

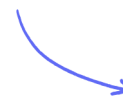
Structured Questions: Paper 2

6.6 Hormones, Homeostasis & Reproduction

6.6.1 Hormones / 6.6.2 Hormones Continued / 6.6.3 Reproduction: Background / 6.6.4 Reproduction: Sex Determination in Males / 6.6.5 Reproduction: Sex Determination in Females / 6.6.6 Skills: Reproduction Diagrams

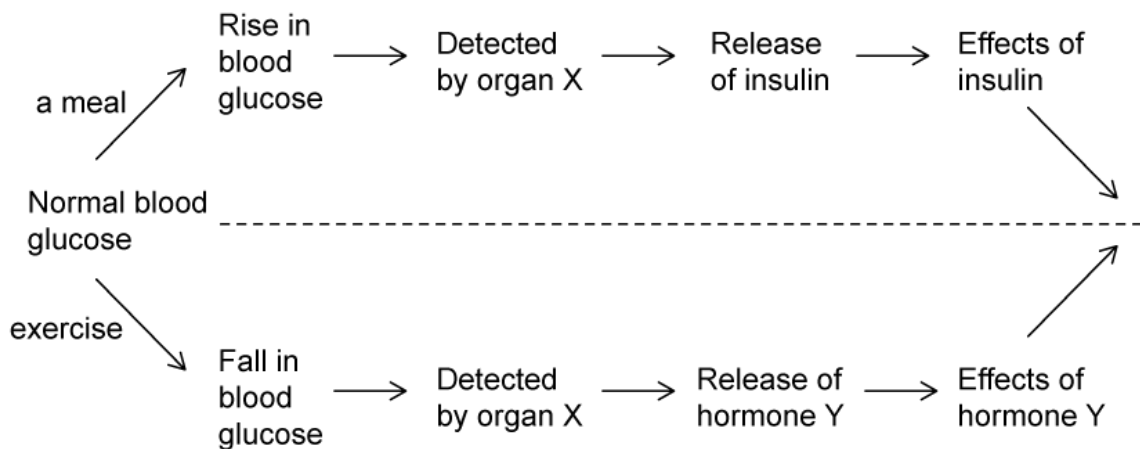
Easy (5 questions)	/40
Medium (5 questions)	/47
Hard (5 questions)	/58
Total Marks	/145

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Easy Questions

1 (a) The diagram below shows some of the events that take place during the regulation of blood glucose.



Identify organ X.

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(1 mark)

(b) Insulin is released when organ X detects a rise in blood glucose levels.

Describe the effects of insulin that restore blood glucose to normal levels.

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(2 marks)

(c) When blood glucose levels fall after exercise organ **X** releases another hormone, hormone **Y**.

(i) Name hormone **Y**.

[1]

(ii) State one mechanism by which hormone **Y** causes blood glucose levels to return to normal.

[1]

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(2 marks)

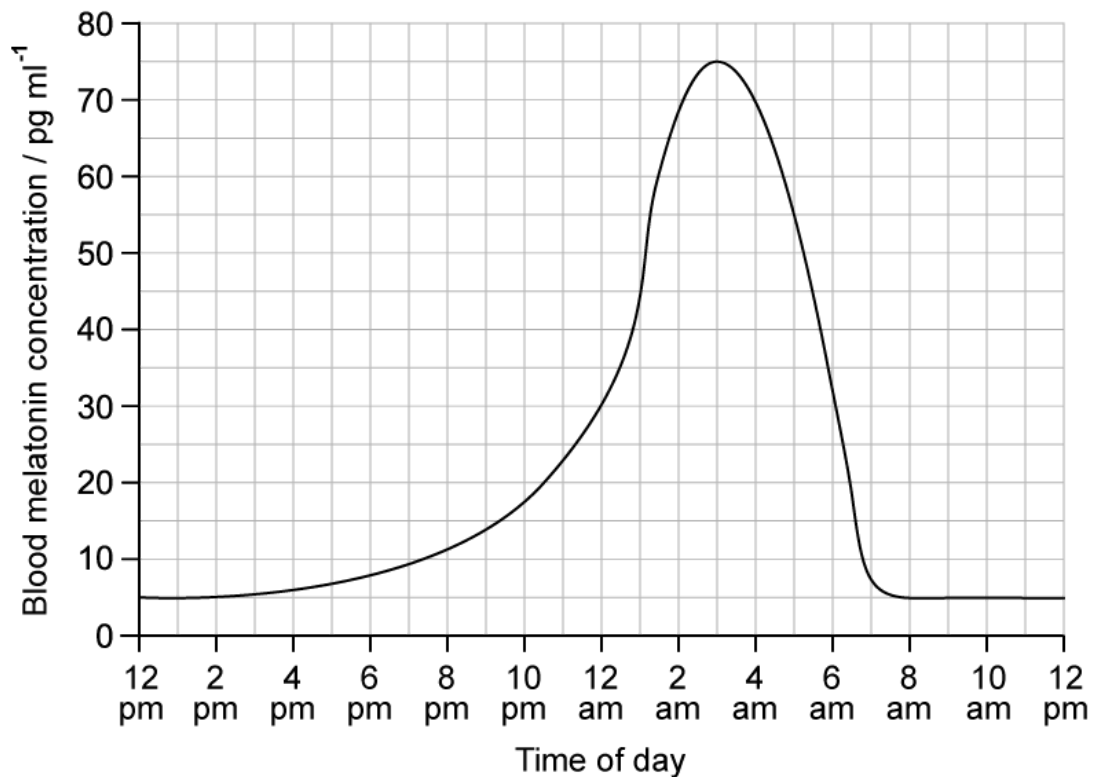
(d) The table below shows some doctor's notes for a patient with diabetes.

Patient age:	9
Patient symptoms:	More thirsty than usual Increased urine production Weight loss Fatigue
White blood cell activity:	High
Suggested treatment:	Monitoring blood glucose levels Insulin injections

Identify, with a reason, whether the patient is likely to have type I or type II diabetes.

