Q1.

6 Fig. 6.1 is a photomicrograph of a section through the ovary of a mammal.

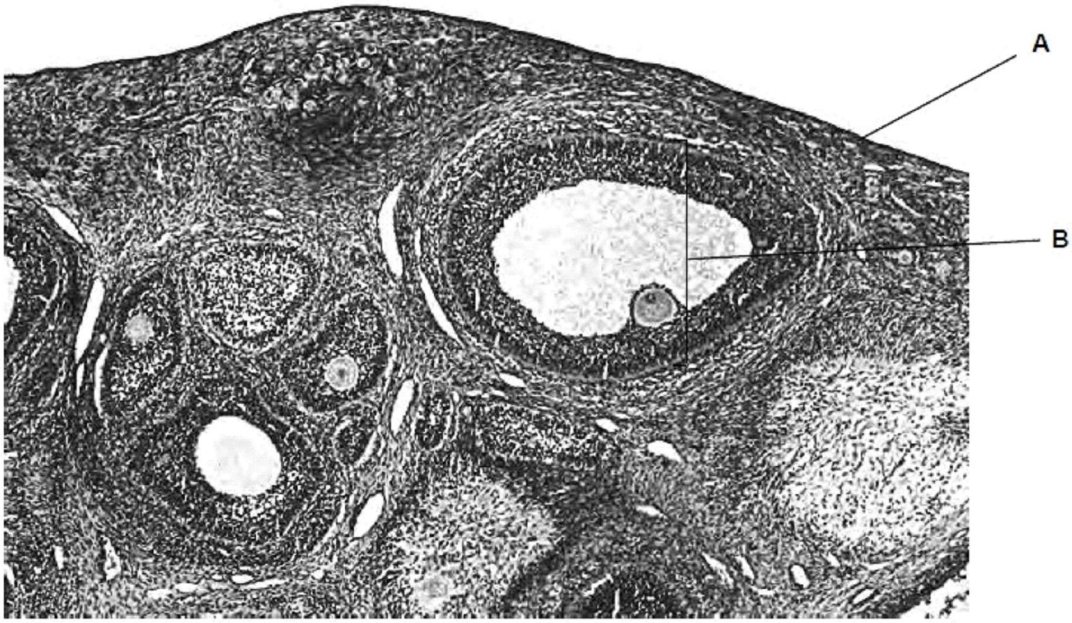

Fig. 6.1

(a) Name **A** and **B**.

A .....

B .....[2]

Fig. 6.2 shows part of the sequence of processes by which female gametes are produced.

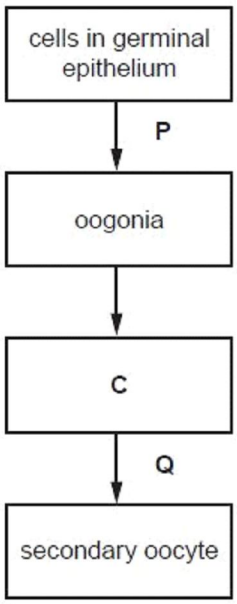

Fig. 6.2

(b) With reference to Fig. 6.2,

(i) name the cell at stage **C**;

..... [1]

(ii) draw a label line **on Fig. 6.1** to a cell at stage **C**; [1]

(iii) name the types of cell division that take place at **P** and **Q**.

P .....

Q ..... [1]

(c) Describe **one** way in which genetic variation between secondary oocytes is achieved during meiosis.

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.....[3]

[Total: 8]

Q2.

4 **(a)** Outline the role of calcium ions in the transmission of nerve impulses.

Ex

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.....[3]

(b) It has been suggested that during maturation of a sperm, the uptake of calcium ions is necessary to produce the vigorous movements of the sperm's flagellum that allow it to penetrate the zona pellucida of an oocyte.

Uptake of calcium ions can be measured by staining the sperm with a non-toxic fluorescent stain. Fluorescence increases as the concentration of calcium ions inside the sperm increases.

Sperm from two types of mice were investigated:

- wild-type mice, whose sperm have a particular protein, **P**. **P** is an ion channel found in the plasma (cell surface) membrane.
- mutant mice whose sperm did not have protein **P**.

The results of the investigation are shown in Fig. 4.1.

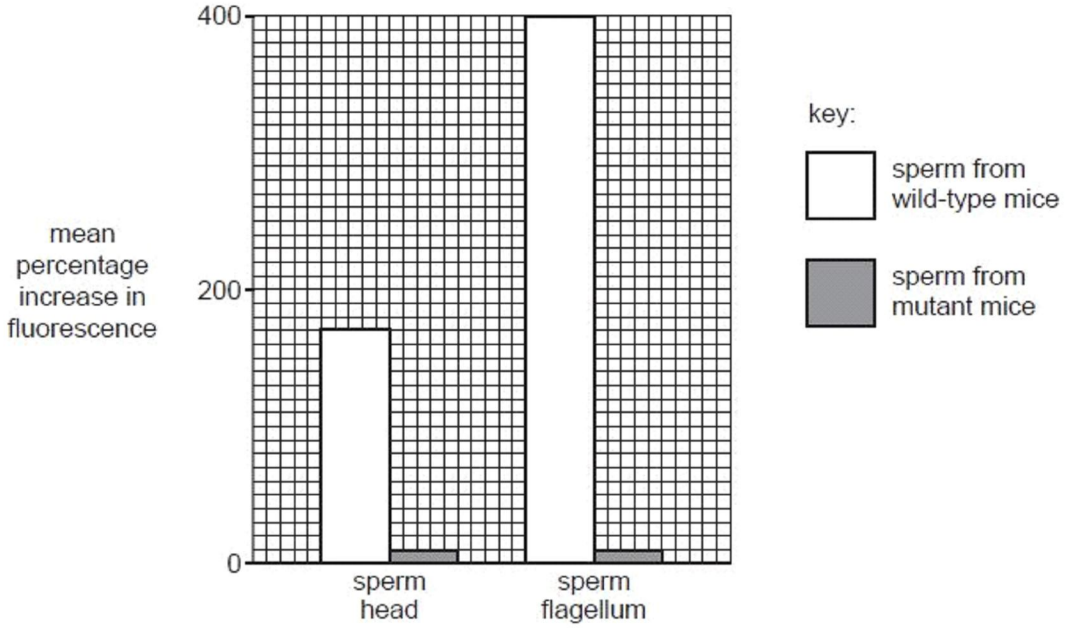

Fig. 4.1

With reference to Fig. 4.1, describe and explain the different mean percentage increases in fluorescence of

(i) sperm from wild-type and mutant mice,

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.....[3]

(ii) sperm heads and flagella.

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.....[3]

(c) The ability of sperm from wild-type and mutant mice to penetrate oocytes was tested using in-vitro fertilisation (IVF) of oocytes with and without a zona pellucida. The results are shown in Fig. 4.2.

