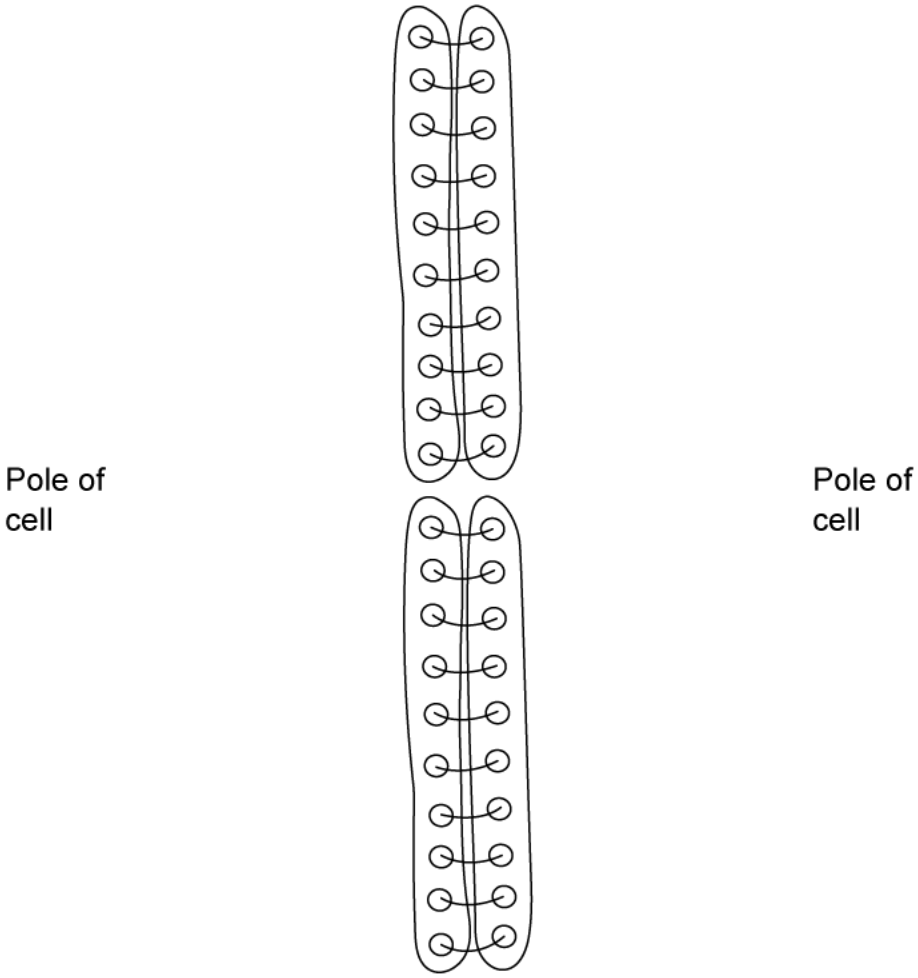
[2 marks]

[2 marks]

Question 2d

d)

While scientific understanding of aphid meiosis is still limited, the holocentric nature of their chromosomes means that aphids are thought to carry out a form of meiosis known as inverted meiosis. The possible behaviour of a homologous pair of aphid chromosomes during metaphase I is shown in the diagram below.



Suggest, with reasons, **two** ways in which meiosis in aphids could be different to conventional meiosis.

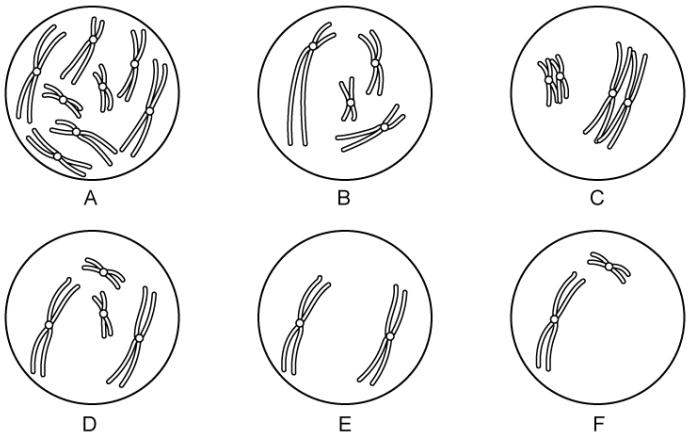
[4 marks]

[4 marks]

Question 3a

a)
The spider mite *Eutetranychus africanus* has very few chromosomes (2n = 4).

The diagram below shows a series of cells undergoing cell division.



Identify, with reasons, which of the cells in the diagram above belong to *E. africanus*.

[3 marks]

[3 marks]

Question 3b

b)
A sample of cells was taken from the reproductive organs of *E. africanus* and the mass of DNA in each cell was determined. Some of the cells' DNA had a mass of 1.7 arbitrary units (a.u.) whilst other cells' DNA had a mass of 3.4 or 6.8 a.u..

