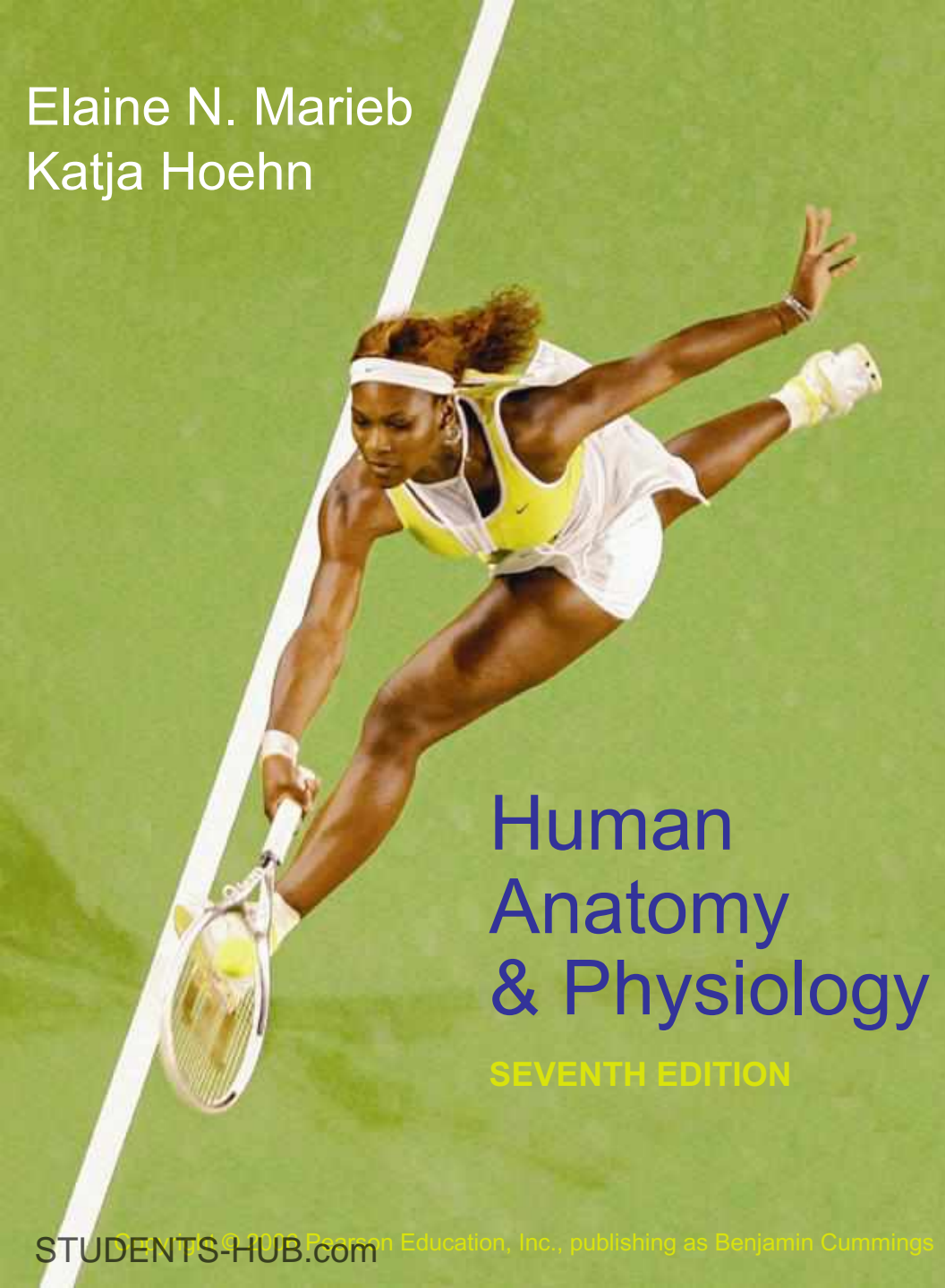


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# Human Anatomy & Physiology

SEVENTH EDITION

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Bluegrass Technical  
and Community College

CHAPTER

# 1

## Introduction The Human Body

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# Overview of Anatomy and Physiology

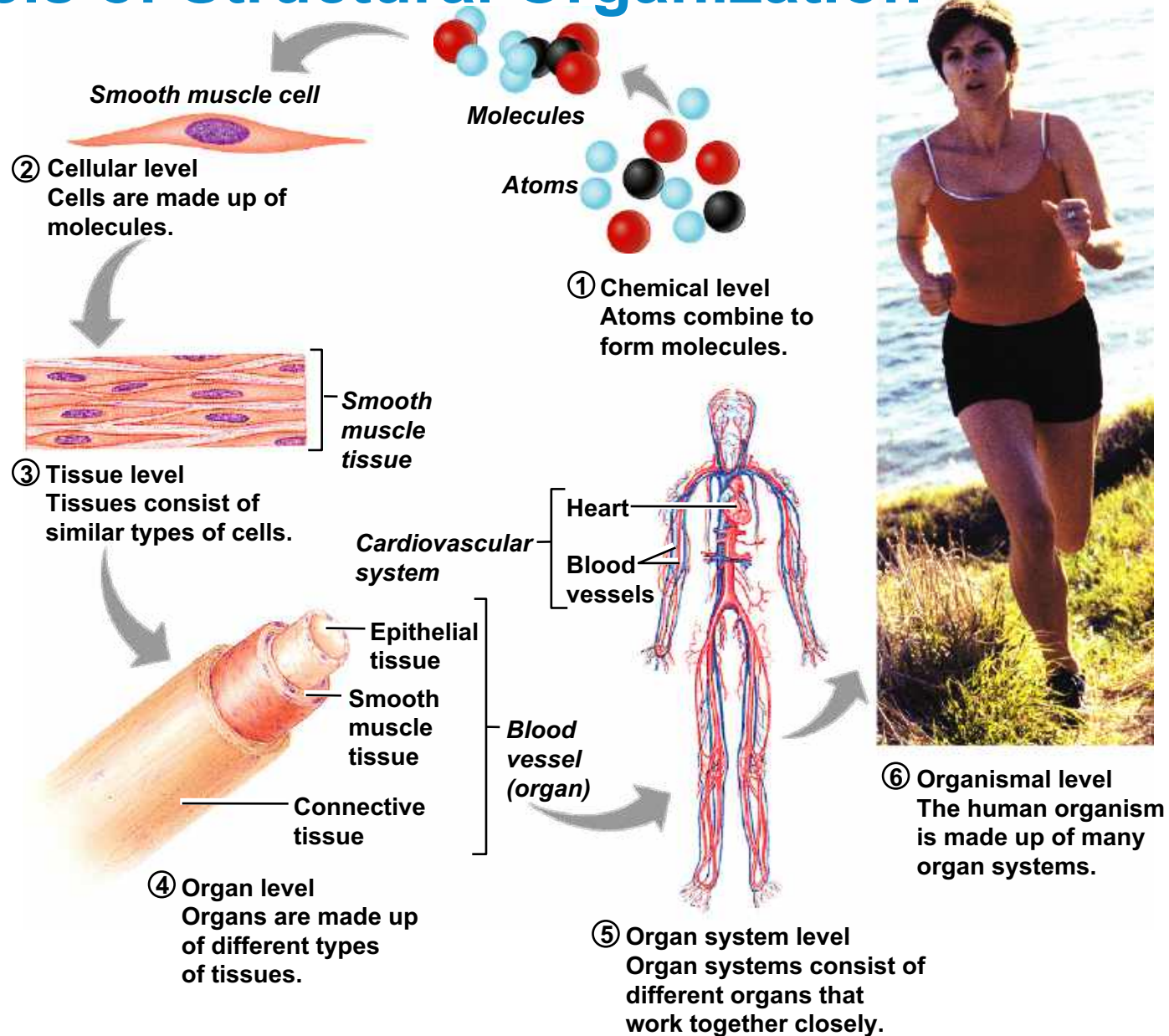
- Anatomy – the study of the structure of body parts and their relationships to one another
  - Gross or macroscopic
  - Microscopic
  - Developmental
- Physiology – the study of the function of the body's structural machinery

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# Levels of Structural Organization

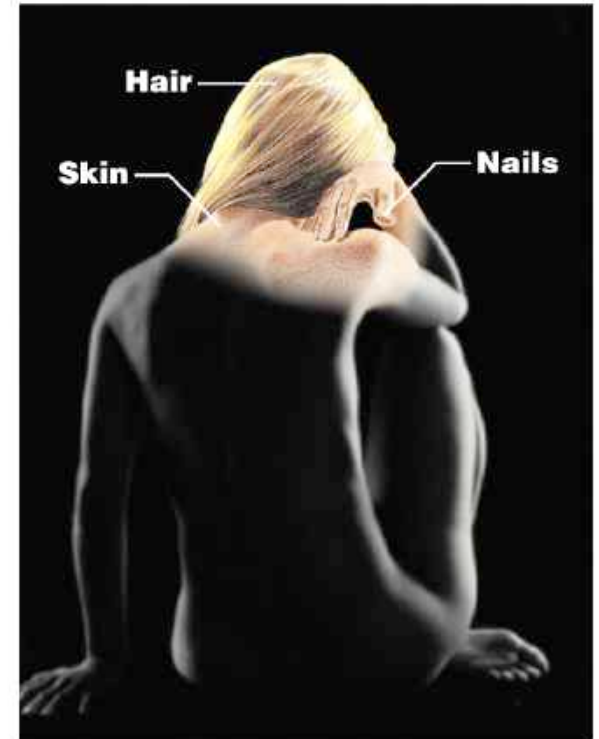
- Chemical – atoms combined to form molecules
- Cellular – cells are made of molecules
- Tissue – consists of similar types of cells
- Organ – made up of different types of tissues
- Organ system – consists of different organs that work closely together
- Organismal – made up of the organ systems