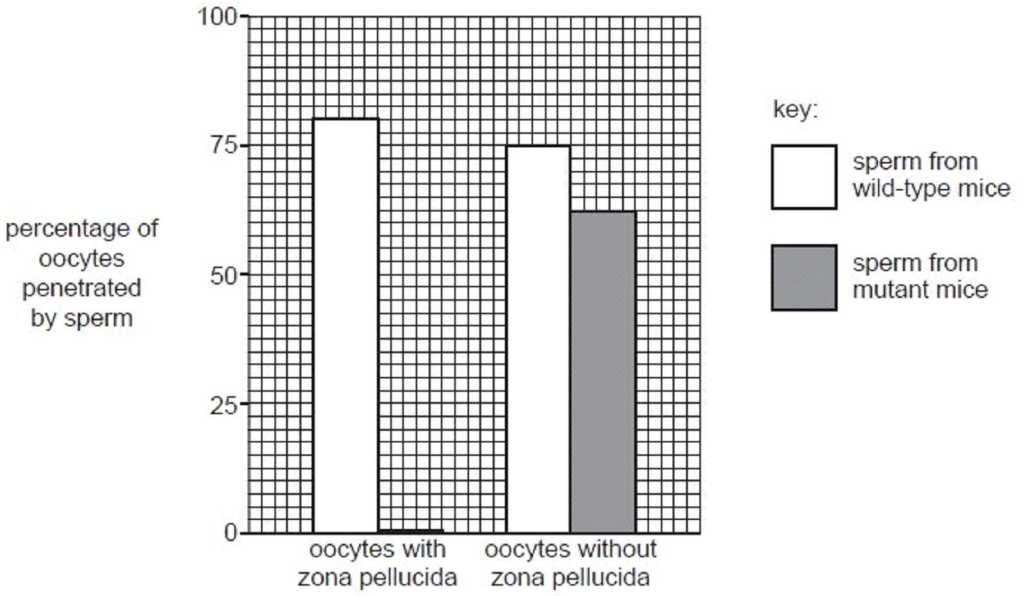

Fig. 4.2

(i) Explain what is meant by *in-vitro fertilisation*.

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.....[2]

(ii) With reference to Fig. 4.2, explain the differences in the ability of sperm from wild-type and mutant mice to penetrate oocytes in IVF.

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.....[4]

[Total: 15]

Q3.

2 **(a)** The steroid hormones oestrogen and progesterone are secreted by the ovary.

State precisely the sites of secretion of each.

oestrogen .....

progesterone ..... [2]

(b) The most effective oral contraceptives for general use are the so-called combined oral contraceptives (COCs), which contain both oestrogen and progesterone.

Explain how COCs produce their effects.

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..... [4]

(c) Describe two **social** implications of the use of contraceptives.

1 .....

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2 .....

..... [2]

[Total: 8]

Q4.

3 Fig. 3.1 shows the structure of part of a seminiferous tubule of a human testis.

For Examine Use

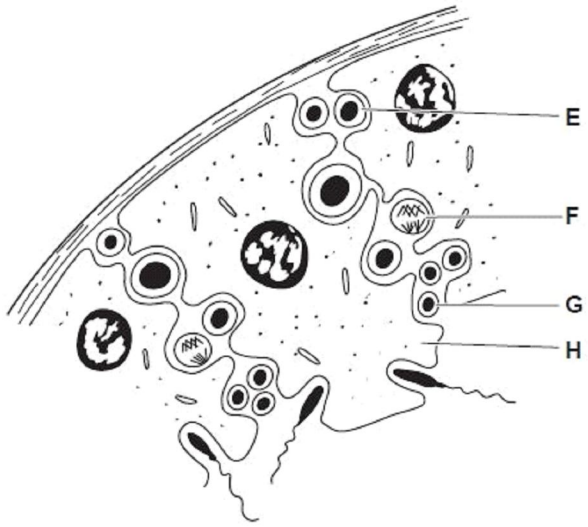

Fig. 3.1

(a) Name cells **E** to **H**.

E .....

F .....

G .....

H ..... [4]

(b) Describe how cell **F** is produced from cell **E** in the process of spermatogenesis.

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..... [4]

[Total: 8]

Q5.

2 Follicle stimulating hormone (FSH) and luteinising hormone (LH) both consist of two polypeptide chains, the α and β chains.

- The α chains of FSH and LH are identical.
- The β chain of FSH has 111 amino acids and that of LH 121 amino acids.
- FSH and LH bind to different receptors in the cell surface membranes of their target cells.
- This binding leads to steroid synthesis by the target cells.

(a) Explain why FSH does not bind to a LH receptor.

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..... [3]

(b) Name the cells of a human female that carry

(i) FSH receptors .....

..... [1]

(ii) LH receptors. .....

..... [1]

(c) Describe what happens when FSH binds to its receptors on its target cells.

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..... [3]

[Total: 8]

Q6.

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

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..... [4]

(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				

[3]

(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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..... [1]

[Total: 8]

Q7.

3 **(a)** Fig. 3.1 shows a drawing of a section through an ovarian follicle.

Ex

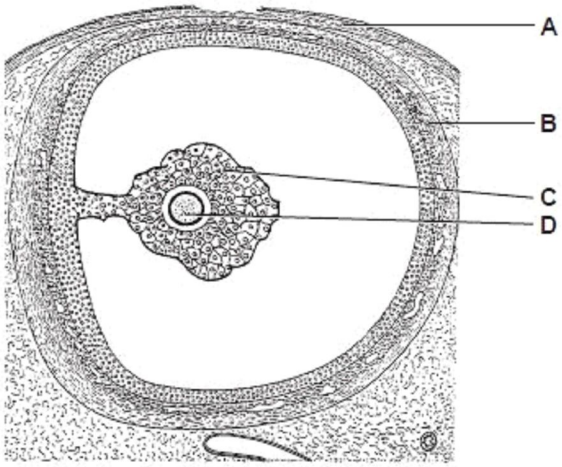

Fig. 3.1

State the names of the parts labelled **A**-**D** in Fig. 3.1.

A .....

B .....

C .....

D ..... [4]

(b) Outline the biological basis of the effect of the oestrogen/progesterone contraceptive pill.

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.....[4]

(c) The zona pellucida of an oocyte is made up of ZP proteins. ZP3, which does not occur anywhere else in the body, has a complex tertiary structure and acts as a receptor for sperm during fertilisation. *Ex*

A new method of contraception, which does not involve the use of hormones, is in the early stages of development. It involves blocking the expression of the gene coding for ZP3.

(i) Explain how blocking the expression of the gene coding for ZP3 acts as a contraceptive.

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.....[3]

(ii) Explain why it is desirable to devise a method of contraception that does not involve oestrogen and progesterone.

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.....[2]

(iii) Explain why it is important, when blocking the expression of the gene coding for ZP3, that ZP3 is only found in the zona pellucida.

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.....[2]

[Total: 15]

Q8.

5 **(a)** In girls, the first menstrual cycle occurs at the onset of puberty.

Outline the role of progesterone in the human menstrual cycle.

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.....[3]

(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.

