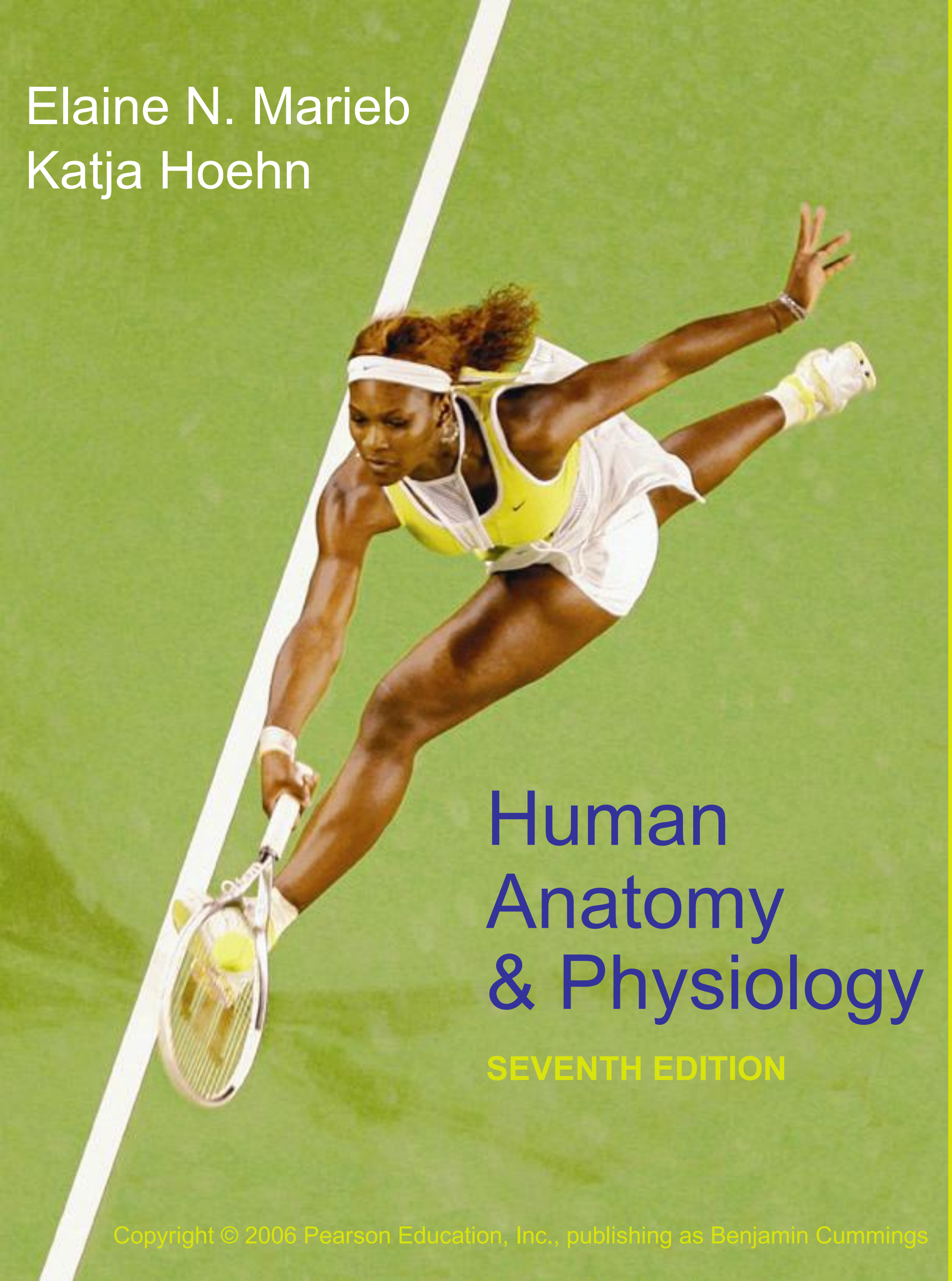

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Human Anatomy & Physiology

SEVENTH EDITION

PowerPoint® Lecture Slides prepared by Vince Austin, Bluegrass Technical and Community College