# Levels of Structural Organization



# Integumentary System

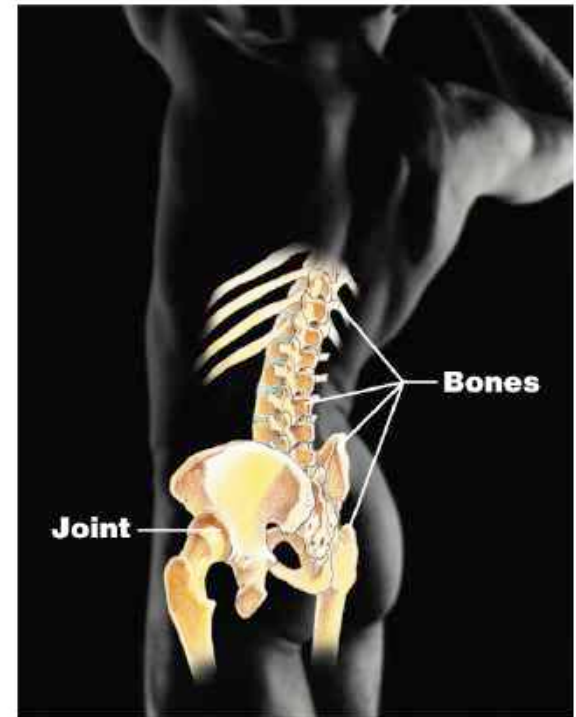
- Forms the external body covering
- Composed of the skin, sweat glands, oil glands, hair, and nails
- Protects deep tissues from injury and synthesizes vitamin D



**(a) Integumentary System**

# Skeletal System

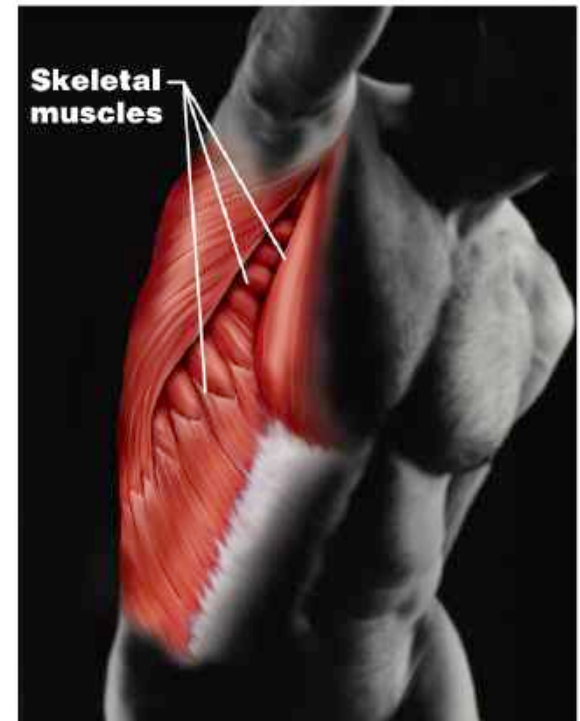
- Composed of bone, cartilage, and ligaments
- Protects and supports body organs
- Provides the framework for muscles
- Site of blood cell formation
- Stores minerals



**(b) Skeletal System**

# Muscular System

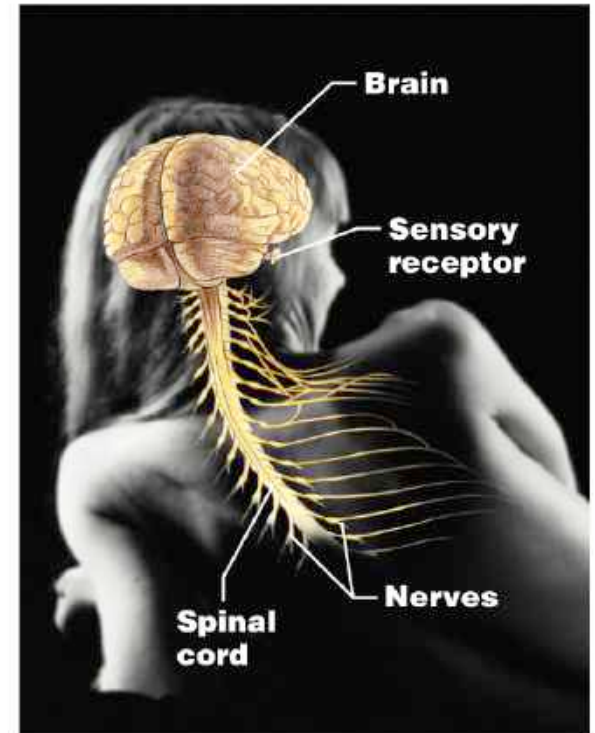
- Composed of muscles and tendons
- Allows manipulation of the environment, locomotion, and facial expression
- Maintains posture
- Produces heat



**(c) Muscular System**

# Nervous System

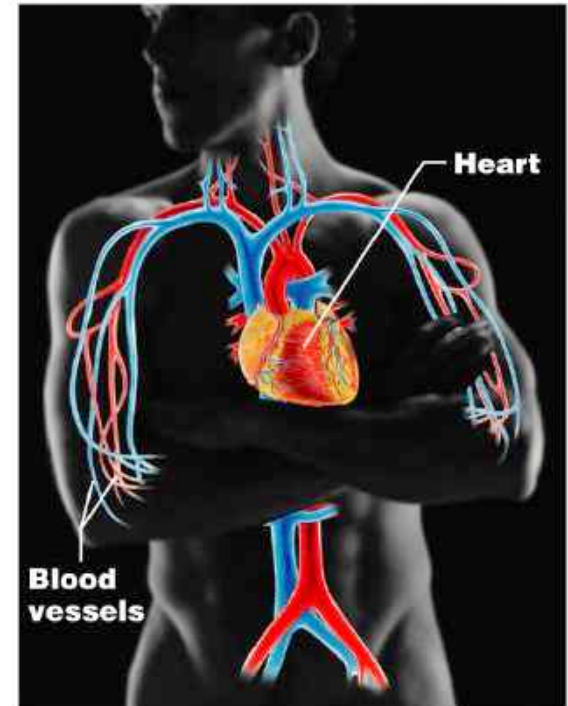
- Composed of the brain, spinal column, and nerves
- Is the fast-acting control system of the body
- Responds to stimuli by activating muscles and glands



(d) Nervous System

# Cardiovascular System

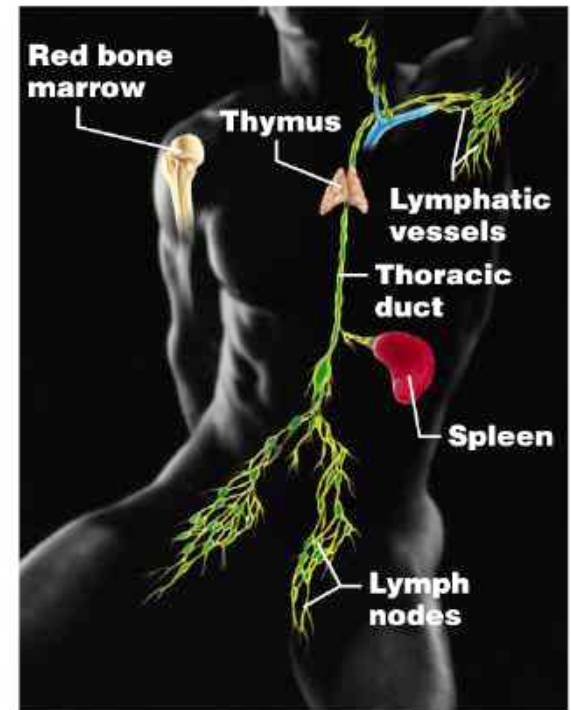
- Composed of the heart and blood vessels
- The heart pumps blood
- The blood vessels transport blood throughout the body



