3.2 Meiosis

Question Paper

Course	DP IB Biology
Section	3. Genetics
Topic	3.2 Meiosis
Difficulty	Hard

Time allowed: 70

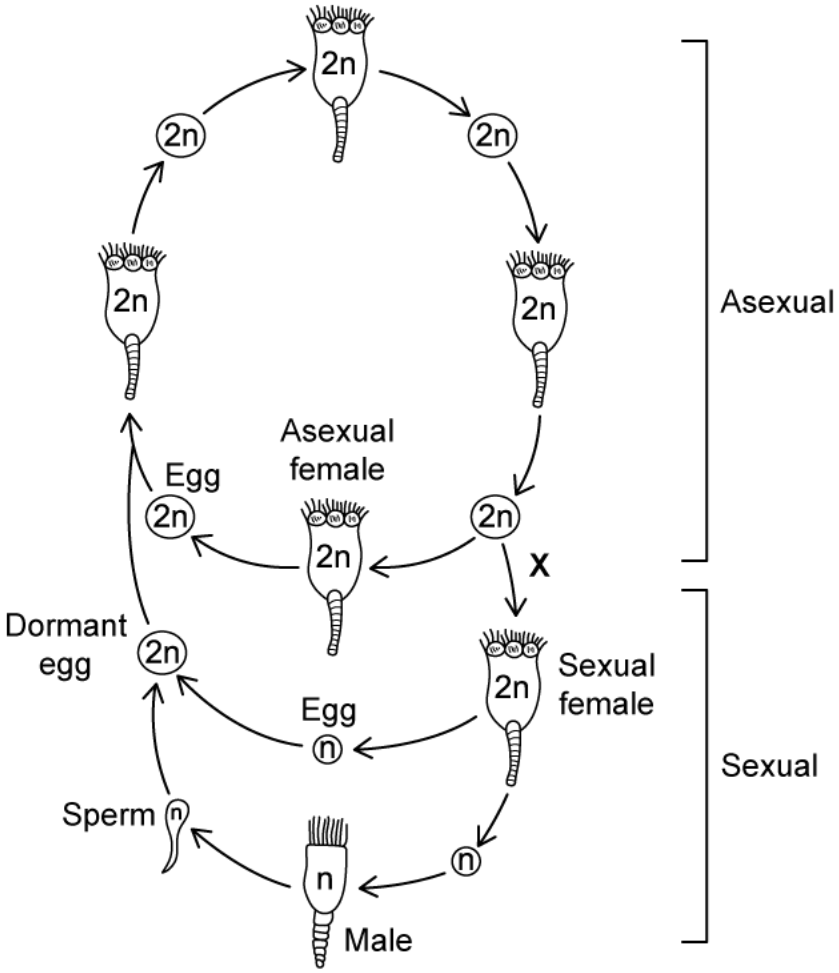
Score: /54

Percentage: /100

Question 1a

a)

Rotifers are multicellular, aquatic animals that range in size from 50 μm to 3 mm. Their reproduction can be either asexual, resulting in the production of genetically identical females, or sexual, resulting in the production of eggs that can remain dormant for many years. A representation of a rotifer life cycle is shown in the diagram below.



Annotate the diagram as follows:

i)

Use the letter **A** to indicate **one** location within the **asexual** phase where mitosis is occurring.

[1 mark]

ii)

Use the letter **B** to indicate **one** location within the **sexual** phase where mitosis is occurring.

[1 mark]

iii)

Use the letter **C** to indicate **two** locations where meiosis is occurring.

[1 mark]

iv)

Use the letter **D** to indicate **one** location where fertilisation is occurring.

[1 mark]

[4 marks]

Question 1b

b)
Explain why meiosis is essential for sexual reproduction.

[2 marks]

[2 marks]

Question 1c

c)
Rotifers mainly reproduce asexually, switching to sexual reproduction for brief periods. The **X** in the diagram in part a) indicates the occurrence of a stimulus that shifts the rotifers from asexual to sexual reproduction. This stimulus could be a change in the environmental conditions, such as a drought that reduces the size of their habitat.

Use the information provided here and in part a) to explain why it is advantageous to rotifers to switch to sexual reproduction when environmental conditions change.

[3 marks]

[3 marks]

Question 1d

d)
Rotifers can be observed using an optical microscope.

