

Ben's Bad Day

Tab 1: Regulating Temperature, Water Balance & Blood Glucose

Simulation: edtechsims.com/homeostasis-bens-bad-day

Scan to open

Name: _____ Class: _____ Date: _____

By the end of this activity, you should be able to:

- state the five components of a negative feedback loop and describe the role of each
- describe how the body regulates body temperature when it is too hot or too cold
- describe how ADH regulates the water potential of the blood
- describe how insulin and glucagon regulate blood glucose concentration

Part A: Key Terms

On the sim: Open Tab 1 and read the Key Terms.**A1** Write the correct term next to each meaning. Choose from: Stimulus, Receptor, Control Centre, Effector, Response.

[5]

Term	What it means
	A muscle or gland that carries out the control centre's instructions.
	A change in the internal or external environment that pushes a variable away from its normal set point.
	The change the effector produces, which counteracts the original stimulus and restores the set point.
	The part of the body that receives the signal, compares it against the set point, and decides what response is needed.
	A cell, tissue, or organ that detects the stimulus and converts it into a signal — a nerve impulse or a hormone.

Table 1

Part B: Ben's Day

On the sim: Work through each scenario in Tab 1. Fill in the negative feedback loop for each one.

B1 7:30 AM · Breakfast Drink

Ben gulps down a big glass of milk and a whole bottle of water at breakfast, trying to wake himself up. Soon after, he's dashing to the bathroom every few minutes.

Step	Your answer
Stimulus	Blood osmolarity falls (blood becomes too dilute) from drinking too much
Receptor	
Control Centre	Hypothalamus reduces its signal to the pituitary gland
Effector	
Response	Less ADH is released; kidneys reabsorb less water, producing more dilute urine

B2 8:30 AM · Cold Walk to Lab

Ben steps outside into a cold morning without a jacket, rushing to school. Within a minute his teeth are chattering and his arms are covered in goosebumps.

Step	Your answer
Stimulus	
Receptor	Thermoreceptors in the skin
Control Centre	
Effector	Skeletal muscles and skin blood vessels
Response	

B3 1:00 PM · No Time for Lunch

Ben's been so busy all morning he skips lunch entirely. By 1:00 PM his blood glucose has dropped low, and he's starting to feel shaky and lightheaded.

Step	Your answer
Stimulus	Blood glucose level falls after skipping a meal
Receptor	
Control Centre	Pancreas acts as its own control centre
Effector	
Response	Glucagon release makes the liver break down glycogen, releasing glucose and raising blood levels

B4 3:00 PM · Hot Afternoon

The afternoon sun is blazing and Ben's classroom fan is broken. Within minutes he's sweating through his shirt and his face is flushed red.

Step	Your answer
Stimulus	Body and external temperature rise
Receptor	
Control Centre	Thermoregulatory centre in the hypothalamus
Effector	
Response	Sweating increases for evaporative cooling; skin vessels dilate to lose more heat

B5 9:30 PM · Forgot to Drink Water

Ben's been so busy he hasn't had a sip of water since lunch. By night time, his mouth is bone dry and his blood is far more concentrated than it should be.

Step	Your answer
Stimulus	
Receptor	Osmoreceptors in the hypothalamus
Control Centre	
Effector	Kidney collecting ducts
Response	ADH release makes kidneys reabsorb more water, diluting the blood

Part C: Check Your Understanding

On the sim: Circle True or False for each statement. If a statement is false, correct it. Then check your answers in the sim's Check Your Understanding section.

C1 A response is the body's way of correcting an imbalance.

True / False Correction (if false):

C2 Drinking too much water at breakfast causes Ben's blood osmolarity to rise.

True / False Correction (if false):

C3 Shivering is an effector response controlled by the thermoregulatory centre in the hypothalamus.

True / False Correction (if false):

C4 Sweating and dilation of skin blood vessels help cool Ben down on a hot afternoon.

True / False Correction (if false):

C5 When Ben is dehydrated, the pituitary gland releases ADH to make the kidneys produce more urine.

True / False Correction (if false):

C6 In Ben's No Time for Lunch scenario, insulin is released to raise his blood glucose level.

True / False Correction (if false):

C7 The hypothalamus acts as the control centre in both the Breakfast Drink and Hot Afternoon scenarios.

True / False Correction (if false):

C8 All five of Ben's homeostatic responses in this activity are examples of negative feedback.

True / False Correction (if false):

C9 Record your score from the sim.

My score: _____ / 8

Part D: Multiple Choice Questions

On the sim: Circle the letter of the best answer. Then check your answers in the sim's Multiple Choice Questions section.