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(2 marks)

- 2 (a) The graph below shows changes in levels of the hormone melatonin over a 24-hour period. Blood melatonin concentration is measured in picograms per ml.



Calculate the percentage increase in melatonin concentration between 2 pm and 12 am.

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(2 marks)

- (b) Identify **one** physiological changes that would occur between 2 pm and 3 am in the body of an individual with the melatonin levels shown in part a).

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(1 mark)

- (c) Another hormone is thyroxin.

Identify the gland that secretes thyroxin.

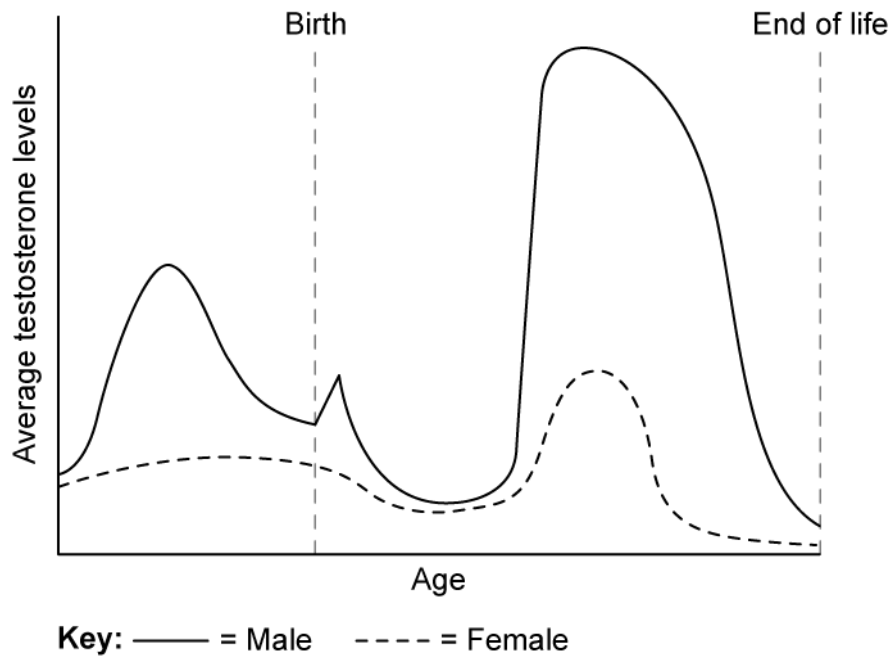
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(1 mark)

(d) Outline the part played by thyroxin in regulating body temperature.

(2 marks)

- 3 (a) The graph below shows changing testosterone levels in male and female humans from before birth until old-age. Note that the scale on the x-axis is not evenly distributed.



Compare and contrast the changes in testosterone levels for males and females.

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(3 marks)

- (b) Outline the reason for the difference in testosterone levels between males and females.

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(3 marks)

- (c) Label the graph in part a) with an **X** at roughly the point at which puberty begins in males.

(1 mark)

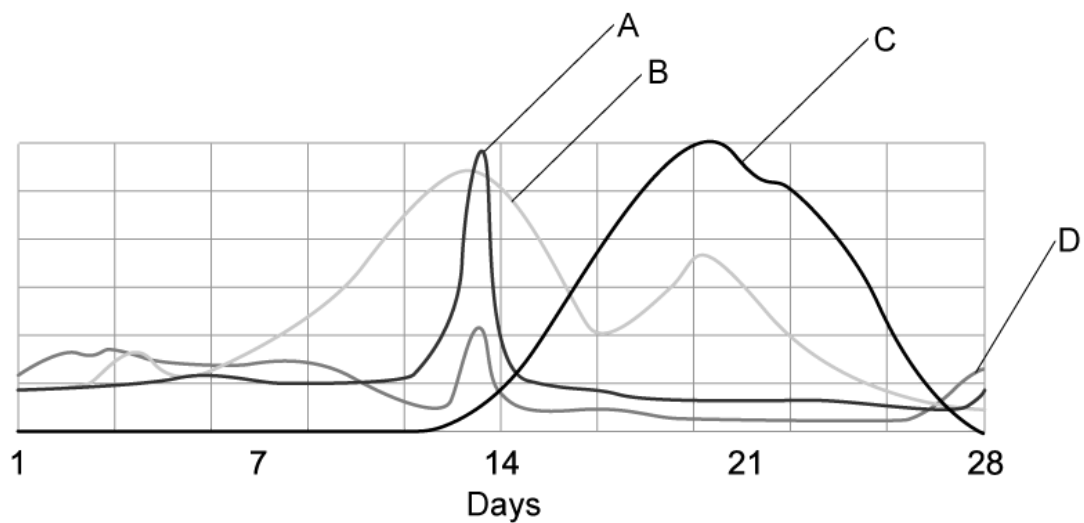
(d) State **two** physiological changes that would occur in males at the point you have marked **X** on the graph in part a).

(2 marks)

4 (a) Explain why William Harvey's 17th Century attempts to observe the events surrounding fertilisation were unsuccessful.

(2 marks)

(b) The process of reproduction is controlled by a series of hormones. The graph below shows changes in the levels of reproductive hormones **A-D** in females during a single menstrual cycle.



Identify, with a reason, the hormone represented by line **A**.

(1 mark)

(c) Line **C** represents the hormone progesterone.

(i) Identify the source of the hormone progesterone during the regular menstrual cycle.

[1]

(ii) State **one** role of progesterone.

[1]

(2 marks)

- (d)** A common treatment for fertility problems is *in vitro* fertilisation, or IVF. During IVF a woman will be given medication containing the hormone FSH.

Explain why medication containing FSH is administered during IVF.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Draw a labelled diagram of the female reproductive system.

(4 marks)

(b) Outline the role of the hormone leptin.

(3 marks)

(c) Compare and contrast type 1 and type 2 diabetes.

(4 marks)

Medium Questions

- 1 (a) Each year, a few people with type I diabetes are given a pancreas transplant. Pancreas transplants are not used to treat people with type II diabetes.

Give **two** reasons why pancreas transplants are not used for the treatment of type II diabetes.