Explain why this is the case.

[1 mark]

[1 mark]

Question 2a

a)
Polyploidy is a condition in which cells have a chromosome number that is greater than the normal diploid (2n) number. Polyploidy is considered to be a useful characteristic in crop plants as it gives rise to bigger plant organs and provides cells which contain a larger variety of alleles for breeding programmes. While polyploidy can occur naturally in plants, it can also be induced artificially using a chemical called colchicine. Colchicine works by preventing the formation of the microtubules that make up the spindle fibres inside cells.

Suggest how colchicine gives rise to tetraploid (4n) cells after **mitosis** in plants.

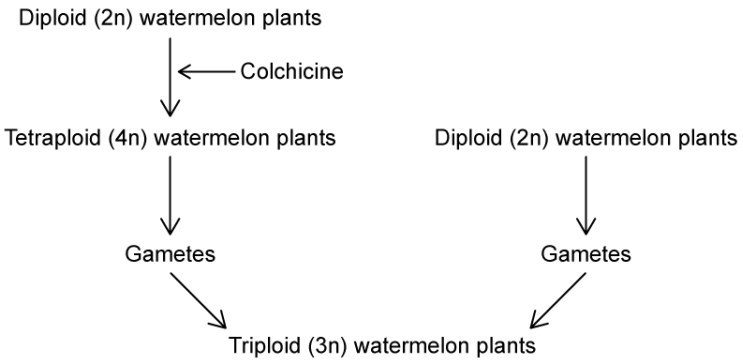
[2 marks]

[2 marks]

Question 2b

b)

Plant scientists have been able to breed seedless watermelons by crossing tetraploid watermelons with regular, diploid plants to produce infertile, triploid (3n) plants. The diagram below illustrates this process. Note that diploid watermelons contain 22 chromosomes.



Suggest why the offspring of the tetraploid-diploid cross are infertile.

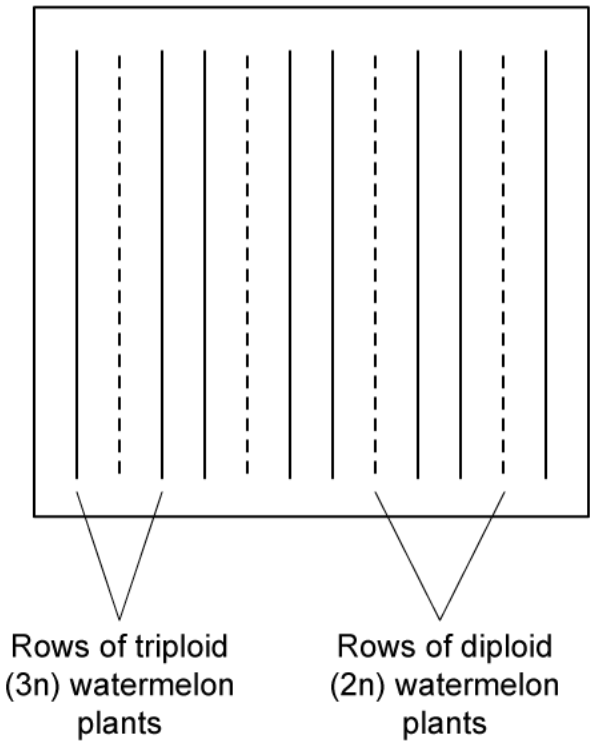
[3 marks]

[3 marks]

Question 2c

c)

For the triploid offspring shown in part b) to start producing fruits, the triploid plants must be pollinated with pollen from diploid plants. Pollination involves the transfer of a plant gamete, pollen, from the flower of one plant to the flower of another. While the diploid pollen does not *fertilise* the triploid plants (they are infertile), it does trigger fruit production, and the resulting watermelon fruits are seedless. The graphic below shows a recommended planting plan for farmers that will ensure pollination of the triploid plants with pollen from diploid plants.



i)

State why diploid plants need to be used for pollination rather than other triploid plants.

[1 mark]

ii)

Suggest **two** disadvantages to farmers of the method described here and in part b) for growing seedless watermelons.

