تَنوير

BIOLOGY

Lec no : Part "3"

File Title : chapter "40"

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وَقُل رَّبِّ زِدْنِي عِلْمًا

Coordination and Control

- Control and coordination within a body depend on the endocrine system and the nervous system
- The endocrine system transmits chemical signals called **hormones** to receptive cells throughout the body via blood
- A hormone may affect one or more regions throughout the body
- Hormones are relatively slow acting, but can have long-lasting effects

التحكم والتنسيق

Endocrine
نوع واحد من الإشارات

Slow chemical signals called (hormons)
الهرمونات

nervous
نوعين من الإشارات

1- Electrical signal called (nerve impulse) (fast)

2- chemical called (Neurotransmit) (Slow)

الغدد

Endocrine
(تفرز هرموناتها للدم)

Exocrine
لا تفرز هرموناتها للدم بل لخلايا مجاورة

Figure 40.6

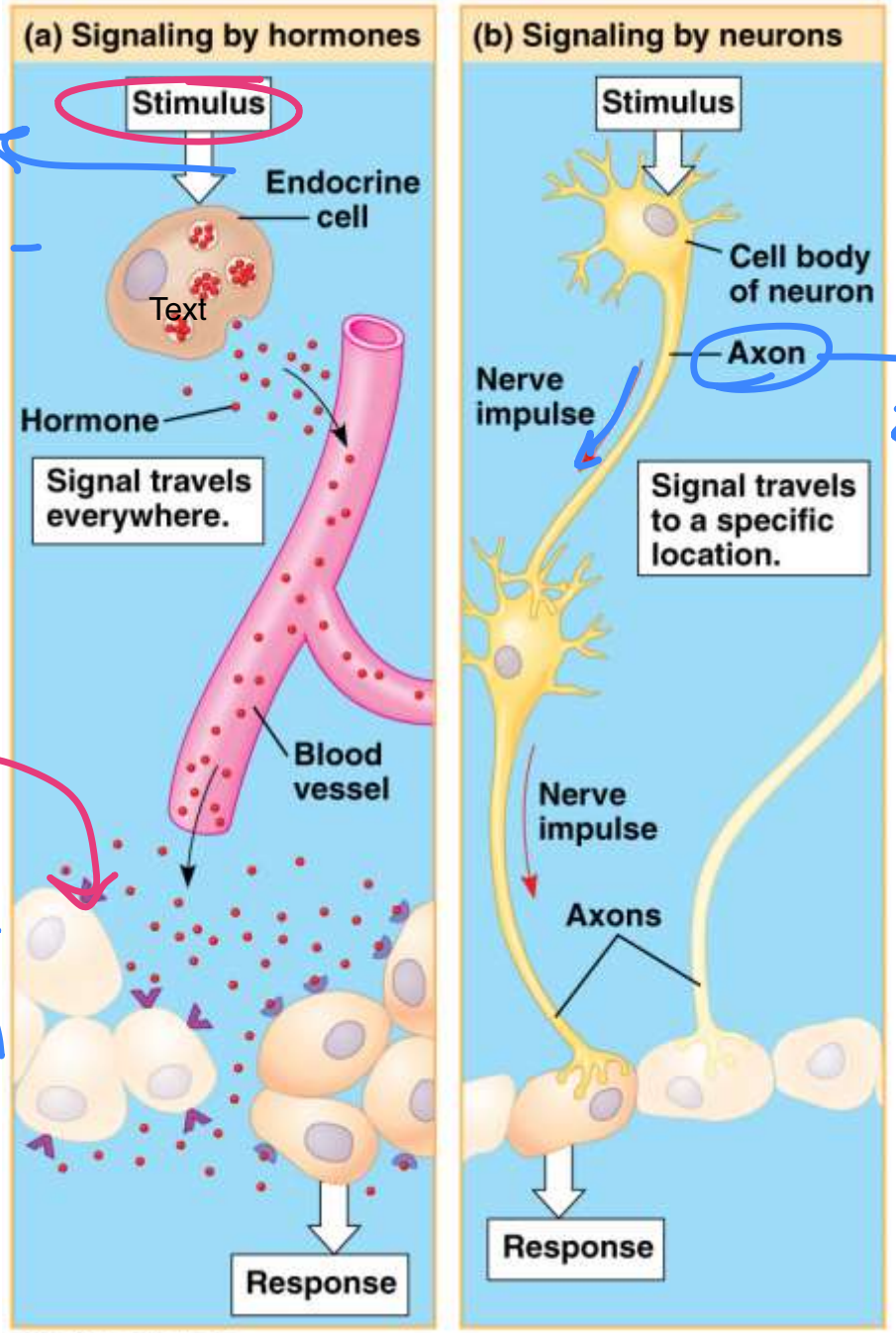
(a) Signaling by hormones
Stimulus
Endocrine cell
Text
Hormone
Signal travels everywhere.
Blood vessel
Response
(b) Signaling by neurons
Stimulus
Cell body of neuron
Axon
Nerve impulse
Signal travels to a specific location.
Nerve impulse
Axons
Response
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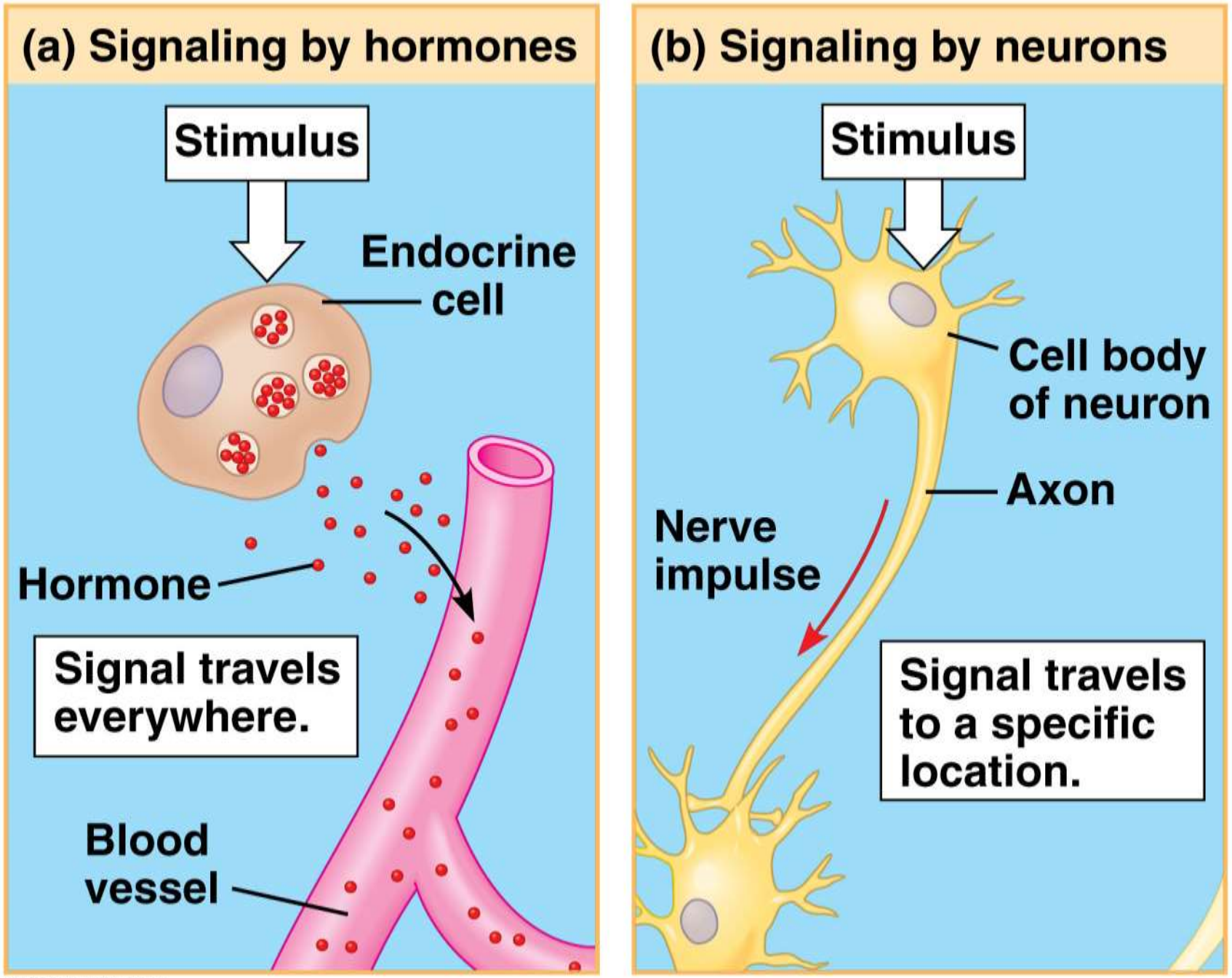
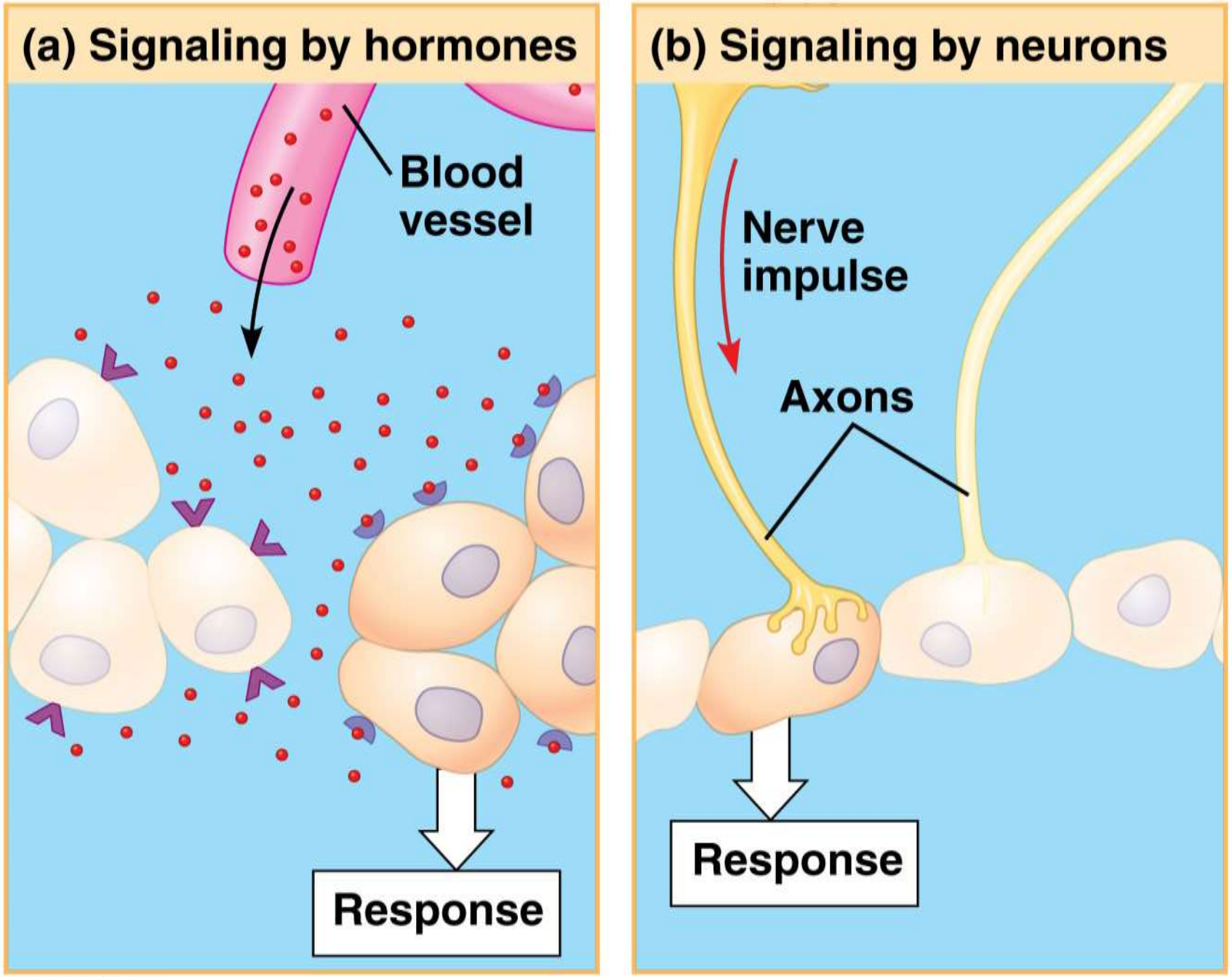
Figure 40.6a



- The nervous system transmits information between specific locations
- The information conveyed depends on a signal's pathway, not the type of signal
- Nerve signal transmission is very fast
- Nerve impulses can be received by neurons, muscle cells, endocrine cells, and exocrine cells

