IB · DP · Biology

2 hours 15 questions

Structured Questions: Paper 2

11.4 Sexual Reproduction

11.4.1 Oogenesis & Spermatogenesis / 11.4.2 Fertilisation / 11.4.3 Pregnancy / 11.4.4 Hormones in Pregnancy / 11.4.5 The Placenta / 11.4.6 Oestrogen Pollution / 11.4.7 Skills: Annotating Sexual Reproduction Diagrams

Easy (5 questions)	/45
Medium (5 questions)	/50
Hard (5 questions)	/45
Total Marks	**/140**

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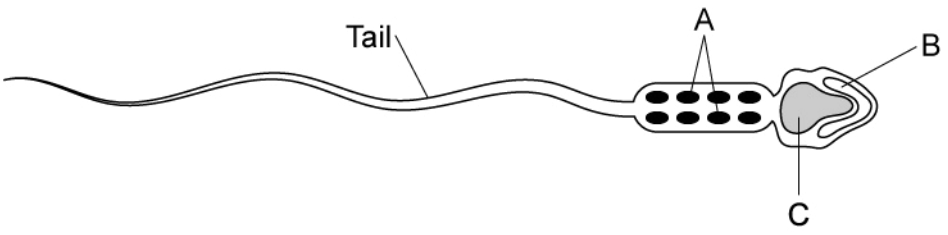
Easy Questions

1 (a) The diagram below shows the structure of a mature human sperm cell.



Identify structures **A**-**C.**

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(3 marks)

(b) Describe the role of structure **A** within the sperm cell shown in part a).

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(2 marks)

(c) A sperm cell is an example of a haploid cell.

(i) Define the term **haploid**.

[1]

(ii) Explain the importance of a sperm cell being haploid.

[1]

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(2 marks)

(d) Structure **B** in part a) assists with the process of fertilisation.

Identify the substances contained within structure **B** that assist with fertilisation.

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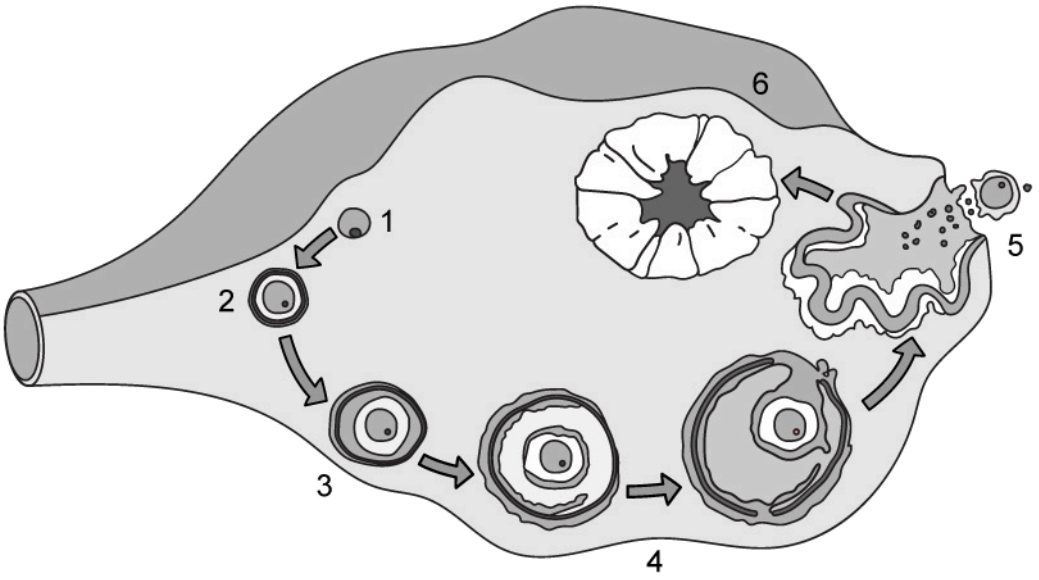
(1 mark)

2 (a) The following diagram shows the process of oogenesis in a human ovary.



Identify the structure present at stage **2** in the diagram.

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(1 mark)

(b) Describe what is happening to the structure identified in a) between steps **3** and **4** in the diagram in part a).

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(2 marks)

(c) Identify **three** similarities between the processes of oogenesis and spermatogenesis.

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(3 marks)

3 (a) Humans are placental mammals.

Outline what is meant by the term **placental mammal**.

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(2 marks)

(b) The table below lists some of the substances that are transported across the placenta, as well as the names of some transport mechanisms.

Substance	Transport mechanism
Carbon dioxide and oxygen	
Glucose	
Antibodies	
Water	

endocytosis **facilitated diffusion** **diffusion** **osmosis**

Identify the transport mechanism for each of the substances by correctly matching them in the table.

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(4 marks)

(c) The placenta primarily consists of finger-like projections called placental, or chorionic, villi.

Suggest why the number of these villi increases throughout the course of a pregnancy.

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(1 mark)

(d) The placenta is also responsible for producing key pregnancy hormones.

(i) Identify **one** hormone produced by the placenta.

[1]

(ii) State the function of the hormone identified in part i).