(2 marks)

- (b) About 85% of people with type II diabetes are overweight or obese. Some people who are obese have gastric bypass surgery (GBS) to help them to lose weight.

Scientists investigated whether having GBS affects sensitivity to insulin. They measured patients' sensitivity to insulin before and after GBS. Some of the patients had type II diabetes. The others did not but were considered to be at high risk of developing the condition.

The table below shows the scientists' results. The higher the number, the greater the sensitivity to insulin.

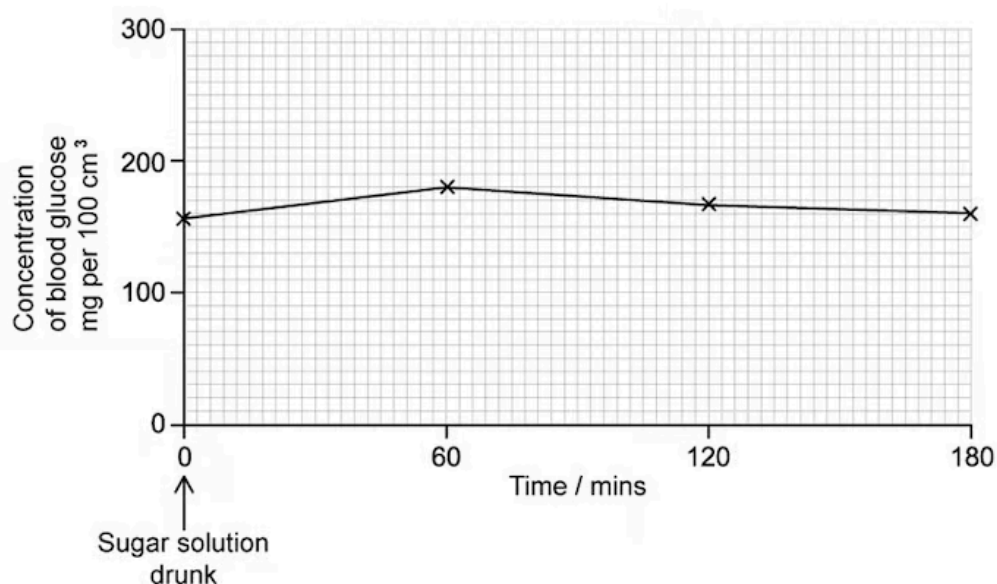
Patient type	Mean sensitivity to insulin / arbitrary units ± Standard Deviation (SD)	
	Before the gastric bypass	After the gastric bypass
Does not have diabetes	0.89 ± 0.29	1.35 ± 0.90
Has type II diabetes	0.45 ± 0.22	1.17 ± 0.92

The scientists concluded that GBS cured many patients' diabetes.

Use the data in the table to evaluate this conclusion.

(2 marks)

- (c) Some diabetic individuals do not produce insulin. In an experiment, a person with diabetes drank a sugary solution and then the glucose concentration in their blood was measured at regular intervals. The results are shown in the graph below.



Suggest **two** reasons why the concentration of glucose decreased after 60 minutes even though this person's blood contained no insulin.

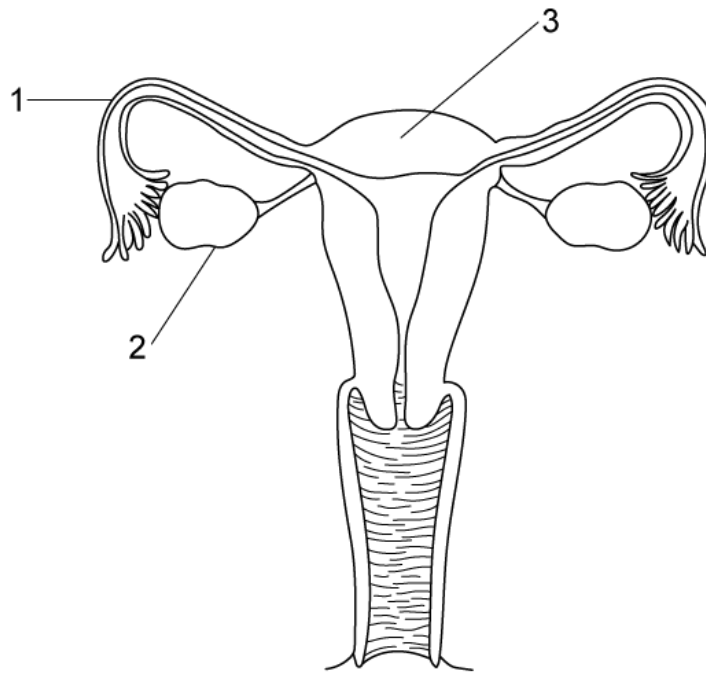
(2 marks)

- (d) The same experiment was repeated on a non-diabetic person. The glucose concentration in their blood prior to drinking the sugary solution was 75 mg per 100 cm³.

Sketch a curve on the graph in part (b) to show the results you would predict.

(1 mark)

2 (a) The diagram shows the female reproductive system in front view



Identify structures **1** and **2**.

(2 marks)

(b) State the function of structure **3** from part (a).

(1 mark)

(c) Outline the role of the SRY gene in the development of female embryonic reproductive organs

(3 marks)

- (d) Ethinylestradiol is a synthetic form of the naturally occurring female hormone oestrogen. A group of scientists found that exposing fish eggs in the lab to ethinylestradiol resulted in fewer male offspring compared to control fish.

The scientists then exposed the fish and their eggs to water from different sources and found that the eggs exposed to river water had similar results to those exposed to ethinylestradiol.

