

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

4.2.1 FERTILITY AND ASSISTED REPRODUCTION

SCORE

/171

PERCENTAGE

%

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1(a) Spermatogenesis in human males produces haploid gametes, called spermatozoa (sperm cells).

The structure of a mature human spermatozoan consists of three sections: a head, a midpiece and a tail.

For each of these sections, describe how its **internal** structure relates to the function of the spermatozoan.

Head

.....

Midpiece

.....

Tail

.....

[3]

(b) During spermatogenesis, the chromatin in the nuclei of sperm cells undergoes a complex transition where histone is replaced by another protein, protamine, which binds to the DNA.

(i) Protamine contains large quantities of the polar amino acid, arginine.

Suggest why having large quantities of arginine enables protamine to bind effectively to DNA molecules.

[2]

(ii) Substituting histone with protamine allows DNA to be more densely packaged.

Suggest **one** advantage of having densely packaged DNA in a sperm nucleus.

[1]

(c) Spermatogenesis in human males produces haploid gametes, called spermatozoa (sperm cells).

It has been found that protamine deficiency can lead to a severe disruption of spermatogenesis affecting male infertility.

An investigation was carried out into the effect of protamine deficiency on the production of healthy sperm cells.

Forty semen samples were collected from four groups of men as shown in the table.

Group	Sperm count	Motility of sperm
1	normal	normal
2	low	normal
3	normal	low
4	low	low

Microscope slides were prepared by fixing and staining a smear from each semen sample. The staining technique used distinguished between protamine deficient and normal sperm cells.

(i) The researchers concluded that the ages of the men in the groups would not affect the validity of the results of this investigation.

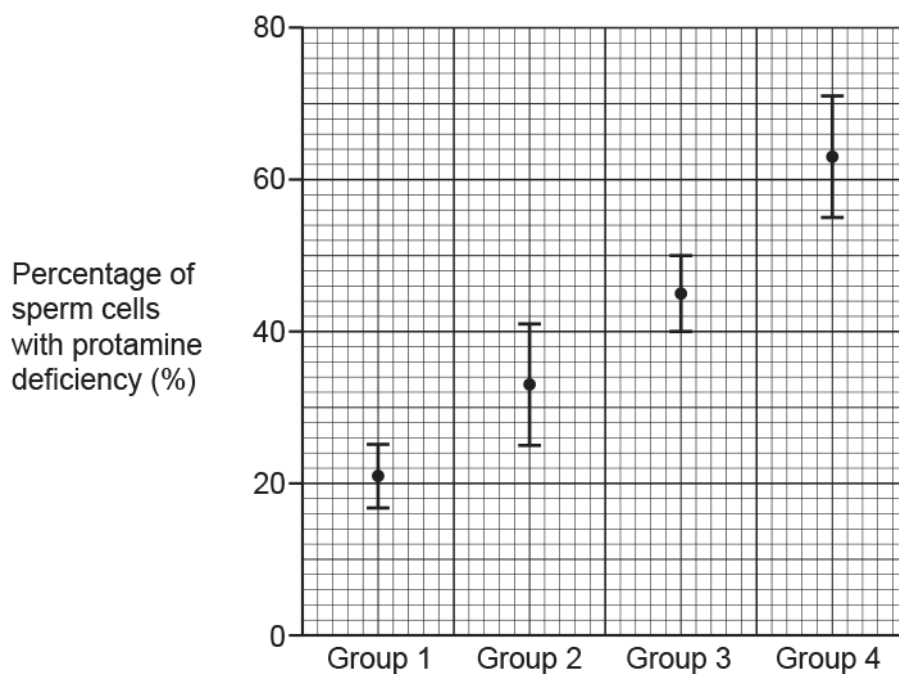
Explain how the researchers could have justified this conclusion.

[2]

(ii) What is the role of **Group 1** in this investigation?

[1]

(iii) The results of the investigation are shown in the graph.



Using the information from the table and the graph, what conclusions can be made about the results of the investigation?

[4]

(d) Female gametes, or ova, are produced during oogenesis.

Compare **and** contrast spermatogenesis and oogenesis in the production of gametes. Include reference to the

[illegible]

[6]

2 Which of the options, **A** to **D**, about the onset of menopause and secretion of female hormones is correct?

- A Secretion of follicle-stimulating hormone (FSH) increases.
- B Secretion of luteinising hormone (LH) decreases.
- C Secretion of oestrogen increases.
- D Secretion of progesterone increases.

Your answer

[1]

3 The contraceptive pill is used to prevent pregnancy. The pill contains synthetic forms of oestrogen and progesterone.

Which of the options, **A** to **D**, is a mechanism by which the pill prevents pregnancy?

- A destruction of the corpus luteum
- B inhibition of FSH and LH secretion
- C thickening of the uterine lining
- D stimulation of GnRH secretion

Your answer

[1]

4 The tail of a sperm cell generates whipping movements that enable the cell to swim.

Which of the options, **A** to **D**, is the component that generates movement in the tail of a sperm cell?

- A actin
- B microtubule
- C myosin
- D troponin

Your answer

[1]

5(a) Fig. 5, below and on the Insert for H422/03, June 2019, is a photomicrograph of a human ovary. Structures within the ovary have been labelled, A to F.

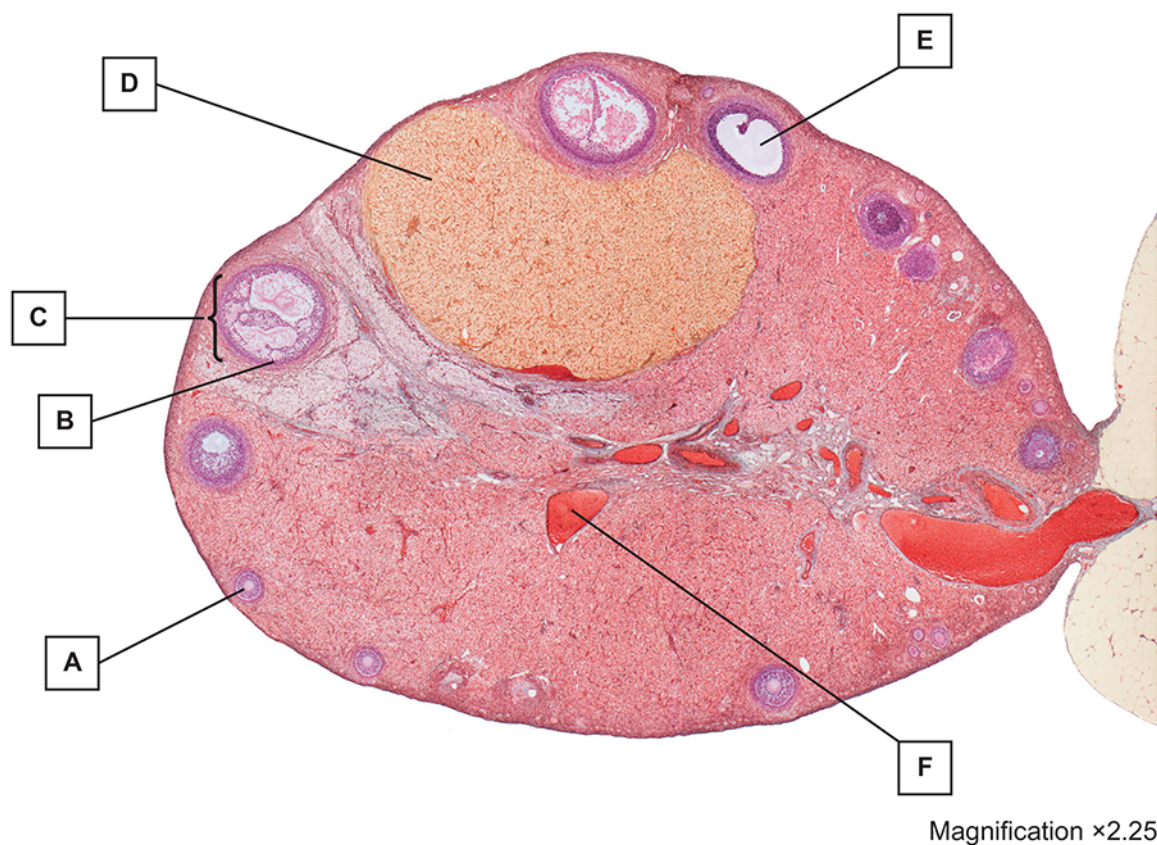


Fig. 5

Using Fig. 5, complete the table below by identifying the structure or label that best fits the description.

Description	Structure	Label
Supplies blood to the ovary	central coiled blood vessel	F
Contains receptors on plasma membranes for FSH		A
Releases oestrogen	follicle	
Contains a haploid nucleus		E
Produces progesterone		D
Gel layer composed of glycoproteins	zona pellucida	

[5]

(b) * The appearance of an ovary changes with age.

A student observed the ovary in Fig. 5 and concluded that this ovary was from a woman who had not yet started menopause.

Analyse Fig. 5 and comment on this conclusion.

[6]

6(a) Fallopian tube cancer may result in the formation of tumours in the epithelial tissue lining the Fallopian tubes.

Fallopian tube cancer treatment often results in infertility. Patients whose treatment has resulted in infertility may be offered egg freezing and subsequent *in vitro* fertilisation (IVF) treatment at a fertility clinic.

Fertility clinics have different mean annual pregnancy rates. Table 2.1 contains some information about mean annual pregnancy rates in two clinics each treating 400 patients.

	Mean annual pregnancy rate (% embryos transferred)
Clinic A	23
Clinic B	16

Table 2.1

The standard deviation, s , for both means is 9.7.

The Student’s t -test can be performed to compare the mean annual pregnancy rate at each clinic and determine if the two are significantly different from each other.

(i) State the null hypothesis for this test.

[1]

(ii) Calculate the variance, s^2 , for these means.

variance = ... [1]

(iii) Calculate the t value for the data in Table 2.1.

Use the formula:

$$t = \frac{|\bar{x}_A - \bar{x}_B|}{\sqrt{\frac{s_A^2}{n_A} + \frac{s_B^2}{n_B}}}$$

Give your answer to **three** decimal places.

$t =$ [3]

(iv) Critical values for degrees of freedom >100 are shown in Table 2.2.

Degrees of freedom	Level of probability		
	0.05	0.01	0.001
>100	1.960	2.576	3.291

Table 2.2

Using Table 2.2 and your answer to (iii), comment on the mean annual pregnancy rates for clinics A and B.

[3]

(b) The stages in one type of IVF treatment are shown below:

1. Hormones are used to stimulate several follicles within the ovary to mature at the same time.
2. Follicles are collected from the ovaries and the oocytes removed.
3. These oocytes are mixed with sperm in a Petri dish.
4. After several days the oocytes are checked for fertilisation.
5. Any resulting embryos are left to develop in an incubator for two to five days.
6. One embryo is transferred into the uterus.

During this treatment:

- The typical number of oocytes collected during stage 2 is between 5 and 25.
- Approximately 50% of the oocytes collected will be fertilised during stage 3.
- Of the total number of oocytes collected during stage 2, about 25% will result in a healthy embryo.

Discuss the ethical issues raised by this type of IVF.

You should use the information provided in your answer.

[4]

7 The β -defensins are a group of peptides found in the male reproductive tract.

One β -defensin is coded for by the *DEFB126* gene. Men who are homozygous for a mutation in *DEFB126* have a normal sperm count with normal motility, but the sperm have a reduced ability to penetrate hyaluronic acid (a model for female cervical mucus).

(i) Suggest why it is thought that the *DEFB126* mutation reduces the chance of successful fertilisation.

----- [2]

(ii) It is estimated that 22% of all Europeans are homozygous for the recessive mutant form of *DEFB126*.

Calculate the allele frequency of the mutant form of *DEFB126* in all Europeans (men and women).

Use the Hardy-Weinberg equations:

$$p + q = 1 \qquad p^2 + 2pq + q^2 = 1$$

Give your answer to 2 significant figures.

frequency = ... [2]

(iii) The fact that the *DEFB126* mutation reduces the chances of successful fertilisation means that, in theory, the allele frequency should have fallen.

Suggest why the allele frequency of the *DEFB126* mutation remains high.

- 8 A Robertsonian translocation is a type of chromosomal translocation in which the long arms of two chromosomes fuse together.

Fig. 31.1 shows this event occurring between chromosomes 14 and 21.

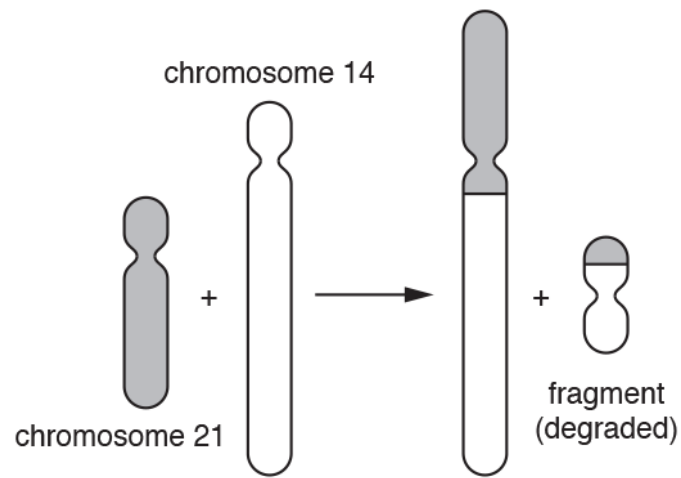


Fig. 31.1

An individual who inherits the translocated chromosome in Fig. 31.1 will either have Down's syndrome or be a carrier of the disorder.

A couple have a child. The mother is a carrier and the father is genetically normal. The genetic material with respect to chromosomes 14 and 21 in the somatic cells of the parents are shown in Fig. 31.2.

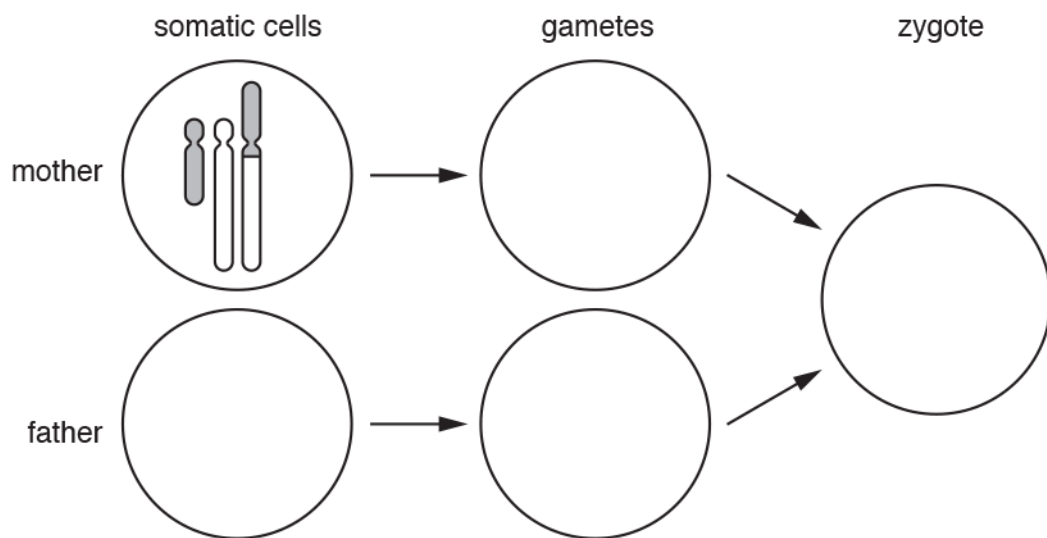


Fig. 31.2

(i) With reference to Fig. 31.2, suggest why the mother does **not** have Down's syndrome.

