

Introduction to Physiology

**Course: Human Physiology
Dentistry**

Lecture No. 1

- 1. Levels of organization in the body**
- 2. Levels of Homeostasis and body fluids**

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What is Anatomy?

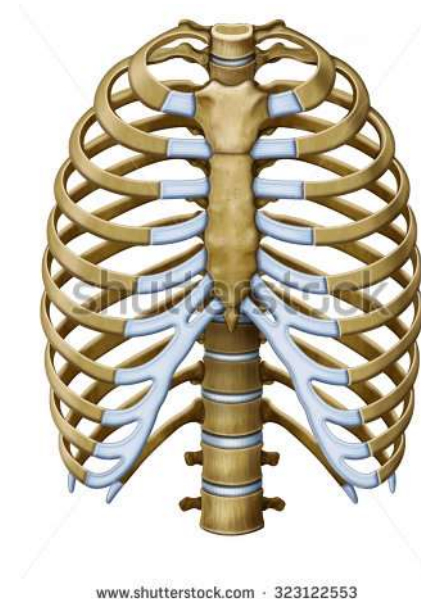
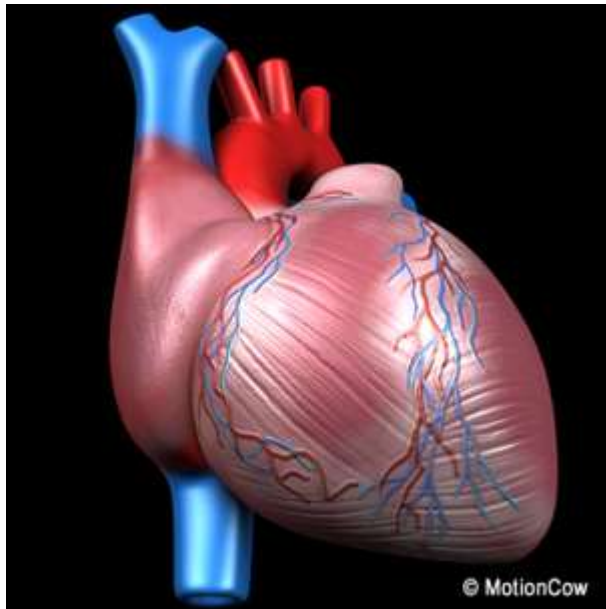
**The study of body
structures and the
relationships among
them**

What is Physiology?

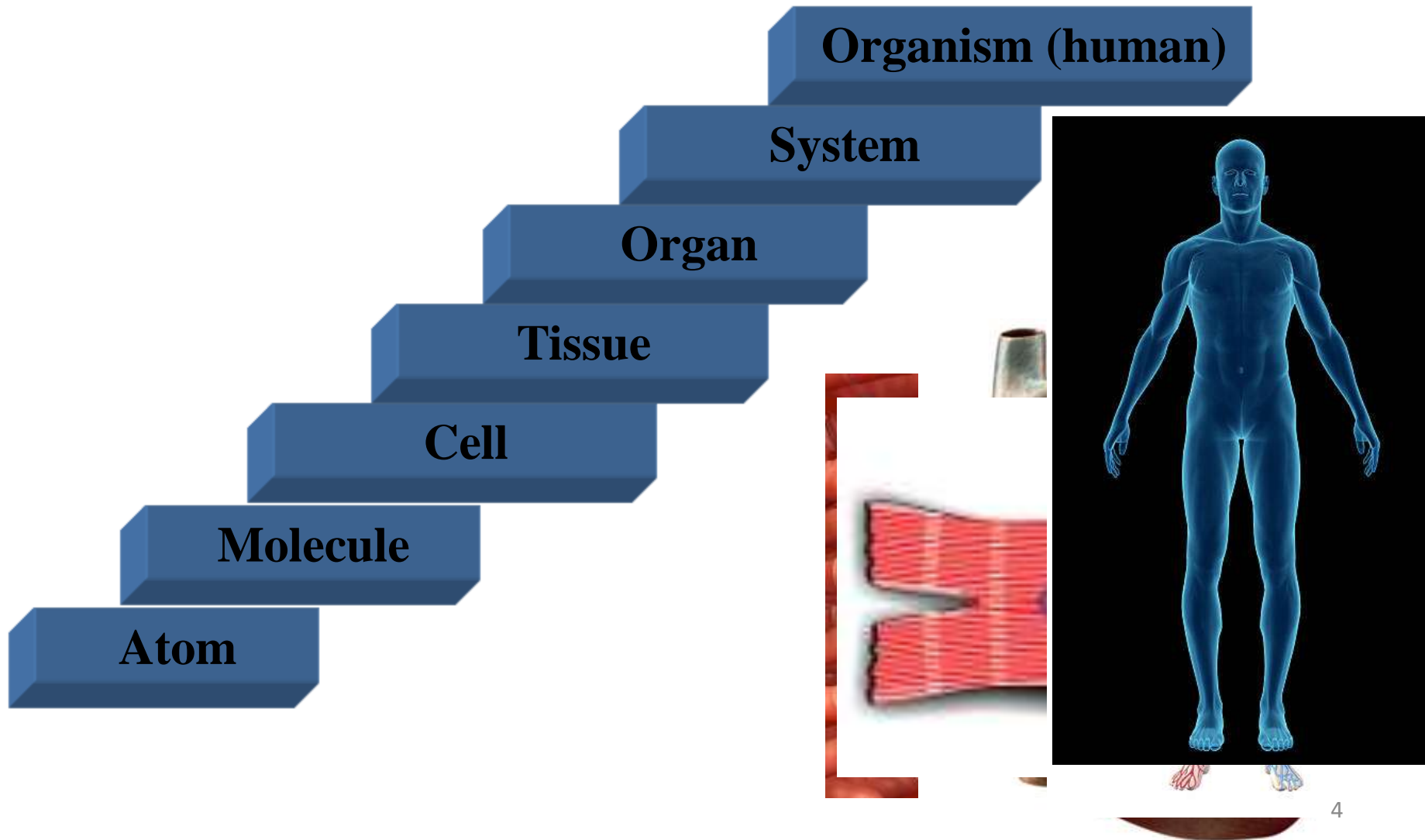
**The study of body
functions**

Structure-Function Relationship

Physiological mechanisms are possible through structural design



Levels of Organization in the Human Body



Cell

- ❑ **The basic unit of structure and function in the human body**
- ❑ **The smallest unit capable of carrying out the processes associated with life**



The amoeba above is made of only one cell and it must perform all the jobs of the organism

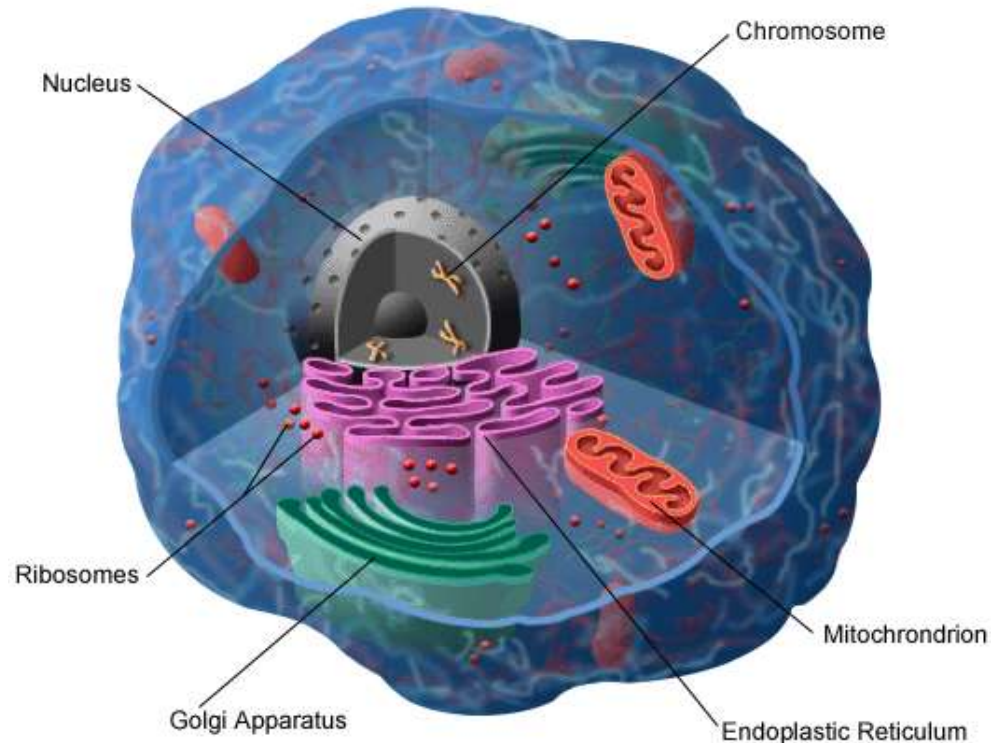


Sponge is multicellular, all cells are similar

Cell, basic unit of life

□ *Cell functions:* 1- *Basic* 2- *Specialized*

- *Basic cell functions:*
 - obtain food & O₂
 - perform chemical reactions
 - eliminate CO₂ & wastes
 - synthesize proteins & cell components



Tissue

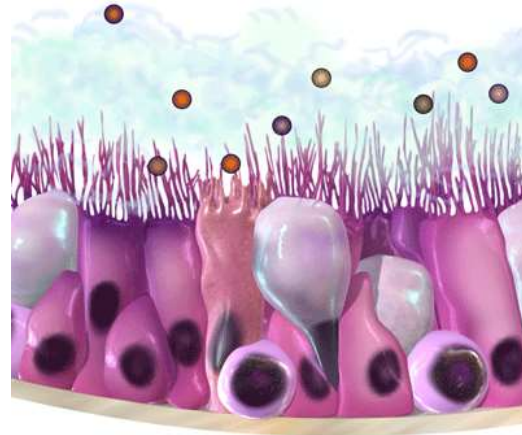
- ❑ **Groups of cells of similar structure & specialized functions**

