Ben's Bad Day — Answer Key

Homeostasis · Negative Feedback Worksheet

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.

8:00 AM · The Wake-Up Jolt

Ben fell asleep hunched over his desk after an all-nighter. A classmate slams a book down and he leaps out of his chair — the room instantly goes fuzzy and dark at the edges. He grabs the desk so he doesn't go down.

Step	Answer
Stimulus	Blood pressure drops suddenly from standing up too fast
Receptor	Baroreceptors in the carotid arteries and aorta
Control Centre	Cardiovascular centre in the medulla oblongata
Effector	Heart muscle and blood vessel walls
Response	Heart rate rises and vessels constrict, restoring blood pressure

8:30 AM · Cold Walk to Lab

Still shaky, Ben steps outside into a cold morning without a jacket, rushing to Chem lab. 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

11:50 AM · The Sprint

Ben's lab report blows off his desk and out an open door. He bolts down the hallway after it, sprinting harder than he has all semester.

Step	Answer
Stimulus	Lactic acid builds up, lowering blood pH
Receptor	Chemoreceptors sensitive to blood pH and CO_2
Control Centre	Respiratory centre in the medulla oblongata
Effector	Diaphragm and intercostal (rib) muscles
Response	Breathing rate rises, exhaling more CO_2 and raising blood pH

8:30 PM · Forgot to Drink Water

Ben's been so busy he hasn't had a sip of water since breakfast. By evening 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

12:00 AM · Midnight Snack

Finally home, Ben devours a big bowl of pasta before bed. Half an hour later his blood glucose is climbing fast.

Step	Answer
Stimulus	Blood glucose level rises after eating
Receptor	Beta cells in the pancreas detect high glucose
Control Centre	Pancreas acts as its own control centre
Effector	Liver, muscle and fat cells
Response	Insulin release drives cells to take up glucose, lowering blood levels

Check Your Understanding

True or False? Circle your answer for each statement.

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

Answer: False

Explanation: *A stimulus is the change that creates the imbalance in the first place — it's the response that corrects it.*

2. Baroreceptors in the carotid arteries and aorta detect Ben's drop in blood pressure when he stands up too fast.

Answer: True

Explanation: *Baroreceptors sense the sudden pressure drop and alert the cardiovascular centre in the medulla oblongata.*

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. The lactic acid produced during Ben's sprint raises his blood pH.

Answer: False

Explanation: *Lactic acid buildup lowers blood pH, making the blood more acidic — the opposite of raising it.*

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

Answer: True

Explanation: *Osmoreceptors in the hypothalamus trigger the pituitary to release ADH, and the kidneys respond by reabsorbing water.*

6. In the pancreas's response to Ben's midnight snack, the pancreas acts as both the receptor and the control centre.

Answer: True

Explanation: *The pancreas's beta cells sense the glucose spike directly and also decide on the response, without needing a separate control centre.*

7. An effector is the structure that first detects a stimulus.

Answer: False

Explanation: *That's the receptor's job. The effector is what carries out the response, further down the loop.*

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

Answer: False

Explanation: *They're all negative feedback — each response counteracts the original change rather than amplifying it.*

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 cold-walk scenario, which pair of effector responses helped restore his body temperature?

A. Sweating and vasodilation

B. Shivering and vasoconstriction of skin blood vessels ✓

C. Increased breathing rate and heart rate

D. Insulin release and glucose uptake

Explanation: *Cold triggers shivering (muscle contraction generates heat) and skin vessel constriction (reduces heat loss) — sweating and vasodilation would cool the body further, which is the wrong direction.*

3. Why does eating a meal trigger insulin release from the pancreas?

A. To raise blood glucose levels further

B. To lower blood glucose by helping cells take up glucose from the blood ✓

C. To break down fat stores for energy

D. To increase thirst and water retention

Explanation: *Rising blood glucose after eating is detected by the pancreas, which releases insulin so cells absorb glucose, bringing levels back down.*

4. Which best describes the role of an effector in a negative feedback loop?

A. It detects the original stimulus

B. It carries out the response that corrects the imbalance ✓

C. It compares the change to the normal set point

D. It causes the imbalance to occur

Explanation: *The effector — a muscle or gland — acts on the control centre's instructions to produce the response.*

5. In the water balance 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 blood vessels to lower blood pressure

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