Feedback systems (HT only)

4.5.3.6 · Biology · revision notes

How adrenaline prepares the body for 'fight or flight', how thyroxine controls metabolic rate, and how negative feedback keeps thyroxine levels steady. This is Higher tier content: expect short explanations and questions that ask you to interpret a simple feedback diagram.

Key facts

- Adrenaline: adrenal glands; released in fear or stress; 'fight or flight'
- Thyroxine: thyroid gland; stimulates basal metabolic rate; growth and development
- Pituitary → TSH → thyroid → thyroxine
- Adrenaline: increases heart rate; more oxygen and glucose to the brain and muscles
- Negative feedback: a change triggers a response that reverses it
- Thyroxine too high → less TSH → less thyroxine (and the reverse)

Notes

Adrenaline

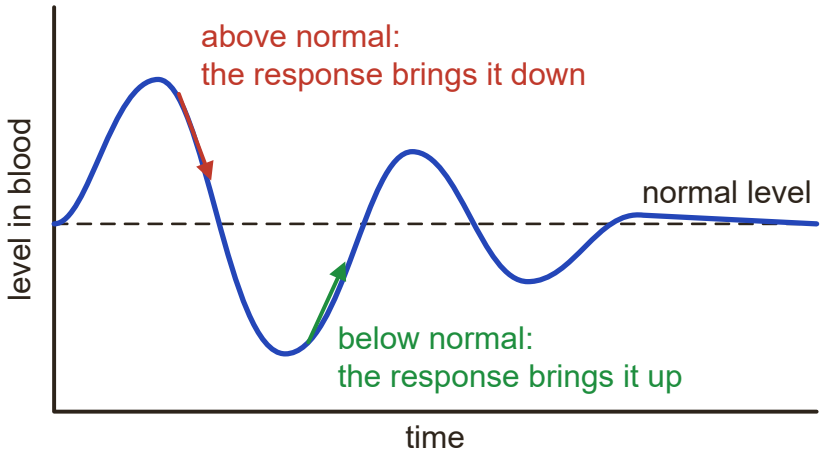
- **Adrenaline** is produced by the **adrenal glands** in times of **fear or stress**.
- It **increases the heart rate** and boosts the delivery of **oxygen and glucose** to the **brain and muscles**.
- This prepares the body for **'fight or flight'**: the muscles can respire faster, releasing more energy for action.

Thyroxine

- **Thyroxine** is produced by the **thyroid gland** in the neck.
- It stimulates the **basal metabolic rate**: the rate of the chemical reactions in your body when you are at rest.
- When the body is cold, more thyroxine raises the metabolic rate, so cells respire faster and release more energy as heat, and body temperature rises.
- It plays an important role in **growth and development**.
- Thyroxine levels are controlled by **negative feedback**.

Negative feedback

- In **negative feedback**, a change away from the normal level triggers a response that **reverses the change**, bringing the level back to normal.



Negative feedback: any change from normal is reversed.

- The pituitary gland releases **TSH** (thyroid stimulating hormone), which stimulates the thyroid to release thyroxine.
- If thyroxine rises **above normal**, TSH release is **inhibited**, so the thyroid releases less thyroxine and the level falls.
- If thyroxine falls **below normal**, more TSH is released, so the thyroid releases more thyroxine and the level rises.
- Insulin and glucagon controlling blood glucose is another example of negative feedback.

How to answer each type of question

Explain the effects of adrenaline 3 to 4 marks **Grade 6**

1. Name the hormone and the gland if asked.
2. Link the chain: heart rate → blood flow → oxygen and glucose → respiration in muscles → energy for action.

Example. A student is frightened by a loud bang, and her heart starts to beat faster.
(a) Name the hormone that causes this response.
(b) Explain how a faster heart rate helps her body respond to danger.

Model answer.