[1]

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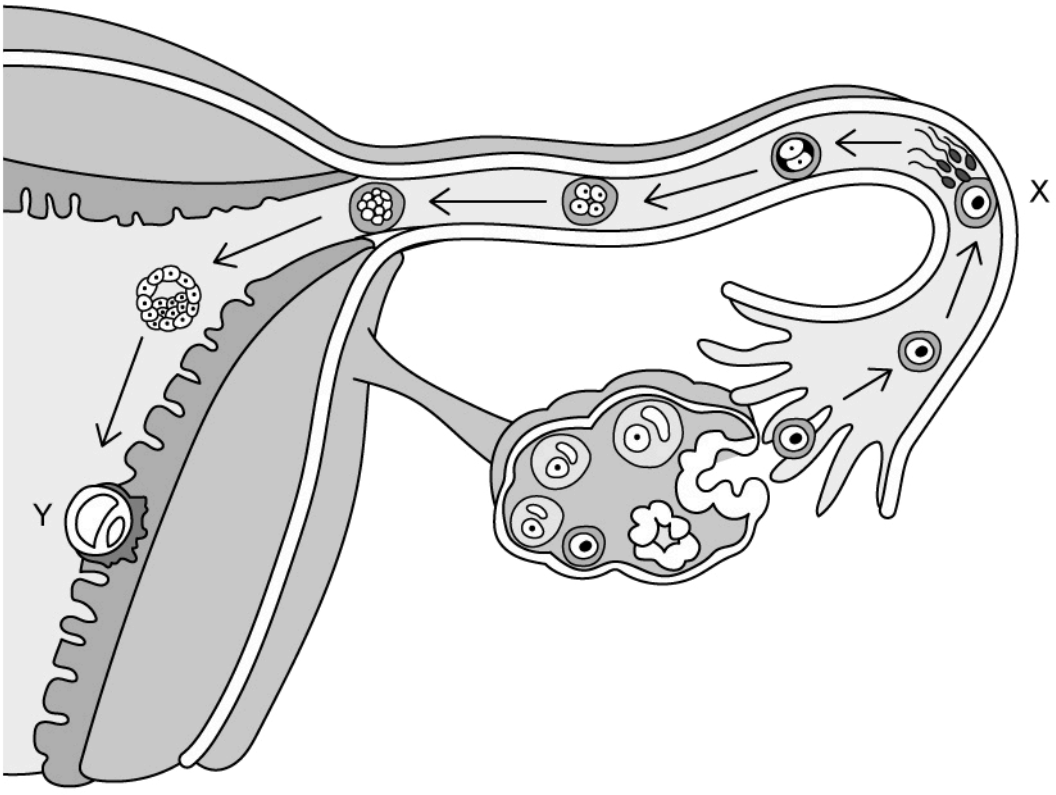
(2 marks)

4 (a) The diagram below shows some of the events that can occur in the female reproductive system after ovulation.



Identify the events occurring at **X** and **Y** in the diagram.

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(2 marks)

(b) Event **X** involves a series of mechanisms that prevent polyspermy.

Define the term **polyspermy**.

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(1 mark)

(c) One of the mechanisms that prevents polyspermy is known as the cortical reaction.

Describe the steps of the cortical reaction.

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(2 marks)

(d) Process **Y** is essential for pregnancy to occur.

Explain the importance of process **Y**

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(2 marks)

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

Describe the secretion and role of human chorionic gonadotropin (hCG) in early pregnancy.

(4 marks)

(b) The process of childbirth occurs in several stages.

Outline the events that occur during childbirth.

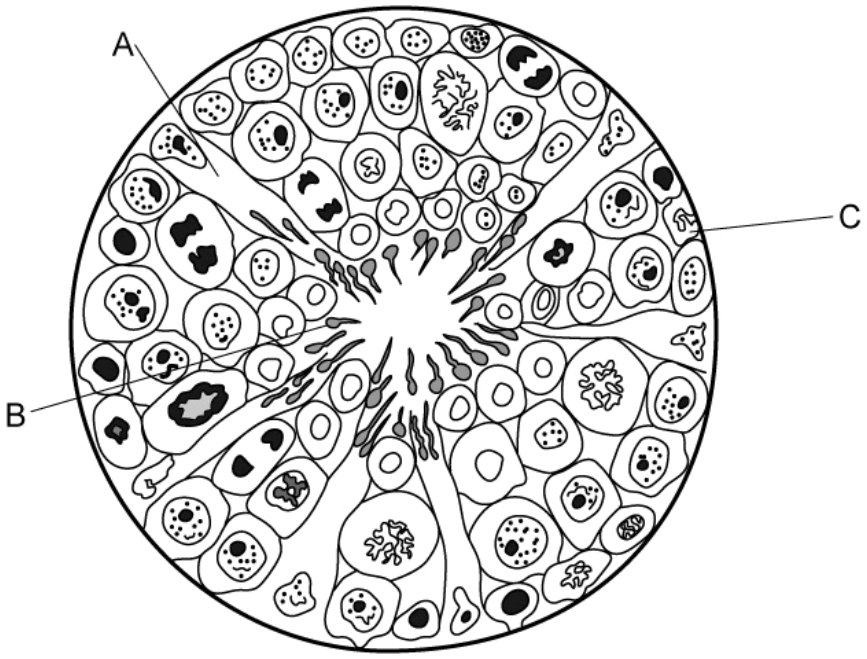
(7 marks)

(c) Draw an annotated diagram of a mature human ovum.

(4 marks)

Medium Questions

1 (a) The image below shows a cross-section through a seminiferous tubule during spermatogenesis.



Identify the cells labelled **A**-**C** in the image.

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(3 marks)

(b) Outline the events that take place between the formation of cells **C** and **B** labelled in part a).

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(3 marks)

(c) Contrast the processes of spermatogenesis and oogenesis.

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(3 marks)

2 (a) Compare and contrast internal and external fertilisation.

