تَنوير

BIOLOGY

Lec no :

File Title : Chapter 40 summary

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وَقُل رَّبِّ زِدْنِي عِلْمًا

Anatomy: Biological structure علم التشريح

Physiology: Biological function علم وظائف الأعضاء

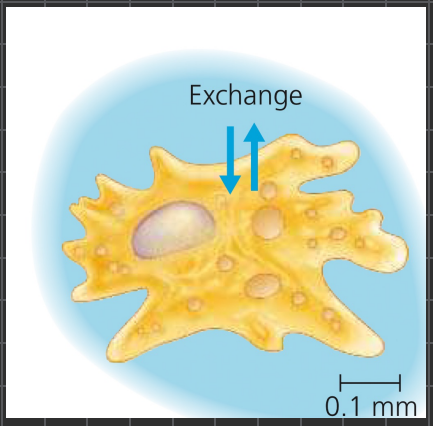
Animals must exchange nutrients, gases, and waste products with the environment

Body plan: The shape and size of the body also called design

How does the body plan of each of these organisms affect the exchange with the environment surrounding them

Amoeba
single cell

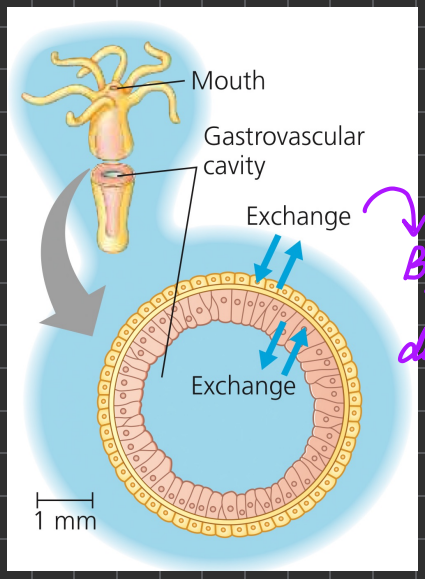
Has a large surface area



Hydra
Two cell layer thick

Because of it's تجويف معوي
Gastrovascular cavity

both outer and inner layers of cells are in contact with the pond water it lives in



By simple diffusion

الدودة الشريطية هي طفيلي يعيش داخل امعاء الانسان ويتغذى عليها

Tapeworm
multicellular

It's Flat shape

makes most of the worm cells in contact with the environment

it get the nutrients from

The intestinal fluid in vertebrates

Cell —(similar cells)→ Tissue —(different tissues)→ organ ⟶ Organ System

Some organs belong to more than one organ system because the have more than on physiological role

Like the pancreas: it produces enzymes important for digestion so it is a part of the digestive system, also it regulates the level of sugar in blood so it is a part of the endocrine system

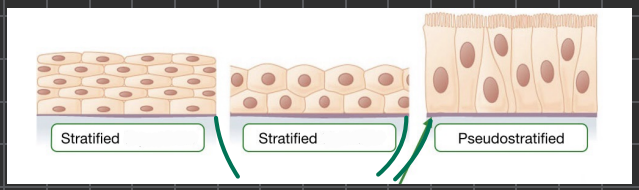
Some organs are made of the same kind of tissue but do different functions like: the lungs and blood vessels both are lined with tissues that ore of the same basic type

Types of Tissues

Epithelial | Connective | Muscle | Nervous

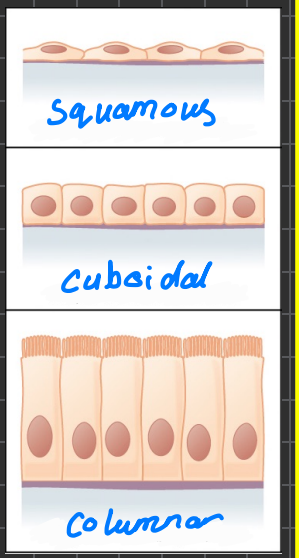
Classified based on:

1) complexity
   - simple one layer
   - stratified multiple layers
   - pseudostratified one layer



basil lamina or basil surface

2) shape of the cell
   - Squamous
   - Cuboidal
   - Columnar



simple because it is one layer

when you name the Epithelial tissue start with the complexity then the cell shape

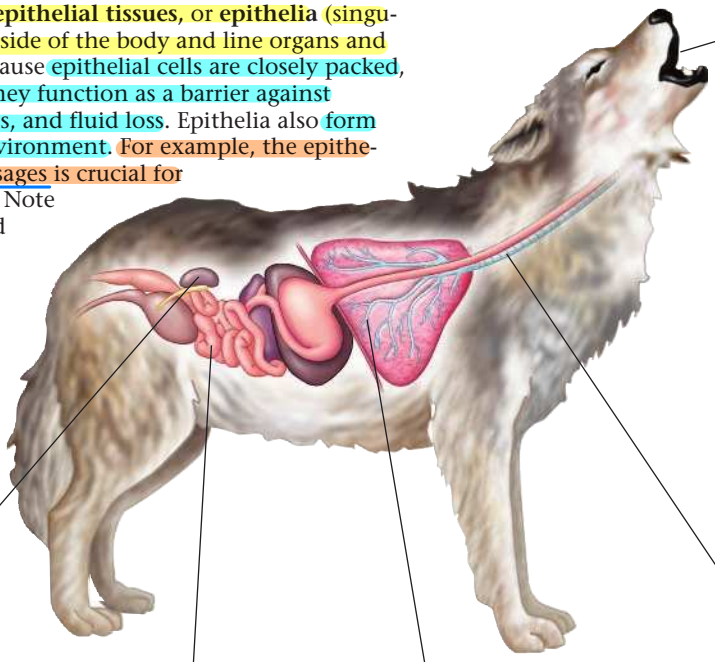
simple / stratified / pseudostratified + squamous / cuboidal / columnar

▼ Figure 40.5 Exploring Structure and Function in Animal Tissues

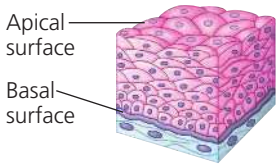
Epithelial Tissue

Occurring as sheets of cells, **epithelial tissues**, or **epithelia** (singular, *epithelium*), cover the outside of the body and line organs and cavities within the body. Because epithelial cells are closely packed, often with tight junctions, they function as a barrier against mechanical injury, pathogens, and fluid loss. Epithelia also form active interfaces with the environment. For example, the epithelium that lines the nasal passages is crucial for olfaction, the sense of smell. Note how different cell shapes and arrangements correlate with distinct functions.

Mastering Biology
Animation: Epithelial Tissue

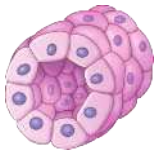


Stratified squamous epithelium



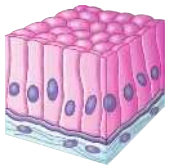
A stratified squamous epithelium is multilayered and regenerates rapidly. New cells formed by division near the basal surface push outward, replacing cells that are sloughed off. This epithelium is commonly found on surfaces subject to abrasion, such as the outer skin and the linings of the mouth, anus,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

Cuboidal epithelium



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.

Simple columnar epithelium

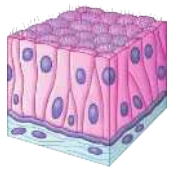


The large, brick-shaped cells of simple columnar epithelia are often found where secretion or active absorption is important. For example, a simple columnar epithelium lines the intestines, secreting digestive juices and absorbing nutrients.