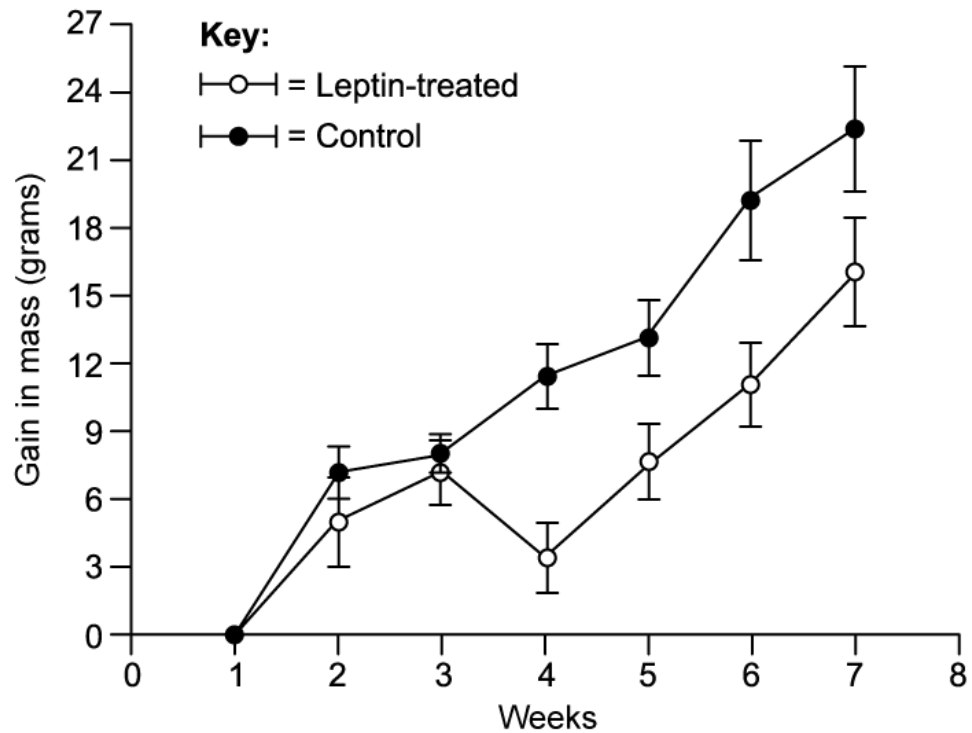
The table gives information on the amount of oestrogen found in different sources of water.

Water source exposed to fish eggs	Oestrogen level ng/m ³
Ground water	5
Surface water - river	60
Surface water - reservoir	12
Drinking water	25

Use your knowledge of hormones and the data provided to suggest an explanation for the scientists' results.

(2 marks)

3 (a) The graph below shows data collected on mice exposed to the hormone leptin. One group of mice were treated with leptin injections. The control mice received no leptin. Both groups of mice were fed the same diet over an eight week period.



Describe the results shown in the graph above.

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(3 marks)

(b) Explain the results shown in part (a).

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(3 marks)

- (c) Another hormone is thyroxine, released from the thyroid gland. Thyroxine contains iodine as part of its chemical structure.

Suggest, with a reason, **two** effects that iodine deficiency may have on the human body.

(2 marks)

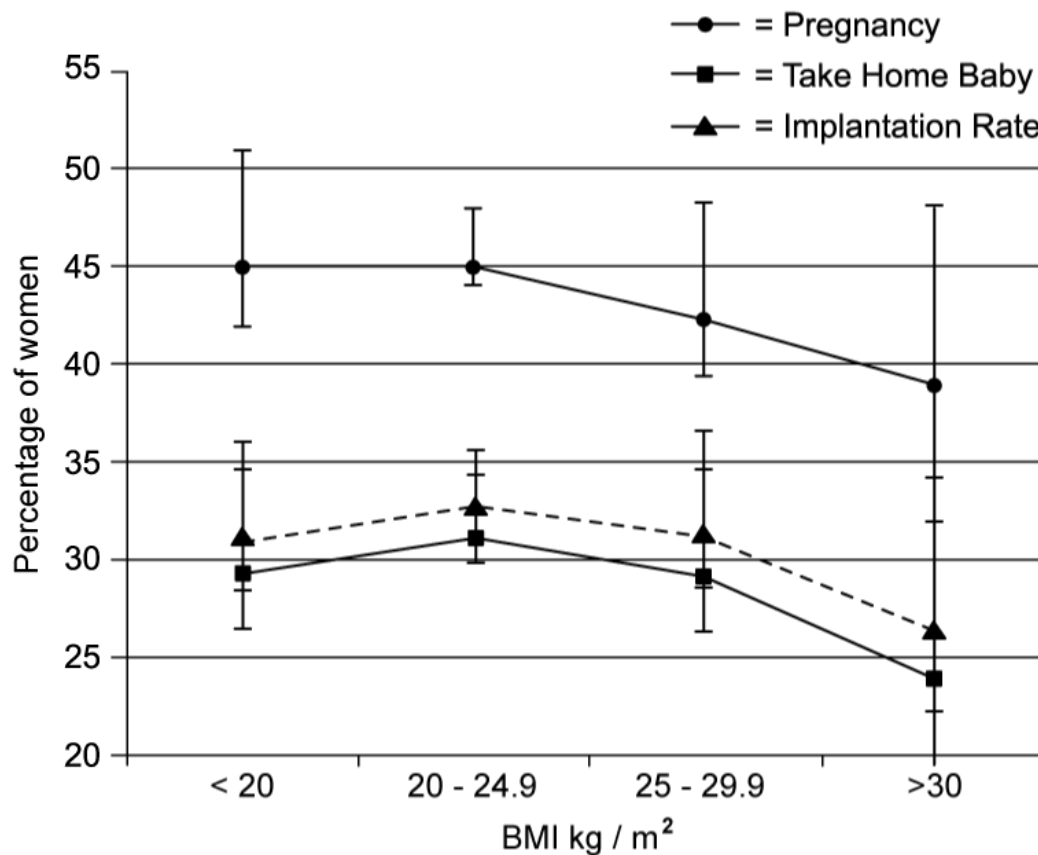
4 (a) *In vitro* fertilisation, known as IVF, involves fertilisation of a female egg outside of the human body. The hormones FSH and LH are used in IVF.

State the functions of FSH and LH in IVF.

(2 marks)

(b) A fertility clinic investigated the effect of body mass index (BMI) on the outcome of the percentage of women who had successful implantation, became and remained pregnant, and were able to take home a healthy baby following IVF treatment.