CHAPTER 1

Introduction

The Human Body

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

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

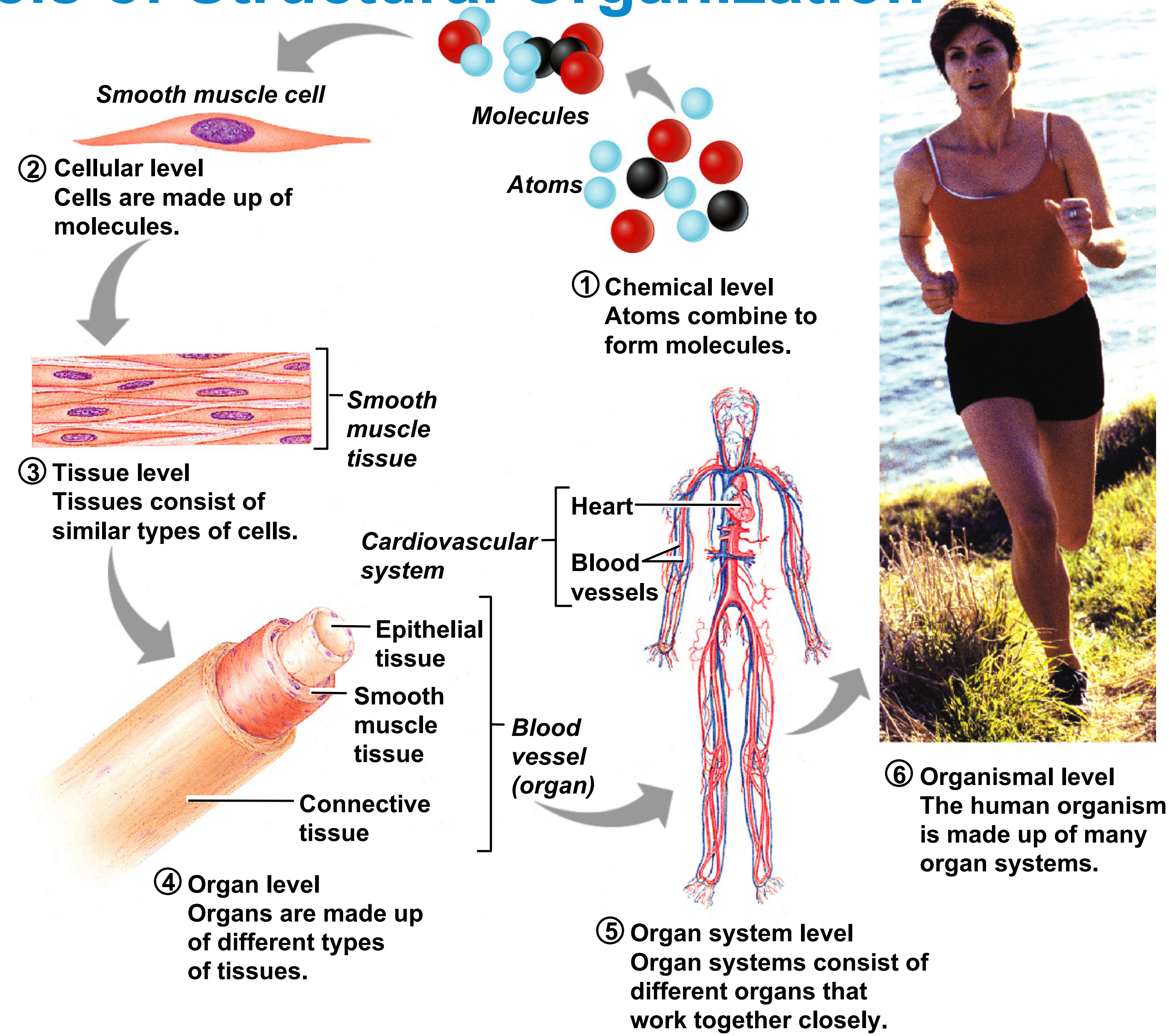
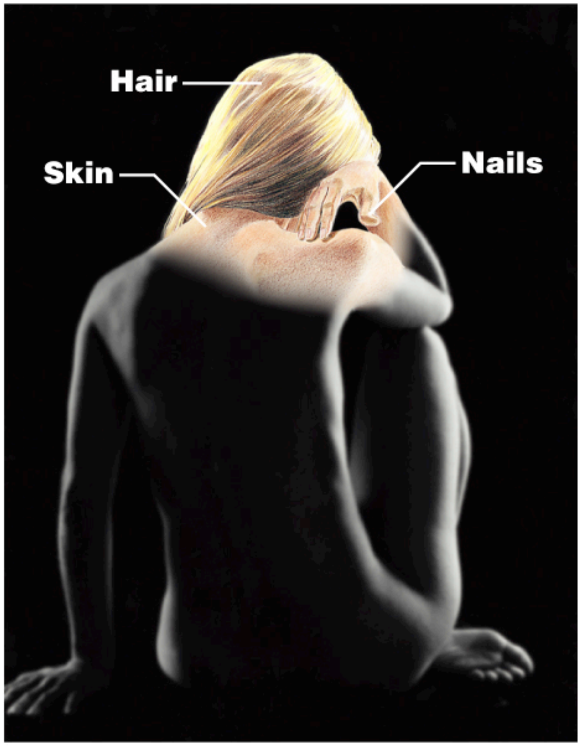


