



تَوِير

# BIOLOGY

Lec no :

File Title : Full Chapter 40

Done By : Leen Al-Ashram

وَقُلْ رَبِّ انزِلْنِي علماً



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَاللَّهُ يَدْعُنَا إِلَى صِرَاطٍ مُسْتَقِيمٍ

سُبْحَانَ اللَّهِ الْعَظِيمِ

Biology : chapter 40, part 1

done by: Ileen Al-Ashraam

shaykhah 2023

# LECTURE PRESENTATIONS

For CAMPBELL BIOLOGY, NINTH EDITION

Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson

## Chapter 40

# Basic Principles of Animal Form and Function



Lectures by  
Erin Barley  
Kathleen Fitzpatrick

# Overview: Diverse Forms, Common Challenges

- **Anatomy** is the study of the biological form of an organism. *مرتبطين ببعض* *علم التشريح* [science of dissection]
- **Physiology** is the study of the biological functions an organism performs. *علم وظائف الأعضاء*
- The comparative study of animals reveals that form and function are closely correlated.



Figure 40.1



# Concept 40.1: Animal form and function are correlated at all levels of organization

always the form & function is related

- Size and shape affect the way an animal interacts with its environment
- Many different animal body plans have evolved and are determined by the genome

# Evolution of Animal Size and Shape

- Physical laws constrain strength, diffusion, movement, and heat exchange
- As animals increase in size, their skeletons must be proportionately larger to support their mass
- Evolutionary convergence reflects different species' adaptations to a similar environmental challenge

Figure 40.2

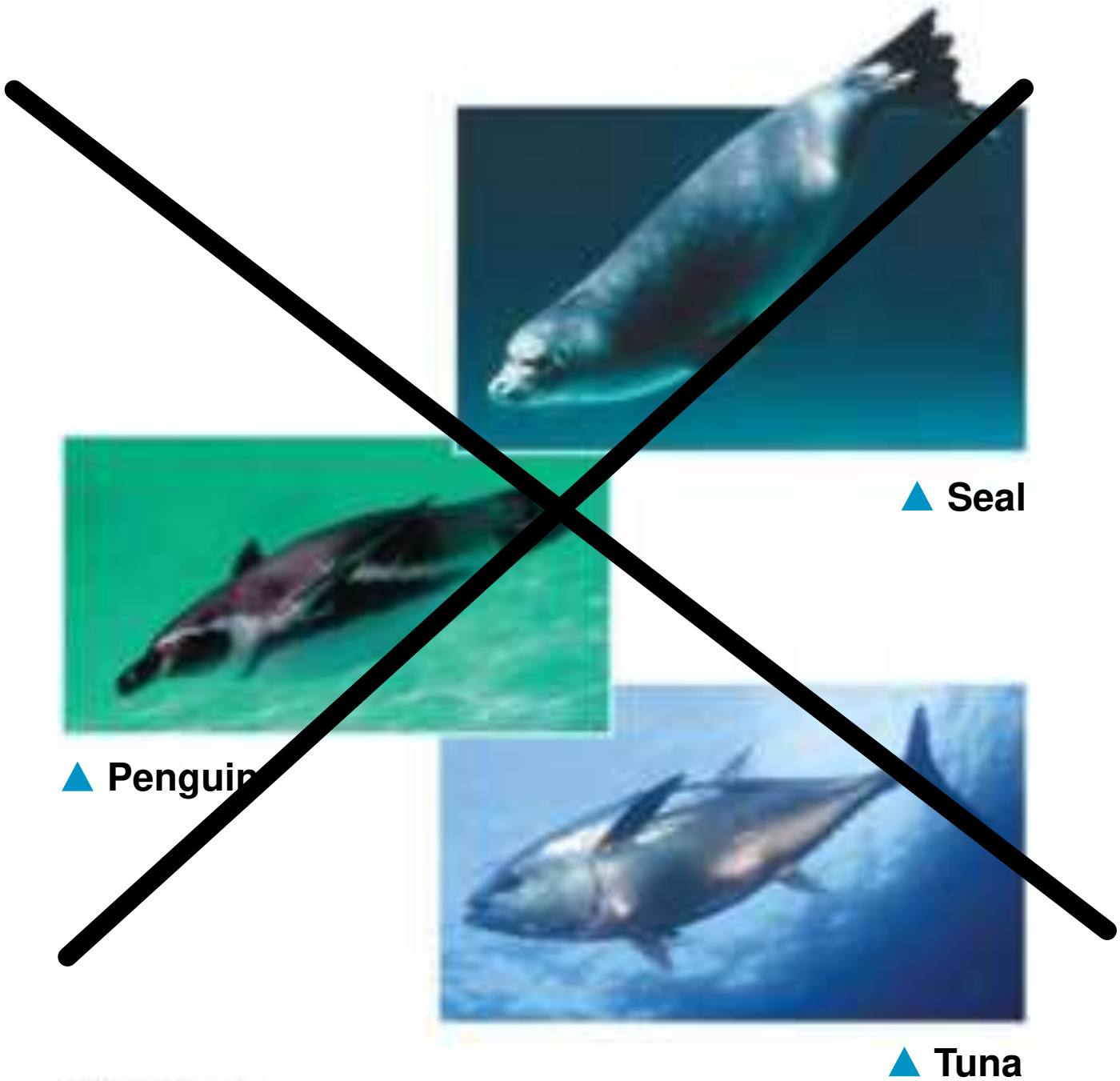


Figure 40.2a

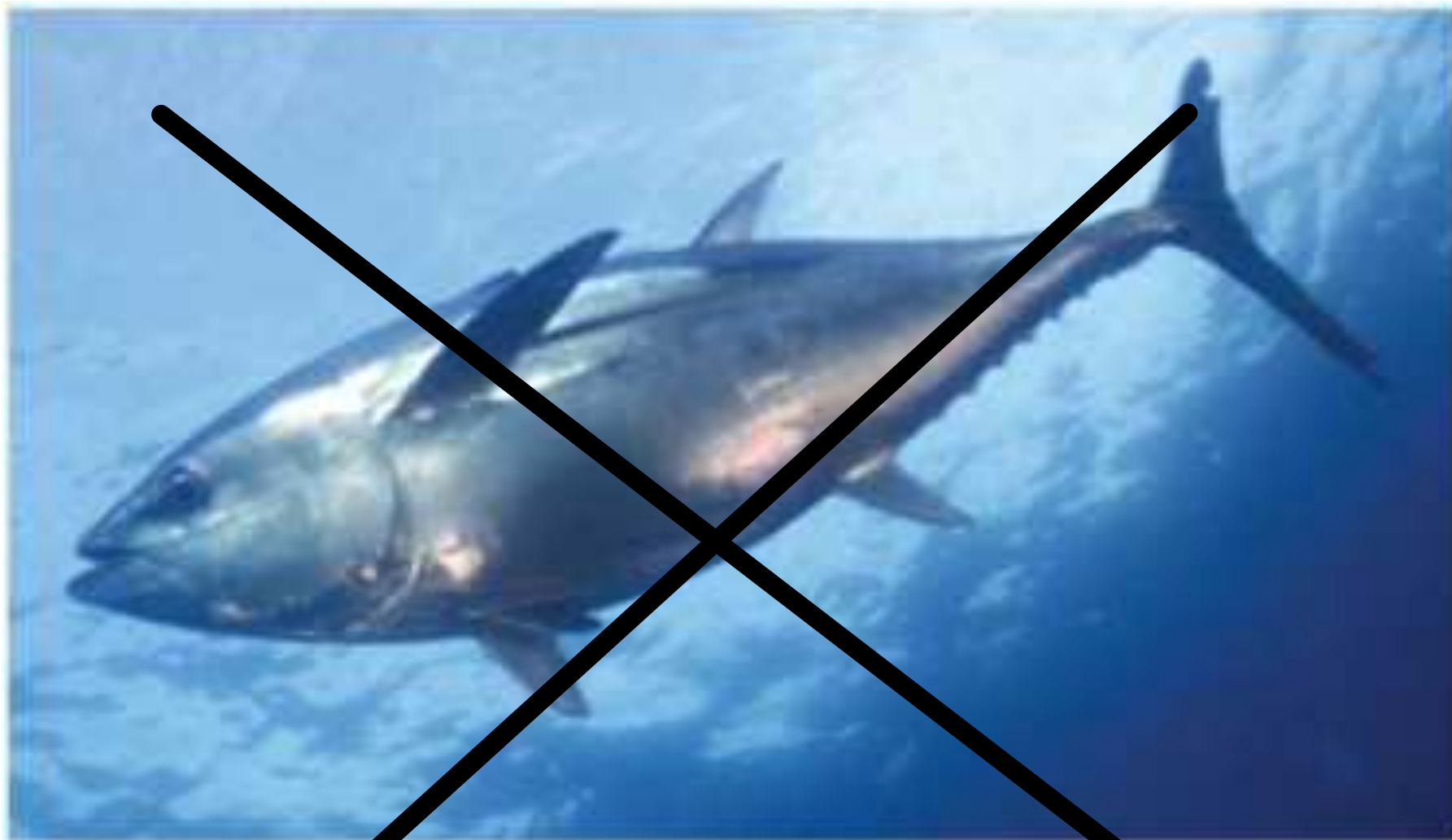


▲ Seal



▲ Penguin

Figure 40.2c



▲ Tuna



If it could make good

# Exchange with the Environment, then it is the perfect situation.

- Materials such as nutrients, waste products, and gases must be exchanged across the cell membranes of animal cells
- Rate of exchange is proportional to a cell's surface area while amount of exchange material is proportional to a cell's volume

- A single-celled protist living in water has a sufficient surface area of plasma membrane to service its entire volume of cytoplasm
- Multicellular organisms with a saclike body plan have body walls that are only two cells thick, facilitating diffusion of materials

increase  
rate  
of  
exchange  
with  
its  
enviro-  
ment

in hydra, for  
example "ANIMALS"

"simple diffusion"



Figure 40.3

\* protists  
\* Not animals

Exchange



lives in water: it has the chance to exchange successfully with the environment

0.1 mm

By its cell membrane

\* protists \* / not animals

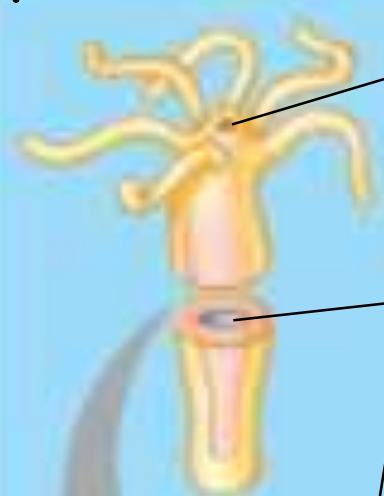
uni-cellular

(a) Single cell [amoeba]

paramecium + euglena

ما ينطبق عليه ينسب له

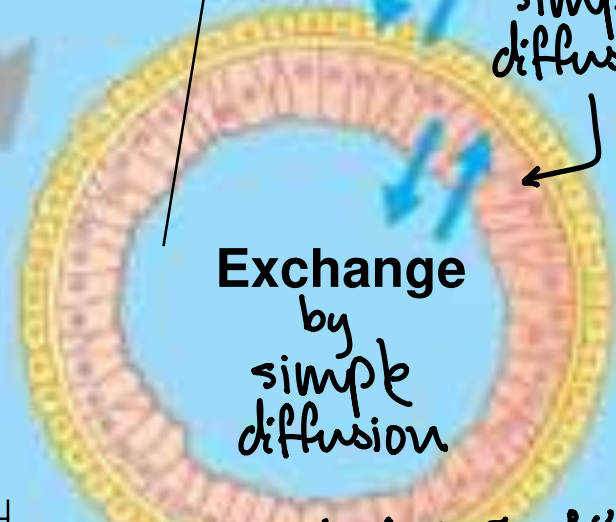
الهيدرا تتغذى على الحيوانات الأصغر منها / تدخله عنده طريقة



Mouth

Gastrovascular cavity  
التجويف الجوي

Exchange by simple diffusion



Exchange by simple diffusion

1 mm

تنتمي إلى مجموعة من حيوانات الجوف  
called: Coelenterata / hydra or Cnidaria

(b) Two layers of cells

ei: hydra, lives in freshwater

- In flat animals such as tapeworms, the distance between cells and the environment is minimized
- More complex organisms have highly folded internal surfaces for exchanging materials

Figure 40.4

الجسم بأكمله طبقي  
من الخلايا : عم يتكون  
system... organs  
[multicellular]

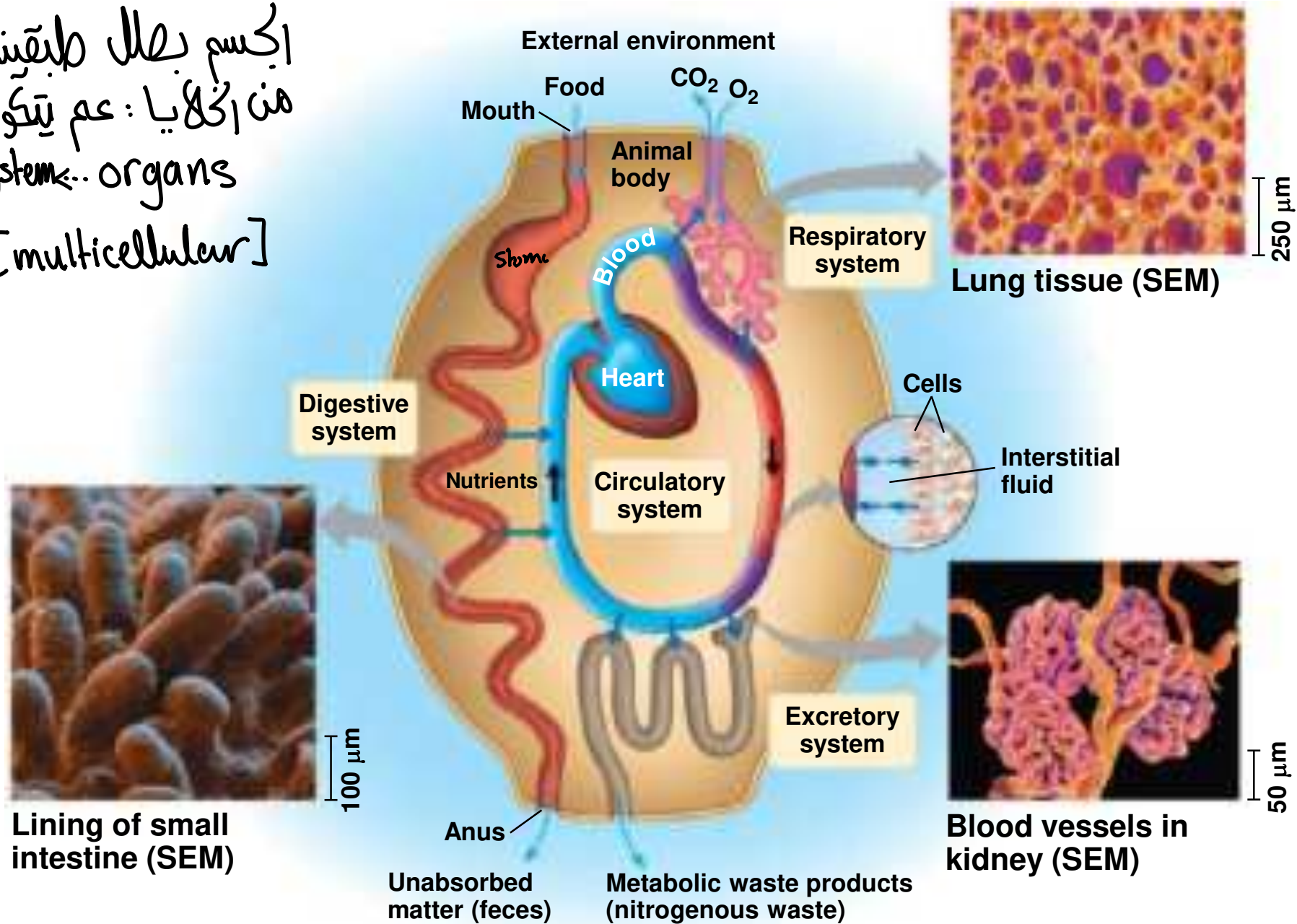
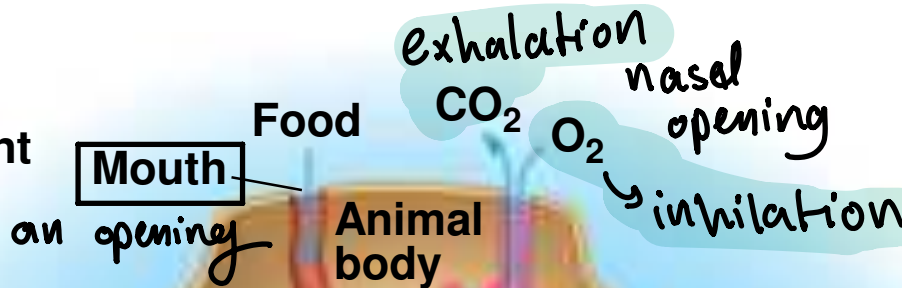


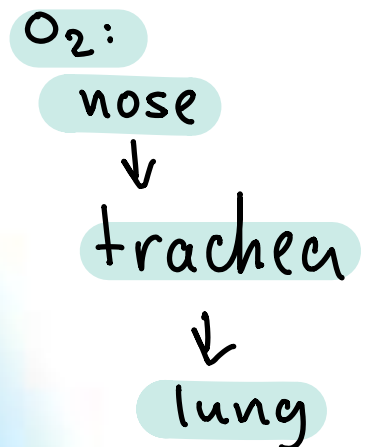


Figure 40.4a

External environment



مشكل جزو الجسم  
يستطيع تبادل المواد  
مباشرة  
ولذلك في فتحات  
في الجسم



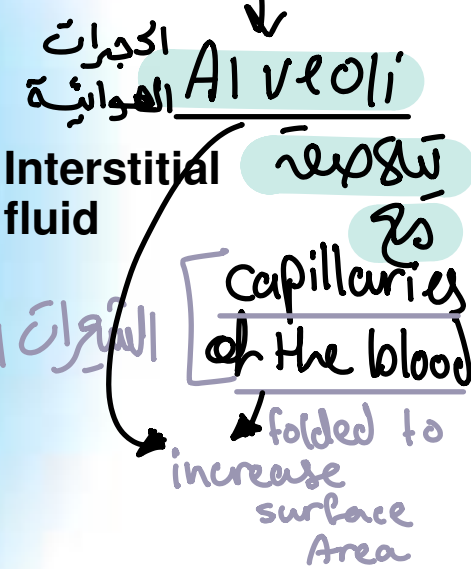
Digestive system

الكبد من الطعام ينقل إلى الدم  
circulatory system

Nutrients  
Circulatory system  
heart + blood

absorption occurs in intestine  
also has villus  
highly folded  
increases surface area volume

الدم يغطي O<sub>2</sub> والفضلات  
ويأخذ CO<sub>2</sub>



an opening  
Anus

undigested / Unabsorbed matter (feces)

urinary opening  
Metabolic waste products (nitrogenous waste)

الجهاز البولي  
Excretory system

الدم يغطي الجهاز التنفسي CO<sub>2</sub> ويأخذ O<sub>2</sub>: الدم يغطي ويأخذ O<sub>2</sub> ويأخذ من CO<sub>2</sub>



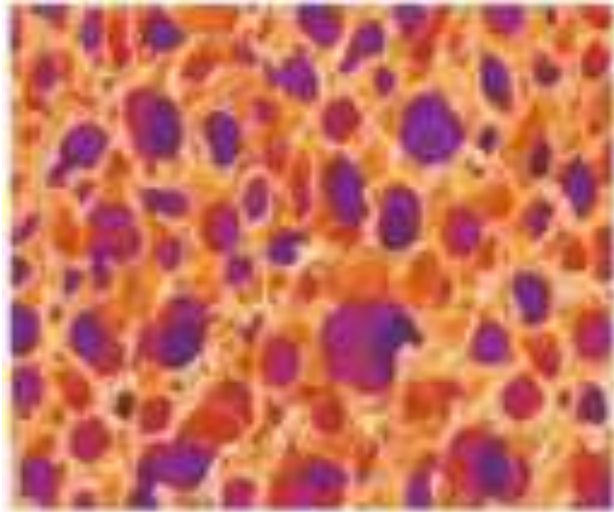
villus : to  
increase  
absorption

100  $\mu\text{m}$

**Lining of small  
intestine (SEM)**

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250  $\mu\text{m}$

**Lung tissue (SEM)**

© 2011 Pearson Education, Inc.



50  $\mu\text{m}$

**Blood vessels in  
kidney (SEM)**

© 2011 Pearson Education, Inc.

- In **vertebrates**, the space between cells is filled with **interstitial fluid**, which allows for the **movement of material into and out of cells**
- A complex body plan helps an animal living in a variable environment to maintain a relatively **stable internal environment**

نصلح الي ما بدنا اياه  
ونخلي الي بدنا ايه

الهدف منه  
عمليات ال exchange

ترتيب هرمي / تدرج

# Hierarchical Organization of Body Plans

- Most animals are composed of specialized cells organized into **tissues** that have different functions
- Tissues make up **organs**, which together make up **organ systems**
- Some organs, such as the **pancreas**, belong to more than one organ system

produces enzymes critical to the function of the digestive system but also regulates the level of sugar in the blood as a vital part of the endocrine system

يفرز  
إنزيمات هاضمة  
مثل الأميليز

②

يفرز هرمونات  
مثل

جهاز الغدد الصماء  
Glucagon  
- Insulin

• Our bodies and those of most other animals are composed of compact masses of cells, with an internal organization much more complex than that of a hydra or a tapeworm. For such a body plan, increasing the number of cells reveals the multilayered basis of specialization. Organ systems include specialized organs made up of specialized tissues and cells

[ أهم أجهزة الجسم  
 وأهم أعضاؤه  
 وأهم وظائفه ]

الجدول ٤٠

Table 40.1 Organ Systems in Mammals		
Organ System	Main Components	Main Functions
Digestive (chapter 42)	Mouth, pharynx, esophagus, stomach, intestines, liver, pancreas, anus	Food processing (1. تناول 2. 3. 4.)
Circulatory	Heart, blood vessels, blood	Internal distribution of materials
Respiratory	Lungs, trachea, other breathing tubes	Gas exchange (uptake of oxygen; disposal of carbon dioxide)
Immune and lymphatic	Bone marrow, lymph nodes, thymus, spleen, lymph vessels, white blood cells	Body defense (fighting infections and cancer) + حماية الجسم من الأمراض + الدفاع
Excretory جهاز الإفراج	Kidneys, ureters, urinary bladder, urethra	Disposal of metabolic wastes; regulation of osmotic balance of blood التخلص من الفضلات الذرورية - تنظيم
Endocrine	Hypothalamus, thyroid, parathyroid, adrenal, and other hormone-secreting glands	Coordination of body activities (such as digestion and metabolism) - تنظيم عمليات الجسم
Reproductive	Ovaries or testes and associated organs	Reproduction
Nervous	Brain, spinal cord, nerves, sensory organs	Coordination of body activities; detection of stimuli and formulation of responses to them
Integumentary	Skin and its derivatives (such as hair, claws, skin glands)	Protection against mechanical injury, infection, dehydration, thermoregulation
Skeletal الهيكلية	Skeleton (bones, tendons, ligaments, cartilage)	Body support, protection of internal organs, movement
Muscular	Skeletal muscles	Locomotion and other movement الحركة

← تغلف الجسم

1. 2. 3. 4.