----- [1]

(ii) The child is born with Down's syndrome.

Complete the diagram in Fig. 31.2 to show the genetic material with respect to chromosomes 14 and 21 in:

- the somatic cell of the father
- the gametes of the mother and father
- the zygote of the child.

[Answer on Fig. 31.2]

[4]

9 Which of the options, **A** to **D**, is an action of luteinising hormone (LH) in males?

- A** inhibition of follicle-stimulating hormone (FSH) release
- B** initiation of spermatogenesis
- C** sensitisation of testicular cells to testosterone
- D** stimulation of testosterone release

Your answer

[1]

10 Meiosis II pauses in the secondary oocyte and is only completed if fertilisation occurs.

Which of the options, A to D, is a description of the **last** meiotic stage prior to fertilisation?

- A Homologous chromosomes align to the equator of the oocyte.
- B Homologous chromosomes migrate to opposite poles of the oocyte.
- C Single chromosomes align to the equator of the oocyte.
- D Sister chromatids migrate to opposite poles of the oocyte.

Your answer

[1]

11

Physiological ageing leads to changes in the male reproductive system. These changes can cause infertility and erectile dysfunction.

- (i) Explain the difference between male infertility and erectile dysfunction.

----- [2]

- (ii) State one factor, other than physiological ageing, that can cause erectile dysfunction.

----- [1]

12(a)

Oogenesis occurs in the ovaries of female mammals, resulting in the production of gametes.

- (i) Name the type of nuclear division that results in the production of **secondary** oocytes from **primary** oocytes during oogenesis.

-----[1]

- (ii) Complete the table below to indicate the stage and type of nuclear division in which the events being described occur.

Event	Type of nuclear division	Stage in nuclear division
Chromosomes line up on the equator; there is no association between homologous chromosomes.		
Homologous chromosomes form bivalents.		
Homologous chromosomes separate and are pulled to opposite poles.		
Crossing over occurs.		

[4]

- (b) Fig. 2.1 shows how oestrogen production varies throughout life in human females.

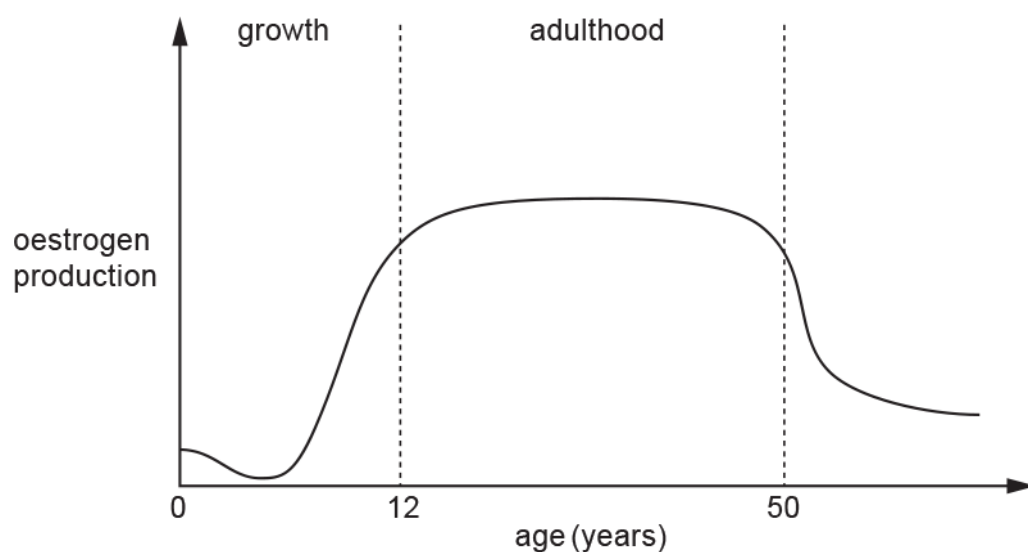


Fig. 2.1

- (i) Explain how the rapid increase in oestrogen production towards the end of the growth phase results in the release of secondary oocytes.

[2]

- (ii) Changes occur to the cells within ovaries over the course of a woman's lifetime.

Use the data in Fig. 2.1 to explain the role of oestrogen production in the changes to ovarian cells that occur during adulthood.

In your answer you should refer to the stages of nuclear division that occur.

[3]

- 13 In spermatogenesis, crossing over of the chromatids of homologous chromosomes gives rise to genetic variation.

Which of the options, **A** to **D**, is the cell type in which crossing over occurs?

- A** primary spermatocyte
- B** secondary spermatocyte
- C** spermatogonium
- D** spermatid

Your answer

[1]

14(a) Fig. 2.1 shows a primary oocyte and its surrounding tissue.

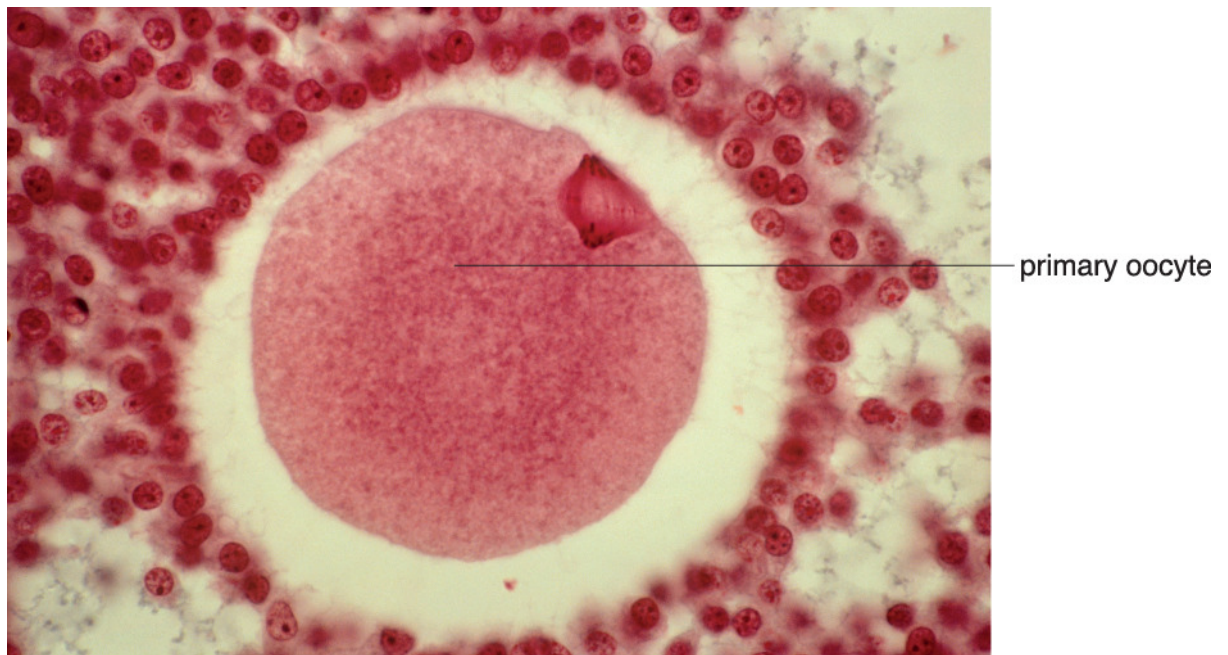


Fig. 2.1

(i) Name the type of nuclear division occurring in a primary oocyte.

-----[1]

(ii) Name the phase of division shown in Fig. 2.1.

-----[1]

(b) Fig. 2.2 shows a student's plan drawing of the primary oocyte shown in Fig. 2.1.

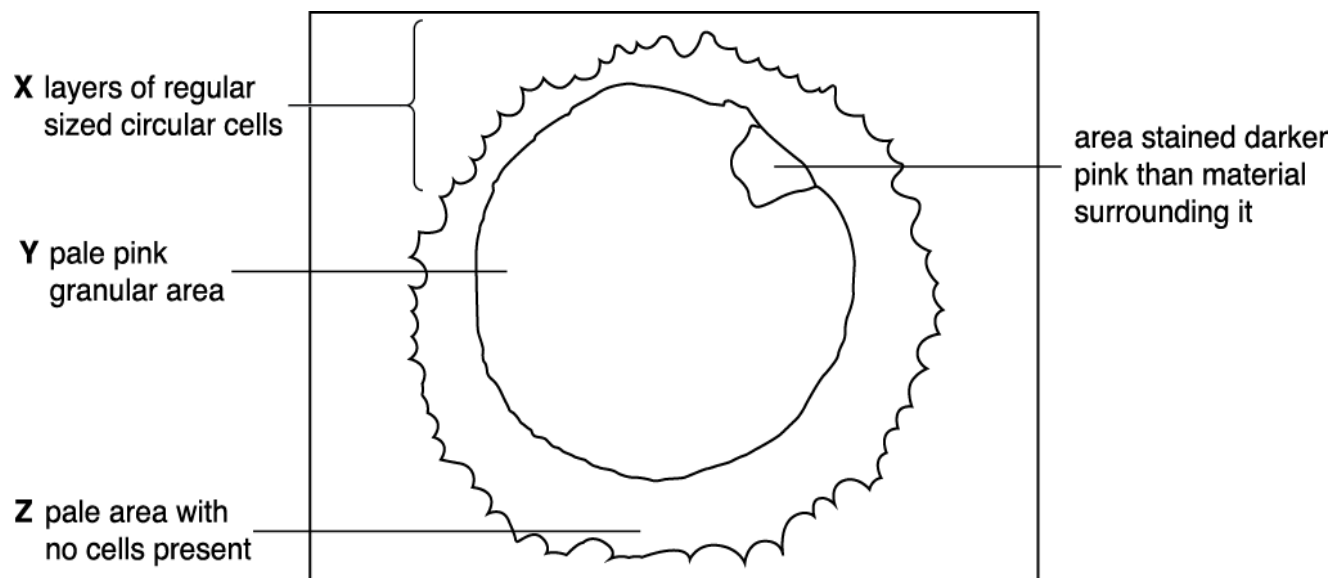


Fig. 2.2

Identify structures X, Y and Z in Fig. 2.2.

X _____

Y _____

Z _____

[3]

- (c) Fig. 2.3 are photomicrographs of two different seminiferous tubules from adult males.

The magnification of the two photomicrographs is the same.

Describe the structural differences in cells and tissues in the two photomicrographs.

[2]

- (d) Treatment for infertility in men may involve giving weekly injections of the hormone human chorionic gonadotropin (hCG). This stimulates the synthesis of testosterone.

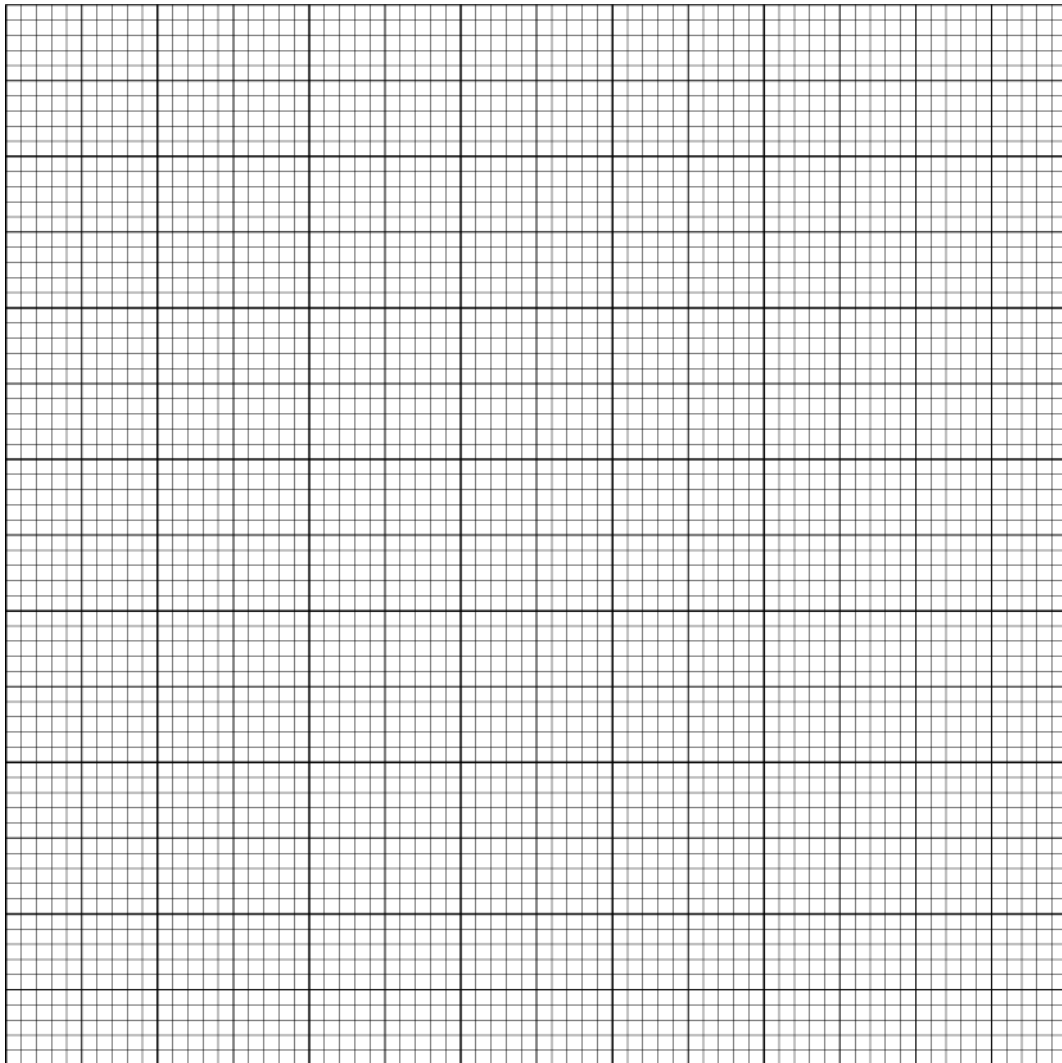
Testosterone is needed for spermatogenesis.

Table 2.1 shows the data collected from men undergoing this treatment.

Days from start of treatment	Mean sperm count (million per cm ³)
0	25
30	35
60	44
90	60
120	69

Table 2.1

- (i) Plot a graph on the grid provided to show this data in the most appropriate way.