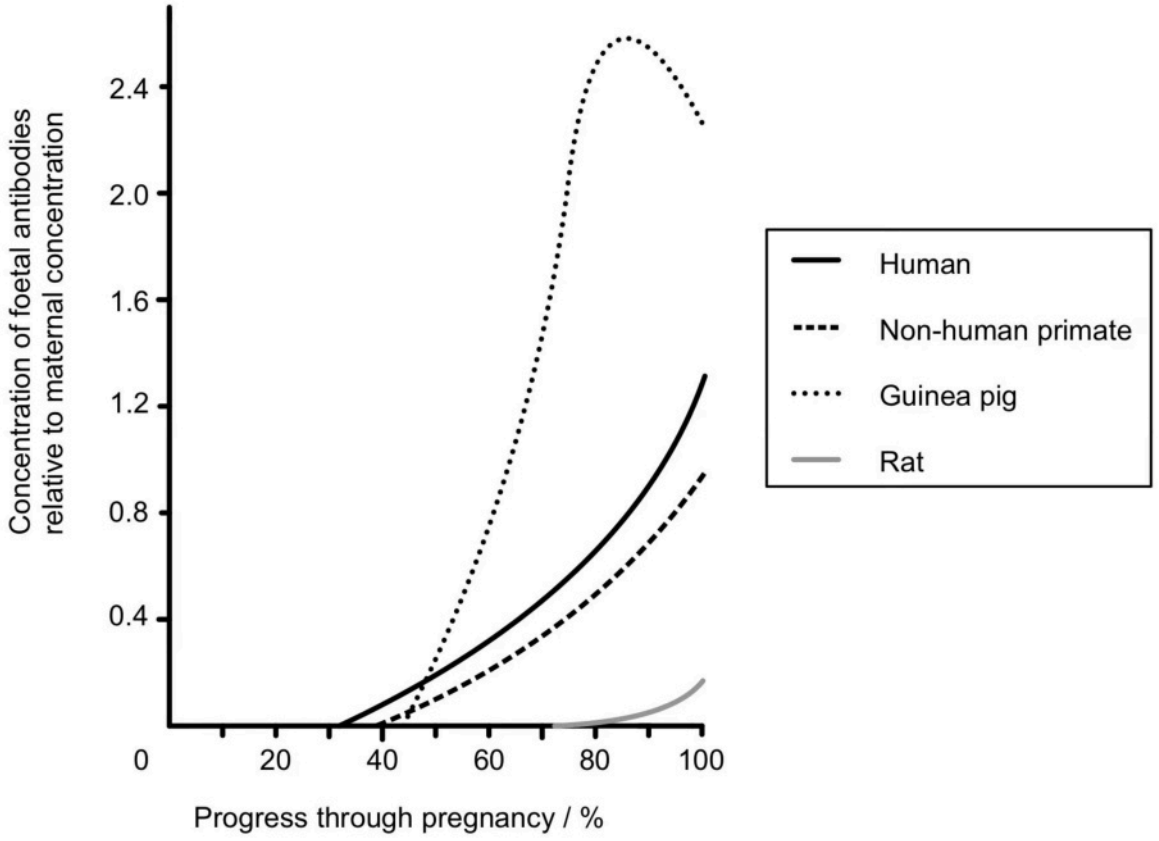
(3 marks)

(b) Fertilisation in humans is followed by implantation of the blastocyst.

Outline the events that allow implantation to occur.

(2 marks)

(c) Once implantation has occurred, part of the blastocyst develops into the placenta. The transfer of antibodies from mother to foetus at the placenta in several different species can be seen in the graph below.



Contrast the changes in antibody concentration in the foetuses of humans and rats.

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(2 marks)

(d) Suggest, with a reason, which of the species in the graph shown in part c) will need the least maternal care from birth.

