1 Meiosis is involved in the production of gametes such as human egg cells and sperm cells.

(a) An investigation was carried out to study the effect of changing the temperature on spindle fibre formation in human egg cells during meiosis.

Five human egg cells undergoing meiosis at 37 °C were incubated at 25 °C for 10 minutes and then returned to 37 °C. After 20 minutes, the number of egg cells showing spindle fibre formation was recorded.

The investigation was repeated at three different incubation temperatures.

The results are shown in the table below.

Incubation temperature / °C	Number of human egg cells used	Number of human egg cells showing spindle fibre formation
25	5	0
28	5	2
33	5	5
37	5	5

(i) Suggest why some of the human egg cells were incubated at 37 °C throughout this investigation.

(1)

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(ii) Using the information in the table, describe the effect of temperature on spindle fibre formation in human egg cells.

(2)

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(b) A student made the statement that all 5 cells would have shown spindle fibre formation if the incubation temperature had been either 35 °C or 31 °C.

(i) Using the information in the table, give evidence to support part of this statement.

(2)

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(ii) Using the information in the table, give evidence that may **not** support part of this statement.

(2)

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*(c) Describe and explain **three** ways in which a human sperm cell is specialised for its function.

(6)

(Total for Question 1 = 13 marks)

2 Meiosis is involved in the formation of human gametes.

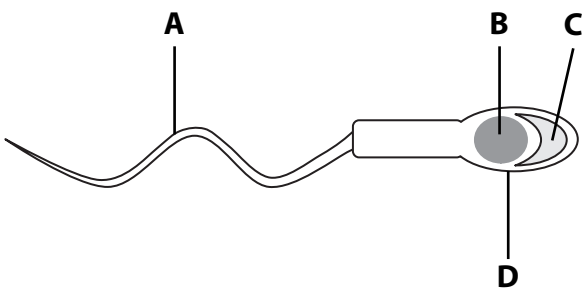
(a) Explain the importance of meiosis in the formation of human sperm and egg cells.

(3)

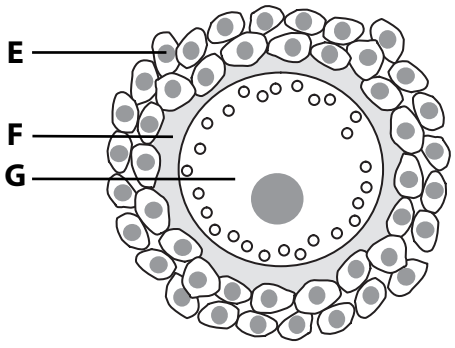
(b) Sperm cells release acrosin, an enzyme found in the acrosome. This enzyme is involved in digesting the zona pellucida (jelly layer) during fertilisation.

The diagrams below show a human sperm cell and a human egg.

Human sperm cell



Human egg



(i) The table below describes four sites.
Place a cross ☒ in the box below the letter that correctly links the statement to one of the labels on the diagrams above.

(4)

Statement	A	B	C	D	E	F	G
Site containing acrosin	☐	☐	☐	☐	☐	☐	☐
Site where acrosin works	☐	☐	☐	☐	☐	☐	☐
Site containing the haploid number of chromosomes	☐	☐	☐	☐	☐	☐	☐
Site containing mitochondria	☐	☐	☐	☐	☐	☐	☐

(ii) Describe how the acrosin is released from the acrosome.

(2)

(c) An investigation was carried out to study the effect of acrosin activity on fertilisation success. Sperm cells with different levels of acrosin activity were mixed with human eggs in a glass container. The number of eggs fertilised was then counted and the percentage of eggs fertilised was calculated.

The results are shown in the table below.

Acrosin activity / arbitrary units	Percentage of eggs fertilised (%)
2.5	33
3.0	66
4.0	85
5.0	100

(i) A student stated that acrosin needs to be active for the eggs to be fertilised and that the higher the acrosin activity, the greater the percentage of eggs fertilised.

Give **one** piece of evidence from the table that supports some of his statement.

(1)

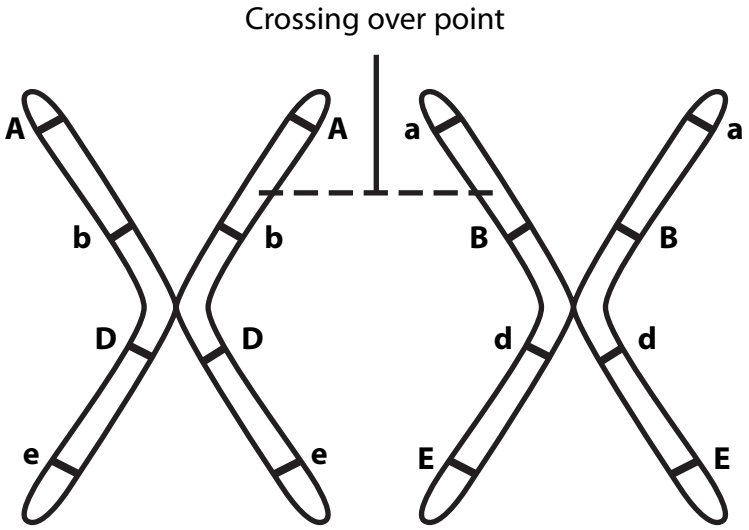
(ii) Using the data in the table, suggest why the student could **not** support all of his statement.