Their results are shown in the graph below.



The clinic advised women with a BMI greater than 30kg/m² to lose weight before embarking on IVF treatment.

Use the data to explain why.

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(2 marks)

(c) State what is meant by the term superovulation.

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(1 mark)

(d) William Harvey conducted observational research on sexual reproduction in deer in the 1600s.

State what Harvey was and was not able to observe in the deer.

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(4 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Outline the events that occur, including the hormones involved, during days 14-28 of the menstrual cycle in the absence of fertilisation.

(5 marks)

(b) The hormone oestrogen is involved in both positive and negative feedback loops within the menstrual cycle.

Explain how oestrogen functions in both positive and negative feedback within the menstrual cycle.

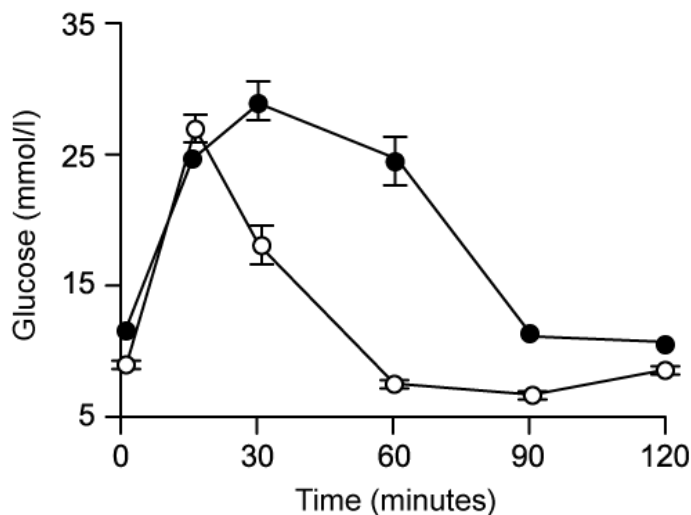
(3 marks)

(c) Describe the role of the pancreas and associated hormones in the control of blood glucose concentration.

(7 marks)

Hard Questions

1 (a) A group of scientists wanted to investigate the control of blood glucose in mice. They fed one group of mice with a normal diet and another group with a 'high fat' diet containing a high level of both fat and sugar for three weeks beforehand. They then measured their blood glucose over a period of 2 hours directly after a meal. Their results are shown below.



Explain the change in blood glucose levels for the **normal diet** mice during the first 90 minutes after the meal.

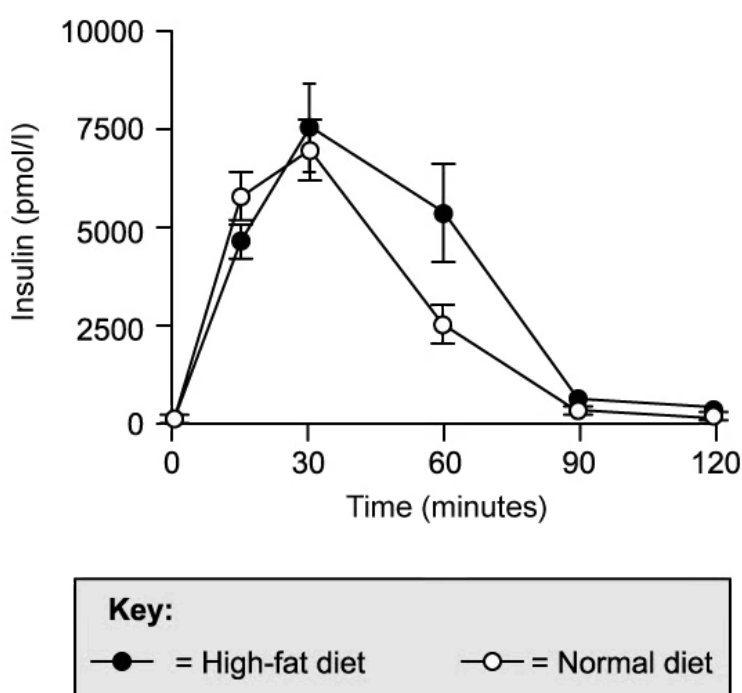
(4 marks)

- (b) After the first 90 minutes, the normal diet mice show an increase in blood glucose despite no more food being eaten.

Explain why blood glucose increases despite no food being consumed.

(2 marks)

- (c) At the same time as measuring blood glucose the scientists in part a) also measured blood insulin levels. Their results are shown below.

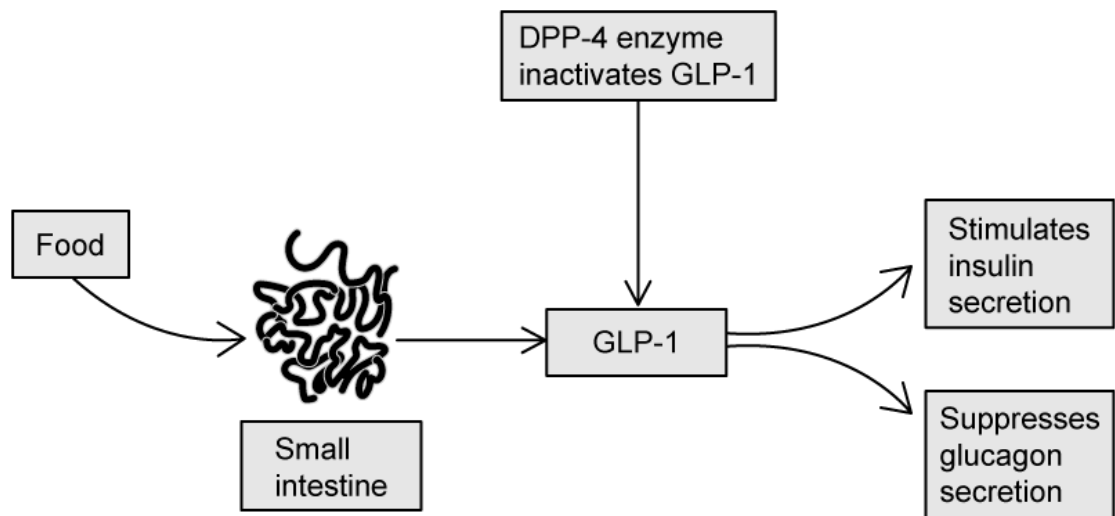


With reference to the changes in insulin, suggest an explanation for the difference in the blood glucose changes between the two groups of mice shown in part a).