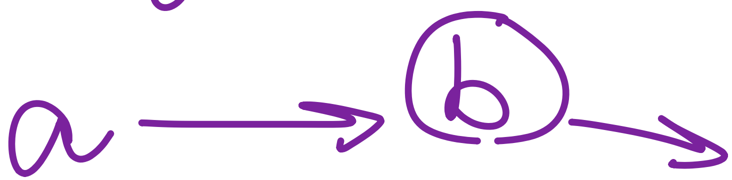
Figure 40.6b



Concept 40.2: Feedback control maintains the internal environment in many animals

- Animals manage their internal environment by regulating or conforming to the external environment

feedback



لما اكون ما بدي
كميات زيادة
من (b) مترجع
لتوقف عمليه انتاجها

Regulating and Conforming

يعني شو فاضل بالبيئة الخارجية بتضل البيئة الداخلية ثابتة

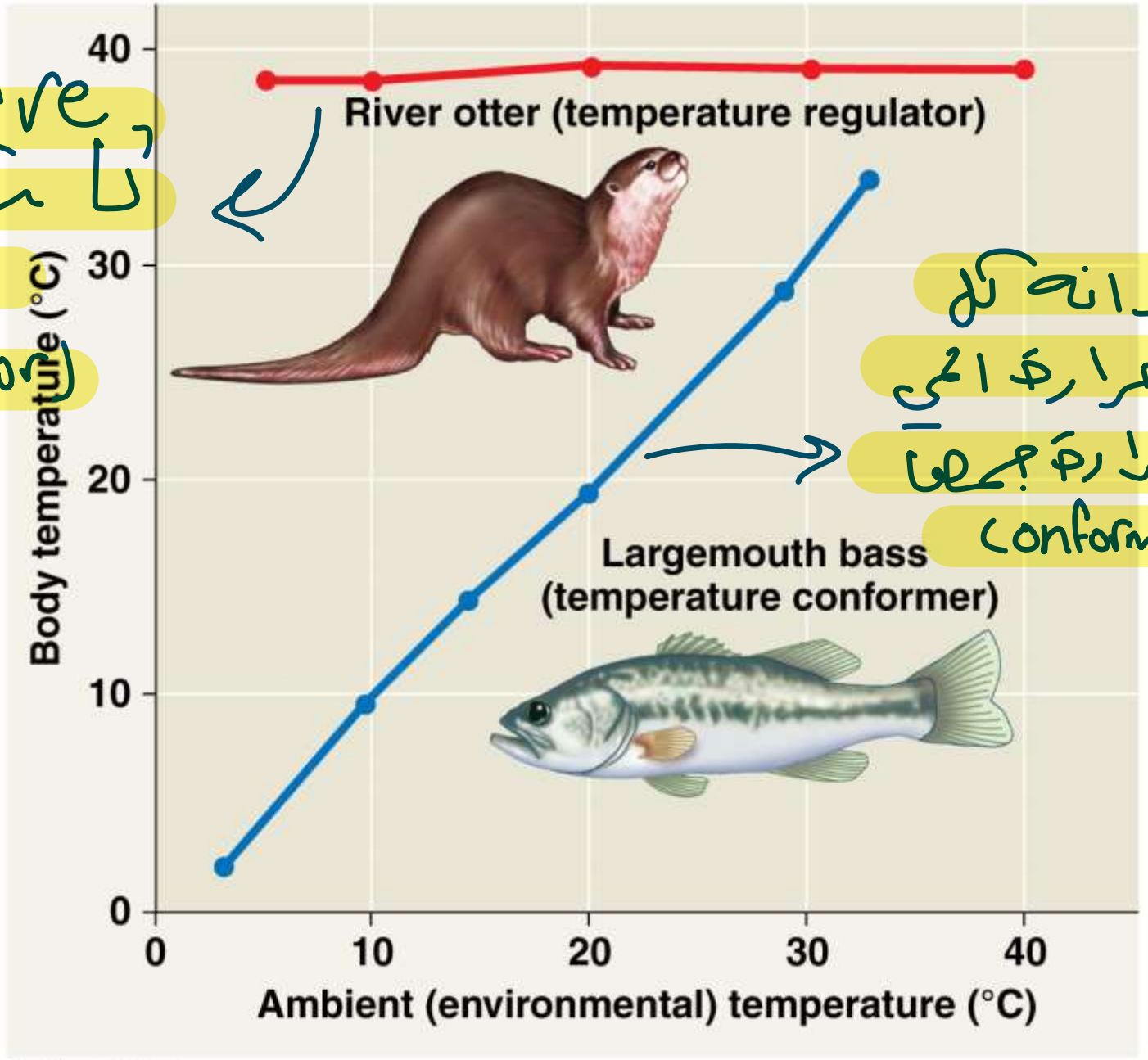
- A **regulator** uses internal control mechanisms to moderate internal change in the face of external, environmental fluctuation
- A **conformer** allows its internal condition to vary with certain external changes

تكيف مع البيئة الخارجية يعني لو تغيرت تتغير

- Animals may regulate some environmental variables while conforming to others

regulate ممكن يكون animal
factor لـ conformer و factors لـ

Figure 40.7



Homeostasis

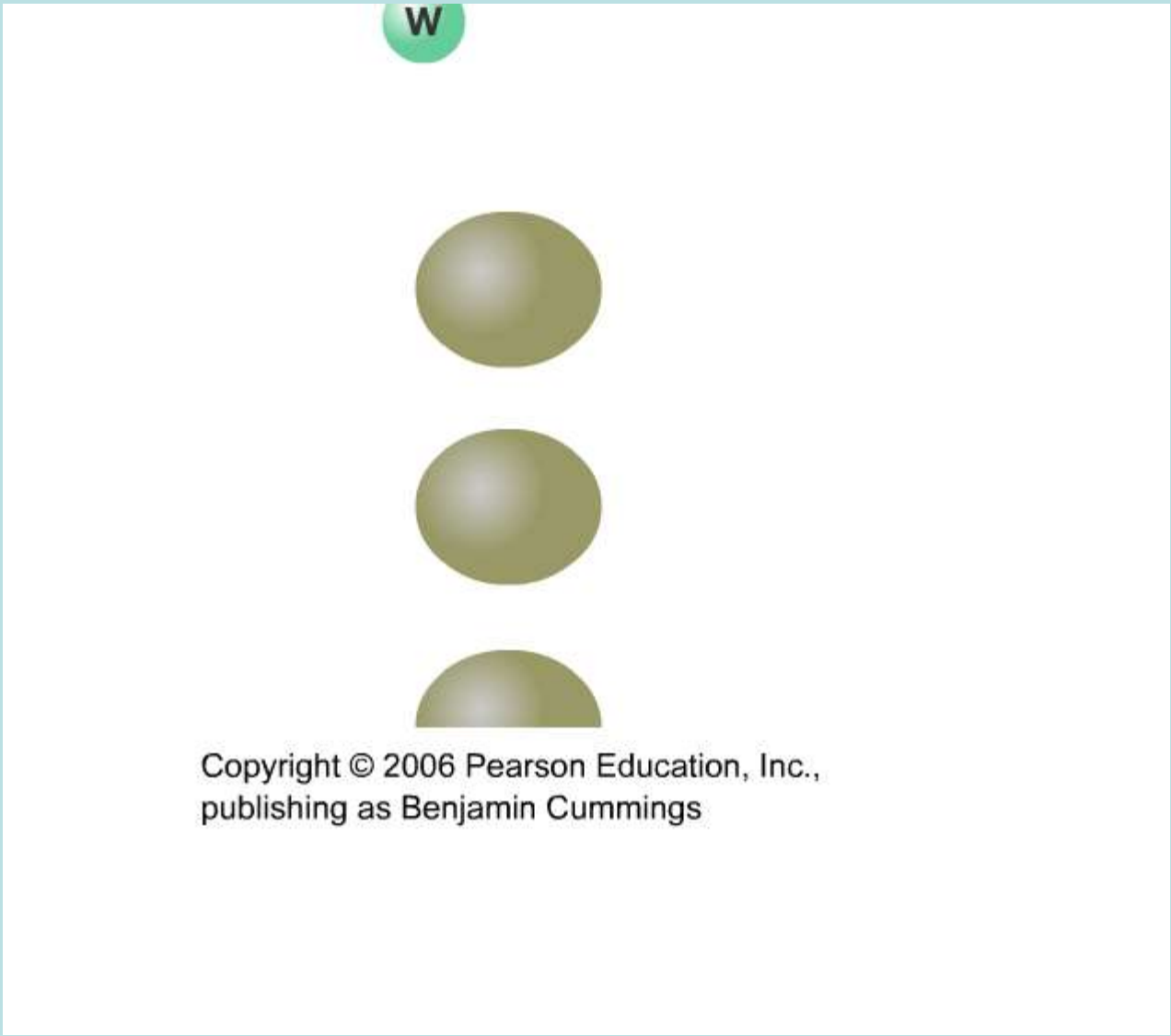
- Organisms use **homeostasis** to maintain a "steady state" or internal balance regardless of external environment
- In humans, body temperature, blood pH, and glucose concentration are each maintained at a constant level

Mechanisms of Homeostasis

- Mechanisms of homeostasis moderate changes in the internal environment
- For a given variable, fluctuations above or below a **set point** serve as a **stimulus**; these are detected by a **sensor** and trigger a **response**
- The response returns the variable to the set point

Animation: Negative Feedback

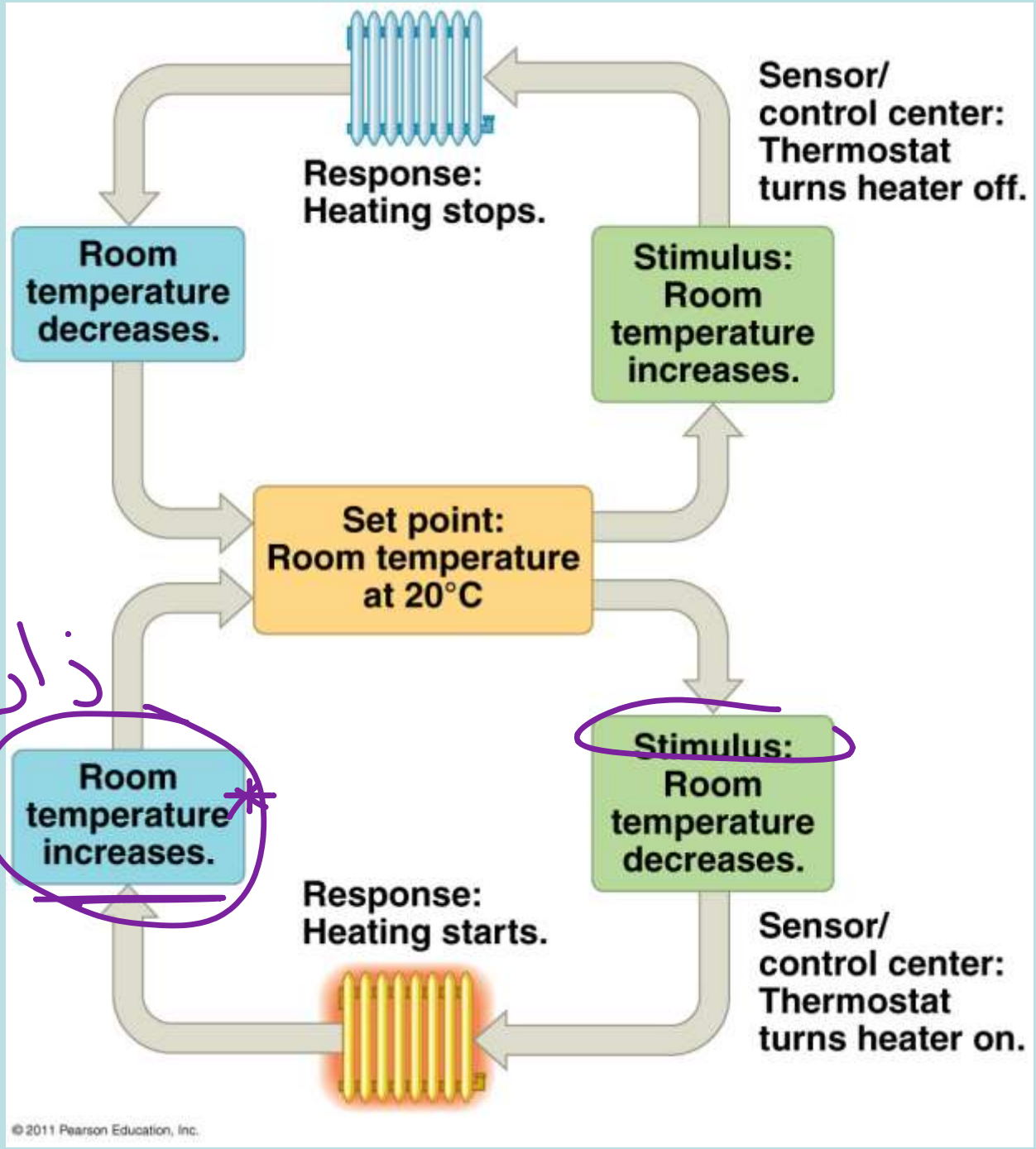
Right-click slide / select “Play”



Animation: Positive Feedback

Right-click slide / select “Play”

Figure 40.8


Response:
Heating stops.
Sensor/
control center:
Thermostat
turns heater off.
Room
temperature
decreases.
Stimulus:
Room
temperature
increases.
Set point:
Room temperature
at 20°C
Stimulus:
Room
temperature
decreases.
Room
temperature
increases.
Response:
Heating starts.
Sensor/
control center:
Thermostat
turns heater on.
© 2011 Pearson Education, Inc.