[4]

The standard deviations for the data were also calculated, as shown in Table 2.2.

Days from start of treatment	Standard deviation
0	20.2
30	18.5
60	15.6
90	14.5
120	12.6

Table 2.2

(ii) What do the standard deviation figures in Table 2.2 tell you about the sperm count of men undergoing this treatment?

----- [1]

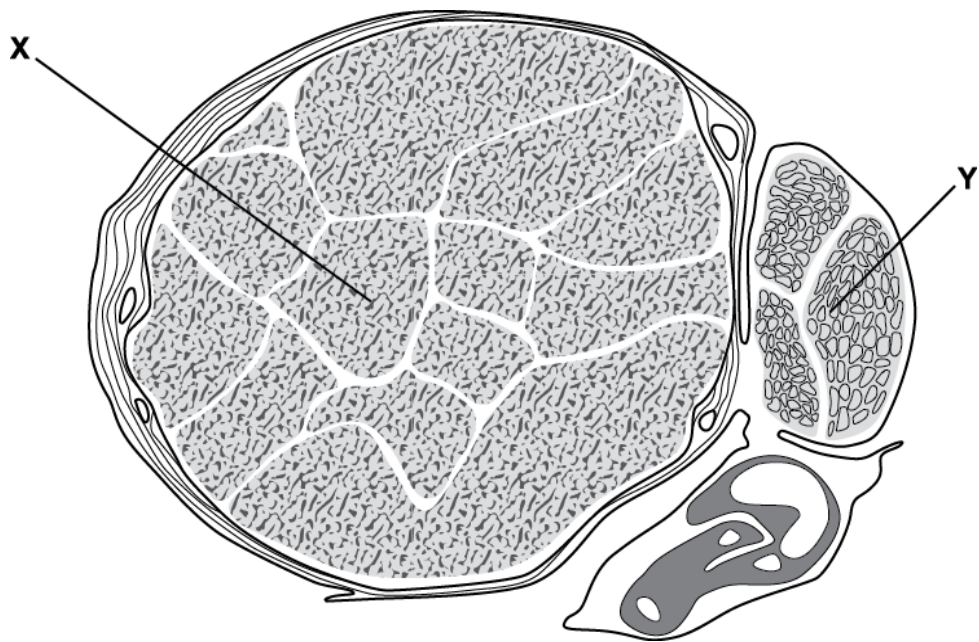
(iii) Calculate the rate at which mean sperm count increases over the 120 days of hCG treatment.

Give your answer to 2 significant figures. Use appropriate units.

Answer ----- [2]

15 The photomicrograph below shows a transverse section through a testis.

Two regions are labelled X and Y.



Which of the rows, A to D, from the table below correctly identifies features of X and Y?

	Production of seminal fluid	Site of FSH activity	Storage of sperm
A	neither X nor Y	X	Y
B	neither X nor Y	Y	X
C	Y	X	Y
D	Y	X	X

Your answer

[1]

16(a) Fig. 3.1 is a diagram of some of the structures found in the female excretory system.

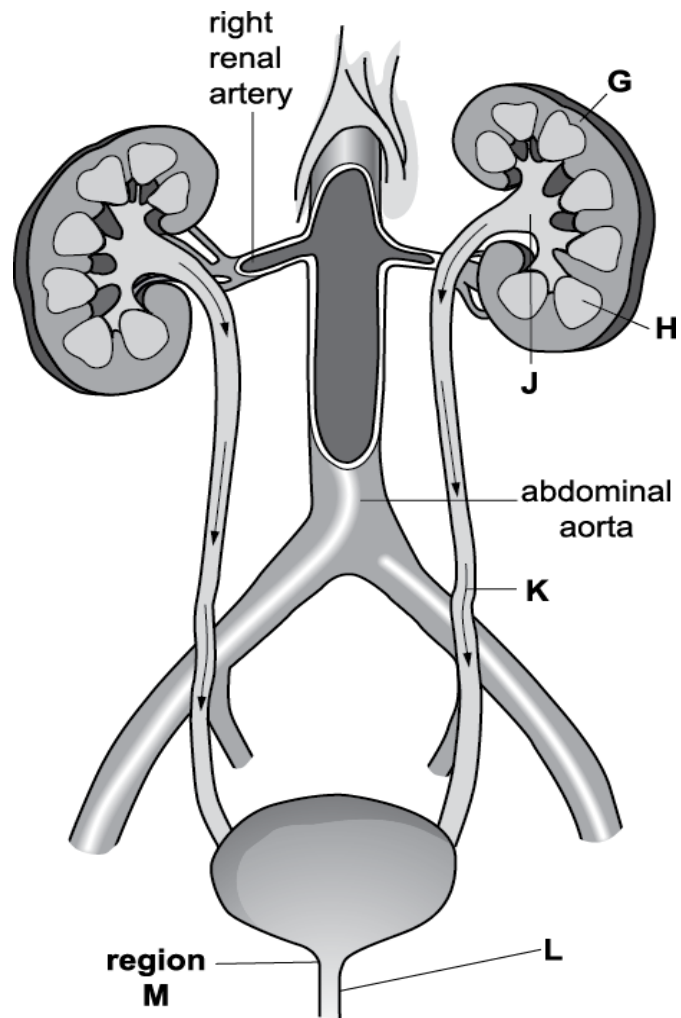


Fig. 3.1

Insert the letter or letters that correspond to each of the following:

(i) a renal pyramid _____

[1]

(ii) the ureter _____

[1]

(iii) where ultrafiltration occurs _____

(b) Name one structure that would be present at **region M** in males.

[1]

17 Chemicals in cigarette smoke have been shown to cause damage to cells in ovaries. Damaged cells are no longer able to perform their normal function.

Explain how damage to cells in the ovaries could result in an earlier onset of the menopause.

[2]

18(a) The growth of a human being from a zygote into a sexually mature adult involves many cycles of cell division by both mitosis and meiosis.

Once formed, cells may differentiate. Some cells will group and become part of a tissue or an organ. Other cells, such as gametes, remain as individual single cells.

The following cells, J, K, L and M, are found in either the human male or human female:

- | | |
|---|----------------------|
| J | oogonium |
| K | primary spermatocyte |
| L | secondary oocyte |
| M | Sertoli cell. |

State the cell or cells from the list above that fit the following descriptions:

(i) diploid cells

-----[1]

(ii) an embryonic diploid cell

-----[1]

(iii) a cell formed by meiosis I.

-----[1]

- (b) In the menstrual cycle, the activity of the reproductive organs is controlled by hormones. Some of these hormones, such as oestrogen, are steroid hormones. Others, such as follicle stimulating hormone (FSH) and luteinising hormone (LH), are glycoproteins.

Oestrogen, FSH and LH molecules carry out their function by binding to receptors.

- Oestrogen receptors are found in the cytoplasm of target cells.
- FSH and LH receptors are found on the cell surface membranes of target cells.

- (i) Suggest why receptors for FSH and LH are located on the cell surface membranes but the receptors for oestrogen are located in the cytoplasm.

----- [2]

- (ii) Name the organ responsible for the secretion of FSH and LH.

----- [1]

(c) Fig. 4.1 shows a simplified diagram of the action of the hormone oestrogen on a target cell.

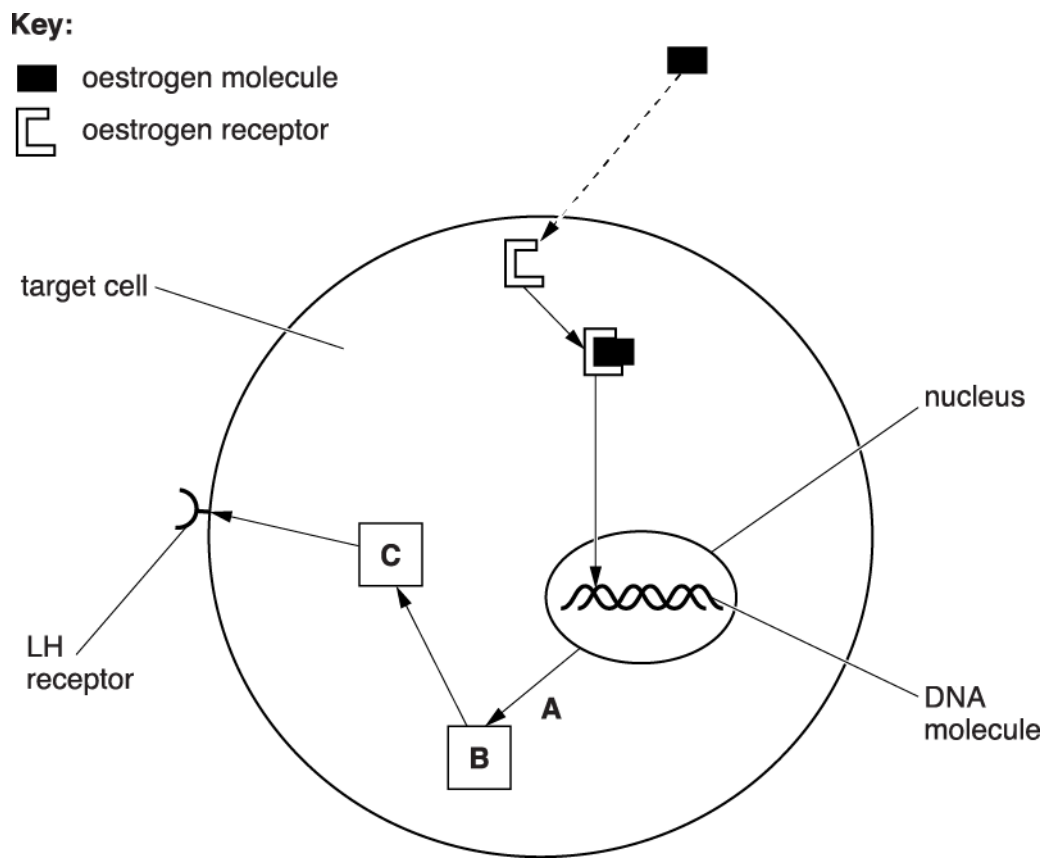


Fig. 4.1

(i) Complete the table below by naming the following molecules and organelles represented in Fig. 4.1.

	Name
Molecule A	
Organelle B	
Organelle C	

[3]

(ii) Suggest the location and the role of the target cell shown in Fig. 4.1.

-----[2]

(d) Cells in the endometrium (the lining of the uterus) have receptors for follicle stimulating hormone (FSH).

Suggest what effect FSH has on the DNA in the nuclei of cells in the endometrium during days 5 to 14 of the menstrual cycle.

Give the reason for your suggestion.

-----[2]

19(a) Some couples are unable to conceive naturally. The Human Fertilisation and Embryo Authority (**HFEA**) regulates the use of fertility treatment and other assisted conception procedures that are carried out in the UK.

- A possible cause of male infertility may be anatomical abnormalities of the male reproductive system.
- One procedure that has been developed in recent years is Surgical Sperm Removal (**SSR**).
- In this procedure, microsurgery is carried out under local anaesthetic and a fluid containing sperm is collected directly from the epididymis.

(i) Name the structure through which sperm normally leave the epididymis.

----- [1]

(ii) Suggest why the concentration of sperm in the fluid collected from the epididymis will be greater than that in semen.

----- [2]

(b) Sperm that has been collected using **SSR** may be used in **IVF** treatment or in **ICSI**.

(i) State what the initials **IVF** and **ICSI** represent.

IVF -----
ICSI -----
[1]

(ii) More embryos result from the use of **SSR**-collected sperm in **ICSI** than from the use of **SSR**-collected sperm in **IVF** treatment.

Suggest why.

----- [1]

- (c) The successful outcome of fertility treatment is pregnancy. If a woman suspects that she may be pregnant, a pregnancy test stick may be used to confirm the pregnancy.

The test stick contains free molecules of an antibody attached to coloured beads containing a dye. The antibodies are specific to the hormone Human Chorionic Gonadotrophin (HCG), which is produced during pregnancy.

- (i) State the region of the antibody molecule that is attached to the coloured bead **and** state the region that will bind to HCG.

Region attached to coloured bead _____

Region that will bind to HCG _____

[1]

- (ii) Fig. 1.1 shows a pregnancy test stick and four possible results, W, X, Y and Z, that could appear in the oval result window.

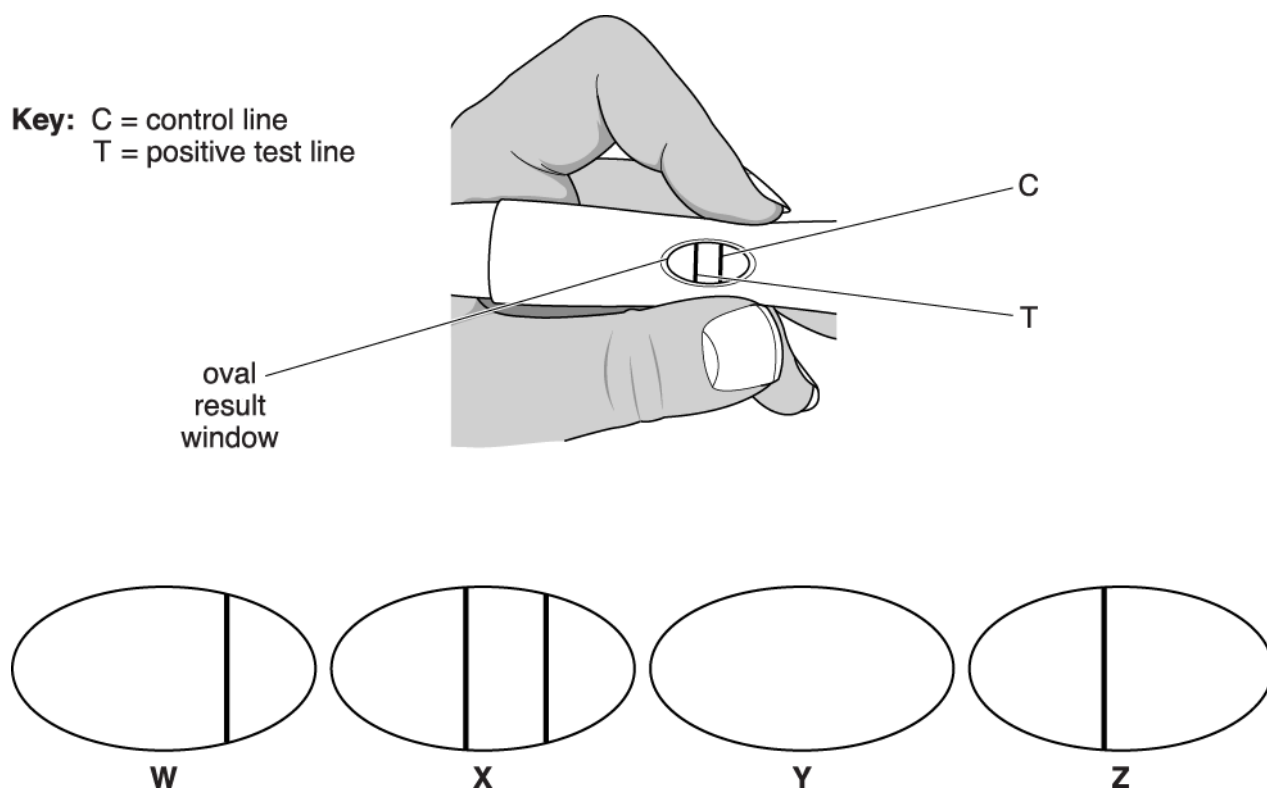


Fig. 1.1

Complete the table below to indicate which conclusions can be drawn from the results shown in windows W

to Z in Fig. 1.1.