# Exploring Structure and Function in Animal Tissues

- Different tissues have different structures that are suited to their functions
- <sup>ANIMAL</sup> Tissues are classified into four main categories:  
① epithelial, ② connective, ③ muscle, and ④ nervous  
<sub>٤٨٦</sub> <sub>٤٨٦</sub> <sub>٤٨٦</sub> <sub>٤٨٦</sub>

Two methods to  
classify epithelial  
Tissue

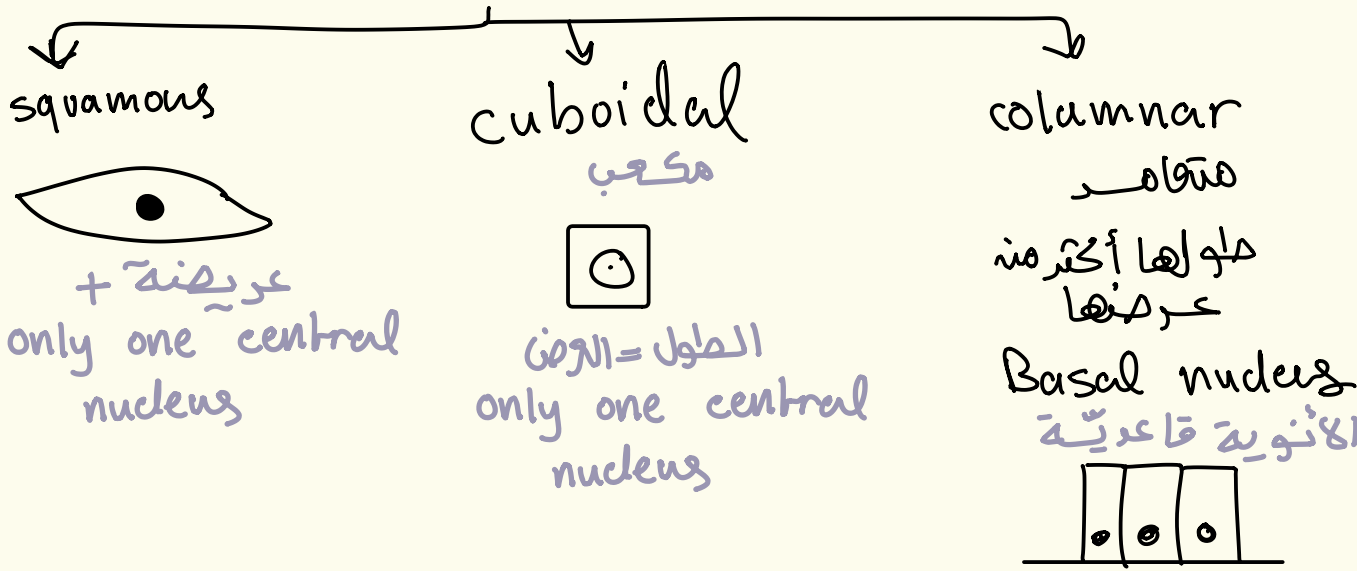
## Epithelial Tissue <sup>→</sup>

- **Epithelial tissue** <sup>①</sup> covers the outside of the body and <sup>②</sup> <sup>يبطن</sup> lines the organs and <sup>تجويف</sup> cavities within the body
- It contains cells that are closely joined <sup>not scattered, متراصة بيوض</sup>
- The shape of epithelial cells may be cuboidal (like dice), columnar (like bricks on end), or squamous (like floor tiles)

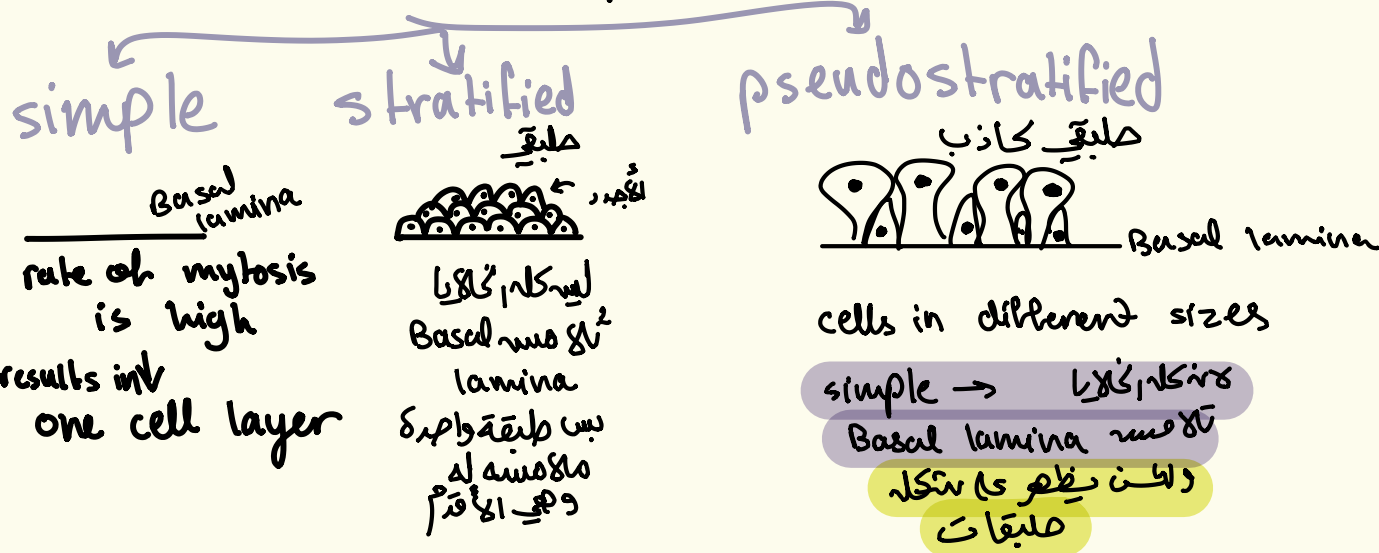


- The arrangement of epithelial cells may be simple (single cell layer), stratified (multiple tiers of cells), or pseudostratified (a single layer of cells of varying length)

# shape of cells



# complexity حسب عدد الطبقات



لما ينبي زائف

Epithelial tissue

نسيج التقرينية صفاً

e.i:

stratified cuboidal

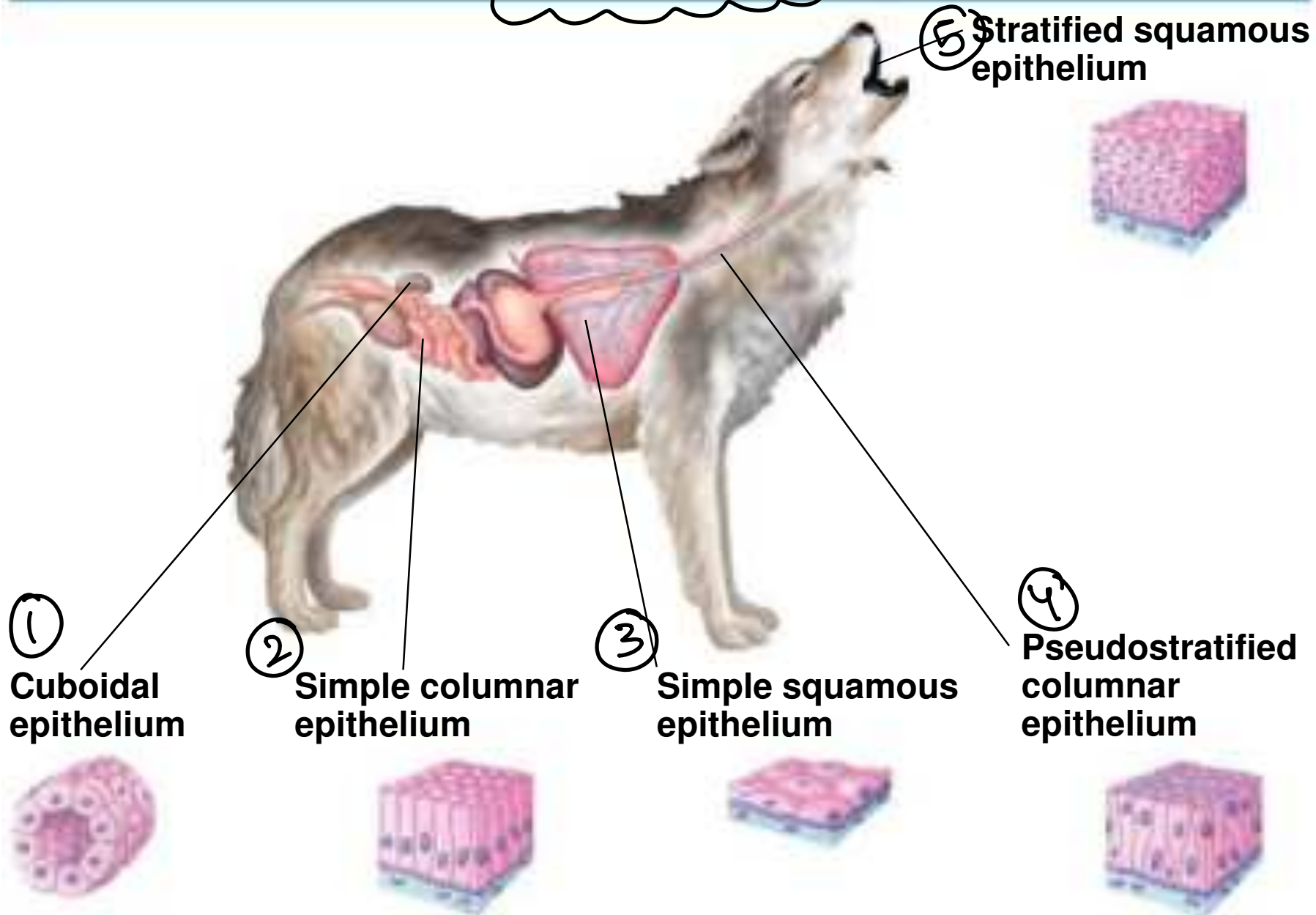
simple columnar

وهذا ببساطة

complexity

ببساطة

# Epithelial Tissue





simple  
Cuboidal epithelium

شوبل = العرض  
= central  
nucleus



A cuboidal epithelium, with dice-shaped cells specialized for secretion, makes up the epithelium of kidney tubules and many glands (including the thyroid gland) and salivary glands.

and absorption

functional units is niron

Simple columnar epithelium



Basal lamina

The large, brick-shaped cells of simple columnar epithelia are often found where secretion or active absorption is important. For example, a simple columnar epithelium lines the intestines, secreting digestive juices and absorbing nutrients.



**Simple squamous epithelium**



The single layer of platelike cells that form a simple squamous epithelium functions in the exchange of material by diffusion. This type of epithelium which is thin and leaky, lines blood vessels and the air sacs (alveoli) of the lungs, where diffusion of nutrients and gases is critical.

→ exchange of nutrients and gases between blood and air sacs  
 انتقال المواد عبر غشاء رقيق  
 تكون الخلايا المسطحة لسهولة انتقال  
 epithelium → انتقال المواد

**Pseudostratified columnar epithelium**

& its usually ciliated



A pseudostratified epithelium consists of a single layer of cells varying in height and the position of their nuclei. In many vertebrates, a pseudostratified epithelium of ciliated cells forms a mucous membrane that lines portions of the respiratory tract.

cells in different size

The beating cilia sweep the film of mucus along the surface.

→ [trachea as a part of it]

→ للتخلص من أي أوساخ "found in air passages" that is covered by mucus

\* عنما نأخذ شهيقاً، الأوكسجين الذي دخل إلى  
 lungs سوف ينتقل إلى الدم عن طريق capillaries  
 جداره يتكون من simple squamous epithelium tissue

[exchange btw alveoli & capillaries]

Both of them consist of simple squamous epithelium tissue





## Stratified squamous epithelium

Apical surface

Basal surface



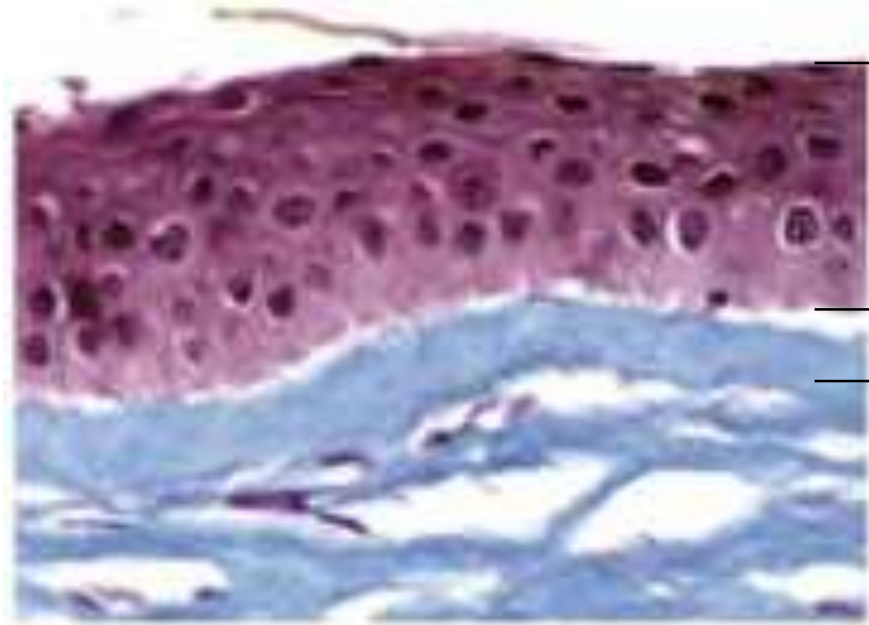
في سطحها،  
الأسفل والعلوي

A stratified squamous epithelium is **multilayered** and **regenerates rapidly**. New cells formed by division near the basal surface (see micrograph below) push outward, replacing cells that are sloughed off. This epithelium is commonly found on surfaces subject to abrasion, such as the outer skin and the linings of the mouth, anus, and vagina.

وهي الطبقة هي  
الأكثر عرضة للتلف

found in  
the openings  
of the body

# Stratified squamous epithelium



Apical surface new cells  
نوي خليا في السطح

Basal surface

Basal lamina

40  $\mu\text{m}$

Polarity of epithelia

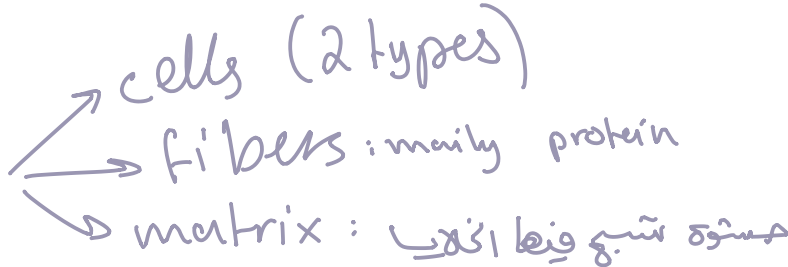
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النسيج الضام

يتكون من

# Connective Tissue

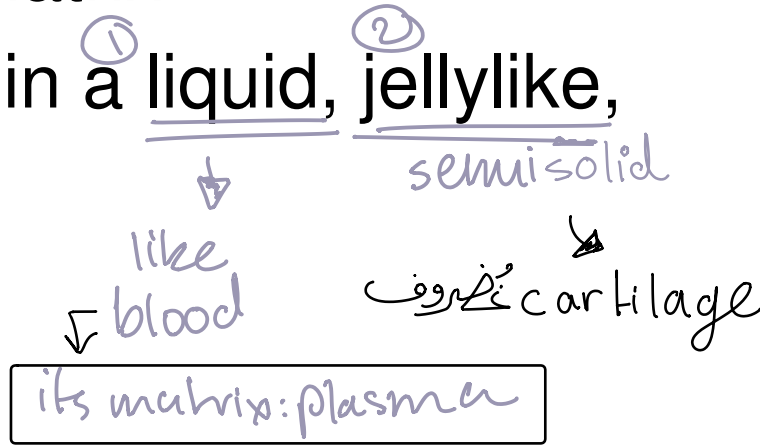


- **Connective tissue** mainly binds and supports other tissues  
 ↳ connects

- It contains sparsely packed cells scattered throughout an extracellular matrix

- The matrix consists of fibers in a liquid, jellylike,

- or solid foundation  
 eri: bonds



- There are three types of connective tissue fiber, all made of protein: <sup>→ its main component</sup>
  - Collagenous fibers provide strength and flexibility
  - مطالمة (مرونة أكثر) – Elastic fibers stretch and snap back to their original length
  - شكوي – Reticular fibers join connective tissue to adjacent tissues

- Connective tissue contains cells, including
  - **Fibroblasts** that secrete the protein of extracellular fibers
  - **Macrophages** that are involved in the immune system

نوع من  
white blood  
cell

الخلايا الملتصقة  
كبيبة في الدم +  
have high rate  
of phagocytosis

connective tissue أفتام  
6 main parts

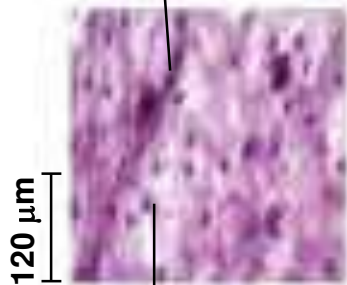
- In vertebrates, the fibers and foundation combine to form six major types of connective tissue:
  - ① – Loose connective <sup>Areolar</sup> tissue binds epithelia to underlying tissues and holds organs in place
  - ② – **Cartilage** is a strong and flexible support material
  - ③ – Fibrous connective tissue is found in **tendons**, which attach muscles to bones, and **ligaments**, which connect bones at joints

- ④ – **Adipose tissue** stores fat for insulation and fuel
- ⑤ – **Blood** is composed of blood cells and cell fragments in blood plasma
- ⑥ – **Bone** is mineralized and forms the skeleton

# Connective Tissue

## Loose connective tissue

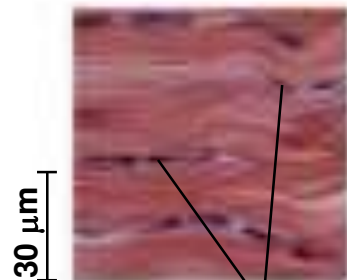
Collagenous fiber



120  $\mu\text{m}$

Elastic fiber

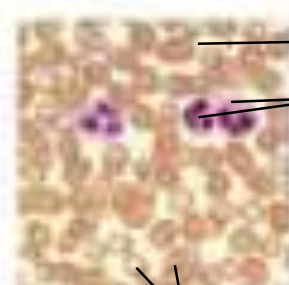
## Fibrous connective tissue



30  $\mu\text{m}$

Nuclei

## Blood



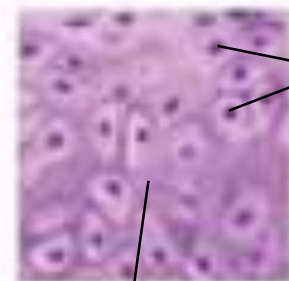
Plasma

White blood cells

55  $\mu\text{m}$

Red blood cells

## Cartilage



Chondrocytes

100  $\mu\text{m}$

Chondroitin sulfate

## Bone



Central canal

700  $\mu\text{m}$

Osteon

## Adipose tissue



Fat droplets

150  $\mu\text{m}$

رخو/فضفاهن

## Loose connective tissue

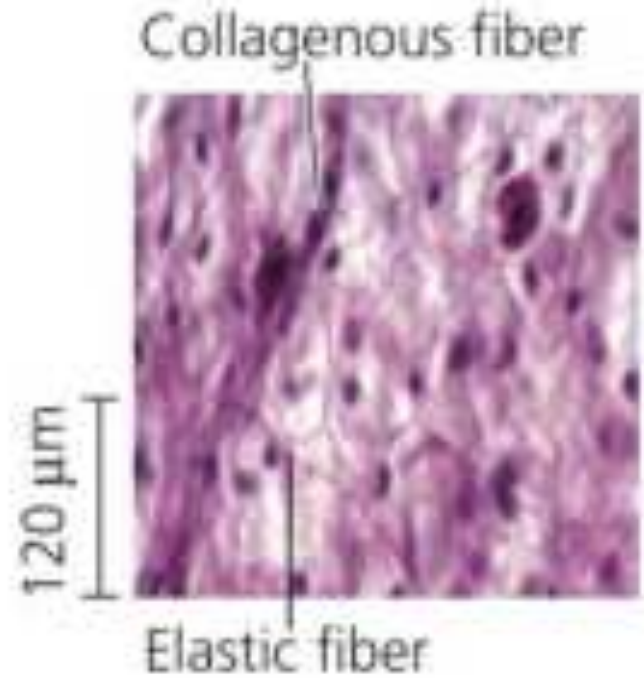
The most widespread connective tissue in the vertebrate body is *loose connective tissue*, which binds epithelia to underlying tissues and holds organs in place. \* Loose connective tissue gets its name from the loose weave of its fibers, which include all three types. It is found in the skin and throughout the body.

\* وظيفته

هوائي

→ also called areolar tissue

↳ has air spaces



\* يتوي أنواع ال fibers الثلاثة  
\* = = خلايا كلها



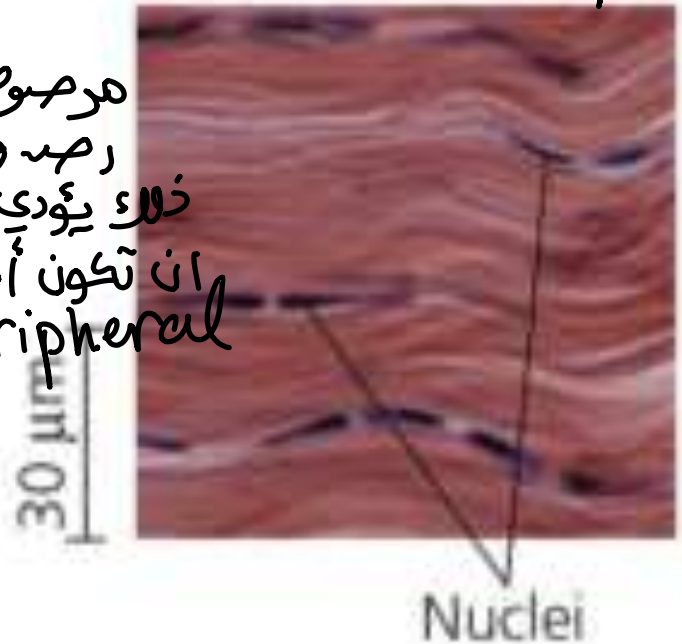
دعامة  
أكثر من  
مرونة

## Fibrous connective tissue

doesn't have any air spaces

Fibrous connective tissue is dense with collagenous fibers. It is found in tendons, which attach muscles to bones, and in ligaments, which connect bones at joints.

مروصود  
رصد و  
ذلك يؤدي إلى  
ان تكون أنوية  
peripheral

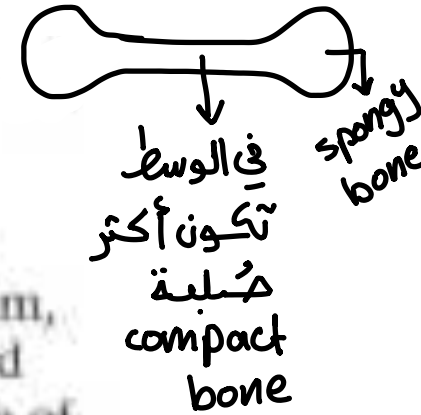


[بالرسمه فوقه مأخوذ من tendon]



# Bone

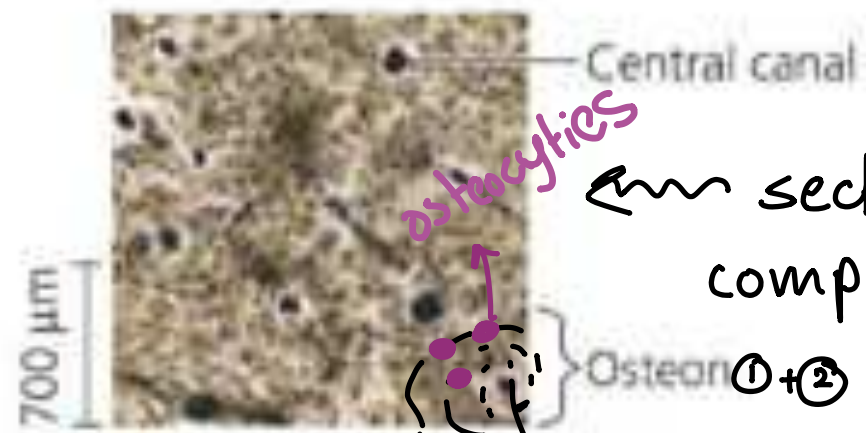
The skeleton of most vertebrates is made of bone, a mineralized connective tissue. Bone-forming cells called osteoblasts deposit a matrix of collagen. Calcium, magnesium, and phosphate ions combine into a hard mineral within the matrix. The microscopic structure of hard mammalian bone consists of repeating units called osteons. Each osteon has concentric layers of the mineralized matrix, which are deposited around a central canal containing blood vessels and nerves.



matrix: solid in appearance & filled with minerals

skull bones

osteoplast: cells of the bone



osteocytes section in the compact bone

① central canal

② Rings

Osteon ①+②

# Adipose tissue

مسؤولة عن  
العكافة والسمنة

هو جود في كل مكان  
تخزن دهون في الجسم

Adipose tissue is a specialized loose connective tissue that stores fat in adipose cells distributed throughout its matrix.