**(f) Cardiovascular System**

# Lymphatic System

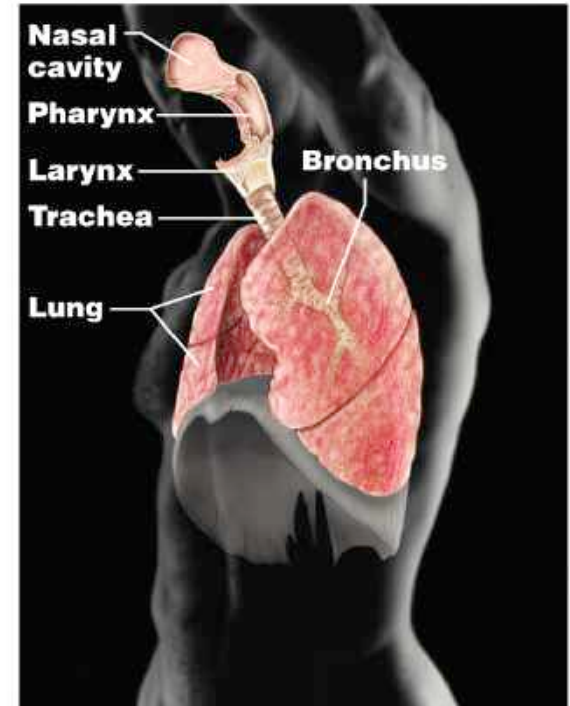
- Composed of red bone marrow, thymus, spleen, lymph nodes, and lymphatic vessels
- Picks up fluid leaked from blood vessels and returns it to blood
- Disposes of debris in the lymphatic stream
- Houses white blood cells involved with immunity



(g) Lymphatic System/Immunity

# Respiratory System

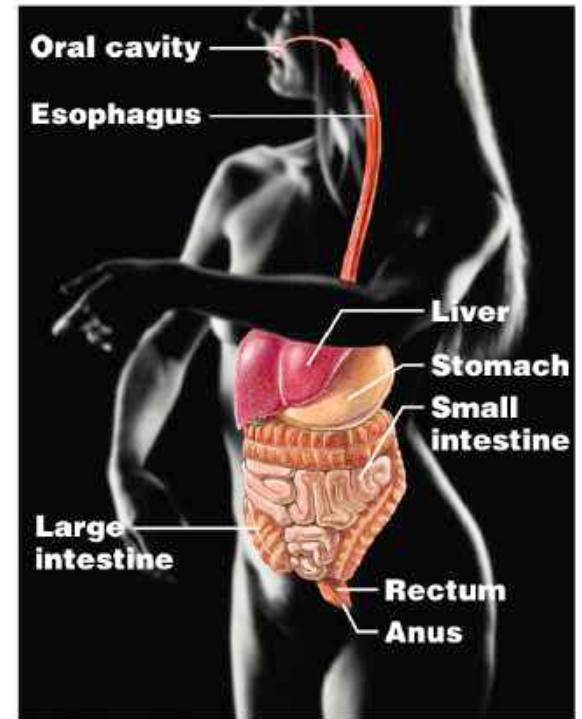
- Composed of the nasal cavity, pharynx, trachea, bronchi, and lungs
- Keeps blood supplied with oxygen and removes carbon dioxide



**(h) Respiratory System**

# Digestive System

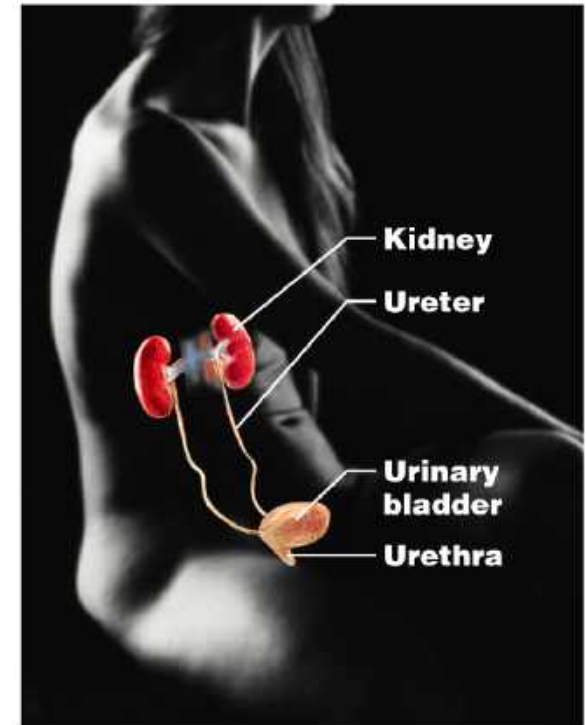
- Composed of the oral cavity, esophagus, stomach, small intestine, large intestine, rectum, anus, and liver
- Breaks down food into absorbable units that enter the blood
- Eliminates indigestible foodstuffs as feces



(i) Digestive System

# Urinary System

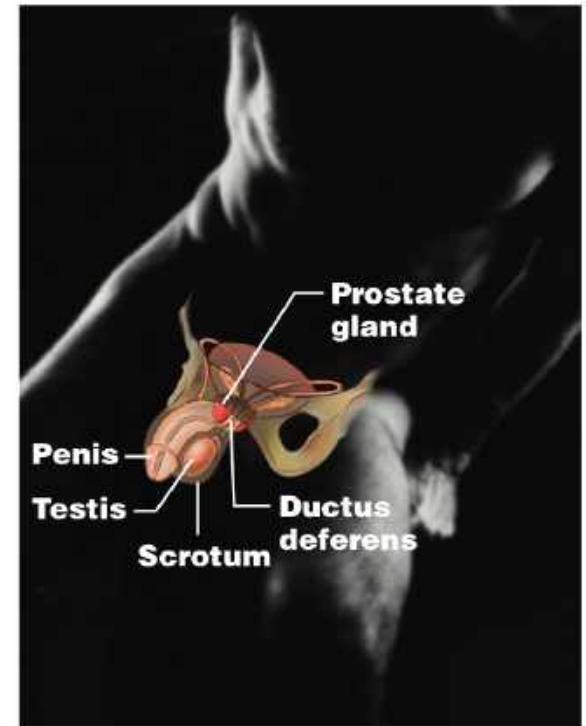
- Composed of kidneys, ureters, urinary bladder, and urethra
- Eliminates nitrogenous wastes from the body
- Regulates water, electrolyte, and pH balance of the blood



**(j) Urinary System**

# Male Reproductive System

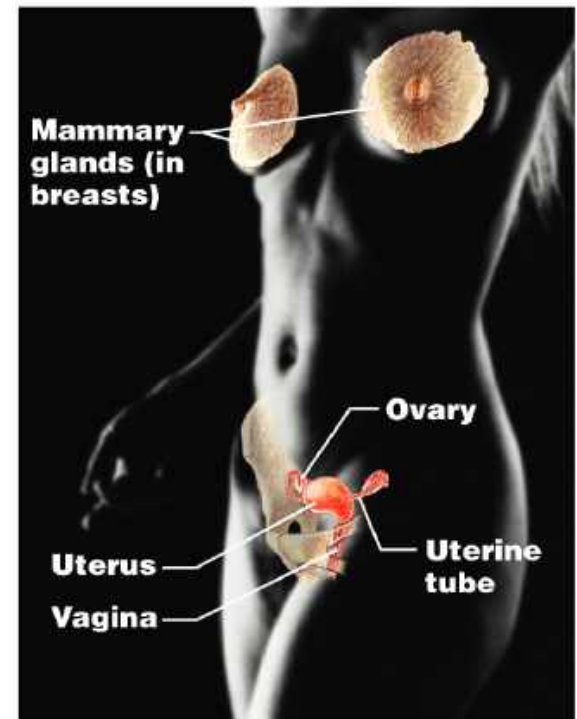
- Composed of prostate gland, penis, testes, scrotum, and ductus deferens
- Main function is the production of offspring
- Testes produce sperm and male sex hormones
- Ducts and glands deliver sperm to the female reproductive tract



**(k) Male Reproductive System**

# Female Reproductive System

- Composed of mammary glands, ovaries, uterine tubes, uterus, and vagina
- Main function is the production of offspring
- Ovaries produce eggs and female sex hormones
- Remaining structures serve as sites for fertilization and development of the fetus
- Mammary glands produce milk to nourish the newborn

