

INTRODUCTION TO HUMAN PHYSIOLOGY

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Outline of lecture

- Definition of physiology
- Organization of human body
- Cell physiology
- Homeostasis – basic concept, Control mechanisms

Physiology

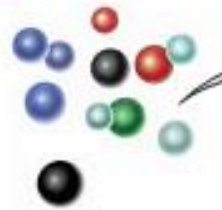
- physio= nature , -logy= study of
- Science of body functions
- the study of the *functions of living things*
- **Hippocrates** (460-377 B.C.) used the word to mean the healing power of nature. He is considered the “Father of Medicine.”
- **Aristotle** (384-322 B.C.) used the word in a broad sense to describe the functioning of all living things.

Questions We Ask in Physiology

Approaches to physiology

- asks “**why**” a function occurs
 - Why do red blood cells carry oxygen?
- asks “**how**” a function occurs
 - How do red blood cells carry oxygen

1 CHEMICAL LEVEL



Atoms (C, H, O, N, P)



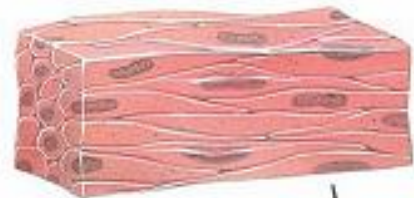
Molecule (DNA)