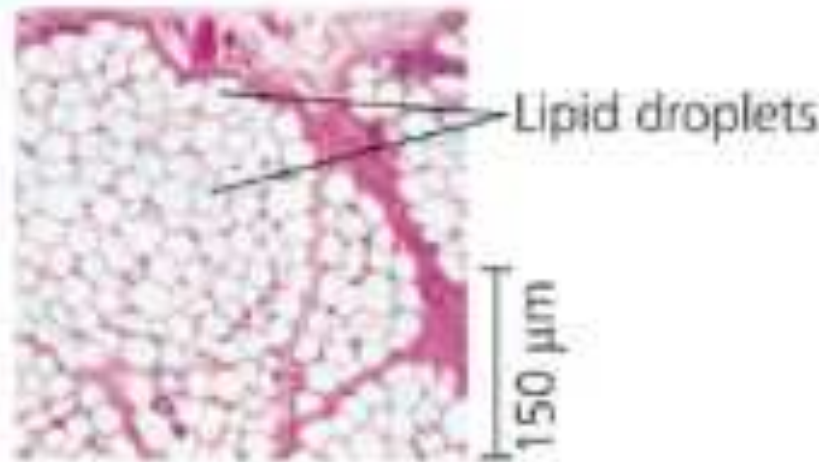
like a cushion  
لحمايتها

الحفاظ على الحرارة

Adipose tissue pads and insulates the body and stores fuel as fat molecules. Each adipose cell contains a large fat droplet that swells when fat is stored and shrinks when the body uses that fat as fuel.

طريقة  
تخزين  
الدهون

من أكثر ما تخزنه fats  
سوف يفتت النواة و  
تصبح peripheral  
nucleus



# Cartilage

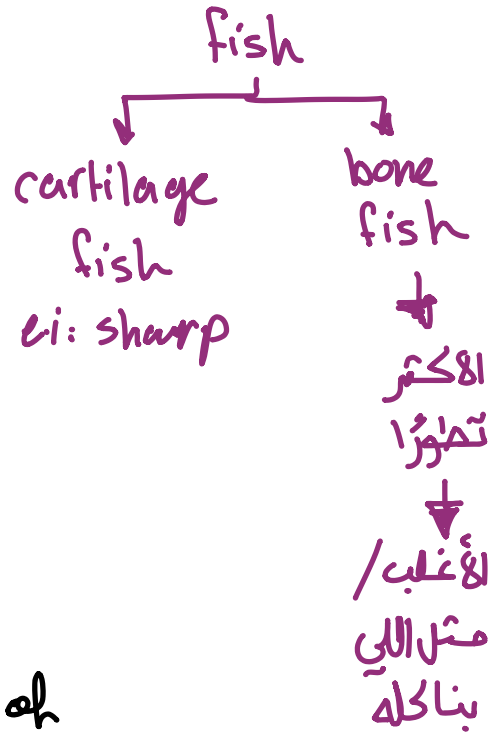
Cartilage contains collagenous fibers embedded in a rubbery protein-carbohydrate complex called chondroitin sulfate.



Cells called *chondrocytes* secrete the collagen and chondroitin sulfate, which together make cartilage a strong yet flexible support material. The skeletons of many vertebrate embryos contain cartilage that is replaced by bone as the embryo matures. Cartilage remains in some locations, such as the disks that act as cushions between vertebrae.

أكثر

يوجد بعض الحيوانات التي يكون ال skeleton لها هو عبارة عن cartilage فقط مثل: sharp



مثل شحمة الأذن/ الأنف  
مثل trachea

وتوجد أيضًا بين العظام لمنع احتكاكه، أيضًا يوجد في

inter vertebral disk بين فقرات العمود الفقري



means cartilage  
Chondrocytes: cells of cartilage; everyone is surrounded with air spaces

Chondroitin sulfate

→ وهو مسؤول عن ذلك → which is most important component of matrix: semisolid

Figure 40.5bg

# Blood ①+②+③

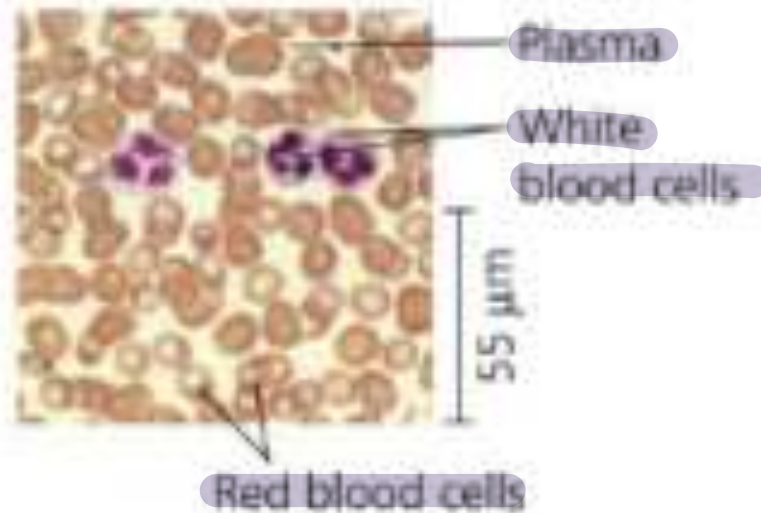
Blood has a liquid extracellular matrix called plasma, which consists of water, salts, and dissolved proteins. Suspended in plasma are erythrocytes (red blood cells), leukocytes (white blood cells), and cell fragments called platelets. Red cells carry oxygen, white cells function in defense, and platelets aid in blood clotting.

qol. ←

bigger than red blood cells, nucleated  
أكبر من خلافة

disc-shaped / biconcave  
not nucleated

③  
جلطة



الحركة : motility

## Muscle Tissue

• **Muscle tissue** consists of long cells called muscle fibers, which contract in response to nerve signals

تكون  
مطاوله  
على شكل خيوط

All muscle cells consist of filaments containing the proteins actin and myosin, which together enable muscles to contract. There are three types of muscle tissue in the vertebrate body: skeletal, smooth, and cardiac.

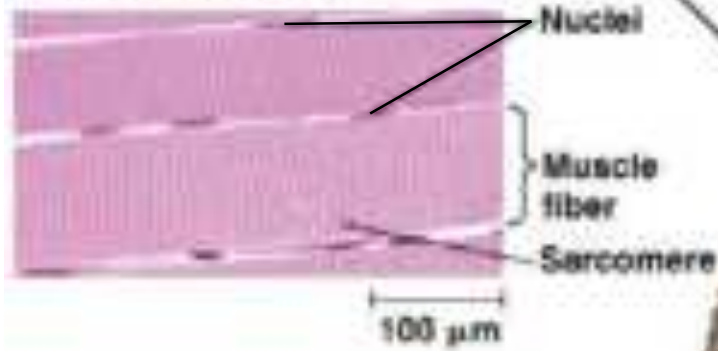
- It is divided in the vertebrate body into three types:
  - **Skeletal muscle**, or striated muscle, is responsible for voluntary movement
  - **Smooth muscle** is responsible for involuntary body activities
  - **Cardiac muscle** is responsible for contraction of the heart



Figure 40.5ca

## Muscle Tissue

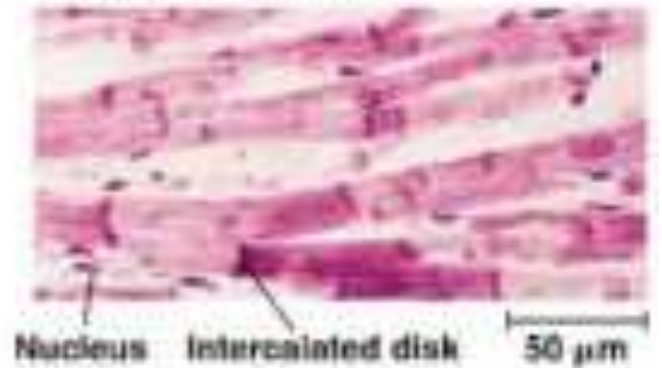
### Skeletal muscle



### Smooth muscle



### Cardiac muscle

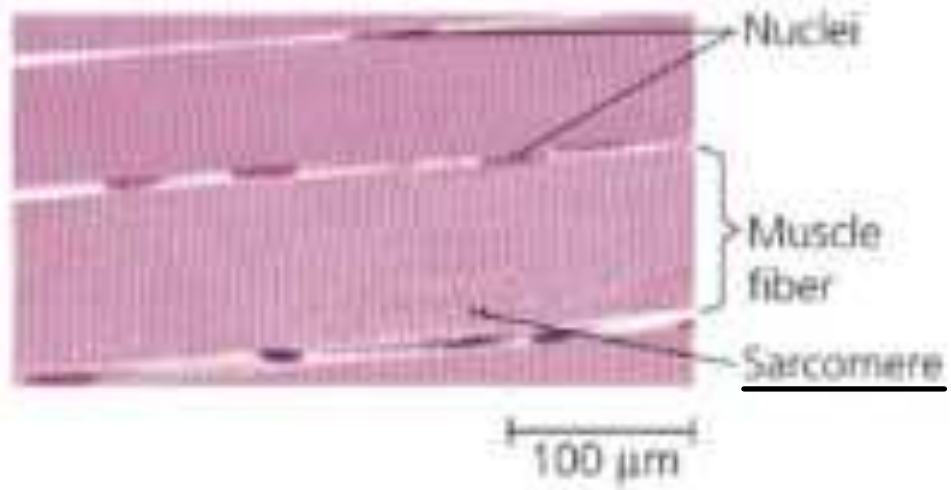


# هيكلية Skeletal muscle

الحركات الإرادية

Attached to bones by tendons, skeletal muscle, or striated muscle, is responsible for voluntary movements. Skeletal muscle consists of bundles of long cells that are called muscle fibers. During development, skeletal muscle fibers form by the fusion of many cells, resulting in multiple nuclei in each muscle fiber. The arrangement of contractile units, or sarcomeres, along the fibers gives the cells a striped (striated) appearance. In adult mammals, building muscle increases the size but not the number of muscle fibers.

- ① \* cylindrical in shape  
↓  
السطوانية الشكل
- ② striated ~~زبد~~
- ③ peripheral multi-nucleated





منه الأمعاء

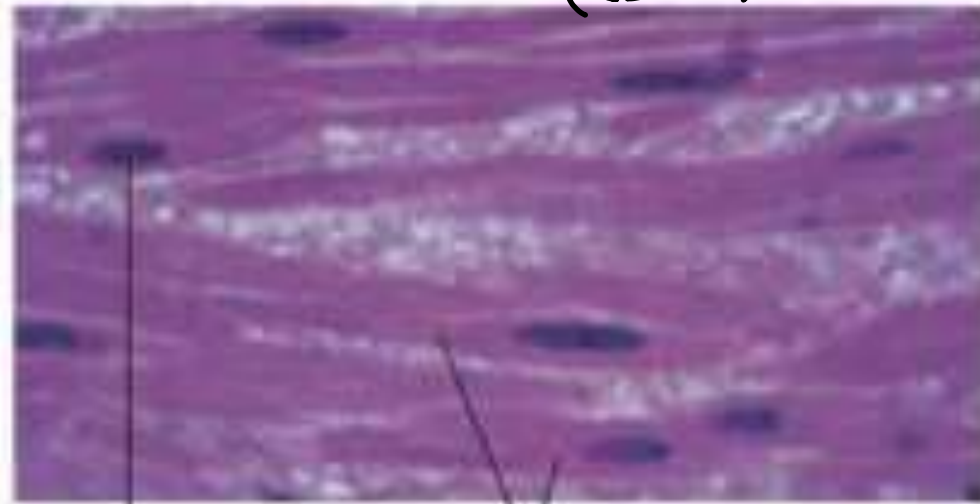
# Smooth muscle, not striated

Smooth muscle, which lacks striations, is found in the walls of the digestive tract, urinary bladder, arteries, and other internal organs. The cells are spindle-shaped. Smooth muscles are responsible for involuntary body activities, such as churning of the stomach and constriction of arteries.

طويلة جدًا

الحركات اللاإرادية كلها  
معدة  
heart  
خطوه لحاله

انقباضات لا  
المعدة (في الجوف)



Nucleus

Muscle fibers

25 μm

One central

Figure 40.5cb

ماخذ من التنين  
اللي قبله/ عشان  
هيك حطوه  
طاله

# Cardiac muscle

major function: contraction of heart → pump blood in symphonic

① + ②  
حضانة  
حاضنة فيها  
فقط

Cardiac muscle forms the contractile wall of the heart. It is striated like skeletal muscle and has similar contractile properties. Unlike skeletal muscle, however, cardiac muscle has branched fibers that interconnect via intercalated disks, which relay signals from cell to cell and help synchronize heart contraction.

like smooth in two things  
① involuntary  
② one central nucleus

also it is cylindrical like it

صورة الكتاب

صورة الانسداد



each muscle fibre contains one central

Nucleus

②

Intercalated disk:

25 μm

gap junctions: harmony in heart beating (symphonic) because of it

نقل الإحساس ويؤدي

## الاستجابة Nervous Tissue

- **Nervous tissue** senses stimuli and transmits signals throughout the animal

two • Nervous tissue contains  
types of cells

① **Neurons**, or nerve cells, that transmit nerve impulses

② **Glial cells**, or **glia**, that help nourish, insulate, and replenish neurons

## Neurons

Neurons are the basic units of the nervous system. A neuron receives nerve impulses from other neurons via its cell body and multiple extensions called dendrites. Neurons transmit impulses to neurons, muscles, or other cells via extensions called axons, which are often bundled together into nerves.

## Glia

The various types of glia help nourish, insulate, and replenish neurons, and in some cases, modulate neuron function.

# Nervous Tissue

## Neurons

Neuron:

Dendrites

extensions: فطير

Cell body

Axon

طويل

40  $\mu\text{m}$



(Fluorescent LM)



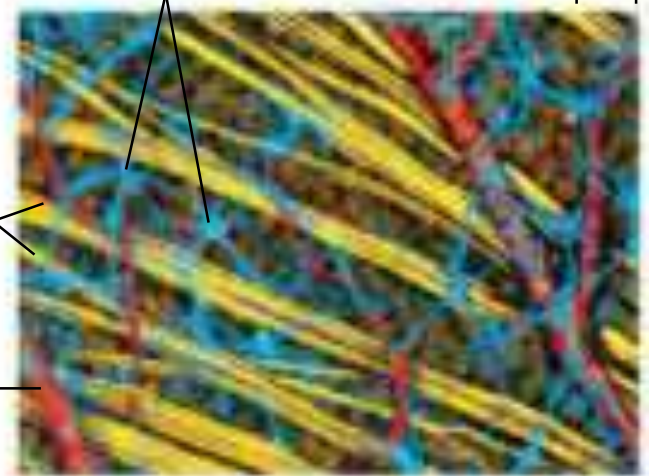
## Glia

Glia

15  $\mu\text{m}$

Axons of neurons

Blood vessel



(Confocal LM)



Figure 40.5db

# Neuron:

①  
 الزوائد  
 الشجرية  
**Dendrites**

②  
**Cell body**

③  
 الاربون  
**Axon**  
 long

40 μm

(Fluorescent LM)



طريقة انتقال  
 السيال العصبي

① → ② → ③  
 → ④ → إلى

Other  
 Axon  
 terminals  
 other  
 neuron  
 gland  
 muscle

Final  
 destination:

③ Axon terminal  
 نهاية الاربون

Axons bond together  
nerve

يُحَوِّمُ نيوترنوس وَيُغْذِوهُ

Glia

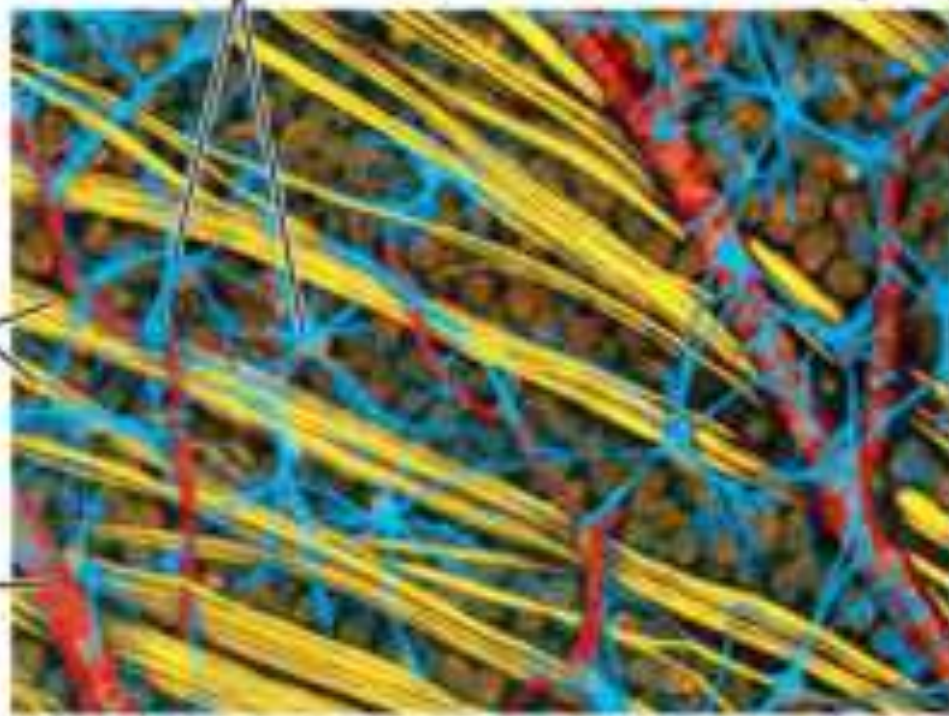
تَظْ  
nerve cells

15 μm

وَيَرْبِطُهُ إِذَا حَارَ أَيُّ  
خَلَّ فِي نَقْلِ الإِشَارَاتِ  
أَدَّ فِي التَّفْرِيقَةِ

Axons of  
neurons  
nerve cells

Blood  
vessel



(Confocal LM)



# Coordination and Control

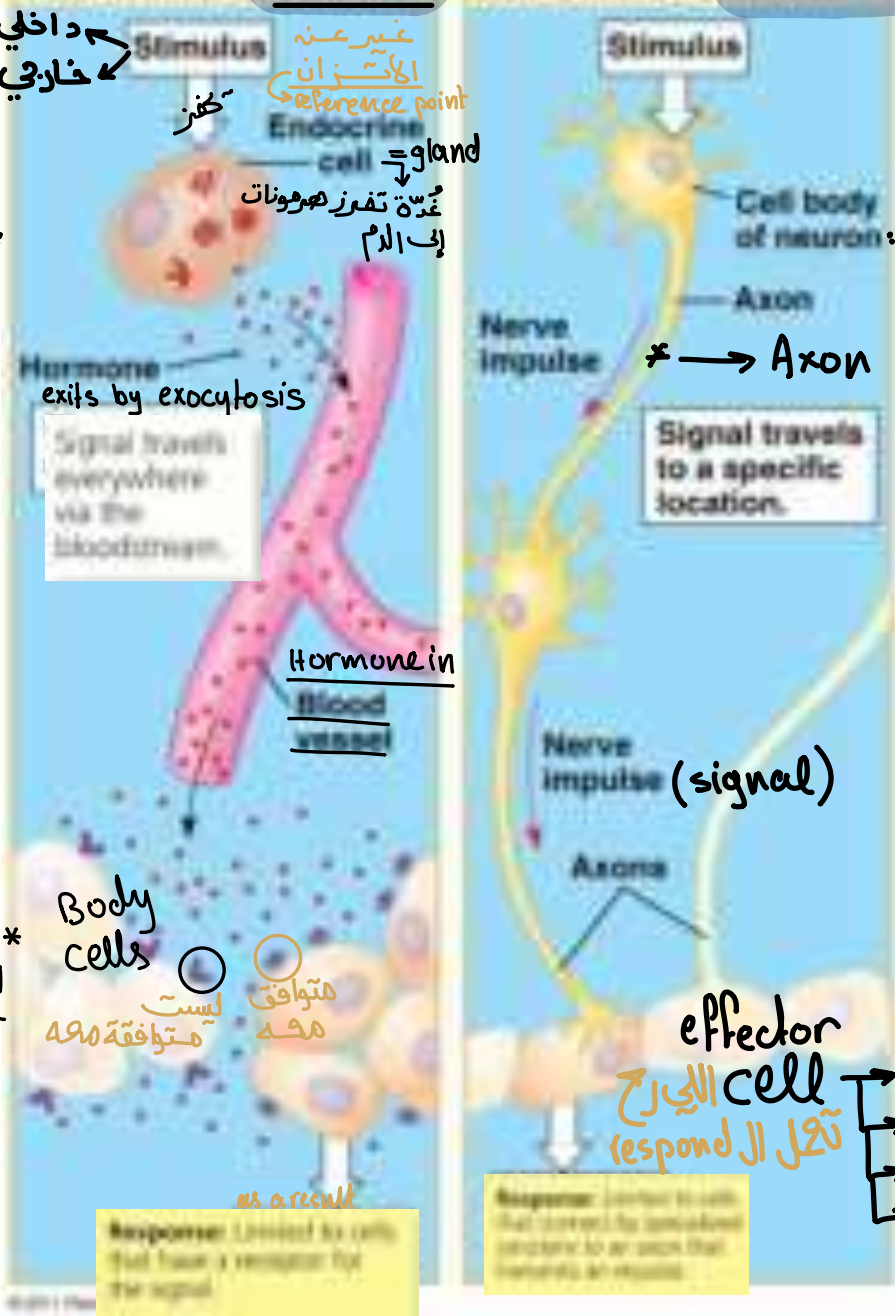
- الأجهزة  
المسؤولة  
عن الcontrol
- Control and coordination within a body depend on the <sup>ES</sup> endocrine system and the nervous system
- The endocrine system transmits chemical signals called **hormones** to receptive cells throughout the body **via blood**
  - A hormone may affect one or more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

Figure 40.6

# coordination with ES vs. coordination with nervous system

(a) Signaling by hormones

(b) Signaling by neurons



داخلي [تغير في درجة الحرارة] ارتفاع أو انخفاض  
 خارجي [الضغط / السكر]

Stimulus  
 غير عنده الأنتزان  
 reference point  
 Endocrine cell = gland  
 غدة تفرز هرمونات إلى الدم

exocrine ← غدة تفرز إلى خلايا أخرى [ليست إلى الدم]

Hormone exits by exocytosis  
 Signal travels everywhere via the bloodstream.

Hormone in blood vessel

Body cells  
 متوافق معه ليست متوافقة معه

\* فقط سوف يؤثر على الخلايا التي تحتوي مستقبلات تناسب الهرمون.

as a result  
 Response limited to cells that have a receptor for the signal

Stimulus  
 Cell body of neuron: nerve cell  
 Axon

Nerve impulse  
 \* → Axon terminals, which is connected to another nerve cell  
 Signal travels to a specific location.

