

Control and co-ordination in mammals

Question Paper 2

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 2

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 The hormone FSH (follicle stimulating hormone) plays important roles in the reproductive cycles of mammals.

(a) State the precise site of secretion of FSH.

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(b) Certain cells in the ovaries and testes have receptors for FSH in their cell surface membranes. FSH can bind with these receptors, which triggers the cells to respond to the hormone.

Mice were genetically modified so that they lacked functioning alleles of the gene that codes for the production of FSH receptors.

(i) Female mice without FSH receptors were sterile. They were found to have normal primary and secondary follicles in their ovaries, but no Graafian (ovarian) follicles or corpora lutea.

Explain these observations.

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- (ii) Spermatozoa were collected from male mice with and without FSH receptors. The mean number of spermatozoa per mouse was estimated. The percentage of spermatozoa that could swim actively was calculated. Table 5.1 shows the results.

Table 5.1

	male mice with FSH receptors	male mice without FSH receptors
mean number of spermatozoa per mouse	5.6×10^6	3.6×10^6
percentage of spermatozoa that could swim actively	62	47

Discuss what these results suggest about the role of FSH in the development of spermatozoa in male mice.

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[Total: 8]

- 2 (a) As part of the technique of In-vitro fertilisation (IVF), several oocytes are collected from a woman who is undergoing treatment. Each oocyte is checked under a microscope.

Explain why oocytes that have a first polar body are used in the fertilisation process.

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- (b) It is possible to freeze embryos that are produced by IVF, using a solution containing sucrose and various salts. The embryos can later be thawed and implanted.

A trial was carried out to compare the success rates of freezing **oocytes** in

- solution **A**, the same solution as is used for freezing embryos
- solution **B**, a different solution containing different concentrations of sucrose and salts.

Oocytes were placed into either solution **A** or solution **B**. They were then frozen and stored at a temperature of -33°C . Later, the oocytes were thawed and then fertilised, using intracytoplasmic sperm injection (ICSI).

- (i) When the oocytes were placed into solution **A** or solution **B**, they quickly reduced in size. Explain why this happened.

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(ii) Table 5.1 shows the results of the trial.

Table 5.1

	number of oocytes frozen	number of oocytes thawed	number of oocytes that survived after thawing	number of oocytes that underwent ICSI	number of oocytes that were successfully fertilised
solution A	60	49	6	6	3
solution B	90	90	67	66	39

With reference to Table 5.1, explain which solution is the better solution to use.

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(iii) Suggest **one** advantage of being able to freeze and thaw oocytes as part of the IVF procedure.

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[Total: 7]

3 Fig. 5.1 shows some of the steps involved in in-vitro fertilisation (IVF).

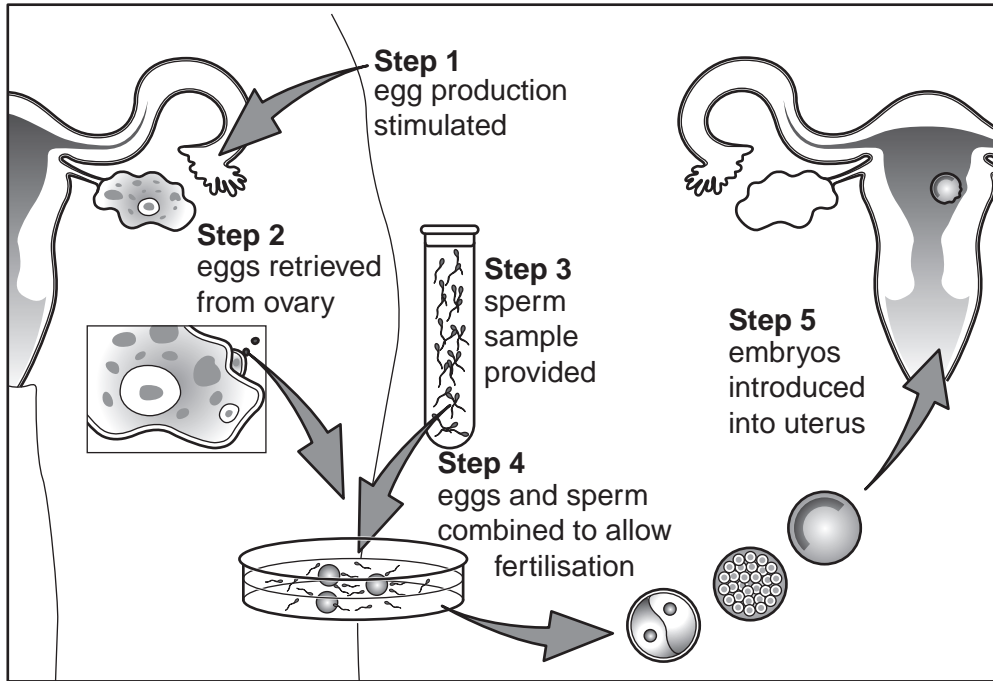


Fig. 5.1

(a) Explain how egg production is stimulated at **step 1**.