- ❑ **4 primary tissue types**

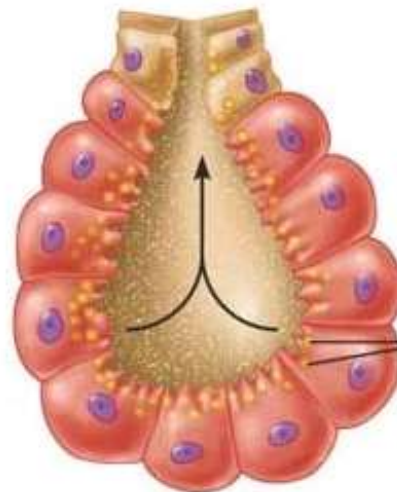
Tissue

Epithelial

Cells specialized for exchanging materials between cell & environment



Sheets
Skin, digestive tract lining

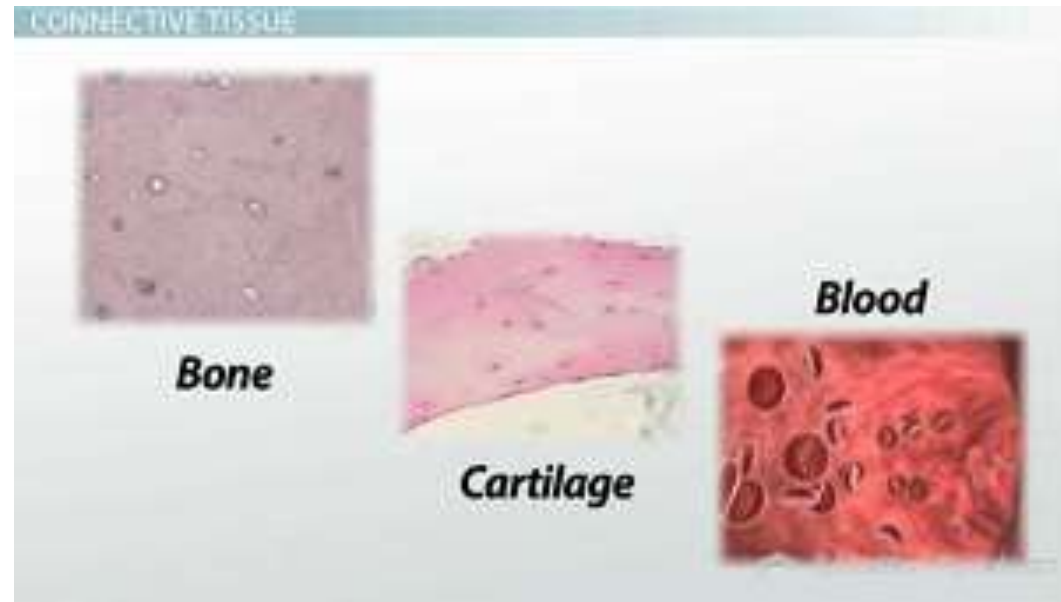


glands

Tissue

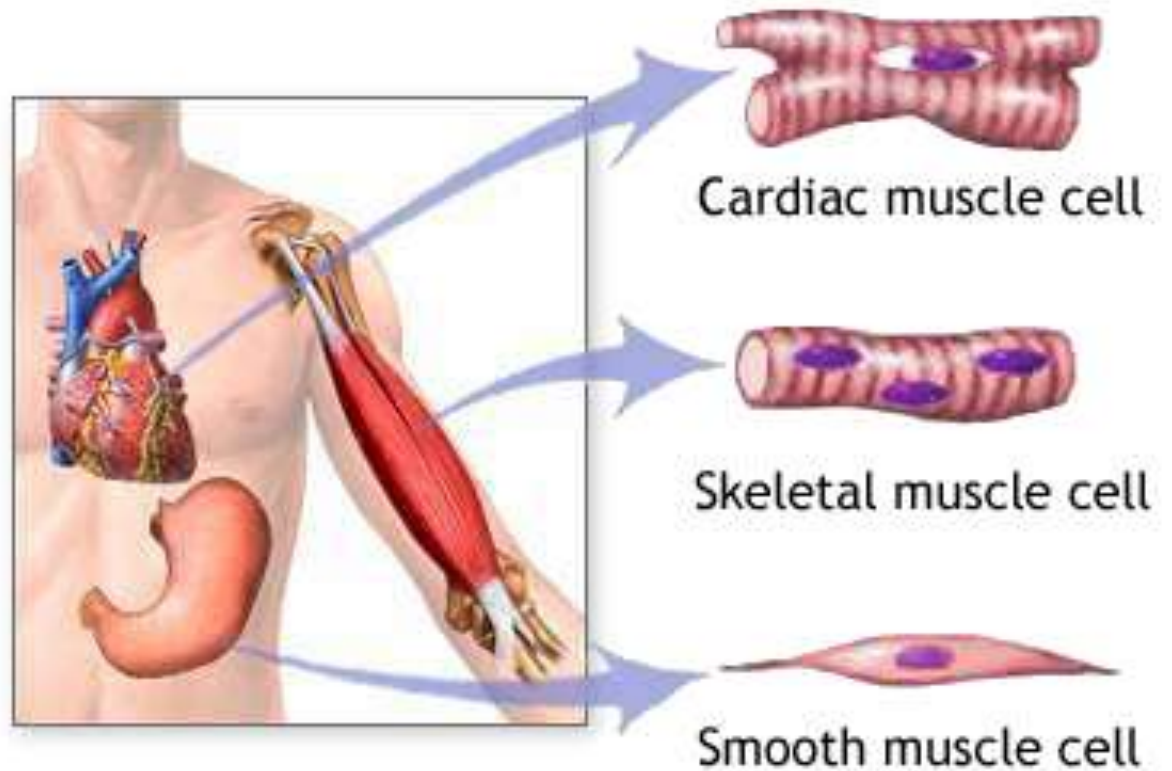
Connective

Few cells within abundant
extracellular material
Supporting/anchoring various
body parts



Tissue

Muscle



Tissue

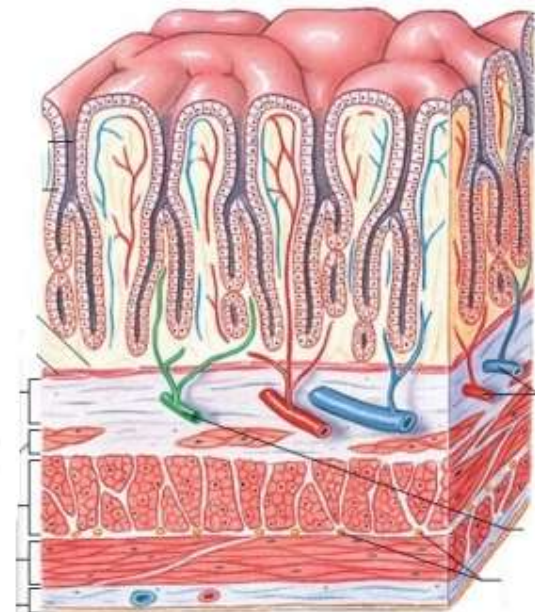
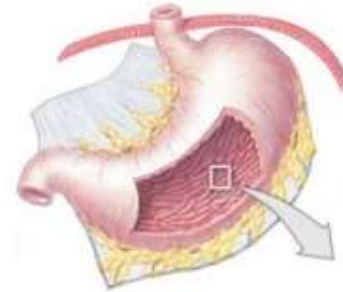
Nervous

**Initiating & transmitting
electrical impulses**



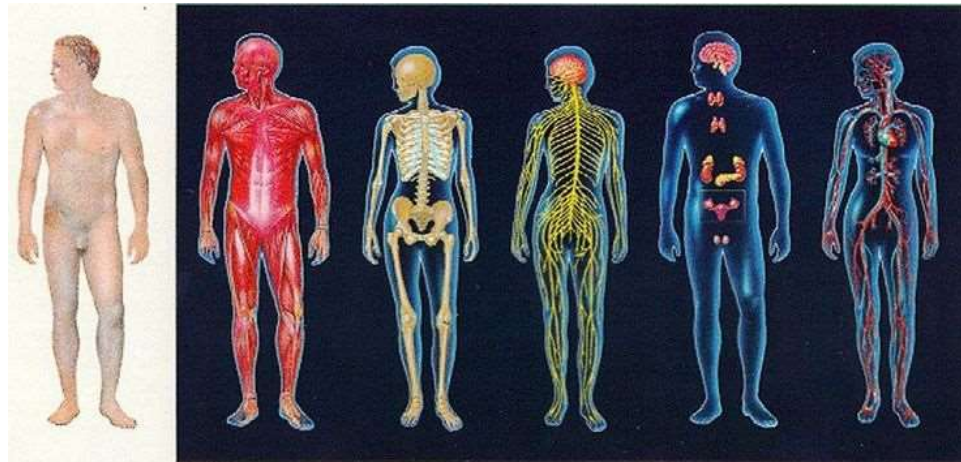
Organ, made up of several tissue types

- The inside surface of the stomach is lined with epithelial tissue
- The wall of the stomach contains smooth muscle
- Nerve tissue in the stomach controls muscle contraction
- These tissues are bound together by connective tissue