Nerve impulse (signal)  
 Axons

effector cell  
 cell التي يرد عليها  
 (respond)  
 → other neuron  
 → muscle cells  
 → endocrine cell  
 → exocrine cell

Response limited to cells that contain the specialized proteins to respond that receive an impulse

example of signaling hormones: → relatively slow, but has long-lasting effect

Pituitary gland  
بنهب إبي

تُفرز من الغدة النخامية

هم المسؤولون عنه  
عمليات  
metabolism

For example, thyroid-stimulating hormone (TSH), which acts solely on thyroid cells, stimulates release of thyroid hormone,  $T_3 + T_4$  which acts on nearly every body tissue to increase oxygen consumption and heat production. It takes seconds for hormones to be released into the bloodstream and carried throughout the body. The effects are often long-lasting, however, because hormones can remain in the bloodstream for minutes or even hours.

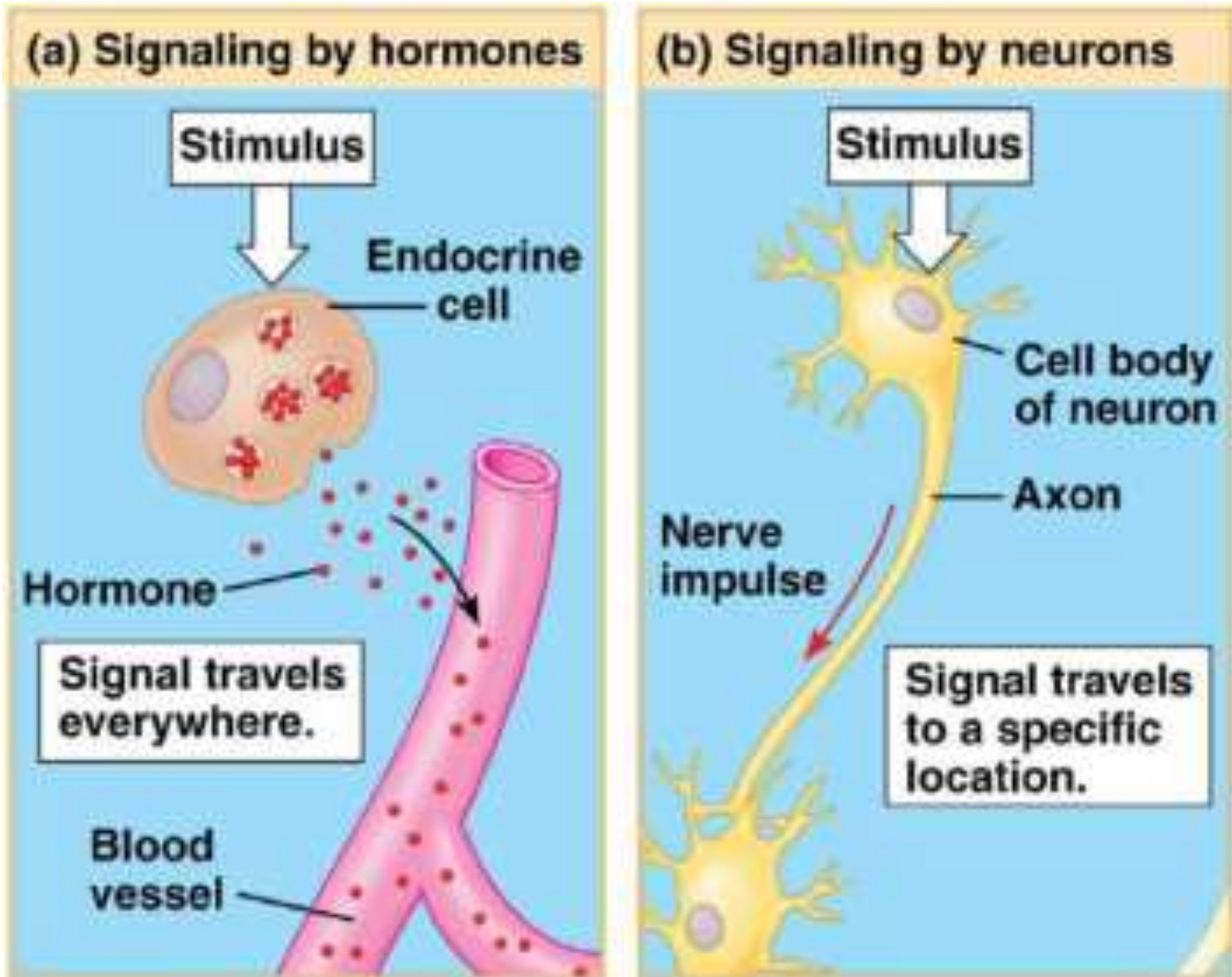
→  
↓  
يحيمشوا بالدم  
ولاوهوا على خلايا  
الجسم/ ولقد وجروا  
أن أغلب خلايا الجسم  
كتوي هستقبلات  
لهرقونات الغدة  
الرقية

example of signaling by neurons:

Unlike the endocrine

system, the nervous system conveys information by the particular pathway the signal takes. For example, a person can distinguish different musical notes because within the ear each note's frequency activates neurons that connect to slightly different locations in the brain.

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

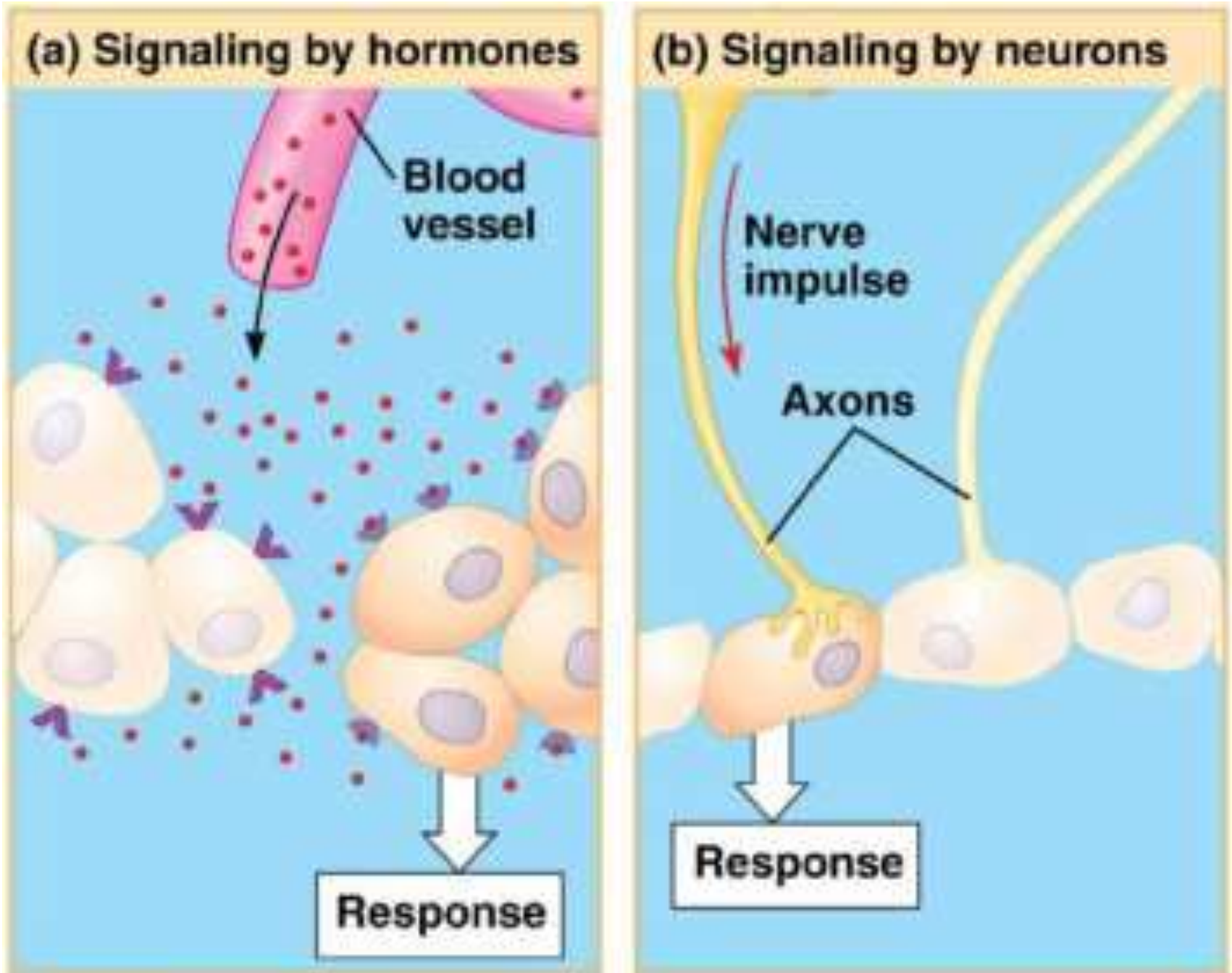
لأنه وبينما  
تتم  
↓  
تكون  
الاستجابة

Nerve signal transmission is very fast + it has short-lasting effect

- Nerve impulses can be received by neurons, muscle cells, endocrine cells, and exocrine cells

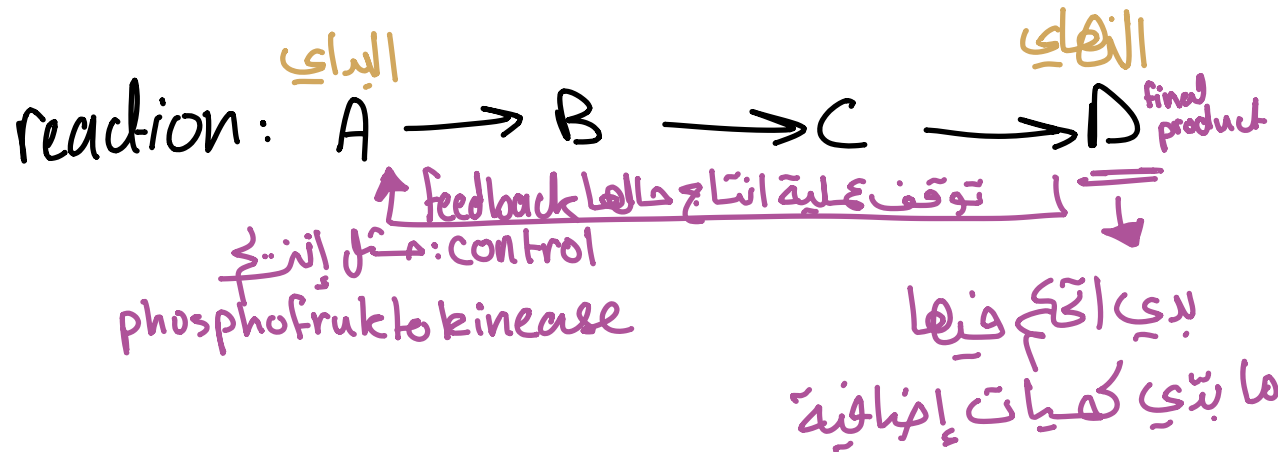


Figure 40.6b



# 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



إذا ضل التفاعل بهذا الشكل  
سوف تبقى D تنتج/ التفاعل  
uncontrolled



# Regulating and Conforming

زينا، مثلاً تركيز

A **regulator** uses internal control mechanisms to moderate internal change in the face of external, environmental fluctuation

الفوكوز عنا  
يجب أن يكون  
بيت  
70 → 110  
مثلاً ازداد السكر  
أومع الصيام  
قل السكر  
الجسم سوف  
يتسفل حاله

الحفاظ على البيئة الداخلية ثابتة على الرغم من التغيرات في البيئة الخارجية

A **conformer** allows its internal condition to vary with certain external changes

الحيوانات قد تنظم بعض المتغيرات البيئية بينما تتكيف مع الأخرى

Animals may regulate some environmental variables while conforming to others

الحيوانات قد تنظم بعض المتغيرات البيئية بينما تتكيف مع الأخرى

constant internal environment despite of the external fluctuation

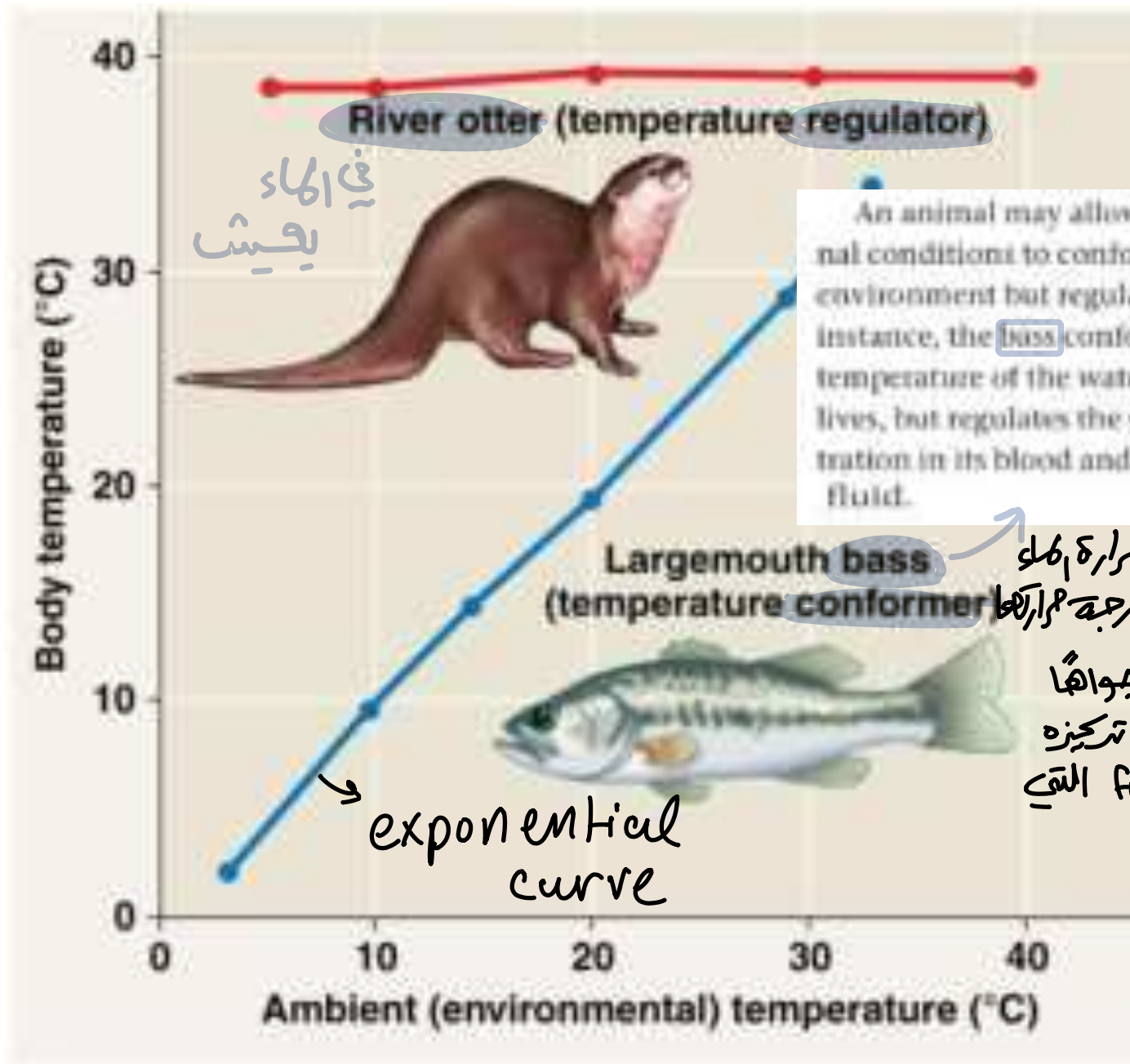
constant internal environment despite of the external fluctuation

the same animal doesn't have to be either regulator or conformer only, some animals might be regulator to certain factor & conformer to another

internal environment يبذل جهود في تفسير ال external environment ليصبح ملائم لل environment : أي انه يتكيف

example

Figure 40.7



# Homeostasis

- Organisms use **homeostasis** to maintain a “steady state” or internal balance regardless of external environment

الاتزان الداخلي

- In humans, <sup>①</sup>body temperature, <sup>②</sup>blood pH, and <sup>③</sup>glucose concentration are each maintained at a constant level

الجسم  
يُنظَر  
في حدود المحافظة  
عليه ثابت

# *Mechanisms of Homeostasis*

- Mechanisms of homeostasis moderate changes in the internal environment
- For a given variable, fluctuations above or below a <sup>①</sup> **set point** serve as a <sup>②</sup> **stimulus**; these are detected by a **sensor** and trigger a <sup>③</sup> **response**
- The response returns the variable to the set point



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Animation: Negative Feedback  
Right-click slide / select "Play"

W

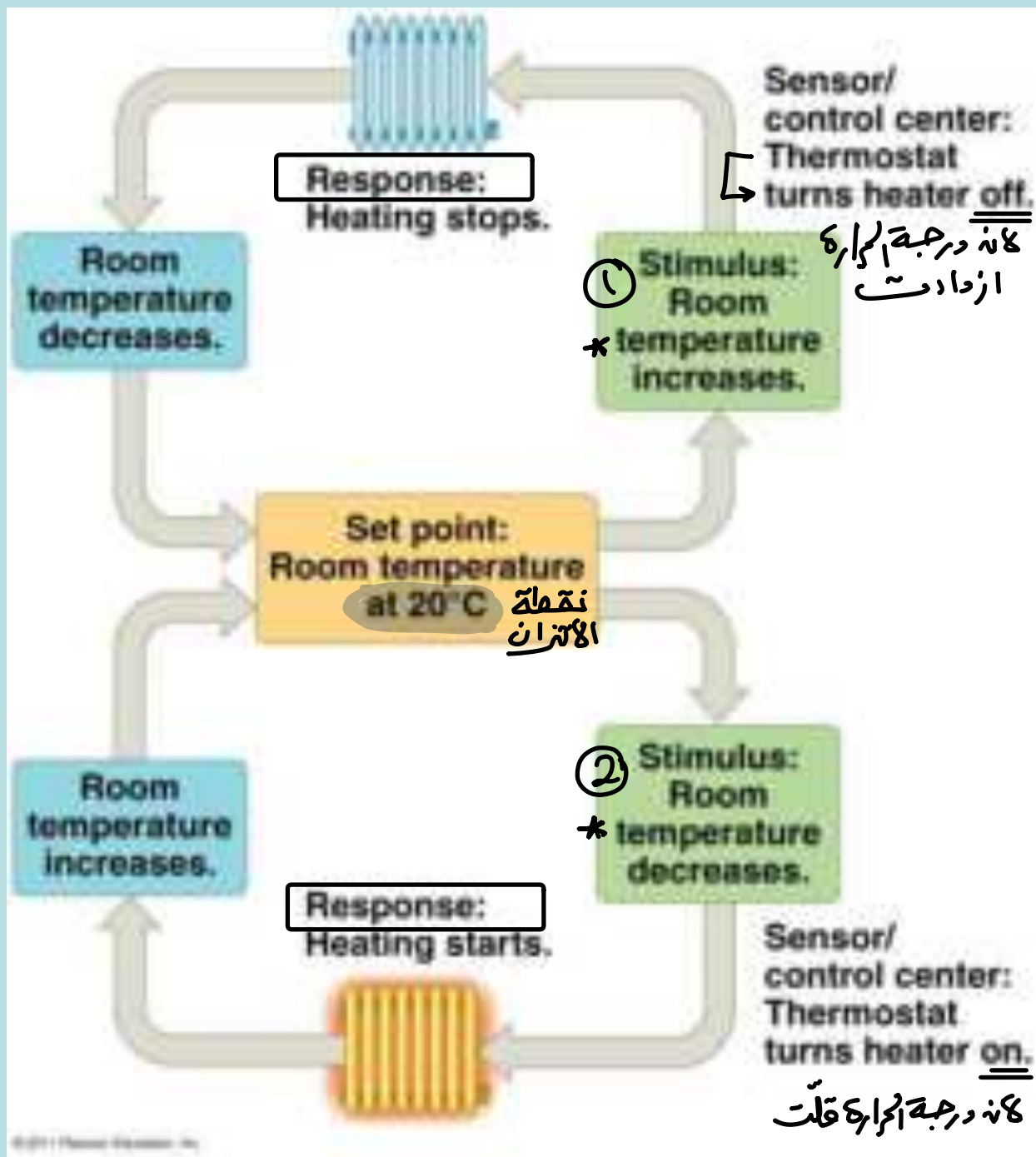


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Animation: Positive Feedback  
Right-click slide / select "Play"



Figure 40.8



# Feedback Control in Homeostasis

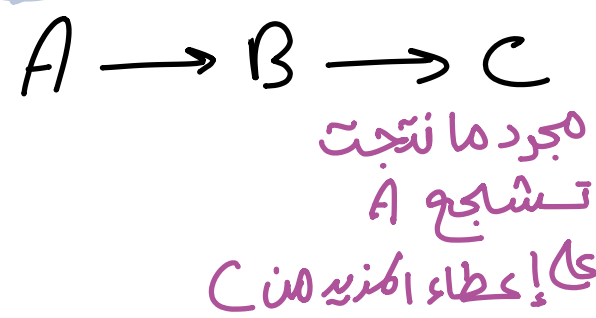
• The dynamic equilibrium of homeostasis is maintained by **negative feedback**, which helps to return a variable to a normal range.

Most homeostatic control systems function by negative feedback, where buildup of the end product shuts the system off.

(1) **inhibition**: *ei:* **ATP** in cellular respiration

كما يزداد تركيز المادة سوف يمتص التفاعل بالعكس ليوقف إنتاجه حاله

(2) **Positive feedback** amplifies a stimulus and does not usually contribute to homeostasis in animals.



أثناء عملية: أ: الولادة، لذا تزيد muscle contraction of uterus

أول ما يخطئ رأس الطفل بجدار الرحم يزداد muscle contraction " تعمل على زيادة أكثر في دفع الطفل لعنق الرحم.

الحناء بأسلوب علمي :

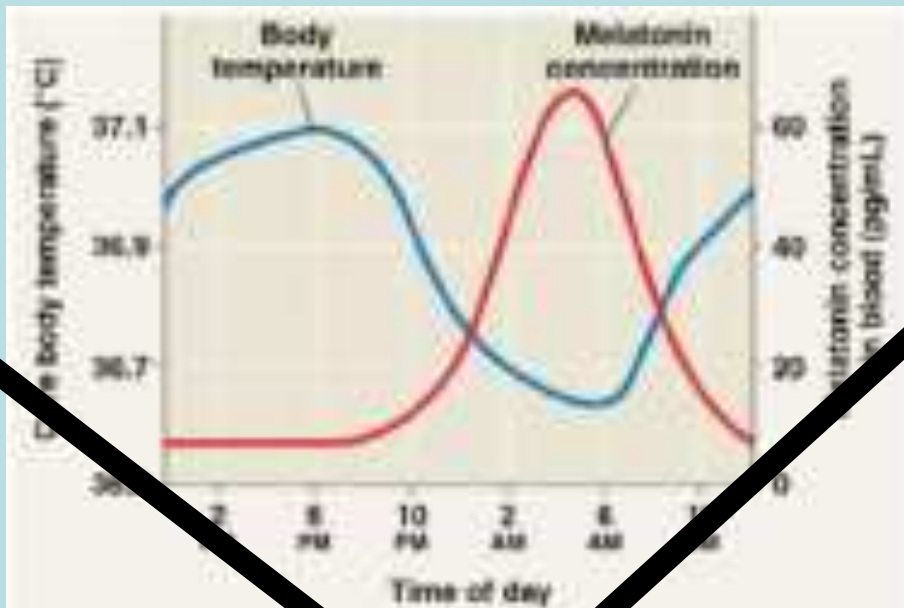


During child-birth, for instance, the pressure of the baby's head against sensors near the opening of the mother's uterus stimulates the uterus to contract. These contractions result in greater pressure against the opening of the uterus, heightening the contractions and thereby causing even greater pressure, ultimately causing the baby to be born.