2 CELLULAR LEVEL



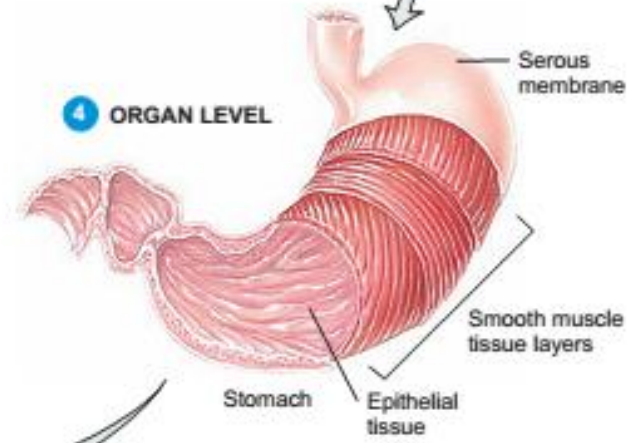
Smooth muscle cell

3 TISSUE LEVEL



Smooth muscle tissue

4 ORGAN LEVEL



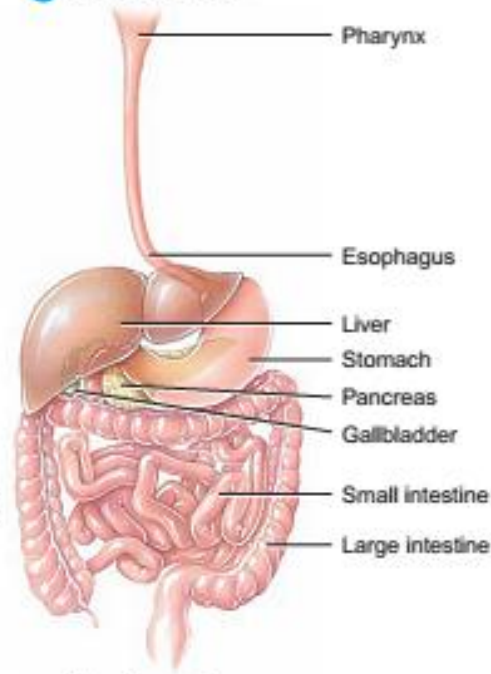
Serous membrane

Smooth muscle tissue layers

Stomach

Epithelial tissue

5 SYSTEM LEVEL



Pharynx

Esophagus

Liver

Stomach

Pancreas

Gallbladder

Small intestine

Large intestine

Digestive system

6 ORGANISMAL LEVEL



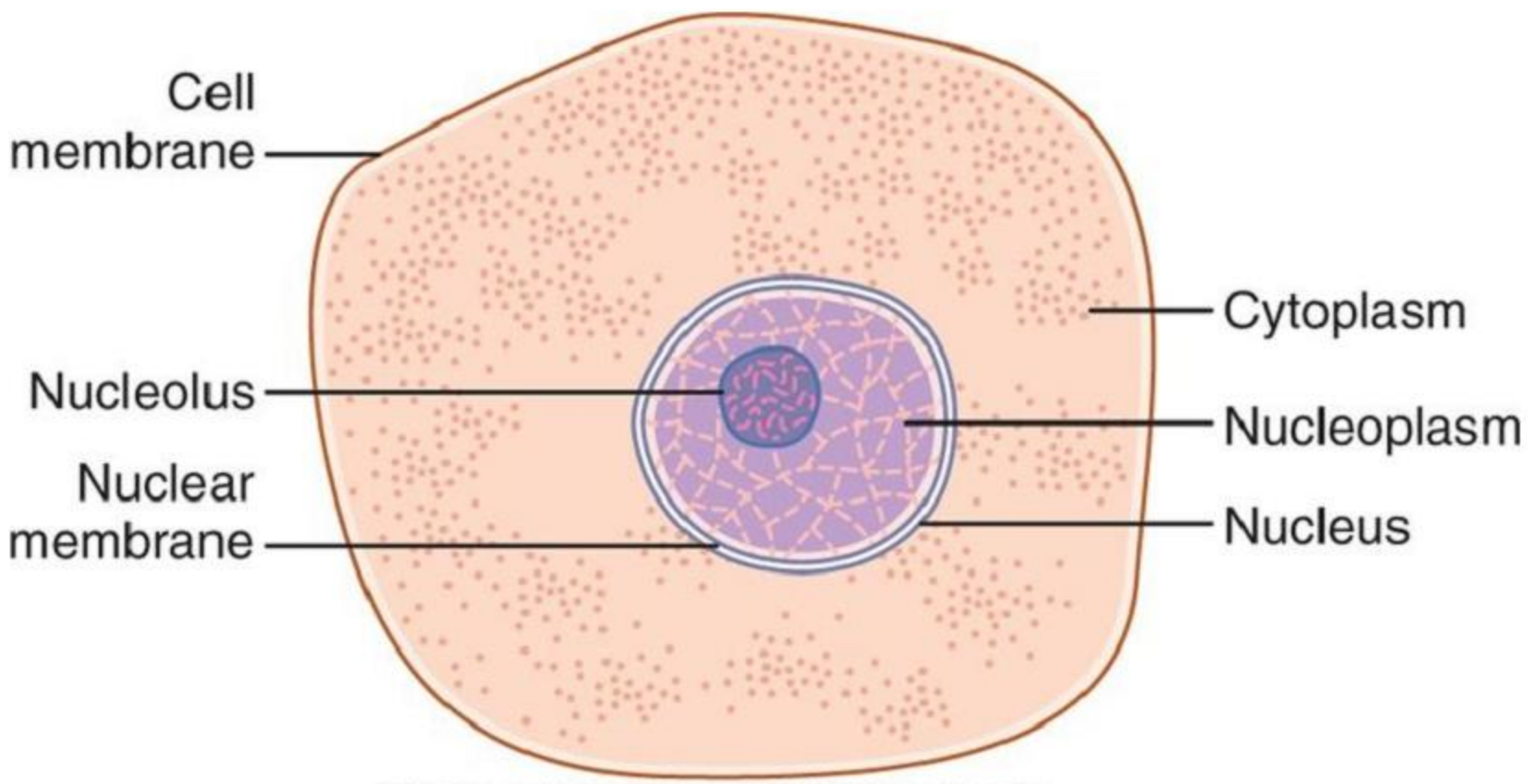
Characteristics of Life

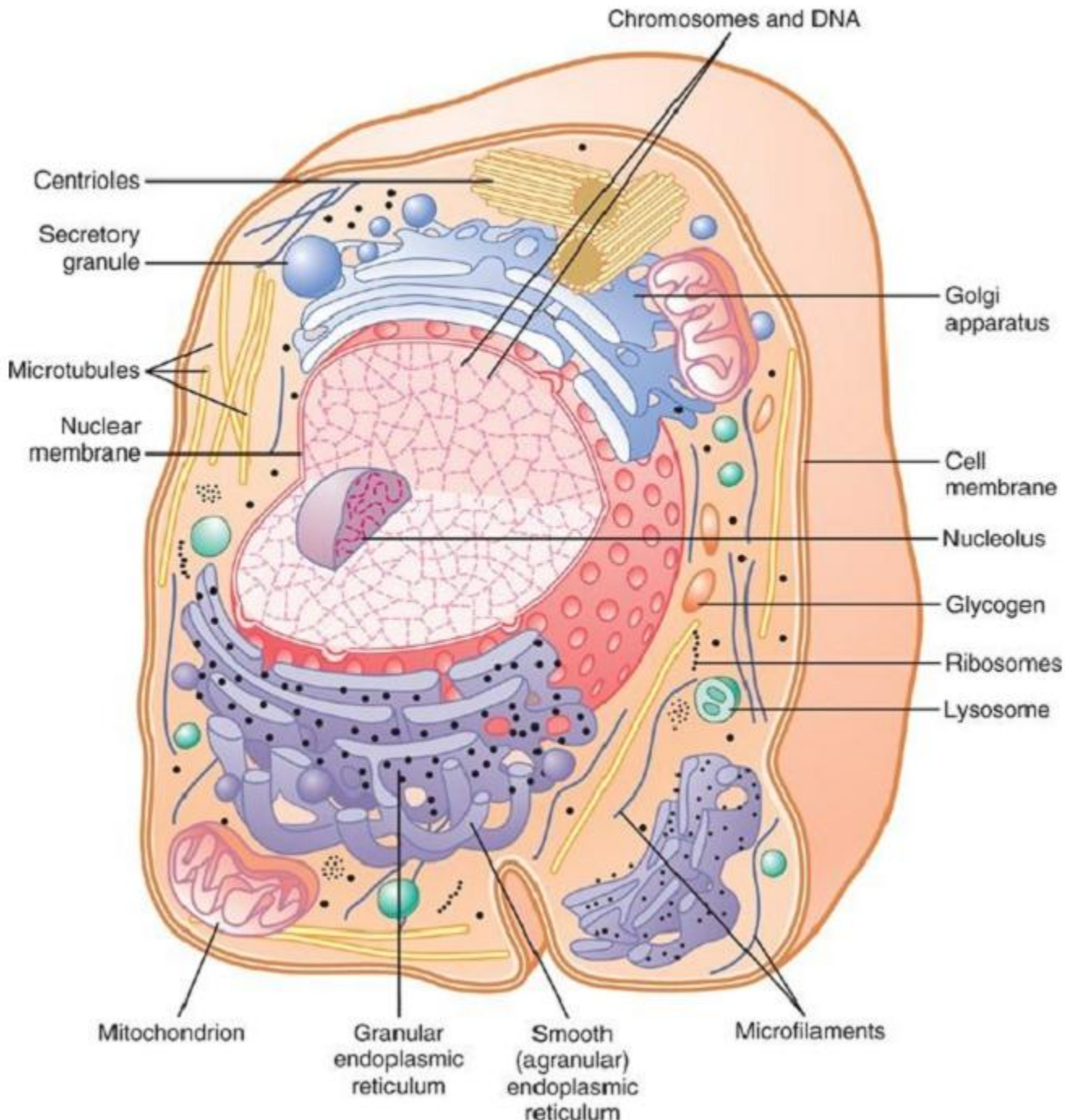
- **Cellular composition:** living matter is always compartmentalized into one or more cells
- **Metabolism:** all chemical reactions of the body
 - *Anabolism vs. Catabolism*
- **Responsiveness:** ability to sense changes (*stimuli*) and adjust or react to those changes; a/k/a Irritability
- **Growth:** increase in size and/or number of cells
- **Development:** changes in an organism over time
- **Reproduction:** new cells or new organisms
- **Biochemical unity:** all living things contain DNA and/or RNA, proteins, lipids, and carbohydrates.

Survival Needs of Living Things

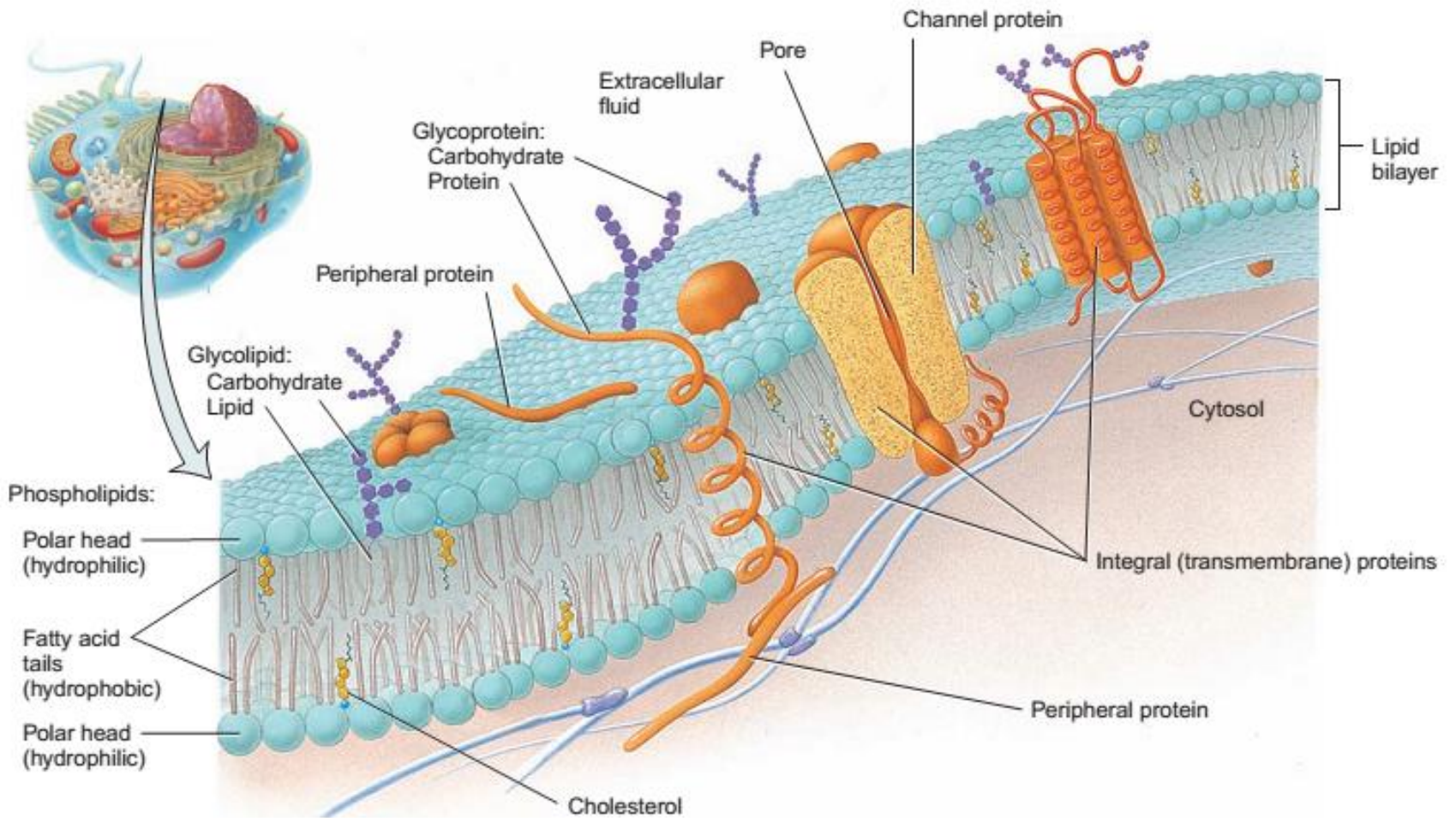
- **Nutrients**– chemical substances used for energy and cell building; carbohydrates, lipids, proteins, vitamins
- **Oxygen** – needed for metabolic reactions
 - *Aerobic respiration*: $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + \text{Energy}$
 - 95% of all chemical reactions in body
 - *Anaerobic respiration*: no oxygen used in these reactions
- **Water** – provides the necessary environment for chemical reactions; used in *dehydration synthesis* and *hydrolysis* reactions
- **Maintaining normal body temperature** – necessary for chemical reactions to occur at life-sustaining rates
- **Atmospheric pressure** – required for proper breathing and gas exchange in the lungs

