

5.3 Hormonal coordination

Name: _____ Class: _____ Date: _____

Total: 22 marks

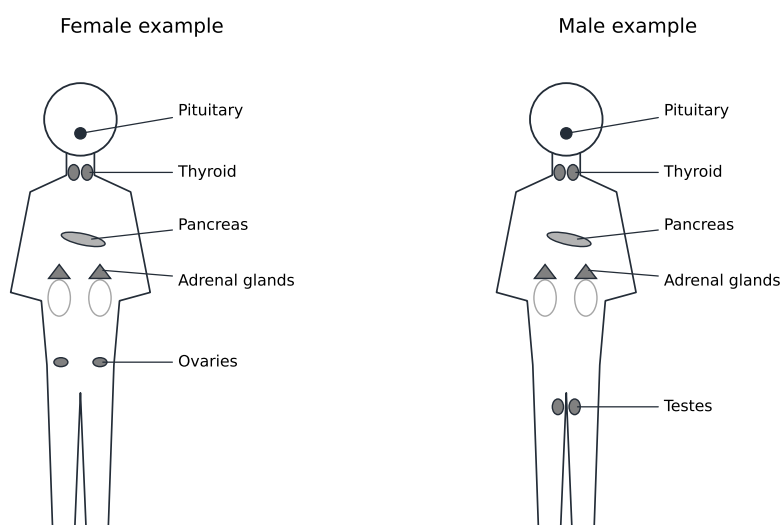
KEY WORDS insulin • glucagon • dialysis • IVF

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.

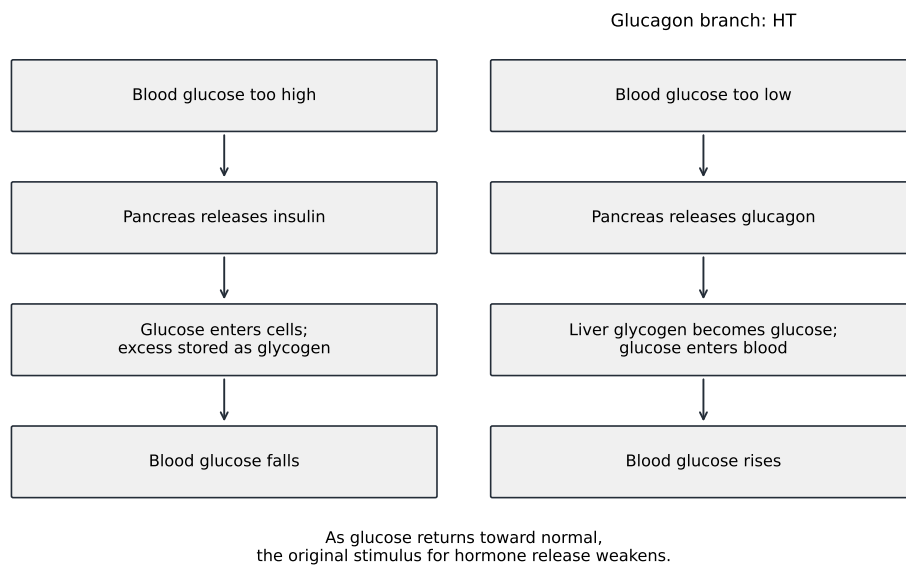
1 Key knowledge and worked examples

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.