Choose from the following:

- pregnant
- not pregnant
- result not valid.

Result window	Conclusion
W	
X	
Y	
Z	

[2]

20(a) Storage of sperm by cryopreservation is not limited to human sperm samples.

The maintenance of the dairy cow population in the United Kingdom also relies on being able to store semen from bulls. These bulls have been bred to father offspring with a high milk yield. Their semen is used to inseminate cows that have also been bred to produce a high milk yield.

Sperm cells may become damaged during cryopreservation or during the thawing process.

Most of the damage that occurs is due to the disruption of the cell surface membranes or intracellular membranes, such as the nuclear envelope.

In addition to the nuclear envelope, identify two further **intracellular** membranes that may be damaged during the cryopreservation or thawing of sperm cells.

1

2

[2]

- (b) Following cryopreservation and thawing, it is important to be able to assess the viability of the sperm before the sample is used.

Since many samples have to be assessed, techniques have been developed that can be automated.

A technique that can be used is flow cytometry.

- Sperm cells are labelled with two different fluorescent molecules.
- A molecule that fluoresces **green**, labels only **undamaged, viable** sperm.
- A molecule that fluoresces **red**, labels only sperm with **membrane damage**.
- Samples containing approximately 10 000 sperm cells are analysed in a flow cytometer.
- The flow cytometer counts the numbers of green and red cells.

Semen from six different bulls was stored using cryopreservation and then thawed.

The thawed semen was analysed using the technique described above.

Table 6.1 on page 17 shows the results obtained.

Results:

Semen sample	Sperm fluorescing green		Sperm fluorescing red	
	Mean percentage	Standard deviation	Mean percentage	Standard deviation
1	47.6	2.5	49.3	2.6
2	56.0	1.2	37.0	1.5
3	47.3	1.5	48.7	1.7
4	50.4	1.1	45.5	1.2
5	52.8	2.7	40.9	2.9
6	47.7	2.8	49.2	2.8

Table 6.1

- (i) Using the information in Table 6.1, describe the effect of cryopreservation on the viability of the sperm in the semen samples.

[2]

- (ii) The standard deviation is a measure of the spread of data around the calculated mean.

The investigators concluded that there was no significant difference between the numbers of red fluorescing sperm cells in semen samples 2 and 5.

Does the evidence in Table 6.1 support this conclusion?

Explain your answer.

[1]

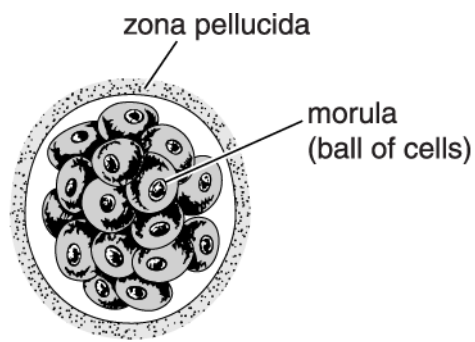
21(a) The human placenta can be considered unique amongst the many human organs in that, unlike other organs, it is a temporary structure.

After implantation, it is essential that the placenta develops correctly so that pregnancy is successful.

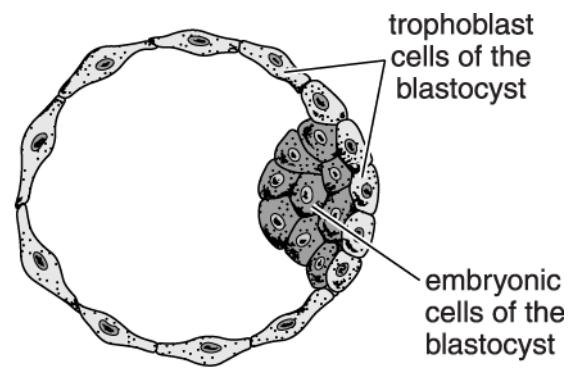
Using the placenta as an example, explain what you understand by the term *organ*.

[2]

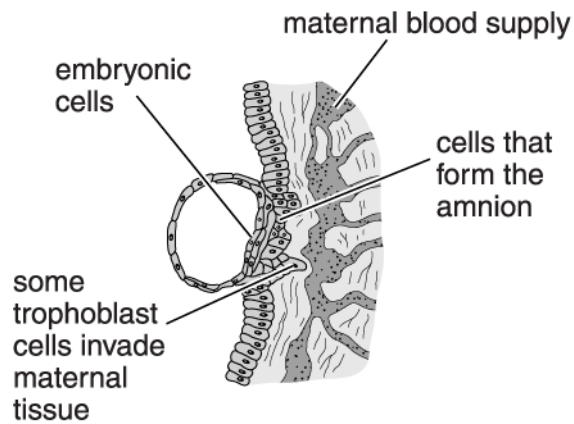
(b)



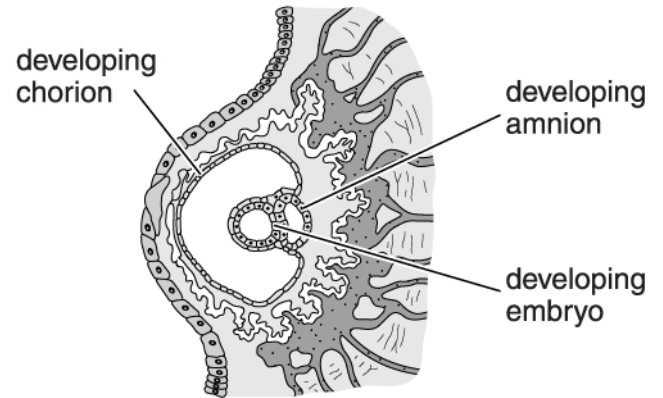
(a) 3–4 days



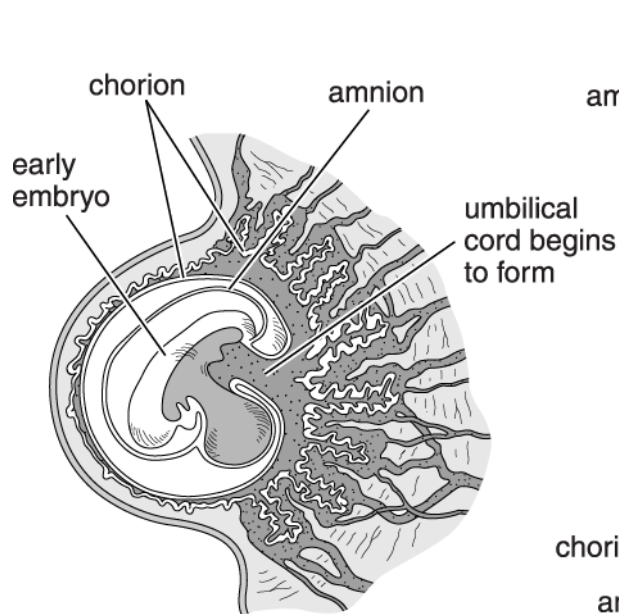
(b) 5–6 days



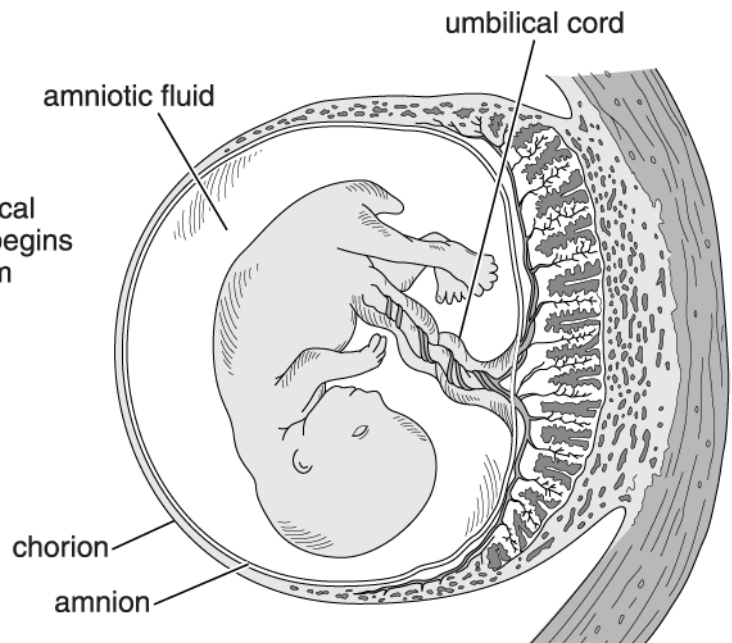
(c) 7–8 days



(d) 3 weeks



(e) 4 weeks



(f) 8 weeks

Fig. 1.1

Fig. 1.1 shows some of the stages that follow fertilisation and the early events in the development of the embryo and the placenta. The diagrams are not drawn to scale.

The following passage describes some of these events.

Complete the passage by inserting the **most appropriate** term.

Immediately following fertilisation, the _____ divides rapidly by _____.

Within three to four days, a ball of cells known as the morula has been formed. The formation of the morula occurs as it travels down the _____.

The morula develops into the blastocyst. The blastocyst implants into the _____ of the uterus approximately seven days after fertilisation.

Some of the dividing cells in the blastocyst _____ to form structures in the early embryo. Other cells will eventually become part of the structures that protect the developing embryo, such as the amnion and the chorion. These are known as the **extra-embryonic membranes**.

[5]

- (c) One role of the trophoblast cells shown in Fig. 1.1(b) is to secrete the hormone human chorionic gonadotrophin (HCG).

State the role of HCG in pregnancy.

----- [1]

- (d) It is important that clinicians identify that a mother is carrying twins.

State the term that is given to the condition where twins are known to be present in the uterus.

----- [1]

- (e) Identical twins may or may not share some of the extra-embryonic membranes that develop in early pregnancy. This depends on the stage at which the embryonic cells split into two separate groups of cells.

The three possible types of identical twin are shown in Table 1.1.

Description	Name of twin type
Each twin has a separate chorion and amnion	Dichorionic-diamniotic or DiDi
Both twins share the same chorion and amnion	Monochorionic-monoamniotic or MoMo
Both twins share the same chorion but each has a separate amnion	Monochorionic-diamniotic or MoDi

Table 1.1

- (i) Using the information in Fig. 1.1 and Table 1.1, suggest which type of identical twin will form if the embryonic cells split between 5 and 6 days after fertilisation.

-----[1]

- (ii) Using the information in Table 1.1, state which of the three types of twins could also be **non-identical twins**.

-----[1]

- (iii) Using the information in Fig. 1.1(f), suggest why **MoMo** twins (both twins sharing the same chorion and amnion) are at a higher risk of experiencing oxygen deprivation in the later stages of pregnancy.

 -----[1]

- (iv) How does a clinician identify that a mother is carrying twins?

 -----[1]

22 Monitoring the changes in the body brought about by reproductive hormones is an important part of fertility treatment.

Hormones control the production of mucus by cells of the cervix.

- Cervical mucus contains water and glycoproteins known as mucins.
- The mucus changes from a thick, sticky consistency to a thin, watery consistency in response to changing levels of reproductive hormones.

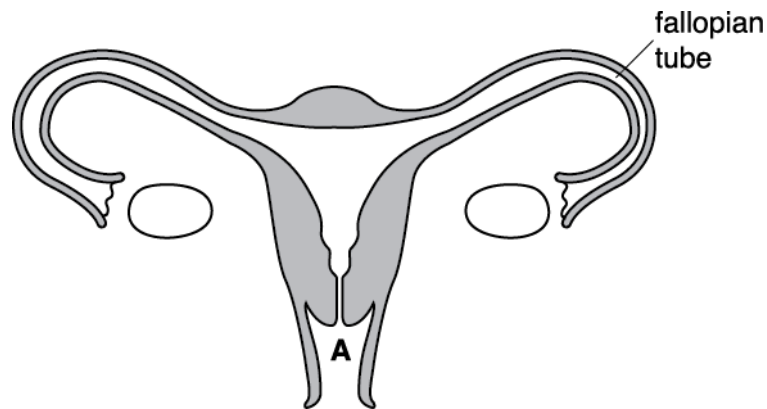
Clomiphene is a fertility drug. It binds to oestrogen receptors in the hypothalamus preventing oestrogen from binding.

Clomiphene stimulates more follicles to mature in the ovaries. This increases the chances of a successful pregnancy.

Suggest how clomiphene increases the chances of a successful pregnancy.

[3]

23(a) The figure shows a diagram of the female urinogenital system.

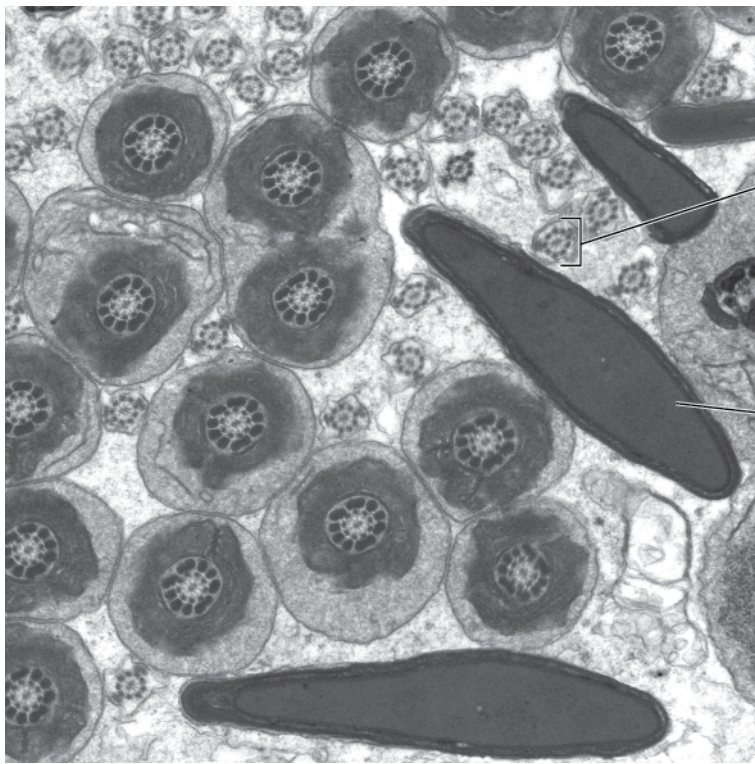


Draw a line the figure, starting at the region labelled **A**, to indicate the path that sperm travel before meeting a secondary oocyte.