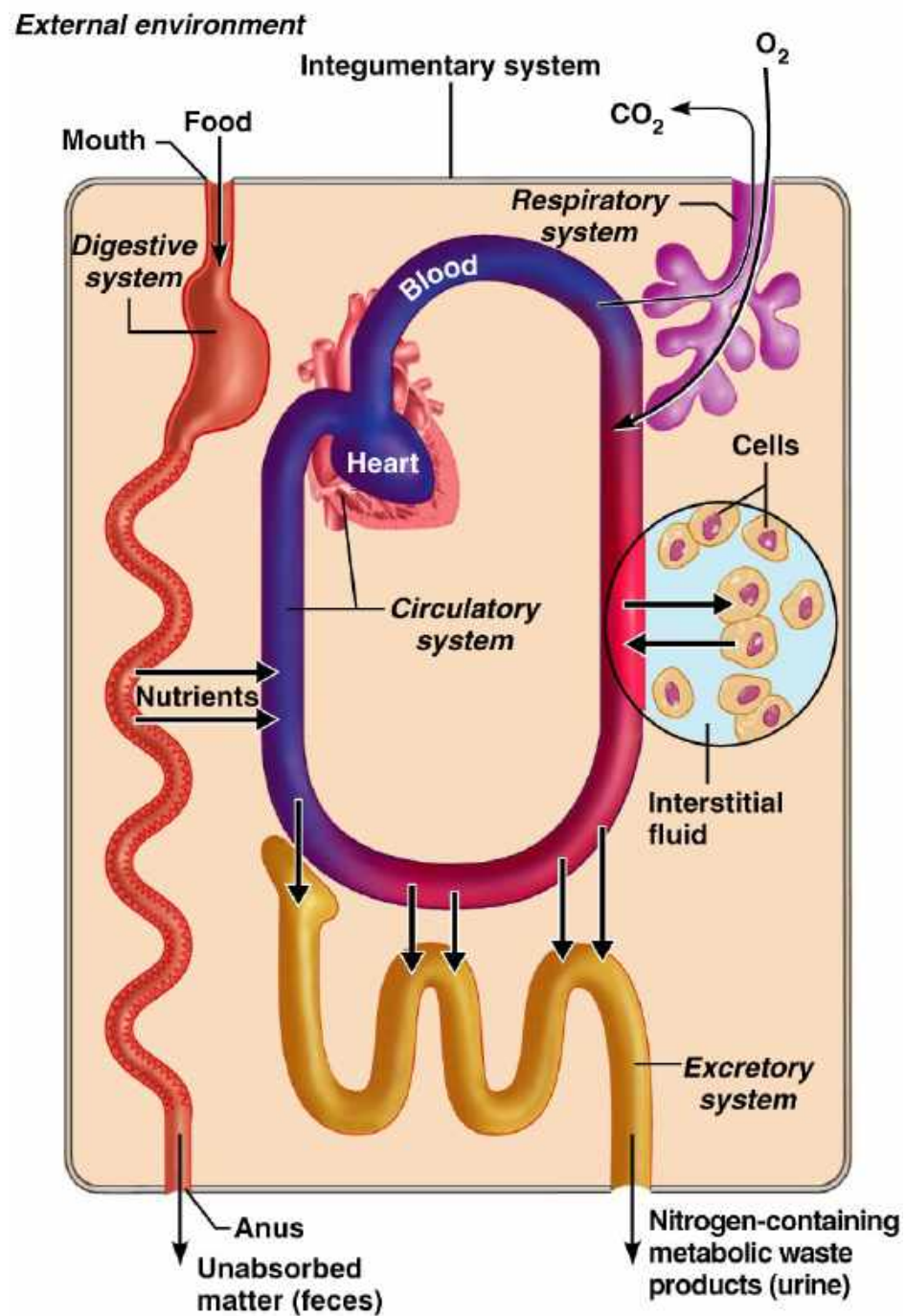


**(I) Female Reproductive System**

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# Organ Systems Interrelationships

- The integumentary system protects the body from the external environment
- Digestive and respiratory systems, in contact with the external environment, take in nutrients and oxygen
- Nutrients and oxygen are distributed by the blood
- Metabolic wastes are eliminated by the urinary and respiratory systems



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# Necessary Life Functions

- **Maintaining boundaries** – the internal environment remains distinct from the external environment
  - **Cellular level** – accomplished by plasma membranes
  - **Organismal level** – accomplished by the skin
- **Movement** – locomotion, propulsion (peristalsis), and contractility

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# Necessary Life Functions

- **Responsiveness** – ability to sense changes in the environment and respond to them
- **Digestion** – breakdown of ingested foodstuffs
- **Metabolism** – all the chemical reactions that occur in the body
- **Excretion** – removal of wastes from the body

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# Necessary Life Functions

- **Reproduction** – cellular and organismal levels
  - **Cellular** – an original cell divides and produces two identical daughter cells
  - **Organismal** – sperm and egg unite to make a whole new person
- **Growth** – increase in size of a body part or of the organism

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# Survival Needs

- **Nutrients** – needed for energy and cell building
- **Oxygen** – necessary for metabolic reactions
- **Water** – provides the necessary environment for chemical reactions
- **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

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# Homeostasis

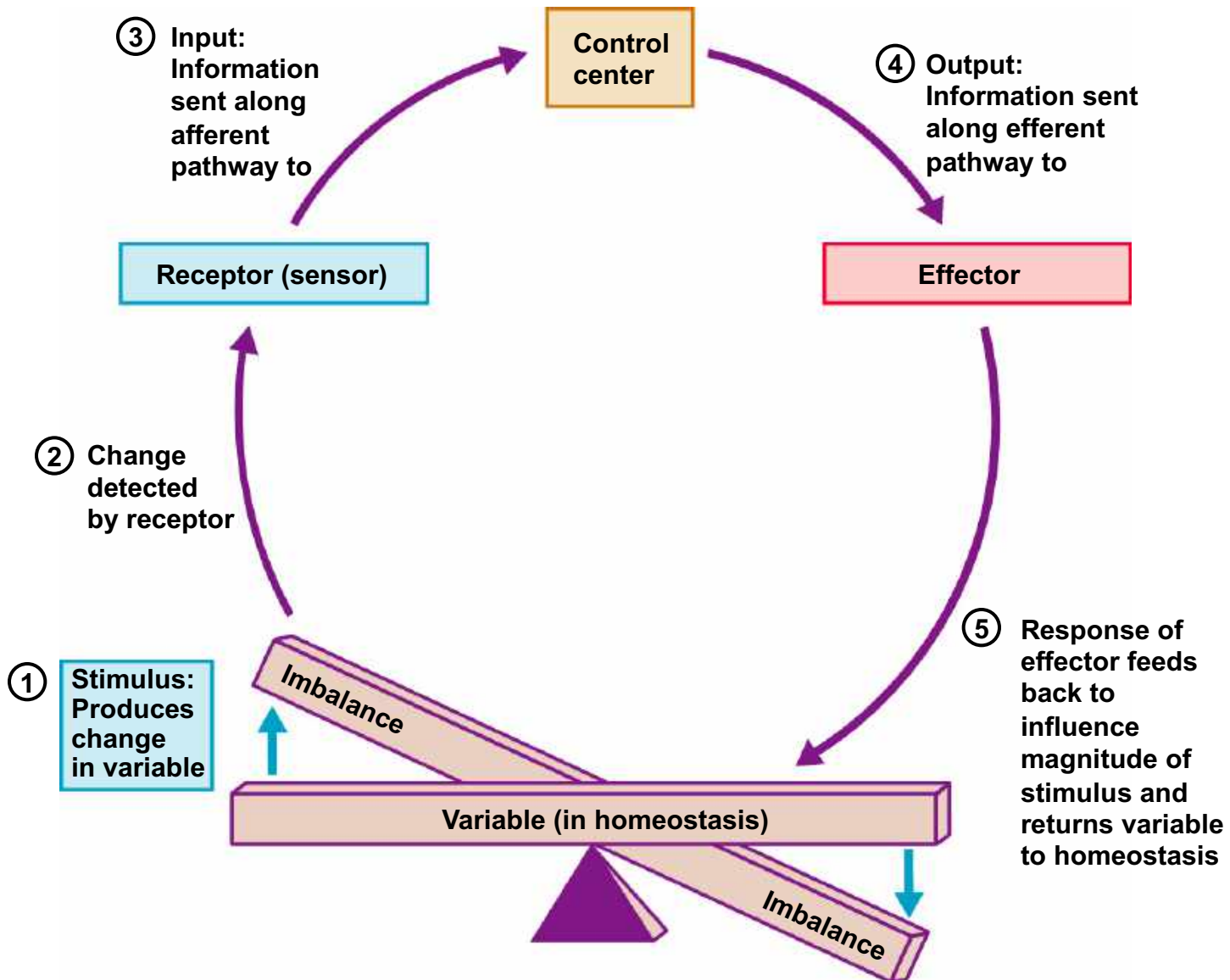
- **Homeostasis** – ability to maintain a relatively stable internal environment in an ever-changing outside world
- The internal environment of the body is in a **dynamic state of equilibrium**
- Chemical, thermal, and neural factors interact to maintain homeostasis

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# Homeostatic Control Mechanisms

- Variables produce a change in the body
- The three interdependent components of control mechanisms:
  - **Receptor** – monitors the environments and responds to changes (stimuli)
  - **Control center** – determines the set point at which the variable is maintained
  - **Effector** – provides the means to respond to stimuli