Stomach wall

Body system, a group of related organs



Integumentary System

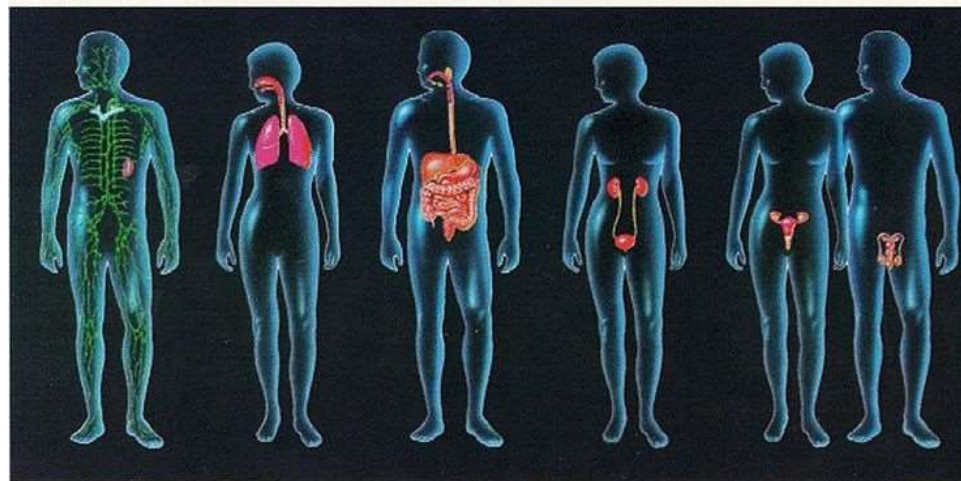
Muscular System

Skeletal System

Nervous System

Endocrine System

Circulatory System



Lymphatic System

Respiratory System

Digestive System

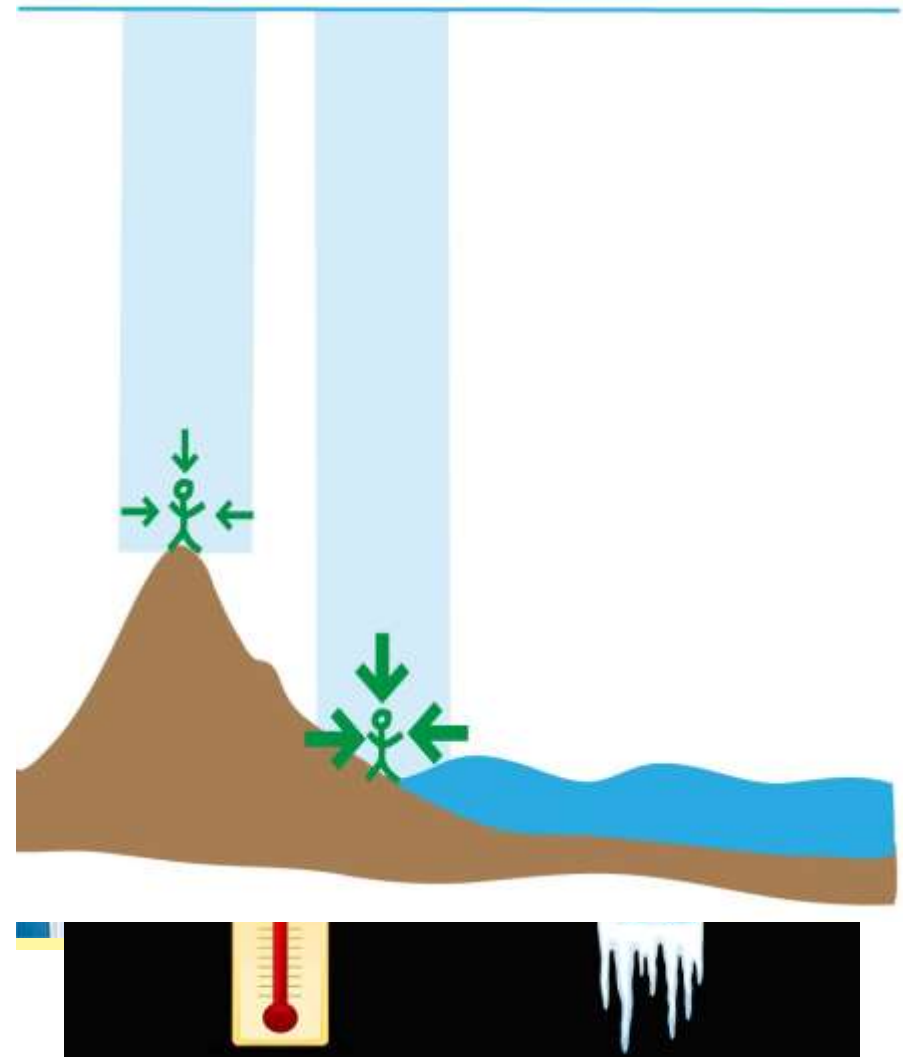
Urinary System

Reproductive System

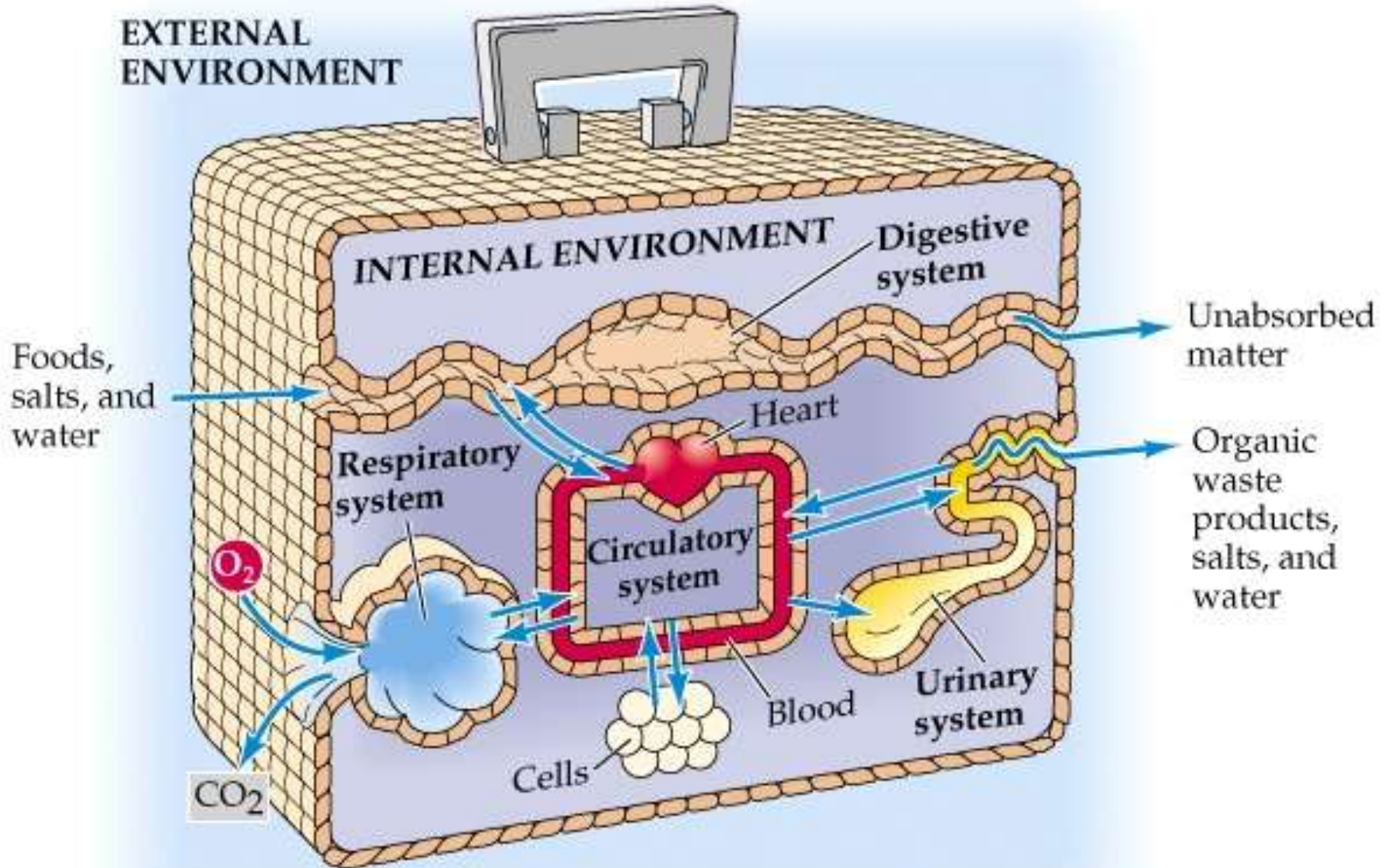
Characteristics of the Living Human Organism

- **Survival Needs**

1. **Nutrients**
2. **Oxygen**
3. **Water**
4. **Normal body temperature**
5. **Atmospheric pressure**

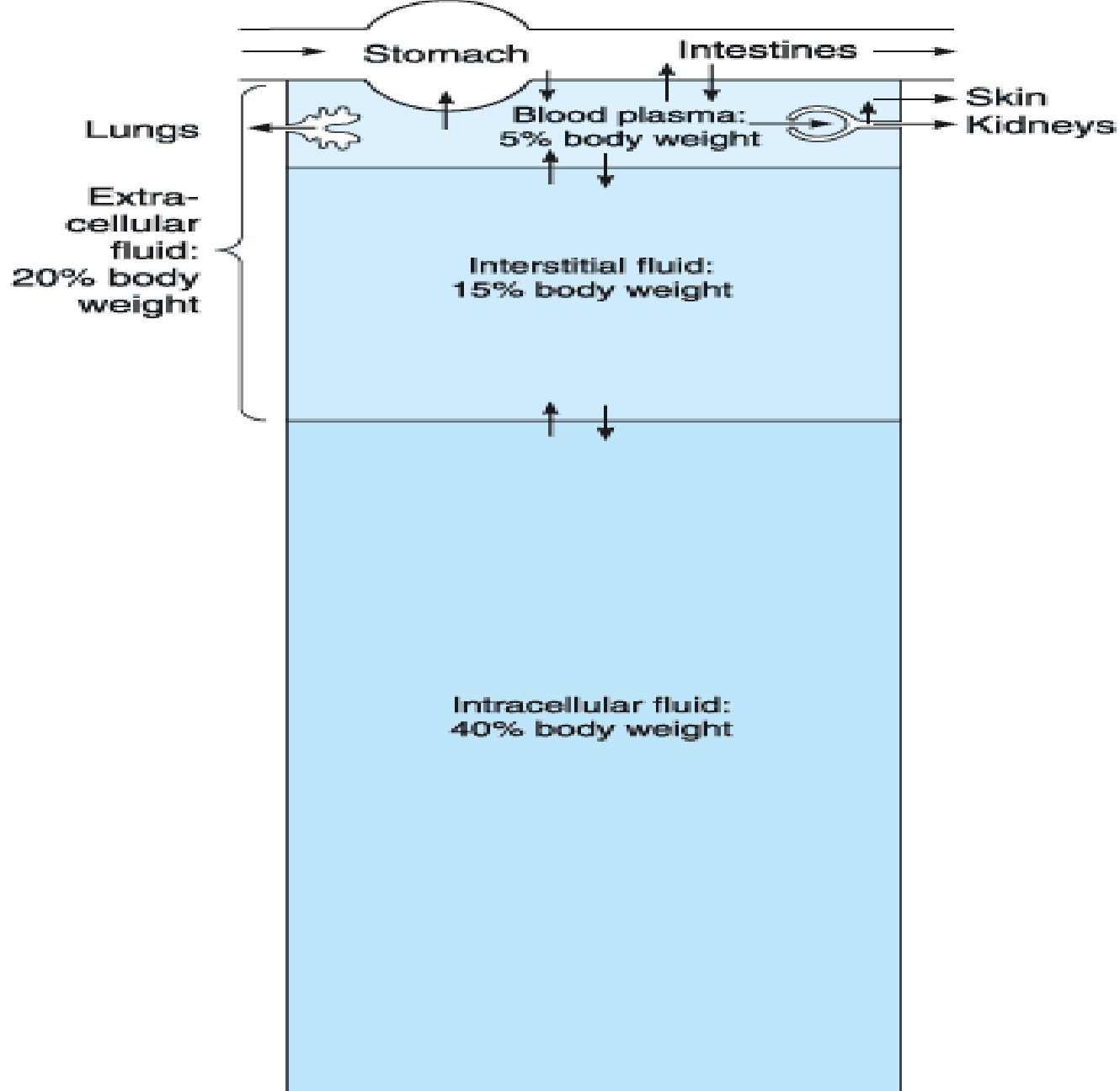


Plan of Human Body



External & Internal Environments

- **Interior of body separated from external environment by a layer of epithelial tissue**
- **Exchange between blood and external environment**
 - **Lungs**
 - **Gastrointestinal tract**
 - **Kidneys**
- **Lumens of respiratory, gastrointestinal, & urinary systems are part of external environment**