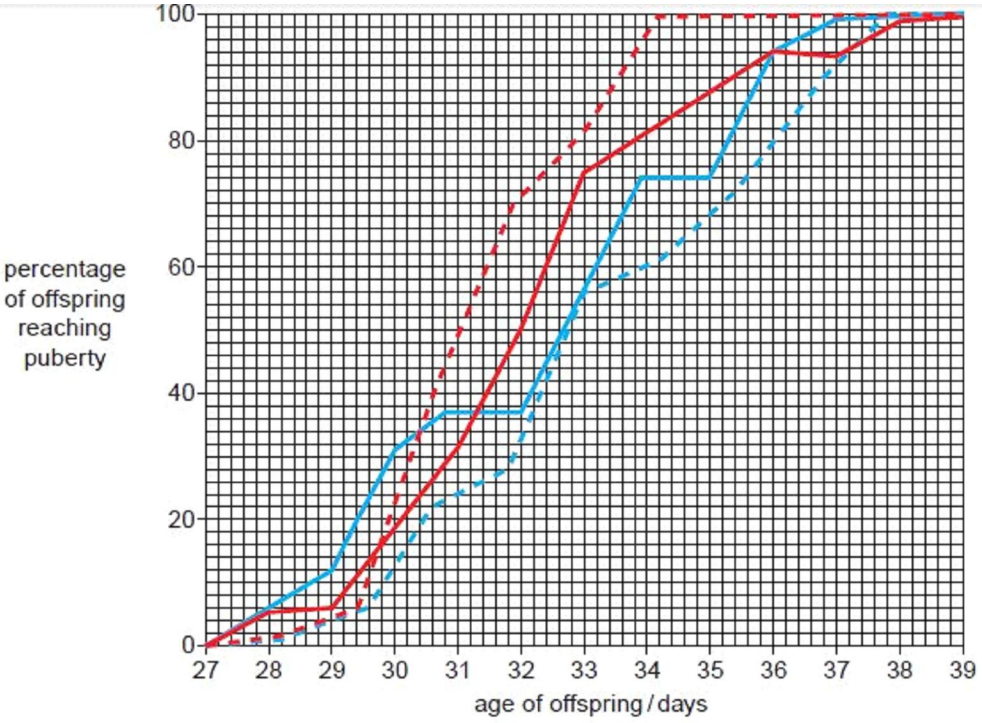
percentage of offspring reaching puberty
100
80
60
40
20
0
27
28
29
30
31
32
33
34
35
36
37
38
39
age of offspring / days
Key:
mother's diet
offspring's diet
high fat
high fat
high fat
normal
normal
high fat
normal
normal

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.

.....[1]

(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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.....[4]

[Total: 8]

Q9.

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

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.....[2]

(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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.....[2]

(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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.....[3]

[Total: 9]

Q10.

5 **(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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..... [2]

(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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..... [2]

(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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..... [2]

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

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..... [1]

[Total: 7]

Q11.

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

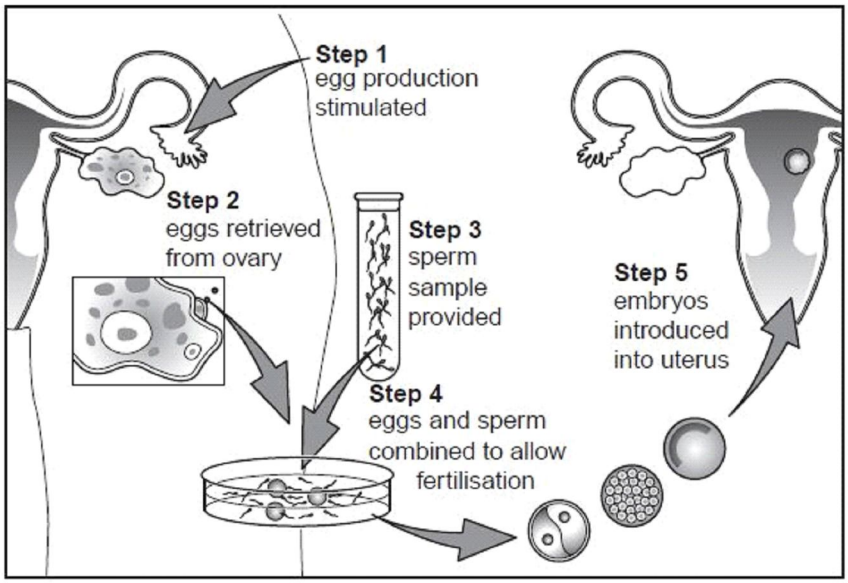

Fig. 5.1

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

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..... [2]

(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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..... [2]

(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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..... [2]

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

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..... [2]

[Total: 8]

Q12.

6 Couples who are unable to conceive naturally may be able to have fertility treatment involving in-vitro fertilisation (IVF).

(a) Outline the technique of IVF.

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..... [4]

(b) Table 6.1 shows the success rate, in terms of live births, for IVF using eggs from women of different ages.

Table 6.1

age of woman	percentage success rate of IVF
under 35	27.6
35 to 37	22.3
38 to 39	18.3
40 to 42	10.0
above 42	less than 5.0

(i) Suggest reasons for the trend shown in Table 6.1.

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..... [2]

(ii) The cost of one IVF treatment is about US$ 5000. In some countries, in-vitro fertilisation is offered free of charge to couples who have not conceived within two years of trying. With reference to Table 6.1, put forward an argument against the public funding of in-vitro fertilisation to all couples who request it.

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..... [2]

[Total: 8]

Q13.

5 (a) Complete Table 5.1 to show, for each of the two hormones, follicle stimulating hormone (FSH) and progesterone,

For Examiner's Use

- the site of secretion
- the target tissue(s)
- the action of the hormone during the human menstrual cycle.

Table 5.1

hormone	site of secretion	target tissue(s)	action during human menstrual cycle
FSH	.....	.....	.....
	.....	.....	.....
	.....	.....	.....
	.....	.....	.....
progesterone	.....	.....	.....
	.....	.....	.....
	.....	.....	.....
	.....	.....	.....

[6]

(b) Explain the biological basis of the oestrogen/progesterone contraceptive pill.

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.....[3]

[Total: 9]

Q14.

5 **(a)** Hormones are secreted by endocrine glands.

Explain what is meant by the term *endocrine gland*.

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.....[2]

(b) Fig. 5.1 shows the changes in concentration in the blood of follicle stimulating hormone (FSH) and luteinising hormone (LH) during the first half of the menstrual cycle.

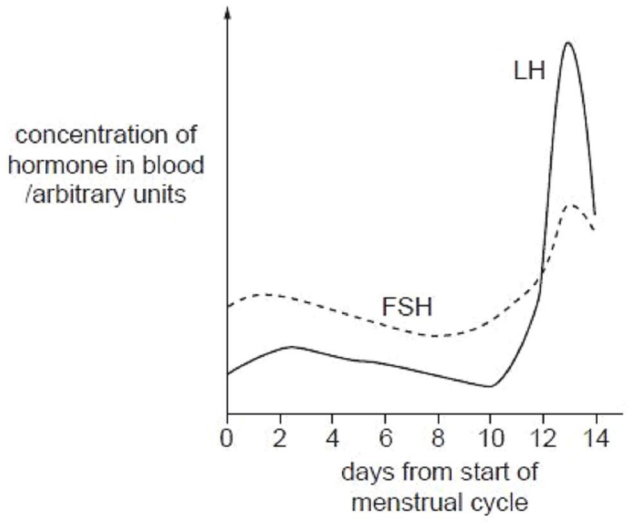

Fig. 5.1

With reference to Fig. 5.1, describe,

(i) the changes that take place in the ovary during this time, as a result of the action of FSH

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.....

.....[2]

(ii) the role of LH.

.....

.....[1]

(c) In preparation for in-vitro fertilisation (IVF), women are injected with FSH. Explain why treatment with FSH is a necessary preparation for IVF.

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.....[2]

(d) The standard treatment with FSH and clomiphene (clomifene) causes significant side-effects. Clomiphene occupies oestrogen receptors, blocking a negative feedback mechanism.

(i) Explain briefly what is meant by *negative feedback*.

.....