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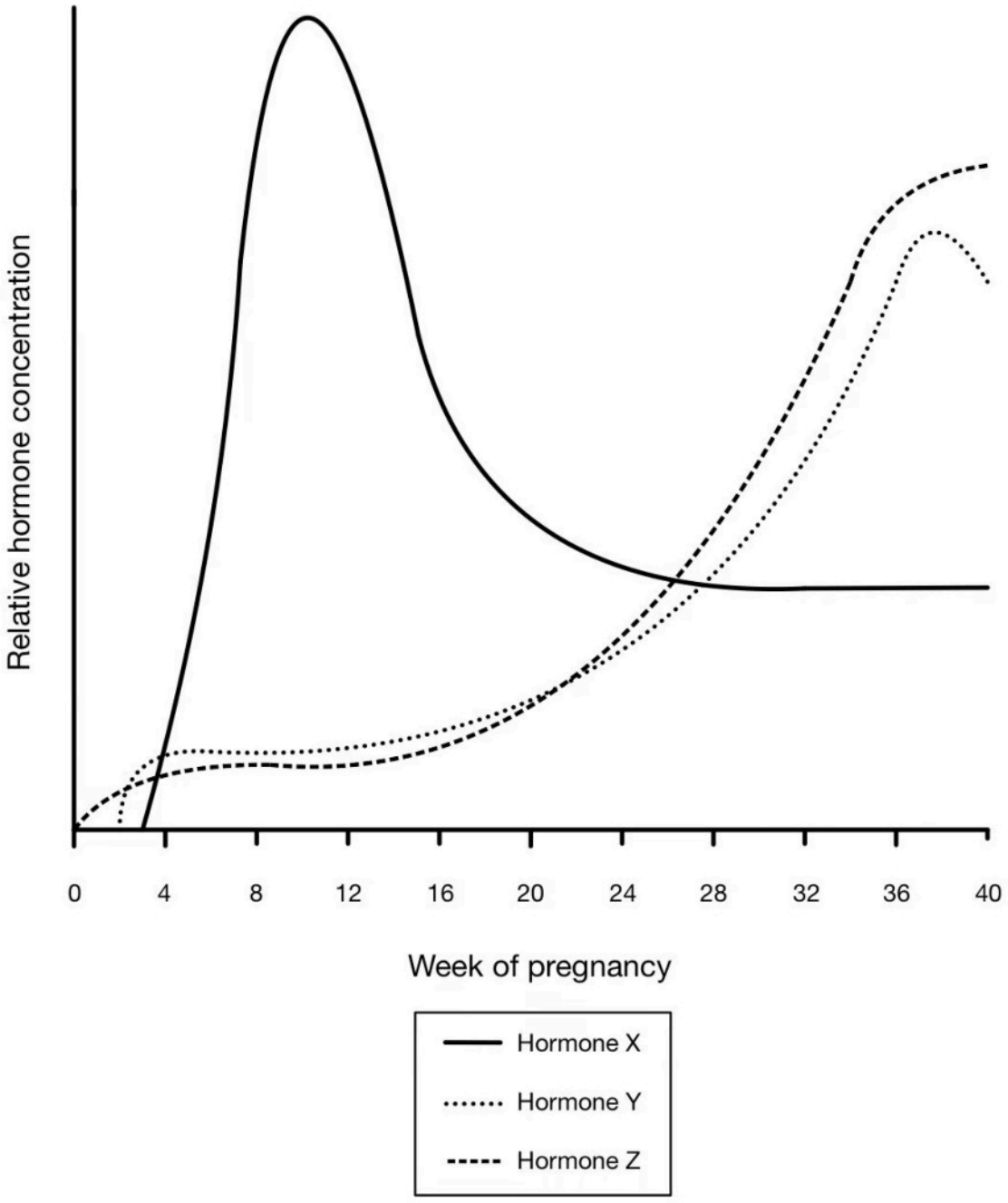
(2 marks)

3 (a) The graph below shows the relative levels of three hormones during pregnancy.



Identify, with a reason, the hormone labelled **X** in the graph above.

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(3 marks)

(b) As the woman's body prepares to give birth, a fourth hormone, oxytocin, has an important role.

Sketch what you might expect to happen to levels of oxytocin on the graph in part a).

Note that hormone **Y** in the graph in part a) is progesterone.

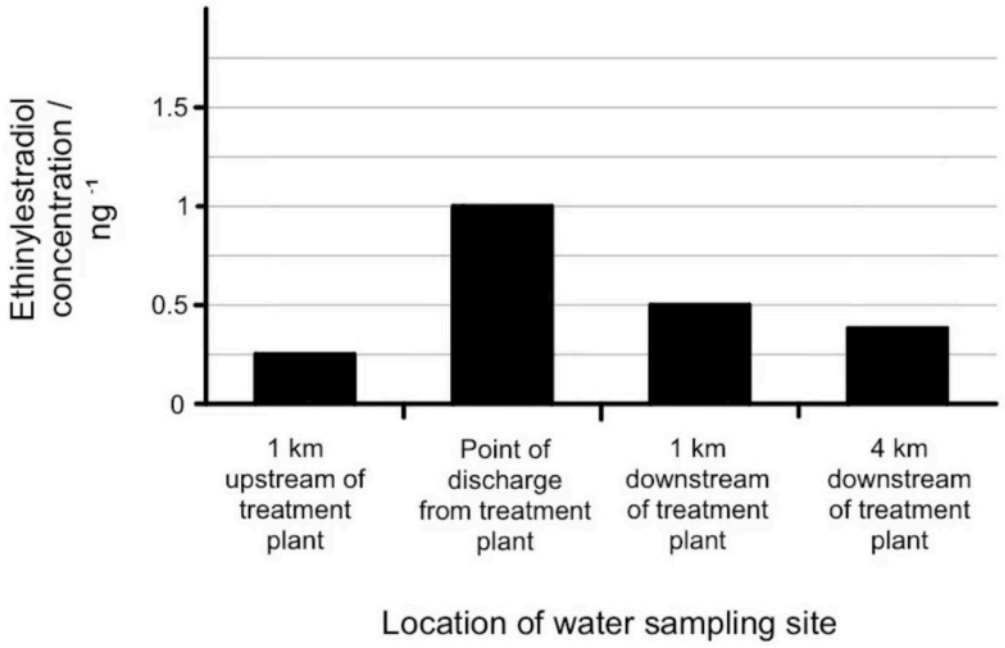
(2 marks)

(c) Oxytocin is part of a positive feedback loop during birth.

Outline the role of this positive feedback loop during birth.

(3 marks)

4 (a) The graph below shows levels of a synthetic oestrogen called ethinylestradiol at different sampling locations along a river. Note that a treatment plant treats sewage wastewater before releasing treated water back into a river.



Calculate the percentage increase in ethinylestradiol concentration between 1 km upstream of the treatment plant and the point of discharge from the treatment plant.

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(2 marks)

(b) One study investigated the effect of ethinylestradiol on reproduction in one species of fish. The researchers exposed fish in separate mesocosms to different concentrations of ethinylestradiol.

Explain why the scientists chose to carry out their investigation in mesocosms.