Source: Ganong WF: *Review of Medical Physiology*, 22nd Edition: <http://www.accessmedicine.com>

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Lymphatics
Lymphatic Failure
= Edema

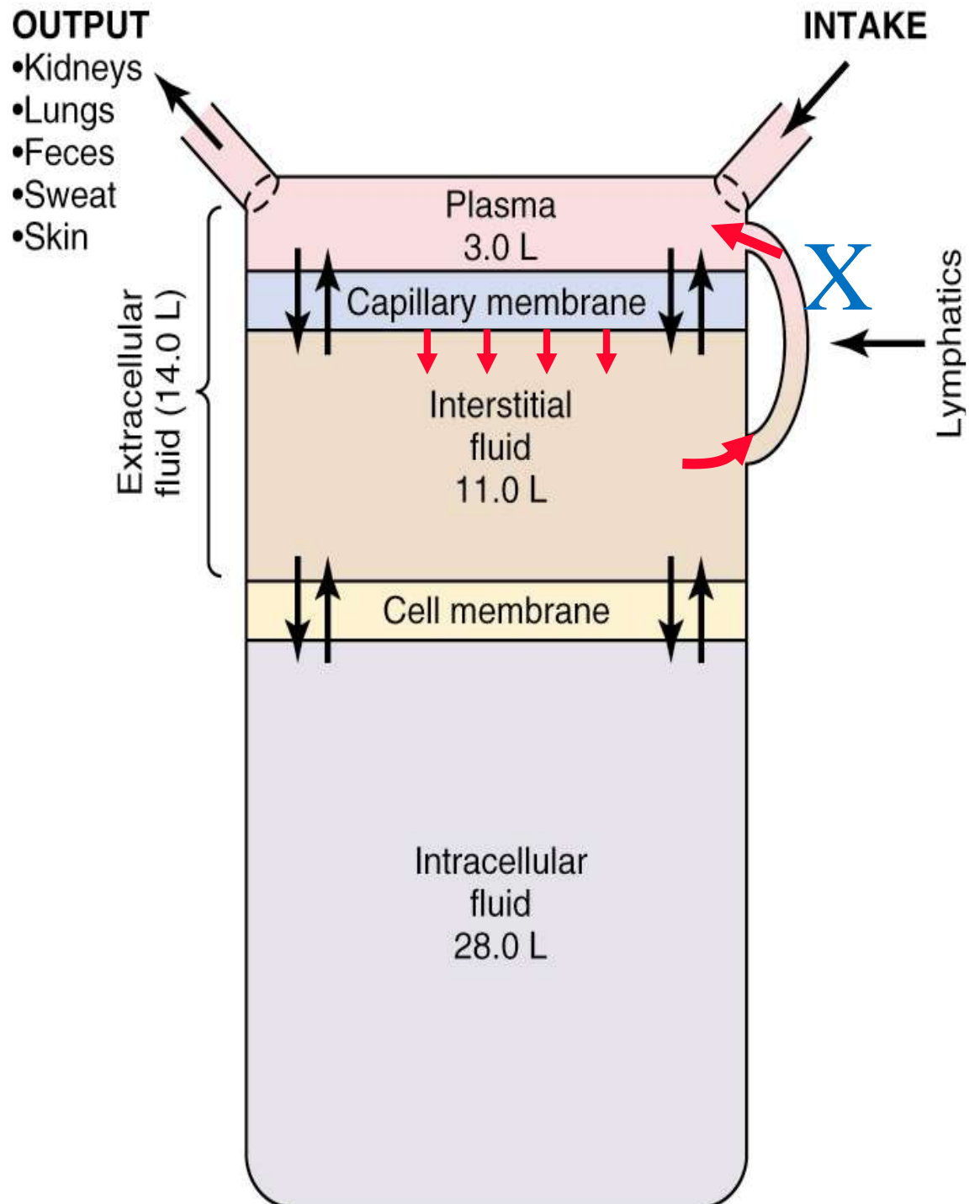
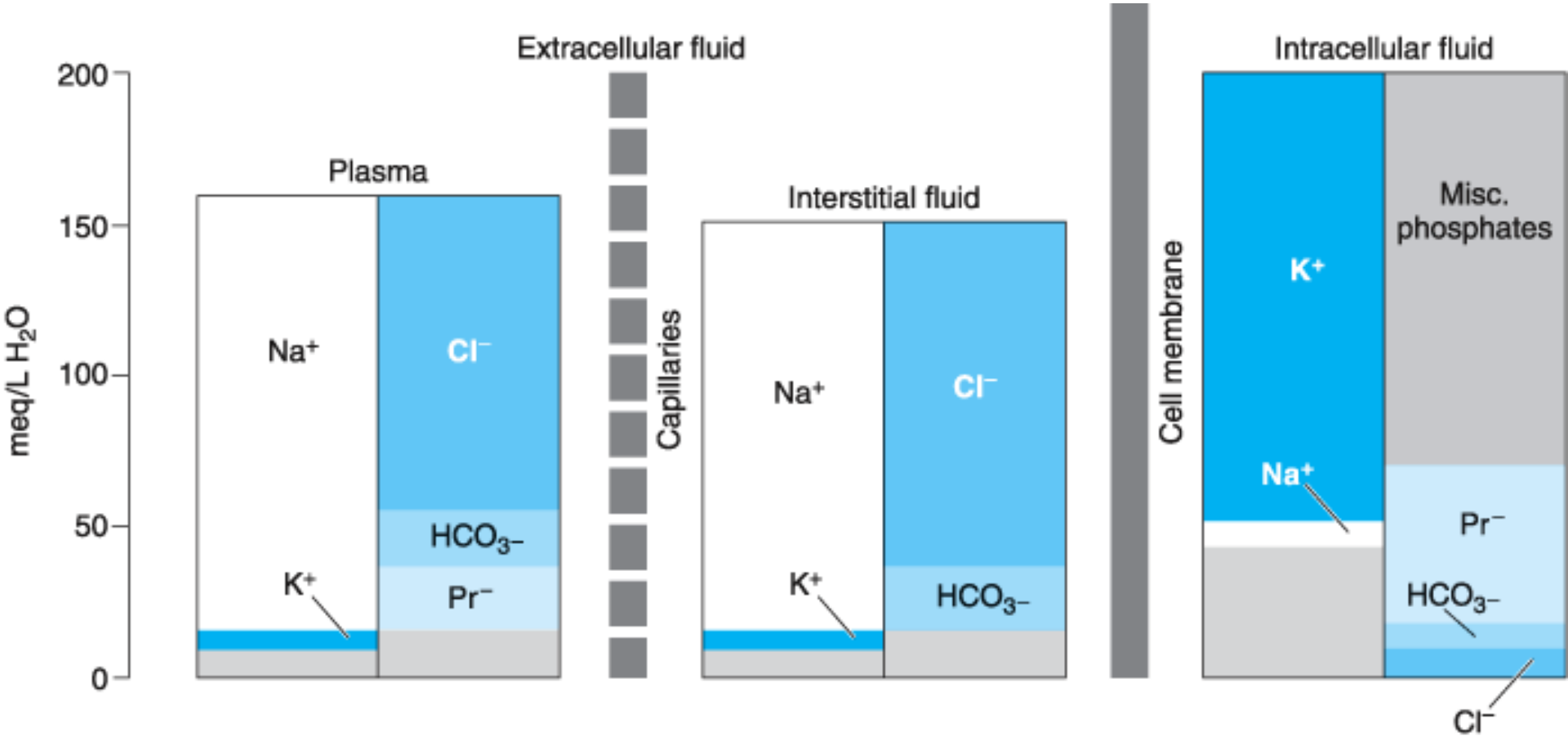


Table 1–1. Total Body Water (As Percentage of Body Weight) in Relation to Age and Sex.

Age (years)	Male (%)	Female (%)
10–18	59	57
18–40	61	51
40–60	55	47
Over 60	52	46



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Body Fluids

- ☐ Mostly water



The Internal Environment

- ❑ The interior of body, the environment of cells inside the body
- ❑ Internal environment = fluid surrounding cells

The ECF is the internal environment

What is in the ECF?