.....[1]

(ii) Outline the feedback mechanism that is blocked by clomiphene.

.....

.....[1]

(e) Recently a so-called 'mild' treatment has been introduced in the hope of avoiding the side-effects of the standard treatment. This treatment does not use clomiphene. Instead, an antagonist to LH secretion is used.

The days in the first half of the menstrual cycle on which injections of FSH and clomiphene are given in the two treatments are shown by asterisks (*) in Fig. 5.2.

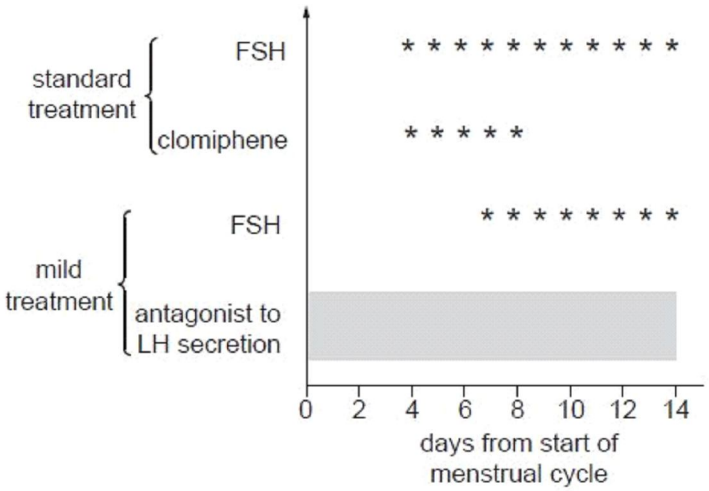

Fig. 5.2

(i) With reference to the concentrations of LH shown in Fig. 5.1, show, using an asterisk on Fig. 5.2 when the antagonist to LH secretion should first be given.

Put your asterisk into the grey area on Fig. 5.2. [1]

Use

(ii) Suggest why an antagonist to LH secretion forms part of the mild treatment.

.....

.....[1]

(f) The average dose of FSH given in the mild treatment is 1300 international units (IU), compared with an average dose of 1800 IU in the standard treatment. This could lead to the mild treatment being less effective.

The outcomes of an investigation into the two treatments are shown in Table 5.1.

Table 5.1

	mild treatment	standard treatment
mean number of oocytes harvested per treatment cycle	6.7	8.5
mean number of embryos produced per treatment cycle	2.8	3.8
percentage of pregnancies resulting in live birth	43.4	44.7

With reference to Table 5.1, compare the effectiveness of the two treatments.

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.....[3]

(g) FSH consists of two polypeptide chains which are encoded by genes on different chromosomes. The two genes, together with their promoters, have been inserted into bacteria to produce the hormone used in fertility treatments.

Explain briefly why promoters need to be transferred into the recipient bacteria together with the two genes for the FSH polypeptides.

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.....[2]

[Total: 16]

Q15.

5 **(a)** Fig. 5.1 shows a section through part of a human testis.

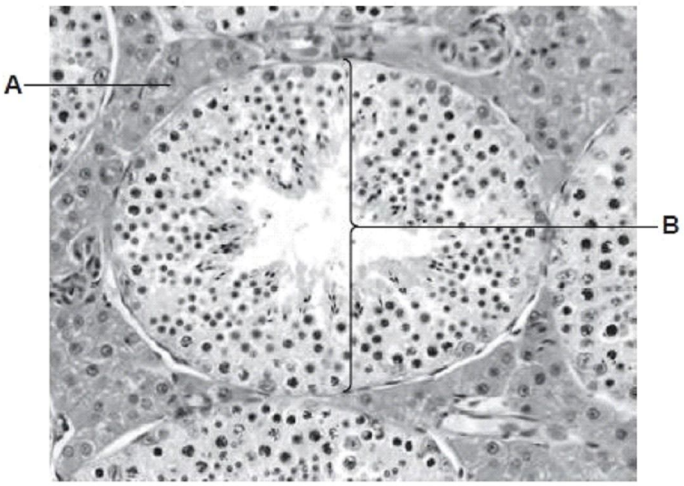

Fig. 5.1

Name structures **A** and **B**.

A .....

B ..... [2]

(b) Spermatogenesis, the production of sperm, begins in the testes of a boy around the age of 11 and can continue for the rest of his life.

Fig. 5.2 outlines the sequence of events that occur during spermatogenesis.

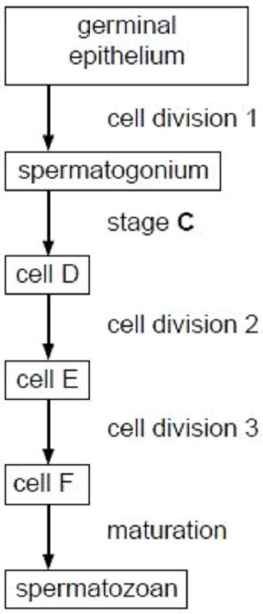

Fig. 5.2

With reference to Fig. 5.2,

(i) state which cell division is mitotic,

.....[1]

(ii) state which cells are haploid,

.....

.....[2]

(iii) state what is happening to the cell during stage **C**.

.....[1]

(c) The middle piece of a spermatozoan contains many mitochondria.

Suggest why a spermatozoan needs so many mitochondria.

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.....[2]

(d) Some couples have difficulty in conceiving. This could be due to a problem with either the male or female reproductive systems.

(i) Suggest reasons why a man may be infertile.

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.....[3]

(ii) *In vitro fertilisation* (IVF) is a widely used treatment for infertility.

Explain what is meant by the term *in vitro fertilisation*.

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.....[2]

(iii) At one IVF clinic, over 1000 treatment cycles were monitored. The number of live births was recorded as a percentage of the number of treatment cycles for each age group. The results are shown in Table 5.1.

Table 5.1

age of women/years	percentage of live births per treatment cycle
under 34	27.6
34 to 36	22.3
37 to 39	18.3
40 to 42	10.0
above 42	less than 5.0

The data in Table 5.1 show that there is a decrease in the percentage of live births per treatment cycle with increasing age.

Explain this trend.

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.....[3]

[Total: 16]

Q15.

3 A recent development in fertility treatment is called in-vitro maturation (IVM). This is both cheaper and safer than the standard procedure used in in-vitro fertilisation (IVF), especially for women with polycystic ovaries. Hormone treatment can be dangerous for women with this condition, in which a number of ovarian follicles mature at the same time.

IVF and IVM are compared in Fig. 3.1.