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- (b) Following **step 3** in Fig. 5.1, the sperm sample is placed in a solution containing various nutrients and other substances, for up to one hour, before being added to the eggs.

Explain why this is done.

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- (c) In 2010, researchers found that they could predict with 93% certainty which embryos produced by in-vitro fertilisation would develop into healthy babies when implanted into the uterus.

Their technique involved the use of time-lapse microscopy. The successful embryos met three criteria:

- the first cytokinesis lasted between 0 and 33 minutes
- the time interval between the first and second cell division was between 7.8 and 14.3 hours
- the time interval between the second and third cell division was between 0 and 5.8 hours.

- (i) Suggest **one** advantage of the use of this new technique in the IVF procedure.

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- (ii) Suggest **one** disadvantage of the use of this technique.

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[Total: 8]

- (b) An investigation was carried out into the effect of the diet of pregnant female rats on the mean age of onset of puberty in their female offspring.

Pregnant female rats were fed either a high fat diet or a normal diet. Their offspring were also fed either a high fat diet or a normal diet. The percentage of offspring that had reached puberty was measured at intervals until the offspring were 39 days old.

The results are shown in Fig. 5.1.

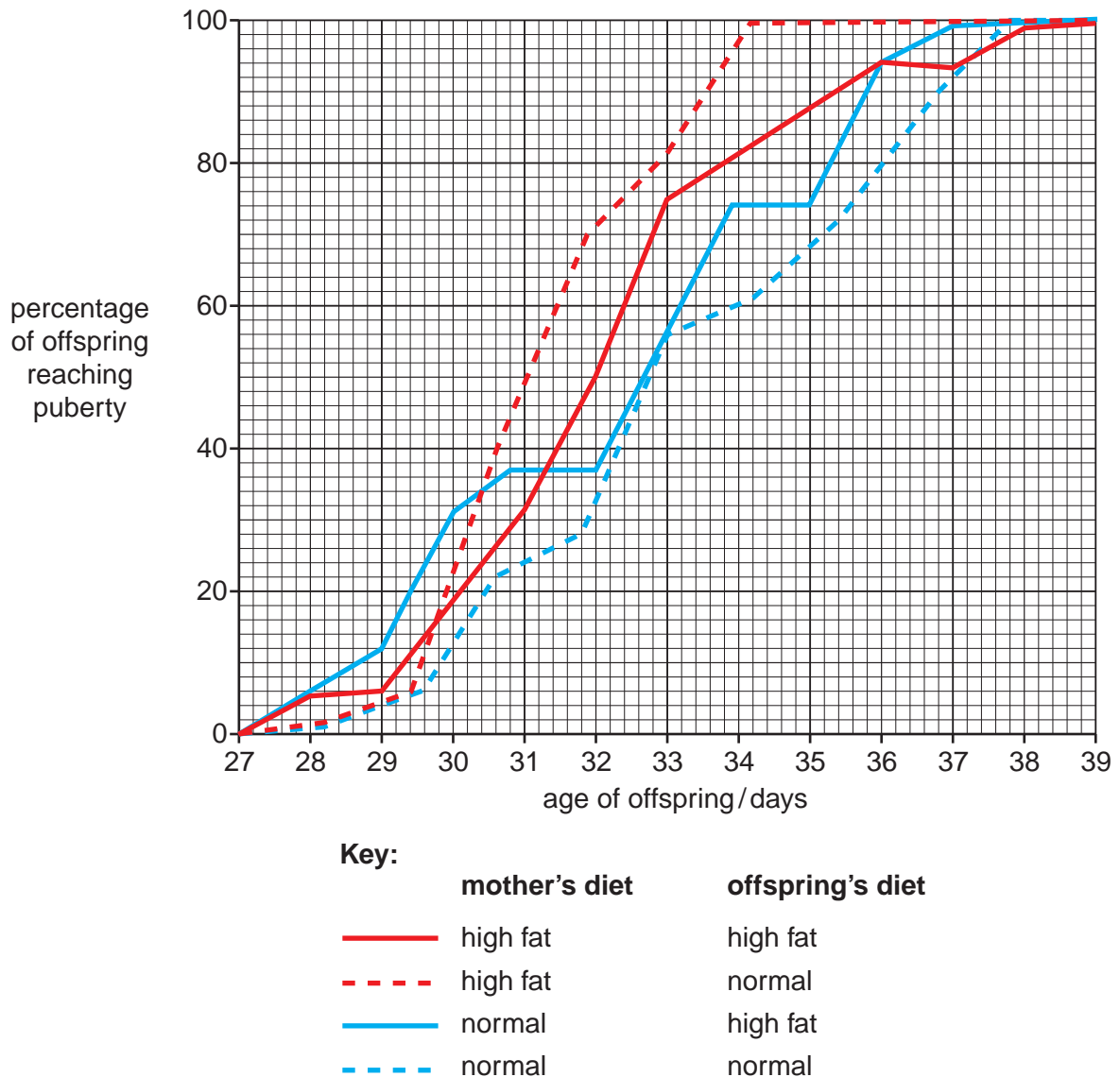


Fig. 5.1

- (i) State the age at which 50% of offspring reached puberty when both the mother and her offspring ate a normal diet.

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- (ii) During the 20th century, the average age of onset of puberty in European girls decreased from about 17 years to about 12 years of age. It has been suggested that a change to a richer diet is largely responsible for this decrease.

With reference to the data in Fig. 5.1, discuss the evidence that changes in diet may be responsible for this decrease in the age of onset of puberty in European girls.

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[Total: 8]

5 (a) Outline the biological basis of the effect of the contraceptive pill.

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(b) In Uganda, many children are infected with HIV from their mothers. This is called vertical HIV transmission.

Uganda has used two ways of trying to reduce vertical HIV transmission. These methods are

- to increase the use of antiretroviral drugs (ARVs) by HIV-infected pregnant women
- to reduce, through contraception, the numbers of unwanted pregnancies.

Table 5.1 shows the percentage reductions in the number of children born with HIV infections and the number of pregnancies in HIV-infected women, that were brought about as a result of the use of ARVs and contraception in 2007.