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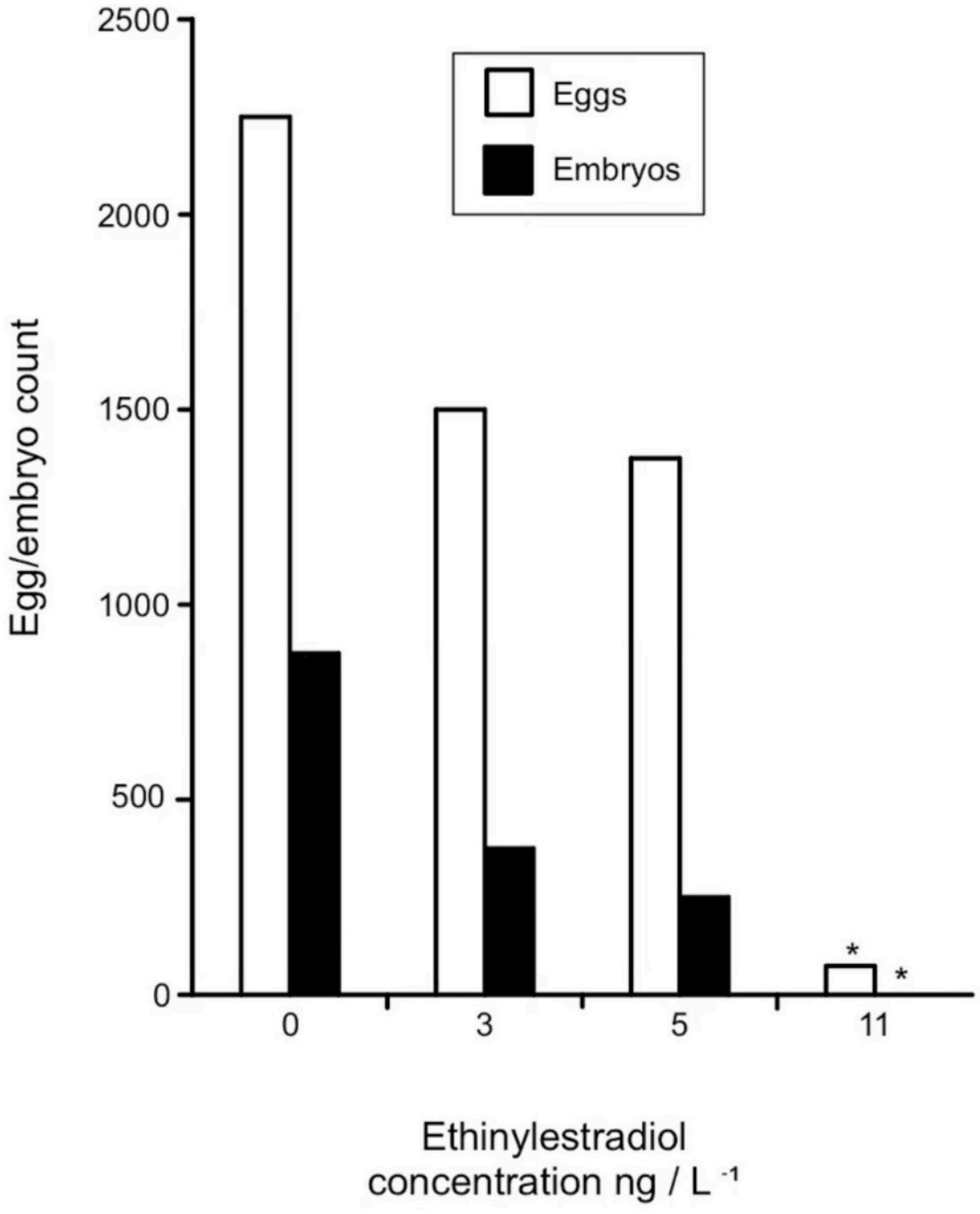
(2 marks)

(c) The scientists measured the effect of changing ethinylestradiol levels on egg production and embryo formation in fish populations. Their results are shown in the graph below. Note that the symbol * denotes a result that is significantly different from the control (0 ng L^{-1}).



A student read these results and concluded that ethinylestradiol was harmful to reproduction in fish.

Use all the information provided throughout Q4 to evaluate the student's conclusion.

(4 marks)

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

Draw an annotated diagram of a mature human sperm cell.

(4 marks)

(b) Describe the process of fertilisation in humans.

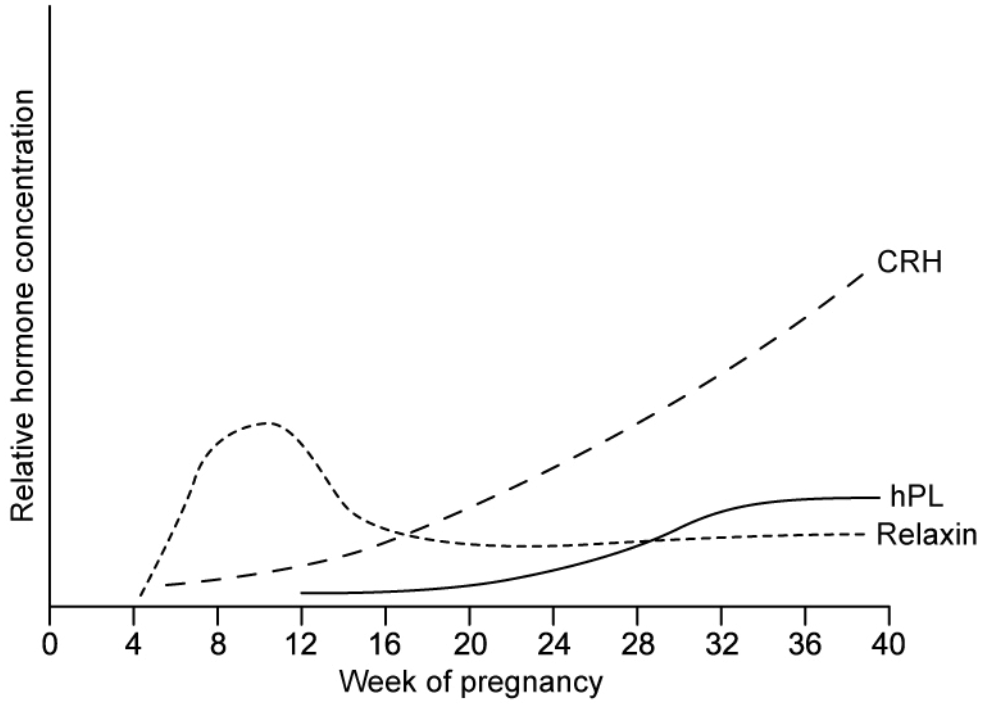
(5 marks)