- Ions
- O₂
- Nutrients (glucose, f.a, a.a)
- Waste products (CO₂, garbage)

Fluid Compartments

≈ 60% of body weight

Extracellular fluid (ECF)
(≈ 1/3)
20% of body weight

Intracellular fluid (ICF)
(≈ 2/3)
40% of body weight

Plasma
25% of ECF
5% of body wt

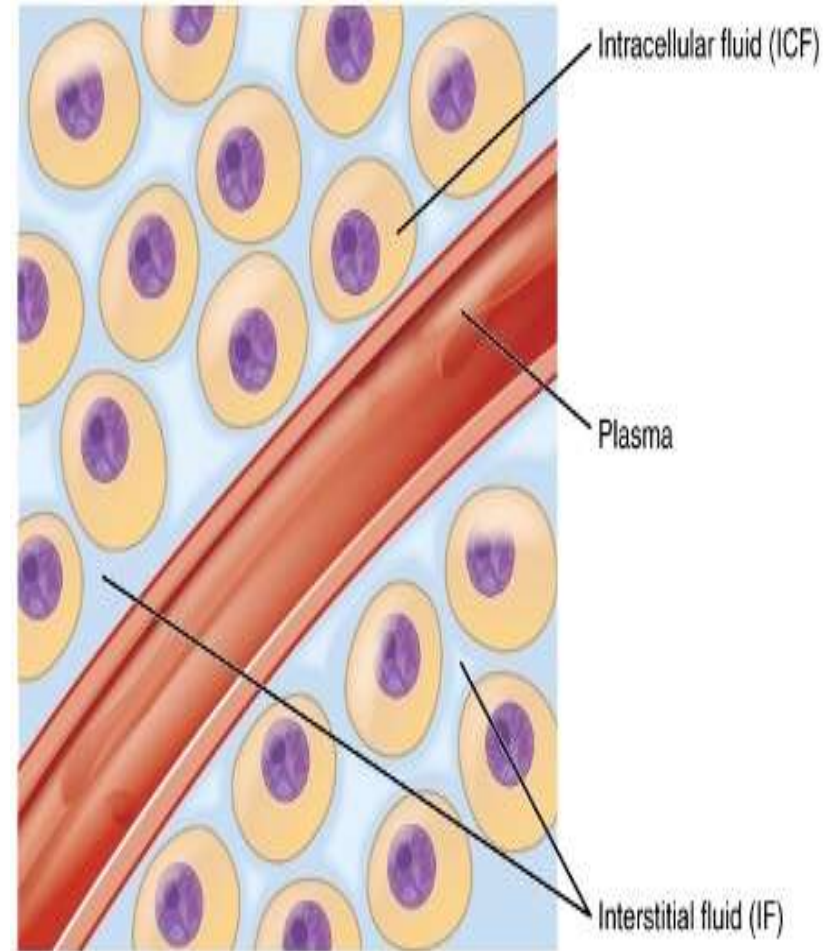
Interstitial fluid
75% of ECF
15% of body wt

Transcellular fluid

CSF
Intraocular
Pleural
Peritoneal
Pericardial
Synovial
Digestive secretions

Homeostasis

- Body cells are surrounded by watery internal environment through which life-sustaining exchanges are made
- **Extracellular fluid (ECF)**
 - Fluid environment in which the cells live (fluid outside the cells)
 - Two components
 - **Plasma, interstitial fluid**
- **Intracellular fluid (ICF)**
 - Fluid contained within all body cells



Homeostasis

= **State of constancy of conditions within the body**

= **Maintaining a dynamic steady state of the internal environment**

“Essential for cell survival”

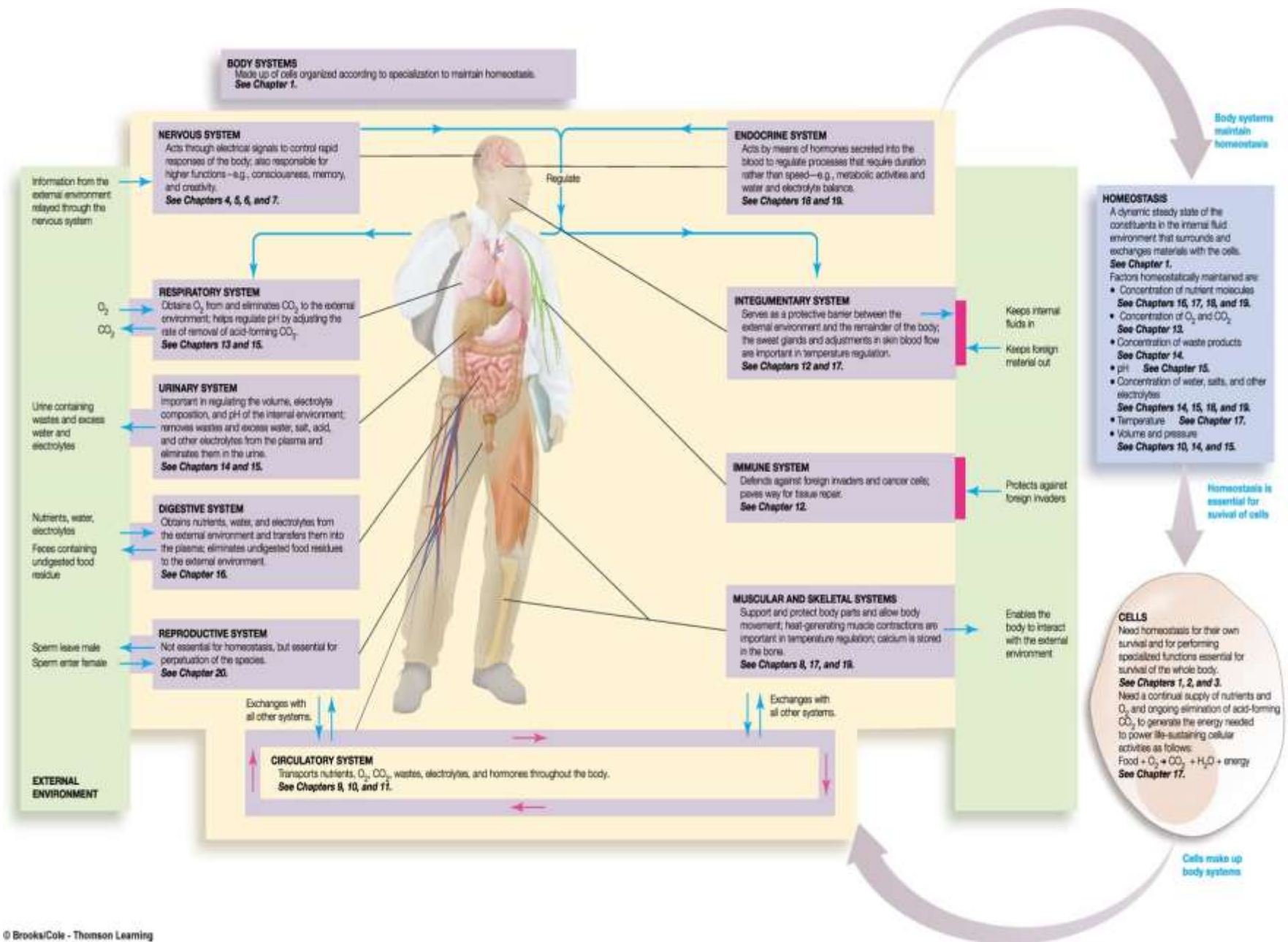
Factors Homeostatically Regulated

- 1. Concentration of nutrient molecules**
- 2. Concentration of gases in blood (O_2 and CO_2)**
- 3. Concentration of waste products**
- 4. pH of blood plasma**
- 5. Concentration of water, salt, and other electrolytes**
- 6. Volume of body fluids and vascular pressure**
- 7. Body Temperature**

The Human Body Systems Contribute to Homeostasis

- ✓ **circulatory** - transports materials (e.g., nutrients, gases)
- ✓ **digestive** - breaks dietary food into small nutrient molecules
- ✓ **respiratory** - obtains oxygen and eliminates carbon dioxide
- ✓ **urinary** - removes and eliminates wastes from the plasma
- ✓ **skeletal** - provides support and protection for soft tissues
- ✓ **muscular** - moves the bones
- ✓ **integumentary** - serves as an outer protective barrier
- ✓ **immune** - defends against foreign invaders
- ✓ **nervous** - controls and coordinates activities rapidly
- ✓ **endocrine** - regulates activities that require duration
- ✓ **reproductive** - ??? perpetuation of the species

Role of Body Systems in Homeostasis



Homeostatic Control Systems

- **Intrinsic (local)** - inherent in an organ
- **Extrinsic (body-wide)** - outside the organ to alter the activity of the organ
 1. **Nervous system**
 2. **Endocrine system**

Homeostatic Control Systems

- Control systems are grouped into two classes
 - **Intrinsic (within) controls** : Local controls that are inherent in an organ
 - Example exercising skeletal muscle consumes more oxygen leading to fall in oxygen concentration in the skeletal muscle (local). This local decrease in oxygen acts directly on smooth muscle of blood vessels of skeletal muscle causing dilatation of these blood vessels (more blood flow means more oxygen supply and thus maintain oxygen level in exercising skeletal muscle.

Extrinsic (outside) controls: Regulatory mechanisms initiated outside an organ

- Accomplished by **nervous and endocrine systems**
- Example: when blood pressure falls, the nervous system acts on heart (increases heart rate and contractility) and on blood vessels (vasoconstriction). Both effects can increase blood pressure to normal.

Mechanisms to maintain homeostasis

1. Negative Feedback

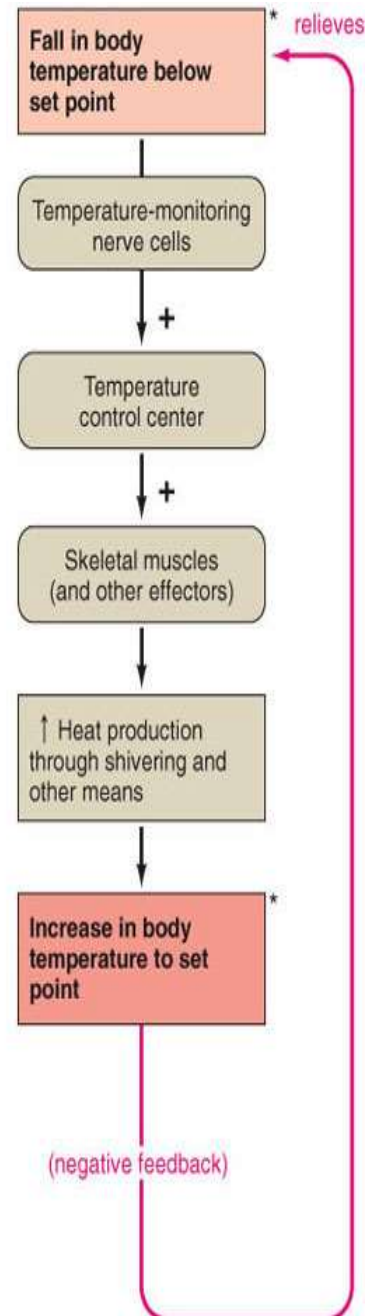
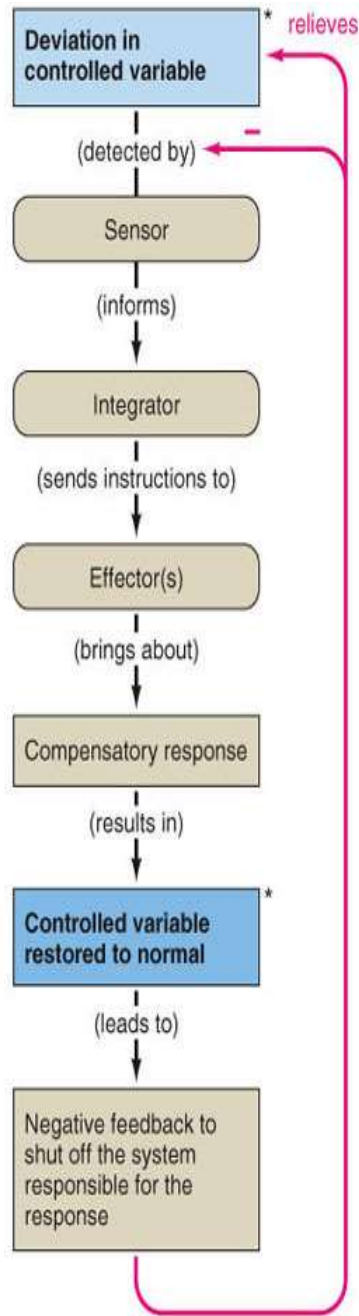
2. Positive Feedback