Feedback Control in Homeostasis

- The dynamic equilibrium of homeostasis is maintained by **negative feedback**, which helps to return a variable to a normal range
- Most homeostatic control systems function by negative feedback, where buildup of the end product shuts the system off
- **Positive feedback** amplifies a stimulus and does not usually contribute to homeostasis in animals

$a \longrightarrow b + c\uparrow$

↳ لما تزيد كمية c برجع وبوقف انتاج مادة a (negative)

↳ لما يكون ما بدي (c) بالحماية بكرة

↳ لما اكون بدي كميات عالية من c فبرجع لل a وبتخلي يتنشط (positive)

Alterations in Homeostasis

- Set points and normal ranges can change with age or show cyclic variation
- In animals and plants, a **circadian rhythm** governs physiological changes that occur roughly every 24 hours

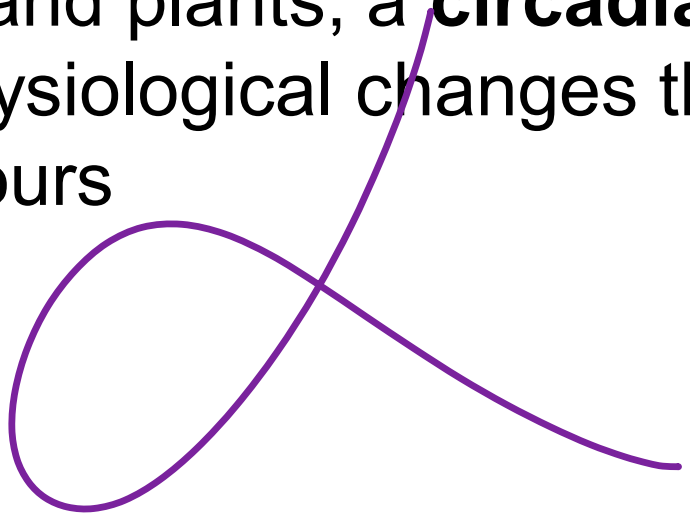


Figure 40.9

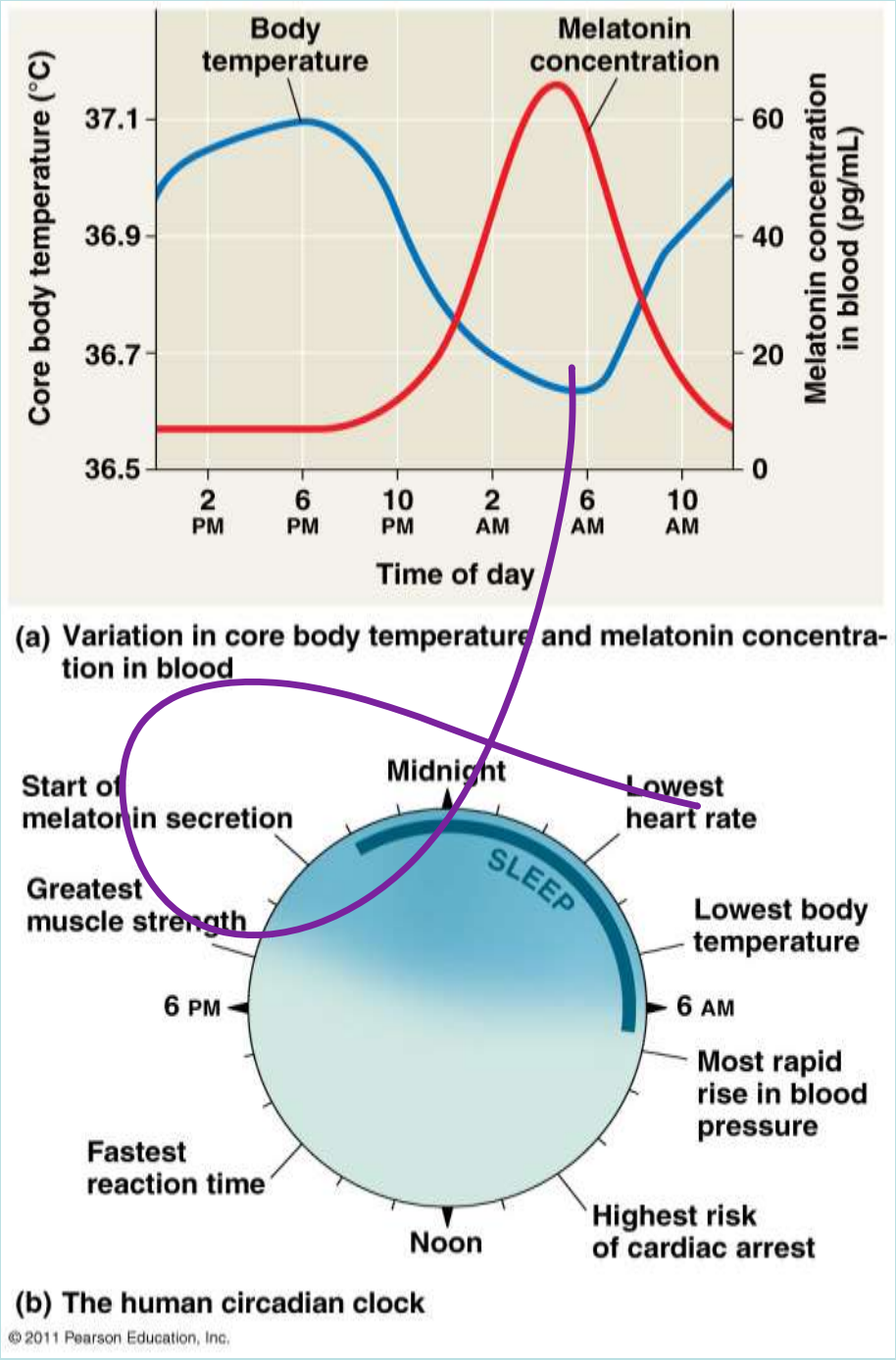
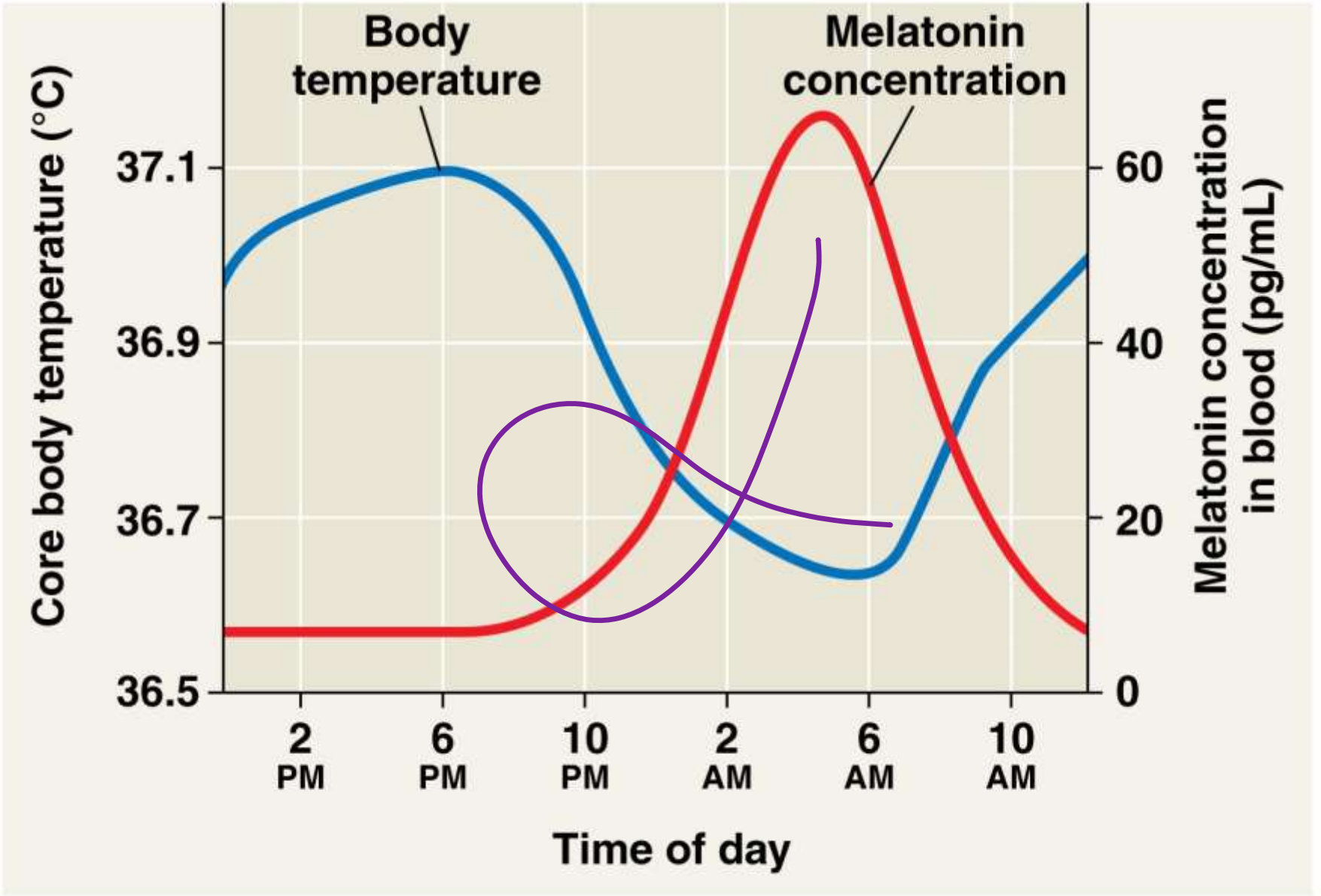
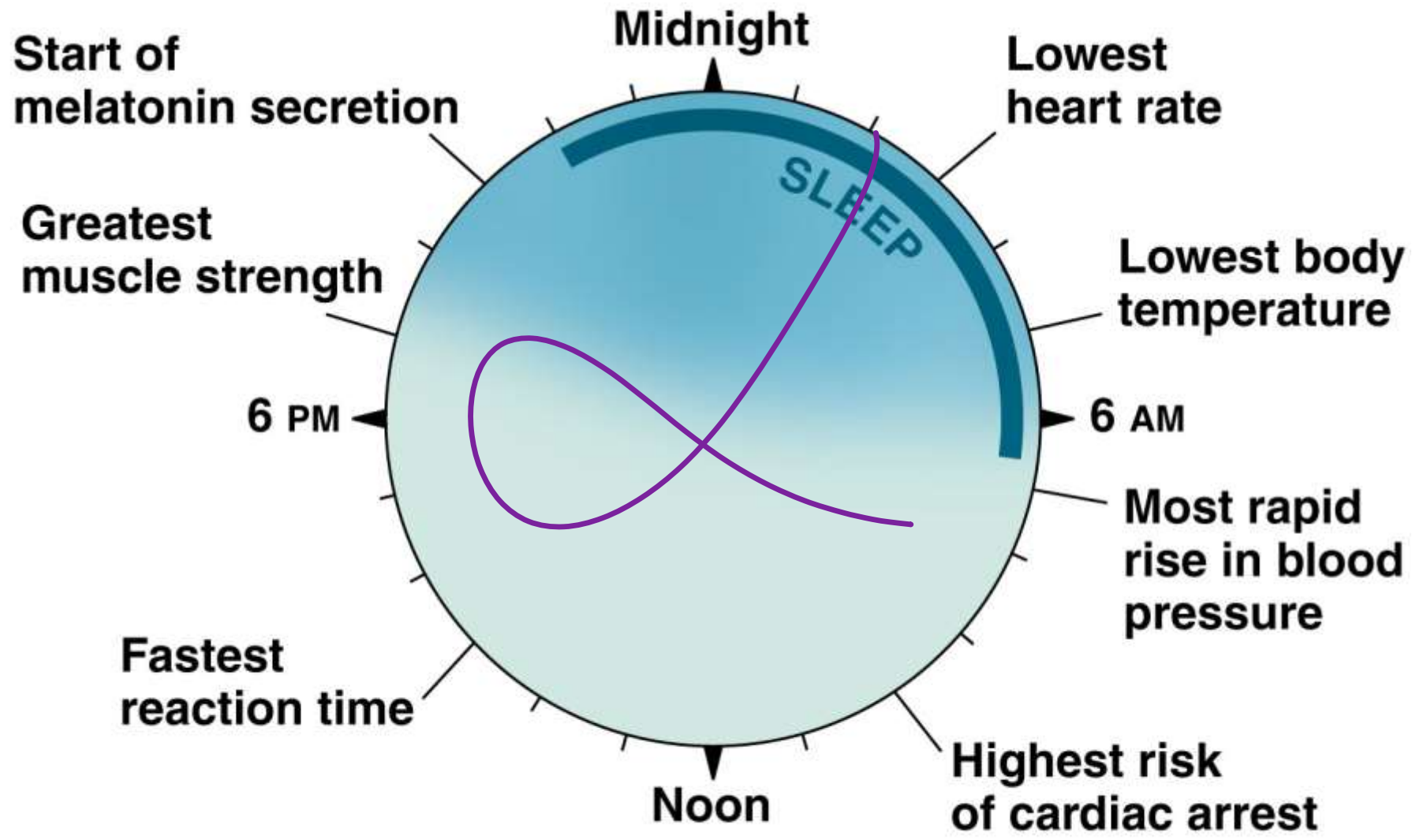


