Control and co-ordination in mammals

Question Paper 5

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Control and co-ordination
Sub Topic	Control and co-ordination in mammals
Booklet	Theory
Paper Type	Question Paper 5

Time Allowed : **58 minutes**

Score : **/ 48**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Table 6.1 shows the mean axon diameter and mean speed of conduction of nerve impulses for four different animals.

Table 6.1

animal	type of neurone	axon diameter / μm	mean speed of conduction / ms^{-1}
A – mammal	myelinated	4	25
B – mammal	unmyelinated	5	3
C – amphibian	myelinated	14	35
D – amphibian	myelinated	10	30

With reference to Table 6.1, describe:

(i) the effect of myelination on the speed of conduction of impulses in mammals

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(ii) the effect of axon diameter on the speed of conduction of impulses in amphibians.

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(b) Explain how myelination affects the speed of conduction of impulses.

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(c) Multiple sclerosis (MS) is an auto-immune condition of humans in which the body's immune system attacks the myelin sheaths which are then damaged. This leads to a decrease in information reaching the brain from sensory receptors.

(i) Suggest how the myelin sheaths may be attacked.

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(ii) Explain why this damage leads to a decrease in information reaching the brain from sensory receptors.

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[Total: 11]

2 Many women use knowledge of their menstrual cycle as a family planning method, avoiding sexual intercourse during the part of the cycle when it is possible for fertilisation to occur. This part of the cycle is known as the fertile window.

In women with regular, 28-day menstrual cycles, ovulation is likely to take place on day 14. Most guidelines state that the fertile window lasts from day 10 to day 17 of the menstrual cycle.

(a) Explain why the fertile window begins several days before ovulation takes place.

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(b) Fig. 4.1 shows how basal body temperature, and the concentration of luteinising hormone, LH, varied during one menstrual cycle of a woman. Basal body temperature is the temperature of the body just after waking in the morning.

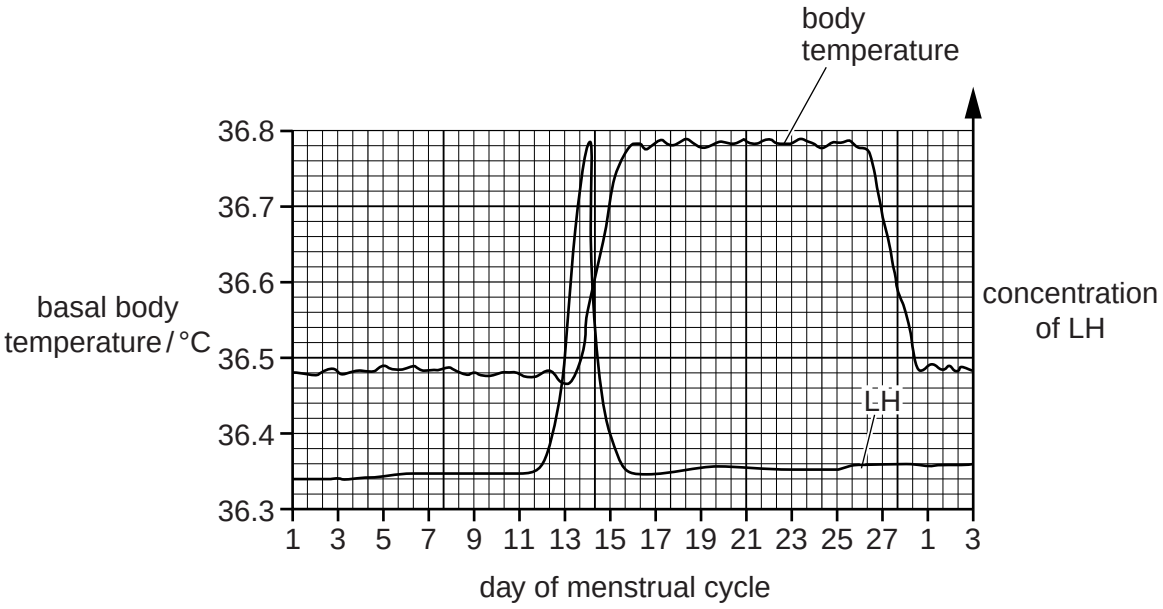

Fig. 4.1

(i) On Fig. 4.1, sketch a curve to show the changes in the concentration of progesterone in the blood during this menstrual cycle. [2]

(ii) The follicular phase of the menstrual cycle begins when menstruation starts, and ends when ovulation takes place.

