Back to the set point

60 minutes • 4.4.A • Chapters 1, 2, 3, 5

Homeostasis, the parts of a loop, and negative feedback in blood glucose and body temperature, with a role play of the temperature loop

BY THE END, STUDENTS CAN

- [ ] Explain what homeostasis is, and why a variable is held within a normal range around a set point 4.4.A
- [ ] Identify the stimulus, sensor, control center, effector and response in a feedback loop 4.4.A
- [ ] Explain how insulin and glucagon return blood glucose to its set point by negative feedback 4.4.A
- [ ] Predict what happens when part of a loop fails, as in type 1 and type 2 diabetes 4.4.A
- [ ] Explain how sweating, vasodilation, vasoconstriction and shivering hold body temperature steady 4.4.A
- [ ] Explain how positive feedback amplifies a response, in labor, lactation and fruit ripening 4.4.A
- [ ] Compare negative and positive feedback, including negative feedback at the molecular level 4.4.A

TIMING

0–5	5 min	**Do now: the thermostat**
5–13	8 min	**Steady, and the loop**
13–28	15 min	**Be the loop**
28–36	8 min	**Two hormones**
36–43	7 min	**Hot day, cold day**
43–53	10 min	**Loop parts sort**
53–60	7 min	**Exit**
	60 min	**One lesson**



STARTER

5 min

Do now: the thermostat

"The heating in this room is set to 70 °F. Describe what happens, step by step, when someone opens a window in winter." Pairs write the steps, then underline the part that notices the change and the part that does something about it.

ON THE BOARD, FROM THE GUIDE

Open the guide on the projector at each chapter (the links work in this PDF). Every figure plays from its own buttons, and the lesson's slides have the same figures, step by step, in the order of this plan.

01 Keeping the inside steady

CHAPTER 01 IN THE SLIDES

Tap the parts of the figure in turn: Body temperature, Blood pH, Blood glucose and Blood osmotic concentration.

> **Predict box:** On a winter walk the air drops from 68 °F to 40 °F (20 °C to 4 °C). What happens to the core temperature of a healthy walker? Hands up or mini whiteboards first.
>
> **Answer B: It stays within about a degree of 98.6 °F, because the body changes how much heat it makes and loses**

02 Every loop has the same parts

CHAPTER 02 IN THE SLIDES

Step through the figure (6 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A change, the **stimulus**, pushes the variable above its set point.
2. A **sensor**, a receptor, detects the change.
3. The **control center** compares it with the set point and sends a signal.
4. An **effector** acts on the signal.
5. The **response** opposes the change, so the level **falls back** to the set point.
6. If it falls **too low**, the same loop works the other way, and it returns to the set point.

> **Predict box:** A drug stops the sensors in a negative feedback loop from detecting anything. The variable then drifts above its set point. What happens next? Hands up or mini whiteboards first.
>
> **Answer C: Nothing corrects it, because no signal reaches the control center, so the effector never acts**

> **Remember it:** Sly Snakes Can Eat Rats (Stimulus, Sensor, Control center, Effector, Response).

03 Two hormones, one level

CHAPTER 03 IN THE SLIDES

Play the animation, Blood glucose held steady. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. Blood glucose is held close to a **set point**, about 90 mg/dL, inside a narrow normal range. Watch the chart and the loop.
2. **Beta cells** in the islets of the pancreas detect the rise and release the hormone **insulin** into the blood.
3. Insulin binds to receptors on **liver and muscle cells**, the effectors. They take glucose in and store it as **glycogen**.
4. Blood glucose falls back to the set point, so less insulin is released. The response has removed the stimulus: **negative feedback**.
5. **Alpha cells** in the islets detect the fall and release the hormone **glucagon**.
6. Glucagon acts on **liver cells**, which break glycogen down to glucose and release it into the blood. Muscle has no glucagon receptors.
7. The level rises back to the set point and less glucagon is released. Two hormones with opposite effects hold blood glucose steady.

> **Predict box:** You skip breakfast and then play soccer for an hour. Which change happens in your blood and your liver? Hands up or mini whiteboards first.
>
> **Answer A: Glucagon rises, and liver cells break glycogen down and release glucose into the blood**

> **Remember it:** In Gone (Insulin, Glucagon).

05 Too hot, too cold

CHAPTER 05 IN THE SLIDES

Play the animation, Body temperature held steady. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. Core body temperature is held close to a **set point** of about 37 °C (98.6 °F), whatever the weather.
2. **Thermoreceptors** in the skin and in the brain detect the change. The **hypothalamus**, the control center, compares it with the set point.
3. It signals the effectors. **Sweat glands** release sweat, which takes heat away as it evaporates, and the skin's arterioles widen (**vasodilation**), so more warm blood flows near the surface.
4. More heat is lost, and the temperature falls back to the set point: **negative feedback**.
5. The hypothalamus signals other effectors. The skin's arterioles narrow (**vasoconstriction**), so less blood flows near the surface and less heat is lost.
6. Skeletal muscles **shiver**, and their respiration releases heat. Hairs are pulled upright.
7. The temperature rises back to the set point. Hot or cold, the response reverses the change that caused it.