Figure 40.9a



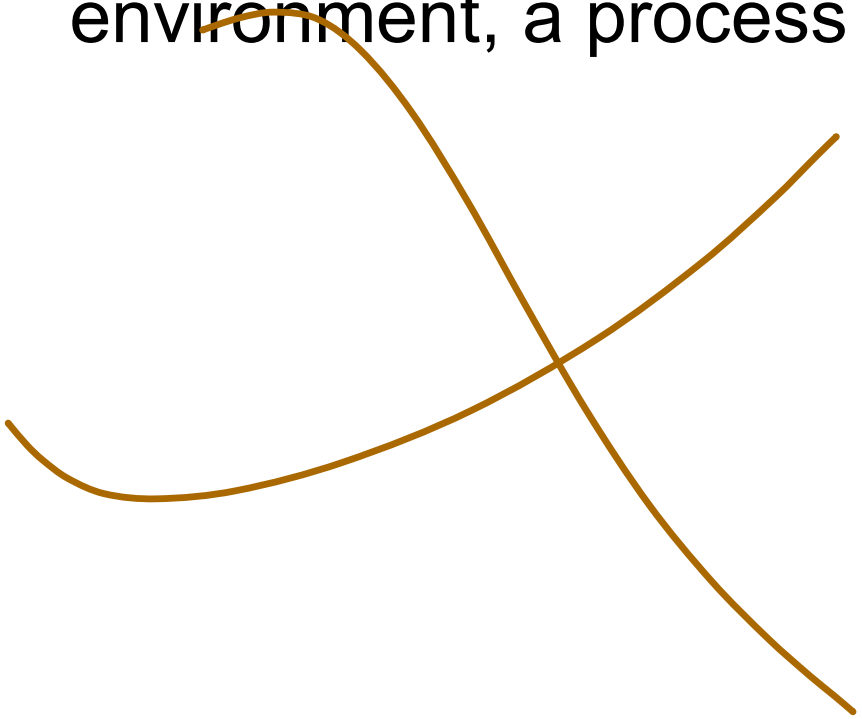
(a) Variation in core body temperature and melatonin concentration in blood

Figure 40.9b



(b) The human circadian clock

- Homeostasis can adjust to changes in external environment, a process called **acclimatization**



Concept 40.3: Homeostatic processes for thermoregulation involve form, function, and behavior

- **Thermoregulation** is the process by which animals maintain an internal temperature within a tolerable range

تنظيم درجة الحرارة في الجسم

فقط مطلوب التعريفات

Endothermy and Ectothermy

تقسم الحيوانات إلى :-

1

- **Endothermic** animals generate heat by metabolism; birds and mammals are endotherms

2

- **Ectothermic** animals gain heat from external sources; ectotherms include most invertebrates, fishes, amphibians, and nonavian reptiles

- In general, ectotherms tolerate greater variation in internal temperature, while endotherms are active at a greater range of external temperatures
- Endothermy is more energetically expensive than ectothermy

Figure 40.10

(a) A walrus, an endotherm

(b) A lizard, an ectotherm

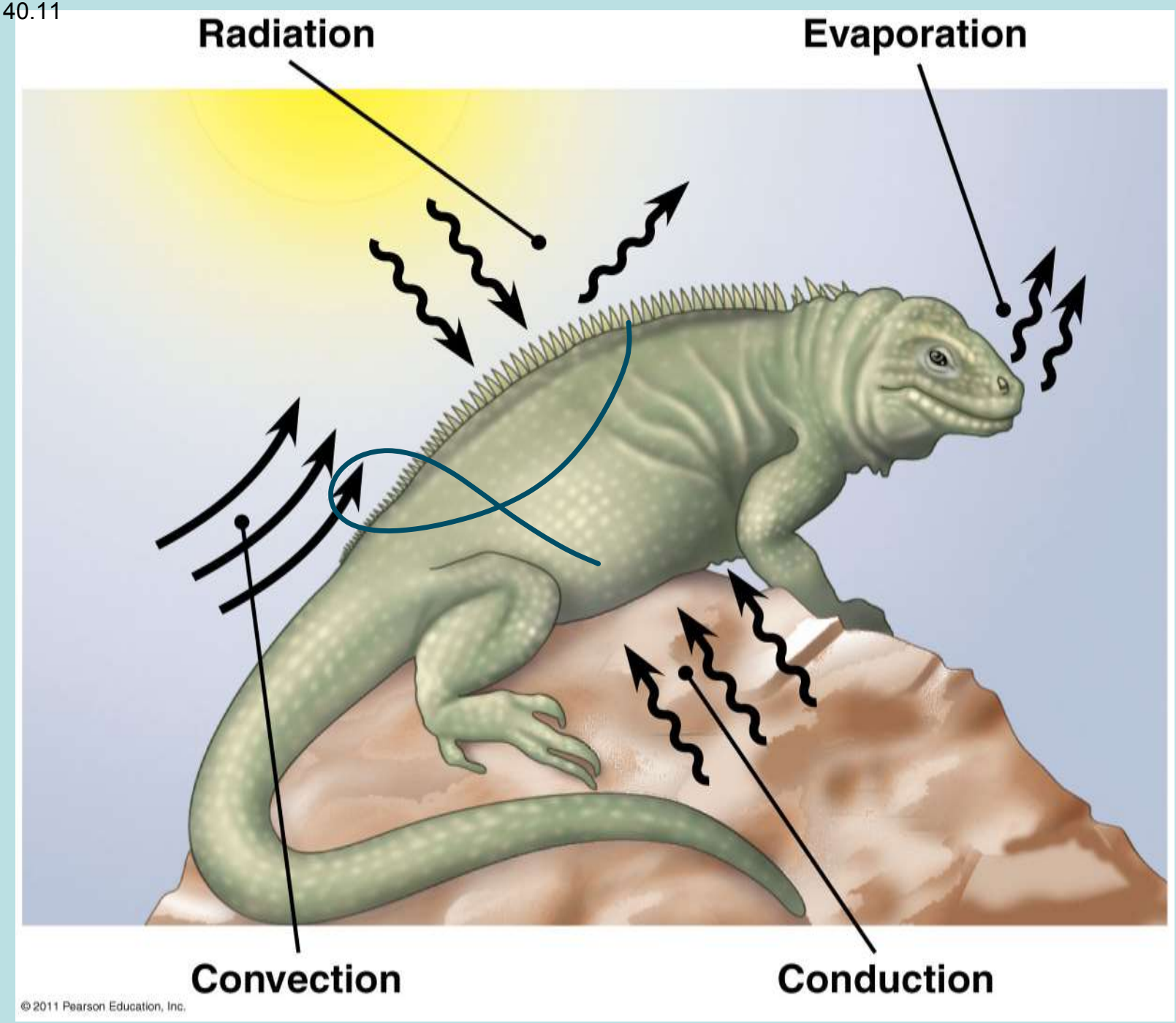
Variation in Body Temperature

- The body temperature of a poikilotherm varies with its environment
- The body temperature of a homeotherm is relatively constant
- The relationship between heat source and body temperature is not fixed (that is, not all poikilotherms are ectotherms)

Balancing Heat Loss and Gain

- Organisms exchange heat by four physical processes: radiation, evaporation, convection, and conduction

Figure 40.11


Radiation
Evaporation
Convection
Conduction
© 2011 Pearson Education, Inc.

- Heat regulation in mammals often involves the **integumentary system**: skin, hair, and nails
- Five adaptations help animals thermoregulate:
  - Insulation
  - Circulatory adaptations
  - Cooling by evaporative heat loss
  - Behavioral responses
  - Adjusting metabolic heat production

Insulation

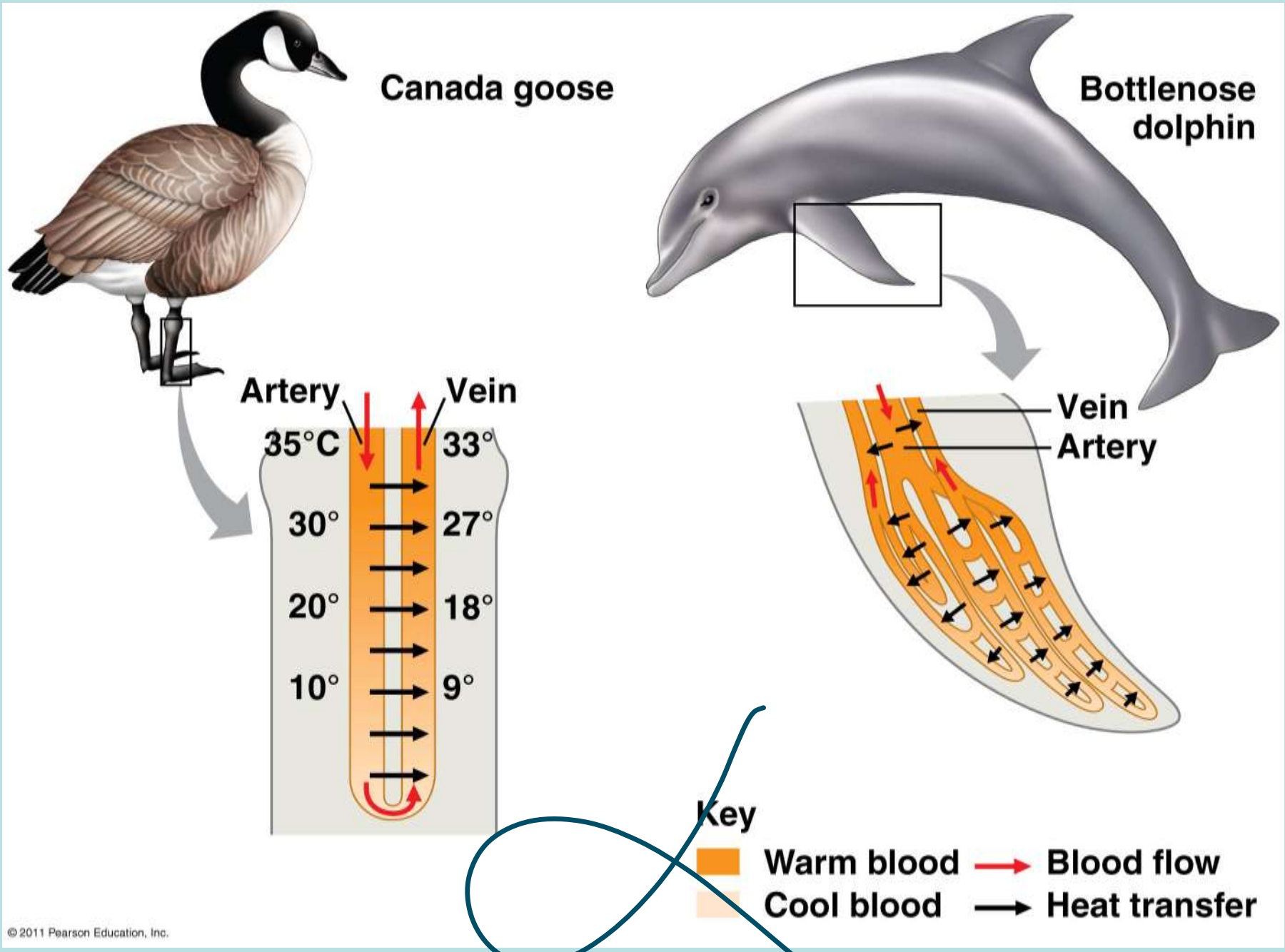
- Insulation is a major thermoregulatory adaptation in mammals and birds
- Skin, feathers, fur, and blubber reduce heat flow between an animal and its environment
- Insulation is especially important in marine mammals such as whales and walruses

Circulatory Adaptations

- Regulation of blood flow near the body surface significantly affects thermoregulation
- Many endotherms and some ectotherms can alter the amount of blood flowing between the body core and the skin
- In vasodilation, blood flow in the skin increases, facilitating heat loss
- In vasoconstriction, blood flow in the skin decreases, lowering heat loss

- The arrangement of blood vessels in many marine mammals and birds allows for **countercurrent exchange**
- Countercurrent heat exchangers transfer heat between fluids flowing in opposite directions and reduce heat loss

Figure 40.12


Canada goose
Bottlenose dolphin
Artery
Vein
35°C
33°
30°
27°
20°
18°
10°
9°
Vein
Artery
Key
Warm blood
Cool blood
Blood flow
Heat transfer
© 2011 Pearson Education, Inc.