CELL PHYSIOLOGY





CELL MEMBRANE



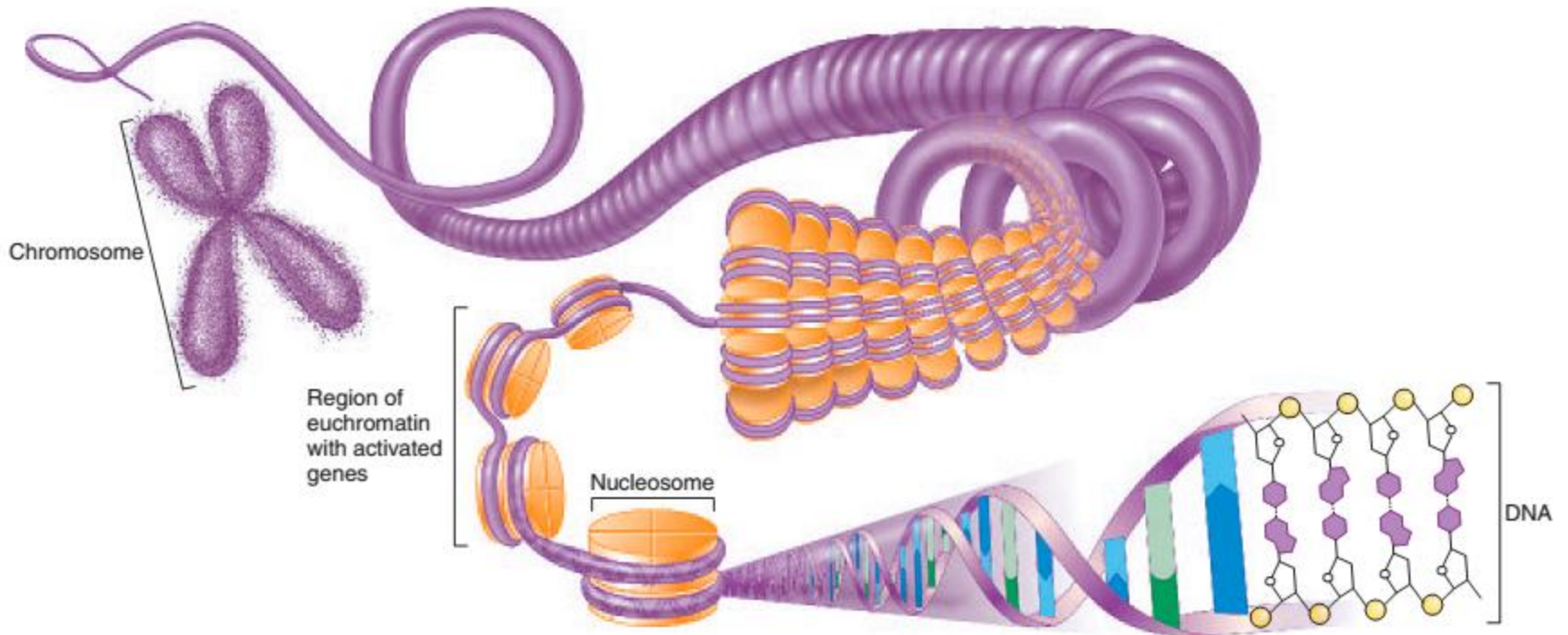
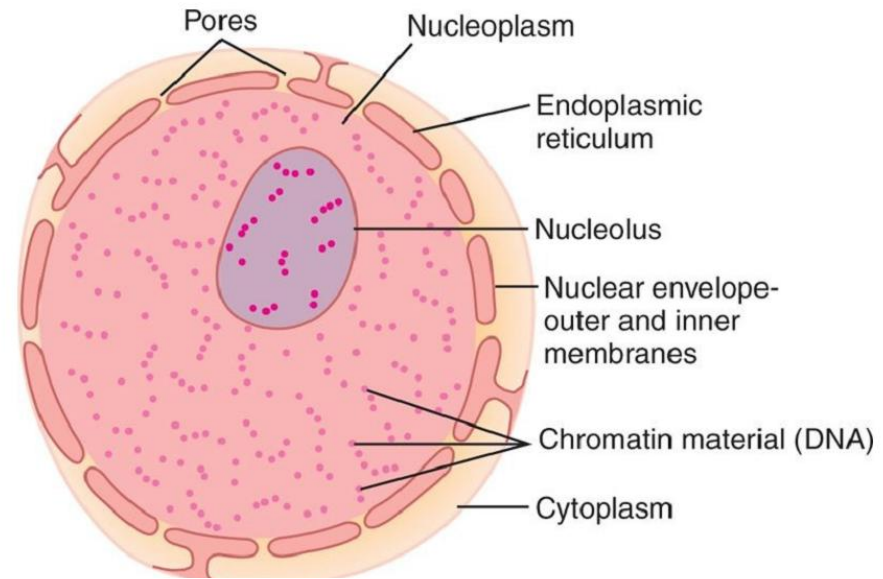
Structure of cell membrane

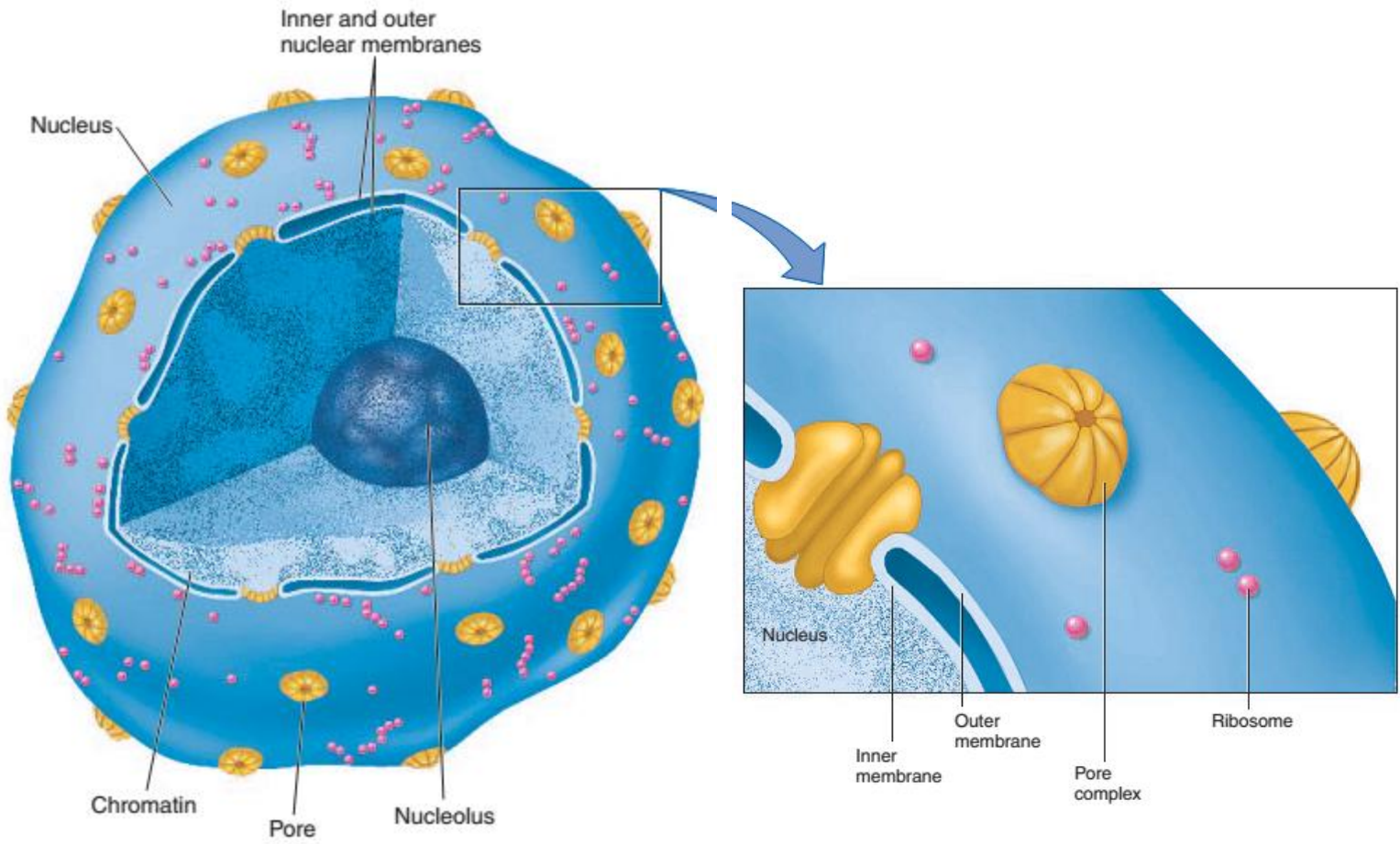
- “Fluid mosaic model”
- Consists of **lipids bilayer** with interspersed **proteins**
- **Lipids:** 75% phospholipids, 20% cholesterol & 5% glycolipids
- **Proteins:** integral (transmembrane) & peripheral
- **Glycocalyx:** sugary coat of carbohydrates portions of glycoproteins & glycolipids