Use your knowledge of the cell cycle to explain this observation.

[3 marks]

[3 marks]

Question 3c

c)
A species of false spider mite, *Brevipalpus phoenicis*, is the only animal to have so far been identified as having exclusively haploid cells throughout its life cycle. *B. phoenicis* populations are entirely female, producing eggs which hatch into more females.

The discovery of the haploid nature of *B. phoenicis* was a surprise to scientists, who believed that being diploid was essential due to the evolutionary advantage that it provides.

i)
Identify the type of cell division by which *B. pheonicis* produces eggs.

[1 mark]

ii)
Suggest why scientists might think that diploidy provides an evolutionary advantage.

[1 mark]

iii)
B. phoenicis is a highly successful pest of citrus, tea, and palm plantations. Suggest how *B. phoenicis* might have evolved to become such a successful pest despite the points covered in parts i) and ii) above.

[1 mark]

[3 marks]

Question 3d

d)
While studying the cells of *B. phoenicis* scientists discovered that the cells of all individuals contained bacteria. Treatment with antibiotics caused female *B. phoenicis* to lay eggs that hatched into haploid males.

i)
Suggest the experimental measure that the scientists would need to take in order to demonstrate that the link between antibiotic treatment and male egg development is causal.

[1 mark]

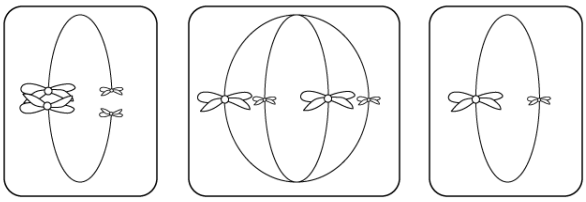
ii)
Suggest why treatment with antibiotics might have enabled the production of male offspring.

[2 marks]

[3 marks]

Question 4a

a)
The diagram below shows three cells in different stages of cell division. Note that all of the cells shown have the same 2n chromosome number.



Identify the cell(s) in the diagram above that show the following:

i)
Homologous chromosomes

[1 mark]

ii)
Meiosis

[1 mark]

iii)
Reduction division

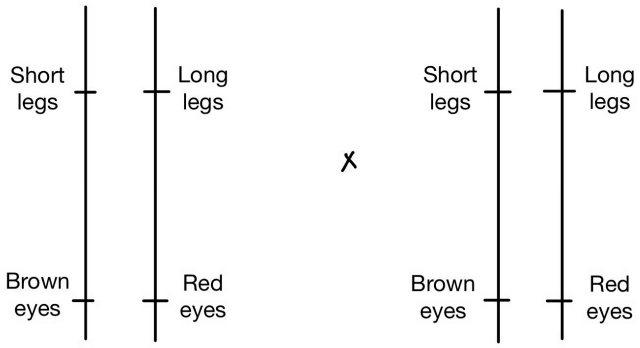
[1 mark]

[3 marks]

Question 4b

b)

Fruit flies, *Drosophila melanogaster*, are frequently used in scientific studies. The diagram below shows the gene loci and alleles of two genes on a pair of chromosomes in a male and female *D. melanogaster* individual. Note that the dominant alleles are long legs and red eyes.



A cross was carried out between the two individuals shown above. The table below shows the number of offspring with short/long legs and brown/red eyes produced from the cross.

Characteristics	Number of offspring
Short legs and brown eyes	545
Long legs and red eyes	182
Short legs and red eyes	14
Long legs and brown eyes	12

Calculate the offspring ratios for the cross shown. Give your answers to the nearest whole number.

[2 marks]

Question 4c

c)

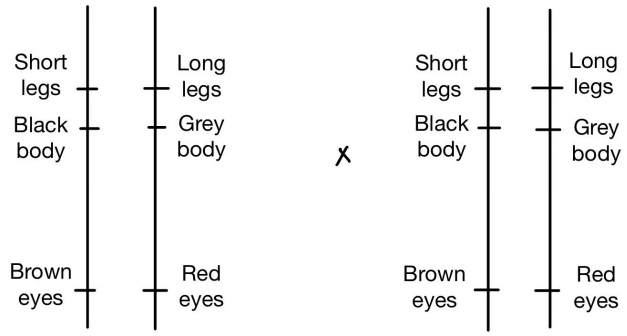
Explain the offspring ratios shown in part b).

[3 marks]

[3 marks]

Question 4d

d)
The diagram below shows the gene loci and alleles for a third gene on the chromosomes of the individuals in part b). Note that the grey body allele is dominant to the black body allele.



Suggest, with a reason, how the numbers of offspring with short/long legs and black/grey bodies would differ from the numbers with short/long legs and brown/red eyes shown in part b).

[2 marks]

[2 marks]

Question 5a

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

a)
Compare and contrast meiosis I and meiosis II.

[8 marks]

[8 marks]

Question 5b

b)
Use named examples to describe the roles of mitosis and meiosis in living organisms.

[6 marks]

[6 marks]