- Some bony fishes and sharks also use countercurrent heat exchanges
- Many endothermic insects have countercurrent heat exchangers that help maintain a high temperature in the thorax

Cooling by Evaporative Heat Loss

- Many types of animals lose heat through evaporation of water from their skin
- Panting increases the cooling effect in birds and many mammals
- Sweating or bathing moistens the skin, helping to cool an animal down

Behavioral Responses

- Both endotherms and ectotherms use behavioral responses to control body temperature
- Some terrestrial invertebrates have postures that minimize or maximize absorption of solar heat

Figure 40.13

Adjusting Metabolic Heat Production

- Thermogenesis is the adjustment of metabolic heat production to maintain body temperature
- Thermogenesis is increased by muscle activity such as moving or shivering
- Nonshivering thermogenesis takes place when hormones cause mitochondria to increase their metabolic activity
- Some ectotherms can also shiver to increase body temperature

Figure 40.14

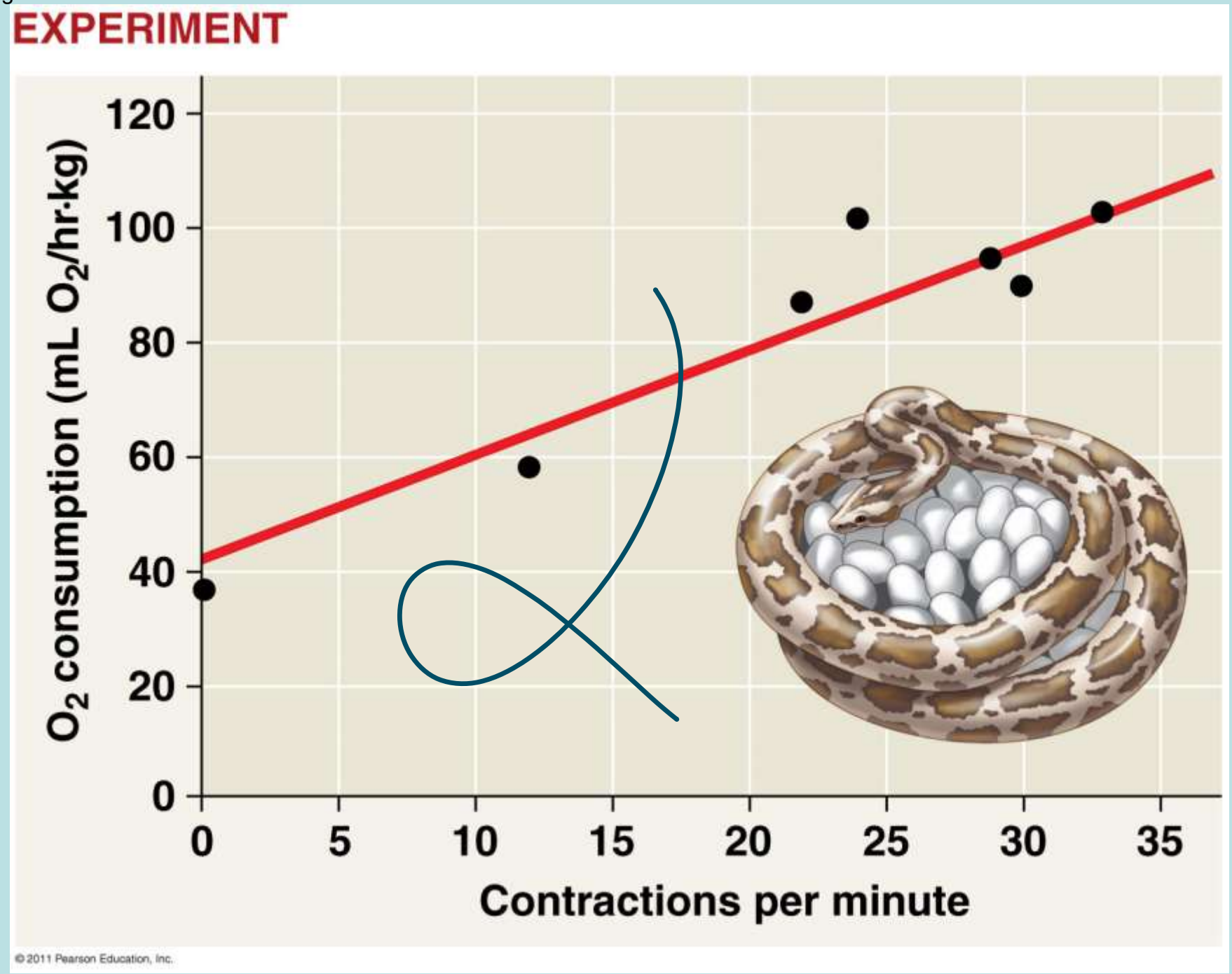

EXPERIMENT
120
100
80
60
40
20
0
O_2 consumption (mL O_2/hr·kg)
0
5
10
15
20
25
30
35
Contractions per minute
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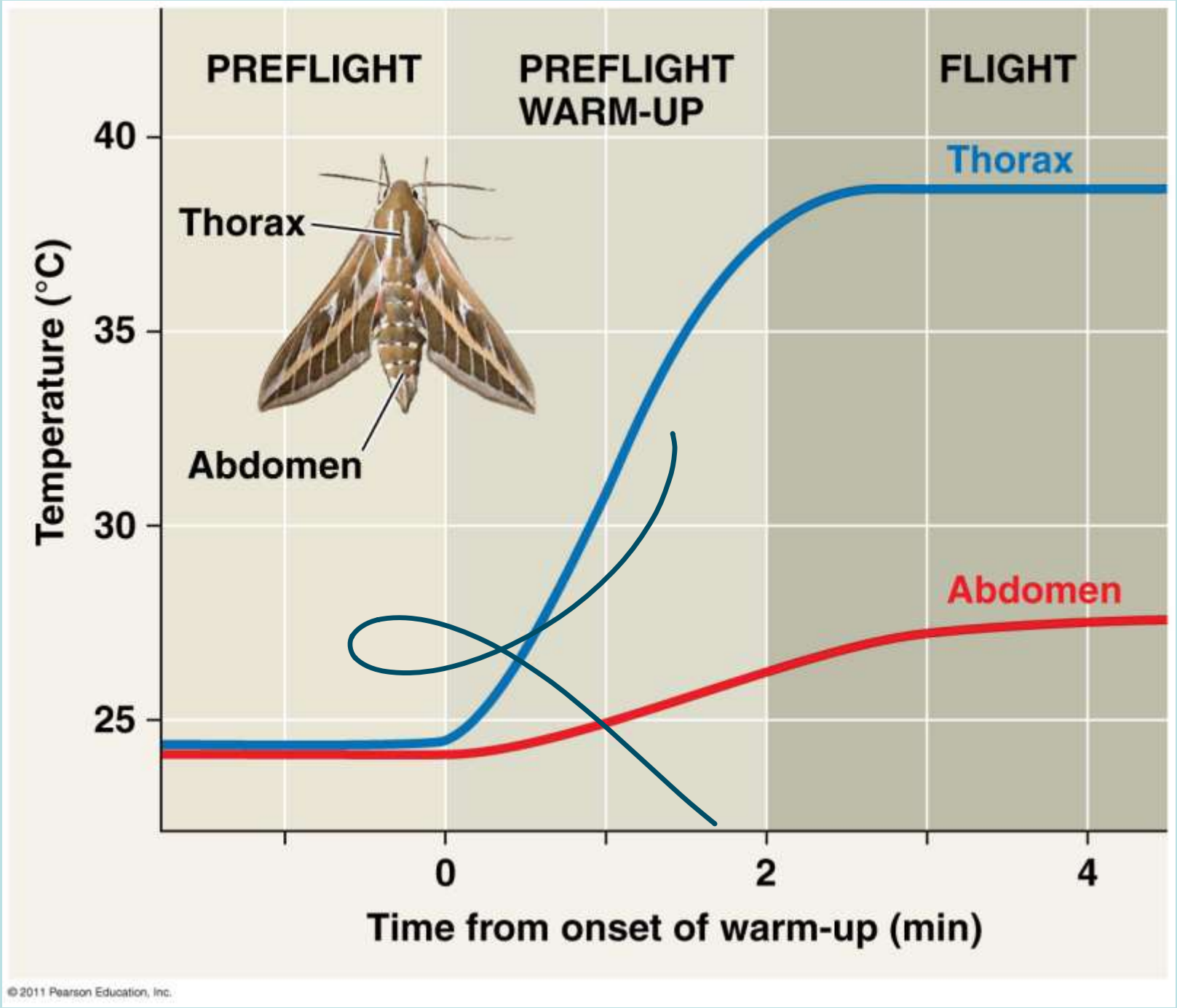
Figure 40.15



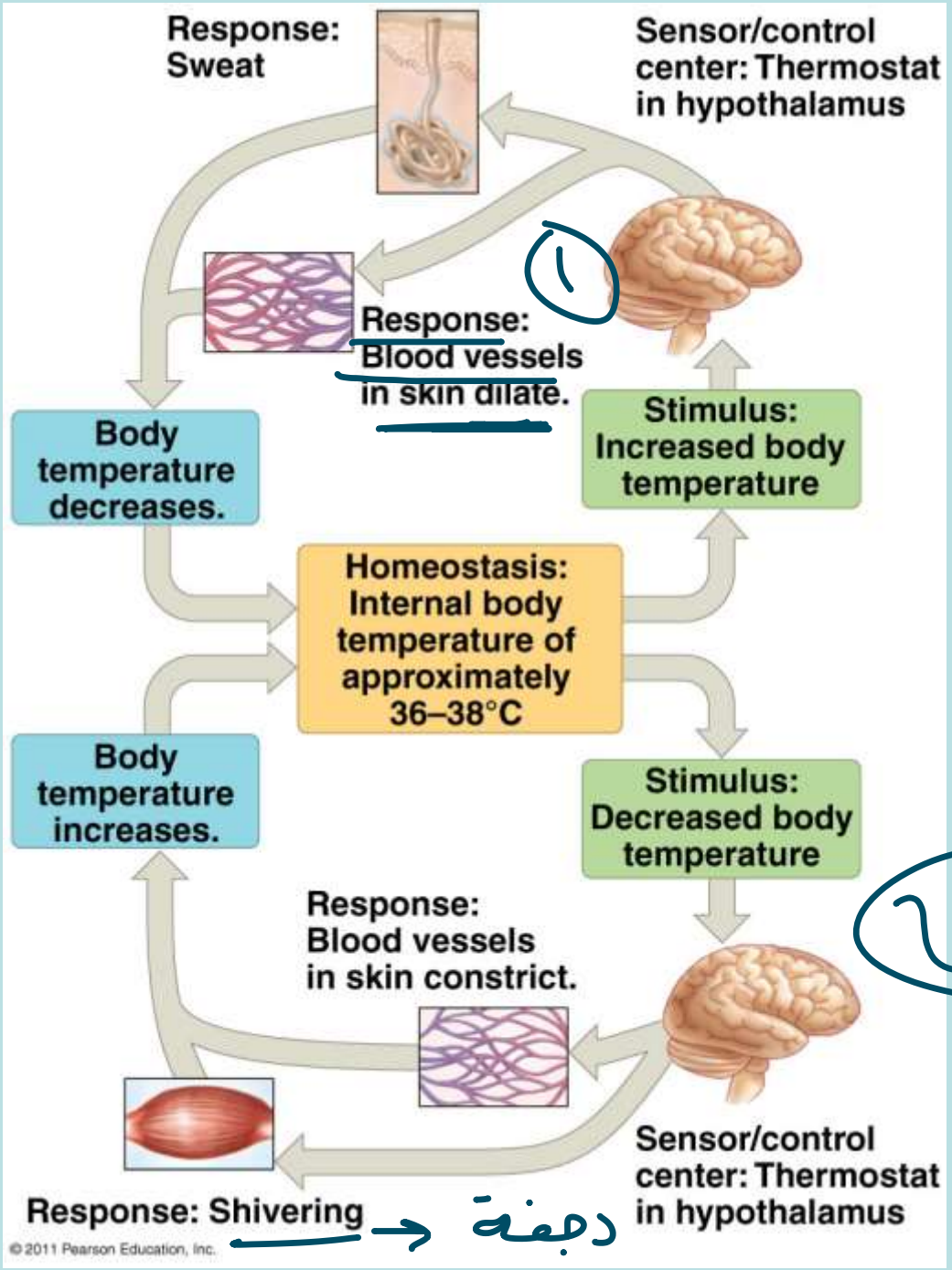
Acclimatization in Thermoregulation

- Birds and mammals can vary their insulation to acclimatize to seasonal temperature changes
- When temperatures are subzero, some ectotherms produce “antifreeze” compounds to prevent ice formation in their cells