This question should be answered on the figure.

[1]

- (b) The following figure is a photomicrograph of sperm cells in the testes. Some of the sperm cells are seen in cross-section.



Identify the precise part of the sperm cell labelled A in the photomicrograph.

----- [2]

(c) Fertilisation is the fusion of a male and female gamete.

Outline how fertilisation increases genetic variation.

----- [2]

(d) Implantation is the first stage of pregnancy.

- (i) Name the stage of embryo development that consists of a few dozen cells, which form approximately five days after fertilisation.

-----[1]

- (ii) State the precise location where implantation usually occurs.

-----[2]

- (iii) The implantation of a fertilised egg in the fallopian tube is known as an ectopic pregnancy.

Suggest why the symptoms of an advanced ectopic pregnancy may be low blood pressure and a high pulse rate.

-----[2]

24(a) Hormones such as luteinising hormone (LH) and human chorionic gonadotrophin (hCG) play a key role in the control of the menstrual cycle and in the establishment of a pregnancy.

LH and hCG are large glycoproteins each consisting of two protein subunits.

- The alpha subunit is identical in both hormones and is a chain of 92 amino acids.
- The beta subunit of LH contains 121 amino acids.
- The beta subunit of hCG contains 145 amino acids.
- LH can be detected in urine using a test strip containing monoclonal antibodies.
- Monoclonal antibodies are complementary to one specific area on a large antigen molecule. This area is known as an **epitope**.

- (i) Suggest which part of the LH molecule acts as an epitope for the production of the monoclonal antibodies in urine testing kits. Explain your reasoning.

[2]

- (ii) Fig. 6.1 is a diagram of an LH testing strip.

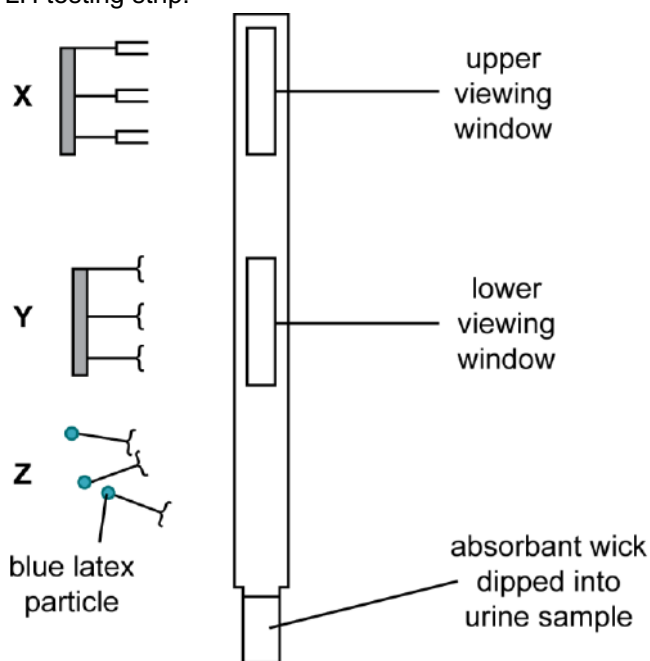


Fig. 6.1

The molecules X, Y and Z represent the monoclonal antibody molecules used in the test strip.

Which molecule(s) would be specific to LH?

-----[1]

(b) The four test strips, D to G in Fig. 6.2, show possible results following the testing of a sample of urine.

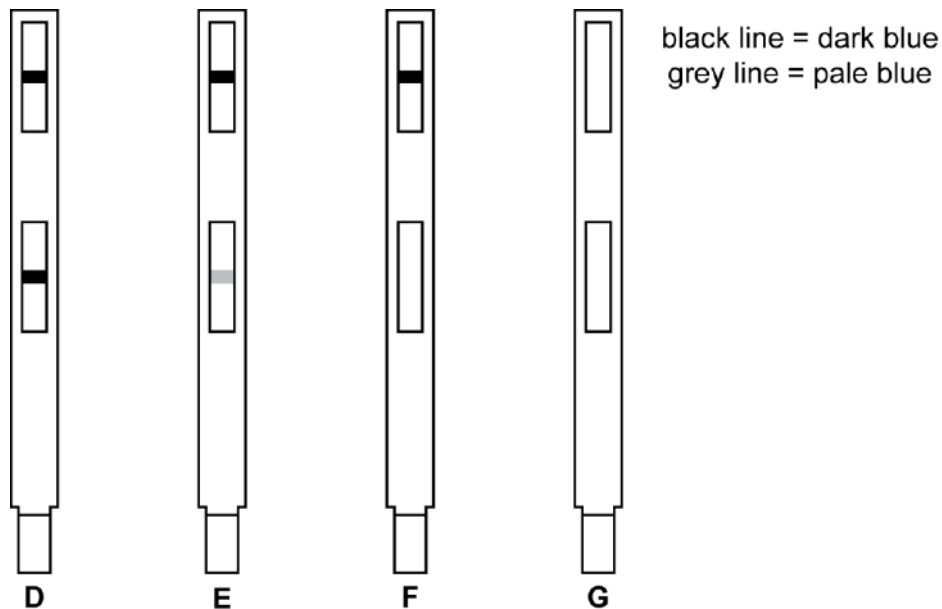


Fig. 6.2

(i) Which test strip(s) in Fig. 6.2 indicate the presence of LH?

-----[1]

(ii) Which of the test strips shown in Fig. 6.2 indicates that **ovulation** has taken place?

Explain your answer.

-----[2]

(iii) The time taken to metabolise and excrete hormones is expressed as their **half-life**.

- The half-life of LH is **20 minutes**.
- The half-life of most other reproductive hormones is several hours.

Suggest why the short half-life of LH increases the risk of a **false negative result** when using an LH test strip.

-----[1]

(c) For intrauterine insemination to be successful, the timing of insemination must coincide with successful ovulation.

- LH and hCG are known to bind to the same receptors.
- Injections of hCG can be given so the time of ovulation is known precisely.
- hCG has a half-life of up to 39 hours.

Explain why a **false positive** result could occur if a **pregnancy test** is taken too soon after an **hCG** injection and intrauterine insemination.

[2]

25 Mice with a knockout of the gene encoding GnRH are infertile.

A study was carried out with GnRH-knockout mice to compare the effectiveness of two treatments for infertility.

Three groups each containing five females were treated from birth with weekly injections of:

- sodium chloride (S)
or
- synthetic FSH and LH (FL)
or
- synthetic GnRH (G).

The mice treated with sodium chloride were used as controls.

One fertile male was housed with each group of five females. Fertility was measured as the number of successful pregnancies (becoming pregnant and producing young) for each female (1 to 5) over the course of 120 days.

The results are shown in Table 35.1.

Treatment group	Number of successful pregnancies						
	Mouse 1	Mouse 2	Mouse 3	Mouse 4	Mouse 5	Mean	Standard deviation
S (control)	0	0	0	0	0	0	0.0
FL	2	6	7	1	5	4.2	
G	3	1	2	2	1	1.8	0.8

Table 35.1

(i) Explain why a knockout of the gene encoding GnRH causes infertility in female mice.

[2]

(ii) Using the formula provided, calculate the standard deviation for the data in the FL treatment group in Table 35.1.

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

Standard deviation = ... [2]

- (iii) Using your standard deviation and the data in **Table 35.1**, evaluate the relative effectiveness of the two hormone treatments for the restoration of fertility in GnRH– knockout mice.

.....

.....

.....

..... [2]

- (iv) State **one** variable that should have been controlled during this investigation to ensure the **validity** of the conclusions.

.....

..... [1]

26(a) Several factors are known to affect fertility in men. One of these factors is Body Mass Index (BMI).

Table 35.1 shows measurements obtained for semen samples from two groups of men with different BMIs.

Group	Number in group	BMI	Mean semen volume (cm ³)	Mean total sperm count (10 ⁶)	Mean total progressively motile sperm (10 ⁶)
A	47	20–25	2.6	342.0	74.2
B	50	>25	3.0	413.1	110.4

Table 35.1

- (i) What can be concluded about the effect of BMI on the **concentration** and **quality** of semen samples in this study?

Analyse the information in **Table 35.1** to support your conclusion.

[4]

- (ii) Suggest **two** ways in which the design of this study could be modified in order to improve the validity of a conclusion about the effect of BMI on fertility in men.

[2]

(b) Ageing is known to affect the male urinogenital system in a number of ways.

Fig. 35.1 is a diagram of the male urinogenital system.

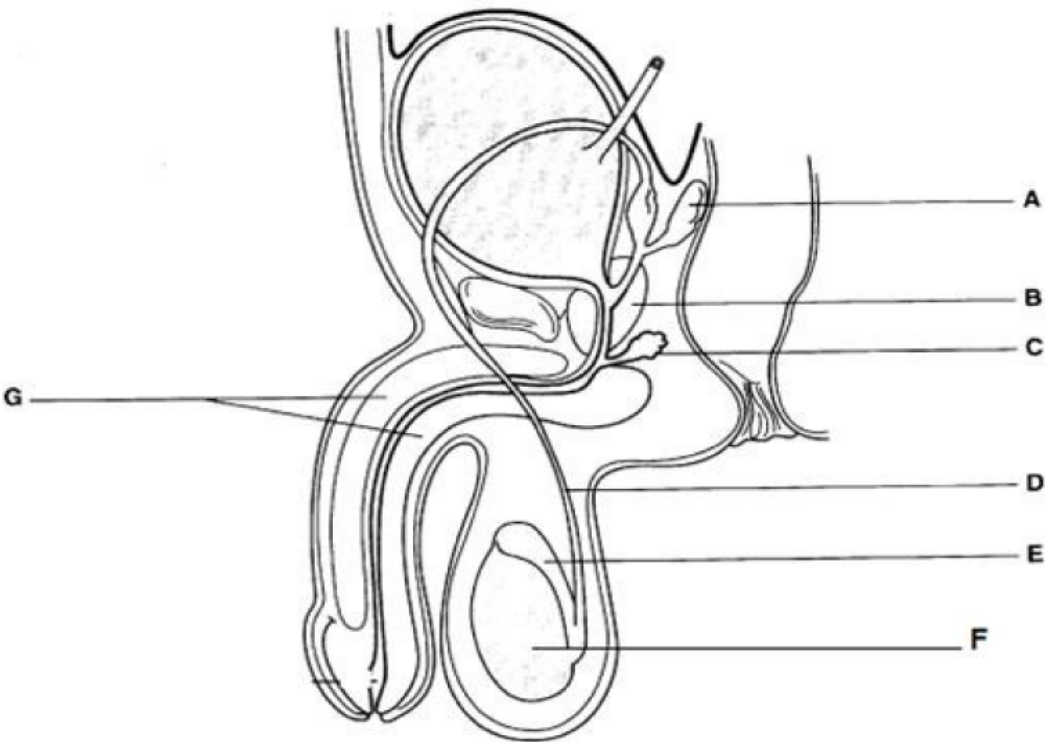


Fig. 35.1

Complete Table 35.1 below so that the correct letter from Fig. 35.1 is against each of the following statements:

Statement	Letter
If this is enlarged it can lead to difficulty in starting to urinate or emptying a full bladder.	
Changes in this structure mean sperm can fail to become motile.	
Changes in this structure can lead to more chromosome abnormalities in sperm.	
Changes in tissues here can lead to erectile dysfunction.	

Table 35.1

[4]

27 A pregnancy can be confirmed by detecting a substance which is only present in urine if an early embryo is developing.

Which of the following substances is present in the urine of a woman who is pregnant?

- A HCG antigen
- B HCG antibody
- C GnRH antigen
- D GnRH antibody

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		<i>head</i> (contains) <u>haploid</u> nucleus AND to ensure diploid number of chromosomes is maintained on fertilisation ✓ (has) <u>acrosome</u> AND contains hydrolytic enzymes to digest zona pellucida ✓ max 1 <i>midpiece</i> (contains) <u>mitochondria</u> AND (provide) energy for movement / tail (of spermatozoa) ✓ <i>tail</i> (contains) contractile fibres / microtubules / flagellum AND creates whip-like movements / enable swimming action ✓	3 max(A O1.1)	Structure AND function required for 1 mark in each section ALLOW for fertilisation of haploid secondary oocyte / to donate DNA (to zygote formed) at fertilisation DO NOT ALLOW to create / make energy
	b	i	DNA has phosphate (groups) in the backbone ✓ phosphate (group) is charged ✓ <i>idea that</i> forces of attraction occurs between opposite charges on phosphate and arginine ✓	2 max(A O2.1)	ALLOW has sugar-phosphate backbone
		ii	enables sperm nucleus to be small ✓ greater protection of DNA molecules ✓	1 max(A O2.1)	ALLOW enables the head of the sperm to be small
	c	i	similar age men used in all study groups ✓ no significant difference in (mean) age of men in study ✓	2(AO3.2)	
		ii	control (group)	1(AO3.3)	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	1 group 1 / men with normal sperm count and motility had lowest percentage of sperm with protamine deficiency ✓ 2 group 4 / men with low sperm count and motility had highest percentage of sperm with protamine deficiency ✓ 3 (group 3 and 4 shows) protamine deficiency affects sperm motility more than sperm count / AW ✓ 4 percentage of sperm with protamine deficiency is higher in men with , low fertility / infertility ✓ 5 difference between , groups 1 and 2 / groups 2 and 3 / groups 3 and 4 , is not statistically significant ✓ 6 difference between , groups 1 and 3 / groups 2 and 4 / groups 1 and 4 is statistically significant ✓ 7 AVP ✓	4 MAX(AO3.1)	e.g. overlap of error bars group 2 and 3 e.g. no overlap of error bars

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	d		<i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i> <i>In summary:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> ◦ <i>award the higher mark where the Communication Statement has been met.</i> ◦ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • The science content determines the level. • The Communication Statement determines the mark within a level. Level 3 (5–6 marks) There are statements showing similarities and differences between spermatogenesis and oogenesis. Role of hormones included in similarities and differences. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) There are statements showing similarities and differences between spermatogenesis and oogenesis. Role of hormones is unclear or not linked to similarities / differences. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i>	6(AO2.5)	Indicative scientific points may include <i>Similarities</i> • meiotic division • mitotic divisions • primordial germ cells • haploid gametes produced • multiplication phase • growth phase • maturation phase • initiated by gonadotrophin releasing hormone / GnRH • both affected by luteinising hormone / LH and follicle stimulating hormone / FSH <i>Differences</i> spermatogenesis • second meiotic division is completed immediately after the first • spermatozoa are smaller than ova • primary spermatocytes form secondary spermatocytes of even size • no polar bodies formed • FSH causes cells in testes to be more receptive to testosterone • LH causes cells in testes to release testosterone • continuous process oogenesis • second meiotic division only occurs after fertilisation • primary oocyte has uneven division • primary oocyte forms secondary oocyte and polar body • one large ovum and smaller polar bodies formed • FSH / LH cause maturation of follicles in ovary • FSH / LH cause release of oestrogen • surge of LH causes release of secondary oocyte • staggered process