3. Feedforward

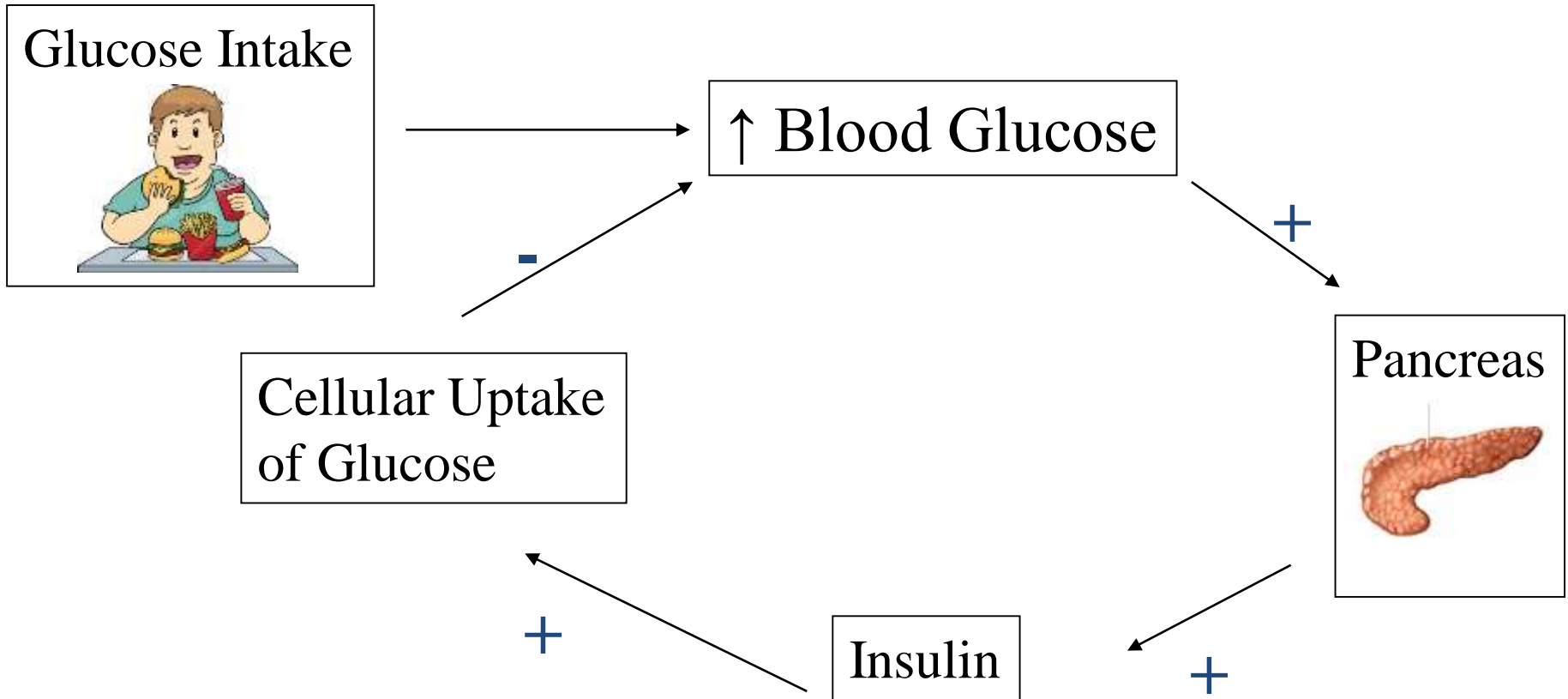
Homeostatic Control Systems

- **Negative feedback system**
 - **Primary type of homeostatic control**
 - **Opposes initial change**
 - **Components**
 - **Sensor**
 - **Monitors magnitude of a controlled variable**
 - **Control center**
 - **Compares sensor's input with a set point**
 - **Effector**
 - **Makes a response to produce a desired effect**