# Homeostatic Control Mechanisms



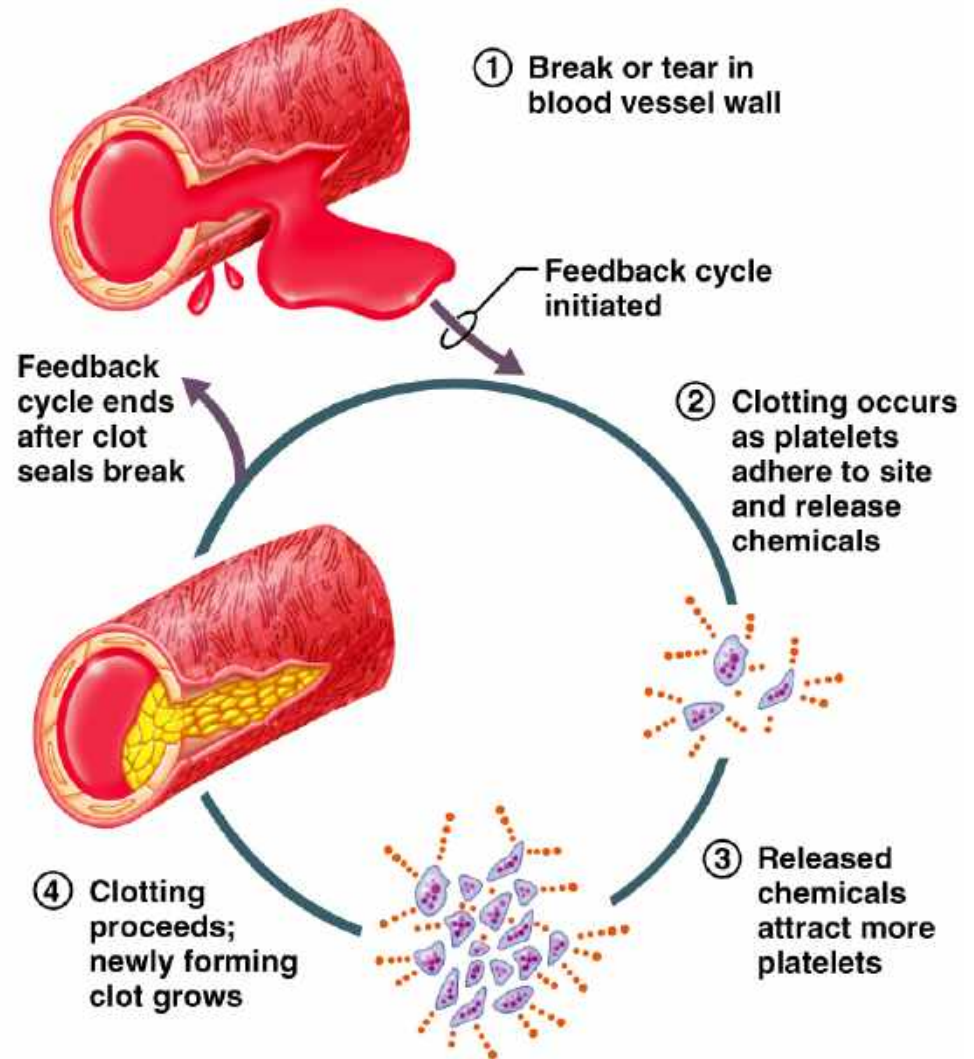
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# Negative Feedback

- In negative feedback systems, the output shuts off the original stimulus
- Example: Regulation of room temperature

# Positive Feedback

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



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# Feedforward system

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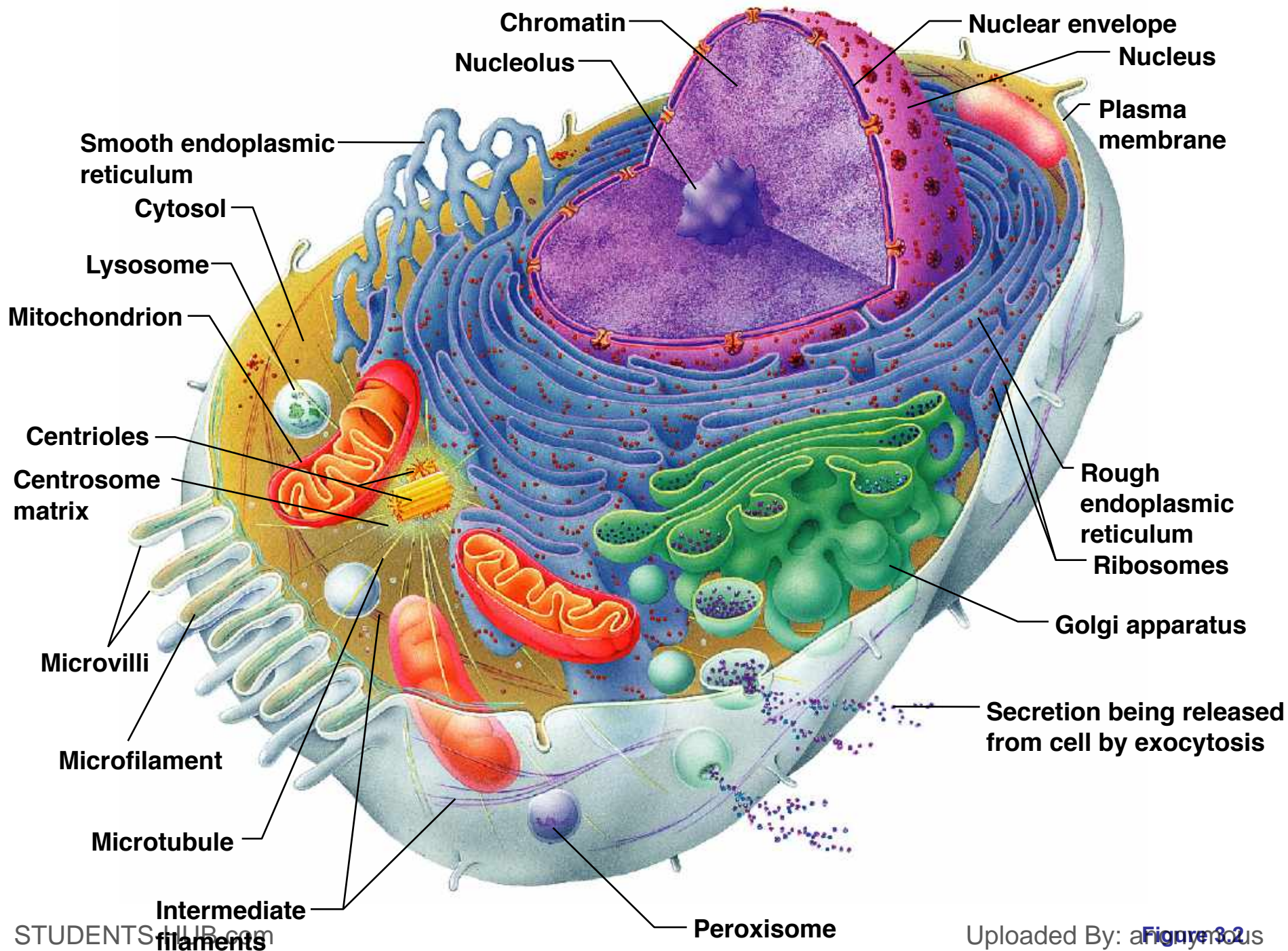
# Homeostatic Imbalance

- Disturbance of homeostasis or the body's normal equilibrium
- Overwhelming the usual negative feedback mechanisms allows destructive positive feedback mechanisms to take over

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# Cell Theory

- The cell is the basic structural and functional unit of life
- Organismal activity depends on individual and collective activity of cells
- Biochemical activities of cells are dictated by subcellular structure
- Continuity of life has a cellular basis