Functions of cell membrane

- **Lipid bilayer**: *selectively permeable* allows fat soluble substances such as oxygen & alcohol to pass through them
- Provide **framework for arrangement of proteins & carbohydrates** molecules
- **Proteins**: Integral proteins acts as *ion channels, carriers (transporters), pumps, enzymes, receptors*
- **Carbohydrates**: *Glycocalyx* acts as receptors for binding hormones, helps to attach other cells

Nucleus





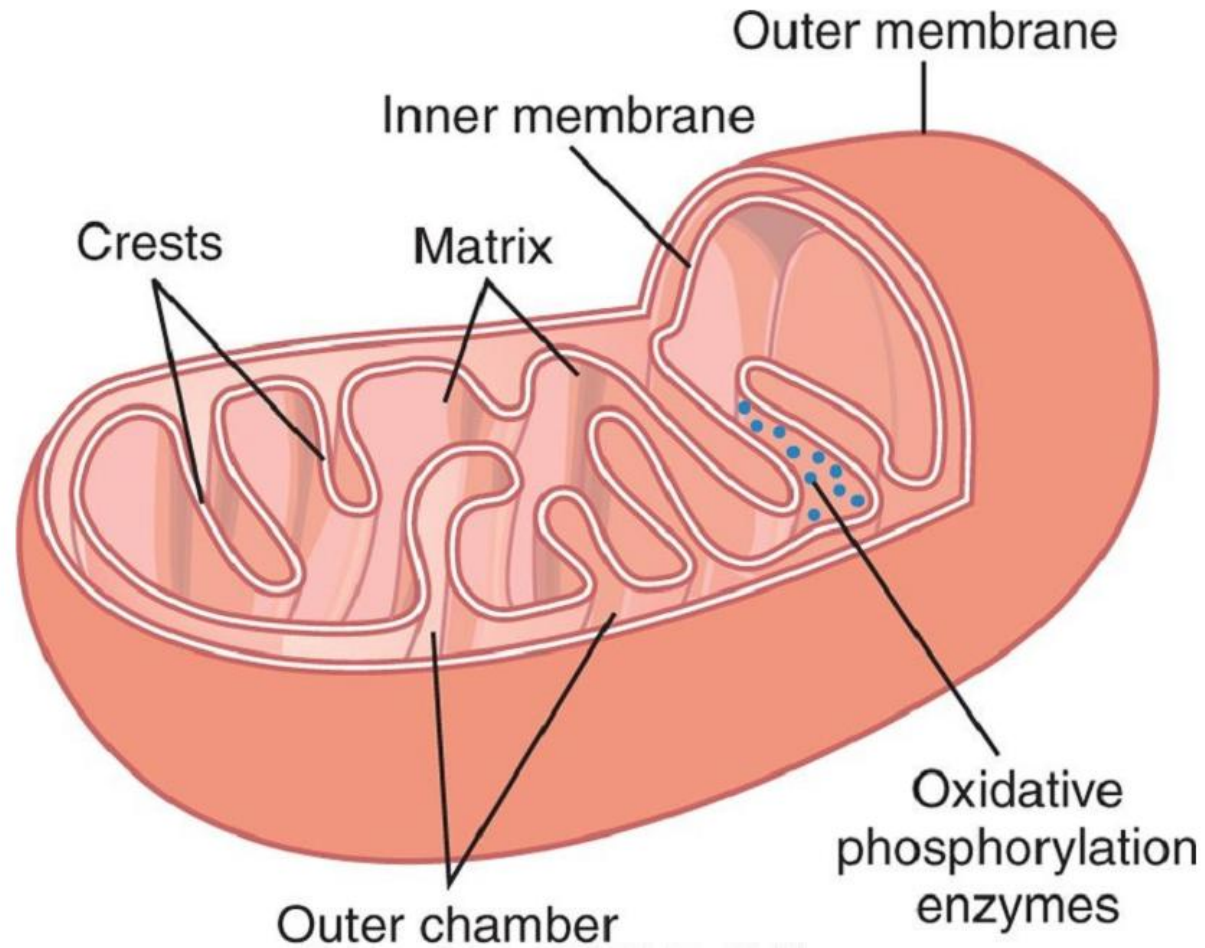
CELL ORGANELLES

Cytoplasm

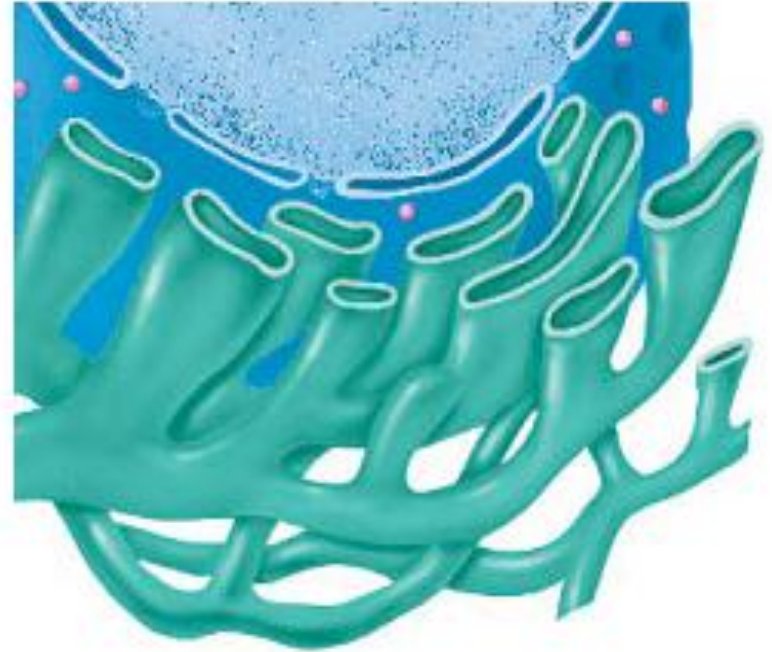
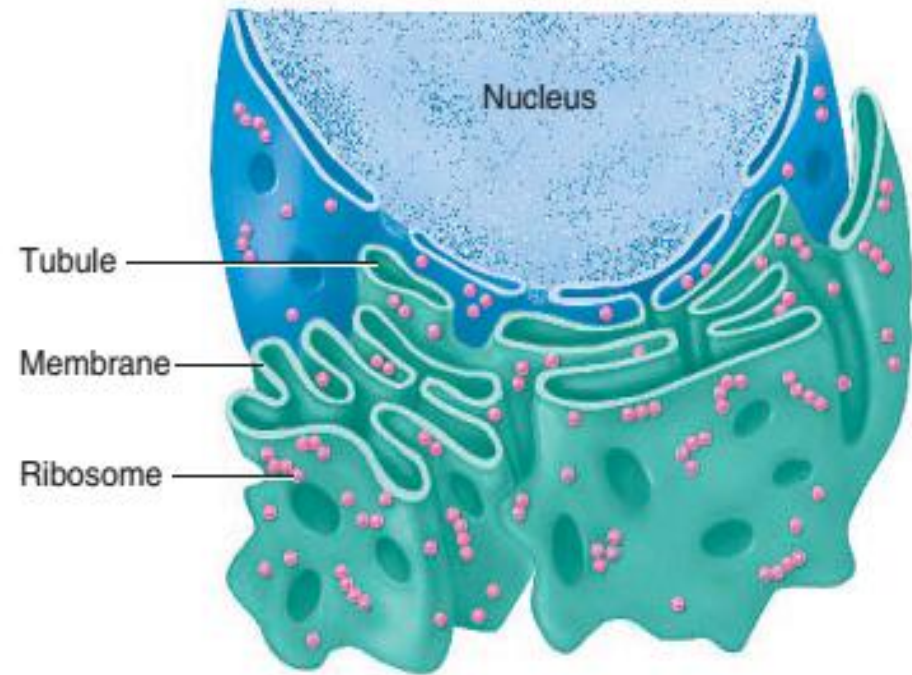
Contains cellular organelles