Figure 1.1

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

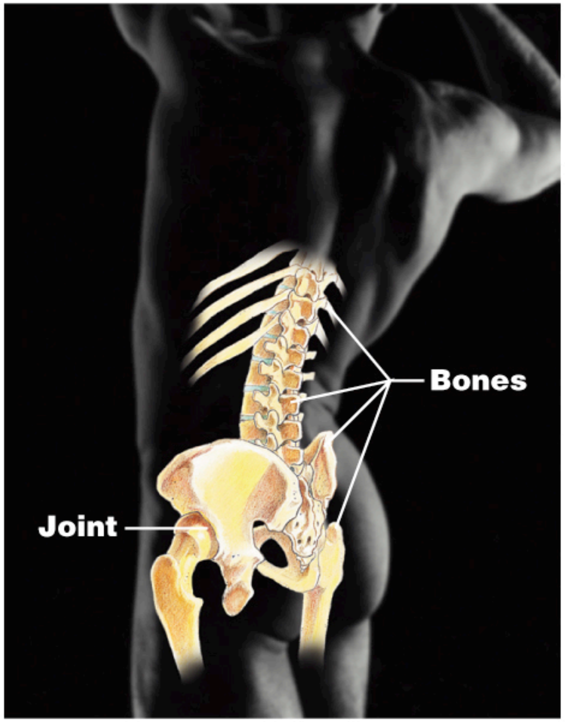


(a) Integumentary System

Figure 1.3a

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

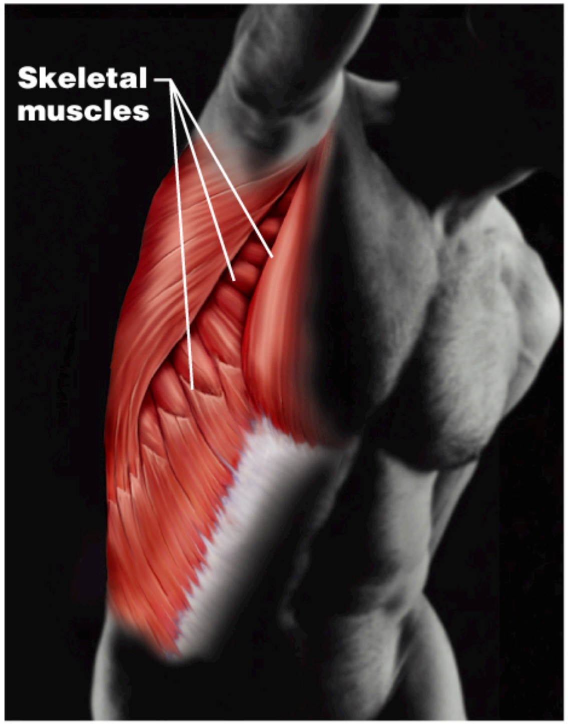


(b) Skeletal System

Figure 1.3b

Muscular System

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