(1)

Total for Question 2 = 11 marks

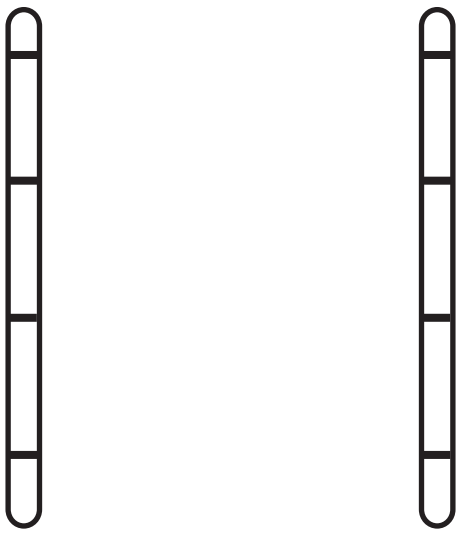
3 Meiosis leads to the production of gametes and is important in allowing genetic variation to occur.

(a) The diagram below shows one homologous pair of chromosomes during early meiosis.
Four genes (A, B, D and E) and the crossing over point have been labelled.



At the end of meiosis, four gametes will have been produced, each with a different combination of alleles.
Complete the diagram below to show the combination of alleles for the two recombinant chromosomes.

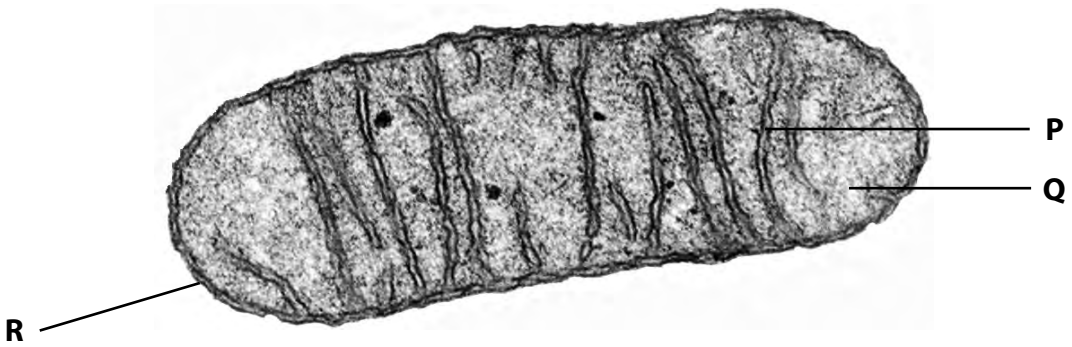
(1)



(b) Sperm cells are gametes. They contain mitochondria in their mid region.

(i) The photograph below shows a mitochondrion as seen using an electron microscope.

(3)



CNRI / Science Photo Library
Magnification x 90 000

Name the labelled structures shown in the photograph above.

P .....

Q .....

R .....

(ii) Explain the function of mitochondria in sperm cells.

(3)

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(c) In some species of mammal, at fertilisation most of the sperm cell enters the egg cell. The fertilised cell then divides by mitosis.

(i) A sperm cell containing 65 mitochondria fertilises an egg cell containing 100 000 mitochondria.
Calculate the percentage of the total mitochondria in this fertilised cell that come from the sperm cell. Show your working.

(2)

Answer ..... %

(ii) State how many cells there would be after the fertilised egg has divided, by mitosis, **four** times.

(1)

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(Total for Question 3 = 10 marks)

4 Meiosis is involved in producing gametes such as sperm cells and egg cells.

(a) Describe **three** structural differences between a human sperm cell and a human egg cell.

(3)

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2 .....

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3 .....

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(b) When a sperm cell reaches an egg cell, enzymes are released from the head of the sperm. Explain the reasons for the release of these enzymes.

(2)

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(c) Describe what happens in the egg cell once the sperm cell nucleus has entered it.

(2)

(d) In plants, a double fertilisation occurs.

(i) One fertilisation involves a male gamete nucleus fusing with the egg cell nucleus. Give **two** functions of this fertilisation.

(2)

1 .....

2 .....

(ii) In the second fertilisation, the other male gamete nucleus fuses with two polar nuclei forming a triploid structure. Name the triploid structure formed.

(1)

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(Total for Question 4 = 10 marks)