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# Plasma Membrane

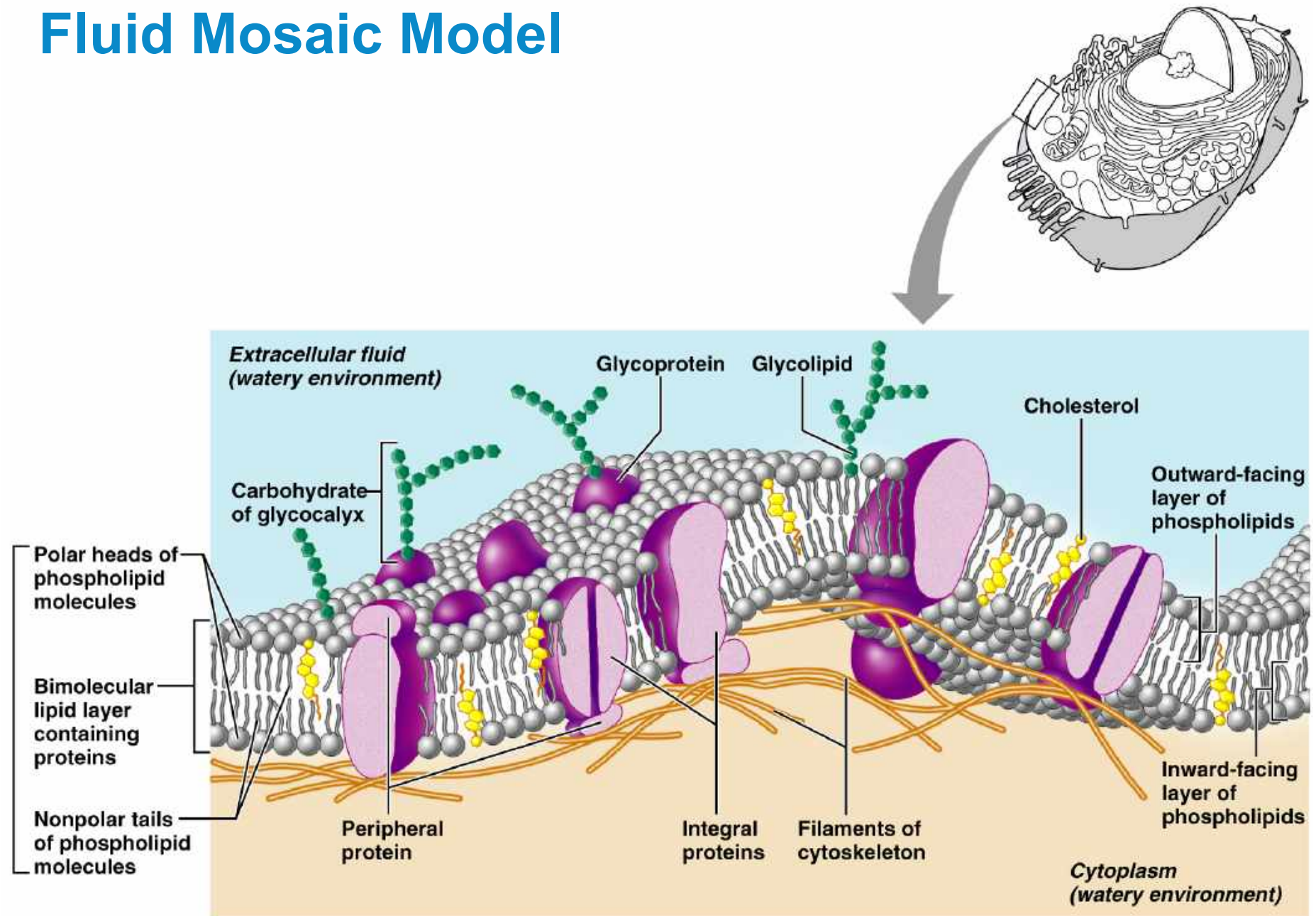
- Separates intracellular fluids from extracellular fluids
- Plays a dynamic role in cellular activity
- Glycocalyx is a glycoprotein area abutting the cell that provides highly specific biological markers by which cells recognize one another

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# Fluid Mosaic Model

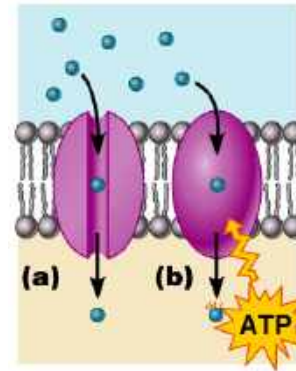
- Double bilayer of lipids with imbedded, dispersed proteins
- Bilayer consists of phospholipids, cholesterol, and glycolipids
  - Glycolipids are lipids with bound carbohydrate
  - Phospholipids have hydrophobic and hydrophilic bipoles

# Fluid Mosaic Model



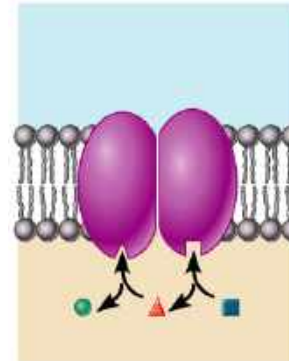
# Functions of Membrane Proteins

- Transport
- Enzymatic activity
- Receptors for signal transduction



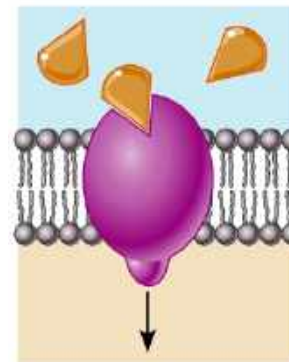
## Transport

**(a)** A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute. **(b)** Some transport proteins hydrolyze ATP as an energy source to actively pump substances across the membrane.



## Enzymatic activity

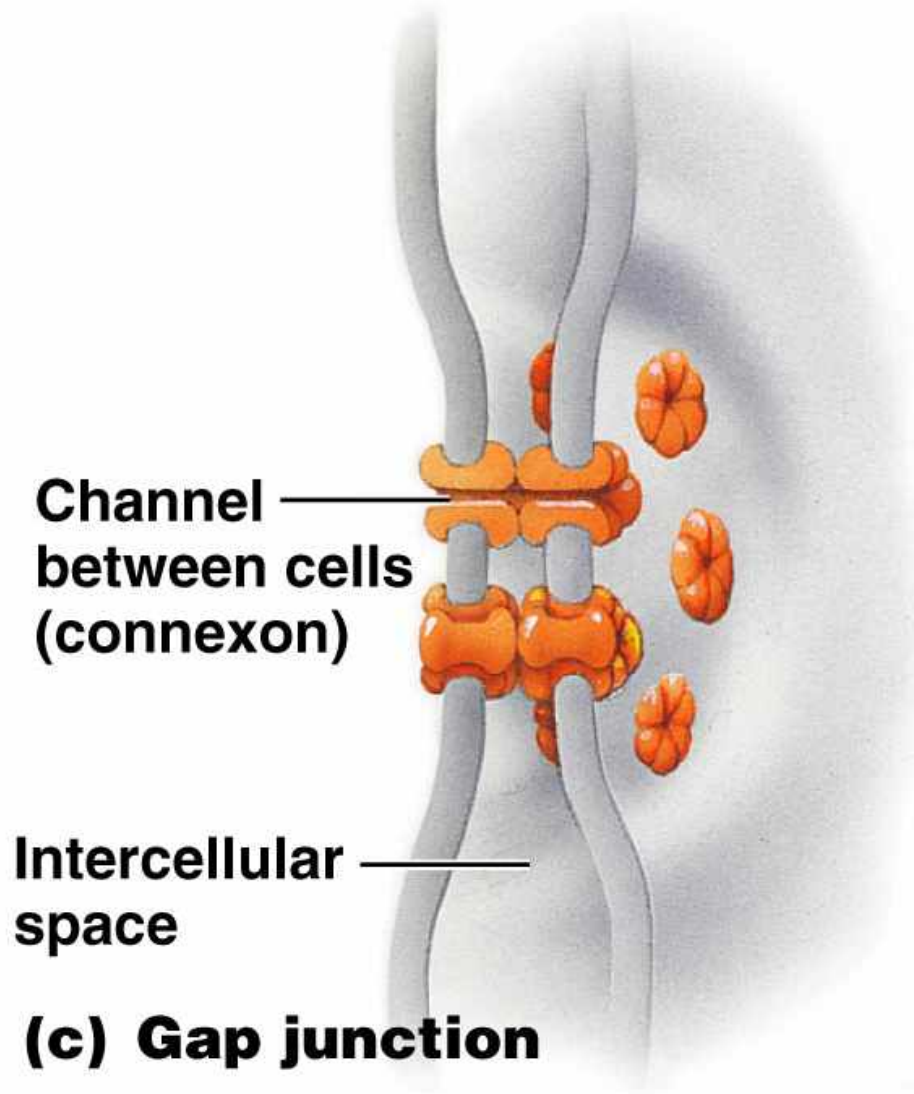
A protein built into the membrane may be an enzyme with its active site exposed to substances in the adjacent solution. In some cases, several enzymes in a membrane act as a team that catalyzes sequential steps of a metabolic pathway as indicated (right to left) here.



## Receptors for signal transduction

A membrane protein exposed to the outside of the cell may have a binding site with a specific shape that fits the shape of a chemical messenger, such as a hormone. The external signal may cause a conformational change in the protein that initiates a chain of chemical reactions in the cell.