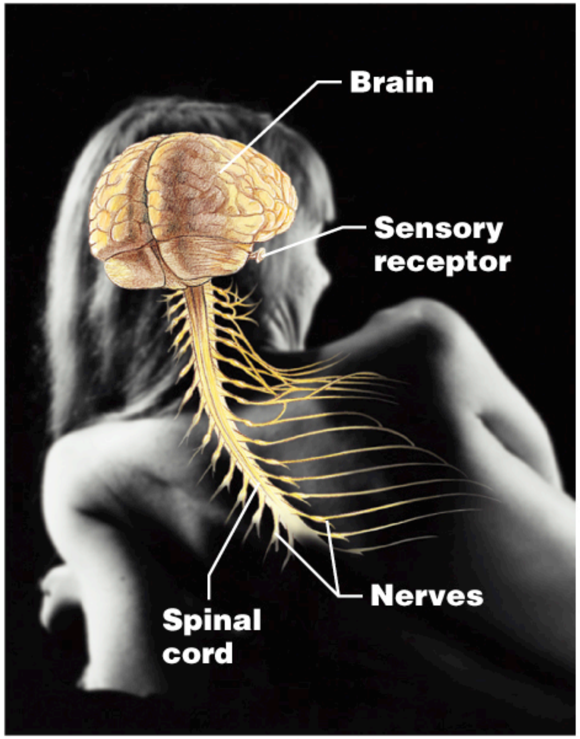


(c) Muscular System

Figure 1.3c

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

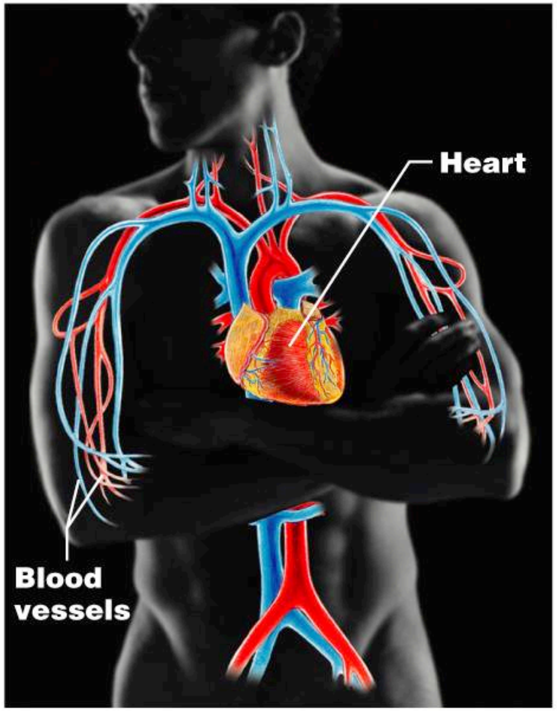


(d) Nervous System

Figure 1.3d

Cardiovascular System

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

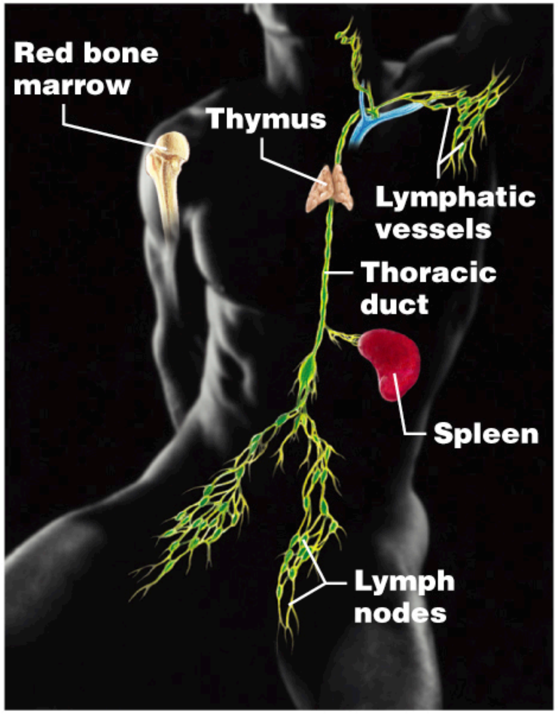


(f) Cardiovascular System