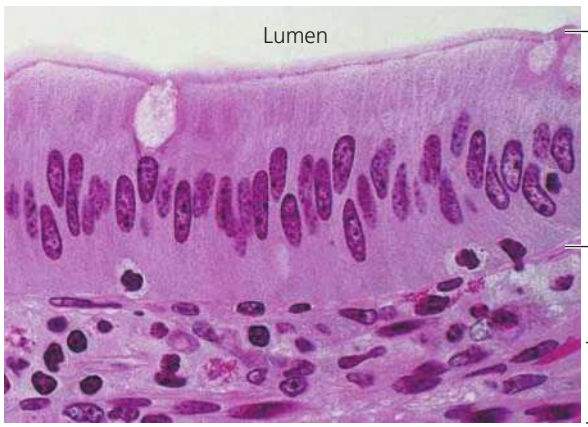
Simple squamous epithelium

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 of the lungs, where diffusion of nutrients and gases is essential.

Pseudostratified columnar epithelium



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



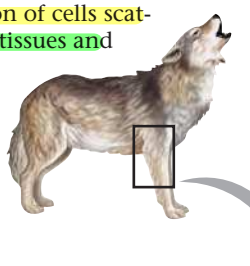
Polarity of epithelia

All epithelia are polarized, meaning that they have two different sides.[1] The *apical* surface faces the lumen (cavity) or outside of the organ and is therefore exposed to fluid or air. Specialized projections often cover this surface. For example, the apical surface of the epithelium lining the small intestine is covered with microvilli, projections that increase the surface area available for absorbing nutrients.[2] Opposite the apical surface of each epithelium is the *basal* surface.

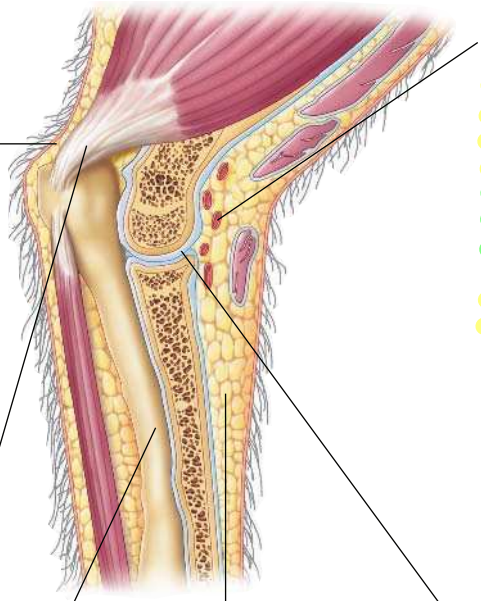
Connective Tissue

Connective tissue, consisting of a sparse population of cells scattered through an extracellular matrix, holds many tissues and organs together and in place. The matrix generally consists of a web of fibers embedded in a liquid, jellylike, or solid foundation. Within the matrix are numerous cells called **fibroblasts**, which secrete fiber proteins, and **macrophages**, which engulf foreign particles and any cell debris by phagocytosis.

Connective tissue fibers are of three kinds: *Collagenous fibers* provide strength and flexibility, *reticular fibers* join connective tissue to adjacent tissues, and *elastic fibers* make tissues elastic. If you pinch a fold of tissue on the back of your hand, the collagenous and reticular fibers prevent the skin from being pulled far from the bone, whereas the elastic fibers restore the skin to its original shape when you release your grip. Different mixtures of fibers and foundation form the major types of connective tissue shown below.

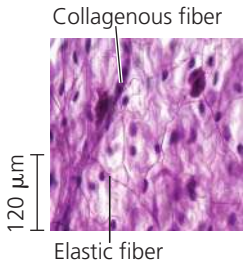


Mastering Biology **Animation: Connective Tissue**



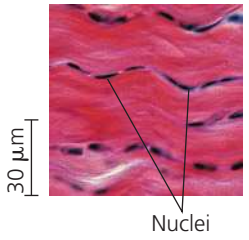
Loose connective tissue

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.



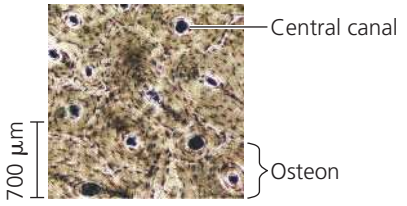
Fibrous connective tissue

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.