With reference to Fig. 4.1, suggest when the follicular phase began and ended during this menstrual cycle.

began …… *ended* …… [1]

(c) Three methods that a woman can use for determining her fertile window are:

method 1 using the date at which each menstruation begins to predict when ovulation will occur

method 2 using disposable urine dip sticks to measure the amount of LH breakdown products in urine (the more LH in the blood, the more breakdown products are present in urine)

method 3 wearing an electronic device in the armpit that continuously measures body temperature.

(i) Suggest why using **method 1** alone is not likely to be a very reliable method of avoiding conception.

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(ii) Explain how **method 2** could be used to avoid conception.

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(iii) Suggest why **method 3** is likely to be a better predictor of ovulation than measuring basal temperature with a thermometer each day.

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(d) A study was carried out into the timing of the fertile window. The study involved 221 women who were trying to get pregnant.

Urine samples from each woman were tested for LH breakdown products every day for several months. The women recorded the days on which they had sexual intercourse, and also the days on which menstruation began.

136 of the women became pregnant during the study.

The results were used to calculate the probability of a woman being in the fertile window on each day of her cycle. The results for women with regular 28-day cycles are shown in Fig. 4.2.

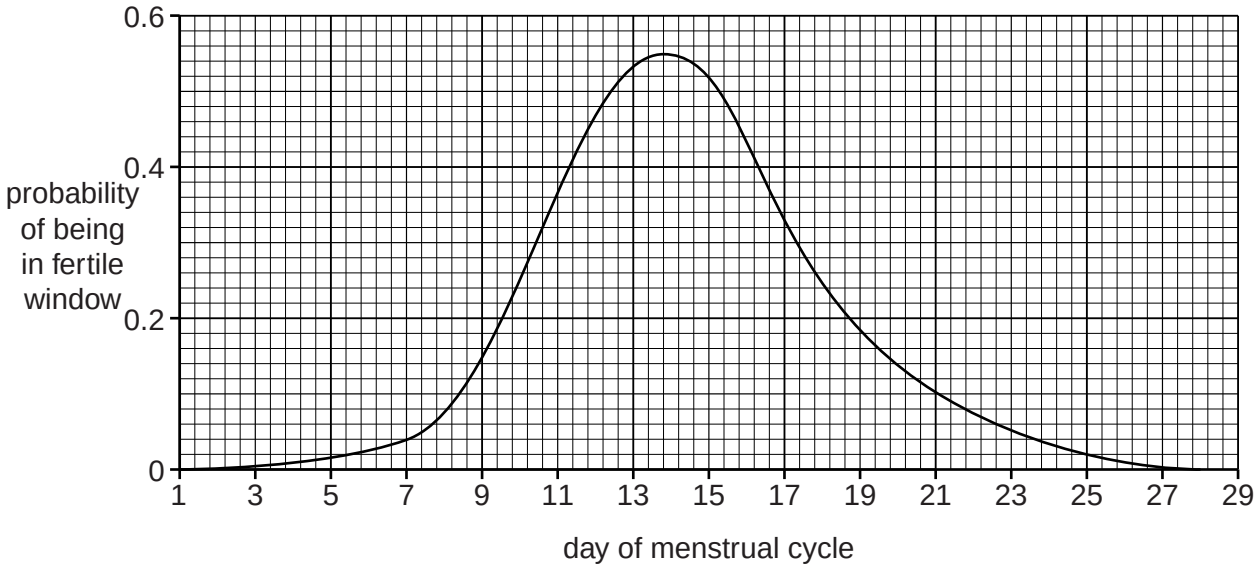

Fig. 4.2

Discuss what these results suggest about the guidelines that the fertile window lasts from day 10 to day 17 of the menstrual cycle.

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[Total: 15]

3 **(a)** Nerve impulses have to cross synapses. The events that enable a nerve impulse to cross a cholinergic synapse are listed in Table 1.1.