Figure 1.3f

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

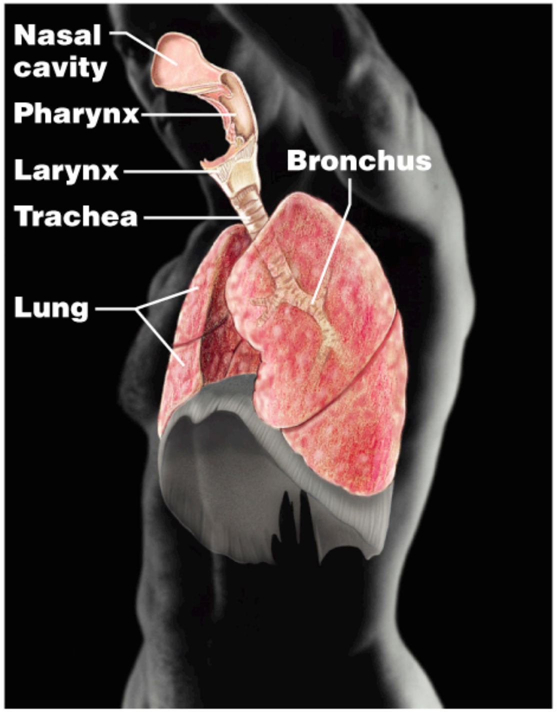


(g) Lymphatic System/Immunity

Figure 1.3g

Respiratory System

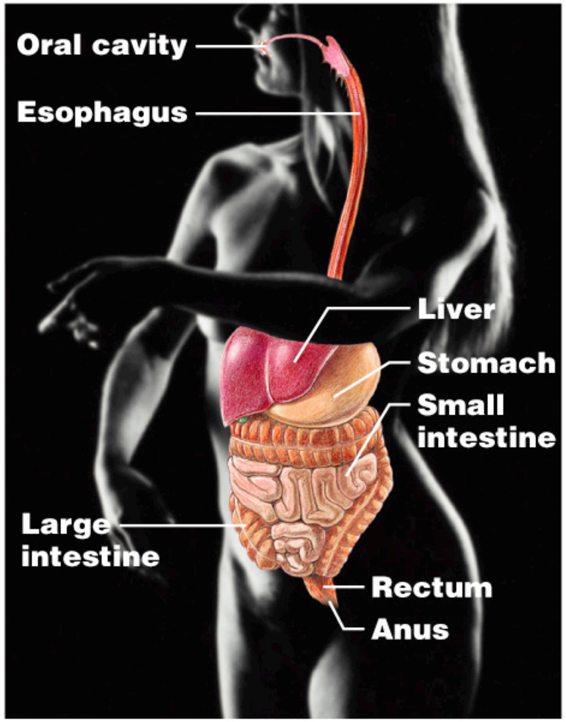
- Composed of the nasal cavity, pharynx, trachea, bronchi, and lungs
- Keeps blood supplied with oxygen and removes carbon dioxide