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 1 (1–2 marks) There are statements showing either similarities or differences between spermatogenesis and oogenesis. Role of hormones is unclear or not linked to similarities / differences. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		
			Total	19	
2			A	1(AO1.1)	
			Total	1	
3			B	1 AO2.5	
			Total	1	
4			B	1 AO1.1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																												
5	a		Award one mark for each correct row <table><tr><th>Description</th><th>Structure</th><th>Label</th><td></td></tr><tr><td>Supplies blood to the ovary</td><td>central coiled blood vessel</td><td>F</td><td></td></tr><tr><td>Contains receptors on plasma membranes for FSH</td><td>follicle / granulosa cells</td><td>A</td><td>✓</td></tr><tr><td>Releases oestrogen</td><td>follicle</td><td>A / C / E</td><td>✓</td></tr><tr><td>Contains a haploid nucleus</td><td>secondary oocyte / polar body</td><td>E</td><td>✓</td></tr><tr><td>Produces progesterone</td><td>corpus luteum / empty Graafian follicle / yellow body</td><td>D</td><td>✓</td></tr><tr><td>Gel layer composed of glycoproteins</td><td>zona pellucida</td><td>B</td><td>✓</td></tr></table>	Description	Structure	Label		Supplies blood to the ovary	central coiled blood vessel	F		Contains receptors on plasma membranes for FSH	follicle / granulosa cells	A	✓	Releases oestrogen	follicle	A / C / E	✓	Contains a haploid nucleus	secondary oocyte / polar body	E	✓	Produces progesterone	corpus luteum / empty Graafian follicle / yellow body	D	✓	Gel layer composed of glycoproteins	zona pellucida	B	✓	5 (AO 2.3) (AO 2.5)	IGNORE ovum ALLOW granulosa cell <u>Examiner's Comments</u> Identifying the label that best fitted the description was generally answered well with most candidates using C as the structure that released oestrogen and B for the gelatinous layer. However not many candidates identified the structures that had receptors for FSH, has a haploid nucleus or produces progesterone. In some cases candidates referred to Sertoli cells and sperm/spermatozoa which indicates they did not read the question carefully to note that the photomicrograph was that of an ovary.
Description	Structure	Label																															
Supplies blood to the ovary	central coiled blood vessel	F																															
Contains receptors on plasma membranes for FSH	follicle / granulosa cells	A	✓																														
Releases oestrogen	follicle	A / C / E	✓																														
Contains a haploid nucleus	secondary oocyte / polar body	E	✓																														
Produces progesterone	corpus luteum / empty Graafian follicle / yellow body	D	✓																														
Gel layer composed of glycoproteins	zona pellucida	B	✓																														

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	Summary of instructions to markers: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in <i>italics</i>):</i> ◦ <i>award the higher mark where the Communication Statement has been met.</i> ◦ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • The science content determines the level. • The Communication Statement determines the mark within a level. Level 3 (5-6 marks) Detailed analysis of the micrograph is present. There is a consideration of the number of primary oocytes present in the ovary. Comments made about the varying stages of maturation evident in the micrograph. The relevance of the structures in determining the age of the patient is considered. Justified comments are made with reference to evidence supporting/undermining conclusion. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.</i> Level 2 (3-4 marks) Some analysis of the micrograph is present. Some consideration of the number of primary oocytes present or their varying	6 (AO 3.1) (AO 3.2)	NOTE without a second ovary with which to compare the micrograph in Fig 5.1, it is beyond the capability of an A level student to make this judgement. IGNORE comments that do not relate to evidence in the micrograph e.g. "AMH is only present in the ovary until menopause" as this can not be observed. AO3.1 Analysis of the micrograph may include • there are approximately 20 follicles/oocytes present • high follicle density can be observed • there are follicles present in all stages of maturation • a corpus luteum / ruptured follicle is present • a post-menopause patient would be expected to have a (very) small number of follicles/oocytes AO3.2 Judgements based on the micrograph may include • the number of follicles/oocytes visible represents only one 'slice' of the ovary i.e. (potentially) misrepresentative • 20 may or may not indicate a plentiful number of follicles/oocytes • it is not possible to determine whether the follicles will go on to mature successfully from this single image • the presence of follicles indicates that the patient has not passed menopause • presence of empty Graafian follicle/ corpus luteum indicates patient is (potentially) ovulating • presence of corpus luteum indicates patient is (potentially) producing progesterone • <i>idea that</i> a firm conclusion can not be made in the absence of other micrographs to compare it to

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	stages of maturation evident in the micrograph is made. Their part in determining the age of the patient is attempted. Comment(s) are made with some reference to evidence supporting/undermining conclusion. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.</i> Level 1 (1–2 marks) Little or no analysis of the micrograph is present. An attempt to describe the relevant structures present in the micrograph is made. A comment on the conclusion may be limited. No or little reference to evidence supporting/undermining conclusion (statement is supported or undermined). <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.		<u>Examiner's Comments</u> This question showed a range of answers from the very detailed and well-constructed to those that recalled facts about the menopause and did not relate the facts to observations seen in Figure 5. It should be noted there are two aspects to this question. The first being that the candidate should identify features that can be observed (not learnt facts) in the figure that indicate if the woman has (or has not) started the menopause e.g. follicles are present in different stages of development, a large number (~20) of follicles present. The second, and often overlooked, aspect of the question is that candidates had to make a comment “on this conclusion”. Examiners were looking for candidates to make direct reference to the students’ conclusion and not make their own conclusion. This subtle difference was often not evident in answers. A few candidates made statements such as “I agree with the student’s conclusion” or “I support the student’s conclusion” or “I disagree with the student’s conclusion”. Both aspects of the question needed to be addressed to gain full access to Level 2.  OCR support OCR ‘Delivery Guides’ on the effects of ageing on the reproductive system (4.2.2): https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb04-module-4-energy-reproduction-and-populations/delivery-guide-bbdg023-the-effects-of-ageing-on-the-reproductive-system-422 Exemplar 4

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					In support of the student's statement; * Fig 5 shows both maturing follicles and secondary oocytes which suggest that the woman is still able to produce oocytes which can be fertilised by sperm. * There is also a corpus luteum which only develops during the menstrual cycle when stimulated by LH so would not be seen in a post-menopausal woman. Against the student's statement; * Perhaps this woman has fewer secondary oocytes than expected in a woman who hasn't gone through menopause, so the corpus luteum could be compared [6] Additional answer space if required to an ovary which definitely hasn't gone through menopause * It is likely this woman hasn't gone through menopause however it should be compared to other ovaries to compare the number levels of the woman should also be found as this is significant evidence for menopause. This is a good response and well-constructed. It was clear from this response that the candidate had addressed both parts of the question. In the first line they refer to the student's statement directly and then go on to also link evidence they have identified from the image (presence of maturing follicles and oocytes at different stages of development and the presence of a corpus luteum). This candidate also then recognises that one image is not adequate and indeed should be compared to other images such as those from an ovary of woman who is known to have not yet started the menopause. To that end the candidate has effectively analysed the image (and drawn appropriate conclusions from the structure present) and also commented on the conclusion (by demonstrating how it can both be supported but also assessing the confidence of such conclusions in the absence of further information).
			Total	0	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6	a	i	difference between the <u>means</u> is due to, chance / AW, OR the <u>means</u> will be, the same / equal / AW OR there is no significant difference between the <u>means</u> (of annual pregnancy rate) ✓	1 (AO 2.7)	<u>Examiner's Comments</u> Many candidates were able to correctly give a null hypothesis that included both 'significant differences' and the term 'mean'. Many more candidates demonstrated an understanding of what a null hypothesis is compared to previous years.
		ii	94.09	1 (AO 2.8)	<u>Examiner's Comments</u> In questions where the format of the numerical answer is not specified candidates should expect to give the answer in full. In this case the answer was 94.09 and with no instruction to round given in the question this is what was required. Candidates who rounded up they were not given credit.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	<i>t value</i> 10.206 ✓✓✓	3 (AO 2.8)	ALLOW ecf from (c) (ii) DO NOT ALLOW if negative sign is given If answer is recorded to the incorrect number of decimal places (10.21 or 10.2) then award 2 marks maximum If answer is incorrect or missing allow marks for process stages as follows: • <i>one mark for modulus calculation 7</i> • <i>one mark for denominator calculation prior to square rooting 0.47045</i> <u>Examiner's Comments</u> Many candidates gained full marks on this question by substituting the values into the formula provided. Those that rounded or gained the incorrect answer in (c)(ii) were given error carried forward, as is usual. Some candidates appeared not to understand how to use the generic formula. For example, some candidates thought 'S^2_A' meant 'S^2 multiplied by A', rather than the variance <i>for</i> data set A. Other candidates didn't read the question carefully and hence did not give their answer to 3 decimal places.

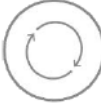
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iv	Any three from: calculated value/ 10.206 is greater than, the critical value /1.960, at the 5% significance level / $p = 0.05$ ✓ the (calculated) value is (also) greater than the critical value at the 1% significance level / $p = 0.01$ ✓ (so the researchers can) reject the null hypothesis ✓ the difference in <u>mean</u> annual pregnancy rates is NOT due to (random) chance ✓	3 (AO 3.2)	ALLOW ecf from (iii) IGNORE idea that the '10.206 is greater than the 1.96 and/or 2.56' unqualified ALLOW mp1 and mp2 for statements that clearly refer to the calculated value being larger than the critical value at 2 or more / all significant levels <u>Examiner's Comments</u> A number of candidates were confident with this question and were able to draw conclusions from statistical tests while using the data tables effectively. Some answers did not gain credit due to poor expression in the answer for example referring to the t-value and not qualifying if this was the calculated t-value or the critical t-value. In some cases candidates' knowledge of the t-test was lacking and candidates incorrectly stated the null hypothesis should be accepted and was due to chance.  OCR support Mathematical skills statistics booklet can offer support when using t-test: https://www.ocr.org.uk/Images/338621-mathematical-skills-statistics-booklet.doc 'Maths for Biology' website can also be used in order to provide support on statistical tests: https://www.ocr.org.uk/subjects/biology/maths-for-biology/handling-data/

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	Maximum of 3 marks for any one side of the discussion <i>Positive</i> enables childless people to have children (which may improve mental wellbeing) ✓ provides eggs (through donation) to other women ✓ provides embryos for experimentation ✓ AVP ✓ <i>Negative</i> low success rate / AW ✓ costs a lot of money for relatively unproductive procedure ✓ destroys life (through the disposal of embryos) / AW ✓ physically stressful ✓ mentally stressful ✓ many, eggs / embryos, are 'wasted' ✓ requires a lot of, time / surgical facilities / highly qualified staff, which might be used on other procedures ✓ AVP ✓	4 (AO 3.2)	IGNORE general comments about all fertility treatments e.g. single parent, unnatural process, 'playing God' e.g. unused embryos can be used to provide stem cells, selection of embryos without genetic fault ALLOW reference to data from question e.g. 23% and 16% success rates of the clinics / around one quarter of eggs resulting in pregnancy IGNORE references to multiple pregnancies (as the question specifies this type of IVF and states that only one embryo is transferred) IGNORE reference to higher risk of autism (as correlation is found in ICSI not this type of IVF) e.g. correct ref to increased risk of medical issues, (named) health risk(s) / side effects for mother from hormonal treatment, genetic defects passed on from faulty gamete used in IVF process Examiner's Comments A common misunderstanding in this question was for candidates to given generic points relating to all forms of fertility treatment and/nor not reading the information provided carefully enough. For example reference to multiple births (and or consequences of multiple births) is not relevant here as only one embryo was transferred (see step 6). Good answers considered issues that were both for and against the use of this form of IVF, but some candidates only focused on the negative issues. Candidates should always aim to give a balanced discussion in ethical based questions. In this question candidates were expected to quote the success rates of this form of IVF i.e. 23% and 16% success rates of the clinics (see information provided in Table 2.1 on page 5). Some candidates also gave their

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					answer as a series of questions and as such left the examiner to decide if this was a comment in support of this form of IVF or against it; in these cases marks could not always be supported.  AFL In terms of examination technique candidates should also appreciate that if the question asks them to “use the information provided”, they should quote data (if provided) to support their comment(s).
			Total	0	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7		i	(sperm can't) reach the, oviduct / fallopian tube ✓ (so) fertilise a <u>secondary oocyte</u> ✓	2 AO2.1	<u>Examiner's Comments</u> A lot of candidates were able to suggest an inability to reach or pass through the fallopian tubes/oviduct but many referred to the sperm fertilising an egg not a secondary oocyte. Some candidates discussed the acidity of the vagina without mentioning the restriction of movement and its consequences. AfL It is useful to tabulate or highlight key points that are extended at A Level compared to the candidate's GCSE knowledge/ specification.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	0.47 ✓ ✓	2 AO2.2	Correct answer = 2 marks even if no working shown. If answer is incorrect then award 1 mark if; <i>answer not to 2 sig figs:</i> 0.469 q^2 / p^2: 0.22 ✓ (<i>incorrect q^2 or p^2</i>) <u>Examiner's Comments</u> The majority of the candidates attempted this calculation and a few candidates were able to score full marks. Most candidates did related q (or p) to 0.22 but often did not realise this value is for the square of q (or p) and thus did not square root it to obtain the answer. Some candidates did not answer correctly to 2 significant figures.  OCR support 'Maths for Biology' website can offer support on the correct use of the significant figures: https://ocr.org.uk/subjects/biology/maths-for-biology/handling-data/ OCR delivery guide on the 'Population genetics and epigenetics': https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb05-module-5-genetics-control-and-homeostasis/delivery-guide-bbdg028-population-genetics-and-epigenetics-512v

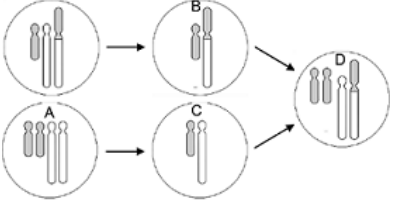
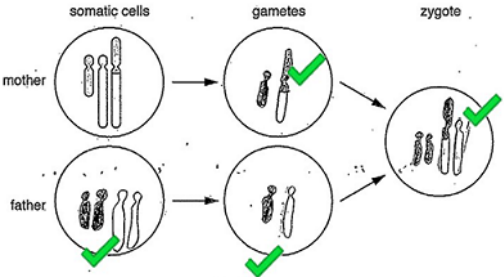
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	(heterozygotes) have a selective advantage OR No effect on heterozygotes ✓	1 AO3.1	IGNORE ref to IVF ALLOW only affects homozygous recessive <u>Examiner's Comments</u> The majority of the candidates attempted an answer to this question. A few candidates did correlate this with malaria and sickle cell anaemia and were thus able to suggest the idea of a selective advantage. Many answers referred to artificial techniques of fertilisation which were ignored as this would not have a significant impact on worldwide allele frequencies over generations.
			Total	0	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8		i	does not have trisomy 21 ✓	1	AW e.g. 'no excess of chromosome 21' ALLOW <u>only</u> has two of chromosome 21 <u>Examiner's Comments</u> This question required candidates to know that Down's syndrome is a disorder caused by extra genetic material relating to chromosome 21. This can be when there are three distinct copies of chromosome 21(trisomy 21) or some extra material relating to chromosome 21. In this case the mother does not have any extra genetic material and therefore does not have Down's syndrome.