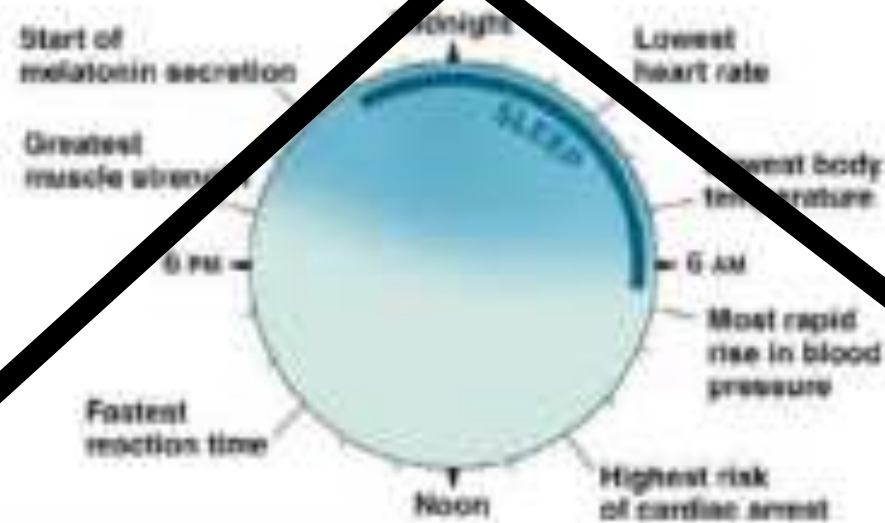
# *Alterations in Homeostasis*

- 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

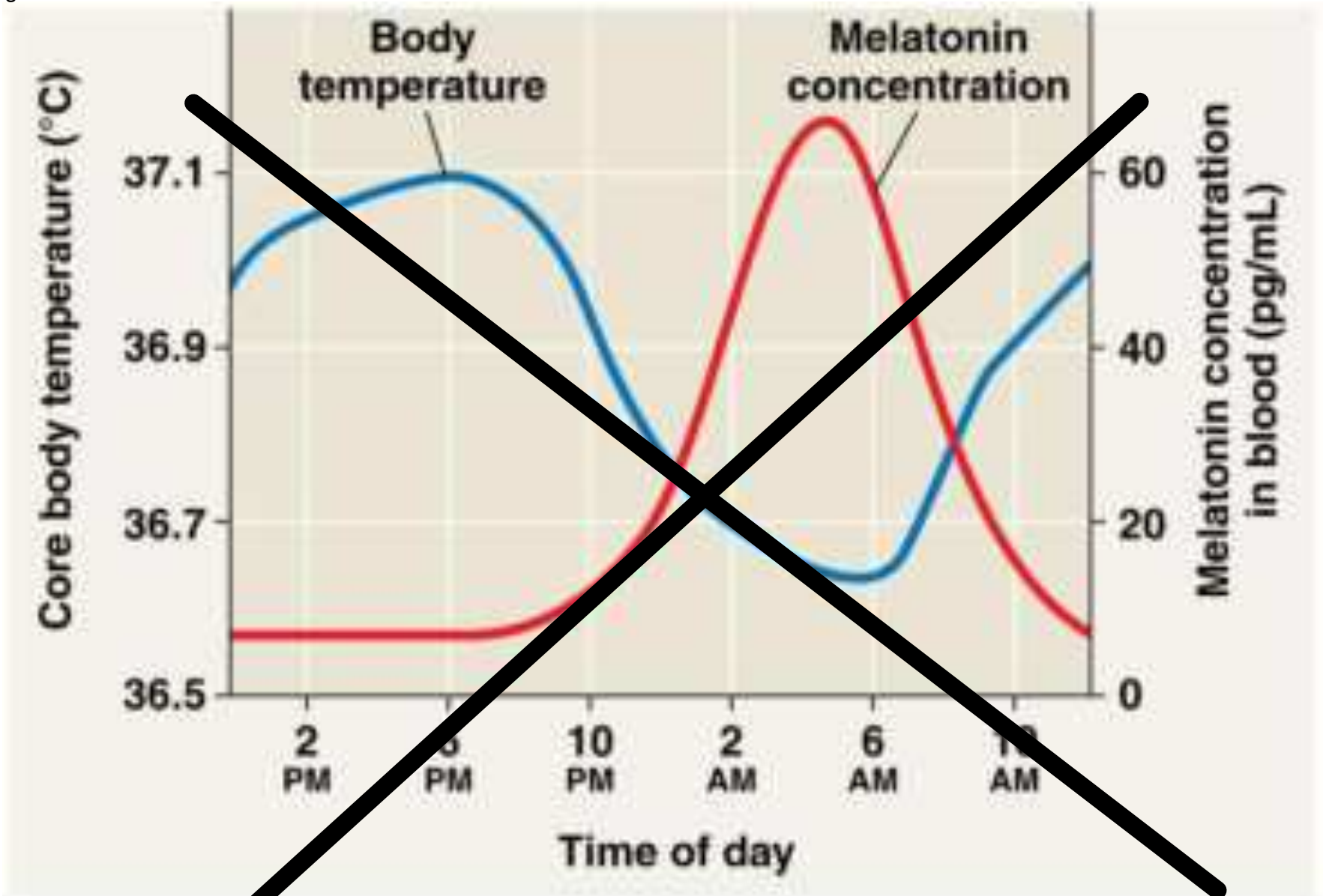


(a) Variation in core body temperature and melatonin concentration in blood



(b) The human circadian clock

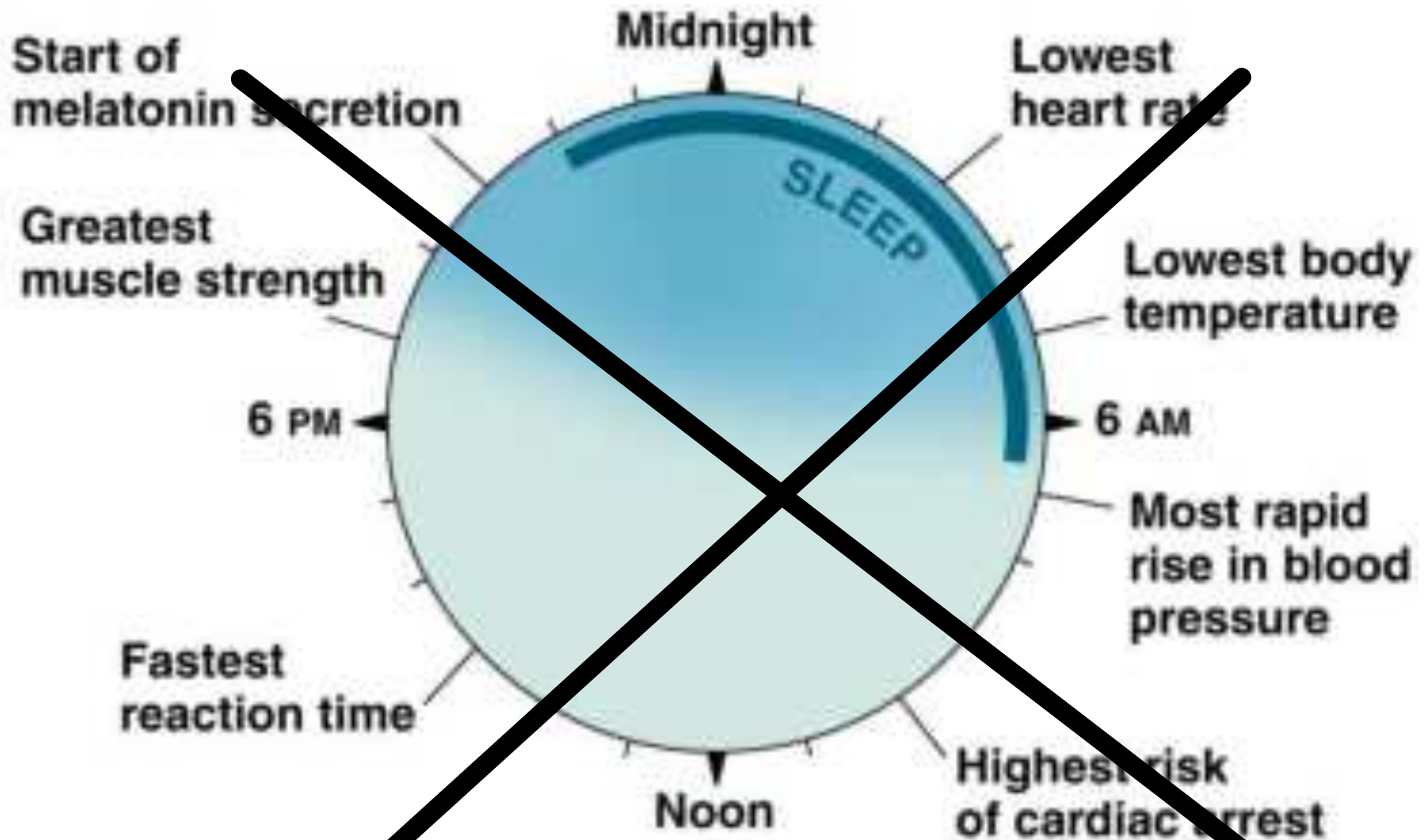
Figure 40.9a



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

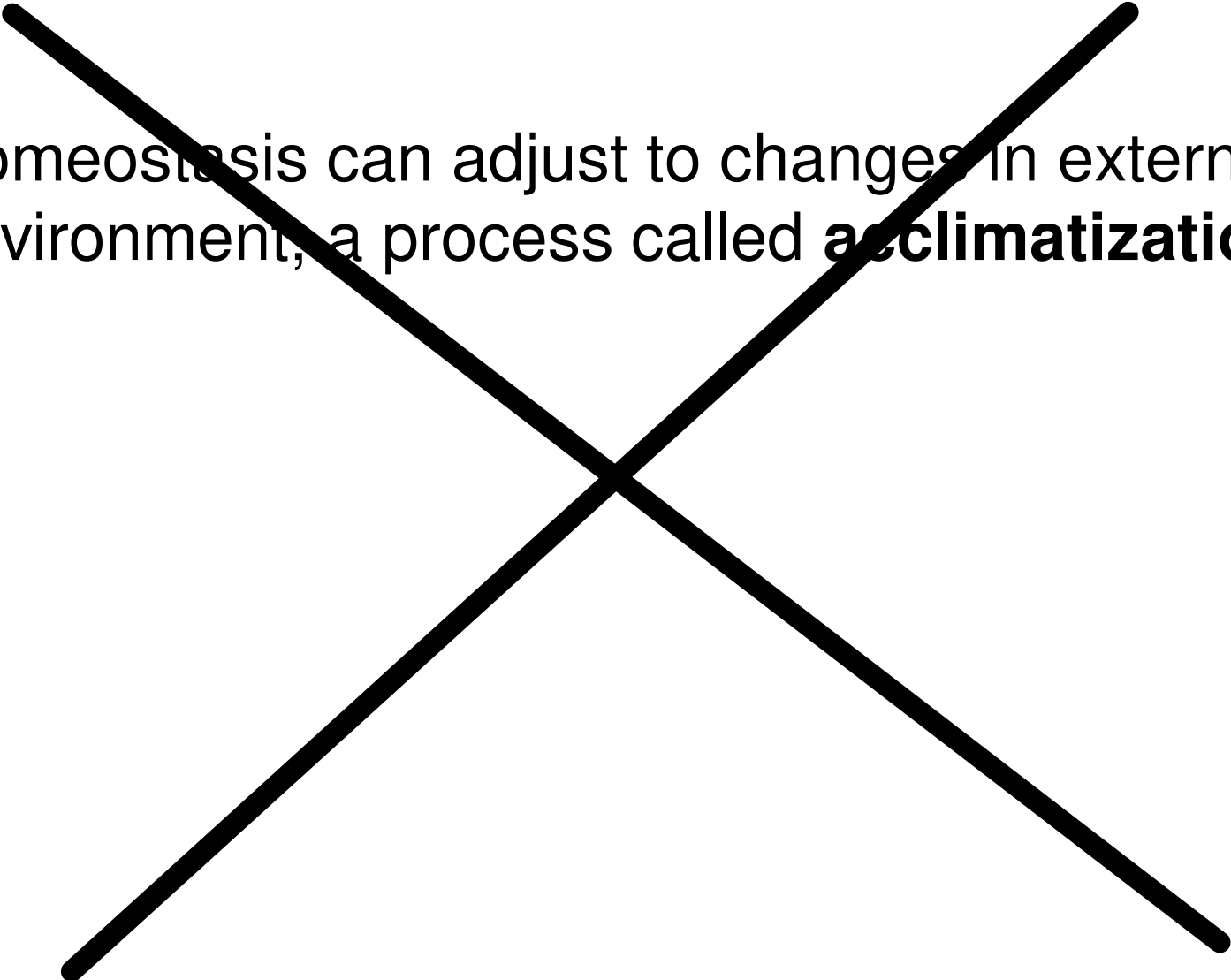


Figure 40.9b



(b) The human circadian clock

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- 
- 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** <sup>التنظيم الحراري</sup> is the process by which animals maintain an internal temperature within a tolerable range [constant internal temperature]

Human (36 → 38)

# ANIMALS according to thermoregulation

① are classified to:

## Endothermy and Ectothermy

we can maintain our constant body temp. regardless to the external environment

ندول جهور  
أكثر

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

هنا

يهاجروا

ناكل / نلبس منبج / نشغل دفاي  
أكثر

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

conformer  
to heat.

كلار كيوانات عدا ابلذكور في endothermic

- 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**



Figure 40.10a



**(a) A walrus, an endotherm**

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**(b) A lizard, an ectotherm**

© 2011 Pearson Education, Inc.

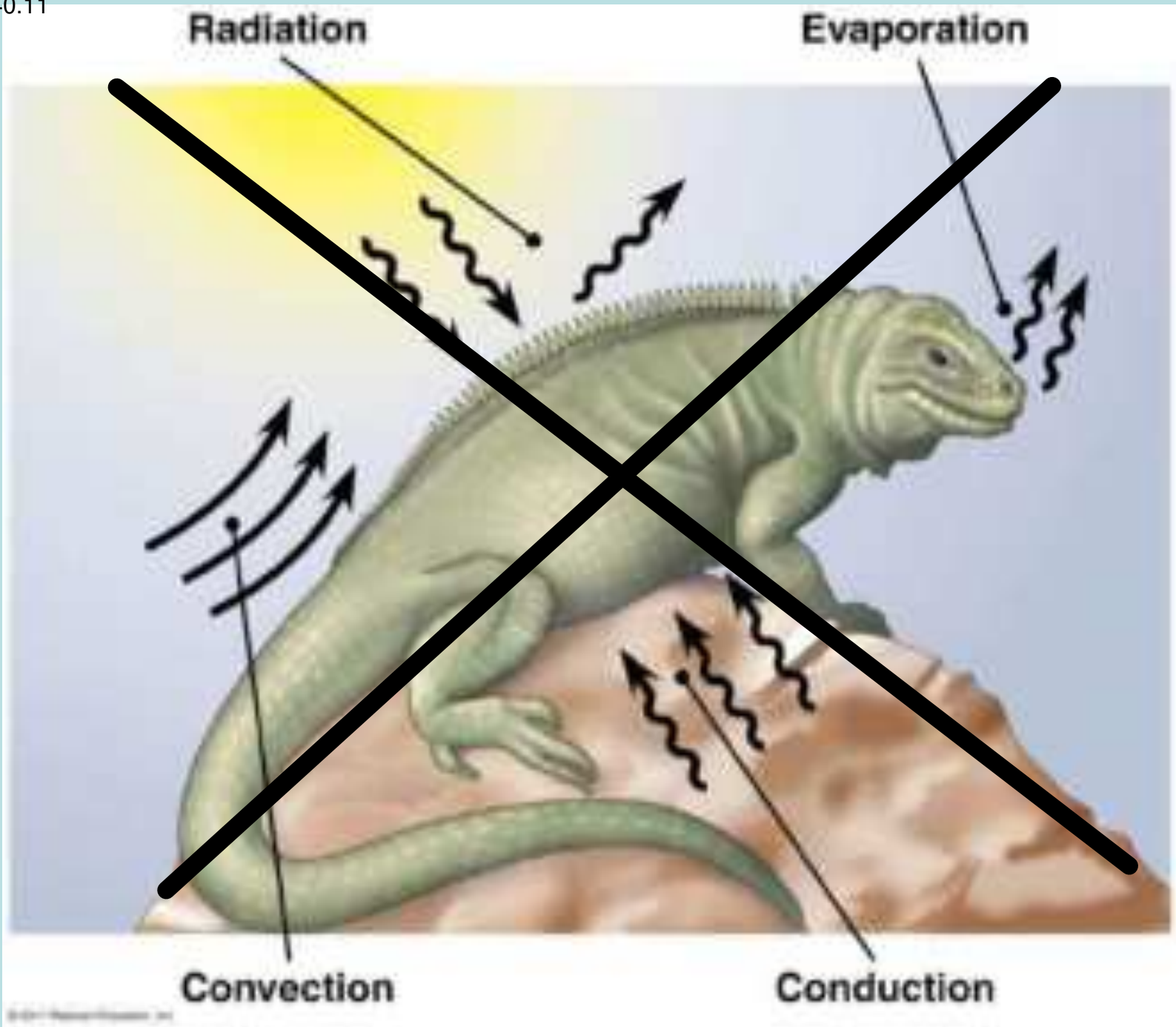
# Variation in Body Temperature

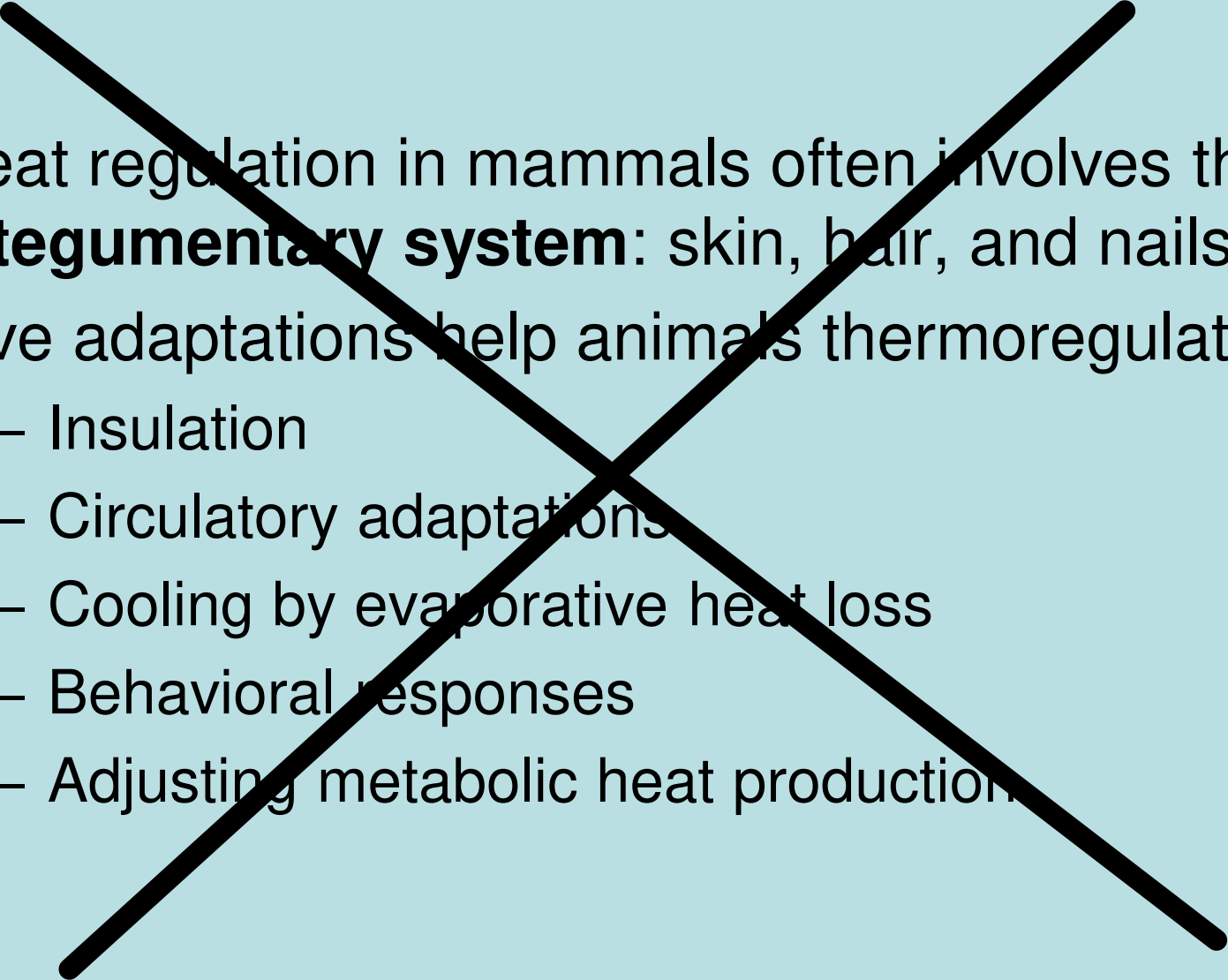
- The body temperature of a poikilotherm varies with its environment
- The body temperature of a homeotherm is relatively constant
- The relationship between heat source and body temperature is not fixed (that is, not all poikilotherms are ectotherms)