(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

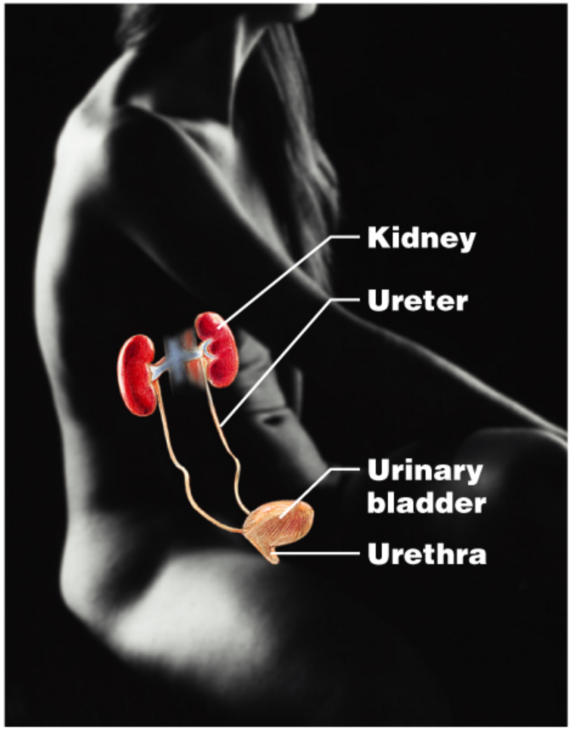


(i) Digestive System

Figure 1.3i

Urinary System

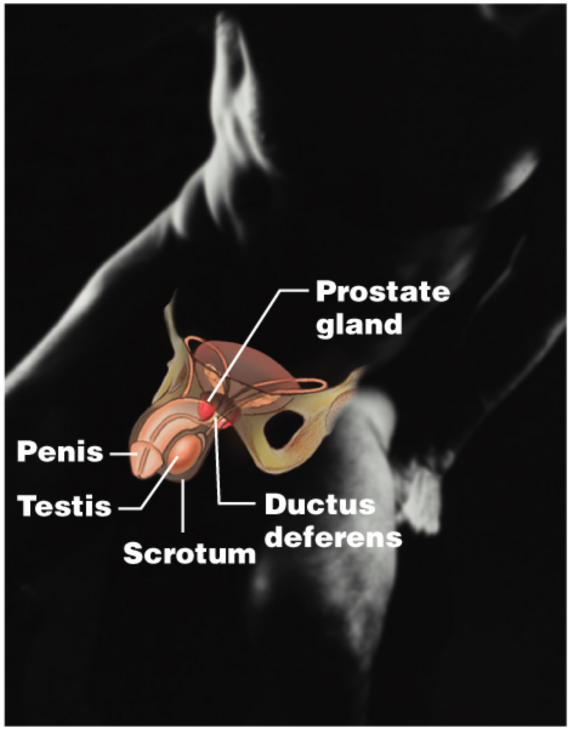
- Composed of kidneys, ureters, urinary bladder, and urethra
- Eliminates nitrogenous wastes from the body
- Regulates water, electrolyte, and pH balance of the blood