# Membrane Junctions: Gap Junction

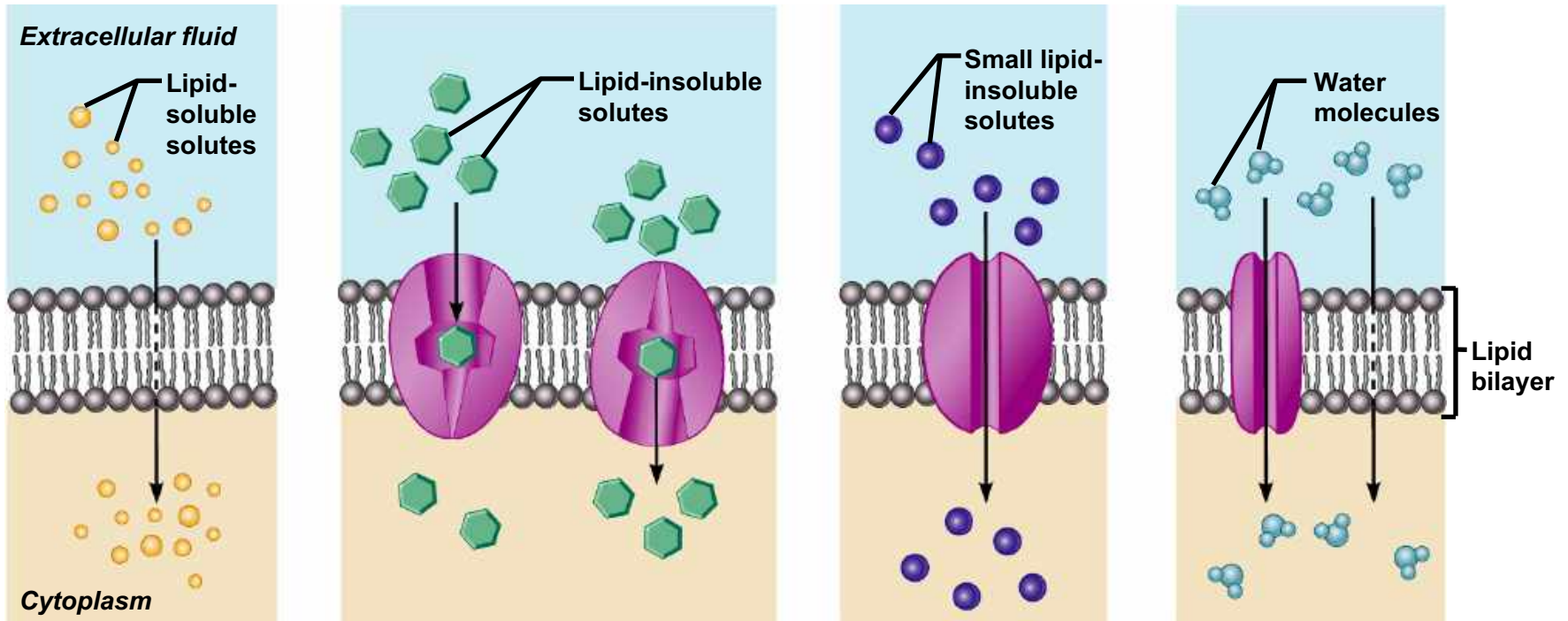


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# Passive Membrane Transport: Diffusion

- Simple diffusion – nonpolar and lipid-soluble substances
  - Diffuse directly through the lipid bilayer
  - Diffuse through channel proteins
- Facilitated diffusion
  - Transport of glucose, amino acids, and ions
  - Transported substances bind carrier proteins or pass through protein channels

# Diffusion Through the Plasma Membrane



(a) Simple diffusion directly through the phospholipid bilayer

(b) Carrier-mediated facilitated diffusion via protein carrier specific for one chemical; binding of substrate causes shape change in transport protein

(c) Channel-mediated facilitated diffusion through a channel protein; mostly ions selected on basis of size and charge

(d) Osmosis, diffusion through a specific channel protein (aquaporin) or through the lipid bilayer

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# Active Transport

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# Active Transport

- Uses ATP to move solutes across a membrane
- Requires carrier proteins

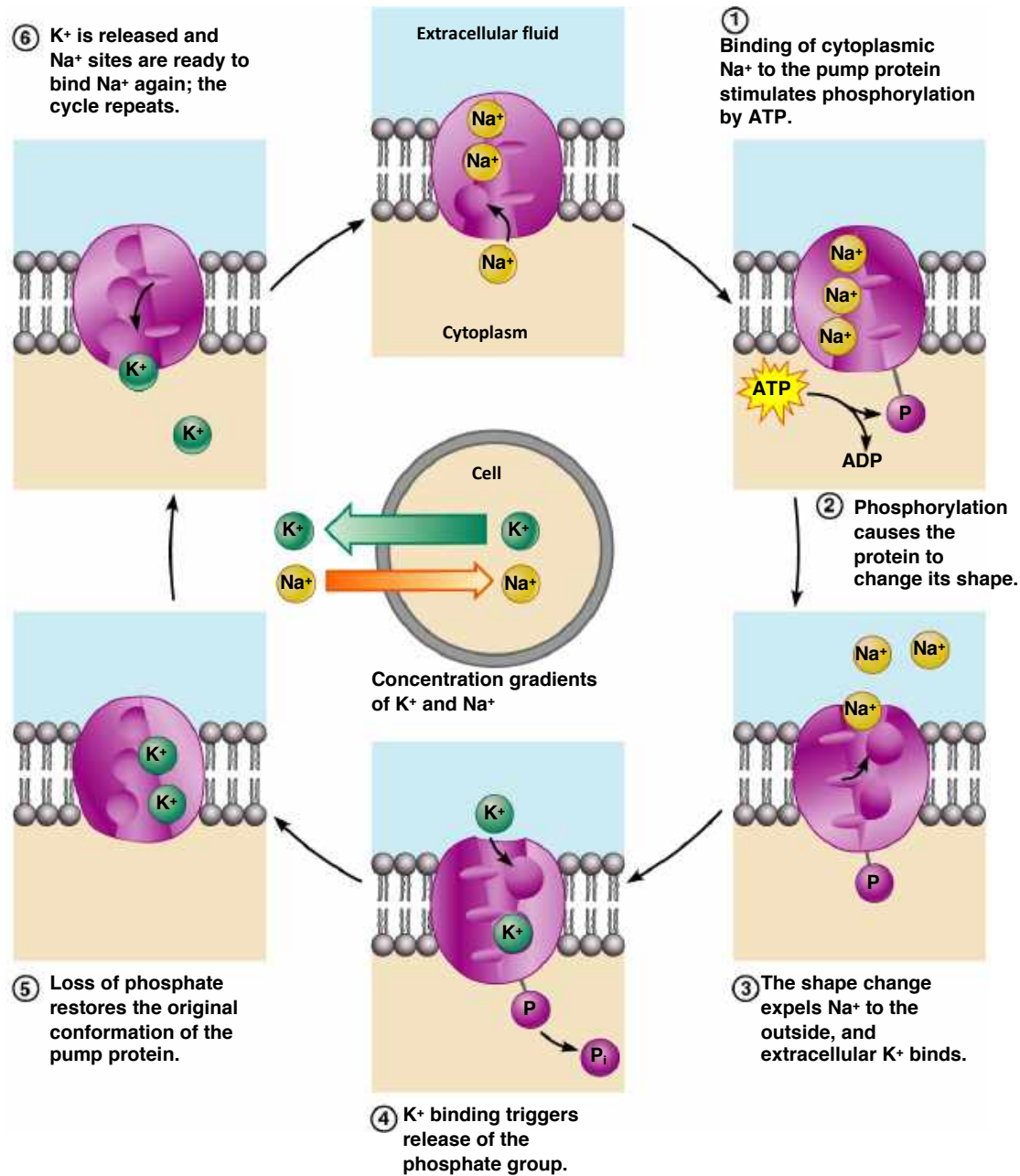
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# Types of Active Transport

- **Primary active transport** – hydrolysis of ATP phosphorylates the transport protein causing conformational change
- **Secondary active transport** – use of an exchange pump (such as the  $\text{Na}^+$ - $\text{K}^+$  pump) indirectly to drive the transport of other solutes

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# Primary Active Transport



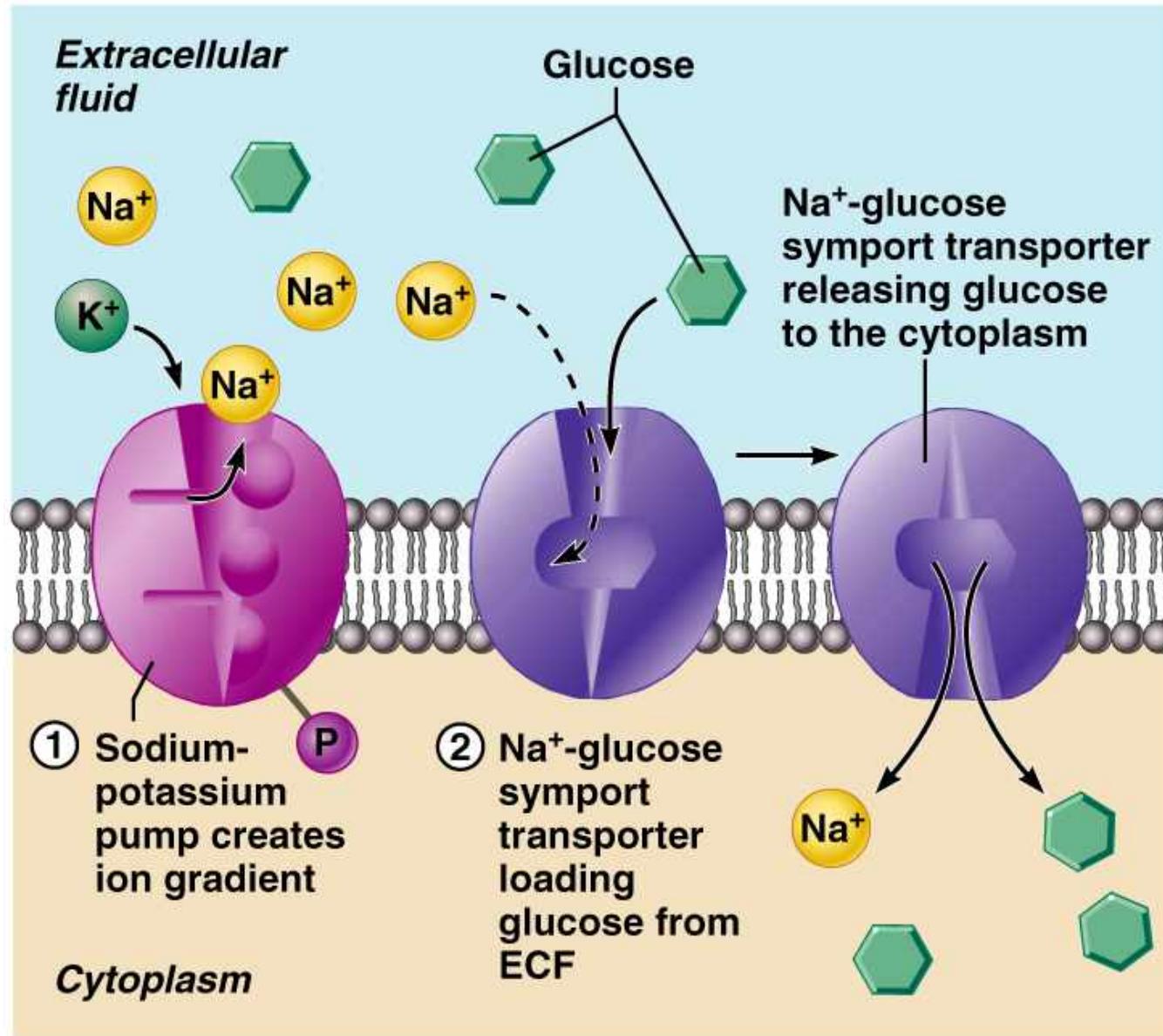
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# Secondary Active Transport

