Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.

Enduring understanding 2.C:
Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.

Essential knowledge 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

a. Negative feedback mechanisms maintain dynamic homeostasis for a particular condition (variable) by regulating physiological processes, returning the changing condition back to its target set point.

To foster student understanding of this concept, instructors can choose an illustrative example such as:

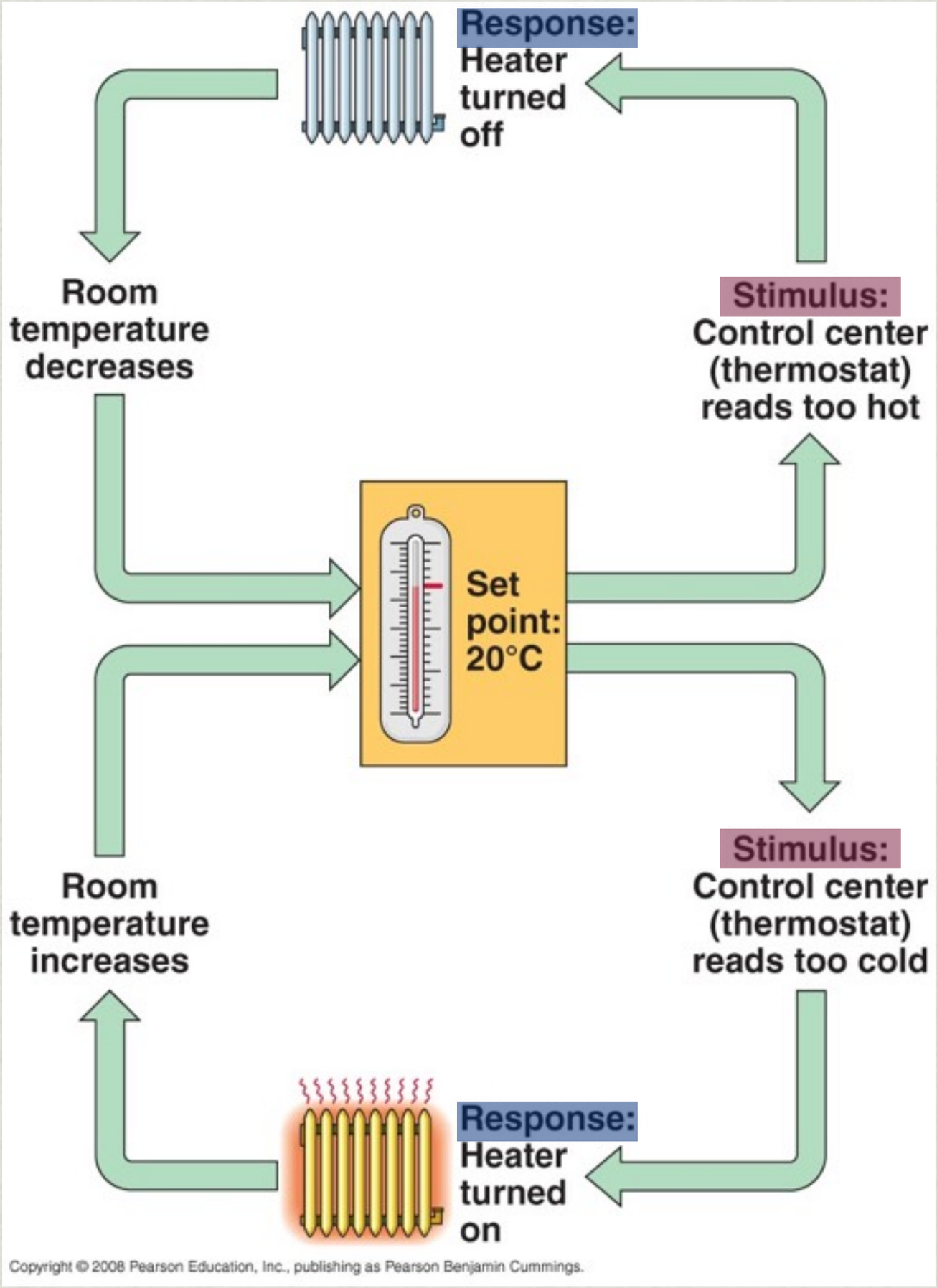
Operons in gene regulation

Temperature regulation in animals

Plant responses to water limitations

Homeostasis

- **Homeostasis:** “steady state” refers to the maintenance of an internal environment.
- It means that an internal environment stays relatively constant in spite of external environmental fluctuations some of which may be extreme.
- Human examples
  - Blood pH 7.4 (+/- .1)
  - Temperature 98.6° F
  - Blood Glucose Concentration 70-110mg/100ml