Physiological Thermostats and Fever

- Thermoregulation is controlled by a region of the brain called the **hypothalamus** →
- The hypothalamus triggers heat loss or heat generating mechanisms
- Fever is the result of a change to the set point for a biological thermostat

Figure 40.16


Response: Sweat
Sensor/control center: Thermostat in hypothalamus
Response: Blood vessels in skin dilate.
Stimulus: Increased body temperature
Body temperature decreases.
Homeostasis: Internal body temperature of approximately 36–38°C
Body temperature increases.
Stimulus: Decreased body temperature
Response: Blood vessels in skin constrict.
Sensor/control center: Thermostat in hypothalamus
Response: Shivering
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Concept 40.4: Energy requirements are related to animal size, activity, and environment

احتياج الجسم للطاقة :-

علم الطاقة الحيوية

- **Bioenergetics** is the overall flow and transformation of energy in an animal
- It determines how much food an animal needs and it relates to an animal's size, activity, and environment

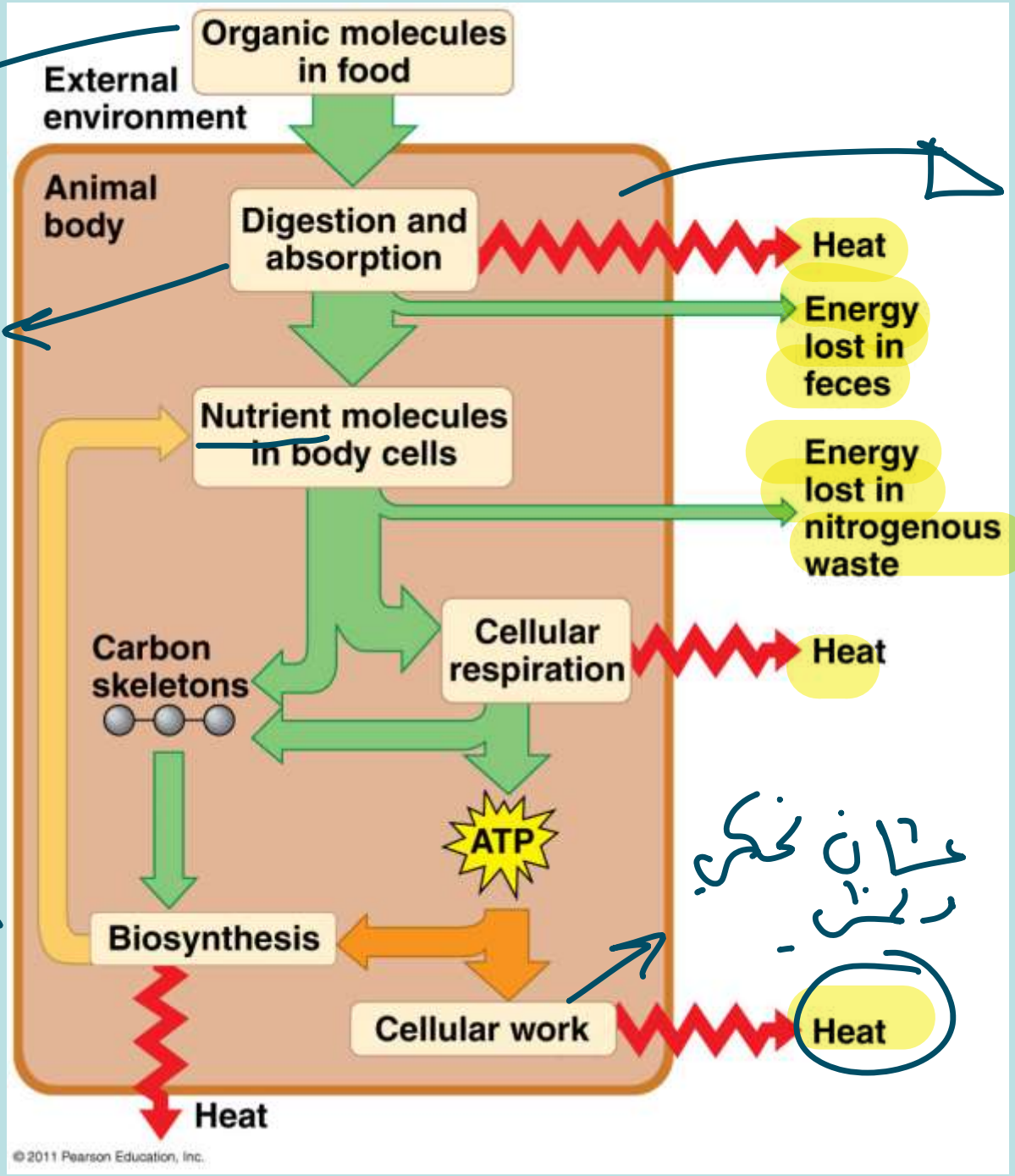
المصدر الوحيد للطاقة لنا : الأكل

Energy Allocation and Use

توزيع الطاقة

- Animals harvest chemical energy from food
- Energy-containing molecules from food are usually used to make ATP, which powers cellular work
- After the needs of staying alive are met, remaining food molecules can be used in biosynthesis
- Biosynthesis includes body growth and repair, synthesis of storage material such as fat, and production of gametes

Figure 40.17


Organic molecules in food
External environment
Animal body
Digestion and absorption
Heat
Energy lost in feces
Nutrient molecules in body cells
Energy lost in nitrogenous waste
Carbon skeletons
Cellular respiration
Heat
ATP
Biosynthesis
Cellular work
Heat
Heat
© 2011 Pearson Education, Inc.

Quantifying Energy Use

قياس كمية الطاقة

معدل الأيض

- **Metabolic rate** is the amount of energy an animal uses in a unit of time

كمية الطاقة في وحدة الزمن

- Metabolic rate can be determined by
  - An animal's heat loss
  - The amount of oxygen consumed or carbon dioxide produced

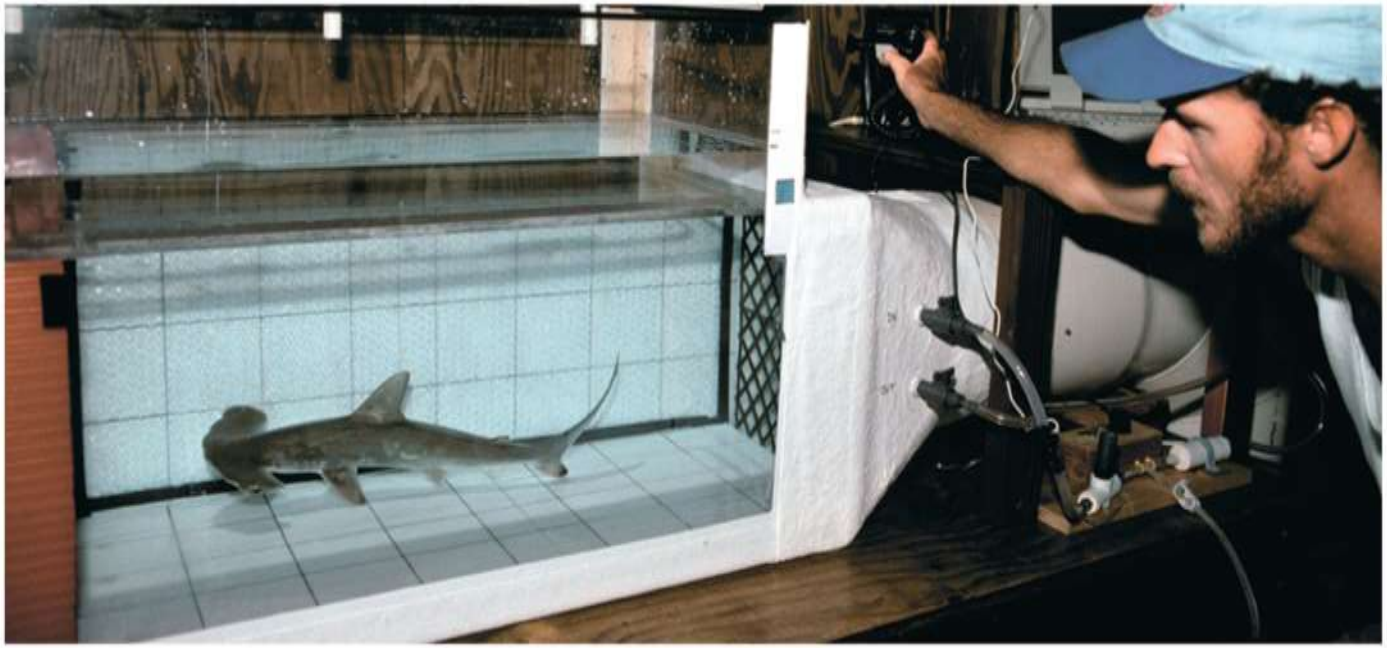
يمكن قياسه:-

١- كمية الأكسجين اللي استهلكها

٢- كمية CO_2 اللي طلعت

٣- كمية energy اللي ٤٠١

Figure 40.18



Minimum Metabolic Rate and Thermoregulation

- **Basal metabolic rate (BMR)** is the metabolic rate of an endotherm at rest at a "comfortable" temperature
- **Standard metabolic rate (SMR)** is the metabolic rate of an ectotherm at rest at a specific temperature
- Both rates assume a nongrowing, fasting, and nonstressed animal
- Ectotherms have much lower metabolic rates than endotherms of a comparable size

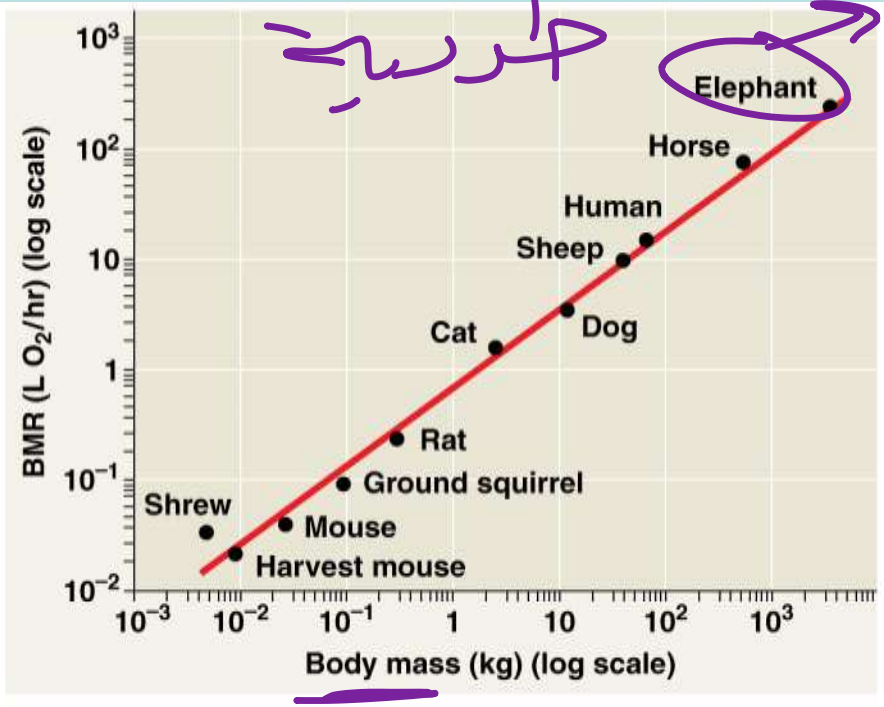
Influences on Metabolic Rate

- Metabolic rates are affected by many factors besides whether an animal is an endotherm or ectotherm
- Two of these factors are size and activity