(c) Outline the process of oogenesis.

(7 marks)

Hard Questions

1 (a) During pregnancy, the placenta releases several hormones into the bloodstream. The graph below shows the relative concentrations of three such hormones, namely corticotropin-releasing hormone (CRH), human placental lactogen (hPL) and relaxin.



Contrast the changes in relative concentrations of hPL and relaxin.

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(3 marks)

(b) Recent studies suggest that CRH is involved with regulating the contractile properties of the myometrium.

With reference to the graph in part a) suggest, with a reason, the role of CRH in pregnancy.

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(2 marks)

(c) The hormone hPL affects several metabolic processes during the course of pregnancy. One such effect is that it decreases the response of the maternal cells to insulin.

Explain how high levels of hPL will benefit the growing foetus.

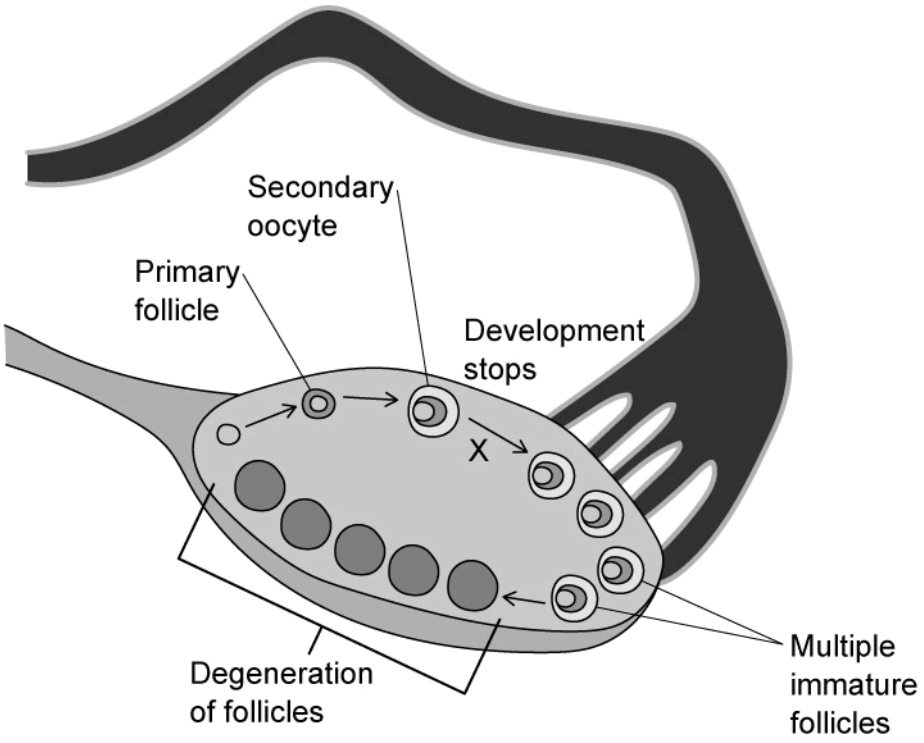
(2 marks)

(d) The hormone relaxin will lead to an increase in renal blood flow during pregnancy.

Suggest why this increased blood flow is important during pregnancy.

(2 marks)

2 (a) Polycystic ovary syndrome (PCOS) is a common hormonal disorder in women aged 15 to 44. The diagram below shows the progression of oogenesis in the ovary of a person suffering from PCOS.



Contrast the process of oogenesis in a person suffering from PCOS with someone who does not have the condition.

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(2 marks)

(b) Women suffering from PCOS will often have low levels of progesterone in their bloodstream.

Use the information in part a) to suggest why this is the case.