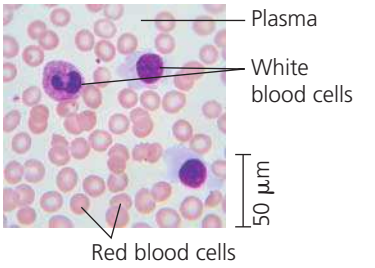
Bone

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.



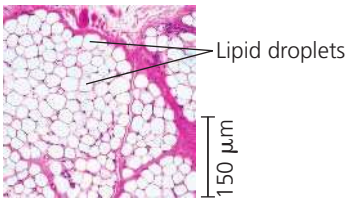
Blood

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.



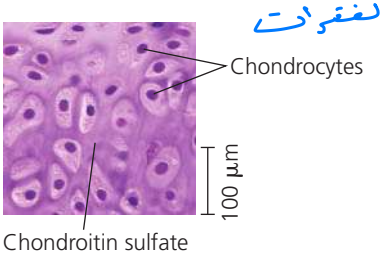
Adipose tissue

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



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.



Connective tissue

Function : 1) Holds organs together
2) Holds organs in place
3) Holds tissues

Connective tissue fibers

Collagenous
Provides strength and flexability

Reticular
Join tissues together

Elastic
provides elasticity

Kinds of Connective tissues

Loose
made of all three Fiber kinds

Found in skin

Fibrous
Dense collagenous Fibers

Found in ligaments and tendons

Bone
Bone-forming cells called osteoblasts deposit a matrix of collagen. Calcium, magnesium, and phosphate ions combine into a hard mineral within the matrix.

Adipose
A specialized loose connective tissue that stores fats in adipose cells

Cartilage
Collagenous fibers embedded in chondroitin sulfate

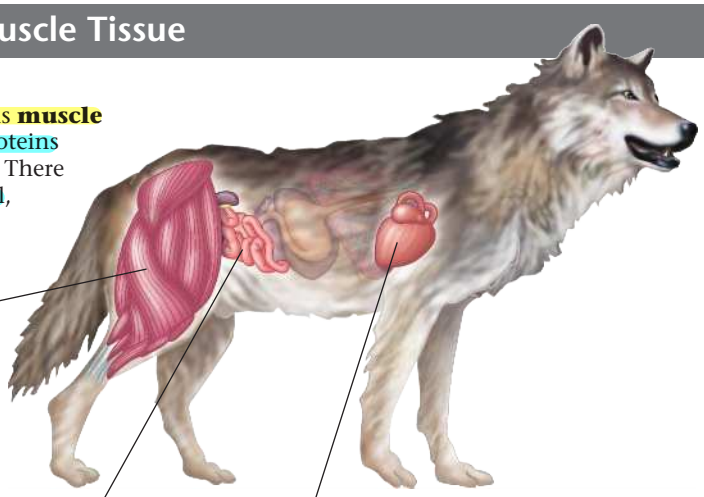
Found in the skeleton of many vertebrate embryos (it is replaced by bone as the embryo mature) also found in disks between the vertebrae

Blood
Contains plasma which consist of water, salt, and dissolved proteins

Muscle Tissue

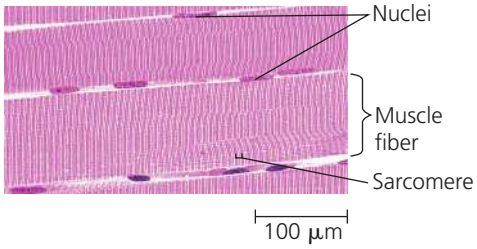
The tissue responsible for nearly all types of body movement is **muscle tissue**. All muscle cells consist of filaments containing the proteins actin and myosin, which together enable muscles to contract. There are three types of muscle tissue in the vertebrate body: skeletal, smooth, and cardiac.

Mastering Biology Animation: Muscle Tissue



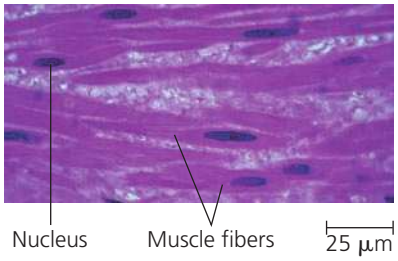
Skeletal muscle

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.