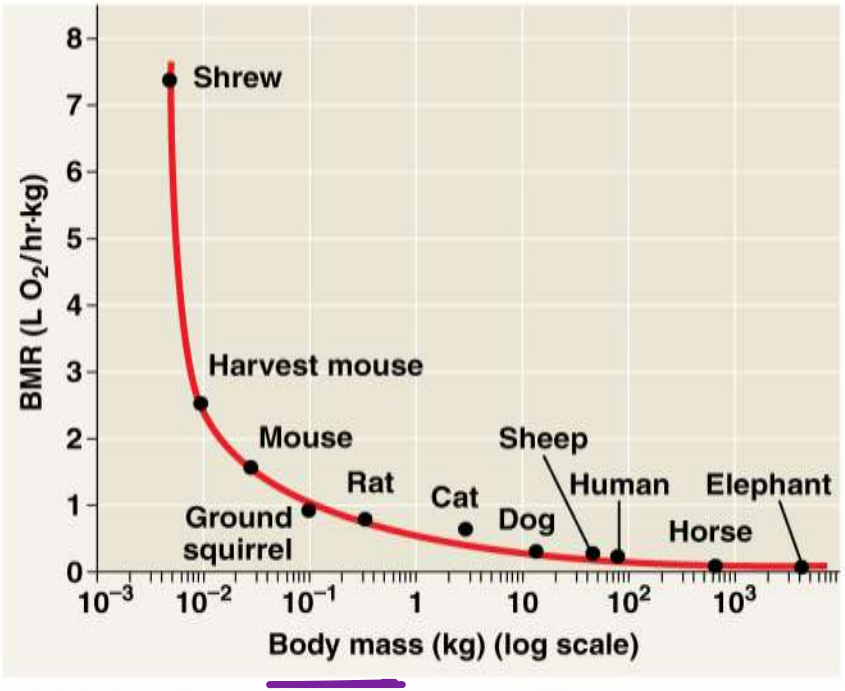
Size and Metabolic Rate

- Metabolic rate is proportional to body mass to the power of three quarters ($m^{3/4}$)
- Smaller animals have higher metabolic rates per gram than larger animals
- The higher metabolic rate of smaller animals leads to a higher oxygen delivery rate, breathing rate, heart rate, and greater (relative) blood volume, compared with a larger animal

Figure 40.19



(a) Relationship of basal metabolic rate (BMR) to body size for various mammals



(b) Relationship of BMR per kilogram of body mass to body size

Activity and Metabolic Rate

- Activity greatly affects metabolic rate for endotherms and ectotherms
- In general, the maximum metabolic rate an animal can sustain is inversely related to the duration of the activity

* هناك واحد بعيرتكض سباق بالبداية يكون النشاط أقل لما يزيد بالتدريج يرتفع النشاط و بالتالي يرتفع metabolic

Energy Budgets

- Different species use energy and materials in food in different ways, depending on their environment
- Use of energy is partitioned to BMR (or SMR), activity, thermoregulation, growth, and reproduction

Figure 40.20

ENERGY BUDGETS:

Size, energy strategy, and environment have a great influence on how the total annual energy expenditure is distributed among energetic needs.

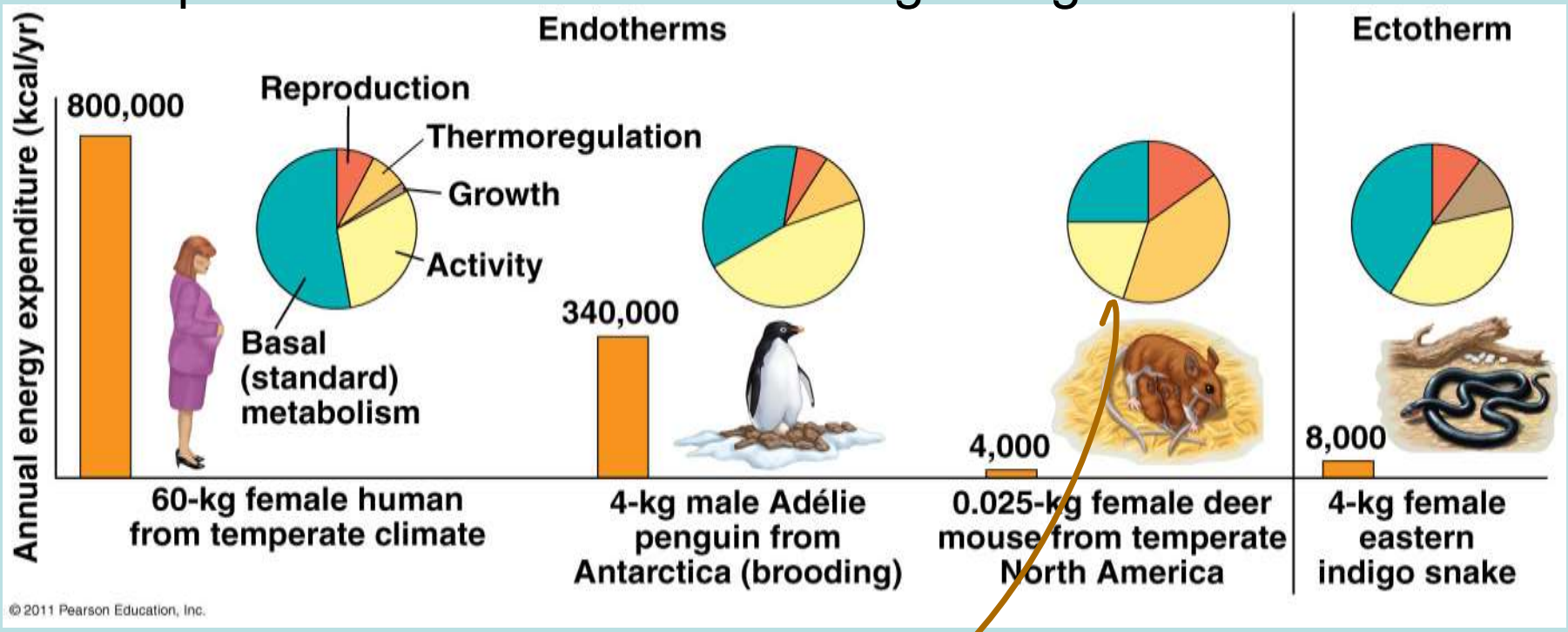


Figure 40.20a

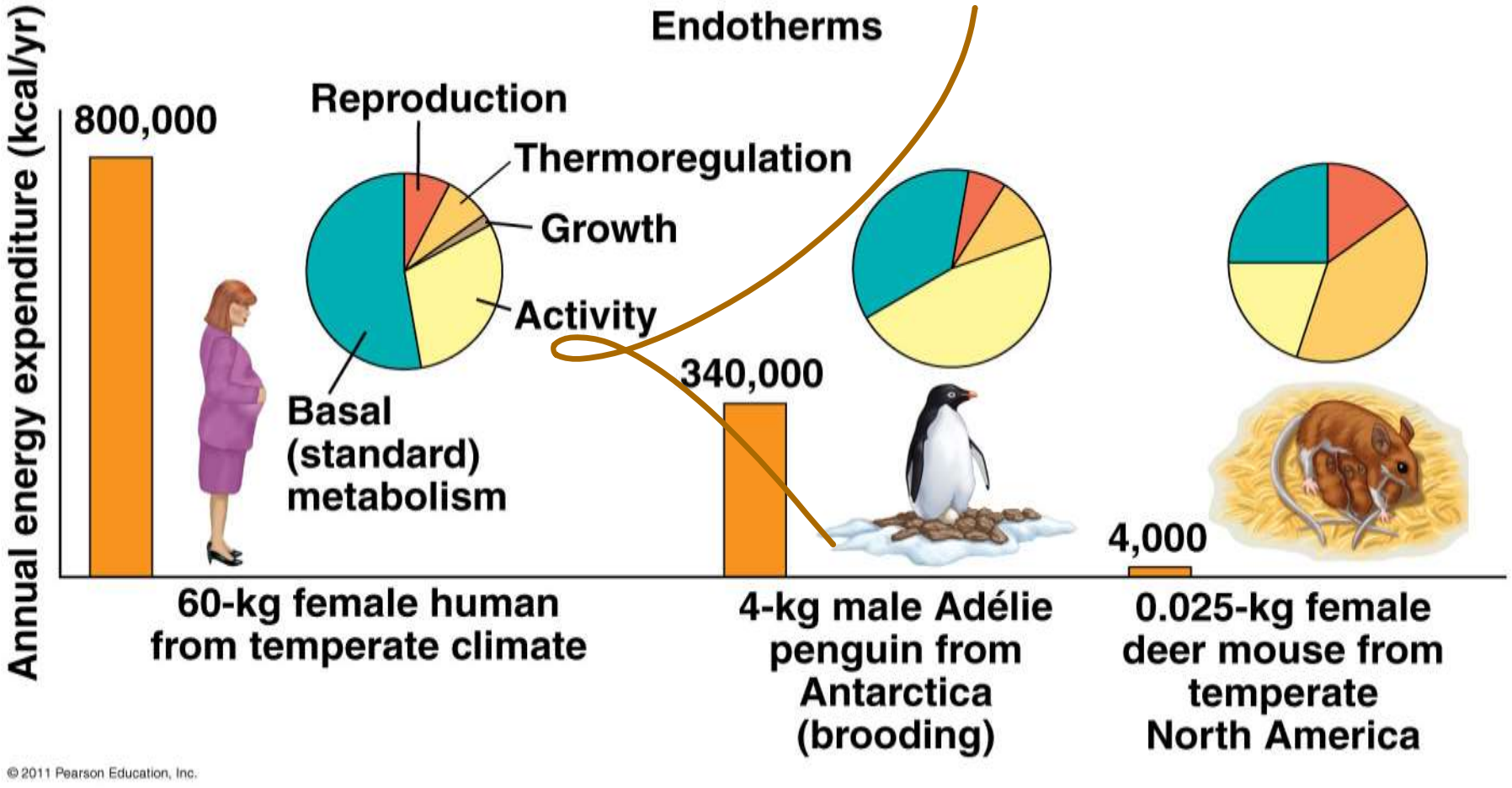
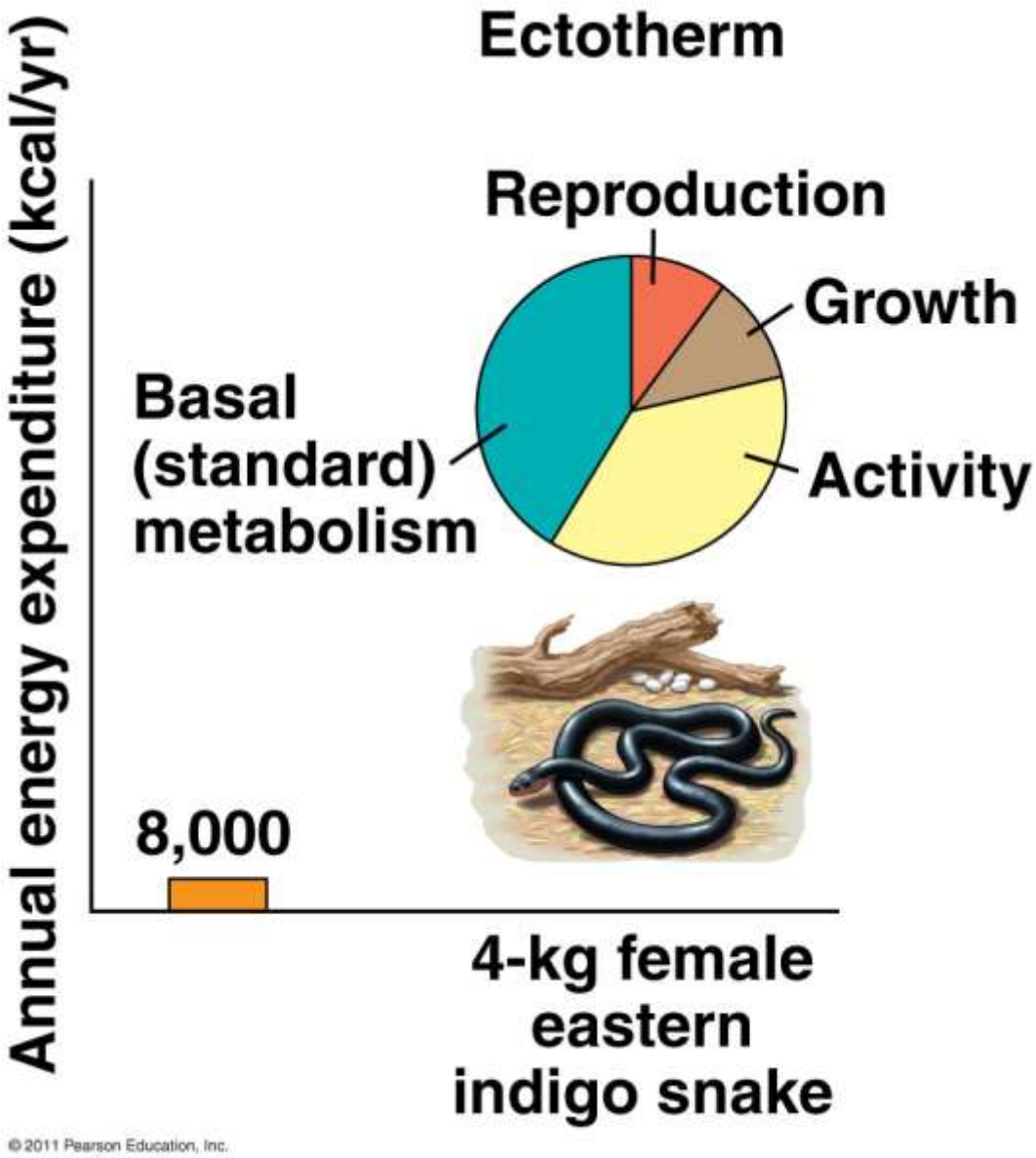