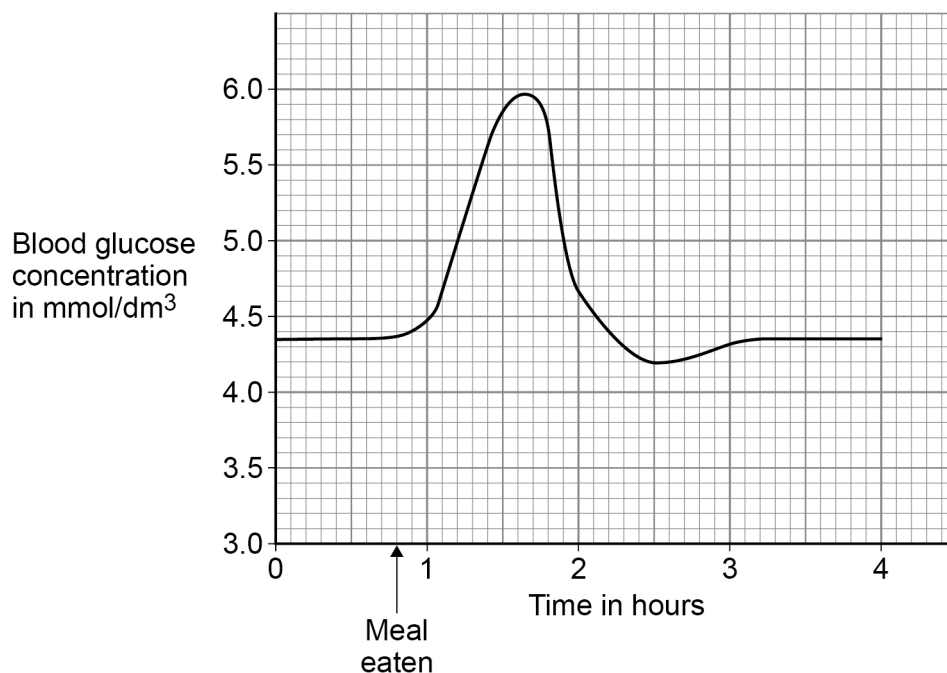


Schematic positions; the two gonad arrangements are alternatives

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**).



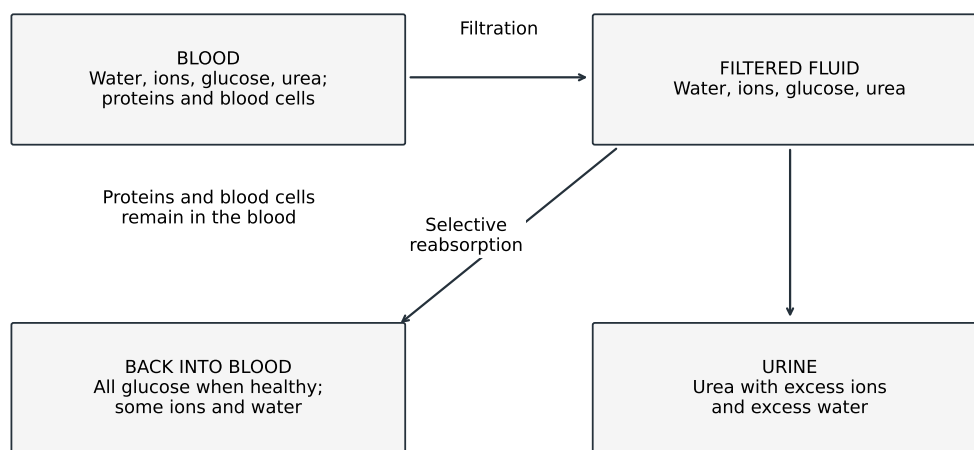
Type 1: insufficient insulin; usual treatment is insulin injections. **Type 2:** cells respond less well to insulin; common treatments are carbohydrate control and exercise, with medicines where appropriate. Obesity is a risk factor, not proof that a person has diabetes.



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/dm³) 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 $3.75 \rightarrow 1.25 \text{ ng/dm}^3$; less water reabsorbed explains urine rate rising $1.8 \rightarrow 8.8 \text{ cm}^3/\text{min}$ and concentration falling $1110 \rightarrow 700$ 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. Diameter 22mm gives $r = d/2 = 11 \text{ mm}$. Use the supplied $\pi = 3.14$ and right-axis day 11 total 39000mm^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]

Solutions

2.1 Hormones are carried in the bloodstream rather than by rapid electrical impulses along neurones, so hormonal responses are generally slower; hormones can remain active for longer than a brief nerve impulse, so their effects generally last longer.

2.2 Insulin; the pancreas.

2.3 LH.

3.1 Type 1: the pancreas fails to produce sufficient insulin; treated with insulin injections. Type 2: body cells have a reduced response to the insulin produced; treated with a carbohydrate-controlled diet and an exercise regime. Obesity is a risk factor for Type 2.

3.2 When glucose is too high the pancreas releases insulin, so cells take up glucose and liver/muscle converts it to glycogen, and glucose falls; when glucose is too low the pancreas releases glucagon, causing liver glycogen to be converted back to glucose and released into the blood, and glucose rises; each response opposes the original change and, as normal levels are restored, the stimulus for that responding hormone weakens – negative feedback.

3.3 Dehydration makes the blood too concentrated, detected by receptors; the pituitary gland releases more ADH into the blood; ADH makes the kidney tubules more permeable, so more water is selectively reabsorbed into the blood; so less, more concentrated, urine is produced – an example of negative feedback.

3.4 The woman is given FSH and LH to stimulate several eggs to mature; eggs are collected and fertilised with the father's sperm in the laboratory; embryos develop into tiny balls of cells and one or two are inserted into the uterus. Concerns: it is emotionally and physically stressful; success rates are not high and it can lead to multiple births, a risk to babies and mother.