MECHANISM OF HOMEOSTASIS

NONBIOLOGICAL EXAMPLE

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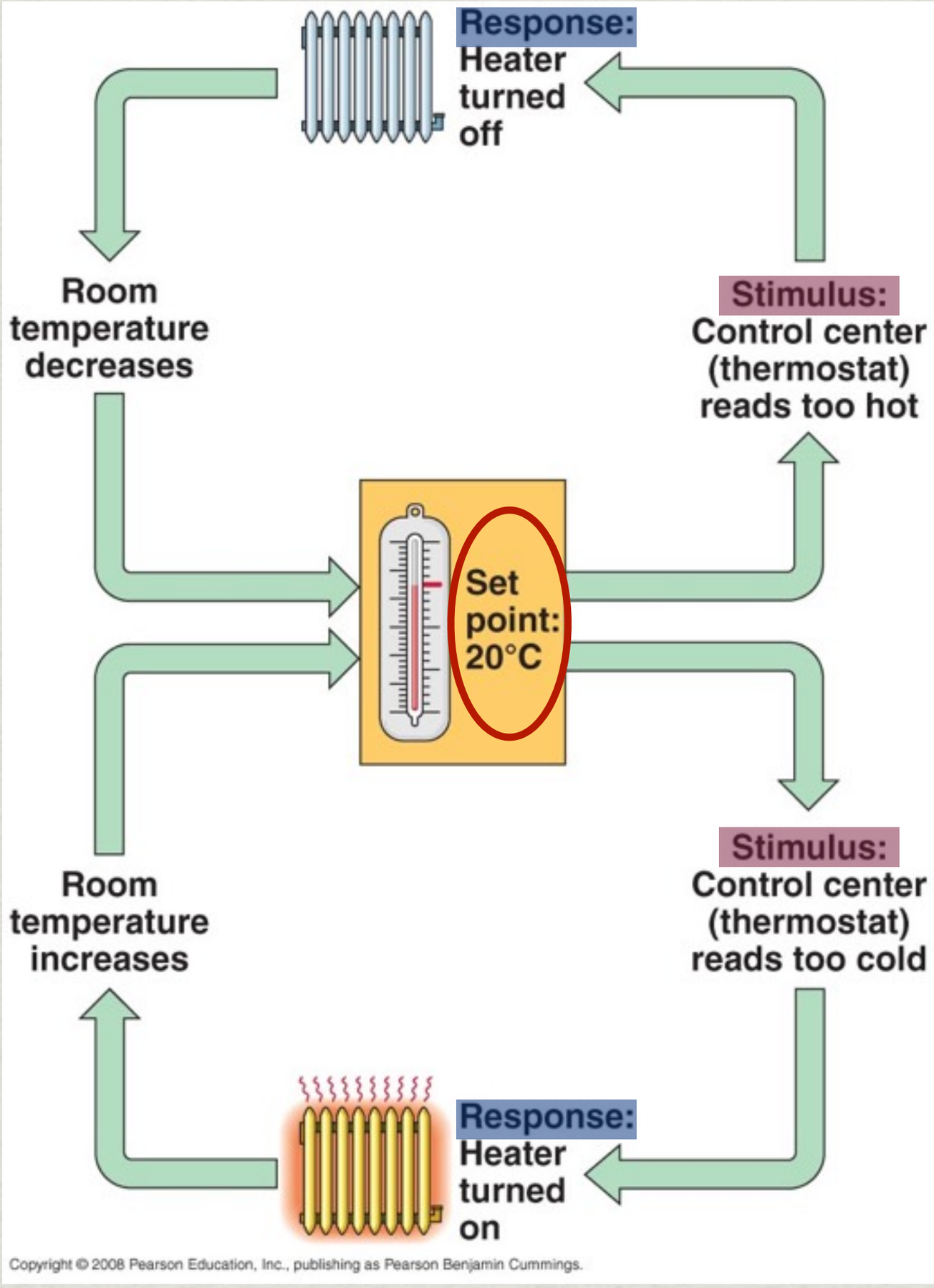

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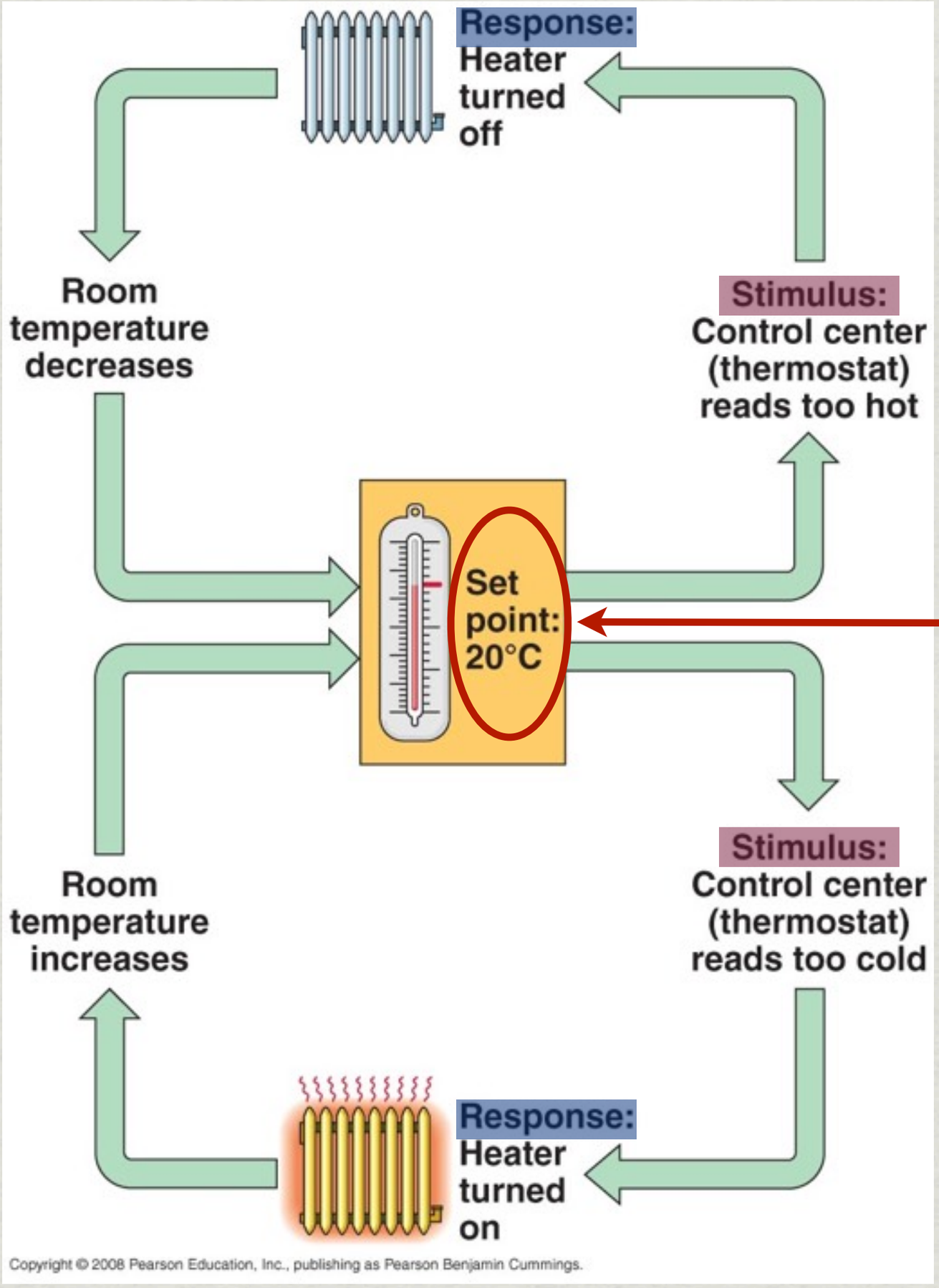

