AP BIOLOGY | UNIT 4 | TOPIC 4.4

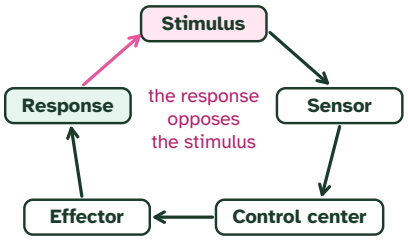
REVISION ON TWO PAGES

Feedback: holding *steady*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Negative feedback opposes a change and returns a variable to its set point. Positive feedback amplifies a change until an outside event ends it.



Draw it like this. Five parts in a ring. The last arrow closes the loop.

4.4.A START HERE

A loop that *undoes* a change

- **Homeostasis** is keeping the internal environment stable while the outside changes. Each controlled variable has a **set point**, the value the body steers toward, and a normal range around it.
- Cells run on enzymes and membranes that work well only in narrow conditions. Staying in range takes a way to detect a change and a way to reverse it: a **feedback loop**.
- In **negative feedback** the response **opposes the stimulus**: a rise brings about a fall, and a fall a rise. Back at the set point the stimulus has gone, so the loop switches itself off.

98.6 °F	70 to 100	7.4
core body temperature (37 °C)	mg/dL of glucose in fasting blood	the pH of blood

4.4.A LEARN THE ORDER

Every loop has the same *five parts*

THE PARTS, IN ORDER

Sly Snakes Can Eat Rats

S Stimulus: the change: a rise or fall from the set point	**S** Sensor: a receptor detects the change	**C** Control center: compares, then signals by nerve or hormone	**E** Effector: a muscle or gland acts	**R** Response: undoes the change

- **A thermostat:** the room cools (stimulus), the thermometer reads the fall (sensor), the circuit compares it with the dial (control center) and switches on the furnace (effector), and the room warms (response).
- **If one part fails,** every link after it is cut off: the effector never acts, and the variable is left to drift.

4.4.A THE AP EXAMPLE

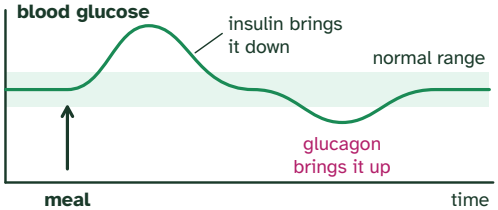
Blood glucose: *two hormones*, one level

- The sensor and the control center are one tissue: the **islets** of the pancreas, which detect glucose in the blood flowing past.

Glucose high after a meal
Beta cells release **insulin**. Liver and muscle cells take glucose in and store it as glycogen; fat cells take some in too.

Glucose low between meals
Alpha cells release **glucagon**. Liver cells break glycogen down and release glucose. Muscle has no glucagon receptors.

- Two hormones with opposite effects push the level back from either side, each switched off as it returns.



Insulin: glucose goes into cells. Gluca**gon**: glucose gone, so the liver releases some

4.4.A WHEN A PART FAILS

Diabetes: a *broken loop*

- **Diabetes mellitus** is a failed glucose loop. Where the loop breaks decides the type; either way the response fails and glucose stays above its normal range.

	TYPE 1	TYPE 2
The break	The immune system destroys the **beta cells**.	Target cells respond weakly: **insulin resistance**.
Insulin	None is released.	Released, often extra at first: the stimulus never goes away.
Inside the cell	Could respond, but no signal comes.	Insulin binds, but fewer glucose transporters reach the membrane.
Treated with	Insulin, injected or pumped.	Diet, exercise, and drugs that make cells more sensitive.

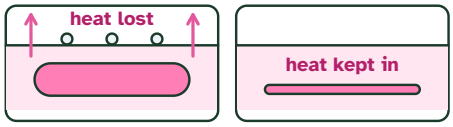
- Above about 180 mg/dL the kidneys cannot take back all the glucose they filter. It spills into the urine and pulls water with it: thirst and frequent urination.