(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

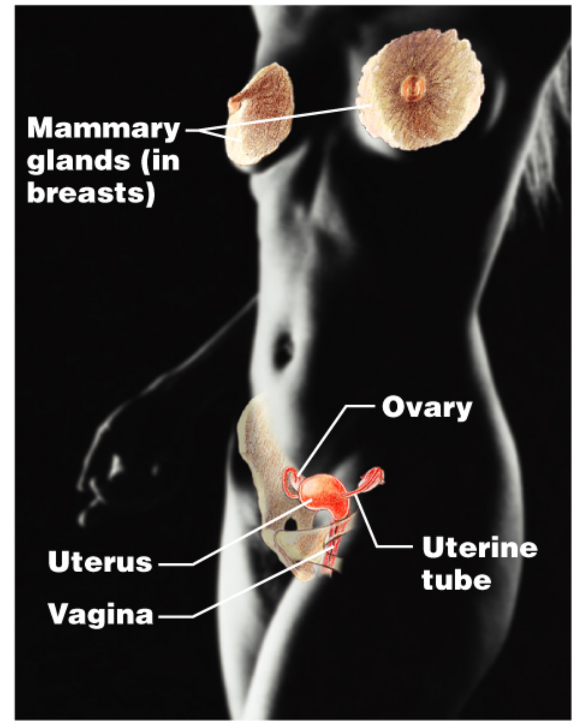


(k) Male Reproductive System

Figure 1.3k

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



(l) Female Reproductive System

Figure 1.3l

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

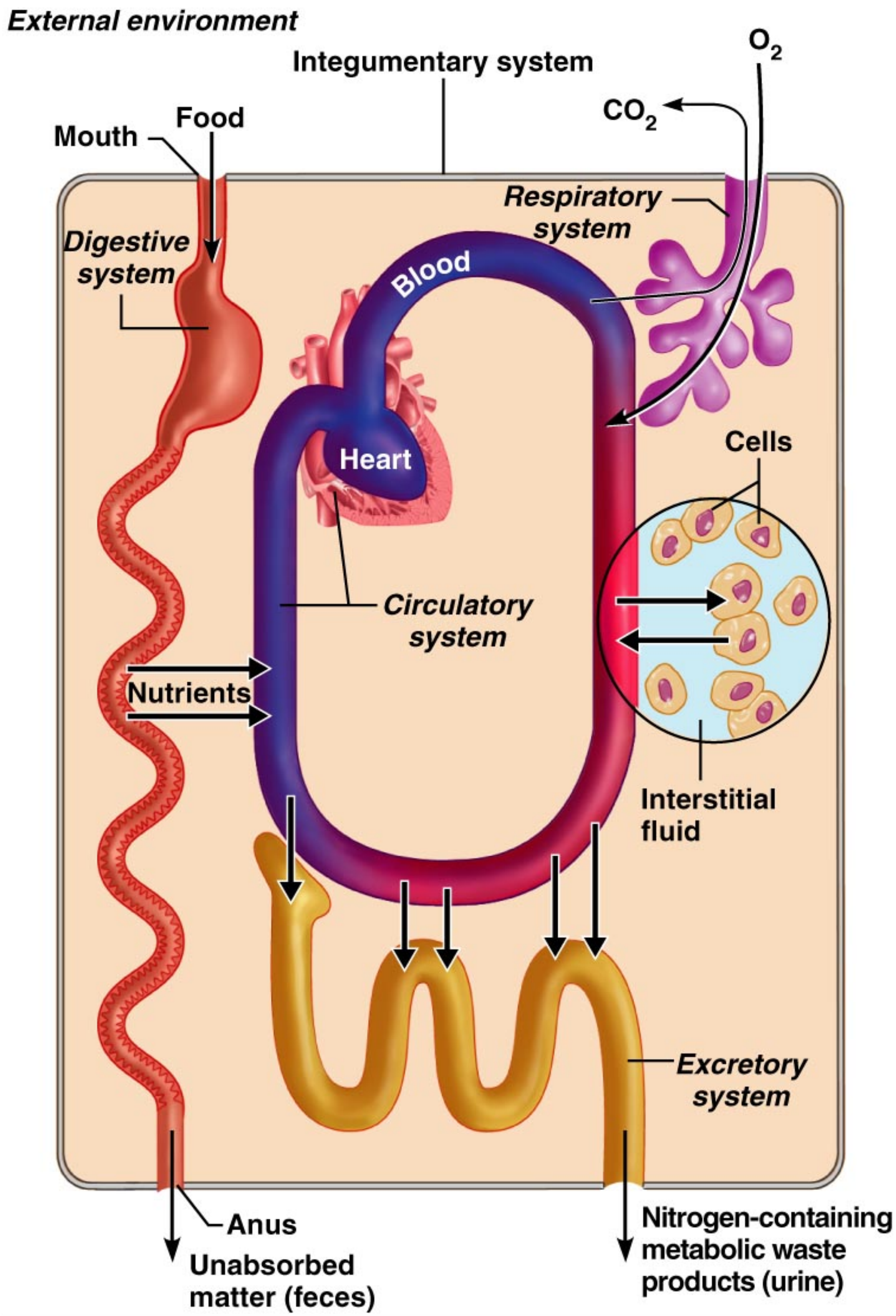

External environment
Integumentary system
O_2
CO_2
Mouth
Food
Respiratory system
Digestive system
Blood
Heart
Cells
Circulatory system
Nutrients
Interstitial fluid
Excretory system
Anus
Unabsorbed matter (feces)
Nitrogen-containing metabolic waste products (urine)