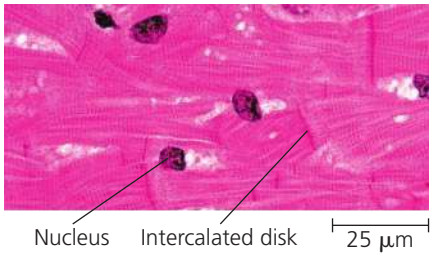
Smooth muscle

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.



Cardiac muscle

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.



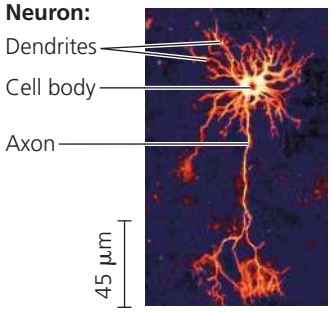
Nervous Tissue

Nervous tissue functions in the receipt, processing, and transmission of information. Nervous tissue contains **neurons**, or nerve cells, which transmit nerve impulses, as well as support cells called **glial cells**, or simply **glia**. In many animals, a concentration of nervous tissue forms a brain, an information-processing center.

Mastering Biology Animation: Nervous Tissue

Neurons

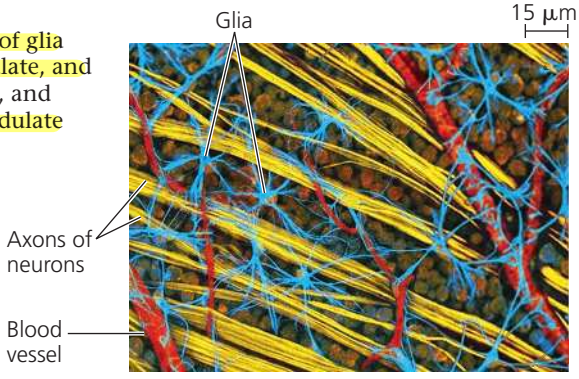
Neurons are the basic units of the nervous system. A neuron receives nerve impulses from other neurons via its cell body and multiple extensions called dendrites. Neurons transmit impulses to neurons, muscles, or other cells via extensions called axons, which are often bundled together into nerves.



(Fluorescent LM)

Glia

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



(Confocal LM)

Muscle tissue

Responsible for almost all body movement

Consist of filaments of actin protein associated with myosin protein

Kinds of muscle tissues

Skeletal

Attached to the bones by tendons
Responsible for voluntary movement
Striated
The muscle fiber has more than one nuclei
When building muscles the size increase but not the number of muscle fibers

Smooth

Found in digestive tract (pharynx, esophagus, stomach, intestines) urinary bladder, arteries
Responsible for involuntary movement
Not striated

Cardiac

Forms the contractile wall of the heart (involuntary movement like smooth muscles)
Striated (the skeletal muscles)
Branched and interconnected by intercalated disks

Coordination and Control

By two systems

Endocrine system		Nervous system
Hormones	Signals	Nerve impulses
Hormones get out of the cell by exocytosis		
seconds to reach and have a long-lasting effect	Duration	Fraction of a second to reach and last for a fraction of a second
Affect only the cells with receptors for the hormone	Effect	Affect other neurons, muscles, cells and glands that produce secretions.
Through the bloodstream throughout the body	Transmission of signals	In long distance: The nerve impulse travels along the axons In short distance: Involves short-range chemical signals
TSH: Thyroid-stimulating hormone which only affect the cells in the thyroid glands making them release hormones increase oxygen consumption and heat production (Metabolism)	Example	the ability to distinguish different musical notes because each note's frequency activates neurons that connect to slightly different locations in the brain

The difference between endocrine and exocrine

- endocrine: when the secretions of the cell go in the blood
- exocrine: when the secretions of the cell don't go in blood, like going to the adjacent cell

