IG.B10 Human Reproduction: Organs, Gametes and the Menstrual Cycle

Total Marks

EDEXCEL 4BI1 · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name the site in the male reproductive system where sperm are produced. Context: male reproductive organs.

(Total for Question 1 is 1 mark)

2 State the function of the sperm duct (vas deferens) in the male reproductive system.

(Total for Question 2 is 1 mark)

3 State one function of the prostate gland in human males.

(Total for Question 3 is 1 mark)

4 Name the female reproductive organ where fertilisation normally takes place. Context: female reproductive tract.

(Total for Question 4 is 1 mark)

5 Define fertilisation in humans, giving the cellular event that occurs. Context: conception and zygote formation.

(Total for Question 5 is 2 marks)

6 Describe one structural adaptation of a sperm cell and explain how it helps the sperm reach and fertilise an egg. Context: gamete adaptations.

(Total for Question 6 is 2 marks)

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7 Describe one structural adaptation of an egg (ovum) cell and explain how this adaptation helps at fertilisation. Context: female gamete structure.

(Total for Question 7 is 2 marks)

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8 Compare two differences between sperm and egg cells, giving one reason for each difference. Context: gamete comparison.

(Total for Question 8 is 4 marks)

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9 Outline the main stages of the human menstrual cycle and name the four hormones involved, stating one role for each hormone. Context: monthly cycle and hormonal control.

(Total for Question 9 is 5 marks)

10 A hormone graph from a single menstrual cycle shows a sharp LH peak at day 14 and rising oestrogen just before day 14. Using this context, state on which day ovulation is most likely to occur and explain why. Context: hormone graph interpretation.

(Total for Question 10 is 2 marks)

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11 Explain how a hormonal contraceptive that contains progesterone (the mini pill) helps prevent pregnancy. Context: contraceptive mechanism using named hormones FSH, LH, oestrogen, progesterone.

(Total for Question 11 is 3 marks)

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12 Describe three ways in which the placenta and umbilical cord allow exchange between mother and fetus. Context: role during pregnancy and gestation.

(Total for Question 12 is 3 marks)

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13 Explain how the structure of the placenta increases the efficiency of exchange between maternal and fetal blood. Context: placental structure and function.

(Total for Question 13 is 5 marks)

14 A pregnant woman breathes air with oxygen at normal concentration while the fetus obtains oxygen via the placenta. State two differences between how oxygen is carried in maternal blood and in fetal blood that help transfer of oxygen across the placenta. Context: fetal haemoglobin and maternal oxygen transport.

(Total for Question 14 is 2 marks)

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15 Extended response: Explain how the placenta supports fetal development throughout pregnancy. Context: structure, exchange, hormonal and protective roles of the placenta and umbilical cord.

Explain how the placenta supports fetal development throughout pregnancy.

(Total for Question 15 is 6 marks)

Mark scheme · IG.B10 Human Reproduction: Organs, Gametes and the Menstrual Cycle

Question 1

- **B1** testes or testis
- **Answer: Testes**

Question 2

- **B1** transports sperm from the testes to the urethra or to the ejaculatory region
- **Answer: Transports sperm from the testes towards the urethra for ejaculation**

Question 3

- **B1** produces seminal fluid/seminal plasma that nourishes and helps transport sperm
- **Answer: Produces seminal fluid that nourishes and helps transport sperm**

Question 4

- **B1** oviduct or fallopian tube
- **Answer: Oviduct (fallopian tube)**

Question 5

- **B1** the fusion of a sperm and an egg
- **B1** the nuclei of the sperm and egg fuse to form a zygote
- **Answer: Fusion of a sperm and an egg, when the nuclei of the two gametes fuse to form a zygote**

Question 6

- **B1** identifies a structural feature, e.g. flagellum/tail, many mitochondria, small head with acrosome
- **B1** explains how that feature helps, e.g. tail enables swimming; mitochondria provide ATP for movement; acrosome releases enzymes to penetrate egg membrane
- **Answer: Example: Flagellum (tail) that propels the sperm so it can swim to the egg. Many mitochondria in the midpiece provide ATP for movement.**

Question 7

- **B1** identifies a feature, e.g. large cytoplasm with food stores, or zona pellucida/cortical granules
- **B1** explains how it helps, e.g. food stores provide nutrients for early embryo, zona pellucida prevents entry of more than one sperm after fertilisation
- **Answer: Example: Large cytoplasm containing stored nutrients to support the early embryo; a zona pellucida helps ensure only one sperm fertilises the egg.**

Question 8

- **B1** difference 1 stated, e.g. sperm are small and motile, egg is large and non-motile
- **B1** reason for difference 1, e.g. sperm need mobility to reach the egg, egg stores nutrients so is larger
- **B1** difference 2 stated, e.g. sperm have many mitochondria/tail and acrosome, egg has nutrient-rich cytoplasm and protective membranes
- **B1** reason for difference 2, e.g. sperm structure aids movement/penetration, egg adaptations support embryo and prevent polyspermy
- **Answer: Sperm are small and motile to swim to the egg; eggs are large with nutrient stores because they nourish the early embryo. Sperm have a tail and many mitochondria for movement; eggs have protective layers and cytoplasm for nutrition and to block multiple sperm.**