- D1** Which correctly orders the components of a negative feedback loop?
- A. Stimulus → Effector → Receptor → Control Centre → Response
 - B. Stimulus → Receptor → Control Centre → Effector → Response
 - C. Receptor → Stimulus → Effector → Control Centre → Response
 - D. Control Centre → Stimulus → Receptor → Effector → Response
- D2** In Ben's Breakfast Drink scenario, what happens after he drinks too much milk and water?
- A. Blood osmolarity rises, so more ADH is released
 - B. Blood osmolarity falls, so less ADH is released and more dilute urine is produced
 - C. Blood glucose rises, so insulin is released
 - D. The kidneys reabsorb more water to concentrate the blood
- D3** Which pair of effector responses helps Ben cool down during the Hot Afternoon scenario?
- A. Shivering and vasoconstriction of skin blood vessels
 - B. Sweating and vasodilation of skin blood vessels
 - C. Increased breathing rate and heart rate
 - D. ADH release and reduced urine output
- D4** In Ben's No Time for Lunch scenario, what does glucagon cause the liver to do?
- A. Store excess glucose as glycogen
 - B. Break down glycogen and release glucose into the blood
 - C. Produce insulin to lower blood glucose
 - D. Absorb water to dilute the blood
- D5** In the Forgot to Drink Water scenario, what does ADH do once released?
- A. Increases urine production to flush out excess water
 - B. Makes the kidneys reabsorb more water, producing more concentrated urine
 - C. Signals the pancreas to release more insulin
 - D. Widens skin blood vessels to release more heat
- D6** Record your score from the sim.
- My score: _____ / 5

Part E: Applying Your Knowledge

E1 Ben plays football for an hour on a hot afternoon and does not drink any water.

(a) Describe two ways his body prevents his temperature from rising too high. [2]

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(b) Explain why he produces a small volume of concentrated urine that evening. [3]

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E2 Insulin and glucagon both act on the liver. Compare the effect of each hormone on the liver and on blood glucose concentration. [3]

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Answer Key: Ben's Bad Day (Tab 1)

Part A

A1 1. Effector 2. Stimulus 3. Response 4. Control Centre 5. Receptor

Part B

B1 7:30 AM · Breakfast Drink

Step	Answer
Stimulus	Blood osmolarity falls (blood becomes too dilute) from drinking too much
Receptor	Osmoreceptors in the hypothalamus
Control Centre	Hypothalamus reduces its signal to the pituitary gland
Effector	Kidney collecting ducts
Response	Less ADH is released; kidneys reabsorb less water, producing more dilute urine

B2 8:30 AM · Cold Walk to Lab

Step	Answer
Stimulus	External temperature drops
Receptor	Thermoreceptors in the skin
Control Centre	Thermoregulatory centre in the hypothalamus
Effector	Skeletal muscles and skin blood vessels
Response	Shivering generates heat; skin vessels constrict to cut heat loss

B3 1:00 PM · No Time for Lunch

Step	Answer
Stimulus	Blood glucose level falls after skipping a meal
Receptor	Alpha cells in the pancreas detect low glucose
Control Centre	Pancreas acts as its own control centre
Effector	Liver cells
Response	Glucagon release makes the liver break down glycogen, releasing glucose and raising blood levels

B4 3:00 PM · Hot Afternoon

Step	Answer
Stimulus	Body and external temperature rise
Receptor	Thermoreceptors in the skin
Control Centre	Thermoregulatory centre in the hypothalamus
Effector	Sweat glands and skin blood vessels
Response	Sweating increases for evaporative cooling; skin vessels dilate to lose more heat

B5 9:30 PM · Forgot to Drink Water

Step	Answer
Stimulus	Blood osmolarity rises as the body dehydrates
Receptor	Osmoreceptors in the hypothalamus
Control Centre	Hypothalamus signals the pituitary gland
Effector	Kidney collecting ducts
Response	ADH release makes kidneys reabsorb more water, diluting the blood

Part C

- C1** True. The response, carried out by the effector, brings the variable back toward its set point.
- C2** False. Drinking too much water dilutes the blood, so osmolarity falls; the kidneys respond by reabsorbing less water.
- C3** True. The hypothalamus signals skeletal muscles to contract rapidly, generating heat.
- C4** True. Sweat cools the body as it evaporates, and wider skin blood vessels let more heat escape near the skin surface.
- C5** False. ADH makes the kidneys reabsorb more water, producing less, more concentrated urine.
- C6** False. Glucagon, not insulin, responds to low blood glucose. Insulin lowers blood glucose.
- C7** True. The hypothalamus controls both water balance (via the pituitary and ADH) and body temperature.
- C8** True. Each response counteracts the original change rather than amplifying it.

Part D

- D1** B. A stimulus is detected by a receptor, which signals a control centre; the control centre triggers an effector to produce the response.
- D2** B. The blood becomes more dilute; less ADH is released, so the kidneys reabsorb less water and produce more dilute urine.
- D3** B. Sweating gives evaporative cooling and vasodilation increases heat loss from the skin.
- D4** B. Glucagon stimulates liver cells to convert stored glycogen into glucose, raising blood glucose.
- D5** B. ADH increases water reabsorption in the collecting ducts, diluting the blood and concentrating the urine.

Part E

E1(a) Sweat glands produce more sweat, which removes heat as it evaporates; arterioles supplying skin capillaries dilate (vasodilation), so more heat is lost from the skin.

E1(b) He loses water in sweat, so his blood becomes more concentrated (lower water potential). Osmoreceptors in the hypothalamus detect this, and more ADH is released from the pituitary gland. ADH makes the kidney collecting ducts reabsorb more water, so less, more concentrated urine is produced.

E2 Insulin (released when blood glucose is high) makes the liver convert glucose into glycogen for storage, lowering blood glucose. Glucagon (released when blood glucose is low) makes the liver break down glycogen into glucose, raising blood glucose. They have opposite (antagonistic) effects.