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
ii	 A ✓ B ✓ C ✓ D ✓	4	ALLOW incorrect proportions of translocated chromosome ALLOW diagrams that do not show centromeric regions DO NOT ALLOW drawings without shading ECF (from A) ECF (from B and C) <u>Examiner's Comments</u> Very few candidates were able to complete all four of the diagrams correctly. Many candidates were not able to identify which chromosomes would be present in the gamete of the mother but were credited with subsequent marks if they understood that the zygote would result from a combination of the two gametes. Candidates need to be careful when completing diagrams such as these to make sure that they include the relevant shading or annotation to distinguish the relevant chromosomes. Exemplar 1  In this response the candidate completed the diagrams correctly. The shape and shading of the chromosomes was clear and unambiguous.
Total		5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9			D	1	
			Total	1	
10			C	1	<u>Examiner's Comments</u> The level of recall demanded by this question proved problematic for many candidates. Despite the question asking about the completion of meiosis II, many candidates selected option A or B which referred to homologous chromosomes. The question was testing the knowledge that meiosis II is halted at metaphase II prior to fertilisation.
			Total	1	
11		i	(erectile dysfunction) is the inability to, get / maintain, an erection ✓ (infertility) is due to problems with, sperm production / release ✓	2	IGNORE sperm cannot fertilise egg unqualified ALLOW abnormal sperm / low sperm count / blocked vas deferens / cannot ejaculate <u>Examiner's Comments</u> This was well answered with the majority of candidates correctly describing both. Some candidates described male infertility as not fertilising an egg which did not discount the possibility of it being an egg dysfunction.
		ii	medication / diabetes / (long term) stress ✓	1	ALLOW nerve damage IGNORE too much alcohol <u>Examiner's Comments</u> This was well answered although many answers centred around the idea of temporary dysfunction.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																				
12	a	i	Meiosis ✓	1	IGNORE ref to I or II. Examiner's Comments The vast majority of candidates achieved the mark for (a)(i).																				
		ii	<table><thead><tr><th>Event</th><th>Type of nuclear division</th><th>Stage in nuclear division</th><th></th></tr></thead><tbody><tr><td>Chromosomes line up on the equator; there is no association between homologous chromosomes.</td><td>mitosis</td><td>(early / late) metaphase</td><td>✓</td></tr><tr><td>Homologous chromosomes form bivalents.</td><td>meiosis</td><td>prophase I</td><td>✓</td></tr><tr><td>Homologous chromosomes separate and are pulled to opposite poles.</td><td>meiosis</td><td>anaphase I</td><td>✓</td></tr><tr><td>Crossing over occurs.</td><td>meiosis</td><td>prophase I</td><td>✓</td></tr></tbody></table>	Event	Type of nuclear division	Stage in nuclear division		Chromosomes line up on the equator; there is no association between homologous chromosomes.	mitosis	(early / late) metaphase	✓	Homologous chromosomes form bivalents.	meiosis	prophase I	✓	Homologous chromosomes separate and are pulled to opposite poles.	meiosis	anaphase I	✓	Crossing over occurs.	meiosis	prophase I	✓	4	1 mark per row – needs correct type and stage Examiner's Comments In (a)(ii) although most candidates scored, many failed to state the correct stage of nuclear division for meiosis by omitting I or II.
Event	Type of nuclear division	Stage in nuclear division																							
Chromosomes line up on the equator; there is no association between homologous chromosomes.	mitosis	(early / late) metaphase	✓																						
Homologous chromosomes form bivalents.	meiosis	prophase I	✓																						
Homologous chromosomes separate and are pulled to opposite poles.	meiosis	anaphase I	✓																						
Crossing over occurs.	meiosis	prophase I	✓																						
	b	i	(rising level of oestrogen) inhibits FSH / causes secretion of LH ✓ LH causes, maturation of follicles / release of secondary oocyte / ovulation ✓ (LH causes) development of corpus luteum (after secondary oocyte release) ✓	2 max	Examiner's Comments Candidates who correctly recognised oestrogen stimulating LH release achieved full marks for (b)(i). Some candidates discussed oestrogen directly causing ovulation and a few felt that both LH and FSH stimulated ovulation. It would be beneficial if these 3 hormones were discussed in terms of their feedback effects on each other and the subsequent changes that occur.																				
		ii	oestrogen production remains high (for most of adulthood) ✓ (primary) oocytes are paused in prophase I (of meiosis) ✓ <i>idea that</i> (high) oestrogen cause, completion / continuation, of meiosis I ✓ (so) forms secondary oocyte ✓ (secondary oocyte) is paused in (metaphase of) meiosis II ✓	3 max	ALLOW suitable age range (e.g. from 12 to 50) Examiner's Comments Generally candidates struggled with (b)(ii) and found it difficult to incorporate meiotic stages into their answer, concentrating on mitotic division of cells and the release of a secondary oocyte. However, more able candidates understood the pauses in meiosis and often continued to discuss the completion of meiosis II upon fertilisation. A few candidates wrote about eggs: all candidates should discuss the menstrual cycle and oogenesis in terms of oocytes.																				
			Total	10																					

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13			A ✓	1	Examiner's Comments Another straightforward question but a disappointing number of candidates answered correctly.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance												
14	a	i	<u>meiosis</u> ✓	1	DO NOT ALLOW mitosis ALLOW meiosis 1												
		ii	anaphase 1 ✓	1	ALLOW telophase 1 ALLOW anaphase OR telophase if (i) states meiosis 1												
	b		X follicle cells / follicular tissue / corona radiata ✓ Y cytoplasm / yolk ✓ Z zona pellucida / layer of, glycoproteins / gel ✓	3	DO NOT ALLOW ‘follicle’												
	c		on photomicrograph where no sperm are present: germ layer absent ✓ no cells close to basement membrane ✓ lumen largely empty/proliferation of Leydig cells (purple stained cells between seminiferous tubules) ✓	max 2	ORA throughout												
	d	i	x-axis labelled ‘days from start of treatment’ AND scale occupies more than 50% of paper AND scale with equidistant points AND zero/0 correctly shown ✓ y-axis labelled ‘mean sperm count (million per cm ³)’ AND scale occupies more than 50% of paper AND scale with equidistant points ✓ all points correctly and clearly plotted ✓ straight line of best fit (l.o.b.f.) ✓	4	<table><tr><th>Days from start of treatment</th><th>Mean sperm count (million per cm³)</th></tr><tr><td>0</td><td>25</td></tr><tr><td>30</td><td>35</td></tr><tr><td>60</td><td>44</td></tr><tr><td>90</td><td>60</td></tr><tr><td>120</td><td>69</td></tr></table>	Days from start of treatment	Mean sperm count (million per cm ³)	0	25	30	35	60	44	90	60	120	69
Days from start of treatment	Mean sperm count (million per cm ³)																
0	25																
30	35																
60	44																
90	60																
120	69																
		ii	decrease in variability over time	1	ALLOW variability among patients decreases (with time)												

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	$3.7 \times 10^5 \text{ cm}^{-3} \text{ day}^{-1}$ ✓✓	2	Correct answer with correct sig fig but wrong unit = 1 mark Correct answer with wrong sig fig but right unit = 1 mark ACCEPT answer in range 3.5 to 3.8×10^5 ALLOW million per cm^3 per day ALLOW correct answer not in standard form
			Total	14	
15			A ✓	1	
			Total	1	
16	a	i	H ✓	1	
		ii	K ✓	1	
		iii	G ✓	1	
	b		prostate (gland) ✓	1	
			Total	4	
17			no / less, oestrogen / progesterone secreted; (due to damage to) follicular cells; no / less development of, endometrium / uterine lining OR FSH stays high; idea of damaged oocytes destroyed;	2	Examiner's Comments This was synoptic with Unit 4 and the question was most commonly answered in terms of cigarettes causing a drop in oestrogen production but no further detail was given in terms of the cells producing the oestrogen or the knock on effect of low oestrogen in terms of the menopause.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18	a	i	J / oogonium AND K / primary spermatocyte AND M / sertoli cell;	1	All three required for one mark Examiner's Comments This required a precise knowledge of the stages involved in the development of the reproductive cells and their genetic components, followed by a comparison of the mechanisms of action of oestrogen, FSH and LH. It initially required detail regarding the entry / or not of these hormones into target cells, followed by identifying the source of FSH and LH. Candidates were then asked to identify molecules or organelles involved in the action of the hormone oestrogen on a target cell as shown in a simplified diagram, followed by the location and role of the target cell. Finally candidates were asked to suggest the effect of FSH in the nuclei of endometrial cells. The question tested both AO1 and AO2. In parts (i) - (iii) most candidates correctly obtained one or two of the correct answers, those obtaining all three were in the minority. Oogonium was correctly answered by most candidates and secondary oocyte the least. Often the two were given the wrong way round and if oogonium was given correctly, it didn't follow that secondary spermatocyte would be given correctly as well.
		ii	J / oogonium;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks
		iii	L / secondary oocyte;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	1 FSH and / or LH cannot, cross / AW, membrane OR oestrogen can cross the, membrane / phospholipid bilayer; 2 (because) oestrogen is lipid soluble OR FSH and / or LH are not lipid soluble; 3 membrane / bilayer, is hydrophobic;	2	CREDIT 'glycoproteins' for FSH and LH and 'steroids' for oestrogen throughout 1.DO NOT CREDIT reference to molecular size 2. CREDIT idea that molecule is lipid - like or hydrophobic ACCEPT non-polar / hydrophobic (for lipid soluble) and polar / hydrophilic (for not lipid soluble) 3. ACCEPT reference to hydrophobic core (of membrane) Examiner's Comments Part (i) called for a straightforward link between ability to cross the cell membrane and lipid solubility and most candidates seemed aware of this link. Marks were quite often lost for incorrectly relating the ability to cross the membrane to molecular size, or considering FSH and LH in terms of binding to a receptor on the cell surface membrane, hence repeating the stem of the question.
		ii	(anterior) pituitary gland;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks Examiner's Comments Most candidates were aware that the organ was the anterior pituitary gland in (ii) ,the main source of error being the brain.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance								
	c	i	<table><tr><th>Letter</th><th>Name</th></tr><tr><td>Molecule A</td><td>messenger RNA /mRNA ;</td></tr><tr><td>Organelle B</td><td>ribosome / rough ER / rough endoplasmic reticulum / RER ;</td></tr><tr><td>Organelle C</td><td>Golgi (apparatus / body) vesicle ;</td></tr></table>	Letter	Name	Molecule A	messenger RNA /mRNA ;	Organelle B	ribosome / rough ER / rough endoplasmic reticulum / RER ;	Organelle C	Golgi (apparatus / body) vesicle ;	3	Mark the first answer in each box. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks IGNORE ‘RNA’ alone ☐ Examiner’s Comments Many candidates scored all three points in (i) showing a good knowledge of the roles of the molecules and organelles. Marks were most commonly lost for not identifying RNA as mRNA and for giving vesicle instead of Golgi vesicle.
Letter	Name												
Molecule A	messenger RNA /mRNA ;												
Organelle B	ribosome / rough ER / rough endoplasmic reticulum / RER ;												
Organelle C	Golgi (apparatus / body) vesicle ;												

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	(cell in) primary / Graafian, follicle OR (in) ovary; <i>because</i> (these cells) detect a, rise / surge in, LH concentrations OR (follicle) responds to (increased) LH by releasing (secondary) oocyte;	2	DO NOT CREDIT follicle unqualified CREDIT ovarian follicle Needs to include idea of <i>increased</i> LH ACCEPT answers which refers to male tissues e.g. Leydig cells / interstitial cells / testis / testes for mp 1 AND (testes) respond to (increased) LH by releasing testosterone for mp 2 Examiner's Comments The Graafian follicle or ovary were correctly identified in (ii) as the target cell in many cases, but the role of LH was less clear. Ovulation appeared in some answers, but it was often not linked to a surge in LH. Noticeably, breast tissue was incorrectly given as an organ with the associated role of lactation.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	d		(stimulates / causes DNA) replication / AW OR <i>idea of switching on genes;</i> <i>idea that so, mitosis / cell division / AW can occur;</i>	2	CREDIT a description ACCEPT cell numbers increase IGNORE references to thickening of endometrium Examiner's Comments In this part, which was a stretch and challenge mark, a lot of candidates associated FSH with the thickening of the endometrial lining and many gained one mark for linking the role of FSH in stimulating cell division. Fewer linked FSH to stimulating DNA replication, necessary for mitosis to occur. Candidates that did not score well usually gave vague explanations about the need for the thickening of the endometrium in preparation for the implantation of the zygote. Another common mistake was stating that DNA replicates by mitosis.
			Total	13	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a	i	vas deferens;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks ACCEPT phonetic spelling IGNORE sperm duct Examiner's Comments The majority of candidates stated vas deferens in part (i).
		ii	<i>idea of</i> more fluid in semen / less fluid in epididymis; from (secretions of), seminal vesicles / prostate (gland);	2	IGNORE references to 'dilution' ACCEPT alternative terms for fluid e.g. liquid Examiner's Comments In part (ii) most candidates appreciated that fluid had been added to the sperm in the semen resulting in a decrease in concentration and many knew that the origin of the fluid was the seminal vesicles or prostate gland. Candidates that did not score well usually made references to fructose and other substances being added to the sperm. They often gained the second mark point for stating the correct origin. A few candidates incorrectly stated that the concentration of sperm in the epididymis is greater because that is where sperm is made and stored.
	b	i	<i>IVF</i> in vitro fertilisation AND <i>ICSI</i> intracytoplasmic sperm injection;	1	BOTH responses required for one mark ACCEPT phonetic spelling DO NOT CREDIT 'intercytoplasmic sperm injection' Examiner's Comment Part (i) required an exact knowledge of both terms and many candidates did not know what the initials ICSI represented, giving a variety of incorrect possibilities.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	(For all types of sperm) sperm directly injected into, (secondary) oocyte, in ICSI; <i>idea that</i> (for SSR sperm) sperm have not fully matured / AW;	1	ACCEPT a description e.g. sperm may not be fully motile acrosome may not be fully functional Examiner's Comment Many candidates thought that the C stood for cervical, which could be linked to errors in part (ii). Most candidates stated that sperm are directly injected into the oocyte in ICSI in (ii). Few candidates made reference to the lack of maturity of the sperm. Some candidates wrote about implantation of the sperm in the fallopian tubes in ICSI and fertilisation occurring naturally in IVF.
	c	i	<i>(coloured bead to)</i> constant AND <i>(HCG to)</i> variable;	1	BOTH responses required for one mark Examiner's Comments It was surprising how many candidates did not know the correct names for the constant and variable regions in (i).