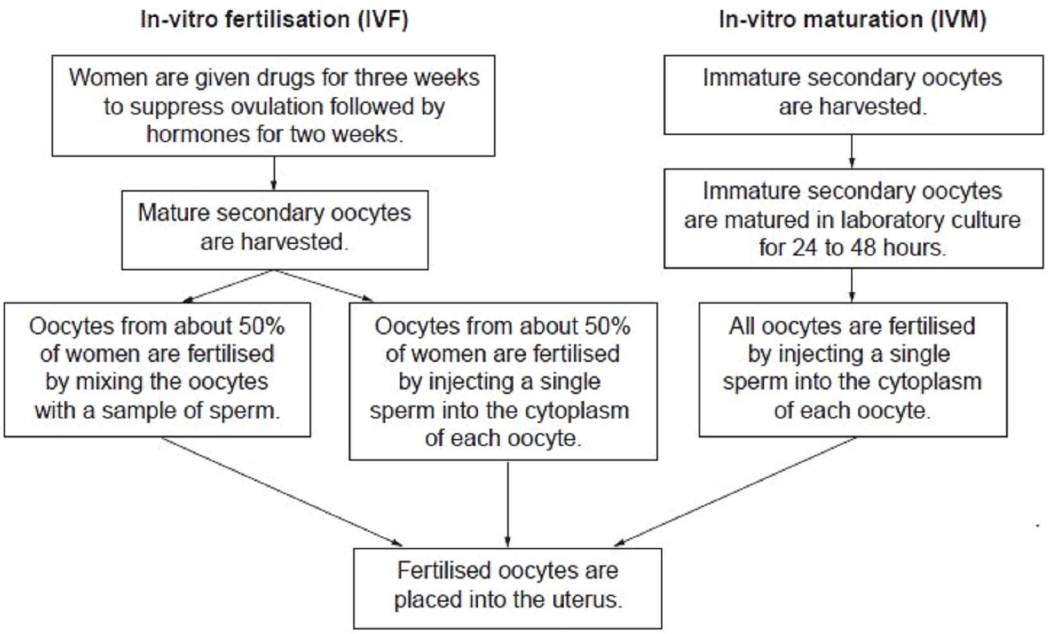

Fig. 3.1

(a) With reference to Fig. 3.1, explain why women are treated with hormones for two weeks after being given drugs to suppress ovulation at the beginning of IVF treatment.

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..... [2]

(b) State the roles of mitosis and meiosis in producing an immature secondary oocyte.

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..... [3]

(c) Suggest one advantage and one possible disadvantage of fertilising an oocyte by injecting a sperm into its cytoplasm instead of mixing the oocyte with a sample of sperm.

advantage .....

.....

disadvantage .....

..... [2]

[Total: 7]

Q17.

2 **(a)** Describe the maturation of a spermatid into a spermatozoon (sperm).

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..... [4]

(b) A method of sorting damaged from undamaged sperm has undergone trials at an *in vitro* fertilisation (IVF) clinic in Australia. It is hoped to use the procedure when attempting IVF with sperm from men with fertility problems.

The sorting process is shown in Fig. 2.1.

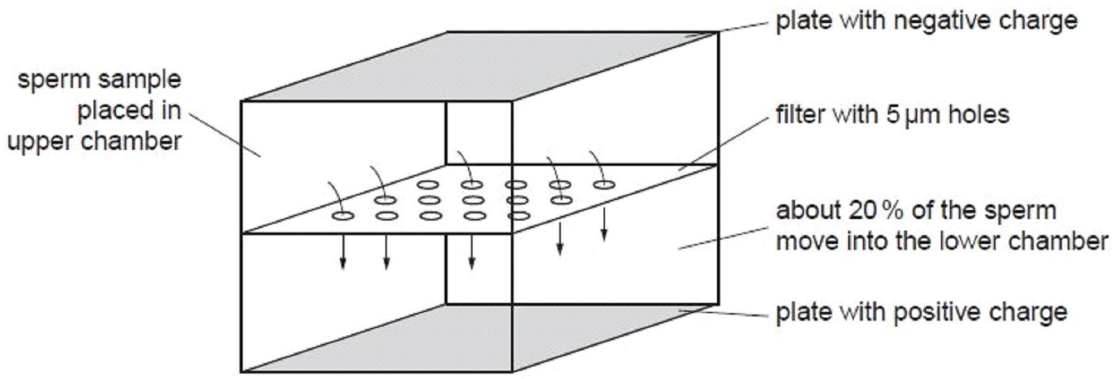

Fig. 2.1

Sperm left in the upper chamber have, on average, twice as much damage to their DNA as those that move into the lower chamber.

In the body, sperm which mature normally move slowly through the epididymis, gradually accumulating molecules of a negatively charged protein in their cell surface membranes. Other sperm move more quickly through the epididymis.

With reference to the information given, including that in Fig. 2.1, explain why only some of the sperm move into the lower chamber. *E*

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..... [3]

[Total: 7]

Q18.

3 **(a)** Outline the differences in the process of gametogenesis in a man compared with that in a woman. E

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.....[3]

(b) The hormone testosterone is secreted by Leydig cells in the testis. These cells form an endocrine gland.

Explain what is meant by an *endocrine gland*.

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.....

.....[2]

(c) In 2009, a research laboratory for family planning in Beijing announced that it had injected 1000 healthy, fertile men with testosterone over a two-year period and found that only 10 of the men were then able to father a child. The men's normal fertility was restored six months after their last injections.

The injections, each of 500 mg of testosterone, resulted in a reduced production of follicle stimulating hormone (FSH) and of luteinising hormone (LH) in the injected men.

Describe the **similarities** between the effect of these testosterone injections on a fertile man with the effect of the oestrogen/progesterone contraceptive pill on production of FSH and LH by a fertile woman.

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.....[3]

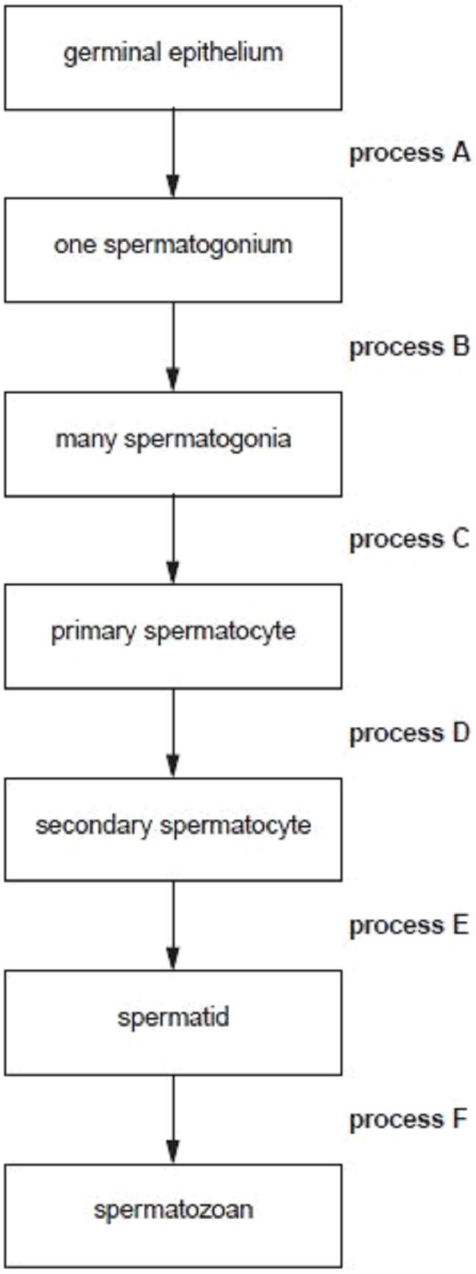
[Total: 8]

Q19.

3 **(a)** Spermatogenesis, the production of male gametes, occurs in the testes of a human male from the age of puberty.

For Examiner Use

Fig. 3.1 outlines the sequence of events that occur during oogenesis.



With reference to Fig. 3.1, state what is happening to cells during:

(i) process B

.....[1]

(ii) process D

.....[1]

(iii) process F.

.....[1]

(b) Female gametes develop inside follicles.

Fig. 3.2 shows a section through a mature (Graafian) follicle in a human ovary.

(b) Female gametes develop inside follicles.