Figure 40.20b



Torpor and Energy Conservation

- **Torpor** is a physiological state in which activity is low and metabolism decreases
- Torpor enables animals to save energy while avoiding difficult and dangerous conditions

.Hibernation is long-term torpor that is an adaptation to winter cold and food scarcity

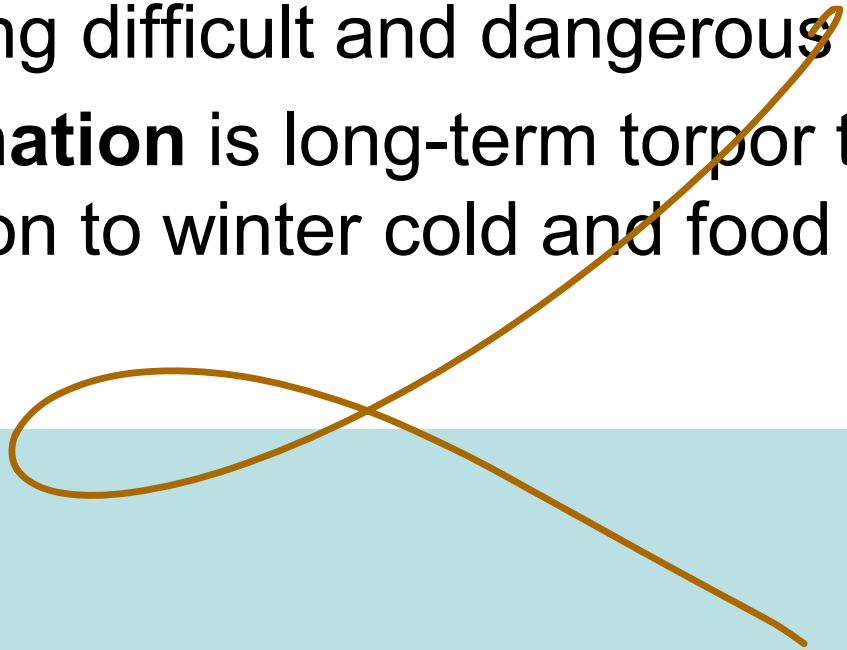
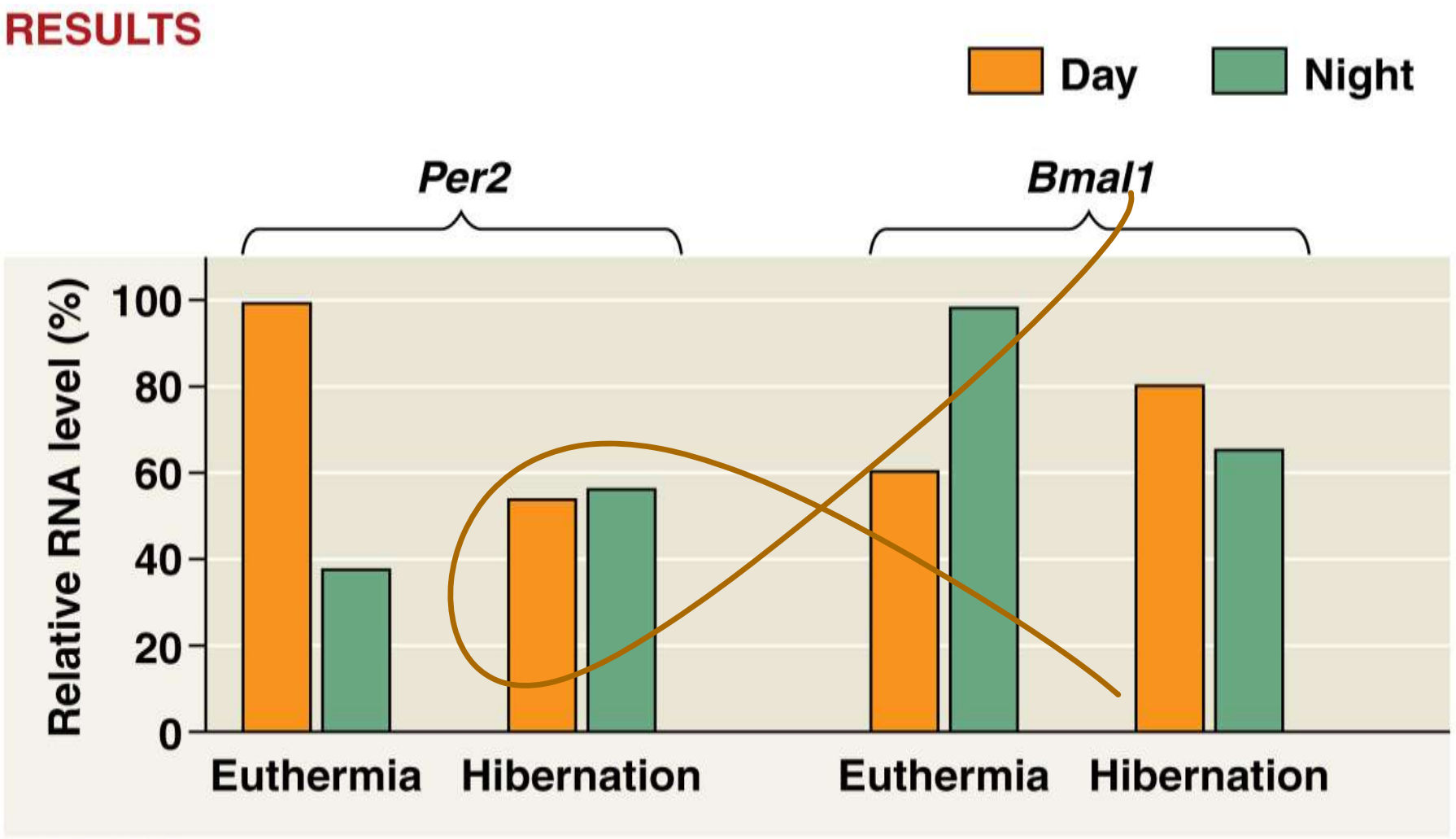


Figure 40.21



- Summer torpor, called estivation, enables animals to survive long periods of high temperatures and scarce water
- Daily torpor is exhibited by many small mammals and birds and seems adapted to feeding patterns

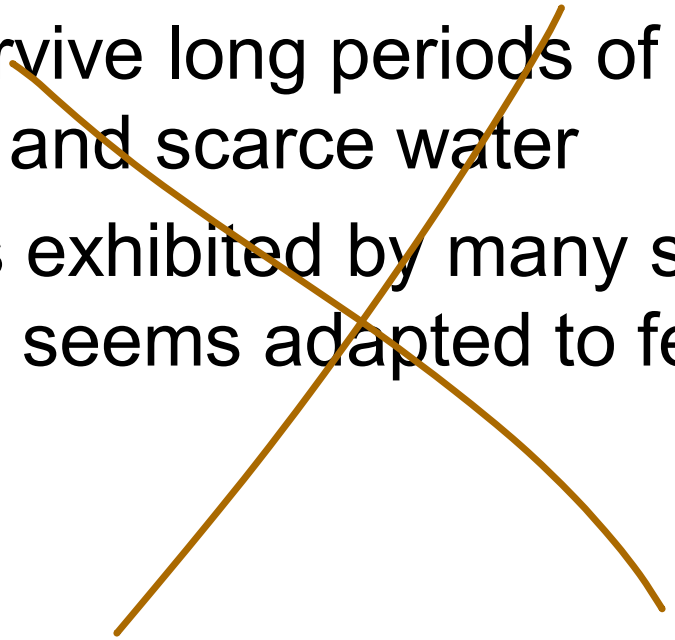


Figure 40.UN01

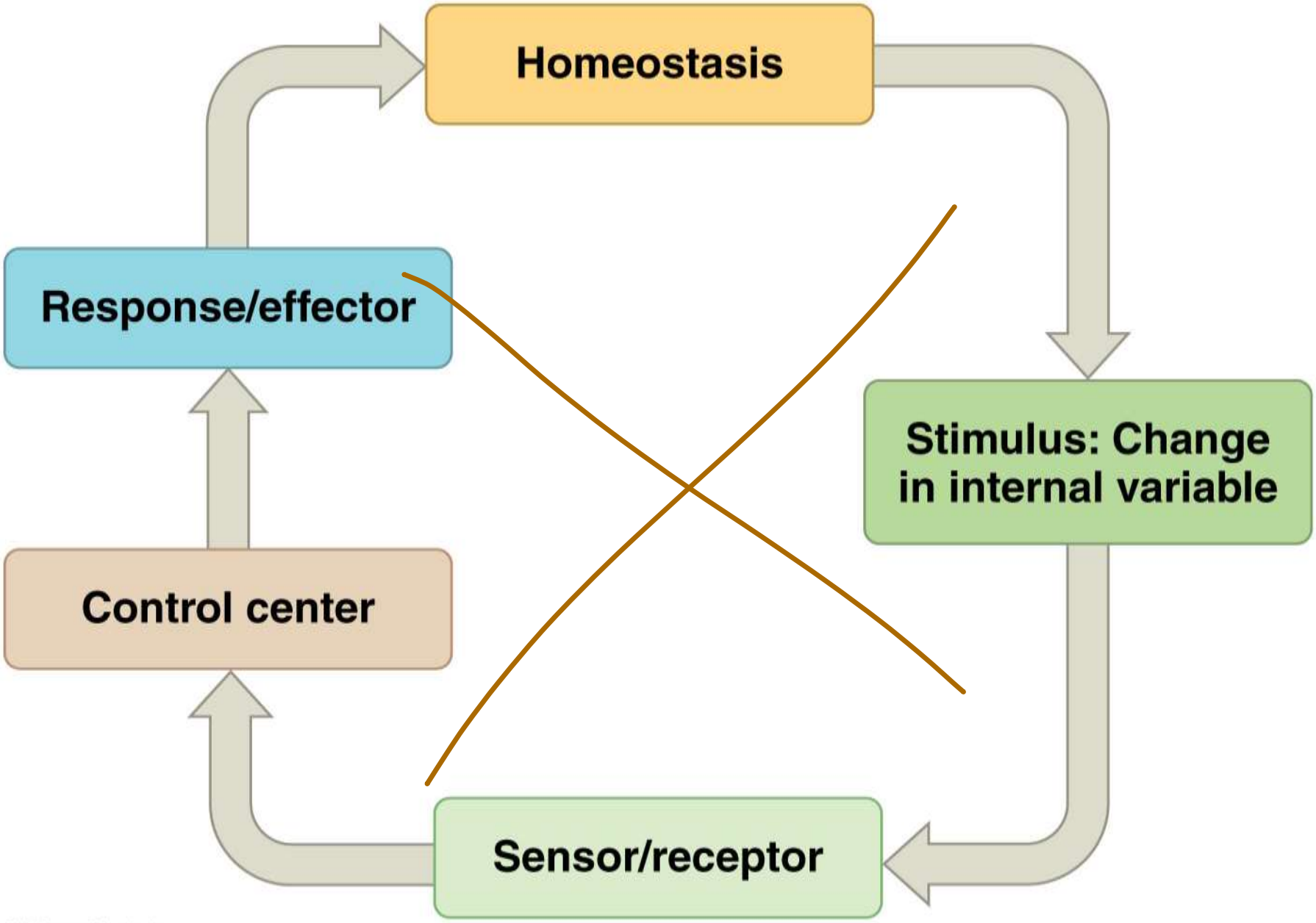


Figure 40.UN02