Question 9

- **B1** mentions menstruation/lining is shed as stage
- **B1** mentions follicle development/egg maturation stage
- **B1** mentions ovulation as stage
- **B1** mentions preparation/thickening of uterine lining or maintenance after ovulation
- **B1** names four hormones and one role each, e.g. FSH stimulates follicle growth, LH triggers ovulation, oestrogen thickens uterus and causes LH surge, progesterone maintains uterine lining
- **Answer: Stages: menstruation when lining is shed; follicle growth and egg maturation; ovulation when the egg is released; and the luteal phase when the lining is thickened and maintained. Hormones: FSH stimulates follicles, LH triggers ovulation, oestrogen helps rebuild the lining and causes the LH surge, progesterone maintains the lining after ovulation.**

Question 10

- **B1** ovulation occurs at or around day 14
- **B1** because the LH surge triggered by rising oestrogen causes the egg to be released
- **Answer: Ovulation occurs at about day 14; the LH surge at day 14, caused by rising oestrogen, triggers release of the egg.**

Question 11

- **B1** states that progesterone thickens cervical mucus or prevents ovulation or both
- **B1** explains that thickened cervical mucus prevents sperm reaching the egg
- **B1** explains that progesterone can suppress FSH and LH release, preventing follicle development and ovulation
- **Answer: Progesterone thickens cervical mucus to block sperm and can suppress FSH and LH so follicles do not mature and ovulation is prevented; both actions reduce the chance of fertilisation.**

Question 12

- **B1** exchange of oxygen from mother to fetus
- **B1** exchange of nutrients, such as glucose and amino acids, from mother to fetus
- **B1** removal of fetal waste products such as carbon dioxide and urea to the mother's blood for disposal
- **Answer: The placenta allows oxygen to diffuse from maternal blood to fetal blood, supplies nutrients like glucose and amino acids to the fetus, and removes fetal wastes such as CO2 and urea into the mother’s circulation for disposal. The umbilical cord contains blood vessels that carry blood to and from the placenta.**

Question 13

- **B1** states that placenta provides a large surface area, e.g. many villi
- **B1** states that fetal and maternal blood are separated by a thin barrier or short diffusion distance
- **B1** states that good blood supply/close contact maintains steep concentration gradients
- **B1** states that villi increase surface area and contain fetal capillaries in contact with maternal blood
- **B1** links these features to increased diffusion rates of oxygen and nutrients and removal of wastes
- **Answer: The placenta has many villi, giving a large surface area and each villus contains fetal capillaries separated from maternal blood by a very thin barrier. Both maternal and fetal blood supplies are extensive so concentration gradients stay steep. These features shorten diffusion distance and increase diffusion area, raising the rate of exchange of oxygen and nutrients to the fetus and removal of waste.**

Question 14

- **B1** fetal haemoglobin has a higher affinity for oxygen than adult haemoglobin
- **B1** maternal blood has a lower oxygen partial pressure at the exchange surface so oxygen diffuses to fetal blood, or maternal blood carries oxygen bound to adult haemoglobin and fetal blood takes it up
- **Answer: Fetal haemoglobin has a higher affinity for oxygen than adult haemoglobin, and maternal blood has oxygen at a partial pressure that allows diffusion to fetal blood so the fetus can take up oxygen.**

Question 15

- **Level 1** (1-2): Basic statements about one or two functions of the placenta with limited linking to fetal development.
- **Level 2** (3-4): Clear description of several functions, including exchange of gases or nutrients and removal of wastes, with some explanation of how these support growth and development.
- **Level 3** (5-6): Detailed explanation linking placental structure to multiple functions, including exchange via villi and umbilical vessels, hormone production and protective roles, and evaluating how these combined roles support healthy fetal growth.
- **Indicative content:**
  - Provides large surface area via many chorionic villi for efficient exchange
  - Thin barrier and close contact between maternal blood and fetal capillaries shortens diffusion distance
  - Umbilical cord contains fetal arteries and a vein to transport oxygenated blood and nutrients to the fetus and carry waste away
  - Maintains concentration gradients through maternal and fetal blood flows, increasing diffusion rates for oxygen and nutrients
  - Removes fetal carbon dioxide and metabolic wastes into maternal circulation for excretion by the mother
  - Produces hormones such as progesterone and oestrogen that help maintain pregnancy and support fetal development
  - Acts as a partial barrier to some pathogens and harmful substances but not all, and transfers antibodies to provide immune protection
  - Supplies nutrients including glucose and amino acids that are essential for fetal growth and development