Regulator: An animal that uses internal mechanism to control internal changes in the face of external fluctuations

Example: we humans regulate our body temperature regardless of the temperature in the surrounding environment

Conformer: An animal that changes it's internal conditions according to the external changes

Example: some kind of fishes change their temperature according to the temperature of the water it is in

- An animal can regulate some internal conditions - and conform to others

Homeostasis ⟶ Requires a control system

- Maintaining internal balance
- stay in a steady state

Examples: we humans maintain our body temperature to stay about 37°C, also we maintain glucose concentration in blood to stay 70-100 mg of glucose per 100 ml of blood as well as maintaining blood PH to be about 7.4

Set point: The value or range of a normal variable in body (تعريف عالكتاب)

Stimulus: A fluctuation in a variable above or below the set point

Response: A physiological activity that helps return the variable to the set point

Feedback control in Homeostasis

Negative feedback

A control mechanism that damps the stimulus

Plays a major role in Homeostasis

For example, when you exercise vigorously, you produce heat, which increases your body temperature. Your nervous system detects this increase and triggers sweating. The evaporation of sweat from your skin then cools your body, helping return body temperature to its set point and eliminating the stimulus.

Positive feedback

A control mechanism that amplifies the stimulus

Helps in the completion of Homeostasis process

For example, 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, ulti- mately causing the baby to be born.

Heat: is the thermal energy that is transferred from one body to another

Thermosregulation: The process that animals use to maintain their temperature at the normal range

Endothermic: means that an animal warms it self by heat generated by metabolism

Ectothermic: means that an animal gains heat from external sources

Most invertebrates, nonavian reptiles, amphibians and fishes

Humans, birds, mammals and insect species

Being an endothermic or ectothemic isn't exclusive

For an example a bird is mainly an endothermic but sometimes it may warm it self in the sun and by that it acts as an ectothermic

Endotherms need more energy than ectotherms

but ectotherms are more tolerate to fluctuations in their internal temperatures

Hypothalamus

responsible for thermoregulation and controls the circadian clock

Group of nerves

function as the thermostat

The mechanism

Heat gain

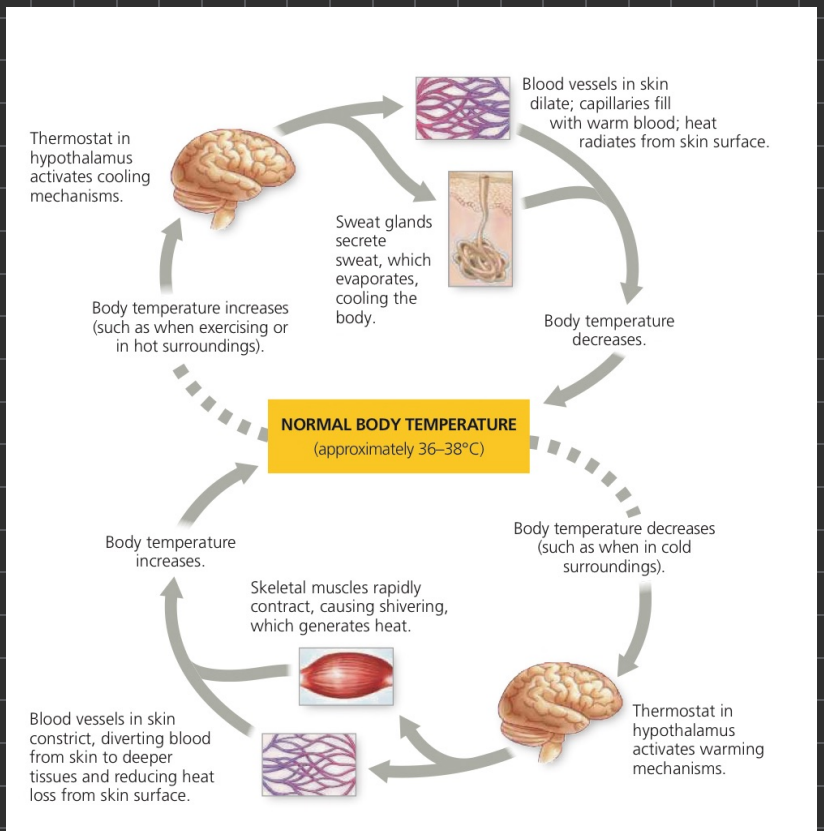
At body temperatures above the normal range, the hypothalamic thermostat promotes cooling of the body
by dilation of vessels in the skin, sweating, or panting