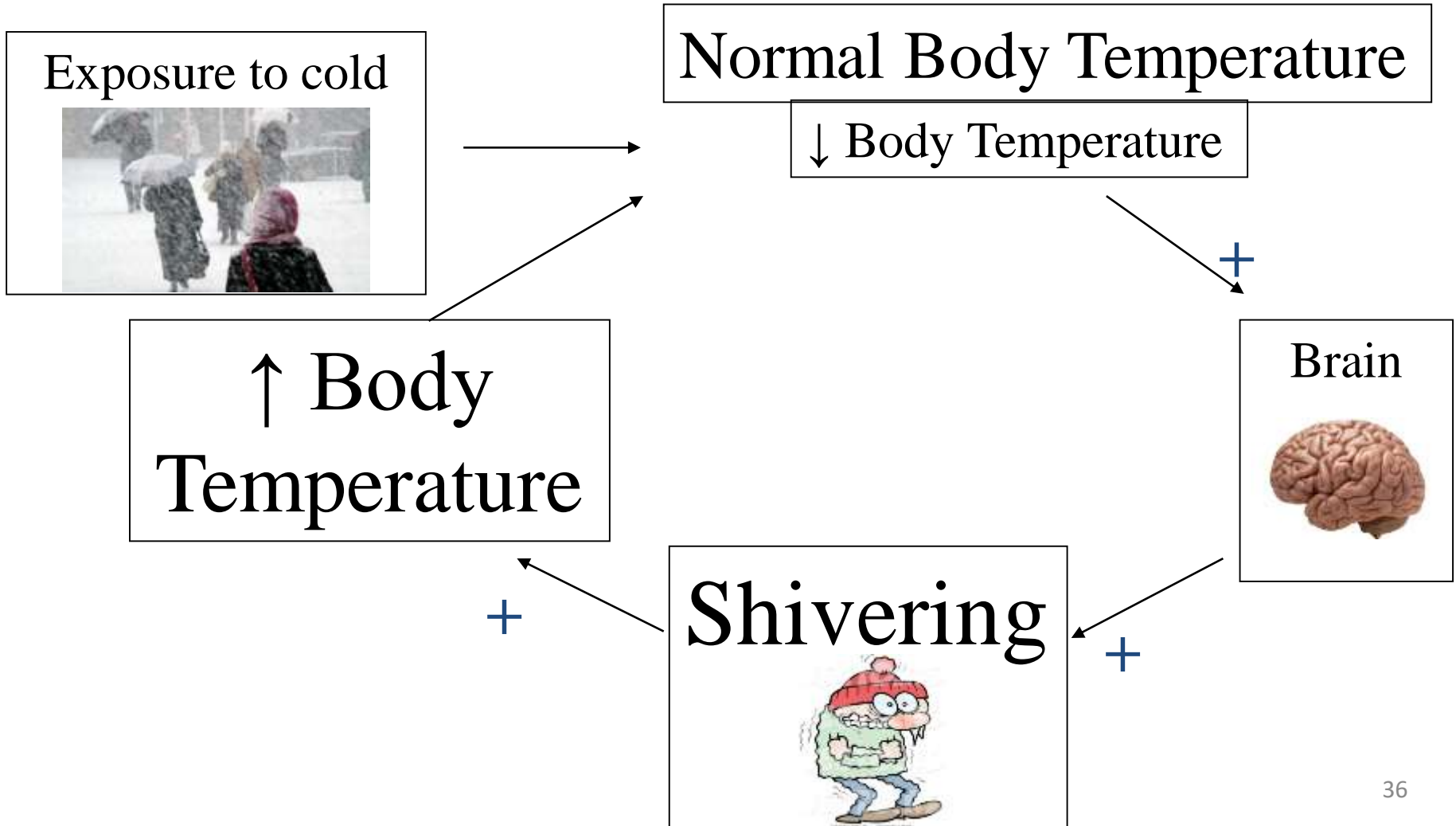
Example of negative feedback mechanism



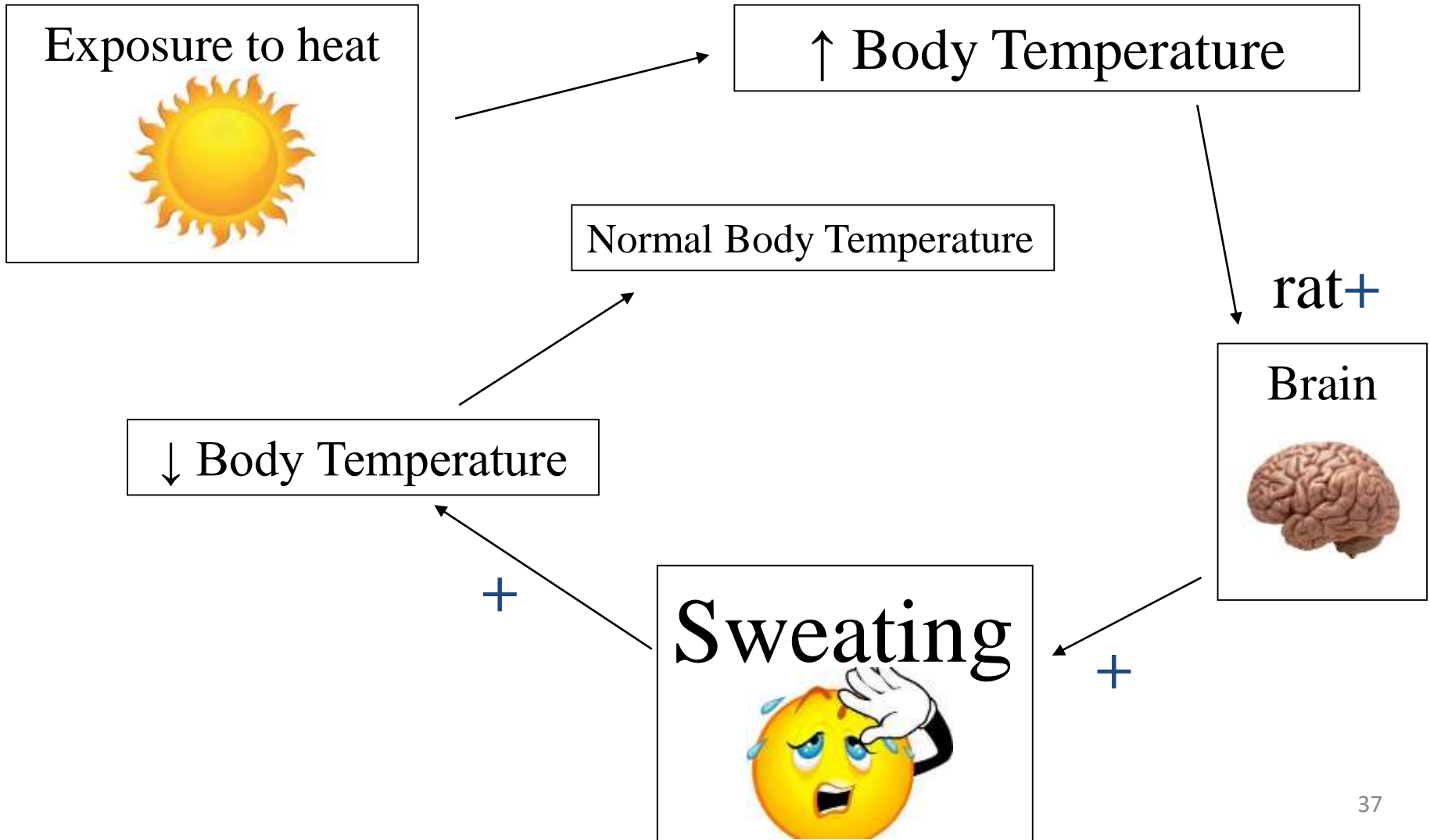
Negative Feedback



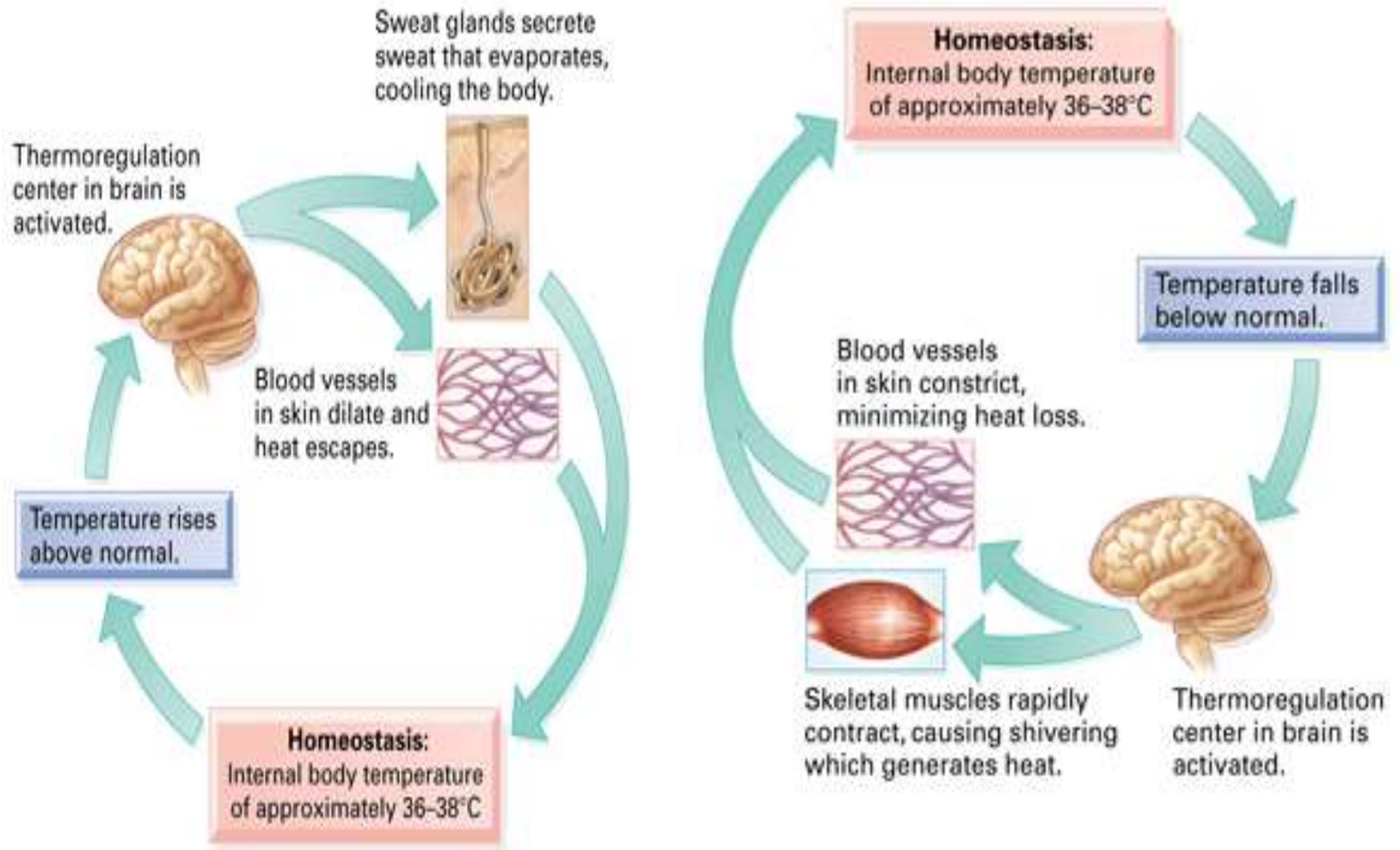
Negative Feedback



Negative Feedback



Maintaining constant body temperature by negative feedback mechanism



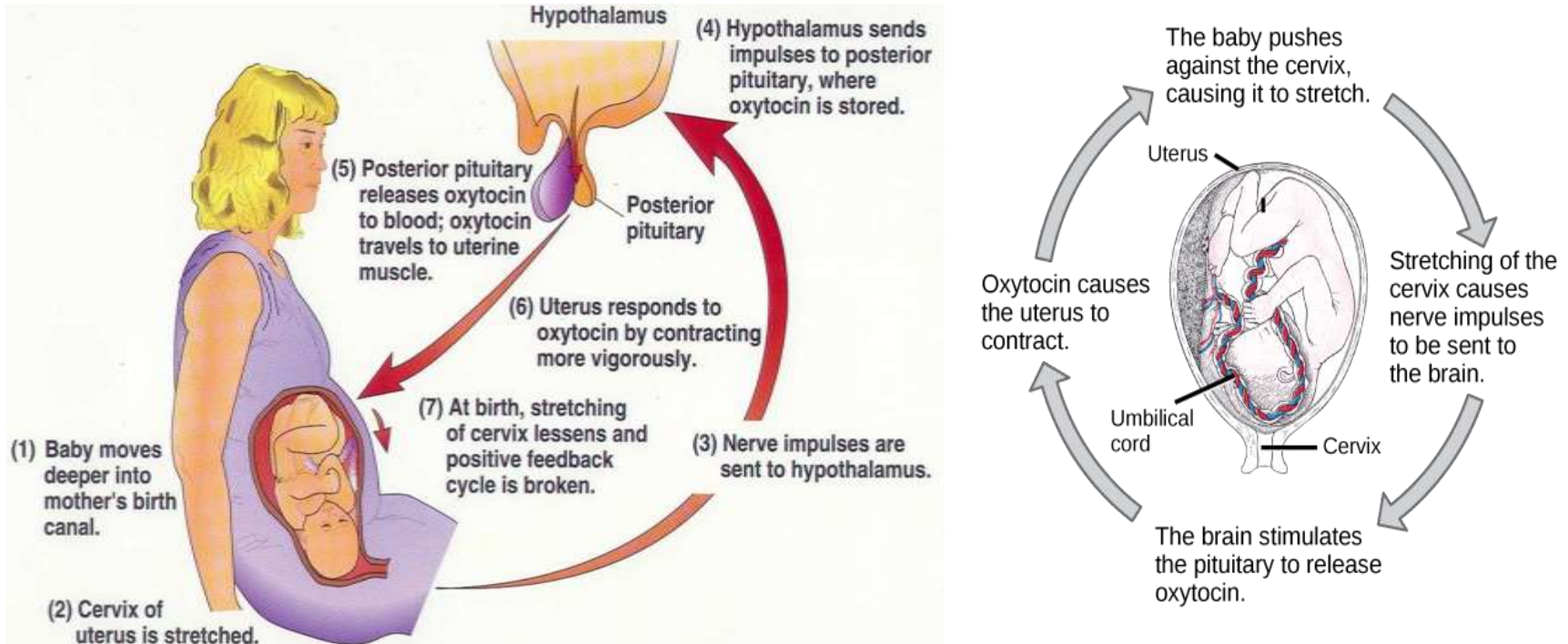
Homeostatic Control Systems

- **Positive feedback system**
 - **Amplifies an initial change.**
 - **Do not occur as often as negative feedback system.**
 - **Example**
 - **Uterine contractions become increasingly stronger until the birth of the baby**

Useful positive feedback

Childbirth

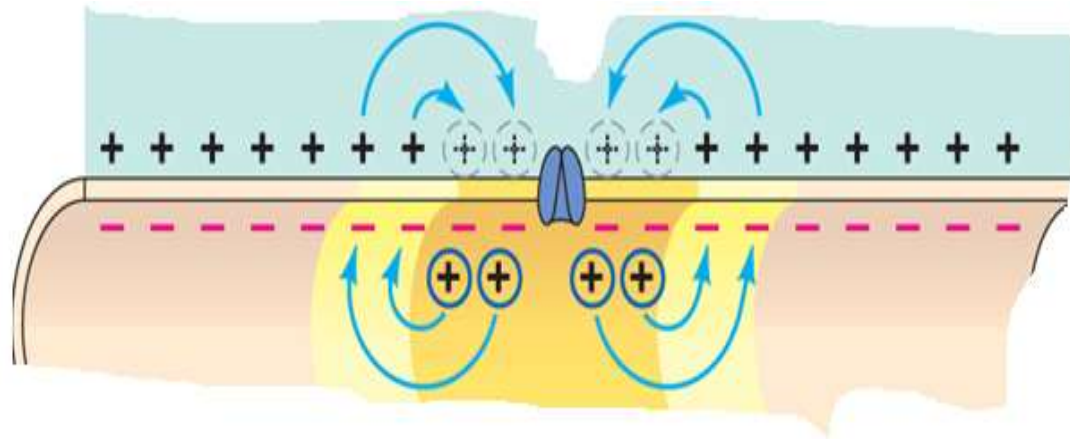
Uterine contraction pushes head to stretch cervix muscle → signals through the uterine muscle, causing even more contraction. This action is repeated until the baby is born.