Temperature, *positive feedback* and the two compared

4.4.A

Too hot, too cold: *body temperature*

- **Thermoreceptors** in the skin and the brain are the sensors. The **hypothalamus** is the control center, and signals the effectors along nerves.
- Negative feedback again, with nerves in place of hormones and a set of effectors for each direction.
- In the cold, tiny muscles also pull the hairs upright: goose bumps.



Circles: sweat on the surface. Pink band: an arteriole that supplies the skin

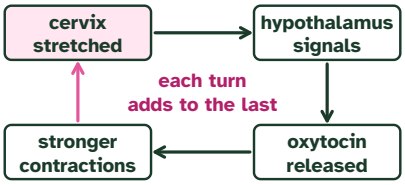
Too hot lose more heat
Sweating: sweat carries heat away as it evaporates. **Vasodilation:** more warm blood flows near the surface.

Too cold keep heat, release more
Vasoconstriction: warm blood stays deeper. **Shivering:** respiration in skeletal muscle releases heat.

4.4.A

Positive feedback: a loop that *runs away*

- In **positive feedback** the response **adds to the stimulus**, so the change grows, and grows faster.
- It would wreck homeostasis, so it is kept for events that must finish fast and completely.
- Nothing inside the loop can stop it. An **event outside the loop** ends it: the birth takes the pressure off the cervix.



BABIES
Birth
The stretched cervix signals the hypothalamus; oxytocin from the posterior pituitary makes the uterus contract harder.

LIKE
Lactation
Suckling releases prolactin (milk is made) and oxytocin (milk is let out). It stops when the baby stops feeding.

RIPE
Ripening
Ethylene, a gas, ripens a fruit and makes it release more ethylene. One ripe fruit sets off its neighbors.

4.4.A COMPARE

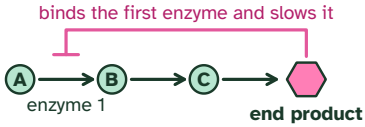
Back to the set point, or *on to the end*

	NEGATIVE FEEDBACK	POSITIVE FEEDBACK
Response	**Opposes the change**	**Adds to the change**
Variable	Returns to its set point.	Moves ever farther from it.
Stopped by	The loop itself.	An event outside the loop.
Job	Keeps conditions steady.	Finishes a process fast.
Examples	Blood glucose, temperature, feedback inhibition.	Labor, lactation, fruit ripening.

4.4.A MOLECULE BY MOLECULE

Feedback *inside a cell*

- **Feedback inhibition**: the end product of a pathway binds the first enzyme at an **allosteric site**. The more product, the less is made.
- Genes too: lactose switches on the *lac* operon, which switches off again once the lactose is used up.



WATCH OUT

Five mistakes that *cost points*

- ✕ **Negative is not bad:** the response opposes the change.
- ✕ **Positive is not good:** it pushes a variable farther from where it started.
- ✕ **Glucagon is not glycogen.** Glucagon is a hormone; glycogen is the polysaccharide it tells the liver to break down.
- ✕ **Blood vessels do not move.** Arterioles widen or narrow, changing how much blood flows near the surface.
- ✕ **Type 1 diabetes is not caused by eating sugar.** It is an immune attack on the beta cells.

COVER THE SHEET

Can you *answer these?*

1. Describe homeostasis, using the term set point.
2. Identify the five parts of a feedback loop, in order.
3. Explain how blood glucose falls after a meal.
4. Predict blood glucose after a meal in type 1 diabetes.
5. Explain why insulin can be high early in type 2 diabetes.
6. Explain how vasodilation cools the body.
7. Describe what ends the feedback loop of labor.
8. Predict what happens when a cell uses up an end product.

IN THE EXAM

Say which way the response goes: against the change (negative) or with it (positive). If a part of a loop fails, trace it link by link: every link after the break is cut off.

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.