5.3 Hormonal coordination

Name: _____ Class: _____ Date: _____ **Total: 22 marks**

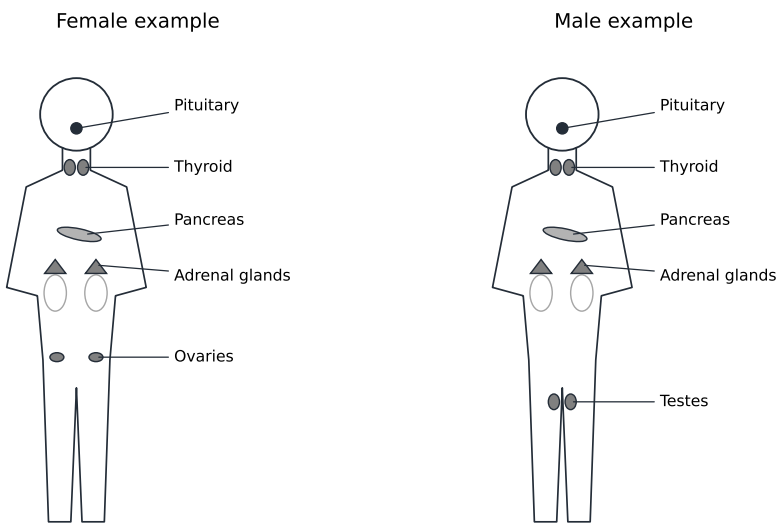
KEY WORDS insulin • glucagon • dialysis • IVF

Objective

Explain hormonal control: endocrine glands, insulin and diabetes, water balance, menstrual hormones, contraception, IVF, adrenaline and thyroxine. Original questions for spec statements 4.5.3.

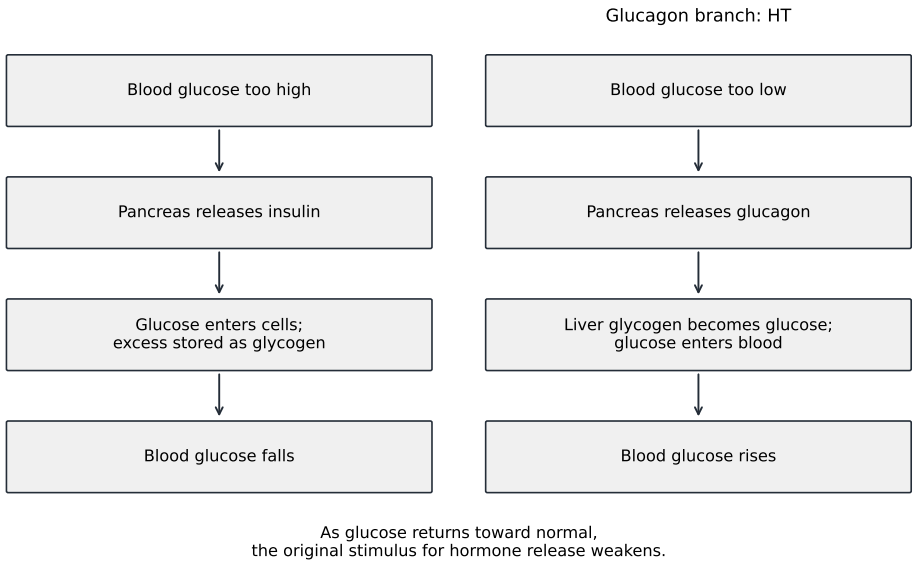
1 Key knowledge and worked examples

The **endocrine system** releases hormones into blood; target organs respond. Responses are usually slower and longer-lasting than nervous responses. The pituitary influences several other glands; the pancreas monitors glucose itself.