[2 marks]

[3 marks]

Question 2d

d)
A watermelon variety that naturally produces fewer seeds has been identified by scientists, and observation of its cells indicates that an event known as reciprocal translocation of chromosomes occurs in the cells of the watermelon variety.
Reciprocal translocation of chromosomes involves the exchange of entire sections of chromosomes between non-homologous chromosomes during meiosis.

i)
Contrast reciprocal translocation of chromosomes and crossing over with each other.

[1 mark]

ii)
Suggest how reciprocal translocation of chromosomes could result in a watermelon plant that produces fruits containing fewer seeds.

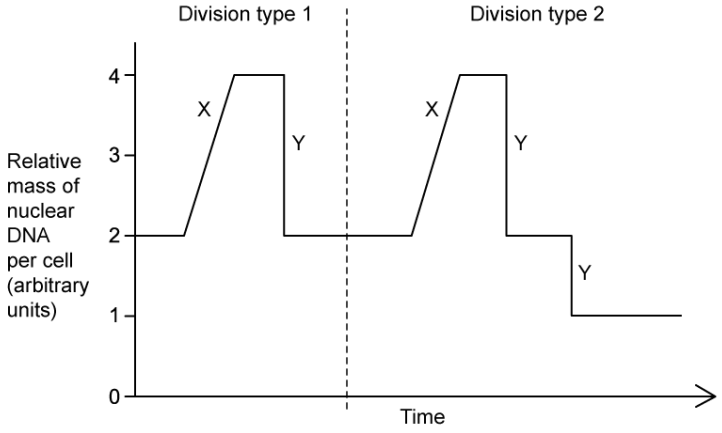
[2 marks]

[3 marks]

Question 3a

a)

The graph below shows how the mass of DNA changes over time during two different types of cell division in a diploid cell.



State what is happening at the following stages in the graph:

i)

Stage **X**

[1 mark]

ii)

Stage **Y**

[1 mark]

[2 marks]

Question 3b

b)

Use the information provided in the graph in part a) to state, with a reason, which of the division types represents **meiosis**.

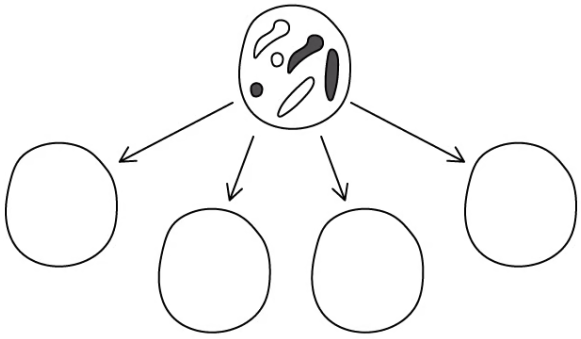
[2 marks]

[2 marks]

Question 3c

c)

The image below shows a diploid cell containing several chromosomes.



Gametes

Draw the possible appearance of **four** different gametes that could be produced from this diploid cell during meiosis.

[2 marks]

[2 marks]

Question 3d

d)

A diploid cell contains 26 chromosomes.

i)

Calculate the number of different combinations of chromosomes that could be generated when this cell divides by meiosis.

[1 mark]

ii)

Explain why the number calculated in part i) is not a true representation of the amount of genetic variation that can be generated from this cell during sexual reproduction.

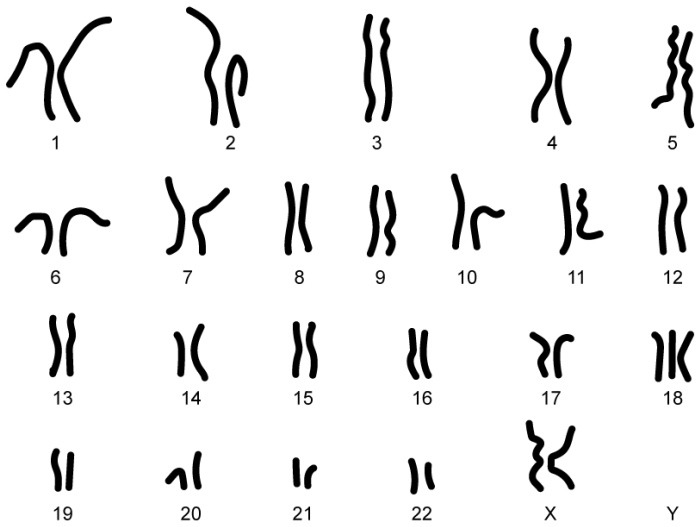
[2 marks]

[3 marks]

Question 4a

a)

Edwards syndrome is a rare but serious condition that influences birth weight and development. Death rates during infancy are high. The image below shows the karyogram of an individual with Edwards syndrome.



i)

Use the karyogram to suggest the cause of Edwards syndrome.