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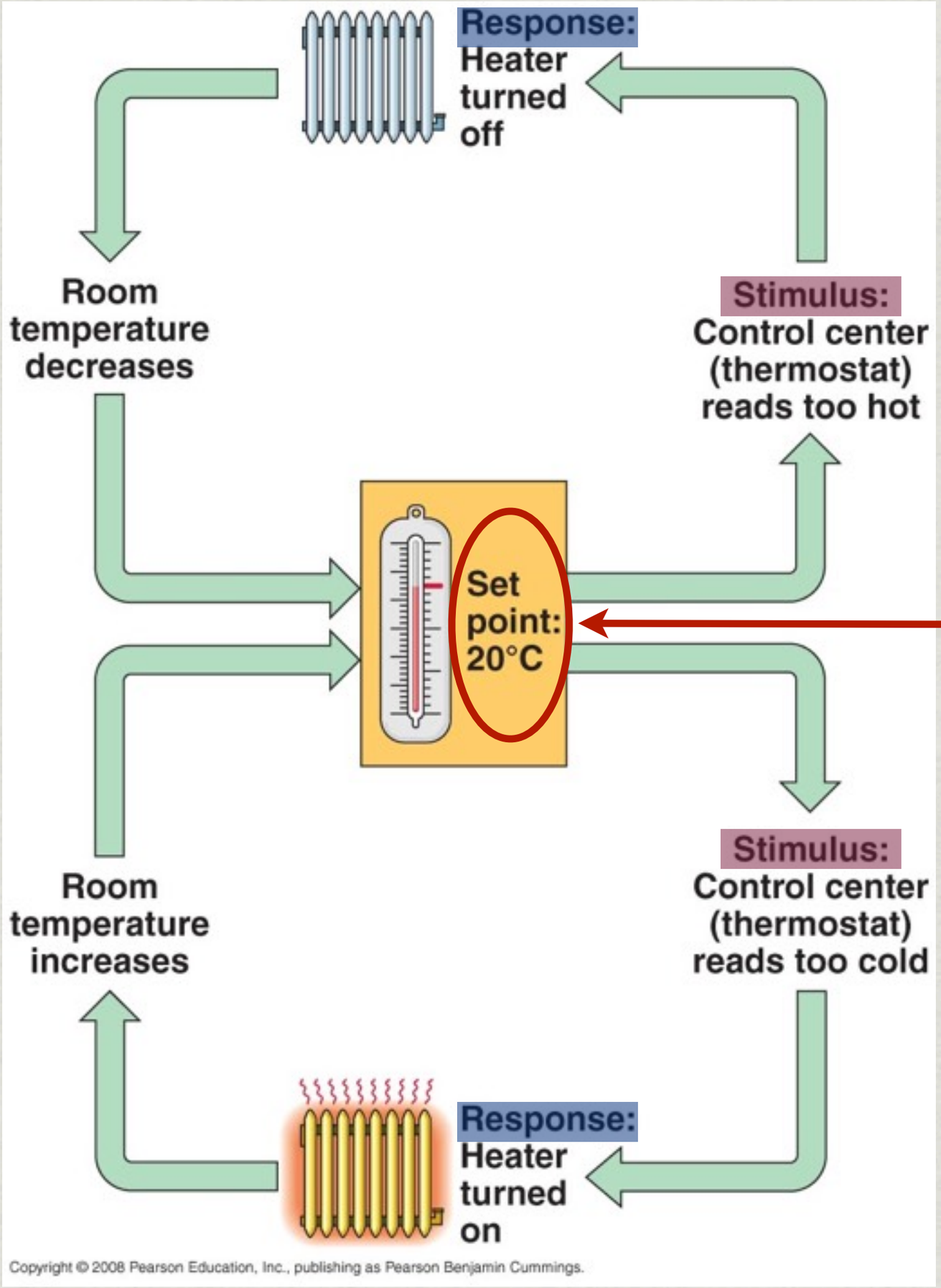