Fig. 3.2 shows a section through a mature (Graafian) follicle in a human ovary.

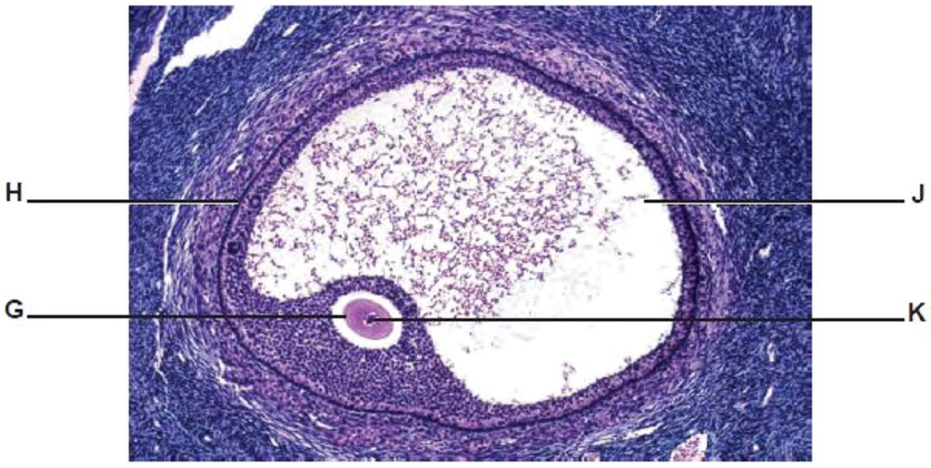


Fig. 3.2

Table 3.1 below lists a number of statements about the mature follicle. Each statement refers to one of the letters **G**, **H**, **J** and **K** shown in Fig. 3.2.

Complete the table using the letters **G**, **H**, **J** and **K**.

Table 3.1

statement	letter
contains protective fluid	
produces oestrogen	
has glycoprotein receptors	
contains 23 chromosomes	

[4]

(c) A man and a woman may be described as infertile if they have failed to conceive a child after 12 months of trying. They may opt for in-vitro fertilisation (IVF) if the woman is producing some normal eggs.

Outline the technique of IVF.

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.....[5]

(d) Not all pregnancies due to IVF treatment result in live births. In the USA in 2008 the figures were:

- 85% of these pregnancies result in live births for women under 35 years old
- 66% of these pregnancies result in live births for women between 38–40 years old.

Suggest reasons for the difference in percentage for the two groups of women.

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.....[2]

[Total: 14]

Q20.

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

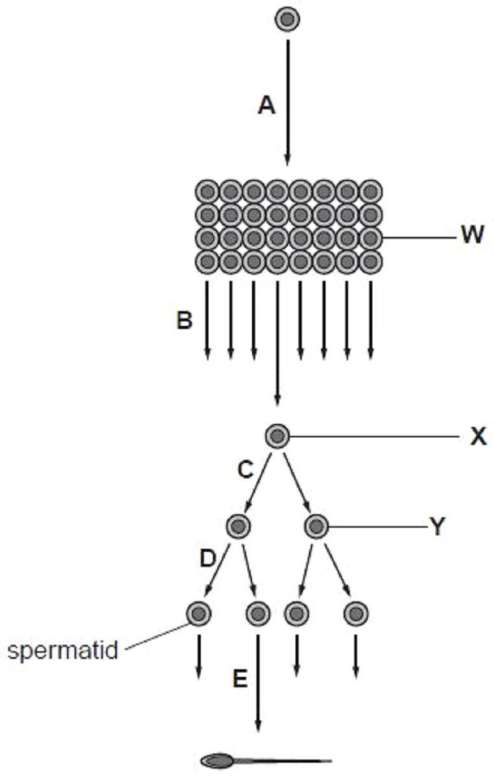


Fig. 4.1

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

.....[1]

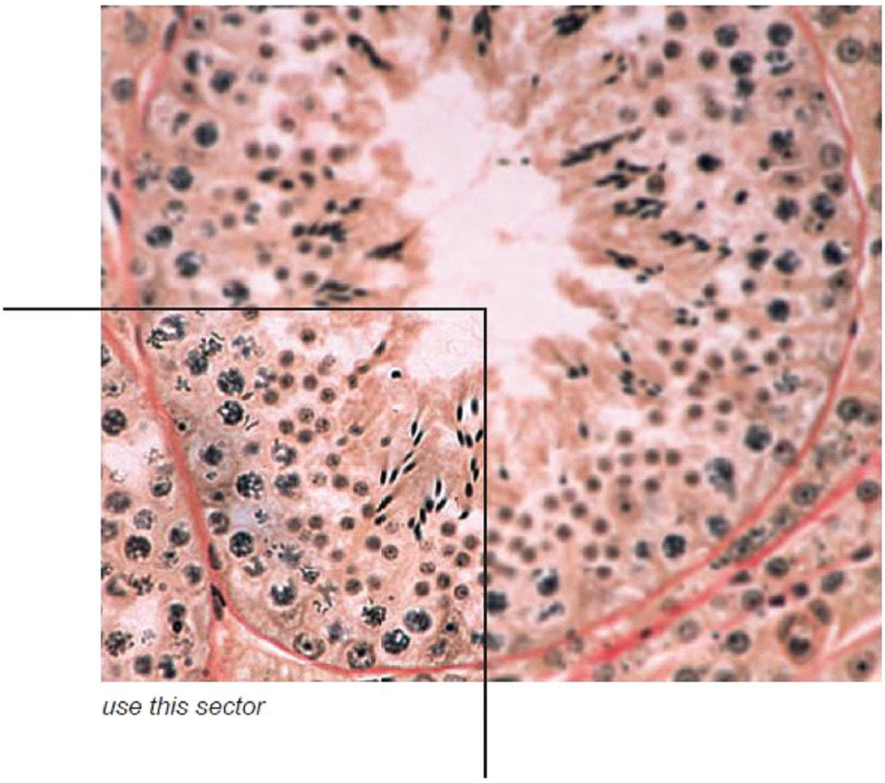
(ii) Name the cells **W**, **X** and **Y**.

W .....

X .....

Y .....[3]

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



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.

For Examin Use

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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.....[2]

(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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.....[2]

(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.

..... [1]

(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

.....

.....

at 25 °C

.....

.....[2]

[Total: 14]

Q21.

5 Many couples who are not able to have children naturally are treated using in-vitro fertilisation (IVF).

E

(a) Describe how and where fertilisation occurs during IVF.

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.....[2]

(b) The embryos resulting from IVF are transferred into the mother's uterus. This is sometimes done after 3 days, and sometimes after 5 days.

Suggest **one** advantage and **one** disadvantage of transferring the embryos after 5 days rather than 3 days.

advantage .....

.....

disadvantage .....

.....[2]

(c) Many IVF clinics usually transfer two or more embryos to the mother's uterus, to increase the chances of a successful pregnancy occurring. However, this increases the risk of more than one embryo developing in the uterus, which in turn increases the risk of problems with the pregnancy or birth.

A study was carried out to compare the success rates of transferring:

- a single embryo that had been carefully chosen as being of 'top quality'
- a non-selected single embryo
- two or more embryos.

Fig. 5.1 shows the results of this study.