# Balancing Heat Loss and Gain

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

Figure 40.11



- 
- 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

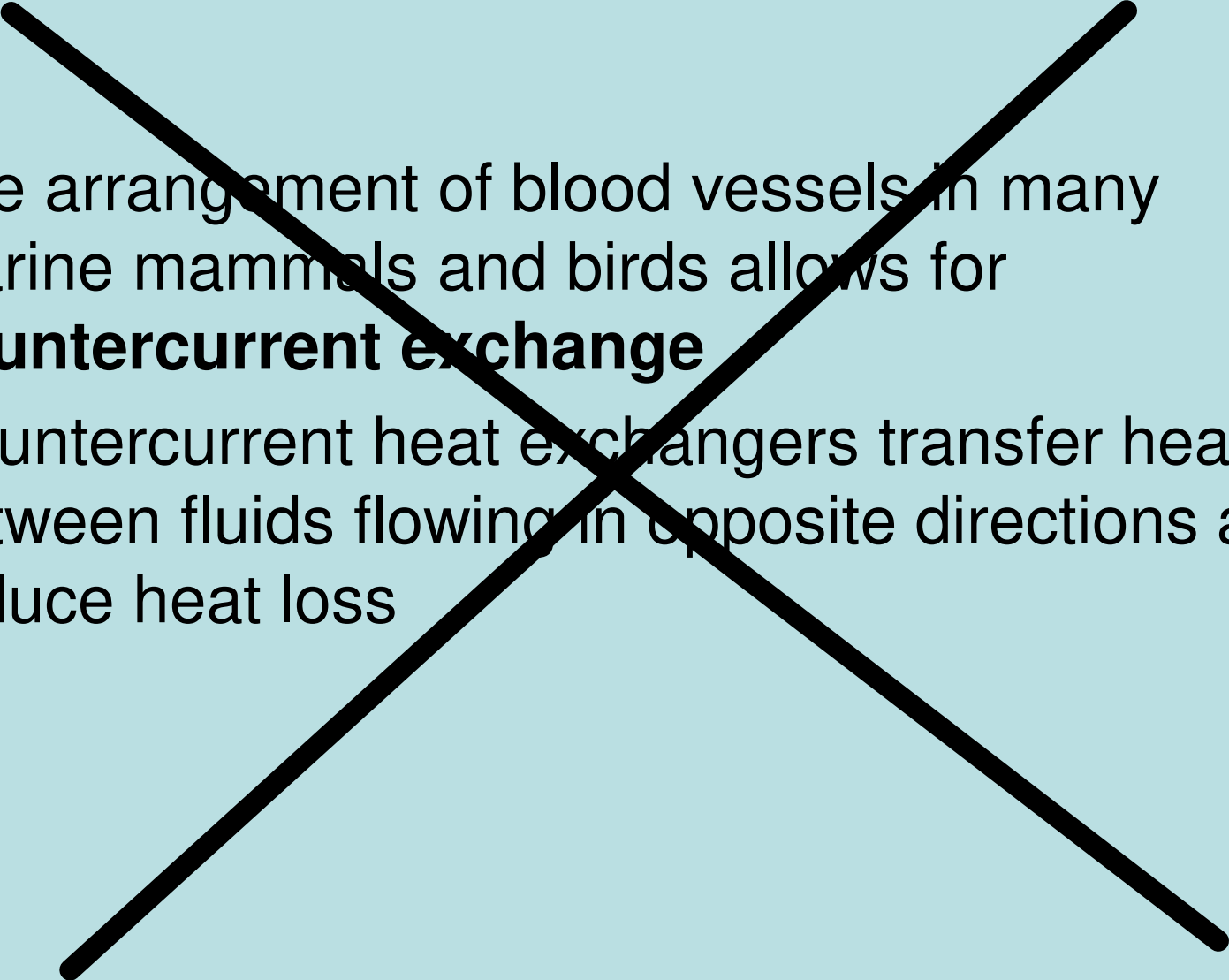
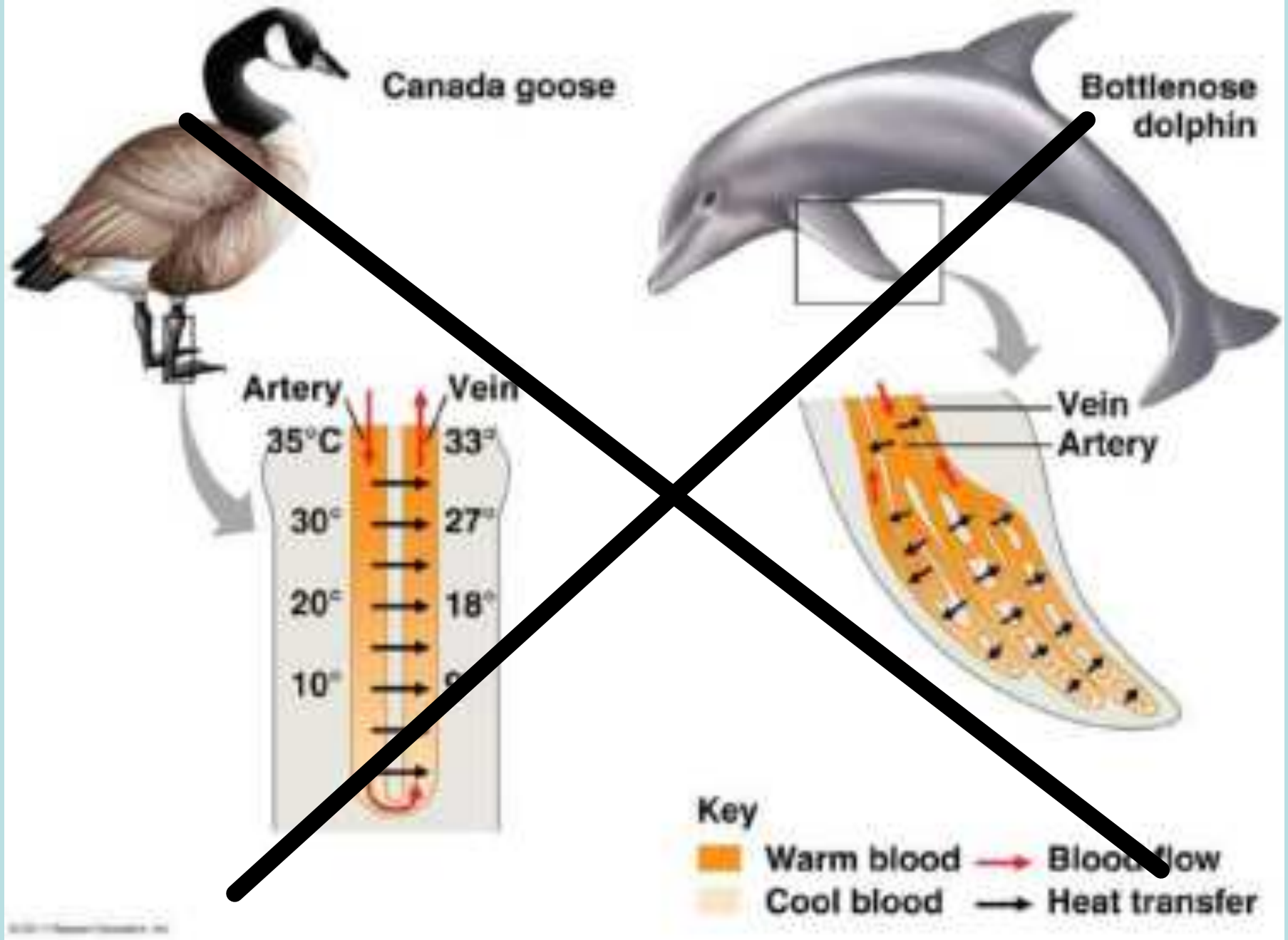
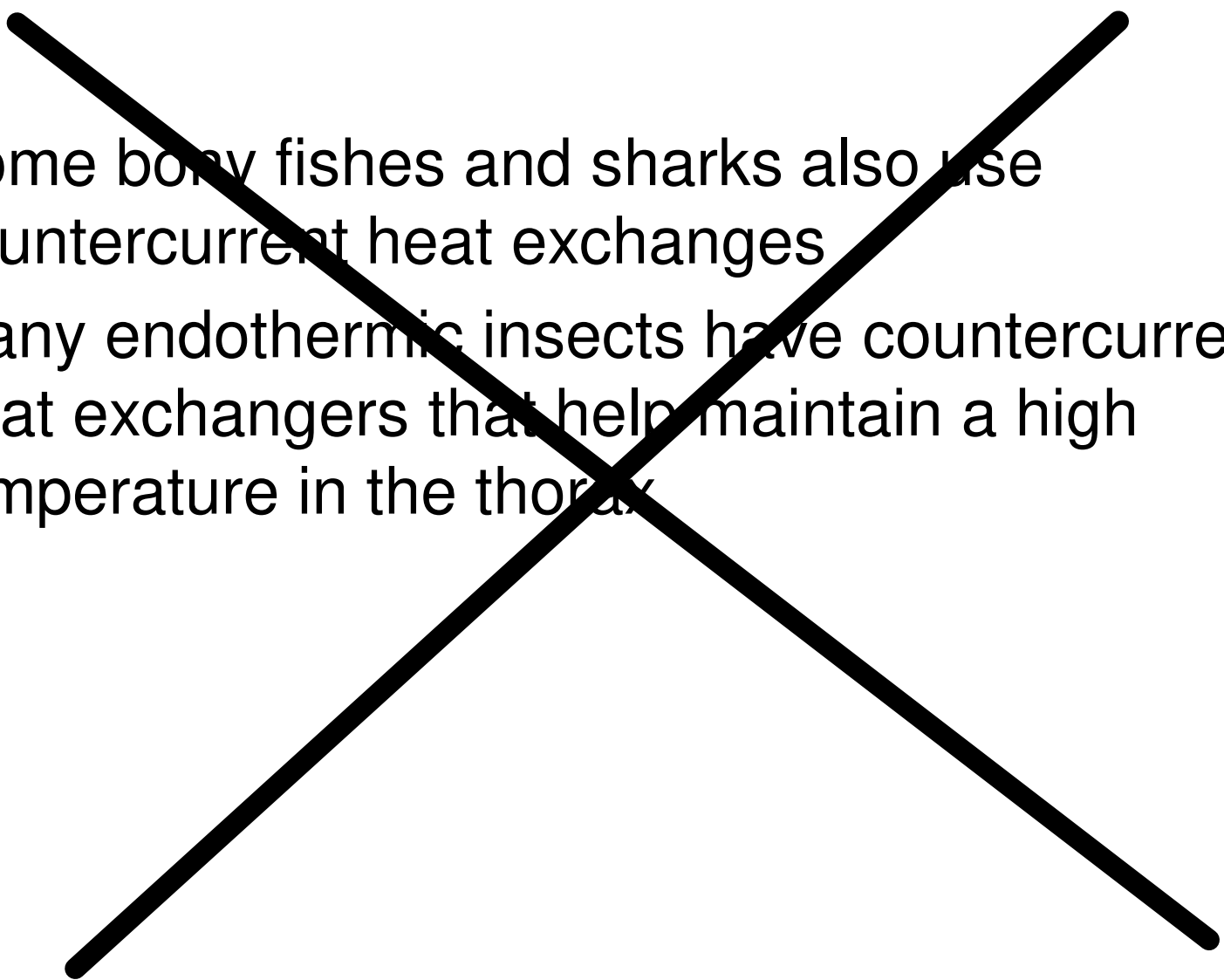
- 
- The arrangement of blood vessels in many marine mammals and birds allows for **countercurrent exchange**
  - Countercurrent heat exchangers transfer heat between fluids flowing in opposite directions and reduce heat loss

Figure 40.12



- 
- 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

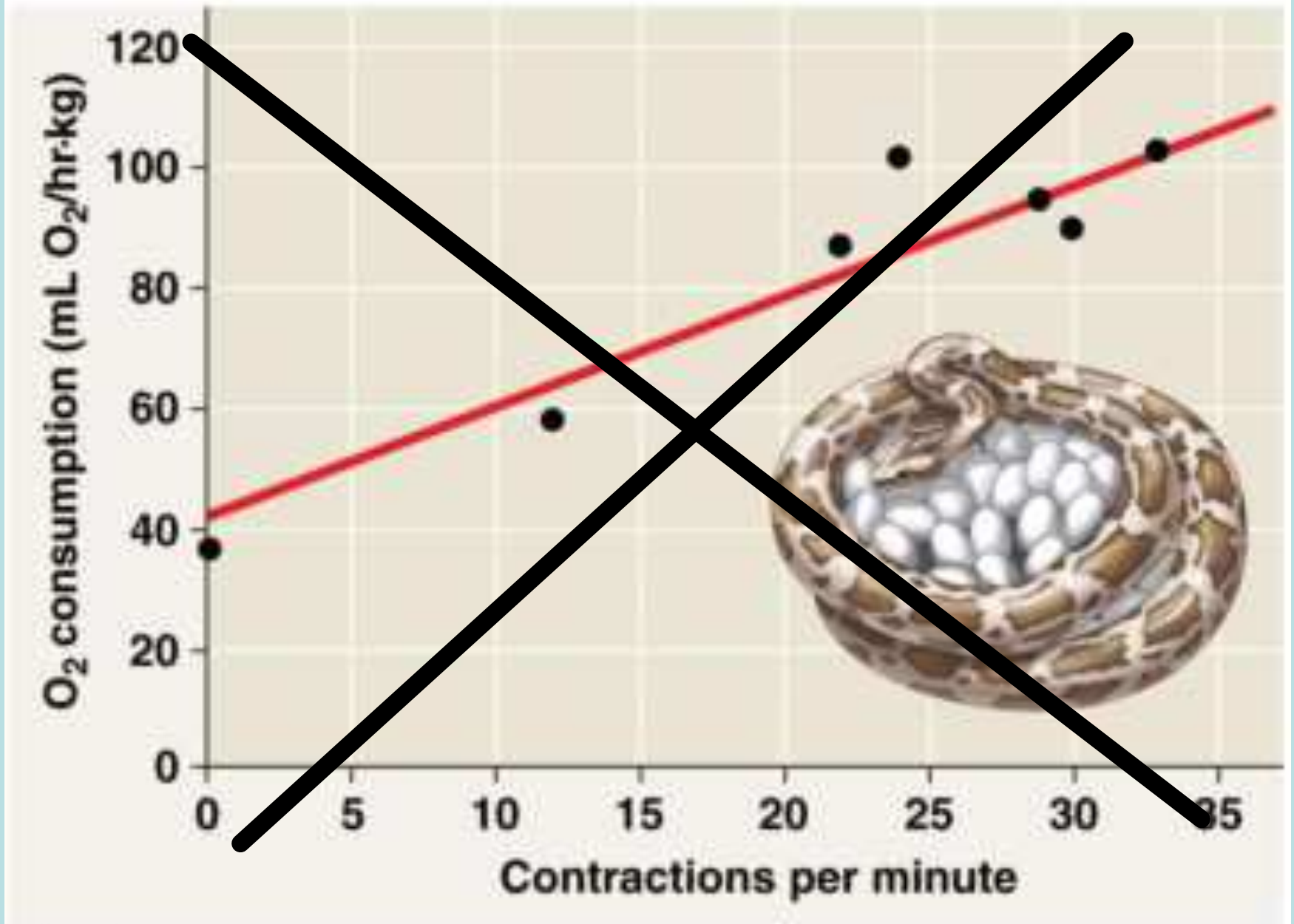
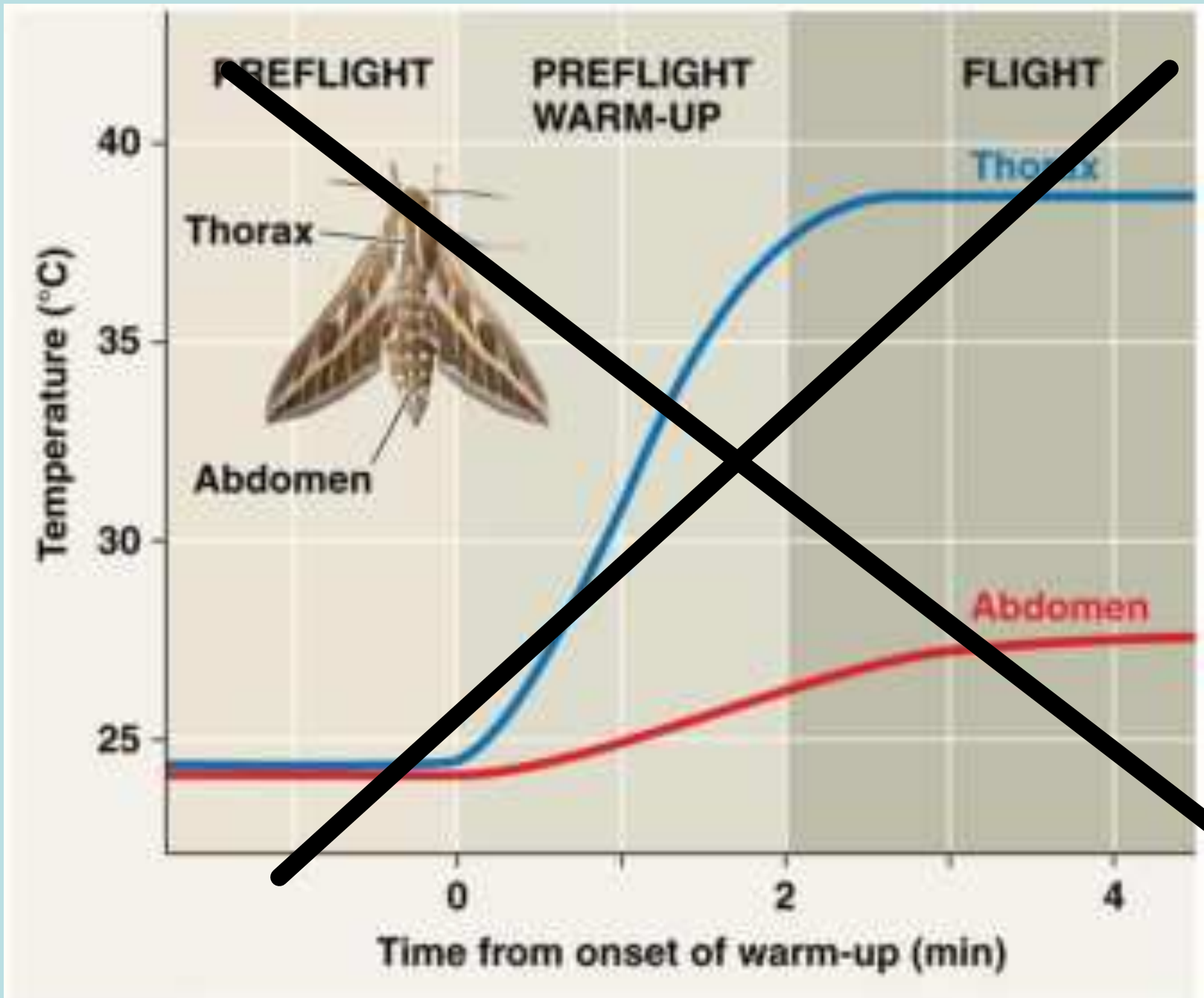


Figure 40.15



# 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



كيف نحافظ على درجة حرارة ثابتة في أجسامنا؟

## Physiological Thermostats and Fever

↓  
we have

our own thermostats

- Thermoregulation is controlled by a region of the brain called the hypothalamus that regulates our body temp.
- The hypothalamus triggers heat loss or heat generating mechanisms
- Fever is the result of a change to the set point for a biological thermostat

تحت الدماغ

مكان وجود  
our  
thermostats

that  
regulates  
our body  
temp.

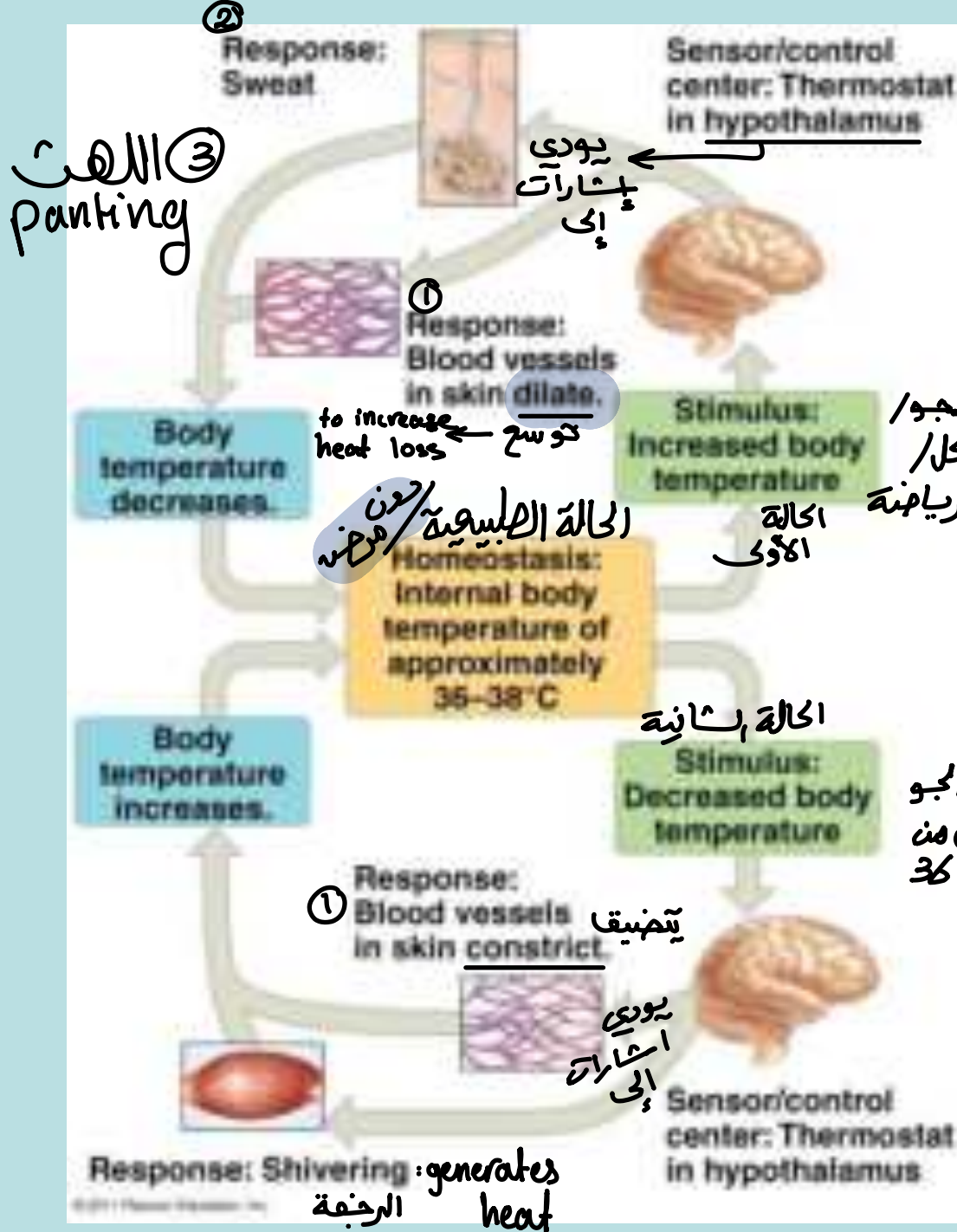
تصبح مثلا (38 → 40) عوضا  
عن الطبيعي (36 → 38)