Heat loss

When body temperatures drop below the normal range, the thermostat inhibits heat loss mechanisms and activates mechanisms that either save heat, such as constricting vessels in the skin, or generate heat, such as shivering.

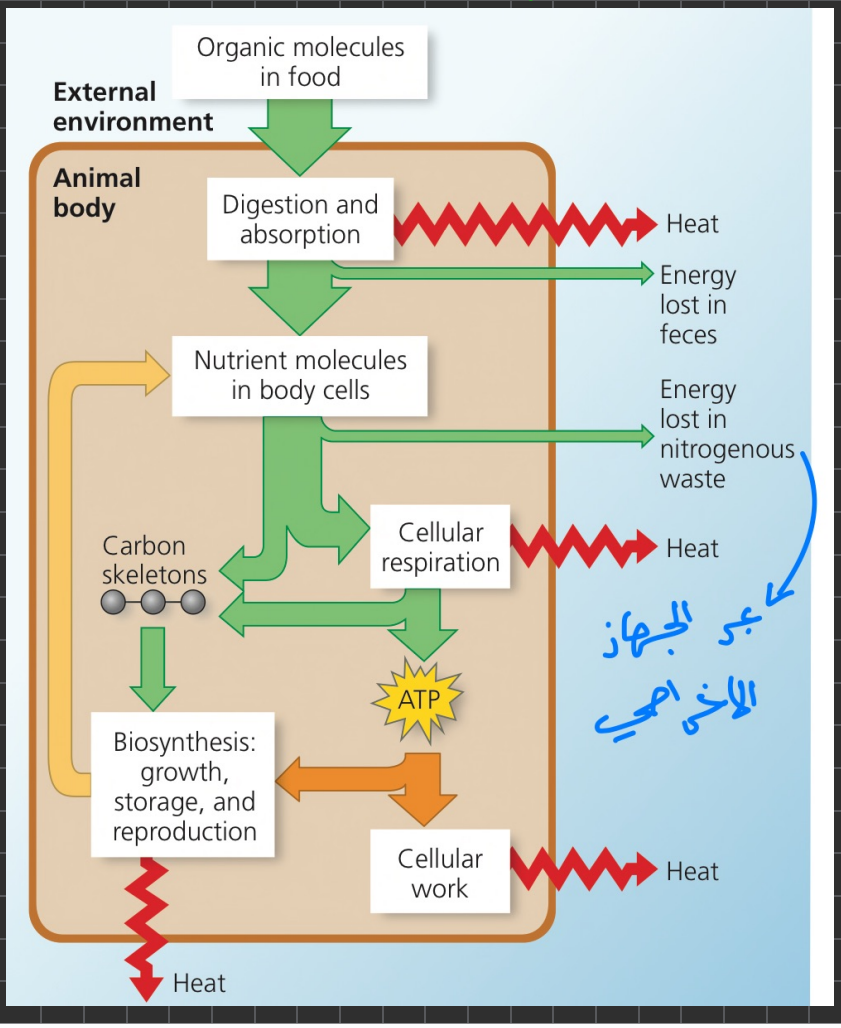
Fever caused by bacteria and viral infection

elevates/raises the body temperature



Bioenergetics: Is the overall flow and transformation of energy in an animal and it determines the nutritional needs

→ depends on ← size, activity, environment



Metabolic rate: The sum of energy consumed in a period of time

Energy is measured in: Calorie (cal), Joule (J), Kilocaloric (Kcal) also written Calorie with a capital C

Equals

1000 cal

4,184 J

Metabolic rate can be determined in several ways :

1) Metabolic rate can be measured by monitoring an animal's rate of heat loss. For this approach, researchers use a calorimeter, which is a closed, insulated chamber equipped with a device that records the heat an animal gives off to its environment.