NONBIOLOGICAL EXAMPLE

CAN ALSO BE A "RANGE "

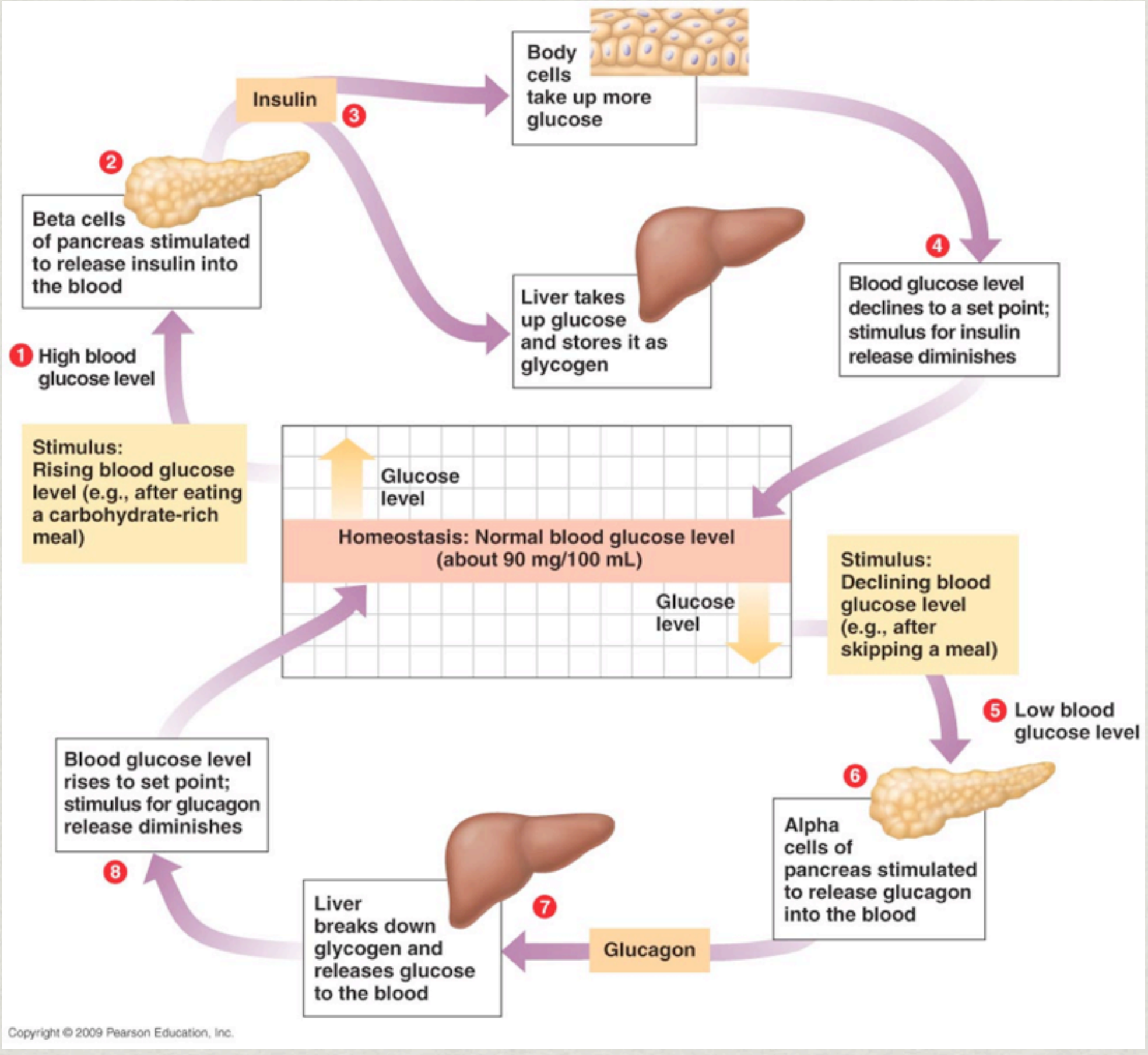
Feedback Control in Homeostasis

- **Negative Feedback:** control mechanism that reduces or counteracts the stimulus