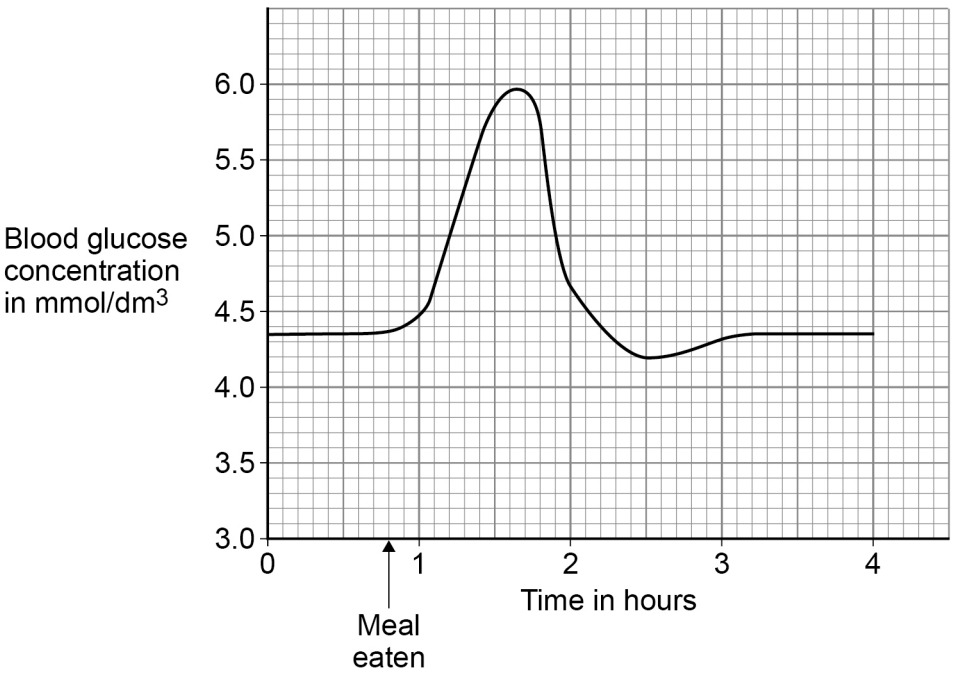


Schematic positions; the two gonad arrangements are alternatives

Insulin from the pancreas lowers high blood glucose: cells take up/use glucose; excess becomes glycogen in liver/muscle. (HT) **Glucagon** raises low blood glucose: liver glycogen becomes glucose released into blood. As levels return toward normal, the initial stimulus for hormone release weakens (**negative feedback**).



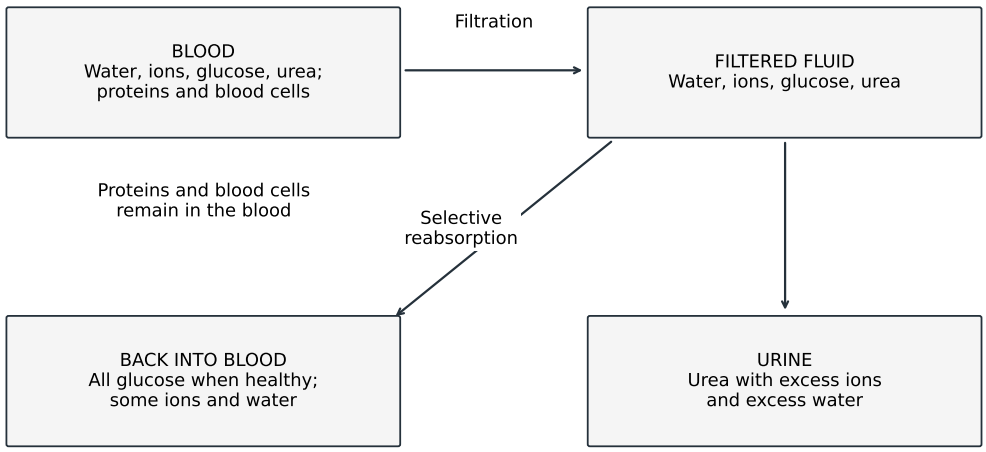
Type 1: insufficient insulin; usual treatment is insulin injections. **Type 2**: cells respond less well to insulin; common treatments are carbohydrate control and exercise, with medicines where appropriate. Obesity is a risk factor, not proof that a person has diabetes.



Worked graph. AQA 2022 Q03.1: insulin would be high at 1.5 hours (accepted 1.1–2.0 hours), inferred from high glucose. Q03.5: Person C has higher glucose (9.56 versus 4.51 mmol/dm^3) and higher insulin (24.32 versus 14.83 arbitrary units). Compare both; do not choose cholesterol. This pattern is consistent with reduced insulin response.

Water/nitrogen balance (bio): animal cells shrink in more concentrated body

fluid and swell in more dilute fluid by osmosis. Lungs/skin lose water; kidneys adjust urine rather than recover these losses. (HT) The liver deaminates excess amino acids, forming toxic ammonia then urea; blood carries urea to kidneys.



Functional process, not anatomy.

Worked, AQA 2024 Q08.2 [4]. Glucose and urea are filtered (1); large proteins are not (1); all glucose is reabsorbed in healthy kidneys (1); urea mostly remains and leaves in urine (1). Some ions and water are reabsorbed according to need.