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance										
		ii	<table><tr><th>Test strip</th><th>Conclusion</th></tr><tr><td>W</td><td>not pregnant</td></tr><tr><td>X</td><td>pregnant</td></tr><tr><td>Y</td><td>result not valid / AW</td></tr><tr><td>Z</td><td>result not valid / AW</td></tr></table> ;;	Test strip	Conclusion	W	not pregnant	X	pregnant	Y	result not valid / AW	Z	result not valid / AW	2	Mark the first answer in each box. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks 4 correct = 2 marks 3 correct = 1 mark ACCEPT 'inconclusive' for 'result not valid' IGNORE 'not clear' Examiner's Comments Most candidates were able to interpret the results given in part (ii) correctly.
Test strip	Conclusion														
W	not pregnant														
X	pregnant														
Y	result not valid / AW														
Z	result not valid / AW														
			Total	8											

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																					
20	a		mitochondrial, (membrane / envelope); acrosome (membrane);	2	DO NOT CREDIT endoplasmic reticulum / Golgi apparatus (as these are not present in spermatozoa) CREDIT lysosome only if candidate indicates that the acrosome is a modified lysosome Examiner's Comments This was about the effects of cryopreservation and subsequent thawing on the viability of sperm samples obtained from the semen of bulls. This was a data question and data was provided for candidates to assess both the effects of cryopreservation on viability and if there was a significant difference between samples. Most candidates were aware of mitochondrial membranes being damaged with the more able ones also being aware of the acrosome membrane.																					
	b	i	(cryopreservation) causes a drop in viability / AW; correct data quoted for two named samples and two percentages AND units(mean) percentage / %;		Only CREDIT if 'percentage' or '%' is used with the figures at least once. <table><tr><th>Semen sample</th><th>Mean percentage fluorescing green</th><th>Mean percentage fluorescing red</th></tr><tr><td>1</td><td>47.6</td><td>49.3</td></tr><tr><td>2</td><td>56.0</td><td>37.0</td></tr><tr><td>3</td><td>47.3</td><td>48.7</td></tr><tr><td>4</td><td>50.4</td><td>45.5</td></tr><tr><td>5</td><td>52.8</td><td>40.9</td></tr><tr><td>6</td><td>47.7</td><td>49.2</td></tr></table>	Semen sample	Mean percentage fluorescing green	Mean percentage fluorescing red	1	47.6	49.3	2	56.0	37.0	3	47.3	48.7	4	50.4	45.5	5	52.8	40.9	6	47.7	49.2
Semen sample	Mean percentage fluorescing green	Mean percentage fluorescing red																								
1	47.6	49.3																								
2	56.0	37.0																								
3	47.3	48.7																								
4	50.4	45.5																								
5	52.8	40.9																								
6	47.7	49.2																								

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	<i>yes because</i> <i>idea that</i> S.D. indicate data overlaps OR <i>idea that</i> difference between the means is small; <i>no because</i> <i>idea that</i> a S.D only overlaps slightly OR there is a difference between the means;	1	No mark available for stating 'yes' or 'no' DO NOT CREDIT ref. to green fluorescing sperm Only CREDIT if Examiner's Comments Very few candidates answered (i) correctly, they needed to relate the effect of cryopreservation on the viability of sperm. Many described the extent of membrane damage or compared samples without even using the term viability in their answer. Part (ii) involved a straightforward consideration of mean values and/or consideration of the spread of data related to the standard deviation values to assess if there was a significant difference between the two samples. Candidates who appreciated this managed a clear concise answer, but there were those who did not seem to be aware of what was needed. Those who quoted data from the sperm fluorescing green failed to score the marking point.
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
21	a		(organ) is a, collection of / AW, tissues, carrying out / AW, a (specific) function / AW ; <i>idea that</i> named tissue(s) allow the placenta to carry out a named function ;	2	Must mention tissue and function DO NOT CREDIT cells instead of tissues CREDIT a statement such as 'the placenta contains maternal blood which allows oxygen to be transported to the fetus' CREDIT reference to other types of tissue e.g. <i>idea that</i> endocrine tissue of placenta secretes hormones ACCEPT ref. to muscle in context of blood vessels Examiner's Comments Most candidates could explain the meaning of term organ but were unable to give examples of any tissues in the placenta.
	b		zygote; mitosis; fallopian tube / oviduct; endometrium; ;	5	Mark the first answer on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks IGNORE fertilised, oocyte / egg IGNORE binary fission DO NOT CREDIT wall ACCEPT lining ACCEPT specialise Examiner's Comments It was not that uncommon to see endothelium in place of endometrium.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		maintains / AW, the corpus luteum;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks OR keeps / stimulates, the corpus luteum secreting progesterone. Examiner's Comments The majority of candidates answered this correctly as multiple pregnancy. One candidate suggested expensive as the answer but could not been given a mark.
	d		multiple pregnancy;	1	DO NOT CREDIT if given as part of a list with multiple births
	e	i	monochorionic-diamniotic / MoDi;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks ACCEPT correct description
		ii	dichorionic-diamniotic / DiDi;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks ACCEPT correct description
		iii	<i>idea that</i> only one placenta AND higher / AW, (oxygen) demand, as twins, grow / develop; (so restricted oxygen) :	1	ACCEPT only one, exchange system / blood supply

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iv	ultrasound (scan) / sonogram / listen for 2 heartbeats;	1	Examiner's Comments The information needed to answer parts (i) and (ii) was present within the stem of the question but many candidates failed to analyse the question correctly and draw this information out. Part (iii) was meant to be a stretch and challenge question. Many candidates appreciated there was only one placenta, few managed to link this fact to a higher oxygen demand with increasing growth or development of the embryos. Candidates who gained this marking point gained it largely on the basis of the umbilical cord being tangled.
			Total	13	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
22			more FSH; (release of FSH) not inhibited by oestrogen; more follicles, ripen / mature; increased, number of (secondary) oocytes released / ovulation; <i>idea of</i> more chances of fertilisation;	Max 3	IGNORE ref. to LH throughout DO NOT CREDIT (clomiphene) stimulates release of FSH CREDIT eggs / ova e.g. more oocytes available to be fertilised Examiner's Comments This was about the factors needed for successful fertilisation, requiring explanations of factors which facilitated the passage of sperm for fertilisation and of clomiphene in enhancing the chances of a successful pregnancy. This involved an initial consideration of the intracellular modification of proteins to form mucins, followed by the mechanism by which ions moved into the cervical mucus, how this resulted in mucus becoming less viscous and why this allowed sperm to travel more easily for fertilisation. The action of clomiphene on the reproductive hormones oestrogen and FSH was analysed. The question tested both AO1 and AO2. the maturing of more follicles, followed by the release of more secondary oocytes that increased the chances of fertilisation were the three points made by most candidates. Relatively few candidates included the inhibition of FSH release by oestrogen or the fact there were increased levels of FSH. Marks were lost for assuming the binding of clomiphene and blocking of oestrogen stimulated the release of FSH.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
23	a		line drawn from point A to point within (either) fallopian tube;	1	CREDIT lines going down both fallopian tubes if arrows are drawn, they must be in the correct direction Examiner's Comments This required knowledge about the early stages of fertilisation and pregnancy. Initially the path taken by the male gamete in the female urogenital system was required to be drawn on a diagram, followed by the identification of a specific part of a labelled sperm from a micrograph. The role of fertilisation in increasing genetic variation was then looked at, followed by identifying a stage of embryonic development, the location of implantation and explaining the symptoms shown by an advanced ectopic pregnancy. The question tested both AO1 and AO2. The path taken by the sperm was almost universally correctly. Marks which were lost were for the path either not reaching the fallopian tube or extending into the ovary.
	b		<i>idea of end / terminal part of;</i>	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			tail / flagellum;		CREDIT flagella Examiner's Comments This required knowledge about the early stages of fertilisation and pregnancy. Initially the path taken by the male gamete in the female urogenital system was required to be drawn on a diagram, followed by the identification of a specific part of a labelled sperm from a micrograph. The role of fertilisation in increasing genetic variation was then looked at, followed by identifying a stage of embryonic development, the location of implantation and explaining the symptoms shown by an advanced ectopic pregnancy. The question tested both AO1 and AO2. Candidates found identification of the part labelled A very difficult, the majority incorrectly labelling it in terms of intracellular components such as mitochondria or microfilaments, rather than the tail or flagellum. The end or the terminal part of the tail was rarely identified.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		gametes are genetically different; <i>idea that</i> which gametes fuse is random; <i>idea of</i> potentially large number of combinations;	Max 2	ALLOW sperm / eggs for 'gametes' throughout IGNORE ref. to meiosis (as question is about fertilisation) IGNORE random, mating / fertilisation e.g. one egg can be fertilised by any one of a large number of sperm Examiner's Comments This required knowledge about the early stages of fertilisation and pregnancy. Initially the path taken by the male gamete in the female urogenital system was required to be drawn on a diagram, followed by the identification of a specific part of a labelled sperm from a micrograph. The role of fertilisation in increasing genetic variation was then looked at, followed by identifying a stage of embryonic development, the location of implantation and explaining the symptoms shown by an advanced ectopic pregnancy. The question tested both AO1 and AO2. Candidates either correctly appreciated that gametes were genetically different and that random fusion of gametes took place with only one of many potential sperm effecting fertilisation or incorrectly focused on events which took place in meiosis prior to fertilisation incorrectly linking genetic variation to crossing over and independent assortment or to the combination of different genes provided by each parent on fertilisation.

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	d	i	blastocyst;	1	CREDIT morula IGNORE zygote / embryo Examiner's Comments This required knowledge about the early stages of fertilisation and pregnancy. Initially the path taken by the male gamete in the female urogenital system was required to be drawn on a diagram, followed by the identification of a specific part of a labelled sperm from a micrograph. The role of fertilisation in increasing genetic variation was then looked at, followed by identifying a stage of embryonic development, the location of implantation and explaining the symptoms shown by an advanced ectopic pregnancy. The question tested both AO1 and AO2. Blastocyst was correctly identified in (i) as the stage of embryonic development after approximately five days of fertilisation by most candidates. A few candidates stated zygote or embryo. The endometrium of the uterus was correctly identified
		ii	endometrium; uterus;	2	IGNORE 'lining' Examiner's Comments Very few candidates correctly linked a fall in blood pressure with blood loss in advanced ectopic pregnancy and that an increase in heart or pulse rate served to maintain blood pressure

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		iii	<i>idea that</i> blood loss will lead to a fall in blood pressure (BP); <i>idea that</i> heart / pulse, rate rises to maintain blood pressure; AVP;	Max 2	e.g. adrenaline release due to (hypovolemic) shock raises heart / pulse rate Examiner's Comments The majority of answers described the growth of the blastocyst compressing the blood vessels in the Fallopian tube, causing a restriction of blood flow through and hence the reduced delivery of oxygen and nutrients. Increased heart or pulse rate was required to increase blood flow to supply adequate oxygen and nutrients to the blastocyst. Quite a few candidates also have the misconception that ectopic pregnancy demands more nutrients so there is an increase in blood supply to the Fallopian tube resulting in low blood pressure in the rest of the body. A few candidates even thought that the ectopic pregnancy is not recognised by the body so there is still menstruation and this blood loss causes low blood pressure
			Total	10	

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24	a	i	(area on) beta subunit (1) <i>Explanation</i> <i>idea that</i> this has different 3D or tertiary structure to hCG OR <i>idea that</i> this has a unique 3D or tertiary structure (1)	2	
		ii	Y AND Z (1)	1	Both letters required for one mark
	b	i	D AND E (1)	1	Both letters required for one mark
		ii	D (no mark) (D) dark line shows high concentration of LH (1) <i>idea of</i> LH surge triggering ovulation (1)	2	
		iii	<i>idea that</i> timing of the test misses the peak concentration of LH (1)	1	
	c		pregnancy test strips detect hCG (1) <i>idea that</i> long half-life means hCG remains high (in blood plasma and) in urine for several days (1) <i>idea that</i> large dose of hCG means it remains high (in blood plasma and) in urine for several days (1)	2	
			Total	9	
25		i	any 2 from: FSH & LH not released (1) follicle not stimulated / oocyte does not develop (by FSH) (1) no ovulation (by LH) (1)	2	
		ii	2.6 (1)(1)	2	ALLOW 2.59 ALLOW ECF for 1 mark unrounded number (2.58844...) = 1 mark
		iii	FL more effective than G, due to higher mean pregnancies (1) Data for FL overlap with G / FL gives more variable effectiveness (1)	2	
		iv	dose of hormones (e.g. per g body mass) (1) age of each male (1)	1	AVP e.g. sexual activity of male
			Total	7	

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26	a	i	<i>conclusion</i> a higher BMI increases sperm concentration and quality <i>data in support</i> concentrations correctly calculated correct unit given data used with units to support statement on quality	4	ALLOW comments referring to a small difference BMI 20 – 25 $342 \div 2.6 = 131.5$ AND BMI > 25 $413.1 \div 3 = 137.7$ 10^6 cm^{-3} OR $10^6 / \text{cm}^3$ <table><tr><td>Group</td><td>BMI</td><td>Total progressively motile sperm (10^6)</td><td>Concentration 10^6 cm^{-3}</td></tr><tr><td>A</td><td>20–25</td><td>74.2</td><td>131.5</td></tr><tr><td>B</td><td>>25</td><td>110.4</td><td>137.7</td></tr></table>	Group	BMI	Total progressively motile sperm (10^6)	Concentration 10^6 cm^{-3}	A	20–25	74.2	131.5	B	>25	110.4	137.7
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A	20–25	74.2	131.5														
B	>25	110.4	137.7														
		ii	Any 2 from: <i>Idea that</i> BMI >25 needs to be subdivided age in both groups should be same larger sample size carry out study over more generations of men / time span of study named factor should be controlled	2	e.g. smoking, fitness level, exposure to STDs or traumatic damage												
	b		<table><tr><th>Statement</th><th>Letter(s)</th></tr><tr><td><i>If this is enlarged it can lead to difficulty in starting to urinate or emptying a full bladder.</i></td><td>B</td></tr><tr><td><i>Changes in this structure mean sperm can fail to become motile.</i></td><td>E</td></tr><tr><td><i>Changes in this structure can lead to chromosome abnormalities in sperm.</i></td><td>F</td></tr><tr><td><i>Changes in tissues here can lead to erectile dysfunction.</i></td><td>G</td></tr></table>	Statement	Letter(s)	<i>If this is enlarged it can lead to difficulty in starting to urinate or emptying a full bladder.</i>	B	<i>Changes in this structure mean sperm can fail to become motile.</i>	E	<i>Changes in this structure can lead to chromosome abnormalities in sperm.</i>	F	<i>Changes in tissues here can lead to erectile dysfunction.</i>	G	4			
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27			A	1	
			Total	1	