- Mitochondria
- Endoplasmic reticulum
- Golgi apparatus
- Ribosomes
- Lysosomes
- Peroxisomes
- Cytoskeleton (microfilaments, microtubules)

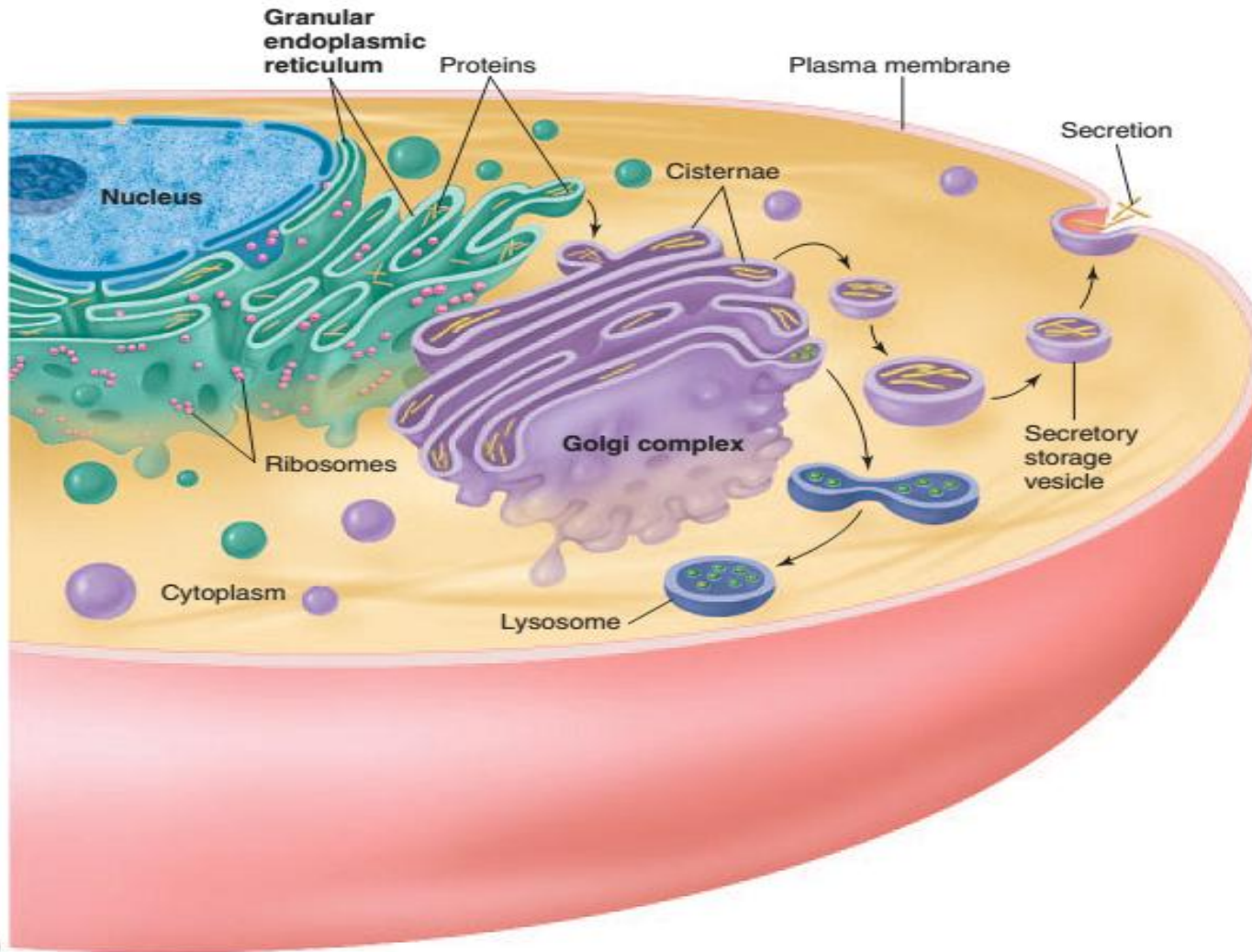
Mitochondria



Endoplasmic reticulum



Golgi apparatus

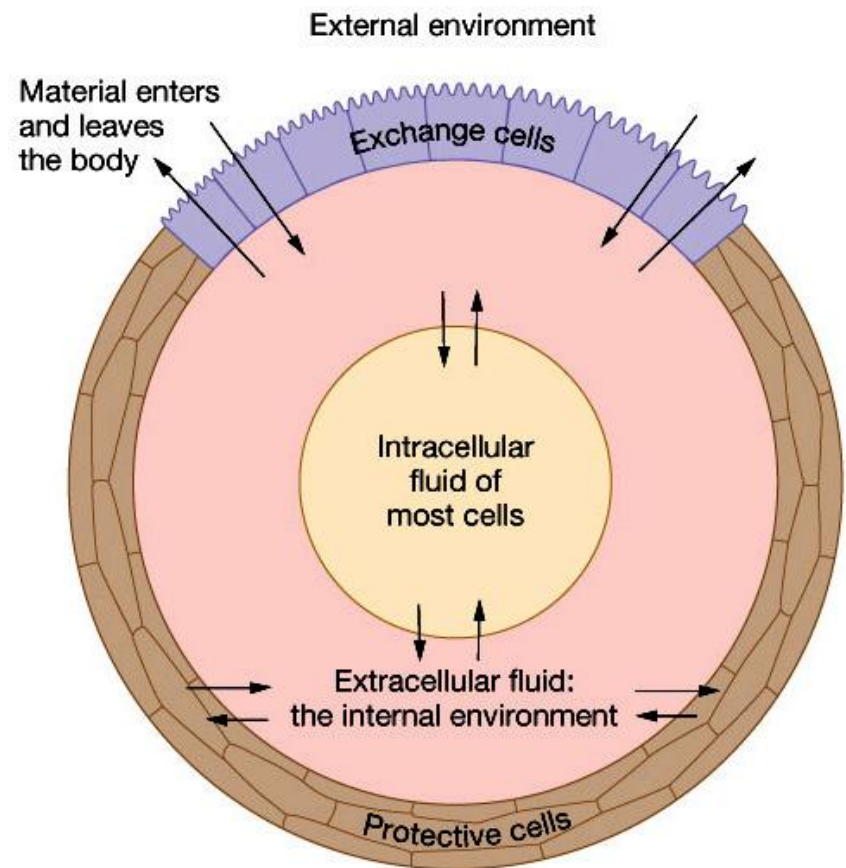


HOMEOSTASIS

Cellular Environments

➤ The vast majority of cells are sheltered from the external environment by a buffer zone called **the extracellular fluid (ECF)**.

➤ Claude Bernard called this the “**milieu interieur**”; internal environment.