Table 5.1 also shows the predicted reductions in 2012 if usage of ARVs and contraception increase as expected.

Table 5.1

	percentage reduction caused			
	by use of ARVs		by contraception	
	in 2007	predicted in 2012	in 2007	predicted in 2012
pregnancies in HIV-infected women	0	0	21.7	34.0
births of HIV-infected children	8.1	18.1	21.6	32.9

- (i) It is estimated that if no ARVs had been used in 2007, 27 000 children would have been born with HIV infection.

Calculate the actual number of children born with HIV infection in 2007.

Show your working.

answer [2]

- (ii) With reference to Table 5.1, explain the difference between the effects of ARVs and contraception on the numbers of pregnancies in HIV-infected women.

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- (iii) There is only a limited amount of money to spend on HIV prevention in Uganda.

With reference to Table 5.1, suggest arguments for spending at least as much money on increasing access to contraception as on providing ARVs to HIV-infected pregnant women.

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[Total: 9]

6 (a) Outline the technique of in-vitro fertilisation (IVF).

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(b) For IVF to be successful, a sperm must have an undamaged plasma (cell surface) membrane, an intact acrosome (a sperm's large lysosome) and be capable of producing ATP for movement.

One method of assessing the quality of a sample of sperm is to mix it with three chemical probes that bind to specific components of the sperm. The probes fluoresce when the sperm are examined with a microscope using ultra-violet (UV) light, allowing their uptake to be determined.

The three probes fluoresce with different colours.

- Probe 1 combines with DNA and fluoresces red, but can enter a sperm only when its plasma membrane is damaged.
- Probe 2 combines with sugars in the acrosome and fluoresces yellow, but can enter the acrosome only when the acrosome membrane is damaged.
- Probe 3 combines with mitochondria and fluoresces bright green in sperm with active mitochondria and less brightly when the mitochondria are less active.

A sample of sperm was mixed with all three probes and examined using UV light.

Complete Table 3.1 by placing ticks (✓) in the appropriate boxes to describe the appearance of sperm that would be suitable for use in IVF.

Table 3.1

appearance of sperm suitable for use in IVF				
target of probe	red	yellow	green	colourless
DNA				
acrosome				
mitochondria				

- (c) The technique of intracytoplasmic sperm injection (ICSI) involves injecting a single, chosen sperm into an oocyte. This technique is often used when standard IVF has failed.

Researchers in Hawaii think that the acrosome of the sperm should be removed before the sperm is injected into the oocyte.

Suggest **one** reason why it might improve the success rate of ICSI to remove the acrosome before injecting a sperm into an oocyte.

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[Total: 8]