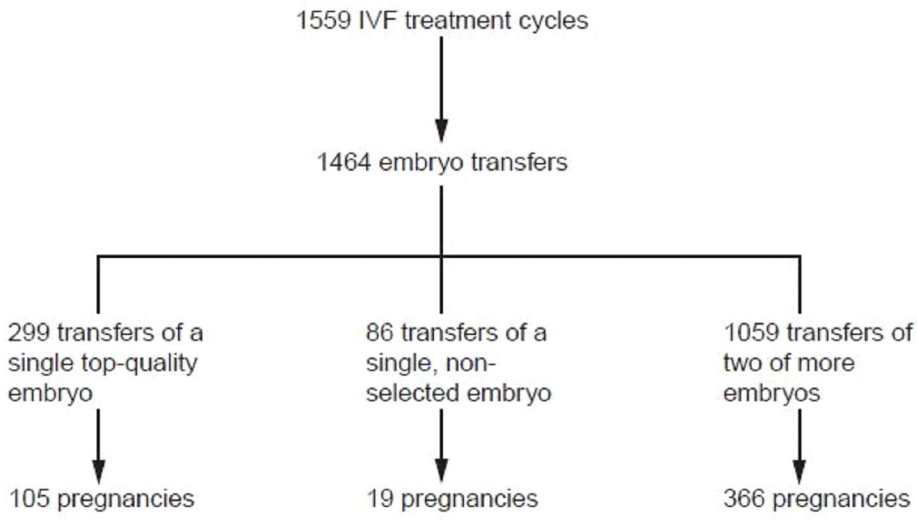

Fig. 5.1

(i) With reference to Fig. 5.1, explain why transferring a single top-quality embryo is now considered to be the best method to maximise the chance of a successful pregnancy.

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.....[3]

(ii) State **one** ethical implication of transferring single top-quality embryos in IVF.

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.....[1]

[Total: 8]

Q22.

4 **(a)** Blood samples were taken from a 29 year old woman each day for a period of 43 days. The concentrations of oestrogen, progesterone and luteinising hormone (LH) in each sample were measured. The results are shown in Fig. 4.1.

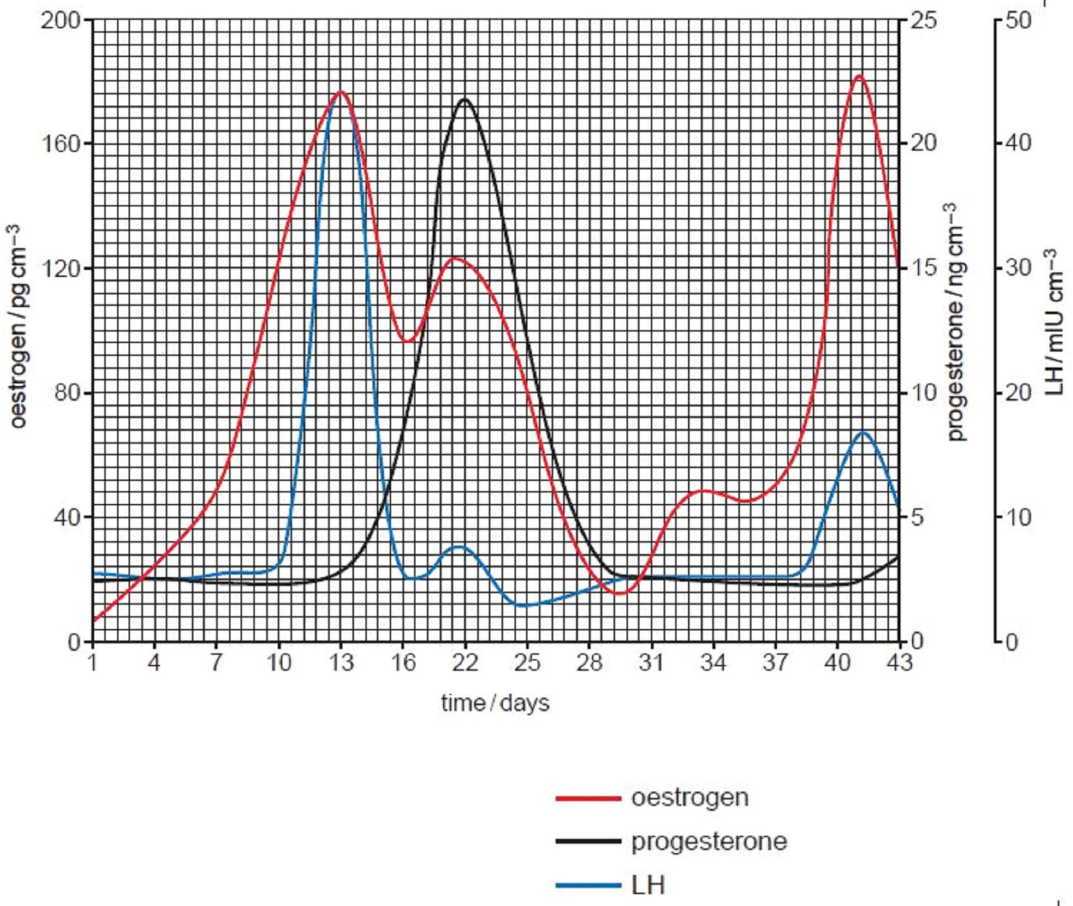

Fig. 4.1

(i) Estimate the length of the woman's menstrual cycle. Show how you worked out your answer.

answer ..... (days) [2]

(ii) The luteal phase is the part of the cycle when a corpus luteum is present in the ovaries. It begins immediately after ovulation, and ends when menstruation starts.

Use Fig. 4.1 to suggest when the luteal phase began and ended.

began ..... *ended* ..... [2]

(iii) Name the organ that secretes LH.

.....[1]

(iv) Describe the roles of LH in the menstrual cycle.

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.....[3]

(b) An investigation was carried out to determine whether the ability of a woman to perform a task involving spatial ability varied at different times of her menstrual cycle.

The investigation involved 12 women. They each performed 24 similar spatial tasks on day 2 and day 22 of their menstrual cycle, for six successive cycles. The tasks involved mentally rotating 3-D shapes.

The researchers used two methods to determine the phase of the menstrual cycle.

- Each woman was asked when her previous menstrual period had begun.
- After each test, a blood sample was taken and the concentrations of oestrogen, progesterone and LH were measured.

(i) Suggest why the researchers used two methods to determine the phase of the menstrual cycle.

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.....[2]

(ii) The mean score for women taking the tests on day 2 of their cycle was 10.50 out of 24. The mean score for women taking the tests on day 22 of their cycle was 7.38 out of 24.

Discuss whether or not these results support the hypothesis that the concentration of oestrogen in the blood affects the ability to perform spatial tasks.

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.....[4]

[Total: 14]

Q23.

4 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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.....[2]

(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.