(HT) Worked ADH chain, Q3.3 [4]. Dehydration concentrates blood, detected by receptors (1) → pituitary releases more ADH (1) → tubules become more permeable; more water returns to blood (1) → less, more concentrated urine (1). As blood returns towards normal, the stimulus weakens. Less ADH gives the opposite result. AQA 2023 Q05.3: ADH falls 3.75→1.25 ng/dm^3; less water reabsorbed explains urine rate rising 1.8→8.8 cm^3/min and concentration falling 1110→700 arbitrary units. Data support the mechanism.

Kidney failure: in dialysis, urea diffuses across a partially permeable membrane into fluid with little/no urea; fresh fluid maintains the gradient. Matched glucose concentrations avoid net glucose loss; large proteins/cells cannot cross. Dialysis needs repeated sessions. Transplant can restore continuous function but requires a donor/surgery and carries rejection and immunosuppression risks. Choose using the patient's circumstances.

Menstrual hormones (interactions HT): FSH matures an egg; LH triggers ovulation. Oestrogen builds the uterus lining; progesterone maintains it. FSH/LH come from the pituitary, oestrogen/progesterone from ovaries. (HT) Oestrogen inhibits FSH and near ovulation promotes the LH surge; progesterone inhibits FSH/LH. Its fall allows lining breakdown. Cycle timing varies; ovulation is not fertilisation.

(HT) Worked, AQA 2023 Q07.2. Diameter22mm gives $r = d/2 = 11$ mm. Use the supplied $\pi = 3.14$ and right-axis day11 total39000mm^3:

$$V_{\text{one}} = \frac{4}{3}\pi r^3$$

$$V_{\text{one}} = \frac{4}{3} \times 3.14 \times (11\ \text{mm})^3 = 5572.45\ \text{mm}^3$$

$$N = \frac{V_{\text{total}}}{V_{\text{one}}}$$

$$N = \frac{39000\ \text{mm}^3}{5572.45\ \text{mm}^3} \approx 7\ \text{follicles}$$

Contraception: hormonal methods inhibit FSH/egg maturation or LH/ovulation. Pills, injections, implants and patches differ; combined patches release oestrogen/progestogen. Barriers stop sperm reaching eggs; spermicides disable sperm; timing methods depend on estimating fertility; sterilisation is intended permanent. Copper IUDs mainly prevent fertilisation; hormonal coils release progestogen. Evaluate correct use, reversibility and the supplied preferences.

(HT) IVF, worked Q3.4 [5]. FSH/LH stimulate several eggs (1) → collect/fertilise in the laboratory (1) → embryos grow into tiny cell balls; transfer one or two to uterus (1). Weigh physical/emotional stress (1), limited success and multiple-birth risks (1). Fertility drugs without IVF may allow pregnancy through intercourse. AQA 2024 Q05.6 requires causal explanations of both contraception and infertility treatment.

(HT) Adrenaline (adrenal glands, fear/stress) increases heart rate and oxygen/glucose delivery to brain and muscles. **Thyroxine** (thyroid) raises basal metabolic rate and supports growth/development. Worked AQA2023 Q05.2 [2]: more thyroxine → faster metabolism/respiration (1) → energy released as heat (1), not created. Negative feedback: low thyroxine increases thyroid stimulation; high thyroxine reduces it, restoring levels towards normal.

Worked example (4 marks, HT). Explain how insulin and glucagon return blood glucose to normal after (a) a sugary meal and (b) a long fast.

(a) High glucose → pancreas secretes insulin; glucose is taken up by cells and converted to glycogen in liver/muscle. (b) Low glucose → pancreas secretes glucagon; liver glycogen is converted back to glucose and released into the blood. As the concentration returns toward normal, the original stimulus for each responding hormone weakens – negative feedback.

2 Practice

2.1 Why are hormonal responses slower than nervous responses but longer-lasting? [2]

2.2 Name the hormone that lowers blood glucose and the organ that produces it. [2]

2.3 Name the hormone that stimulates ovulation. [1]

3 Exam-style questions

3.1 Compare Type 1 and Type 2 diabetes: cause and treatment. [4]

3.2 *(HT)* Explain how negative feedback keeps blood glucose concentration within its normal range, naming both hormones. [4]

3.3 *(Bio, HT)* Explain how the body responds to dehydration by producing concentrated urine. [4]

3.4 *(HT)* A couple cannot conceive because the woman's eggs do not mature. Describe how IVF could help them and give two concerns they should weigh. [5]