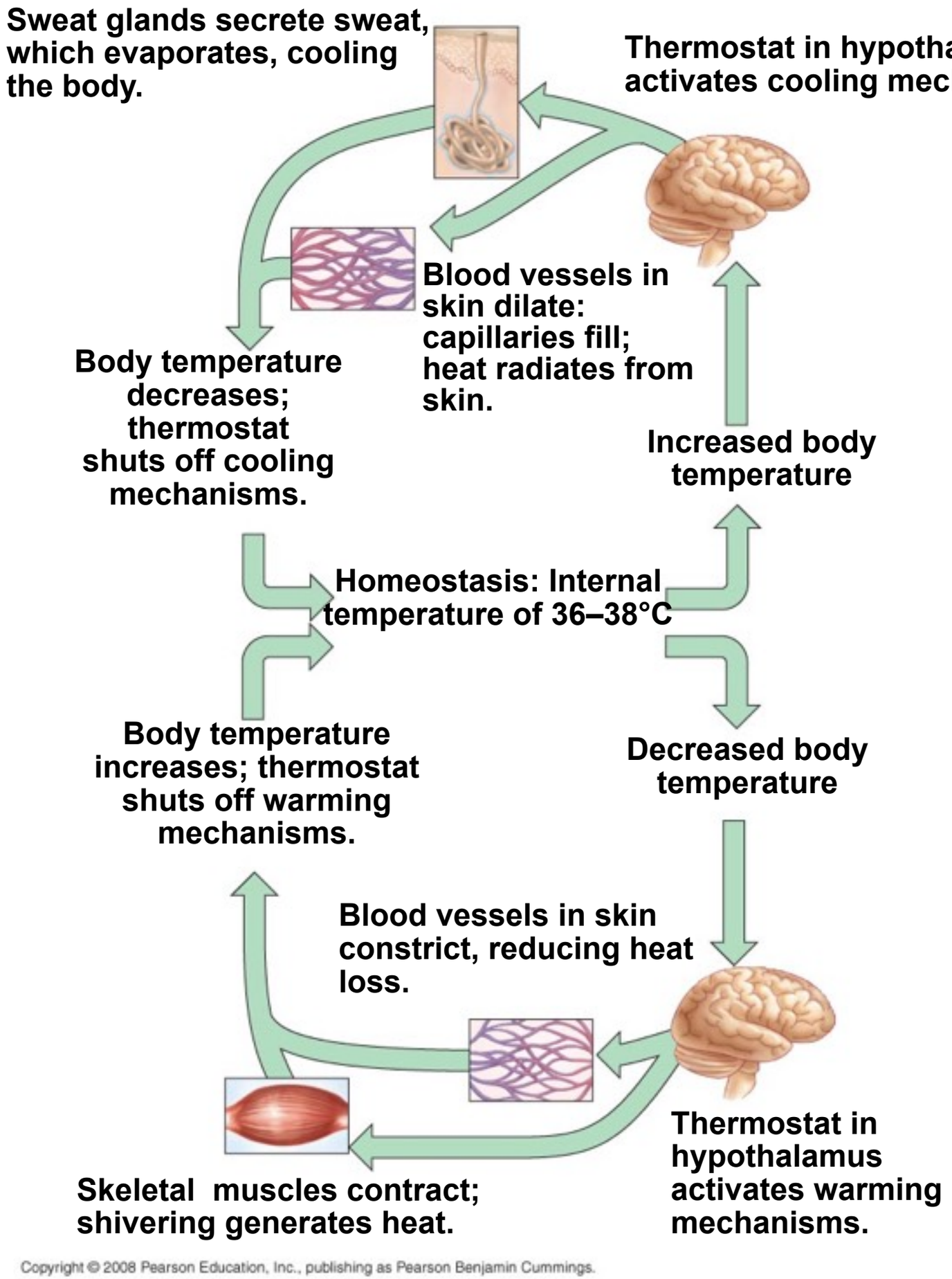
- Blood Glucose Concentration 70-110mg/100ml

CONTROL OF BLOOD SUGAR

NEGATIVE FEEDBACK



CONTROL OF BODY TEMP



NEGATIVE FEEDBACK

Essential knowledge 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

b. Positive feedback mechanisms amplify responses and processes in biological organisms. The variable initiating the response is moved farther away from the initial set-point. Amplification occurs when the stimulus is further activated which, in turn, initiates an additional response that produces system change.

Students should be able to demonstrate understanding of the above concept by using an illustrative example such as:

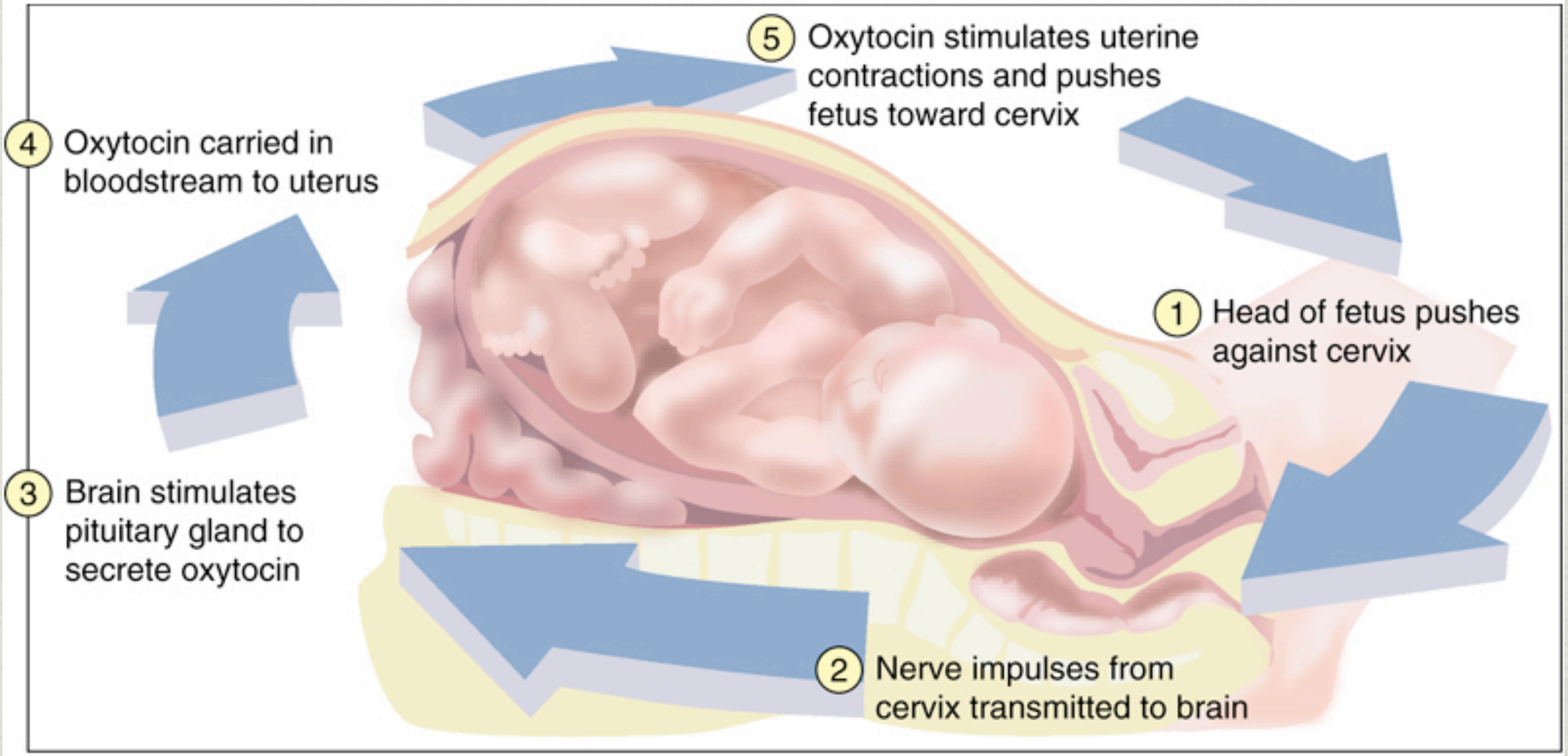
Lactation in mammals

Onset of labor in childbirth

Ripening of fruit

Feedback Control in Homeostasis

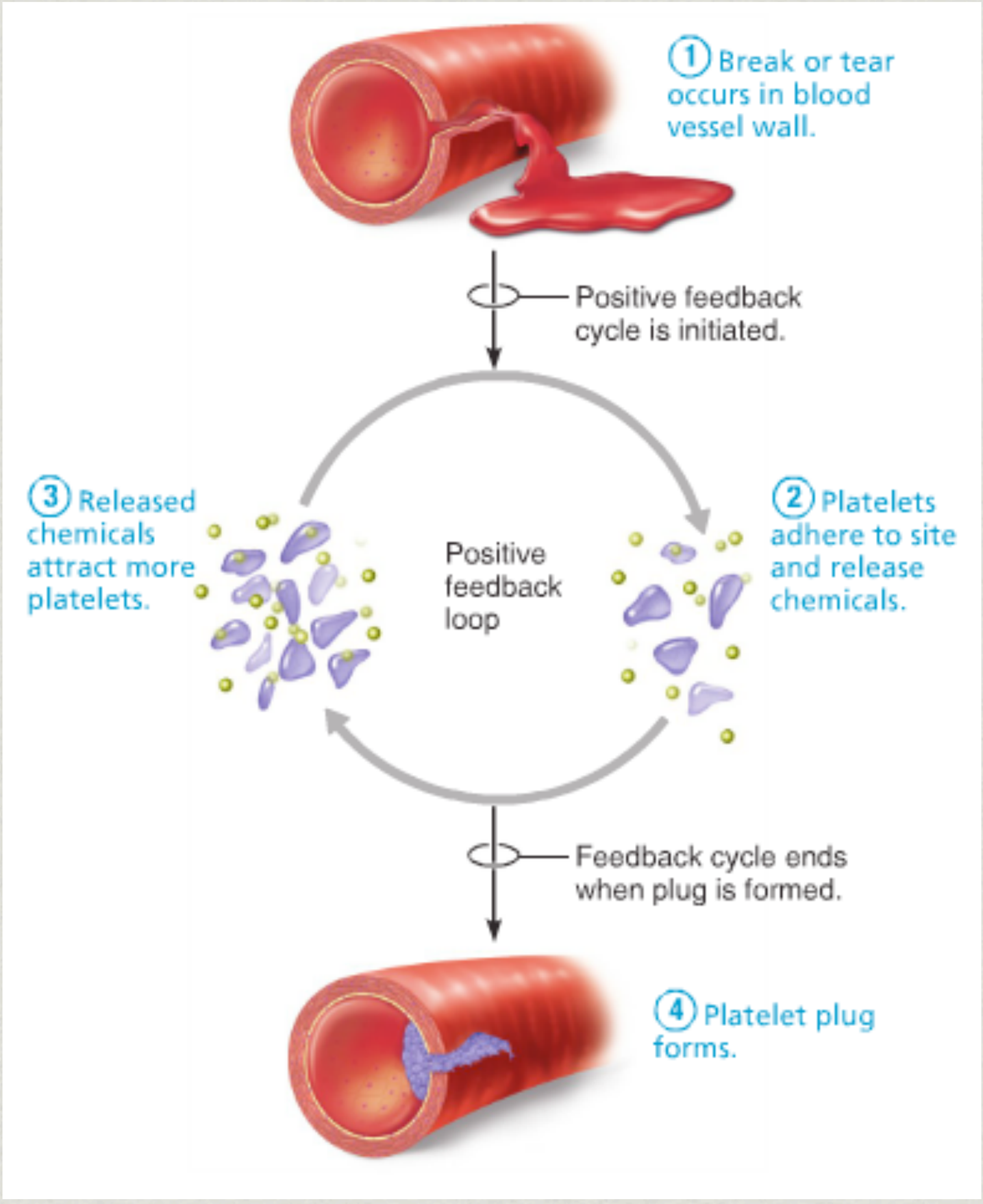
- **Positive Feedback:** control mechanism that amplifies the stimulus.
  - *Does not play a major role in homeostasis but instead helps drive processes to completion.*