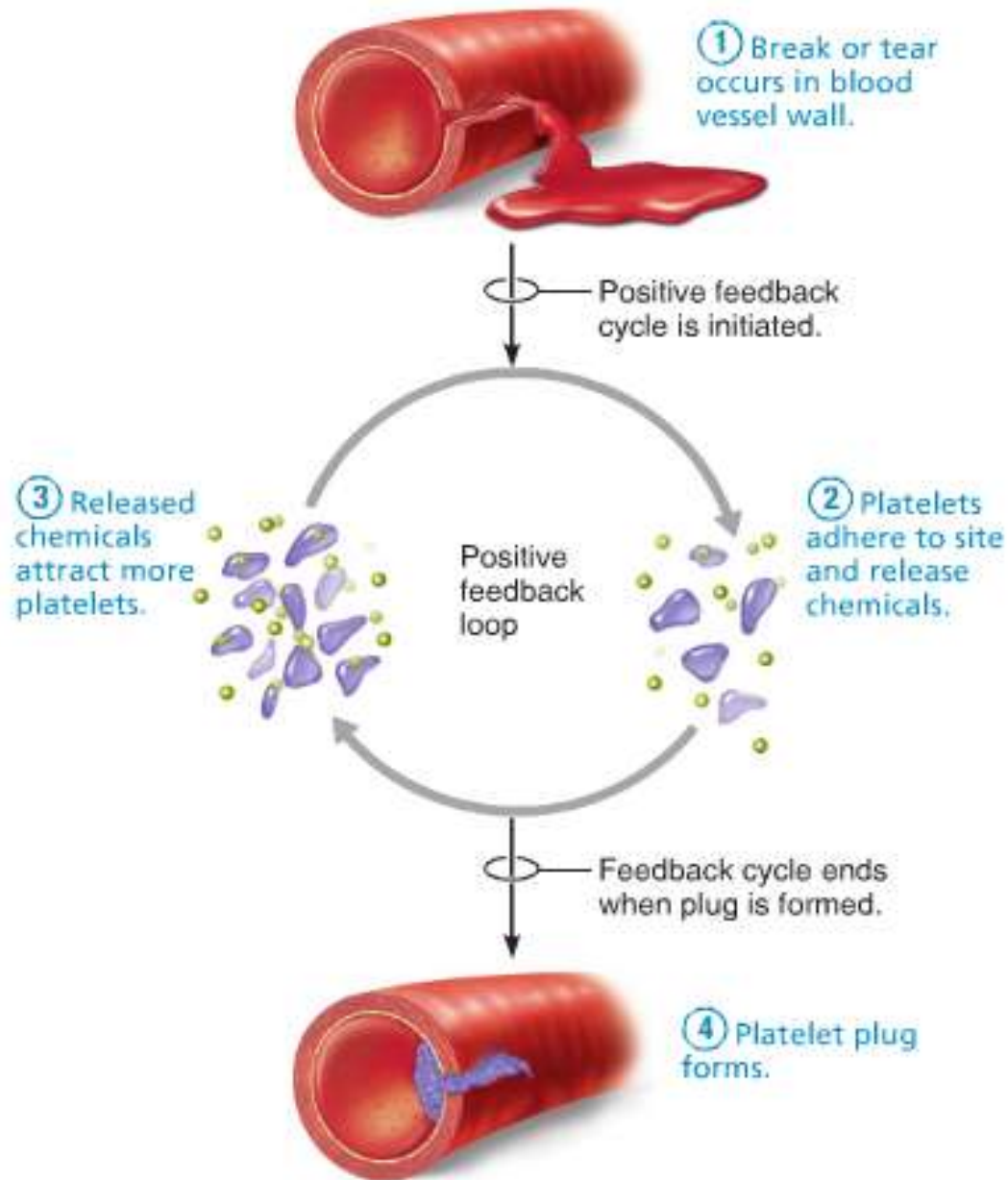
Useful positive feedback

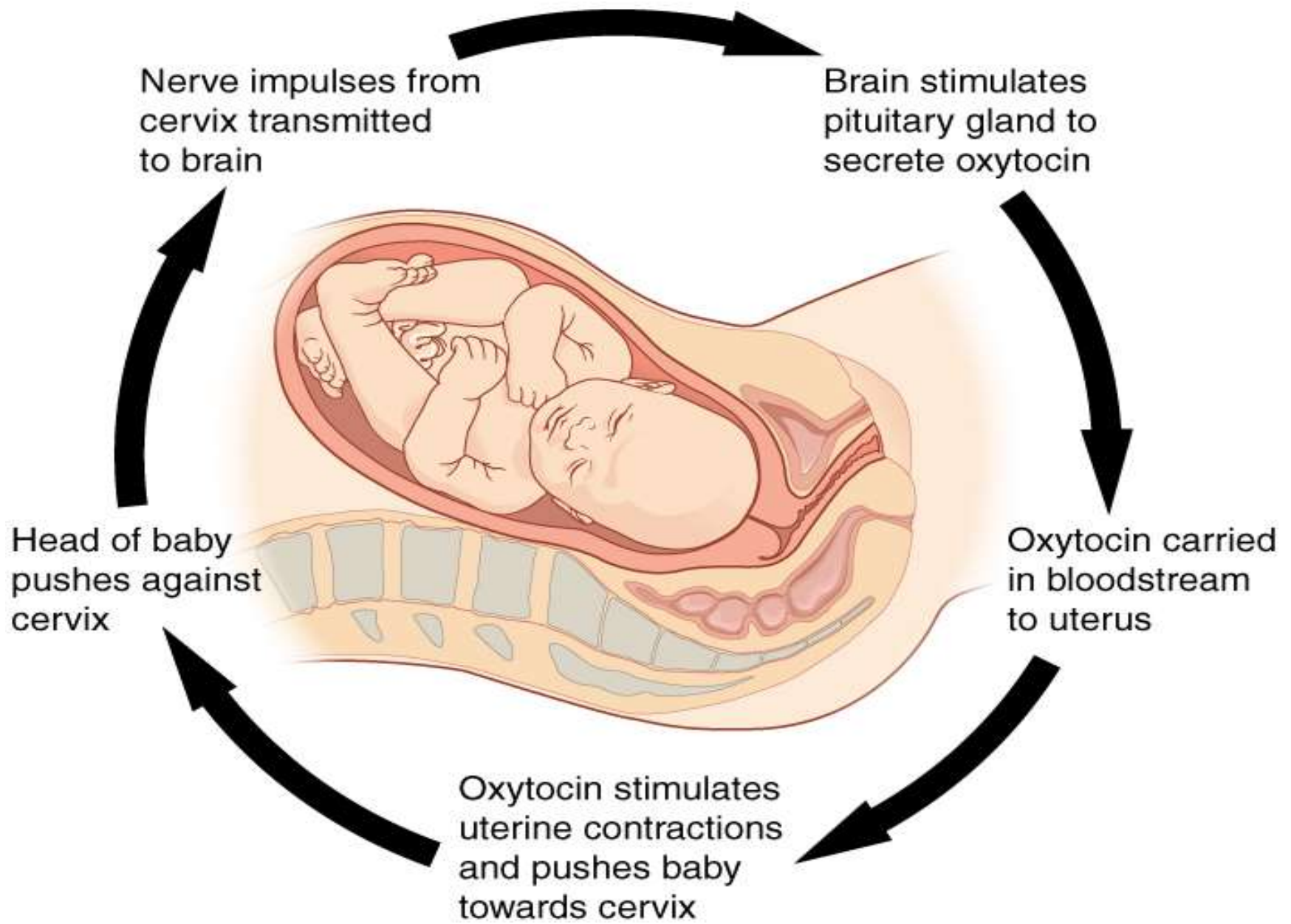
Generation of nerve signals:

Stimulation nerve fiber → causes slight leakage of sodium ions
→ more sodium move in causes change in membrane potential
→ that will cause more & more sodium channels to open and producing Na influx → more change in membrane potential → more opening → until action potential is created and spread all the way to the end of fiber.



Positive feed back mechanism of blood clotting





Disruption in Homeostasis

can lead to illness and death

Pathophysiology

*the abnormal functioning of the body
during disease*

End of lecture 1

Contributions of Body Systems to Homeostasis (cont.)

- Nervous system
 - Controls and coordinates bodily activities that require rapid responses.
 - Detects and initiates reactions to changes in external environment.
- Endocrine system
 - Secreting glands of endocrine regulate activities that require duration rather than speed
 - Controls concentration of nutrients and, by adjusting kidney function, controls internal environment's volume and electrolyte composition
- Reproductive system
 - Not essential for homeostasis (not essential for survival of individual)
 - Is essential for perpetuating the species

Contributions of Body Systems to Homeostasis

- Circulatory system
 - Carries materials from one part of the body to another.
- Digestive system
 - Breaks down dietary food into smaller molecules that can be distributed to body cells.
 - Transfers water and electrolytes from external environment to internal environment.
 - Eliminates undigested food residues to external environment in the feces.

Contributions of Body Systems to Homeostasis (cont.)

- Respiratory system
 - Gets O₂ from and eliminates CO₂ to the external environment
 - Important in maintenance of proper pH of internal environment
- Urinary system
- Removes excess water, salt, acid, and other electrolytes from plasma and eliminates them in urine.
- Skeletal system
 - Provides support and protection for soft tissues and organs
 - Serves as storage reservoir for calcium
 - Along with muscular system enables movement of body and its parts
 - Bone marrow is ultimate source of all blood cells

Contributions of Body Systems to Homeostasis (cont.)

- Muscular system
 - Moves the bones
- Integumentary system
 - Serves as outer protective barrier
 - Important in regulating body temperature
- Immune system
 - Defends against foreign invaders and against body cells that have become cancerous
 - Paves way for repairing or replacing injured or worn-out cells