1 Infertility reduces the chance of successful fertilisation of the egg by a sperm cell. There are many causes of infertility in humans.

One cause of infertility is cigarette smoking. Men who smoke cigarettes have a 30% higher risk of infertility.

Cigarette smoke contains nicotine. The effects of nicotine on the quality of sperm cells have been studied in rats.

Male rats were given nicotine at levels of either 0.5 mg per kg of body mass or 1.0 mg per kg of body mass.

The sperm cells produced by these rats were compared with sperm cells produced by a control group of rats. The rats in the control group were not exposed to nicotine. The defects in the sperm cells produced were recorded and the results are shown in the table below.

Type of sperm cell	**Percentage of each type of sperm cell (%)**		
	Control	**0.5 mg of nicotine per kg**	**1.0 mg of nicotine per kg**
normal sperm cells	93.6	83.2	75.2
sperm cells with flagella defects	3.9		19.9
sperm cells with mid-piece defects	2.0	2.7	3.7
other defects, including missing heads	0.5	1.0	1.2

(a) (i) Complete the table to give the percentage of sperm cells with flagella defects when the rats were given 0.5 mg of nicotine per kg of body mass.

(1)

(ii) Using the information in the table, calculate the difference in the percentage of sperm cells with defective flagella in rats given 1.0 mg of nicotine per kg of body mass compared with the control group.

(1)

.....%

(iii) Name the organelle that may be missing from the sperm cells with mid-piece defects.

(1)

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(iv) Using the information in the table, suggest why nicotine reduces the movement of the sperm cells.

(4)

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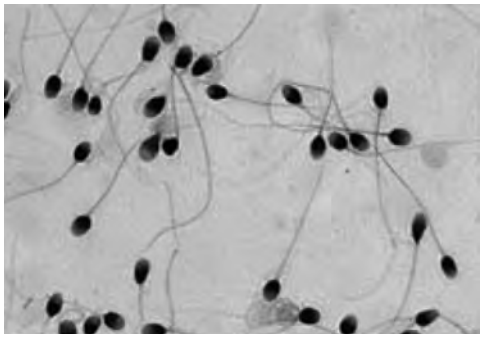
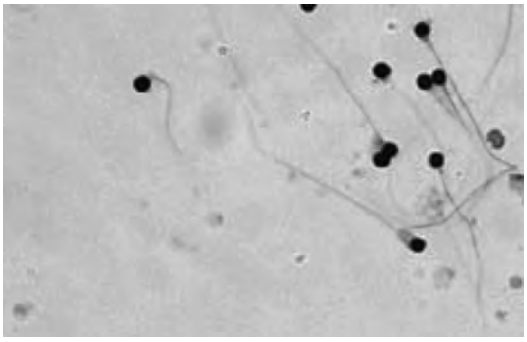
(b) A genetic cause of infertility is globozoospermia.

This condition results in round-headed sperm cells being produced. These sperm cells do not possess an acrosome.

Photograph **A** shows normal sperm cells and photograph **B** shows sperm cells from a man with globozoospermia.



A



B

Magnification ×500

Suggest why the sperm cells in photograph **B** would not be able to fertilise an egg.

(3)

(c) Suggest why a valid study on the effects of globozoospermia on fertility would have to be carried out on non-smokers.

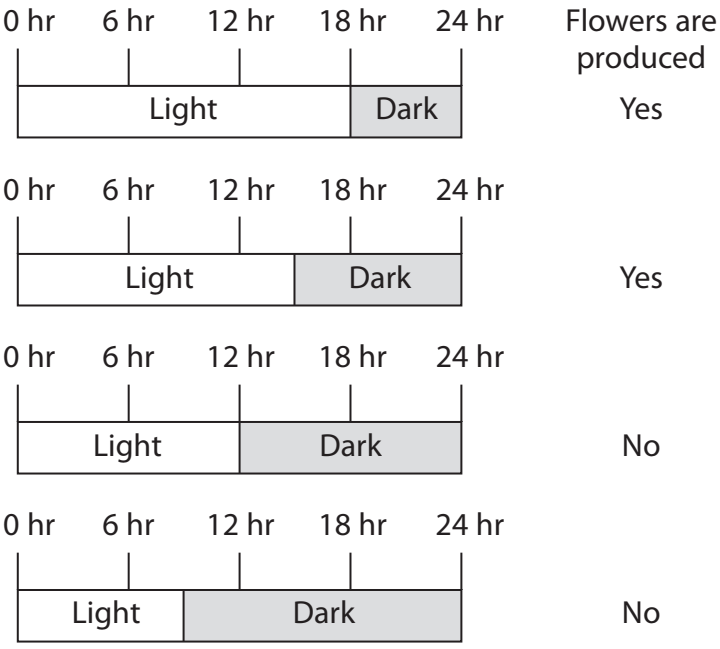
(3)

(Total for Question 1 = 13 marks)

2 Both plants and animals are able to respond to stimuli using photosensitive pigments.

(a) The photosensitive pigment in plants can be involved in a range of responses to environmental cues. This includes flower production in response to day length.

The diagram below shows the results of a study on the effect of day length on flowering in one species of plant.



(i) Place a cross ☒ in the box to complete the conclusion made using these results.

The critical amount of daylight needed for the production of flowers is

(1)

☒ **A** between 15 and 18 hours

☒ **B** between 12 and 15 hours

☒ **C** between 9 and 12 hours

☒ **D** between 6 and 9 hours

(ii) The photosensitive pigment involved in making this plant species produce flowers is likely to be

(1)

☒ **A** IAA

☒ **B** chlorophyll

☒ **C** FAD

☒ **D** phytochrome

(iii) Suggest how the plants were grown to ensure this study was valid.