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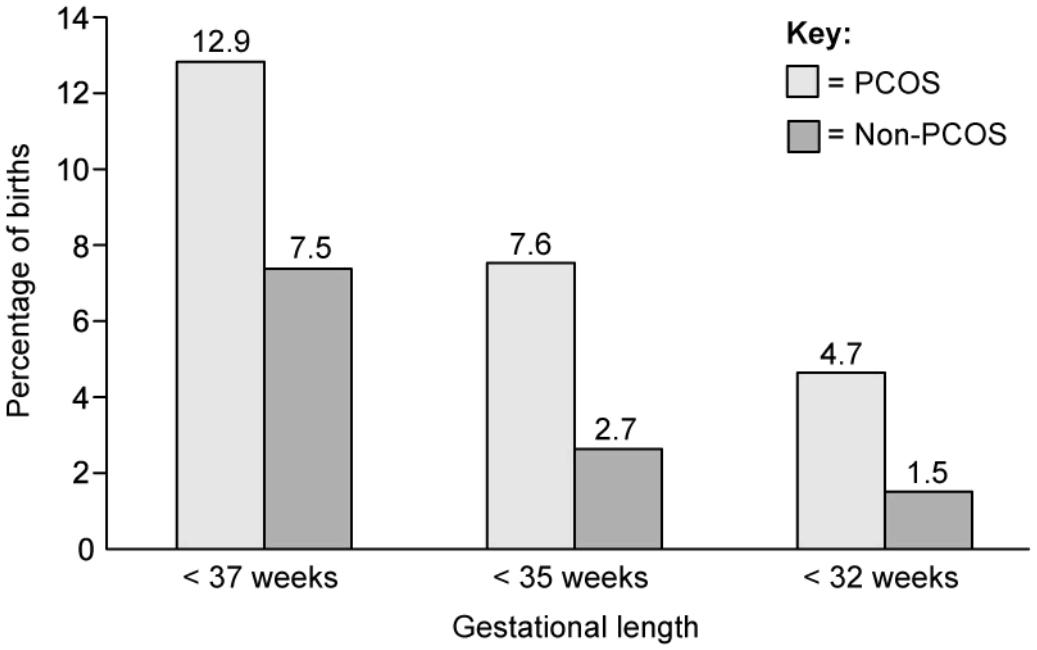
(2 marks)

(c) Scientists investigated the link between PCOS in pregnant women and the risk of premature birth. The study was conducted in the maternity ward of a hospital and only women that had previously been diagnosed with PCOS were included in the PCOS group of the investigation. The results of the investigation are shown in the graph below.



Calculate the percentage difference between the PCOS and non-PCOS groups that delivered their babies between 32 and 35 weeks of pregnancy. Show your working.

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(2 marks)

(d) The scientists concluded that pregnant women suffering from PCOS will have an increased risk of premature birth.

Evaluate this conclusion.

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(3 marks)

3 (a) Research suggests that exposure to elevated levels of ethinylestradiol (synthetic oestrogen) in males leads to a significant decrease in the diameter of the seminiferous tubules, as well as fewer germinal epithelial cells.

Suggest the effect of these changes on spermatogenesis.

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(3 marks)

(b) Scientists measured the effect of changing ethinylestradiol levels on egg production and embryo formation in a species of fish.

Use your knowledge of the effects of oestrogen pollution to suggest a hypothesis for this investigation.

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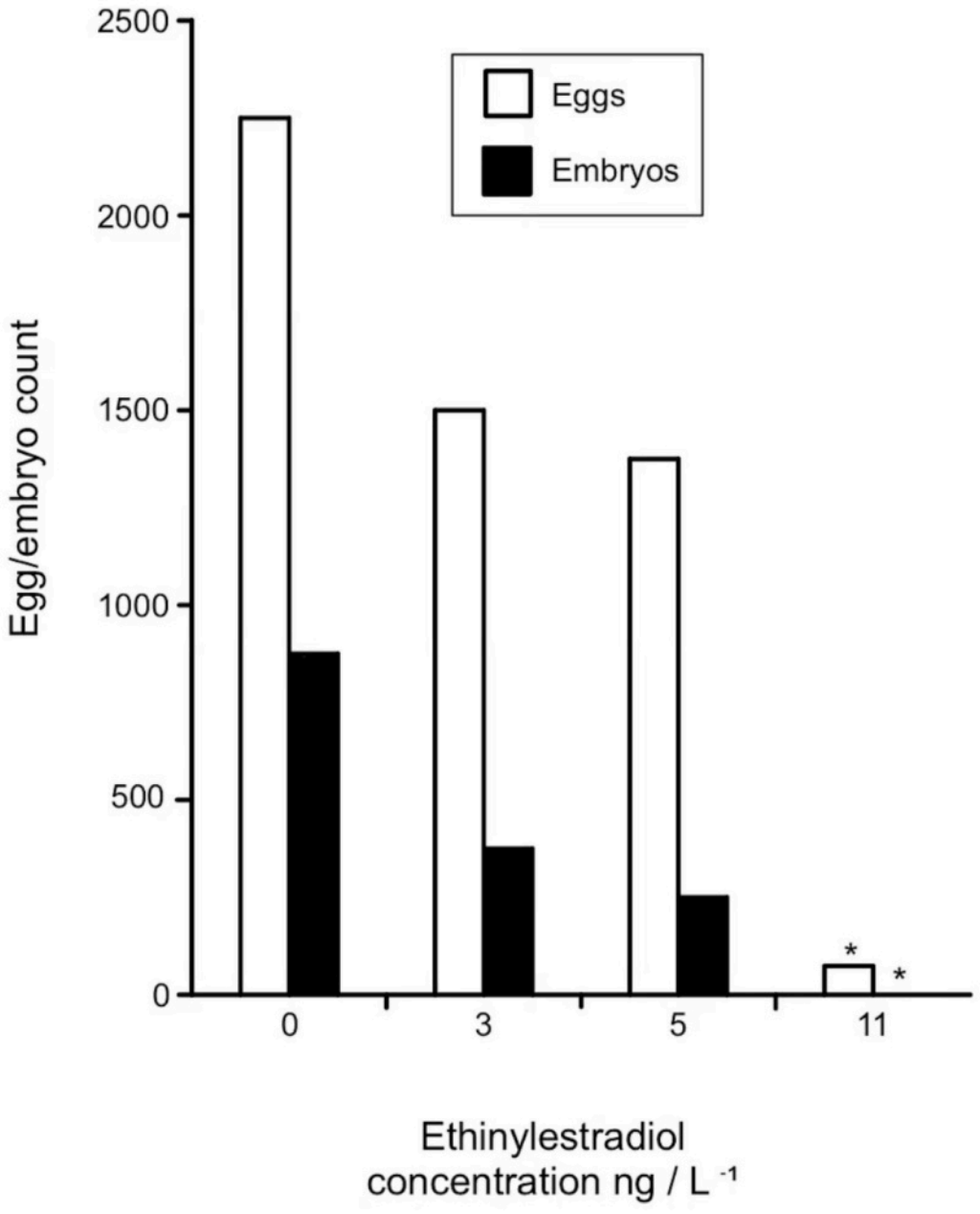
(1 mark)