(a) Adrenaline (1)

(b) More blood is pumped to the brain and muscles (1), delivering more oxygen and glucose (1), so the muscles can respire faster, releasing energy for 'fight or flight' (1)

Explain how thyroxine is controlled by negative feedback

3 to 4 marks | Grade 7

1. Start with the change: thyroxine too high or too low.
2. Say what happens to TSH release from the pituitary gland.
3. Say what the thyroid does, and that the level returns to normal.

Example. A person's blood thyroxine concentration rises above normal.
Explain how negative feedback returns it to normal.

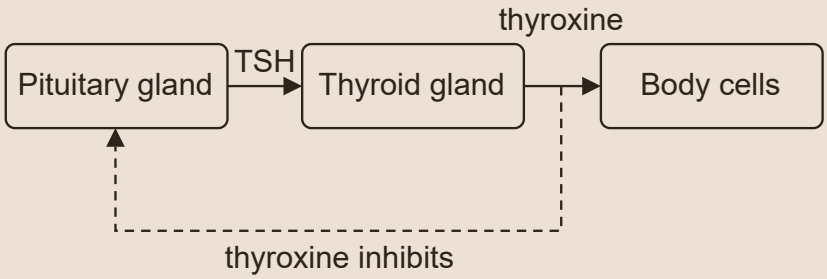
Model answer. The high thyroxine concentration inhibits the release of TSH from the pituitary gland (1). Less TSH reaches the thyroid gland (1), so the thyroid releases less thyroxine (1), and the thyroxine concentration falls back to normal (1).

Interpret a negative feedback diagram

2 to 4 marks | Grade 8

1. Follow each arrow and note whether it means 'stimulates' or 'inhibits'.
2. Work out what happens when one part stops working.
3. Link the hormone level to its effect on the body.

Example. The diagram shows how the thyroxine level in the blood is controlled.



(a) A person's thyroid gland cannot make thyroxine. Predict what happens to their TSH level. Give a reason.
(b) Suggest how their basal metabolic rate is affected. Give a reason.

Model answer.

(a) The TSH level increases / stays high (1), because there is no thyroxine to inhibit the pituitary gland (1)

(b) Their basal metabolic rate is lower than normal (1), because there is no thyroxine to stimulate it (1)

Don't lose marks

- Thinking 'negative' means harmful. Negative feedback means the response reverses the change.
- Mixing up adrenaline (fight or flight) and thyroxine (metabolic rate, growth and development).
- Putting the thyroid in the brain. The thyroid is in the neck; the pituitary is in the brain.

- ✗ Saying adrenaline 'gives you energy'. It increases the delivery of oxygen and glucose so muscles can respire faster.
- ✗ Stopping before the end: say that the level returns to normal.
- ✗ Saying respiration 'produces' or 'makes' energy. Say it releases energy (some as heat).

More tips

Memory tricks

- Negative feedback = 'do the opposite': if it goes up, bring it down; if it goes down, bring it up.
- TSH = Thyroid Stimulating Hormone: its name tells you what it does.
- Think of a thermostat: when the room is warm enough, the heating switches off.
- Adrenaline = alarm hormone: fast and short-term. Thyroxine = steady, long-term control of metabolism.

Exam technique

- In feedback questions, use 'inhibits' and 'stimulates' and follow the diagram one step at a time.
- Always finish a negative feedback explanation with 'so the level returns to normal'.
- For adrenaline, link heart rate → blood flow → oxygen and glucose → respiration in muscles.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 5 — **State the effects of adrenaline**
It increases heart rate and boosts delivery of oxygen and glucose to the brain and muscles.

Grade 5 — **State the role of thyroxine**
It stimulates the basal metabolic rate and is important in growth and development.

Grade 6 — **Define negative feedback**
A change away from normal triggers a response that reverses the change, returning the level to normal.

Grade 7 — **Explain how thyroxine levels are controlled**
High thyroxine inhibits TSH release from the pituitary, so less thyroxine is released, and the reverse.

Grade 8 — **Interpret simple negative feedback diagrams**
Follow the arrows to predict and explain what happens when a hormone level rises or falls.

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