[1 mark]

ii)

Describe the events that have led to the feature noted in part i).

[2 marks]

[3 marks]

Question 4b

b)
Edwards syndrome affects every cell in the body.

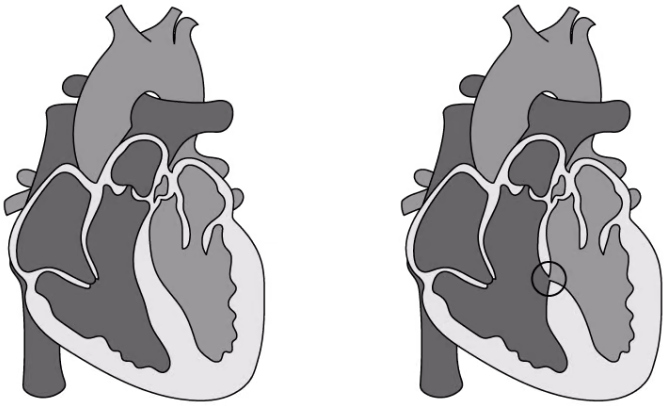
Explain why this is the case.

[2 marks]

[2 marks]

Question 4c

c)
One of the life-threatening complications that babies with Edwards syndrome can be born with is a structural abnormality in the heart. The image below shows a heart abnormality that can be seen in babies born with Edwards syndrome.



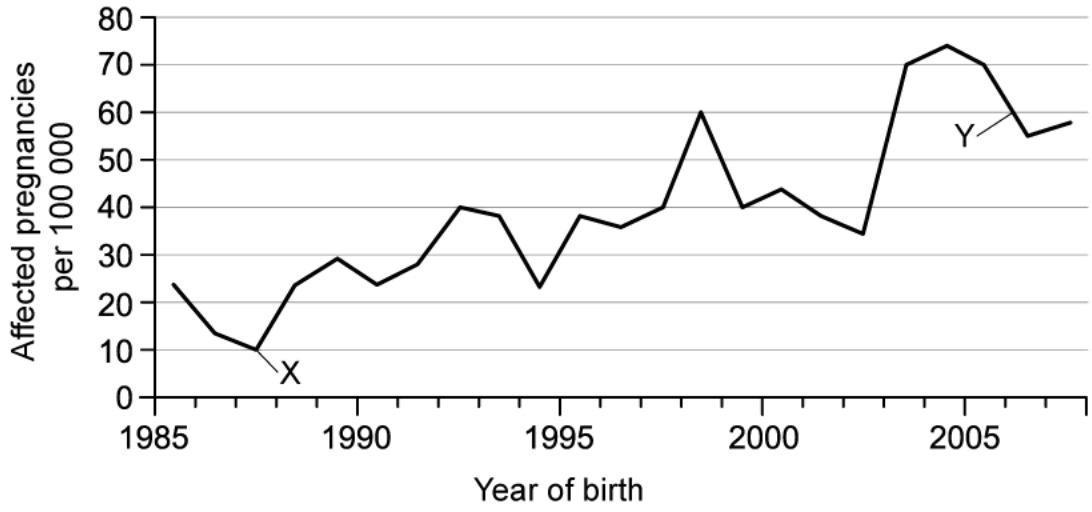
Explain why the abnormality shown in the image can be life-threatening.

[3 marks]

[3 marks]

Question 4d

d)
The graph below shows the number of pregnancies affected by Edwards syndrome between 1985 and 2008.



i)
In the year marked **X** there were 1100 000 pregnancies, and in the year marked **Y** there were 700 000 pregnancies.

Calculate the number of affected pregnancies at the times marked **X** and **Y**.

[2 marks]

ii)
Suggest **one** reason for the difference in affected pregnancies between times **X** and **Y**.

[1 mark]

[3 marks]

Question 5a

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

a)
Describe the process of meiosis.

[8 marks]

[8 marks]

Question 5b

b)
Explain the link between meiosis and evolution.

[5 marks]

[5 marks]