PARTURITION → POSITIVE FEEDBACK

Examples of Positive Feedback

- A ripening apple releases the volatile plant hormone ethylene (the stimulus).
- Ethylene accelerates the ripening of unripe fruit in its vicinity so nearby fruit also ripens, releasing more ethylene (the response).
- All the fruit quickly becomes ripe together.


1 Break or tear occurs in blood vessel wall.
Positive feedback cycle is initiated.
2 Platelets adhere to site and release chemicals.
Positive feedback loop
3 Released chemicals attract more platelets.
Feedback cycle ends when plug is formed.
4 Platelet plug forms.

Final Points on Homeostasis

- Physiological responses to stimuli are not instantaneous, they take time!
- Homeostasis moderates but can not eliminate changes in the internal environment.
- The variable fluctuates whether the organism has a “set point” or a “range”
- Homeostasis is enhanced by adaptations that reduce fluctuations in the first place.
- It is dynamic!

Essential knowledge 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

c. Alteration in the mechanisms of feedback often results in deleterious consequences.

To foster student understanding of this concept, instructors can choose an illustrative example such as:

Diabetes mellitus in response to decreased insulin

Dehydration in response to decreased antidiuretic hormone (ADH)

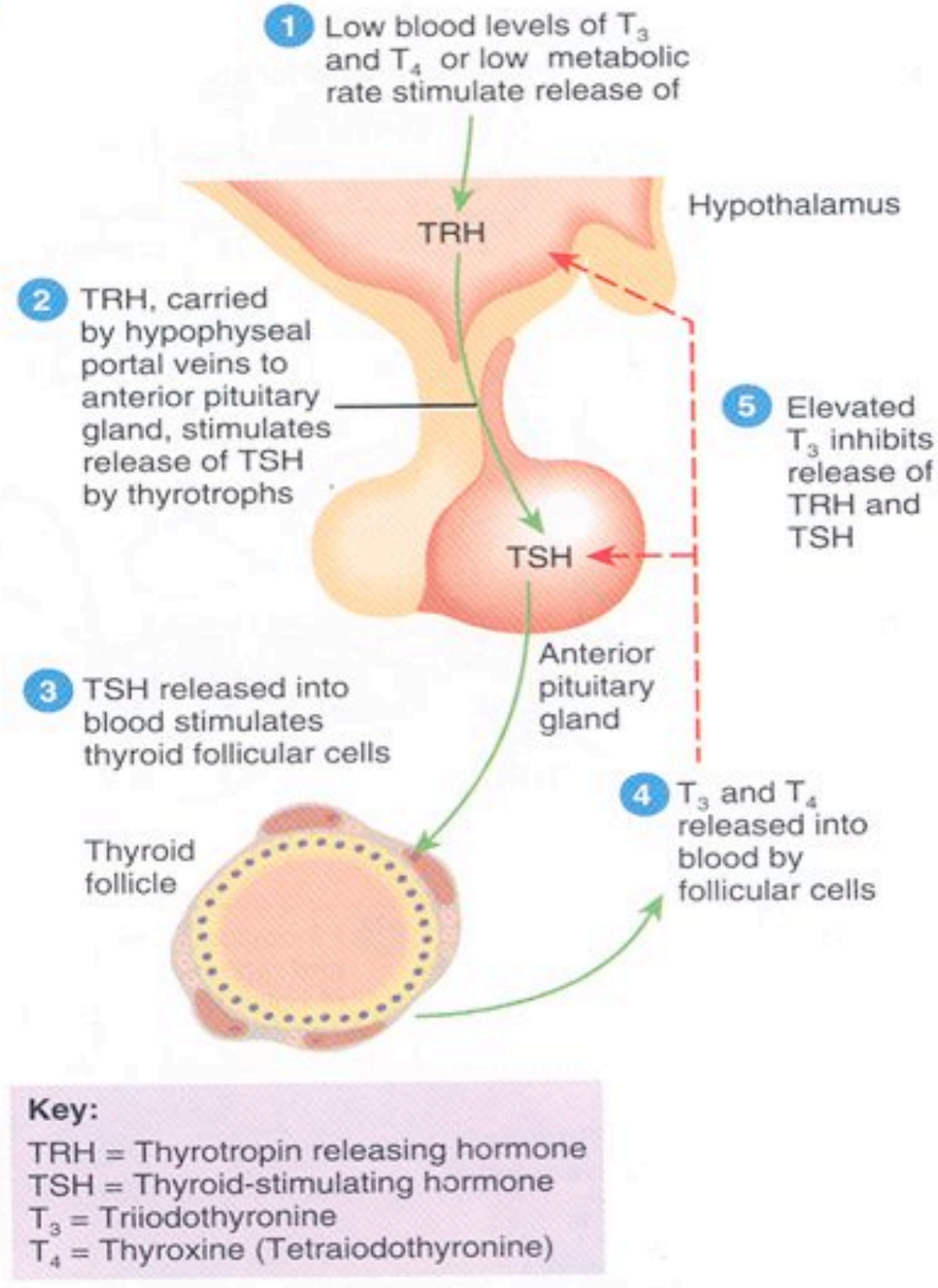
Graves' disease (hyperthyroidism)