> **Predict box:** On a hot, humid day, sweat drips off you instead of drying. Why do you feel hotter than on an equally hot, dry day? Hands up or mini whiteboards first.
>
> **Answer A: Sweat cools you only as it evaporates, and humid air slows evaporation, so less heat leaves you**

THE LESSON

8 min

Steady, and the loop

Chapter 1's figure: tap each scale and ask why the range is narrow. Then chapter 2's figure, step by step: students name the five parts of the thermostat's loop from the Do now on mini whiteboards. Turn over chapter 2's Remember it tiles, and land on what "negative" means.

15 min

Be the loop

The role play below: students wear cards as the sensors, the hypothalamus and the effectors and pass a signal card round the room as the teacher calls a hot day and then a cold one. Run it once smoothly, then once with the sensor "asleep", and ask what happens to the temperature.

8 min

Two hormones

Chapter 3's film on the board. Pause at the meal and at the fast: "Which box is lit? Which hormone, from which cells, to which organ?" Then chapter 3's predict box, the soccer player, by a show of hands.

7 min

Hot day, cold day

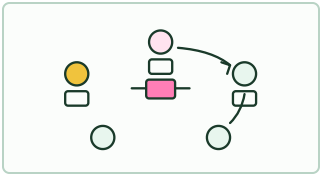
Chapter 5's film. Students match each effector they acted out in the role play to the film's drawing: sweat gland, arteriole, muscle. Ask why the arterioles, not the vessels, are the thing that changes.

10 min

Loop parts sort

The sort below: pairs place twenty cards into five columns, stimulus to response, for the glucose and the temperature loops, then check against chapters 3 and 5.

ACTIVITIES

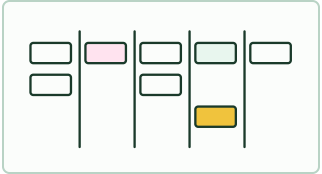


ROLE PLAY

Be the loop

Hand out cards: two sensors (skin and brain thermoreceptors), one hypothalamus, and effectors (sweat glands, skin arterioles, skeletal muscle, hair muscles). The teacher calls "hot day" or "cold day" and hands the stimulus card to a sensor; the signal card travels to the hypothalamus, which sends it to the right effectors, who act it out (fanning, flushing, shivering). Each response hands back a "temperature" card that says the change has been undone. Run it a third time with a sensor who ignores the stimulus.

Needs: cards on string for each role, a stimulus card, a signal card, a "temperature" card; room to stand in a ring.



CARD SORT

Loop parts sort

Twenty cards, the parts of four loops (glucose high, glucose low, too hot, too cold) shuffled together: "blood glucose rises", "beta cells", "liver and muscle cells", "glycogen stored", "thermoreceptors", "hypothalamus", "skin arterioles narrow" and so on. Pairs lay them in five columns, stimulus, sensor, control center, effector, response, one row a loop. A card that fits two places (the islet cells are sensor and control center at once) is worth a discussion.

Needs: a set of twenty printed cards and a five-column mat per pair.

PLENARY

7 min

Exit

On paper: "Blood glucose rises after a meal. Explain how negative feedback returns it to its set point" (4 points: the stimulus, the beta cells and insulin, liver and muscle taking up glucose and storing glycogen, the stimulus removed).

WHAT STUDENTS GET WRONG

"Negative feedback is bad feedback." Negative means the response opposes the change; it is what keeps a variable steady.

"The set point is one exact number." It sits in a normal range; the value wanders a little all the time.

"Glucagon and glycogen are the same thing." Glucagon is the hormone; glycogen is the stored polysaccharide.

"Glucagon makes muscle release glucose." Muscle has no glucagon receptors; the liver releases glucose into the blood.

"Blood vessels move toward the skin when you are hot." The skin's arterioles widen; nothing moves.

STRETCH AND SUPPORT

Stretch: the islets are sensor and control center at once. Draw the glucose loop and explain why it can be faster than a loop that runs through the brain.

Support: a blank five-box loop to fill in for each example, with the words in a bank beside it.

For revision: students can drill this unit's key terms on Cramly.

IN THE GUIDE

- 1 Keeping the inside steady
- 2 Every loop has the same parts
- 3 Two hormones, one level
- 5 Too hot, too cold
- All The whole guide, with the figures that play
- PPTX This lesson's slides, in the order of this plan

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on 4.4 each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?program=ap&units=U4&ced=4.4&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on Unit 4, built from its key terms and ready to print
- A pub quiz with rounds on Unit 4, to present or run with no projector
- The Silent Relay Station escape room, or an escape room built from the question bank on Unit 4

ALREADY ON THE SITE FOR UNIT 4

- Quiz: Feedback
- Exam questions: Unit 4 in the exam maker, a paper with scoring guidelines

CARD SETS ON SPLYCR

Open a set to host it as a class game, or make a copy to edit.

- Unit 4: Cell Communication (part 1)
- Unit 4: Cell Communication (part 2)

How this was made. The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.