زيادة الحرارة دليل على وجود مقاومة  
وحرب بين مسبب المرض وجهاز  
المناعة

نتائج الحرب تعتمد على

- ① كمية ال pathogen
- ② قوة جهاز المناعة

Figure 40.16



③ الالهت  
Panting

إذا زادت الحرارة عن 38  
ال neurons  
سوف تنقل  
إشارات إلى  
hypothalamus

to increase heat loss  
توسيع

الحالة الطبيعية / عن مرضه

من الجو / الأكل / الرياضة  
الحالة الأولى

الحالة الثانية

من الجو  
أقل من 36

يتضيق  
يوري إشارات إلى

Response: Shivering: generates heat  
الرعدة

Figure 40.16a

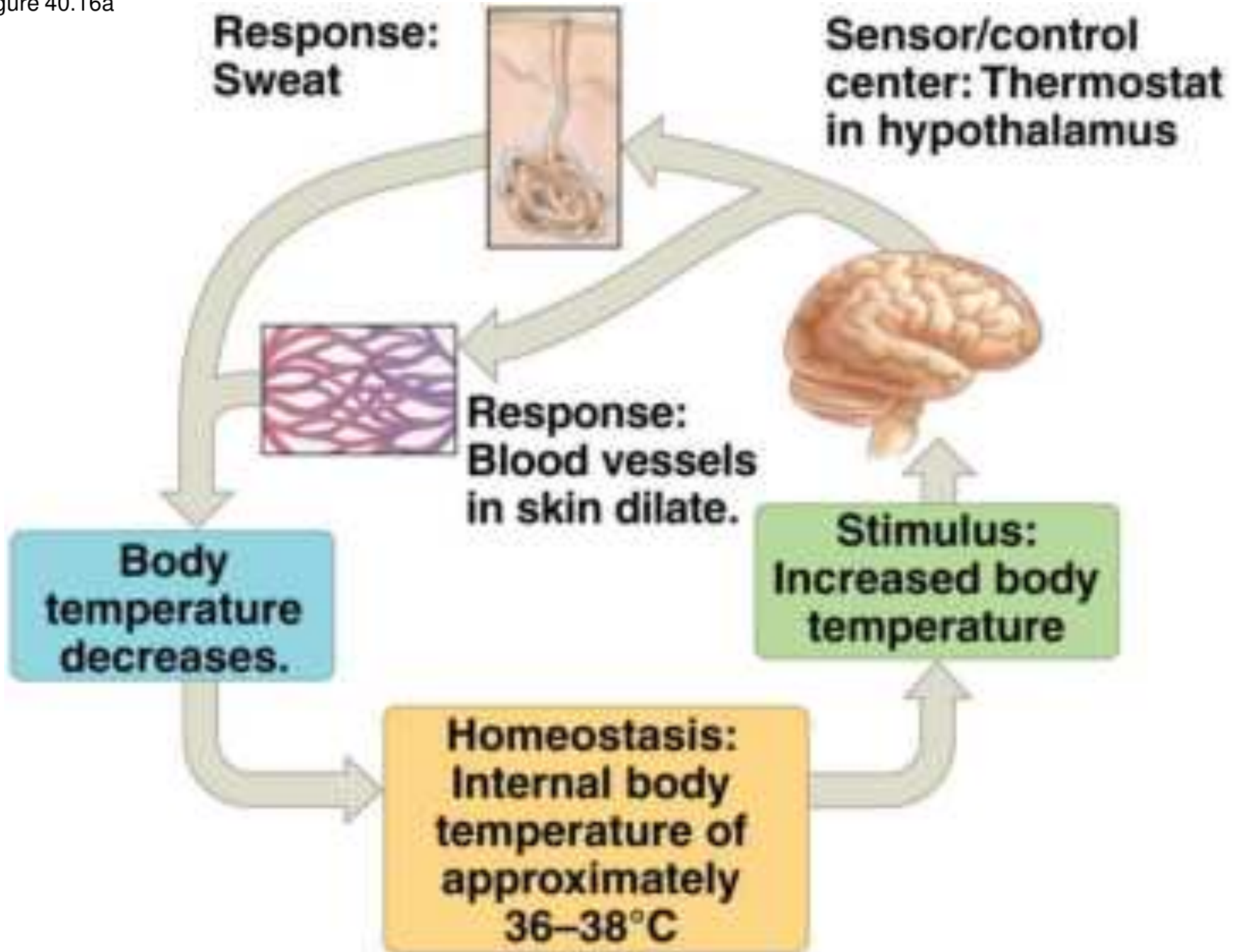
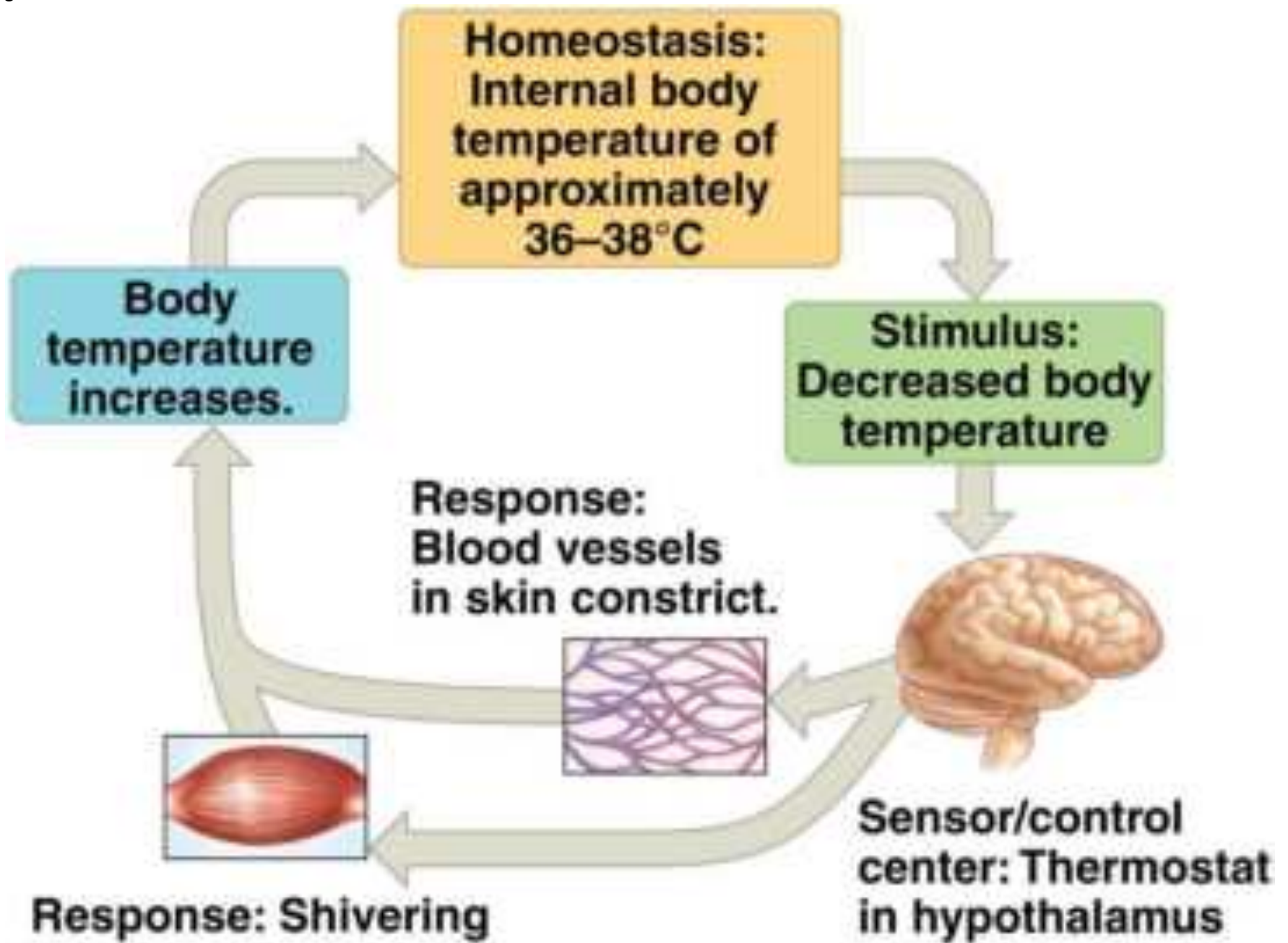


Figure 40.16b



متطلبات الجسم من الطاقة وعلى ماذا تعتمد

# Concept 40.4: Energy requirements are related to animal size, activity, and environment

عاشت  
بالقطب  
أد بالأرض

حوله / ظهرها  
ناهي / ضيف

مصدر الطاقة  
عنا: food

العلم الذي يدرس احتياجات

**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**

واحد قاعد  
وواحد بركض

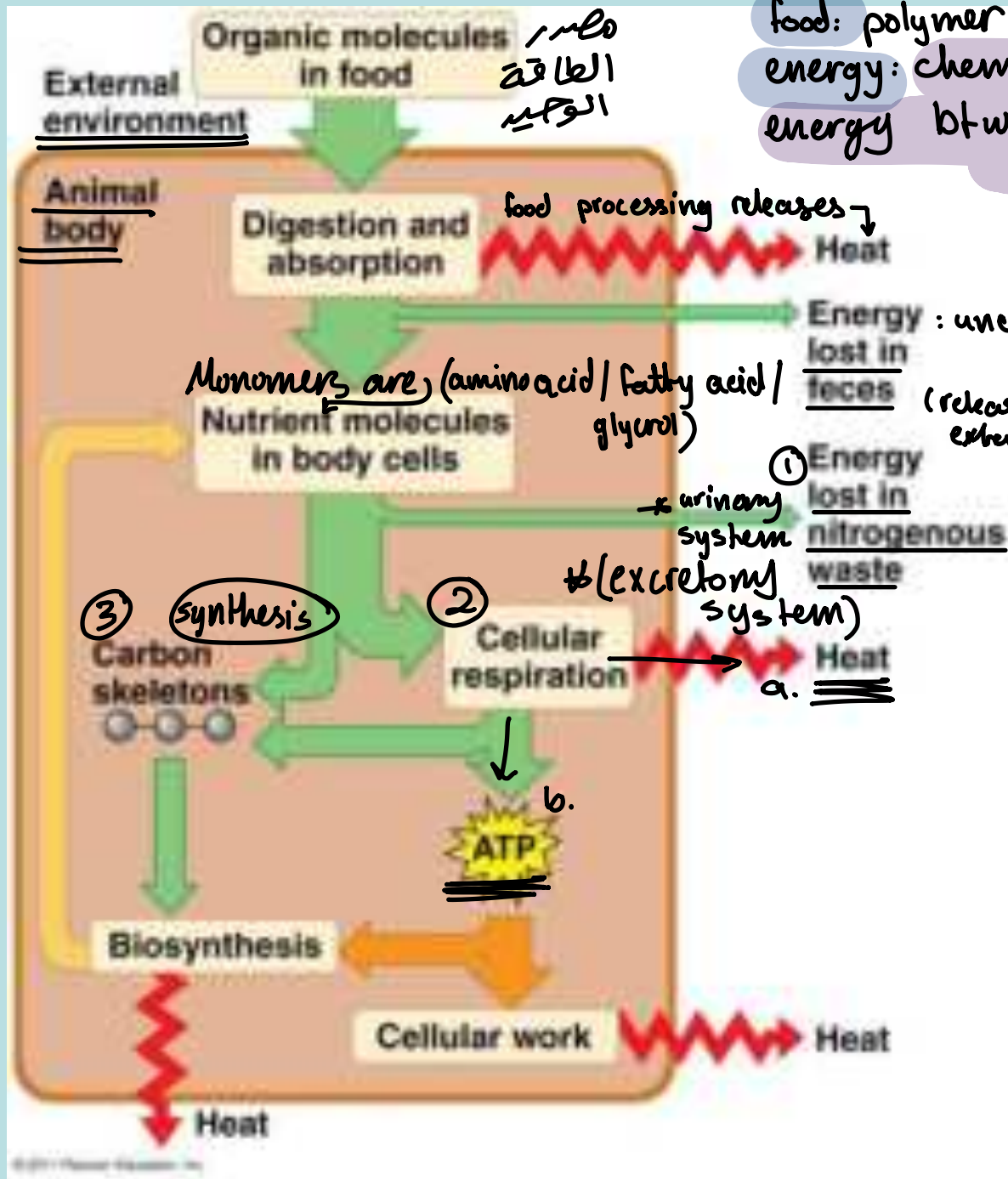
• الجسم  
الطاقة  
وتحولات  
الطاقة



# توزيع الطاقة داخل الجسم Energy Allocation and Use

- 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



food: polymer of organic molecules  
 energy: chemical energy btw its bonds

Monomers are (amino acid / fatty acid / glycerol)  
 Energy lost in feces (released to external environment)

① Energy lost in nitrogenous waste  
 \* urinary system (excretory system)

③ Synthesis

② Cellular respiration

ATP  
 b.

a.



# Quantifying Energy Use

- **Metabolic rate** <sup>معدل الأيض</sup> is the amount of energy an animal uses in a unit of time

نقيس  
قدية • Metabolic rate can be determined by

عم نعمل  
cellular  
respiration – An animal's heat loss <sup>1.</sup>  $\rightarrow$  calorimeter  
 $\downarrow$  thermometer

The amount of oxygen consumed <sup>2.</sup> or carbon dioxide produced <sup>3.</sup>

Energy is measured in:

- joule (J)

- calories (cal)

- kilocalories (C) capital C means kilocalorie

(as used by many nutritionists)

1 kilocalorie = 1000 calories = 4184 joule

metabolic rate in endotherm > in ectotherm

إذا كانت باقي  
العمل ثابتة

لذلك طرق قياسها  
تختلف بينهم

Figure 40.18



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# Minimum Metabolic Rate and Thermoregulation

20  
↓

Animals must maintain a minimum metabolic rate for basic functions such as cell maintenance, breathing, and circulation. Researchers measure this minimum metabolic rate differently for endotherms and ectotherms.

- **Basal metabolic rate (BMR)** is the metabolic rate of an **endotherm** at **rest** at a “comfortable” temperature  
*not growing / fasting / not in stress*  
*↳ isn't eating*

معدل حرارة ثابتة  
جسمه

**Standard metabolic rate (SMR)** is the metabolic rate of an **ectotherm** at rest at a specific temperature

أحنا نختار الحرارة لأن  
هو ما زال حرارة ثابتة

- 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

#4 age  
الصغار أكثر

#5 sex  
male  
أكثر

#6 Temperature  
في المناطق التي  
تعيش بها

#7 nutrition

#2 → طول 2m  
#3 → طول 1.5m

مع هذا  
العكس  
واضاف في  
من الكتاب

# Size and Metabolic Rate

elephant > mouse

- 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

كثافة استهلاك  
1 kg elephant vs 1 kg mouse

e.i : elephant → mouse  
 ينبض قلبه 60 مرة / دقيقة  
 ينبض أكثر من 60 مرة / دقيقة  
 Breathing rate ↑  
 ورج يكون more active

The relationship of metabolic rate to size profoundly affects energy consumption by body cells and tissues.

As shown in **Figure 40.20b**, the energy it takes to maintain each gram of body mass is inversely related to body size. Each gram of a mouse, for instance, requires about 20 times as many calories as a gram of an elephant, even though the whole elephant uses far more calories than the whole mouse. The smaller animal's higher metabolic rate per gram demands a higher rate of oxygen delivery. To meet this demand, the smaller animal must have a higher breathing rate, blood volume (relative to its size), and heart rate.

[Thinking about body size in bioenergetic terms reveals how trade-offs shape the evolution of body plans] As body size decreases, each gram of tissue increases in energy cost. As body size increases, energy costs per gram of tissue decrease, but an ever-larger fraction of body tissue is required for exchange, support, and locomotion.

منه الكتاب  
لم تذكرها  
الدكتورة

20



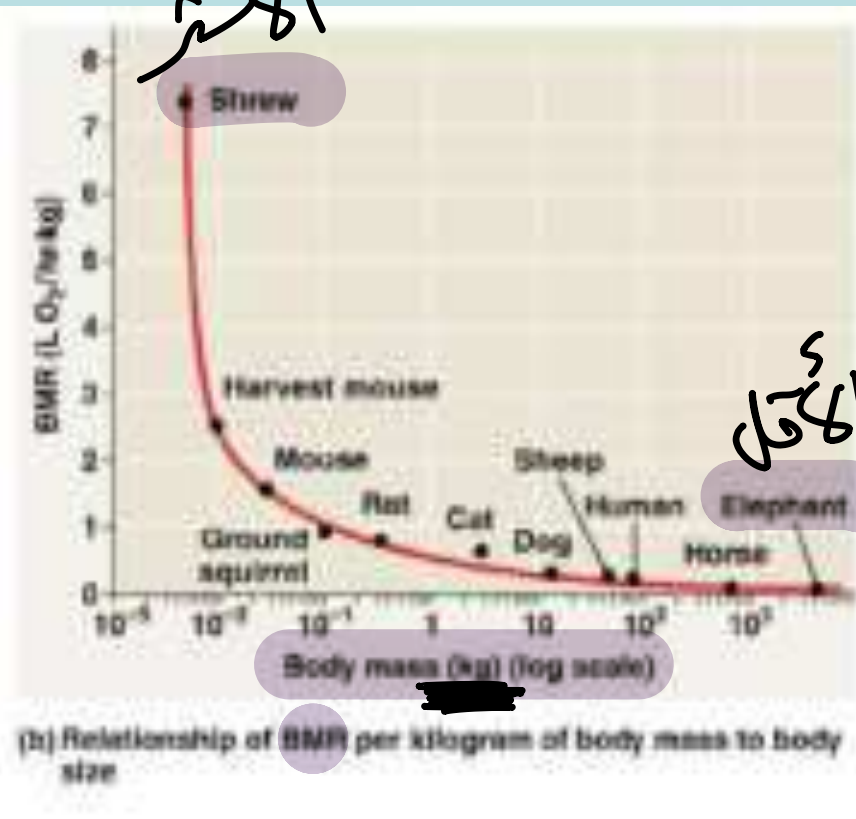
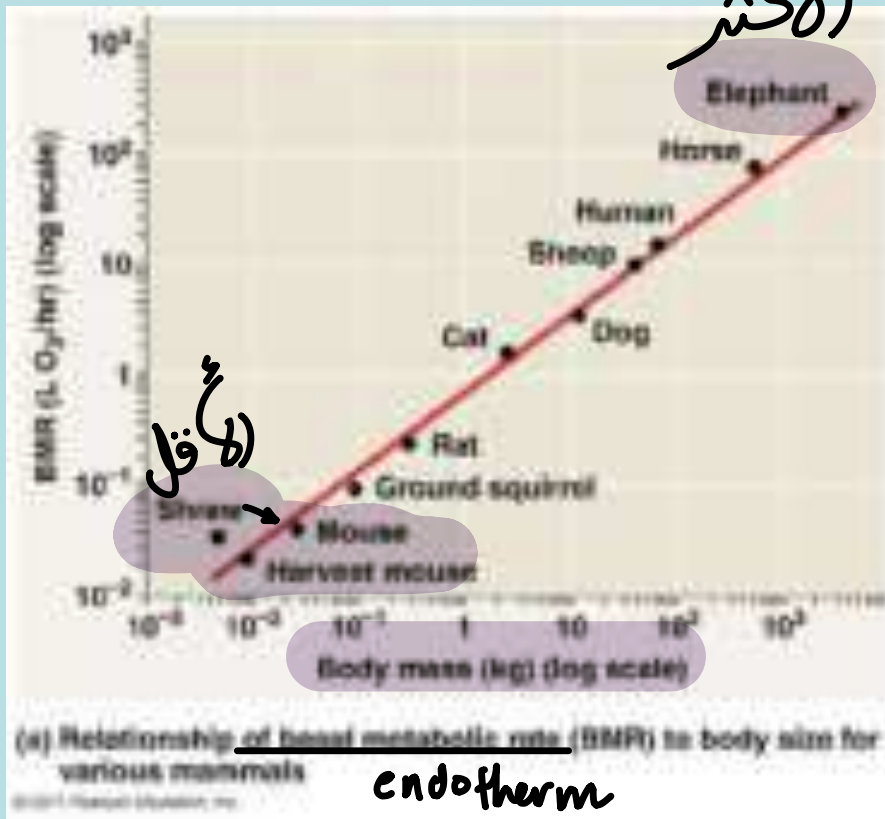
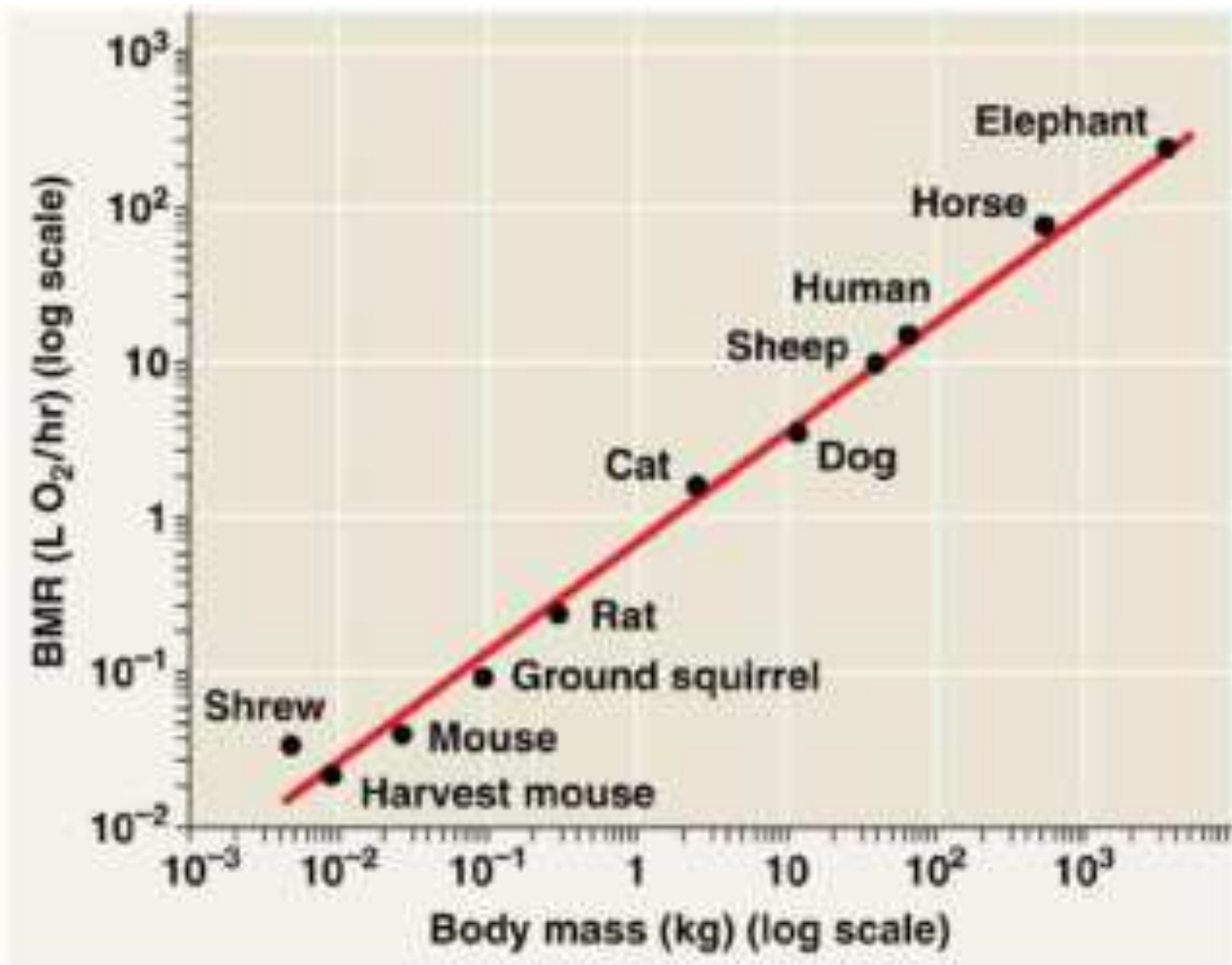
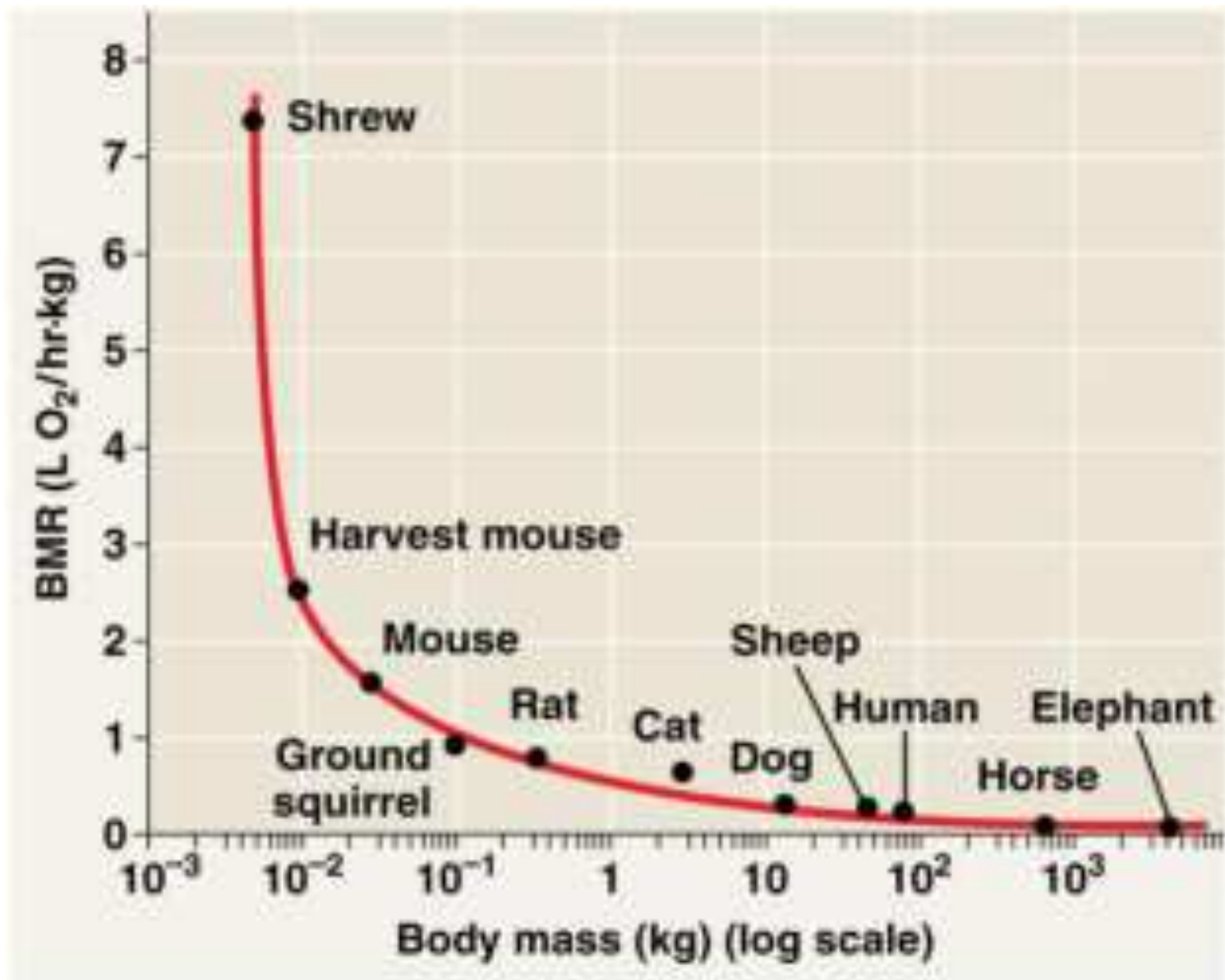


Figure 40.19a



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

Figure 40.19b



(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

Maximum metabolic rates (the highest rates of ATP use) occur during peak activity, such as lifting a heavy object, sprinting, or swimming at high speed. In general, the maximum metabolic rate an animal can sustain is inversely related to the duration of activity.