Blood clotting

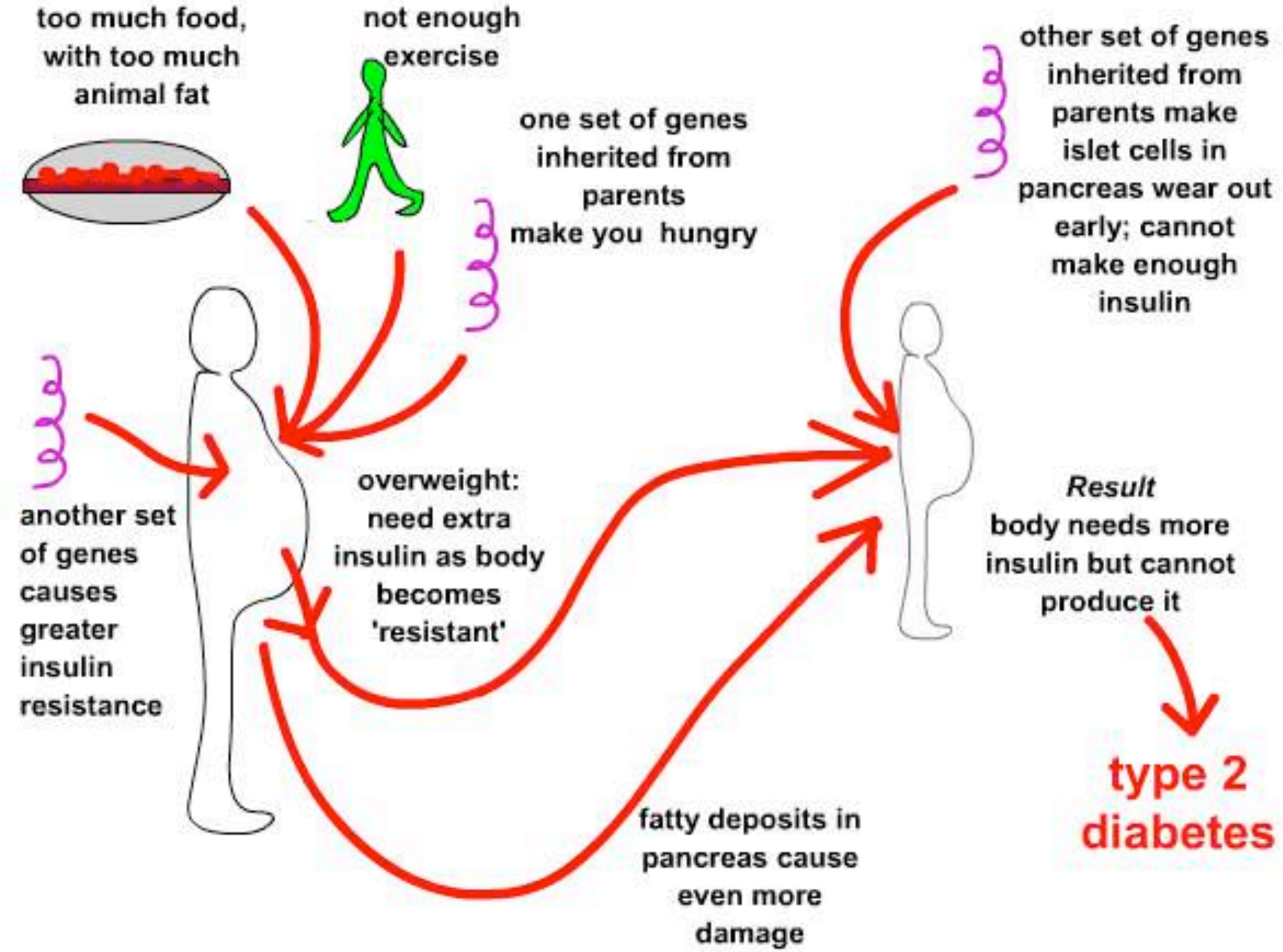
Graves Disease

Thyroid Problems

- What would happen if the thyroid could no longer produce T3 and T4?
- No negative feedback to hypothalamus and anterior pituitary



Diabetes Mellitus



Learning Objectives:

LO 2.15 The student can justify a claim made about the effect(s) on a biological system at the molecular, physiological or organismal level when given a scenario in which one or more components within a negative regulatory system is altered.
[See SP 6.1]

LO 2.16 The student is able to connect how organisms use negative feedback to maintain their internal environments. [See SP 7.2]

LO 2.17 The student is able to evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback mechanisms. [See SP 5.3]

LO 2.18 The student can make predictions about how organisms use negative feedback mechanisms to maintain their internal environments. [See SP 6.4]

LO 2.19 The student is able to make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models. [See SP 6.4]

LO 2.20 The student is able to justify that positive feedback mechanisms amplify responses in organisms. [See SP 6.1]