The events are **not** listed in the correct order.

Table 1.1

event	description of event
A	Calcium ions enter presynaptic neurone knob.
B	Acetylcholine binds to receptor proteins on postsynaptic membrane.
C	Vesicles fuse with presynaptic membrane and release acetylcholine into synaptic cleft.
D	Postsynaptic membrane becomes depolarised.
E	Nerve impulse reaches presynaptic membrane.
F	Acetylcholine diffuses across cleft.
G	Receptor proteins change shape, channels open and sodium ions enter postsynaptic neurone.
H	Calcium ion channels open in presynaptic membrane.
I	Nerve impulse generated in postsynaptic neurone.
J	Vesicles of acetylcholine move towards presynaptic membrane.

Complete Table 1.2 to show the events in the correct order.

Two of the events have been done for you.

Table 1.2

correct order	letter of stage
1	**E**
2	
3	
4	
5	
6	**F**
7	
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9	
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[4]

(b) Synapses have many roles in nervous coordination in mammals.

(i) Explain how synapses ensure one-way transmission of nerve impulses.

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(ii) In a learning activity, it is believed that the number of synapses between brain neurones increases.
Suggest the advantages of this increased number of synapses.

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[Total: 8]

4 **(a)** Fig. 4.1 shows the stages in spermatogenesis in a mammal.

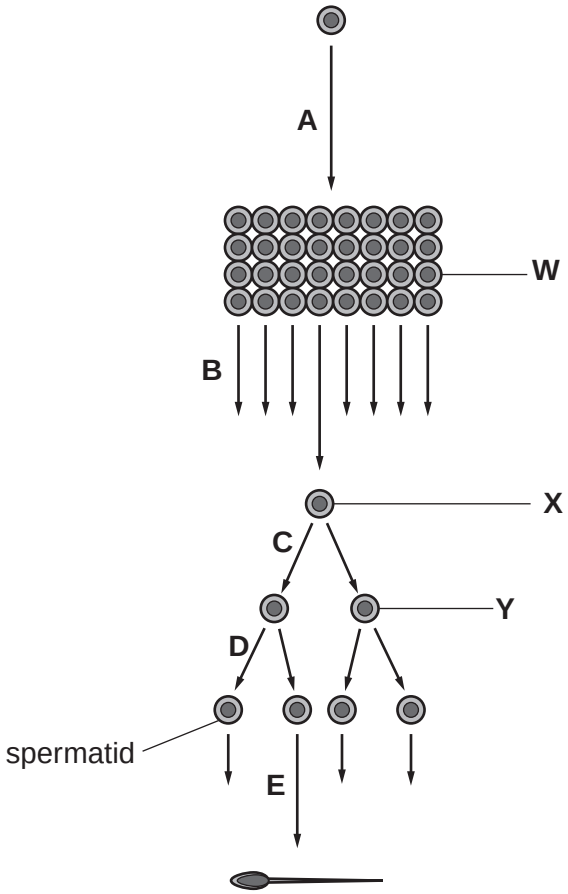

Fig. 4.1

(i) State the letter(s) of the arrow or arrows that represent mitosis.

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(ii) Name the cells **W**, **X** and **Y**.

W .....

X .....

Y .....[3]

(b) Fig. 4.2 is a light micrograph of a transverse section through a seminiferous tubule in a mammalian testis.