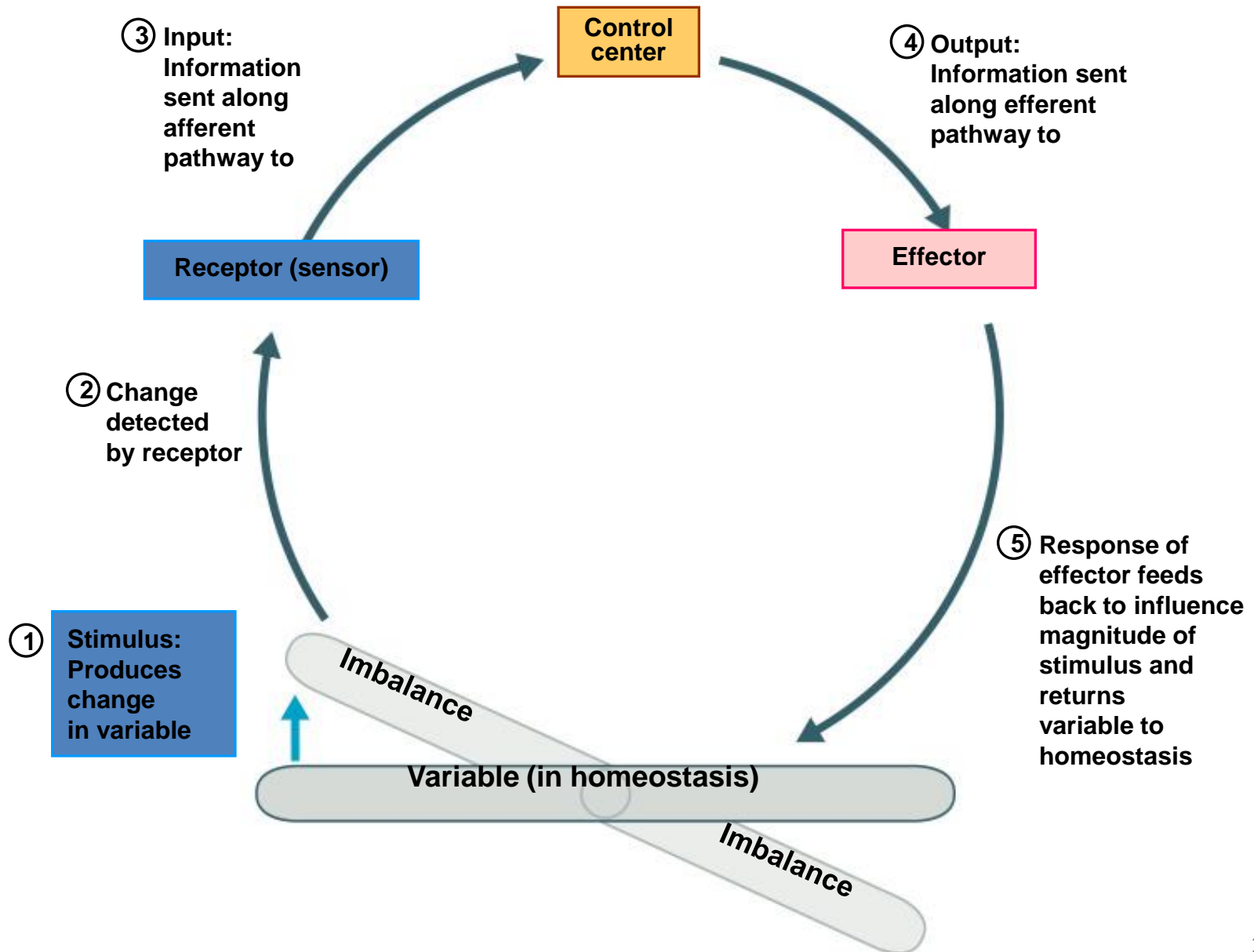
HOMEOSTASIS

- ❖ The condition in which body functions, fluids, temperature, pH, and other properties of the **internal environment are maintained** within a range of values suitable to support life.
- ❖ The internal environment (ECF) of the body is in a dynamic state of equilibrium
- ❖ The term was first used by **Walter Cannon**, a Harvard physiologist in the 1950's.
- ❖ Loss of it results in disease or death

Examples of Homeostatically Regulated Properties

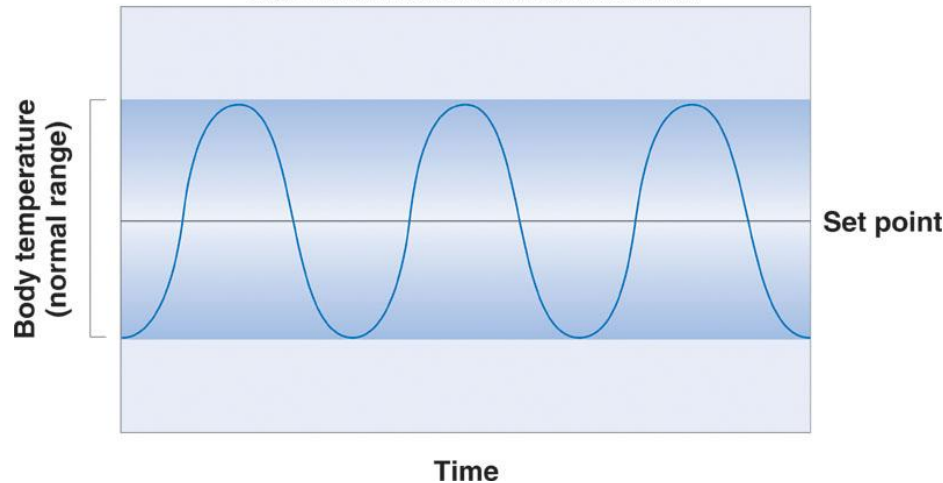
- Body Temperature
- Blood Composition (ions, sugars, proteins, etc)
- Concentrations of O₂ and CO₂ in the blood
- Acid-Base balance (pH)
- Blood osmolarity
- Blood pressure, cardiac output
- Respiratory rate and depth

Homeostatic Control Mechanisms



How does Homeostasis work?

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- Values of variables fluctuate around the **set point** to establish a **normal range** of values.
- **Set point**: the ideal normal value of a variable.
- What is the set point for body temperature? For blood sugar levels? For blood pH?

Feedback Loops

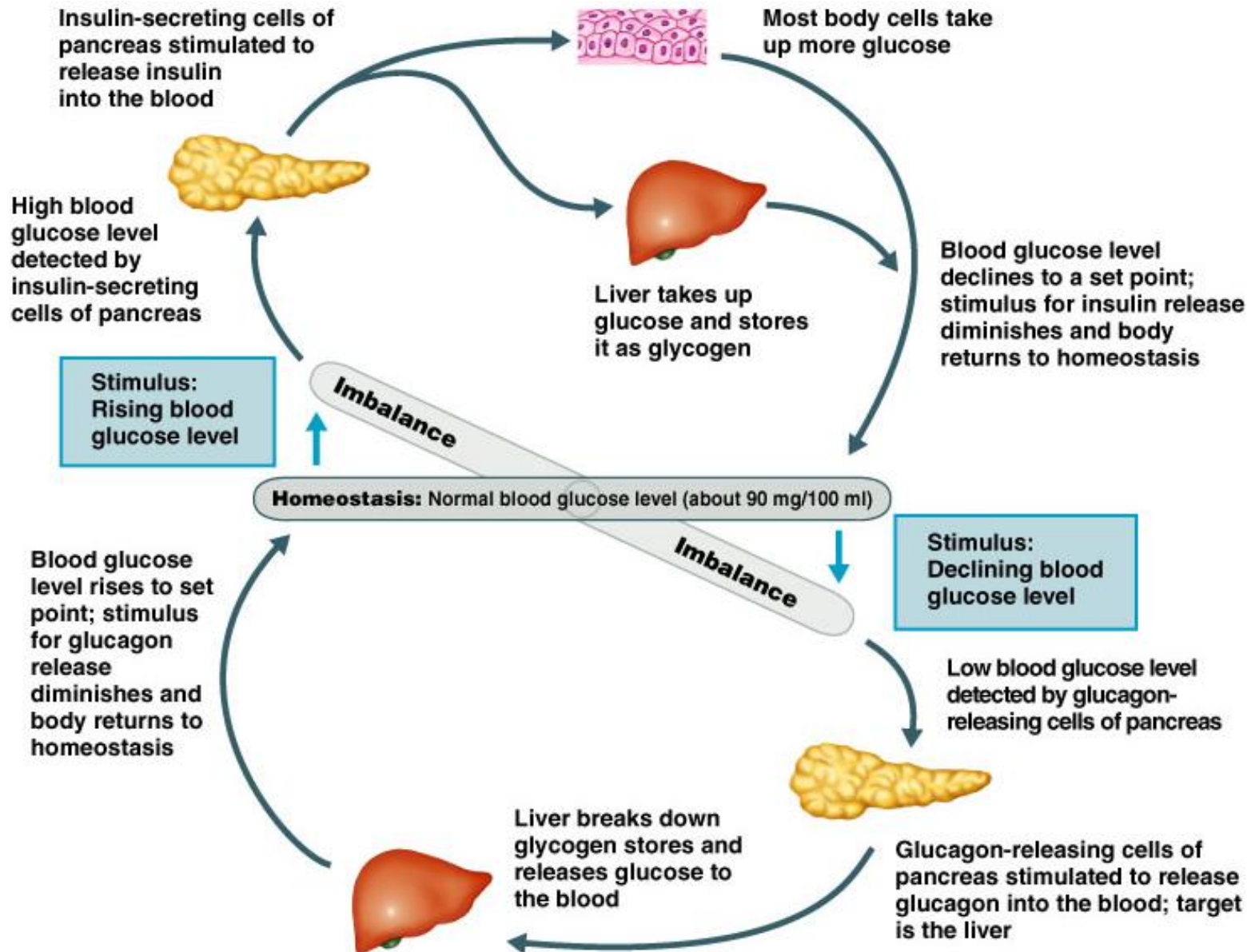
Negative Feedback:

A body mechanism by which any change from an ideal normal value is made smaller or is resisted. (usually leads to a compensated, healthy state, and maintains homeostasis)

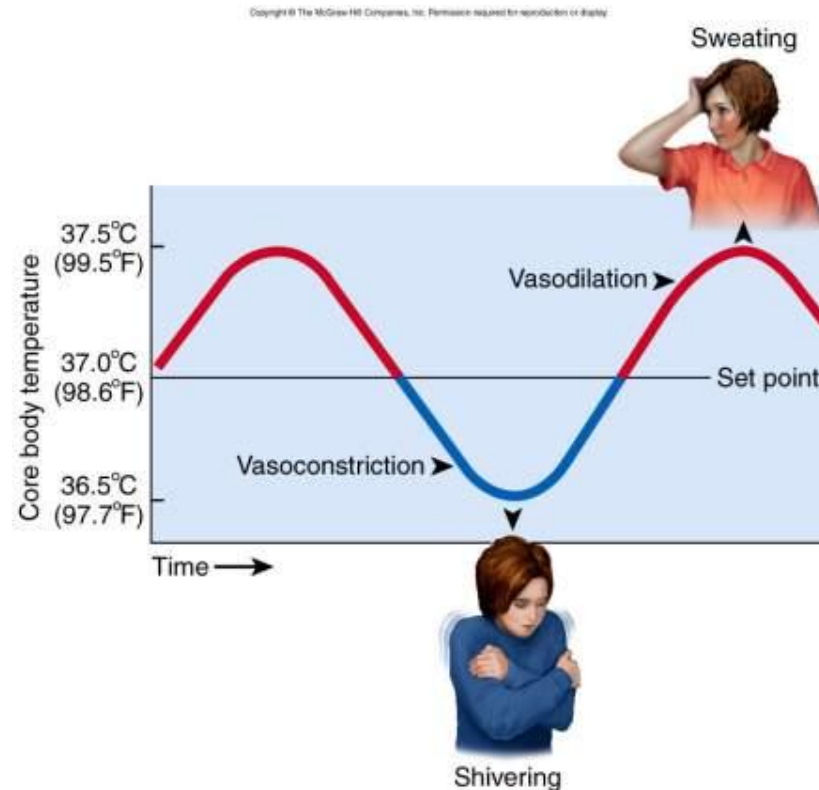
Positive Feedback:

A body mechanism by which any change from an ideal normal value is made greater. (usually, but not always, leads to a decompensated, disease state)

Negative Feedback



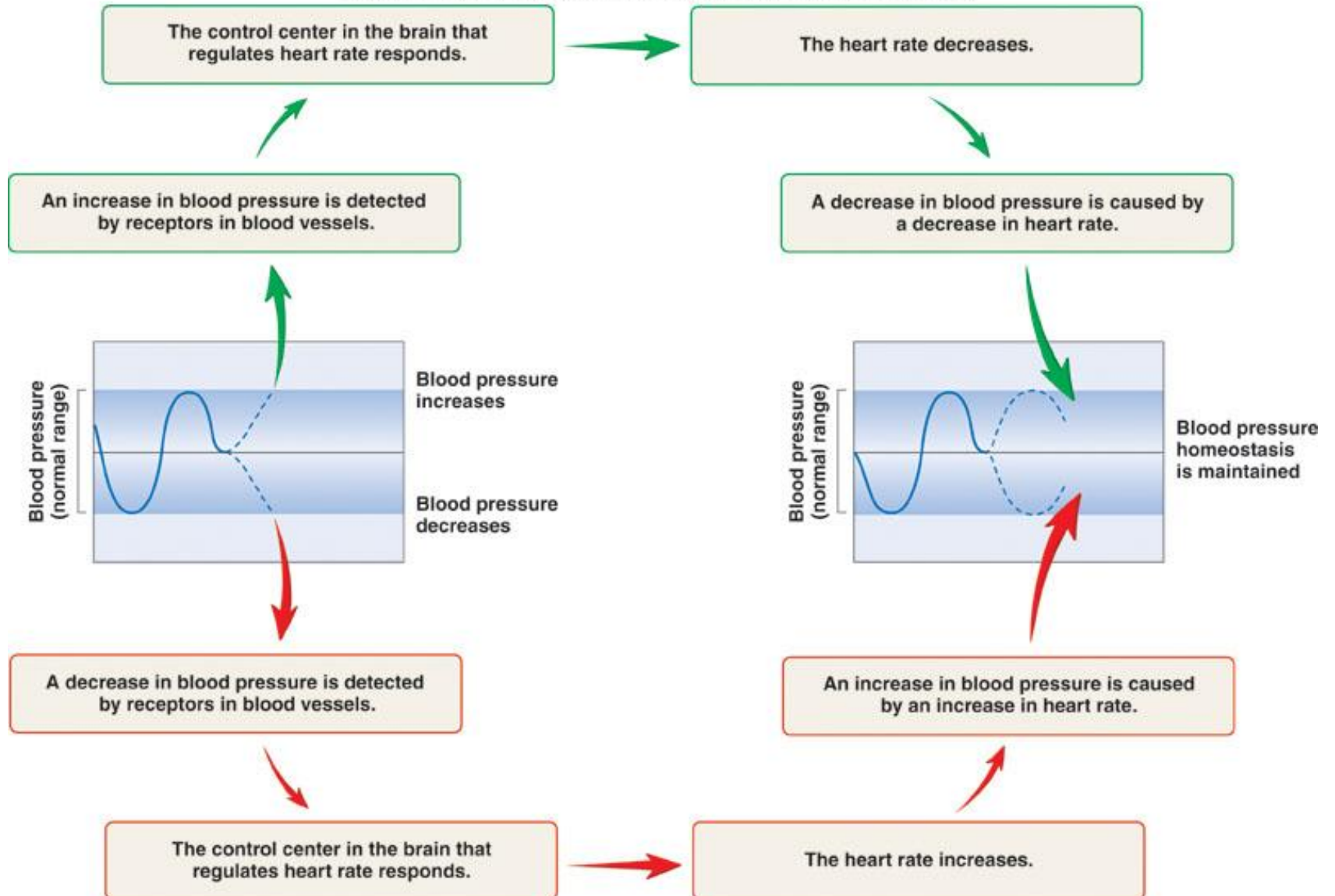
Human Thermoregulation



- **Brain senses change in blood temperature**
 - if overheating, vessels dilate in the skin and sweating begins
 - if too cold, vasoconstriction in the skin and shivering begins