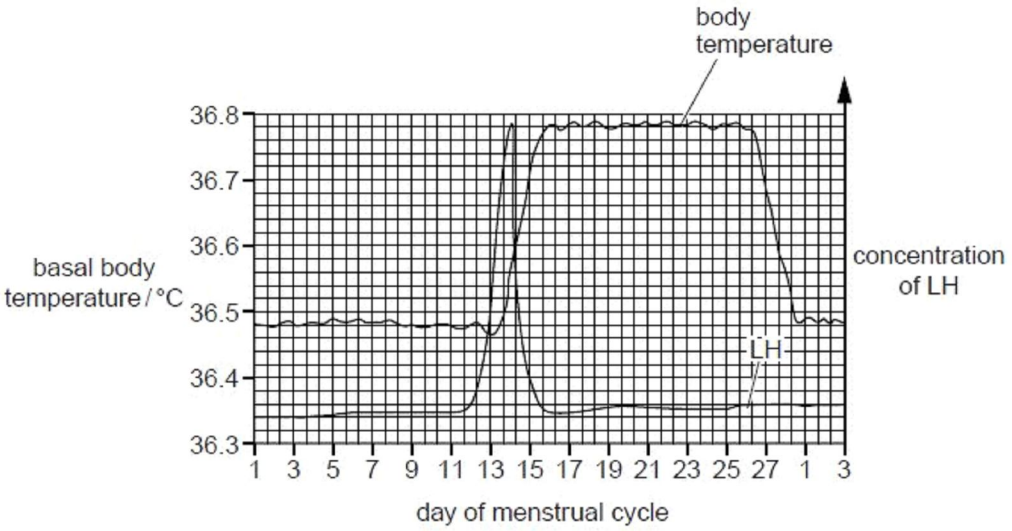

Fig. 4.1

(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:

Ex

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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.....[2]

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

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.....[2]

(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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.....[2]

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

For Examiner's Use

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.

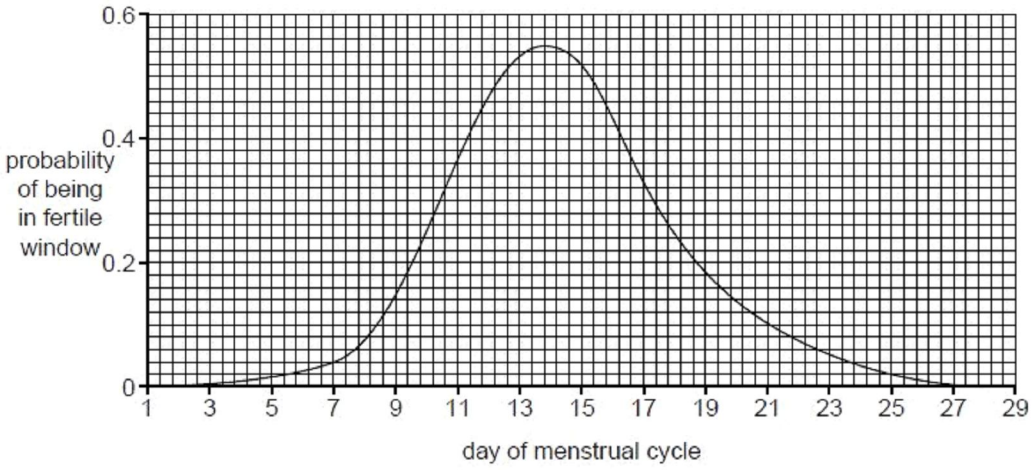

Fig. 4.2

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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.....[4]

[Total: 15]

Q24.

4 (a) Spermatogenesis takes place in the seminiferous tubules, in the testis. Fig. 4.1 is a diagram showing some of the cells in a small sector of a seminiferous tubule.

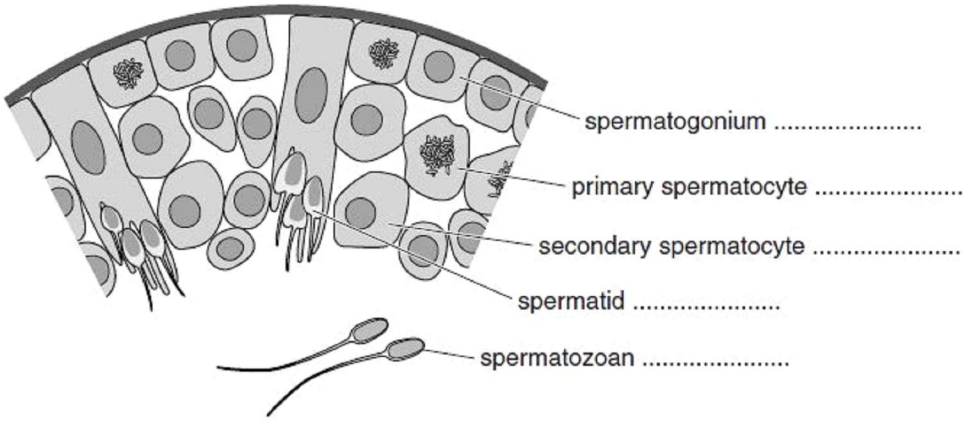

Fig. 4.1

(i) On Fig. 4.1, state whether each of the labelled cells is haploid or diploid.

Write **n** if the cell is haploid and **2n** if the cell is diploid. [2]

(ii) Spermatogenesis involves meiosis, mitosis, growth and maturation.
State which of these processes is involved in each of the following steps in spermatogenesis.

spermatogonium to primary spermatocyte

.....

spermatid to spermatozoan (sperm)

.....[2]

(iii) State **one** role of a Sertoli cell.

.....

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.....[1]

(b) In some men, spermatogenesis does not take place successfully and the sperm that are produced are unable to fertilise an egg. A form of IVF called intra-cytoplasmic sperm injection (ICSI) may enable them to father a child with their partner.

In ICSI, a sperm cell is inserted into a secondary oocyte using a very tiny needle.

Outline the treatment required in order to obtain mature oocytes as part of an IVF procedure.

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.....[4]

(c) One approach to helping an infertile man to father children is to extract immature spermatids from his testes and culture them in the laboratory, in conditions that may increase the number of them that develop into functioning sperm. These can then be used for IVF.

An investigation was carried out to see if adding reproductive hormones to a culture of immature spermatids affects their development.

Samples of spermatids were collected from men in whom the spermatids did not normally develop into functioning sperm. The spermatids were cultured in a suitable liquid medium, kept at 30 °C.

The samples were divided into four groups. No hormones were added to one group. FSH, testosterone or both were added to the other groups. The percentage of spermatids that developed into elongated cells in each group after 24 hours and 48 hours was calculated. The results are shown in Table 4.1.

Table 4.1

hormones added	percentage of spermatids that developed into elongated cells	
	after 24 hours	after 48 hours
none	20	21
FSH	32	31
testosterone	21	19
FSH and testosterone	39	44

(i) With reference to Table 4.1, describe the effects of adding reproductive hormones on the development of the spermatids **after 48 hours.**

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.....[4]

(ii) Suggest a reason for the apparent reduction in the percentage of elongated cells between 24 hours and 48 hours in some of the samples.

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.....[1]

(iii) Suggest why the culture medium was maintained at a temperature of 30 °C, and not at core body temperature (37 °C).

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.....[2]

[Total: 16]

Q25.

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

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

.....[1]

(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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.....[4]

(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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.....[3]

[Total: 8]

Section-B

1.

11 **(a)** Describe the role of the hormone insulin in maintaining a constant blood glucose concentration. [6]

(b) The hormone human chorionic gonadotrophin (HCG) is produced by a woman in the early stages of pregnancy. Describe how a pregnancy test kit can detect the presence of HCG. [9]

[Total: 15]

2.

10 (a) Describe the role of hormones in the maintenance of the human menstrual cycle. [9]

(b) Explain the principles of homeostasis in humans. [6]

[Total: 15]

3.

10 (a) Outline the technique of in-vitro fertilisation (IVF). [8]

(b) Discuss the ethical implications of IVF. [7]

[Total: 15]