2) Metabolic rate can also be determined from the amount of oxygen consumed or carbon dioxide produced by an animal's cellular respiration

3) To calculate metabolic rate over longer periods, researchers record the rate of food consumption, the energy content of the food (about 4.5-5 kcal per gram of protein or carbohydrate and about 9 kcal per gram of fat), and the chemical energy lost in waste products (feces and urine or other nitrogenous wastes).

Basal metabolic rate (BMR) : The minimum metabolic rate of a nongrowing endotherm that is at rest, has an empty stomach, and is not experiencing stress is called the
BMR is measured under a "comfortable" temperature range that requires only the minimum generation or shedding of heat.

Standard metabolic rate (SMR) : The metabolic rate of a fasting, nonstressed ectotherm at rest at a particular temperature

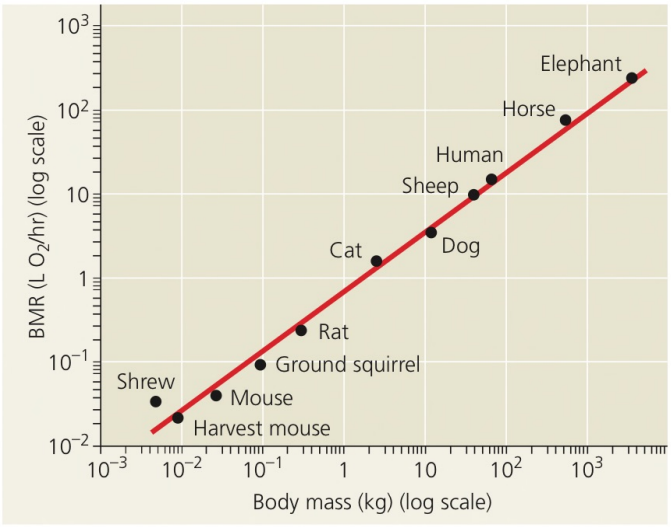
Metabolic rate is affected by:

1) Size ——→ proportionat to the body mass relating to this formula ($m^{3/4}$)

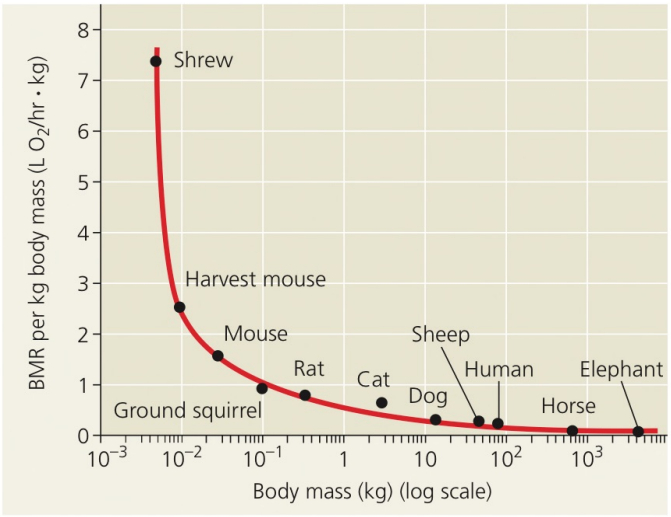
Energy cost increases for bigger animals (total body mass)

Energy cost increases for smaller animals per gram of body mass

▼ **Figure 40.20** **The relationship of metabolic rate to body size.**



(a) Relationship of basal metabolic rate (BMR) to body size for various mammals. From shrew to elephant, size increases 1 millionfold.



(b) Relationship of BMR per kilogram of body mass to body size for the same mammals as in (a).

2) Activity ⟶ metabolic rates increase as activity increase

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.