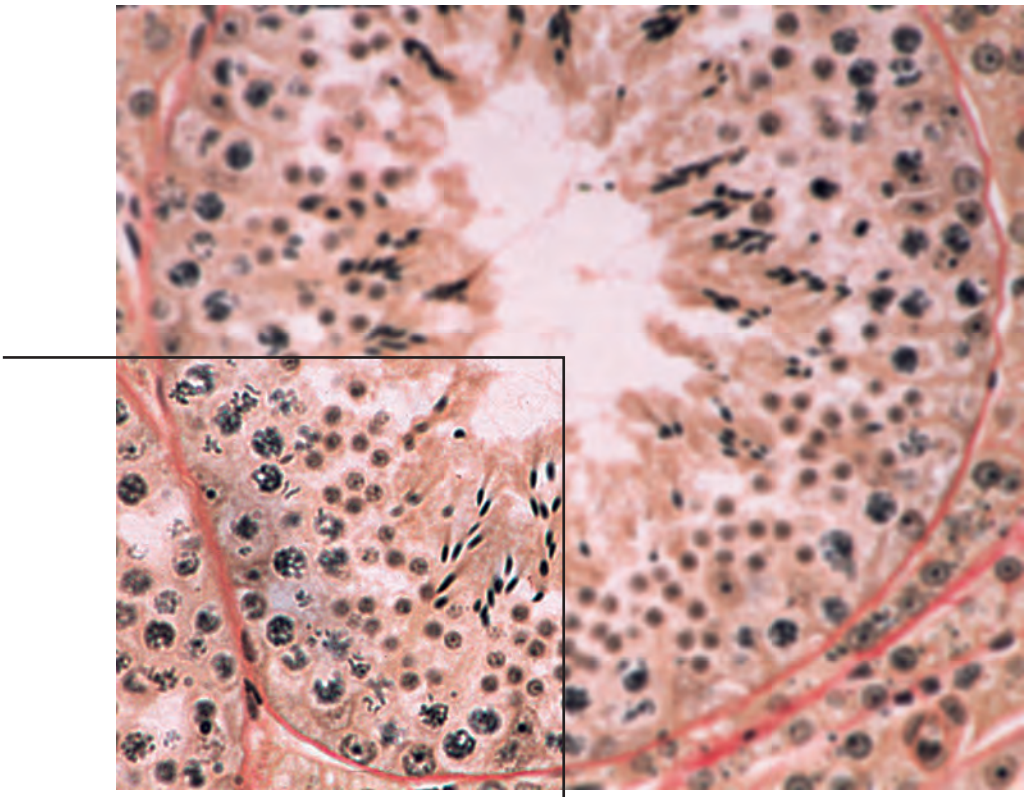

Fig. 4.2

On the sector indicated on Fig. 4.2, use label lines and letters to label:

G a cell in the germinal epithelium

M a maturing sperm cell

Y an area where spermatids are found.

[3]

(c) In all animals so far studied, the production of fully functional sperm is sensitive to temperature.

In the nematode worm, *Caenorhabditis elegans*, spermatogenesis takes place in a similar way to mammals. Two proteins known as argonaute proteins are important in the development of sperm. They are coded for by the genes *alg-3* and *alg-4*.

Table 4.1 shows the effect of mutations in one or both of these genes on the fertility of male worms, at temperatures of 20 °C and 25 °C.

Fertility was measured as the mean number of offspring produced when the male worms mated with normal females.

Table 4.1

male worms	mean number of offspring produced	
	at 20 °C	**at 25 °C**
normal at both gene loci	280	150
mutation in *alg-3* only	125	95
mutation in *alg-4* only	220	85
mutations in **both** *alg-3* **and** *alg-4*	90	0

(i) Describe the effect of increased temperature on the fertility of normal male worms.

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(ii) Compare the effect of increased temperature on the fertility of *alg-3* mutant male worms with the effect on fertility of *alg-4* mutant male worms.

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(iii) An investigation showed that at 20 °C the number of spermatids produced in worms with both mutations, in *alg-3* **and** *alg-4*, was the same as in normal worms.

However, at 25 °C, these mutant worms produced 29% fewer spermatids than the normal worms. Microscopic examination of their testes showed that many of the secondary spermatocytes had failed to complete meiosis.

Use this information to state the letter of **one** arrow on Fig. 4.1 that represents a stage of spermatogenesis affected by mutations in **both** the *alg-3* **and** *alg-4* genes.

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(iv) Table 4.2 shows the effect of temperature on the percentage of spermatids that developed full motility at 20 °C and 25 °C in normal worms and in worms with mutations in **both** *alg-3* **and** *alg-4*.

Table 4.2

male worms	**percentage of sperms with full motility**	
	at 20 °C	**at 25 °C**
normal	57	54
mutations in **both** *alg-3* **and** *alg-4*	10	2

With reference to Table 4.2, and the information in **(iii)**, state the cause or causes of reduced fertility in these mutant worms at each temperature.

at 20 °C

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at 25 °C

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[Total: 14]