## Types of Secondary Active Transport

- **Symport system** – two substances are moved across a membrane in the same direction
- **Antiport system** – two substances are moved across a membrane in opposite directions

# Types of Active Transport

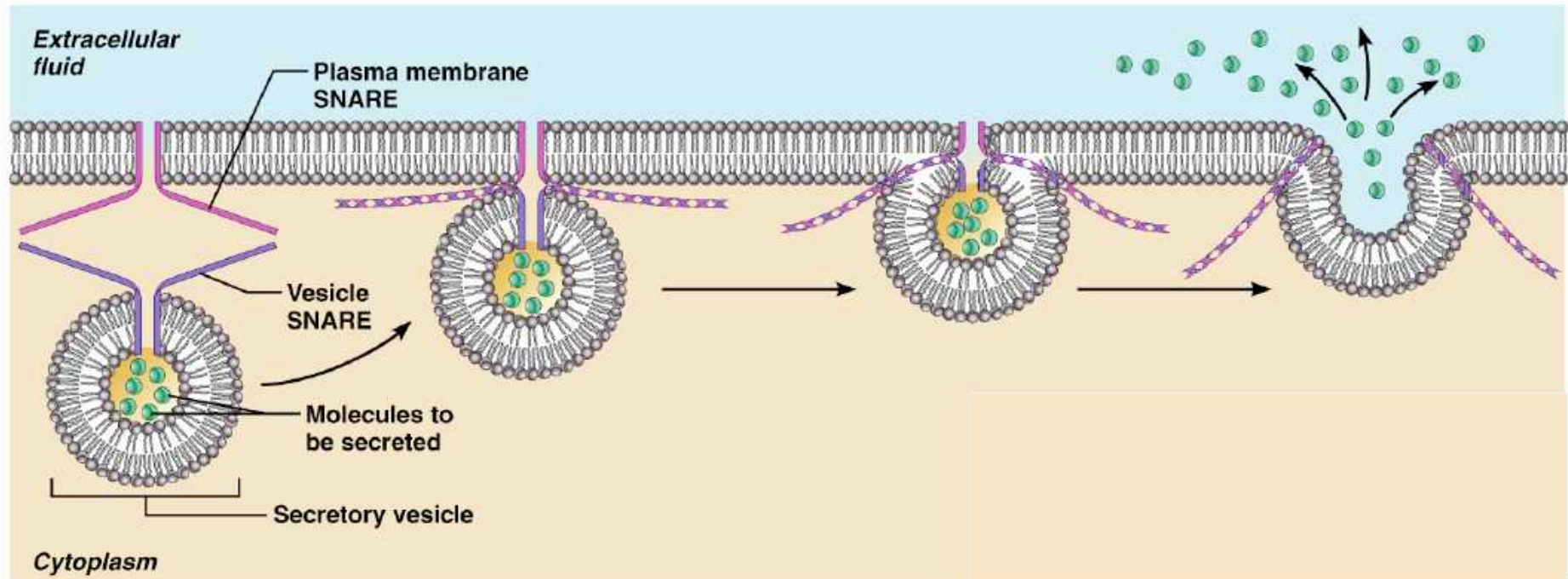


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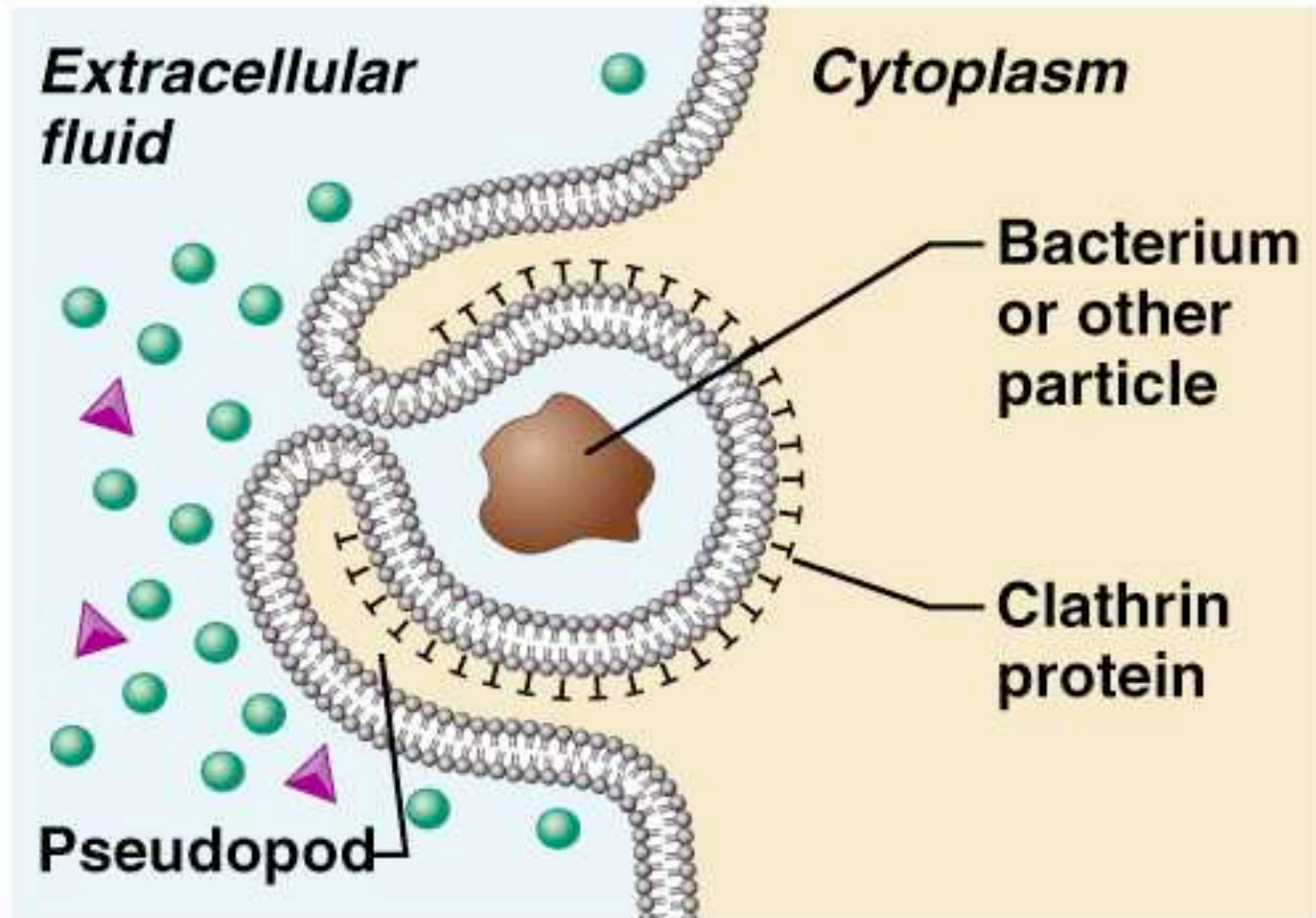
# Vesicular Transport

- Transport of large particles and macromolecules across plasma membranes
  - **Exocytosis** – moves substance from the cell interior to the extracellular space
  - **Endocytosis** – enables large particles and macromolecules to enter the cell

# Exocytosis



# Phagocytosis



**(b) Phagocytosis**