Ben's Bad Day — Answer Key

Regulating Temperature, Water Balance & Blood Glucose Level

Ben cannot catch a break. For each situation below, this key shows the full negative-feedback loop his body uses to fight back: stimulus, receptor, control centre, effector, and response.

Key Terms

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

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	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

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	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

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	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

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	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

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	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

Check Your Understanding

True or False? Circle your answer for each statement.

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

Answer: True

Explanation: *The response — carried out by the effector — is what brings the variable back toward its set point, correcting the imbalance the stimulus created.*

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

Answer: False

Explanation: *Drinking too much water dilutes the blood, so osmolarity falls, not rises — the kidneys respond by reabsorbing less water.*

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

Answer: True

Explanation: *The hypothalamus signals skeletal muscles to contract rapidly, generating heat as a byproduct.*

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

Answer: True

Explanation: *Sweating cools the body through evaporation, and wider skin blood vessels allow more heat to escape from the blood near the skin's surface.*

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

Answer: False

Explanation: *ADH makes the kidneys reabsorb more water, which produces less urine (and more concentrated urine) — not more urine.*

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

Answer: False

Explanation: *It's glucagon, not insulin, that responds to low blood glucose — glucagon causes the liver to break down glycogen and release glucose, raising levels back to normal. Insulin does the opposite: it lowers blood glucose.*

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

Answer: True

Explanation: *The hypothalamus handles both water balance (via the pituitary and ADH) and temperature regulation (via sweating and skin blood vessels) — the same organ, two different loops.*

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

Answer: True

Explanation: *Each response counteracts the original change rather than amplifying it — that's the defining feature of negative feedback.*

Multiple Choice Questions

Circle the letter of the best answer for each question.

1. 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

Explanation: *A stimulus is detected by a receptor, which signals a control centre; the control centre triggers an effector to produce the response.*

2. 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

Explanation: *Drinking too much water dilutes the blood, lowering its osmolarity. Osmoreceptors detect this and less ADH is released, so the kidneys reabsorb less water — producing more dilute urine.*

3. 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

Explanation: *Heat triggers sweating (evaporative cooling) and widening of skin blood vessels (more heat lost from blood near the surface) — shivering and vasoconstriction would warm the body further, the wrong direction.*

4. 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

Explanation: *Glucagon signals liver cells to break down their stored glycogen into glucose, releasing it into the bloodstream to raise blood glucose levels back to normal.*

5. 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

Explanation: *ADH acts on the kidney's collecting ducts to increase water reabsorption, diluting the blood and concentrating the urine.*