(2 marks)

- (d) After carrying out the investigation detailed in parts a) and c), the scientists gave the high fat diet mice supplements of a drug called a DDP-4 inhibitor in their drinking water. The

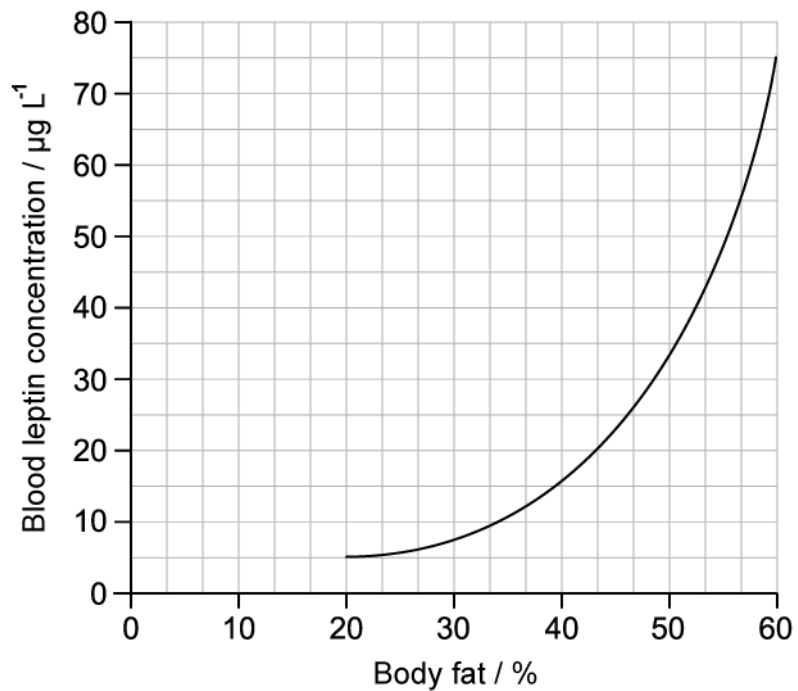
effects of the functional DPP-4 enzyme in the body are shown below.



Suggest, with a reason, how the administration of DPP-4 inhibitors might affect the blood-glucose levels of the high fat diet mice.

(2 marks)

2 (a) The graph below shows blood leptin concentration and body fat percentage in adult humans.



- (i) Calculate the percentage increase in blood leptin concentration when body fat percentage increases from 20 % to 60 %.

[2]

- (ii) Explain the association between body fat percentage and blood leptin concentration shown in the graph.

[1]

(3 marks)

(b) Research carried out in mice has shown that high levels of leptin can induce weight loss in mice with a high body fat percentage.

(i) State how high levels of leptin can lead to weight loss in mice.

[1]

(ii) Suggest why humans with a high body fat percentage might continue to gain weight despite the results shown in part a) above and the evidence collected from research with mice.

[2]

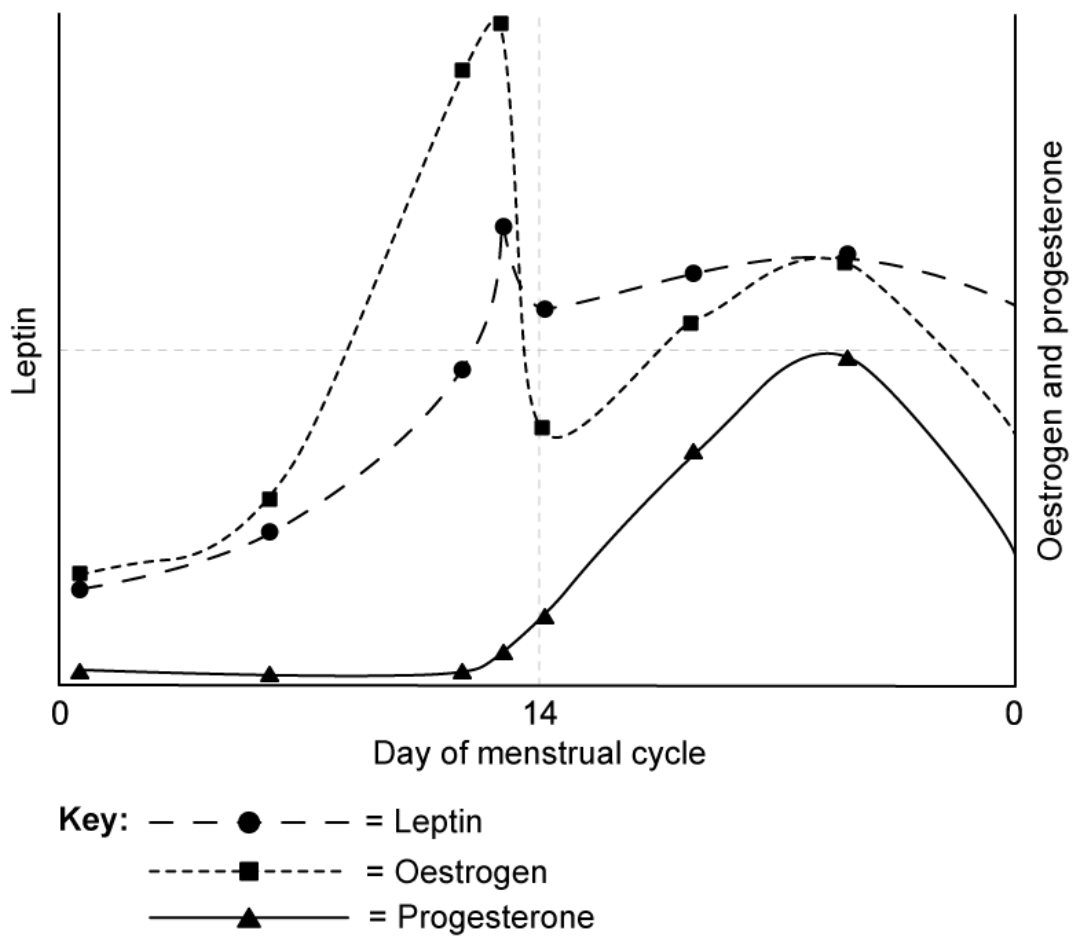
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(3 marks)

(c) Levels of the hormone leptin were recorded, along with levels of some reproductive hormones, in a group of 250 regularly menstruating, healthy women. The average results over one menstrual cycle are shown below.