كل ما زاد  
activity

يزداد  
metabolic  
rate

حتى نوصف  
peak  
of the → peak of  
activity metabolic  
rate

تزيد كلما زاد  
الوقت الذي يستمر فيه

# 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

# ENERGY BUDGETS:

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

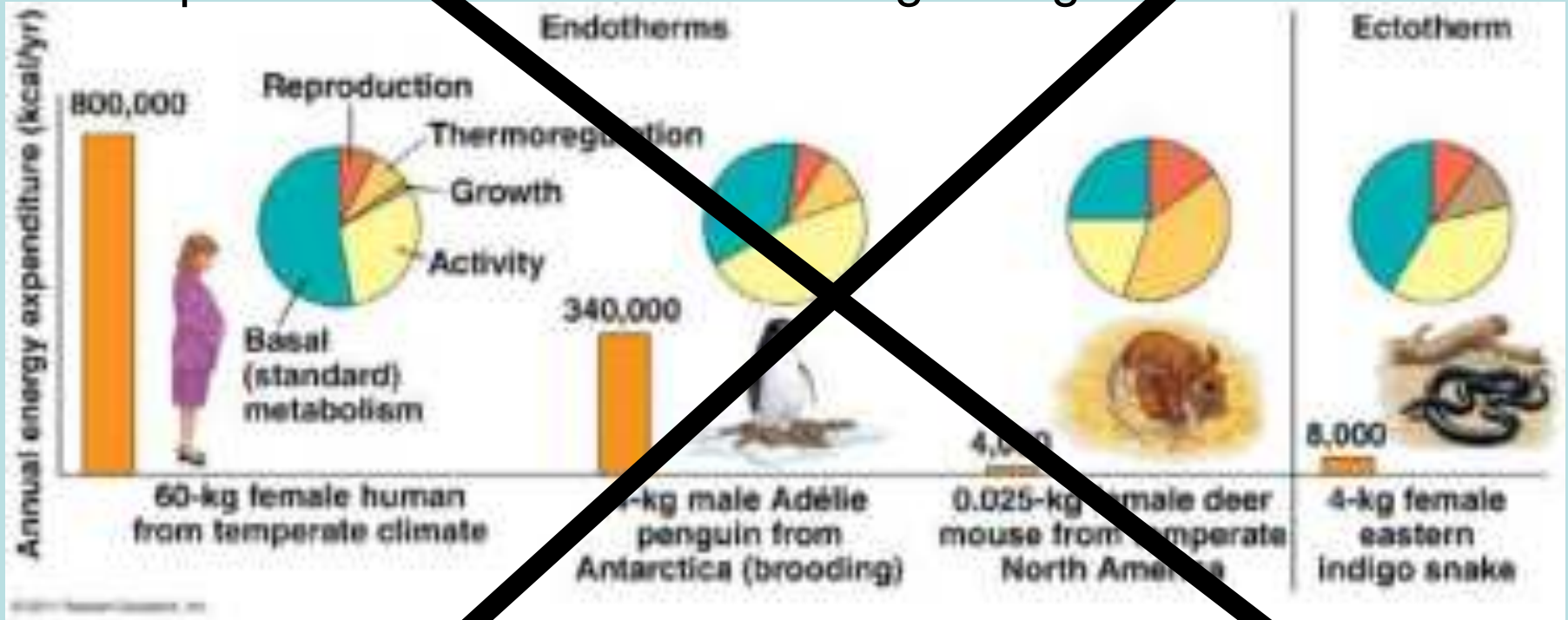




Figure 40.20a

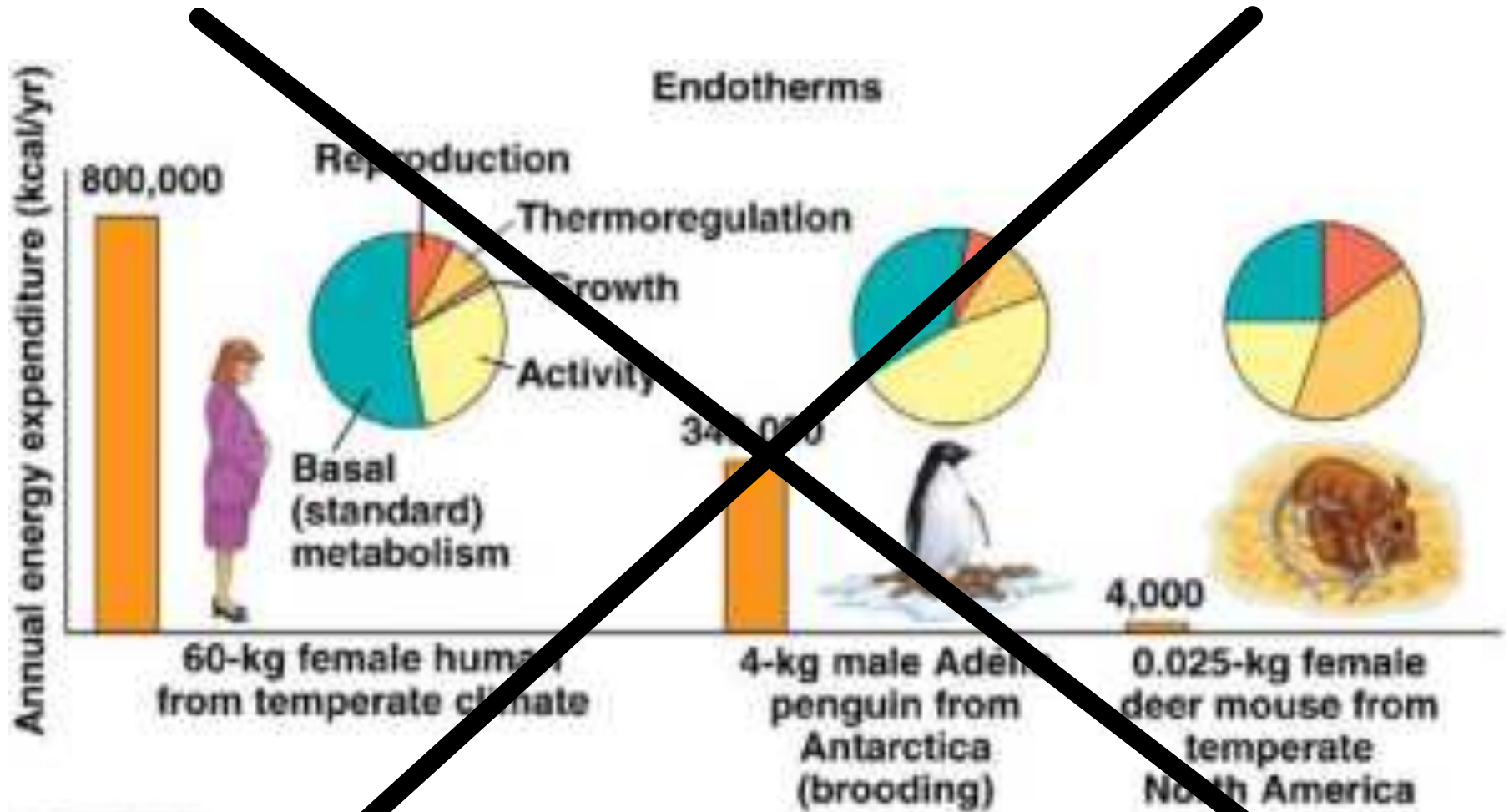
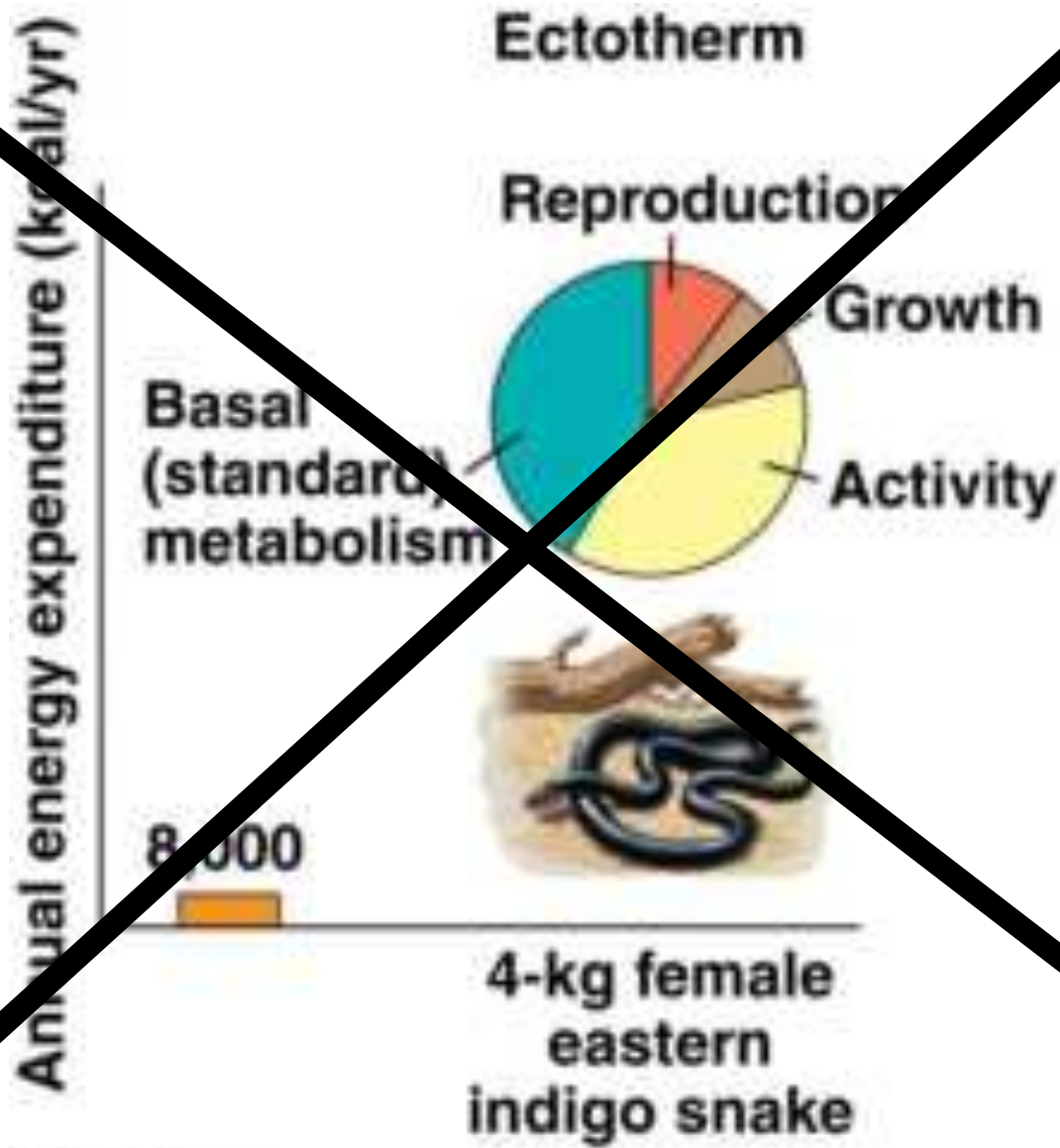




Figure 40.20b

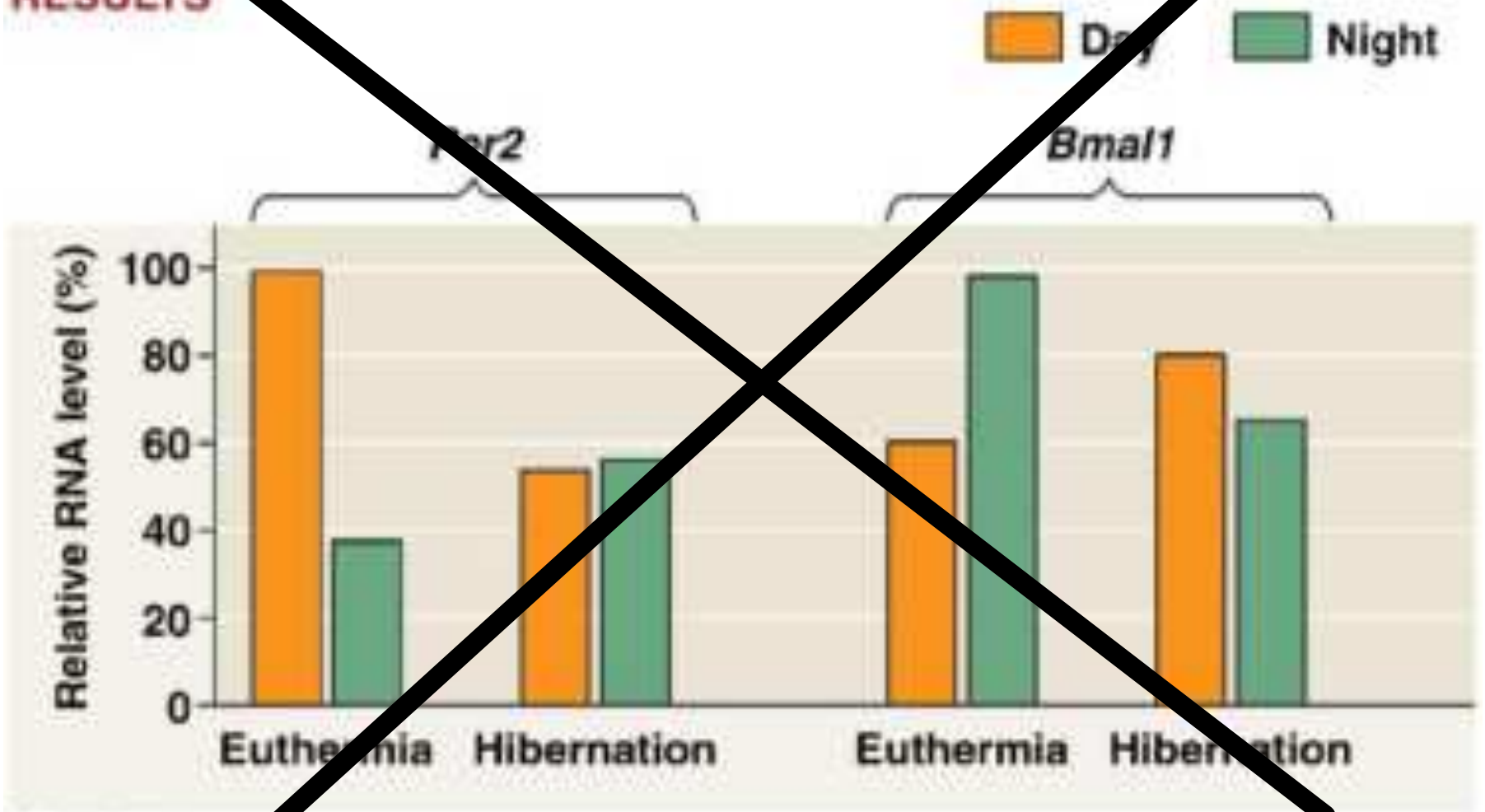


# Torpor and Energy Conservation

- **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

**RESULTS**



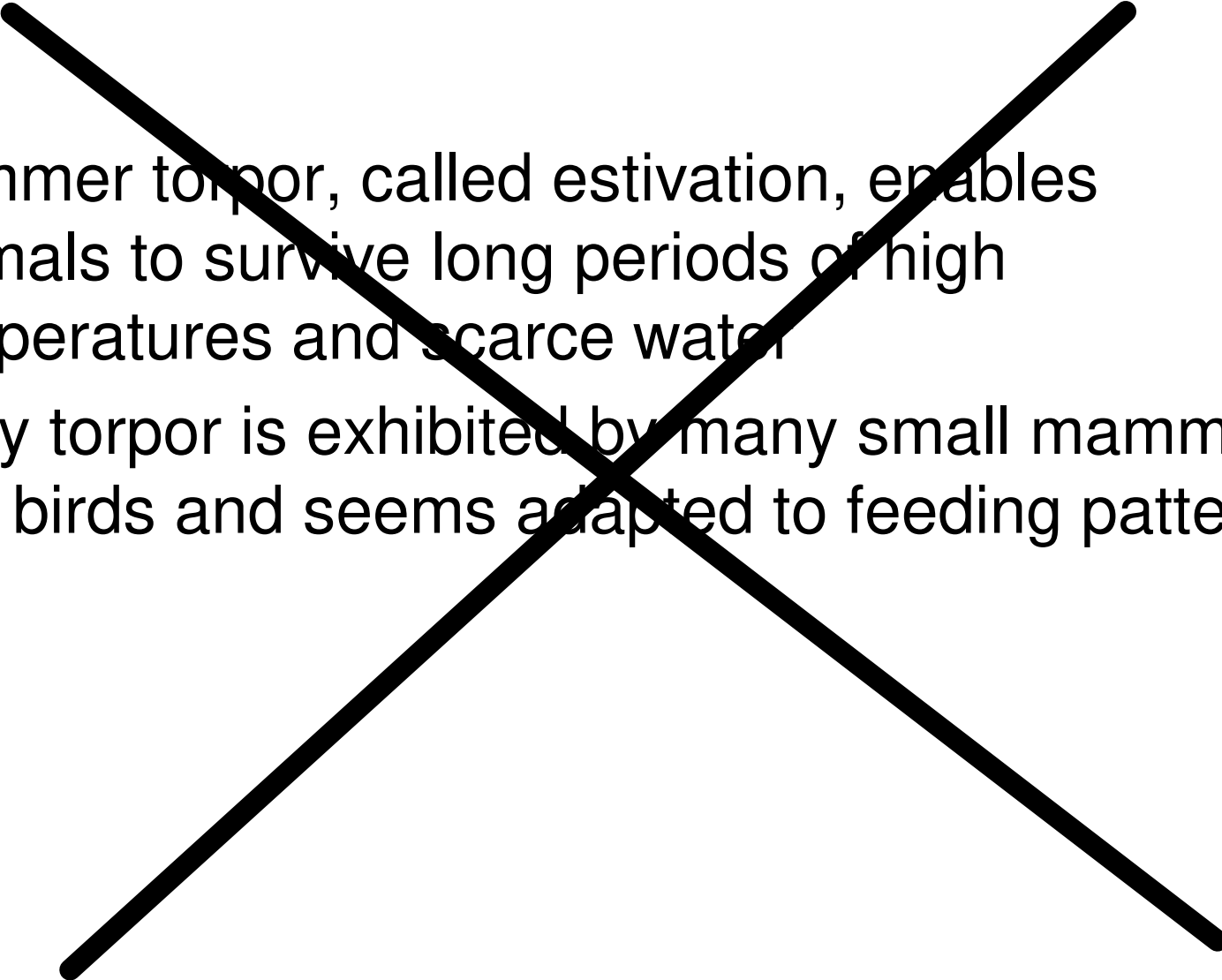
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- Summer torpor, called estivation, enables animals to survive long periods of high temperatures and scarce water
  - Daily torpor is exhibited by many small mammals and birds and seems adapted to feeding patterns

Figure 40.UN01

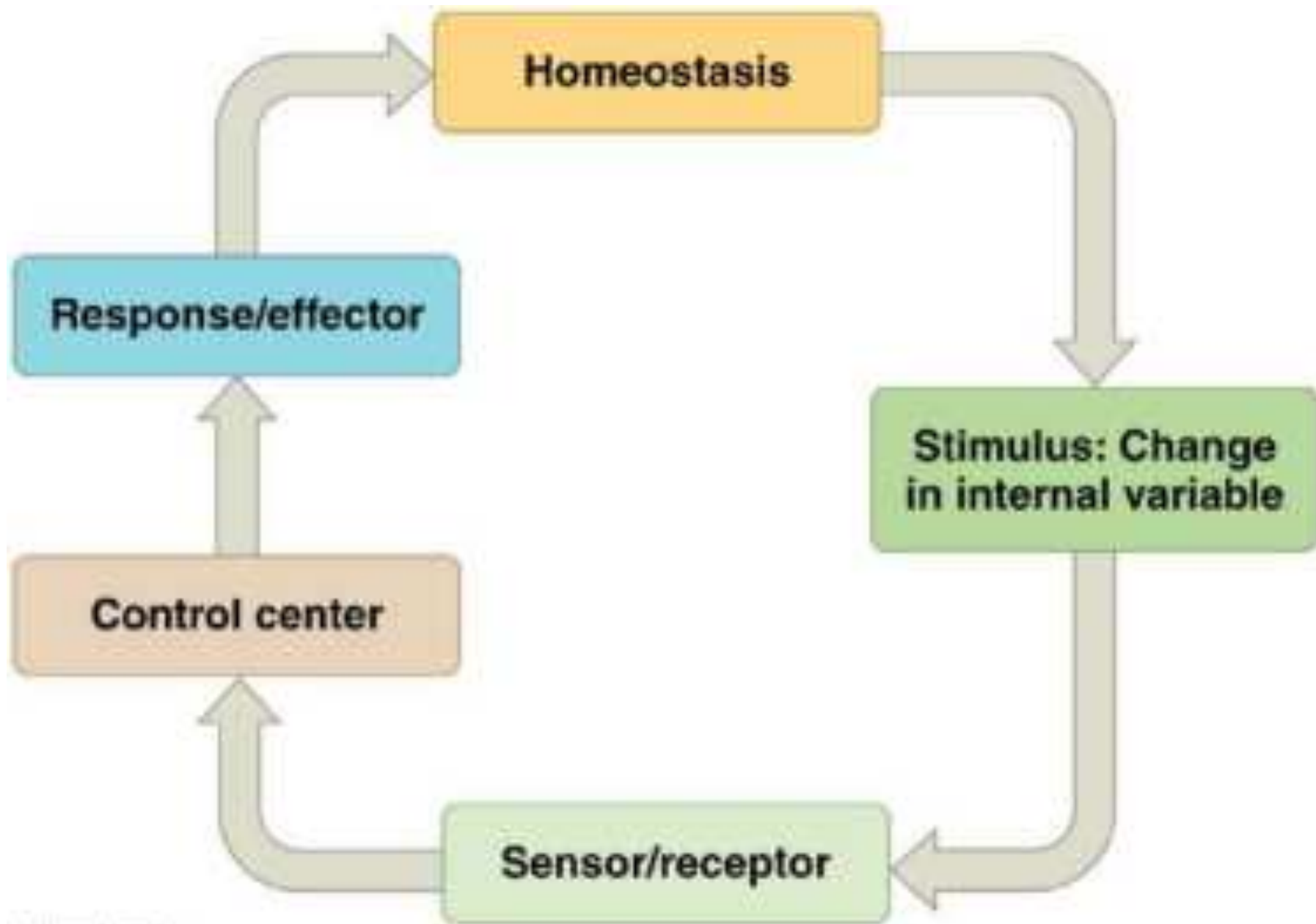


Figure 40.UN02