(c) The results of the investigation described at part c) are shown in the graph below. Note that the symbol * indicates a result that differs significantly from the control (0 ng L^{-1}).



Suggest a possible explanation for the result obtained at an ethinylestradiol concentration of 11 ng L^{-1}.

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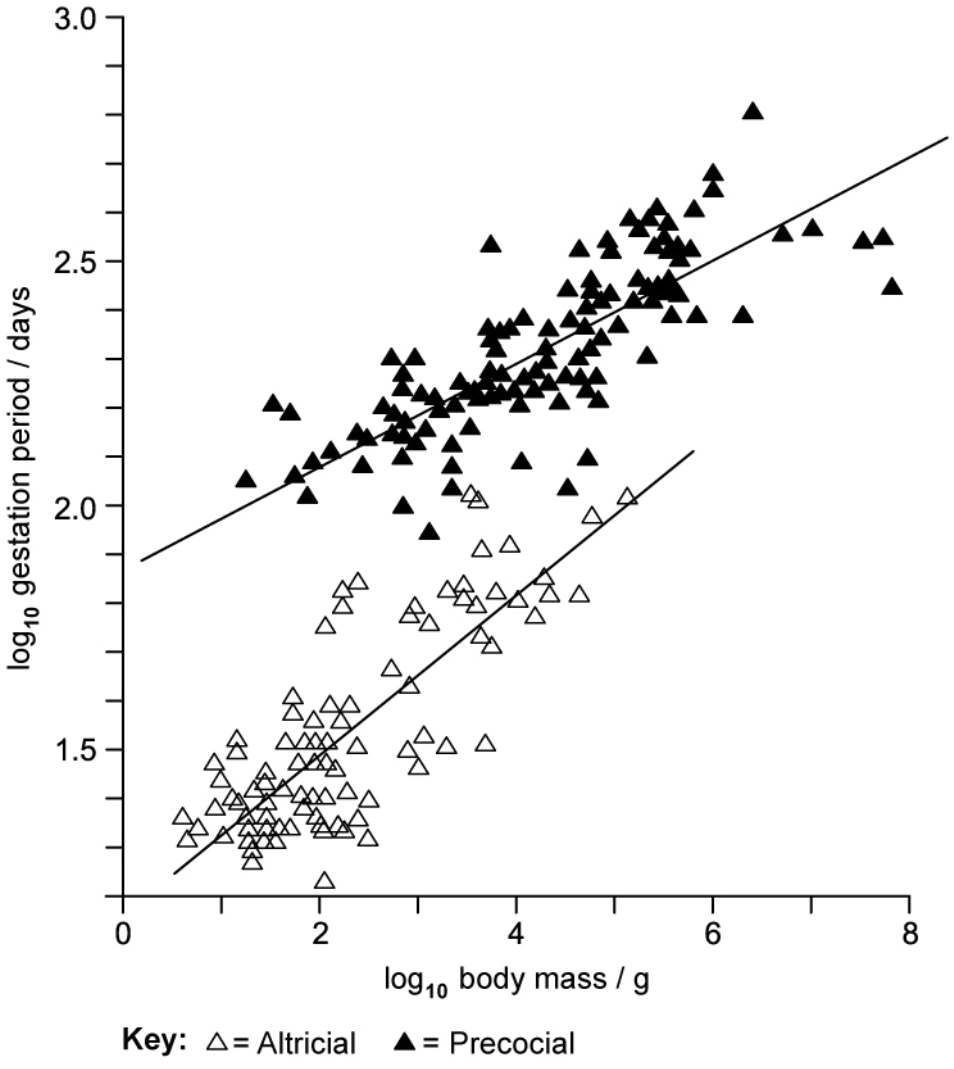
(2 marks)

4 (a) The graph below shows the relationship between body mass and gestation period for different species of mammals.



The American black bear *Ursus americanus* is a large carnivore with an average body mass of 70 kg and a gestation period of 220 days.

Draw the data point for the black bear on the graph. Show your working.

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(2 marks)

(b) Black bear mating season typically occurs from June to August but implantation of the blastocyst will only happen during November or December. Their cubs are born in January or February weighing between 250 and 400 grams and with very little fur covering their bodies. They are blind at this stage and rely on smell to locate their mother.

Based on the information provided, suggest:

(i) Why black bears are considered to be altricial.

[1]

(ii) The benefit to the mother of the reproductive strategy described above.

[1]

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(2 marks)

(c) Large mammals are typically precocial with long gestation periods.

Explain the advantage of this strategy.

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(2 marks)

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

Outline the role of the zona pellucida in an oocyte.

(3 marks)

(b) Compare and contrast the processes of oogenesis and spermatogenesis

(7 marks)

(c) Explain the advantages of internal fertilisation to terrestrial animals.

(5 marks)