One conclusion from the results of the study was that leptin could be involved with the process of ovulation.

Evaluate this conclusion.

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(3 marks)

(d) Suggest, with a reason, **one** other possible conclusion that could be drawn about the role of leptin in reproduction from the results in part c).

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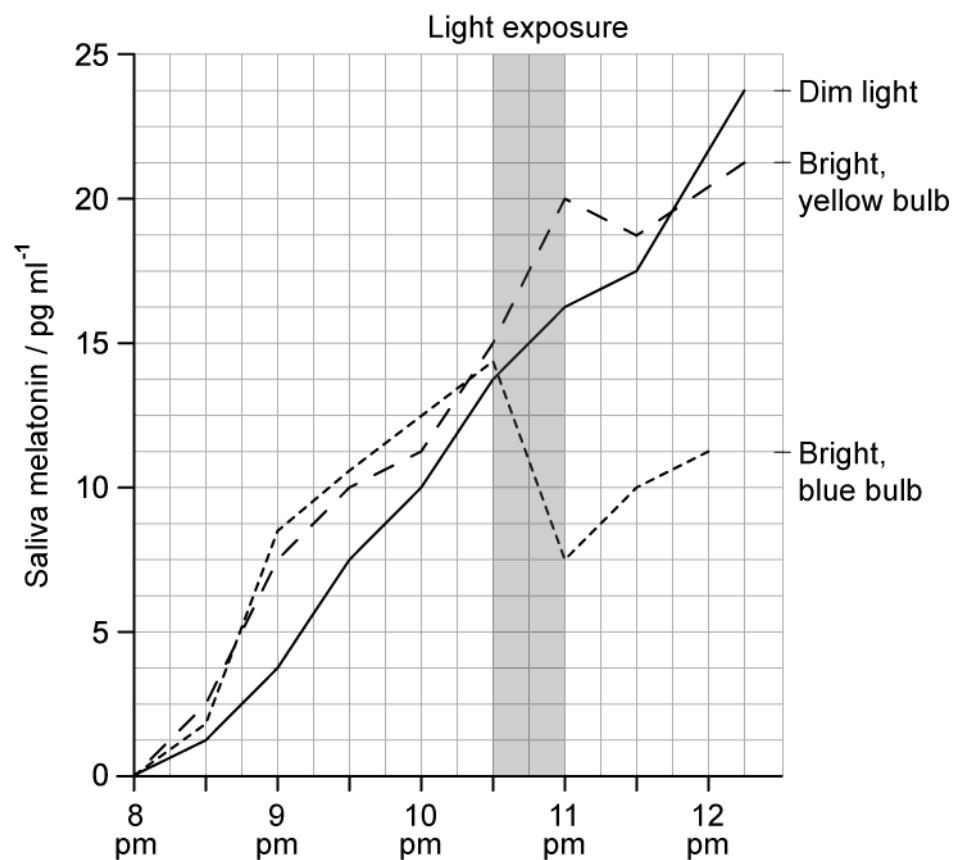
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(2 marks)

3 (a) A group of scientists studied the effect of exposure to bright bathroom lights late in the evening on melatonin levels. Subjects attended a sleep clinic where they were allocated to three different light exposure groups; dim light, bright yellow light, and bright blue light.

Over the course of a week, all of the subjects spent most of each evening carrying out normal activities under dim light, before each group was exposed to a 30 minute period of either continuing dim light, bright yellow light, or bright blue light between 10:30 and 11 pm to simulate exposure to bathroom light.

The saliva melatonin levels of all groups were measured at 30 minute intervals throughout the evening and an average is taken for each light condition. The results are shown below.



Describe the effect of the 30-minute period of light exposure on melatonin levels.

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(3 marks)

- (b)** A student was changing the light bulb in their bathroom and concluded, after reading the data in part a), that the best bulb type for improving their sleep would be a bright, yellow bulb.

Evaluate the student's conclusion using information from part a).

(3 marks)

- (c)** One of the roles of melatonin is to bind to cell membrane receptors on pancreas cells and slow down the secretion of insulin.

(i) Describe the effect that the binding of melatonin to receptors on pancreas cells will have on the body. [2]

(ii) Suggest a benefit of the effect described in part i) during the period at which melatonin levels are high. [1]