(2)

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(iv) Suggest how this study could be changed to produce a more accurate conclusion.

(1)

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(b) For some plant species, day length is not an environmental cue for the production of flowers.

Suggest **one** environmental cue, other than day length, that could stimulate plants of these species to produce flowers.

(1)

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(c) Rhodospin is found in rod cells in the retina of mammalian eyes.

(i) State the location of rhodopsin within a rod cell.

(1)

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(ii) In the table below, place a tick (✓) in the box if the statement applies to the description and place a cross (✗) in the box if the statement does not apply.

(3)

Description	**Statement**		
	Opsin binds to the rod cell membrane	**Rhodopsin bleaches**	**ATP used**
Rhodopsin responding to light			
Rhodopsin being reformed			

(Total for Question 2 = 10 marks)

3 There are many venomous (poisonous) snakes in the world. Many of the venoms from these snakes affect the blood clotting process.

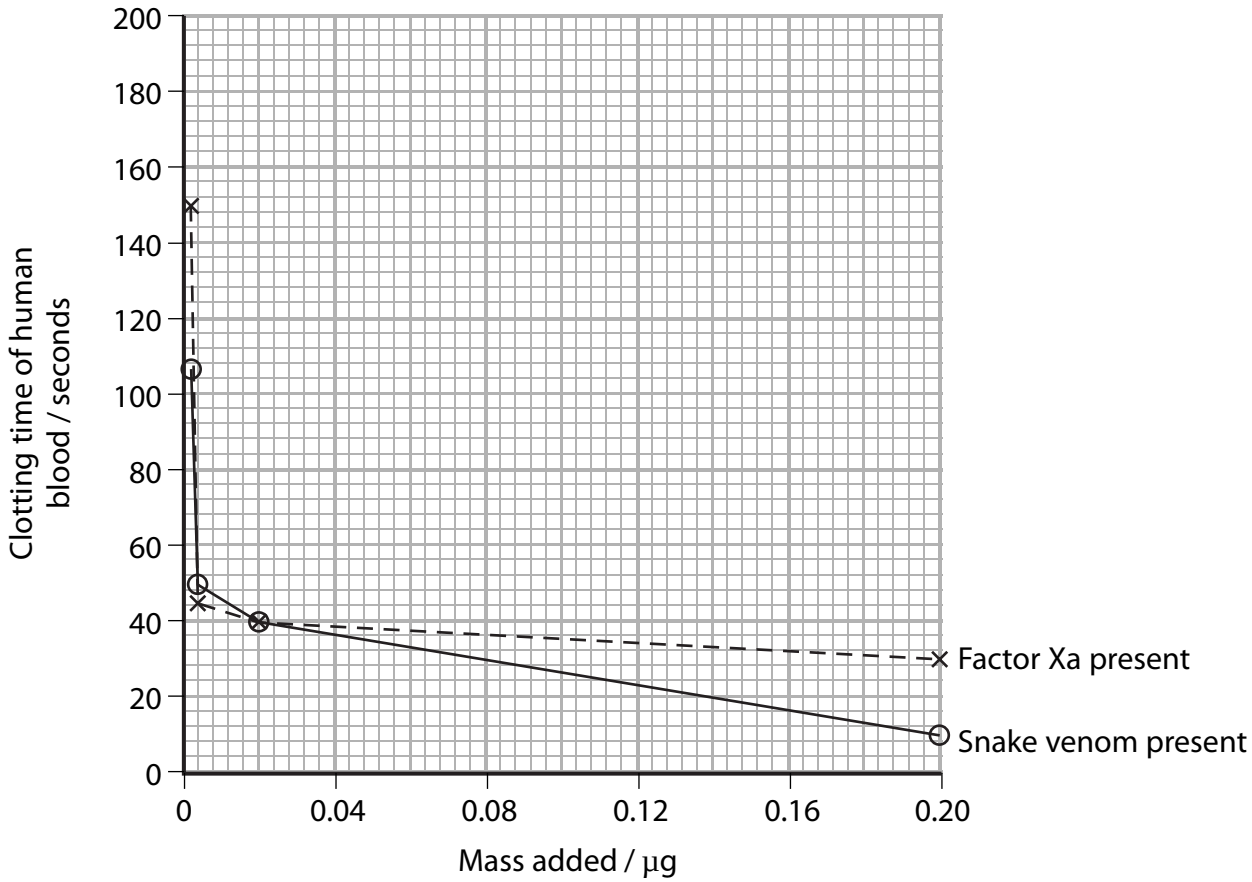
*(a) Describe the blood clotting process.

(4)

(b) Factor Xa is a clotting factor present in human blood.

An experiment was carried out to investigate the time taken for human blood to clot in the presence of different masses of Factor Xa. The experiment was repeated using snake venom in place of Factor Xa.

The graph below shows the results of these experiments.



(i) Using the information in the graph, describe the effect of the snake venom on the clotting time of human blood.

(3)

(ii) Suggest why the clotting time of the human blood with snake venom added was compared with the clotting time in the presence of Factor Xa.

(1)

(c) The component of the snake venom that affects blood clotting is an enzyme.

(i) Describe the structure of an enzyme.

(3)

(ii) Suggest how the enzyme in the snake venom could be involved in the blood clotting process.

(2)

(Total for Question 3 = 13 marks)