Example of Negative Feedback

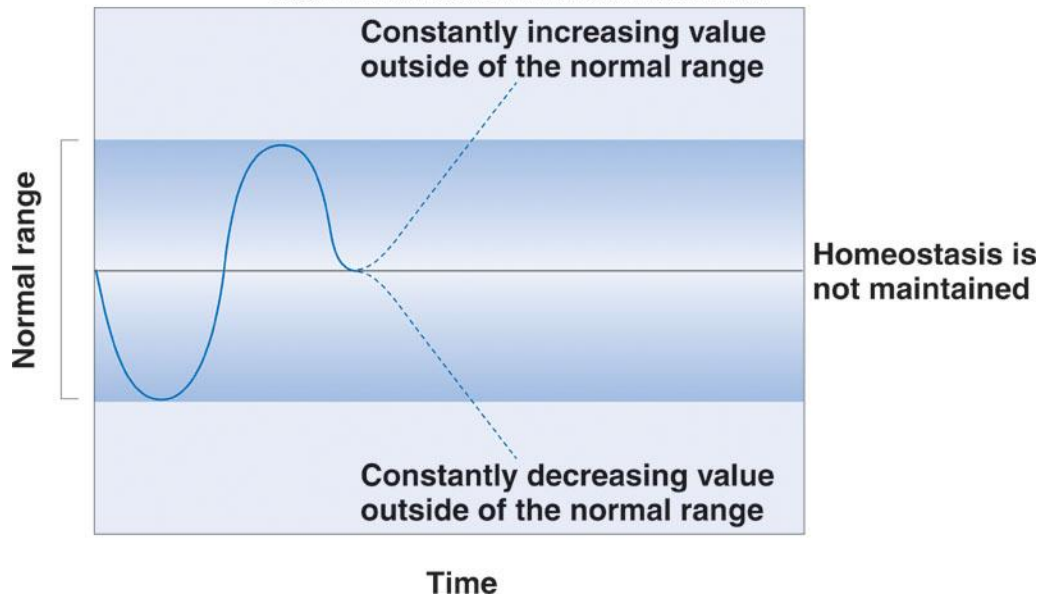
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Positive Feedback

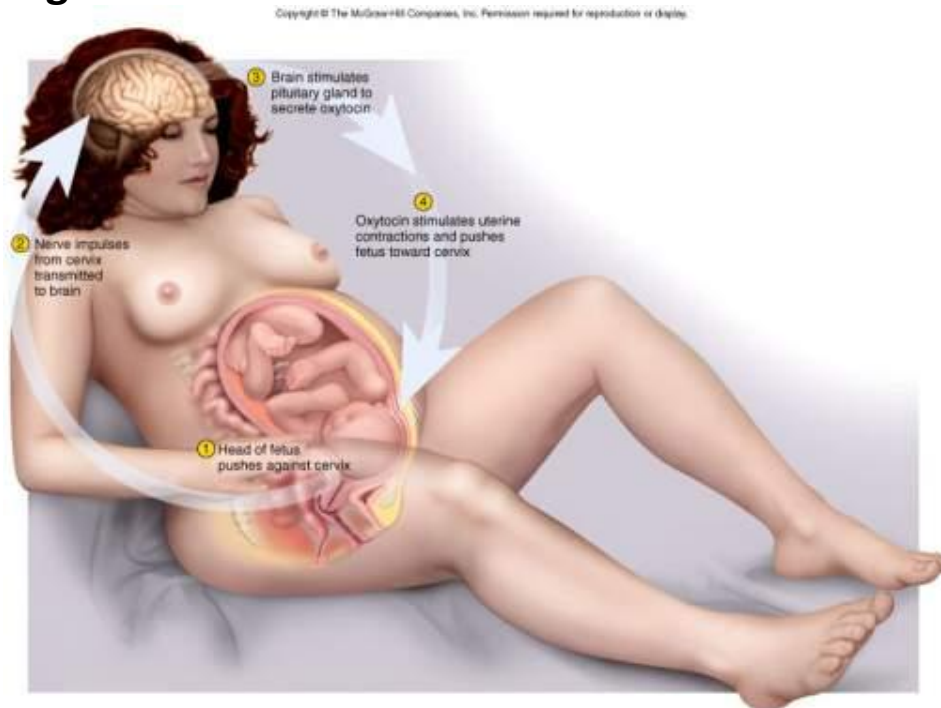
- When a deviation occurs, the response is to make the deviation greater
 - Unusual in normal, healthy individuals, leads away from homeostasis and can result in death
 - Example of normal positive feedback: **childbirth**
 - Example of harmful positive feedback: after hemorrhage, blood pressure drops and the heart's ability to pump blood decreases

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Positive Feedback Loops

- **Self-amplifying change**
 - leads to change in the same direction
- **Normal way of producing rapid changes**
 - occurs with childbirth, blood clotting, protein digestion, and generation of nerve signals



Positive Feedback

- In positive feedback systems, the output enhances or exaggerates the original stimulus
- Example: Regulation of blood clotting

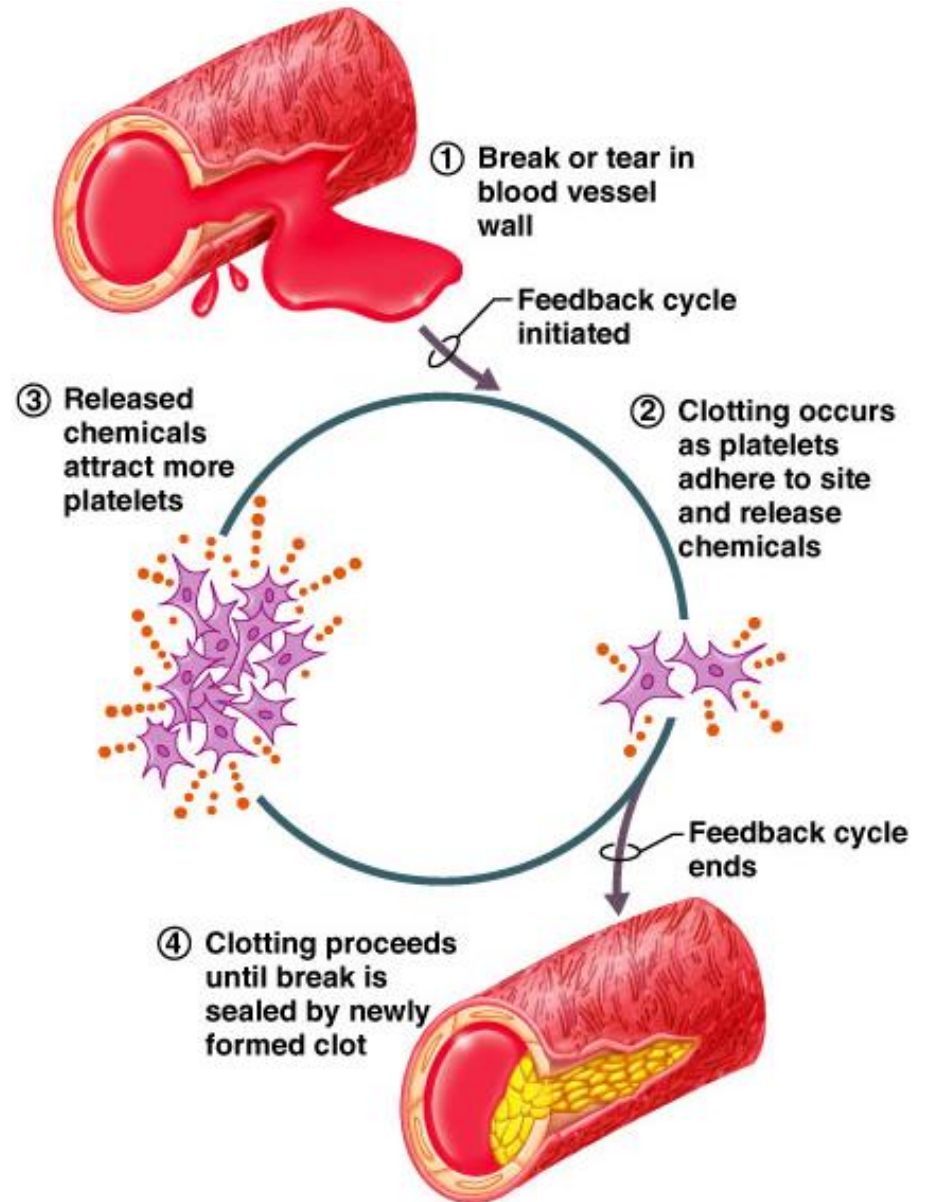


Figure 1.6

Feedforward Control

- The initiation of a response loop in anticipation of change in a current parameter based on prediction.

Examples:

- Increased heart rate before the start of a race.
- Increased salivation and gastric secretions when food is seen, smelled, or even imagined!

THANK YOU