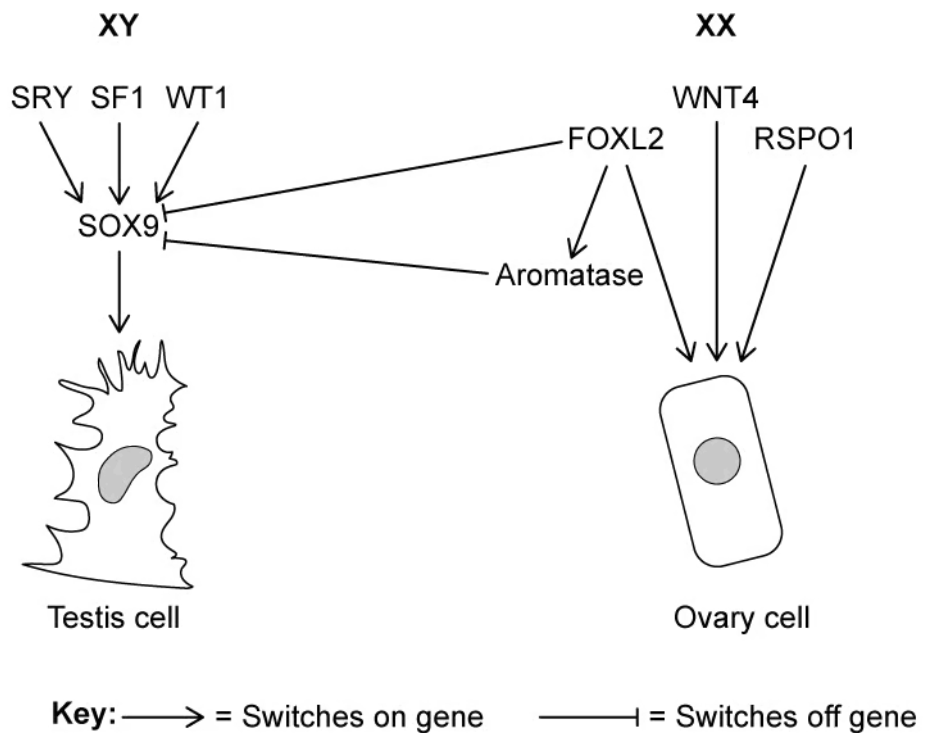
(3 marks)

- (d)** A mutation known as the G allele has been identified in some individuals. The G allele is thought to increase the sensitivity of cells to melatonin. Individuals who regularly undertake shift work at night and who also have the G allele are thought to be at particularly high risk of diabetes.

Use the information provided in parts c) and d) to suggest why individuals with the G allele who regularly work night shifts are thought to be at greater risk of type 2 diabetes.

(2 marks)

4 (a) The image below shows some of the gene pathways that could be involved with sex determination in mammals. Note that 'switching on' a gene refers to activation, while 'switching off' refers to inhibition, e.g. the diagram shows that the gene WT1 activates expression of the gene SOX9.



Including information in the image above, outline the role of SRY in determining biological sex.

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(3 marks)

(b) Suggest, with a reason, a possible outcome resulting from mutations in the following genes shown in part a).

(i) SF1

[2]

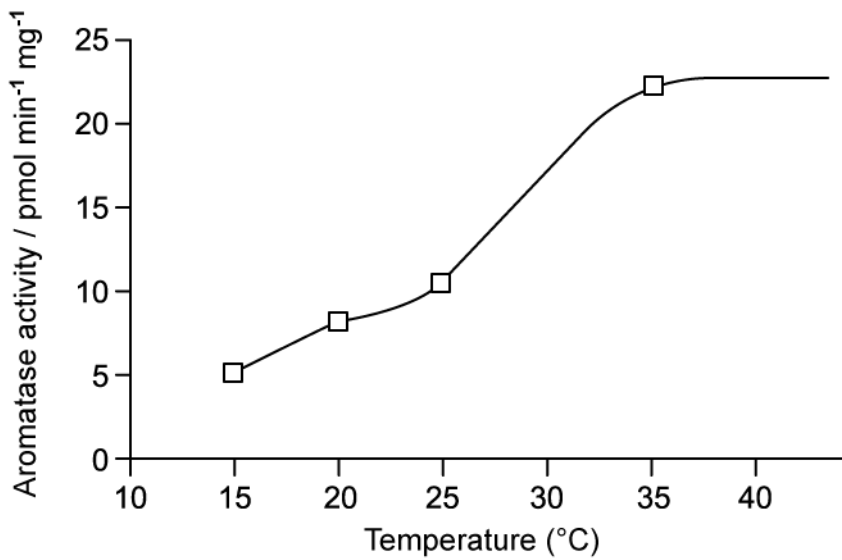
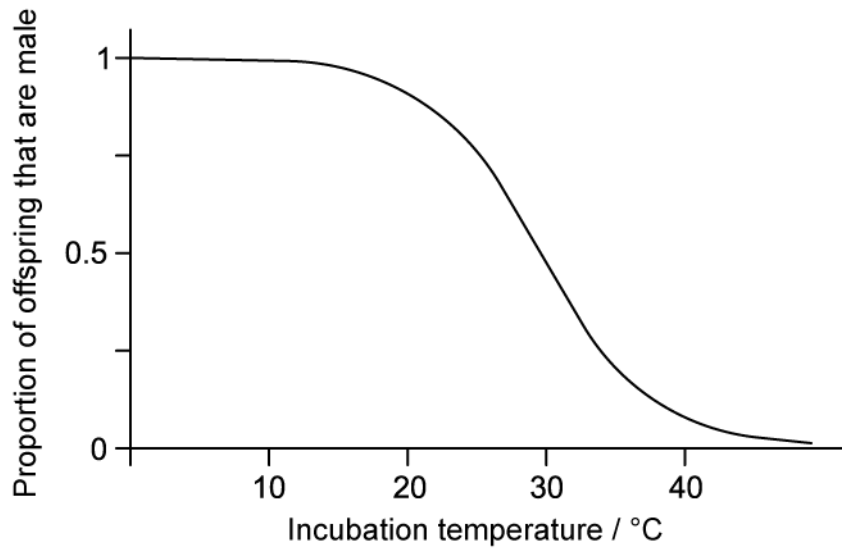
(ii) FOXL2

[2]

(4 marks)

(c) Biological sex in some species of reptile is determined by the temperature at which the reptile eggs are incubated during a thermosensitive period of development. There has been some suggestion among scientists that the enzyme aromatase may be involved in temperature-related sex determination in these reptiles.

A possible example of this is in sea turtles. The graphs below show the effect of developmental temperature on sea turtle sex (top) and on the activity of the enzyme aromatase (bottom).



Use information provided here and in part a) to suggest how aromatase activity may determine sex in sea turtles.

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(2 marks)

(d) Suggest, with a reason, how the current global warming trends may impact populations of the sea turtles described in part c).

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(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Draw a labelled diagram of the male reproductive system.

(7 marks)

(b) Describe the role of hormones in the regulation of the menstrual cycle.

(8 marks)