Figure 1.2

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

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

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

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

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

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

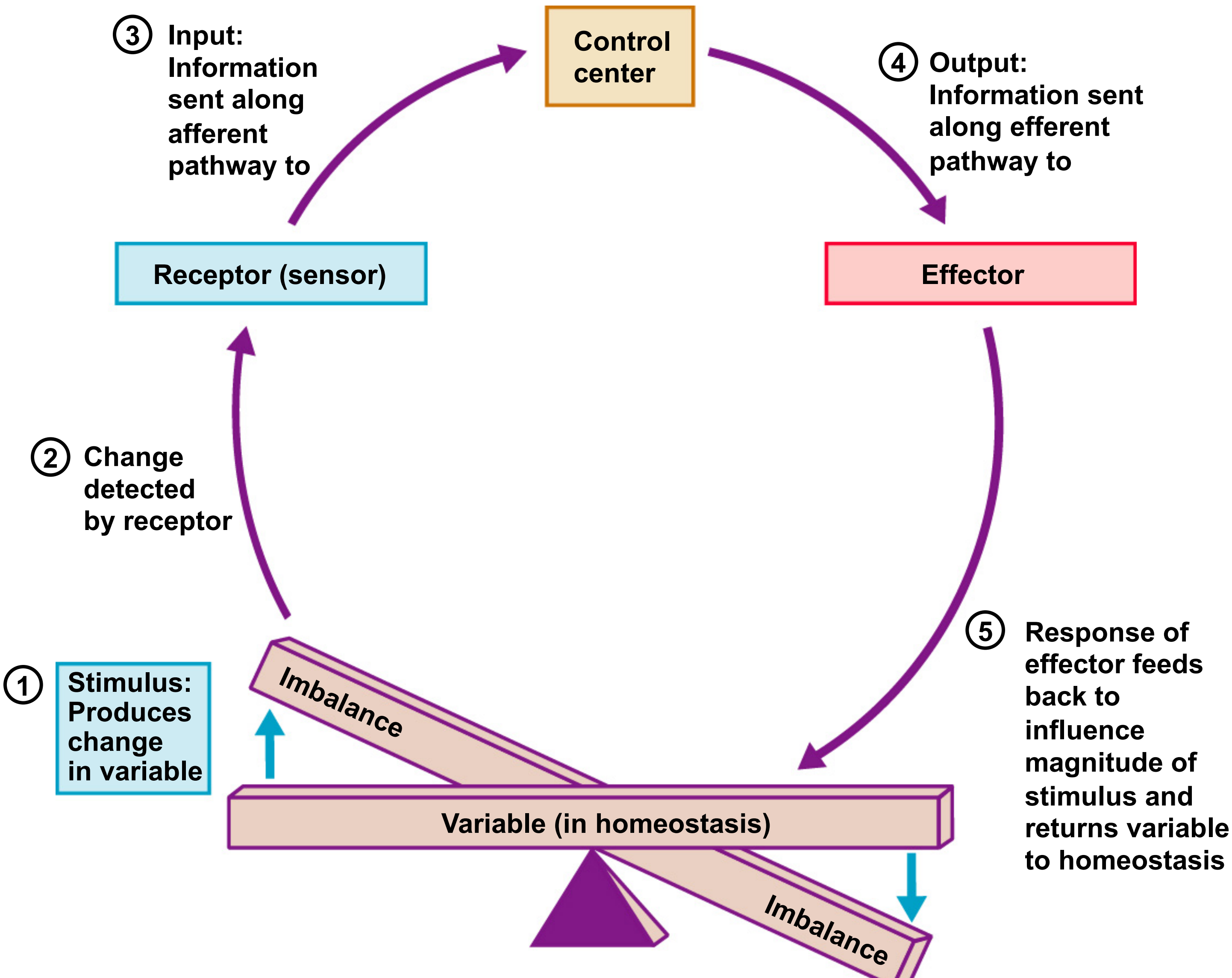


Figure 1.4

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

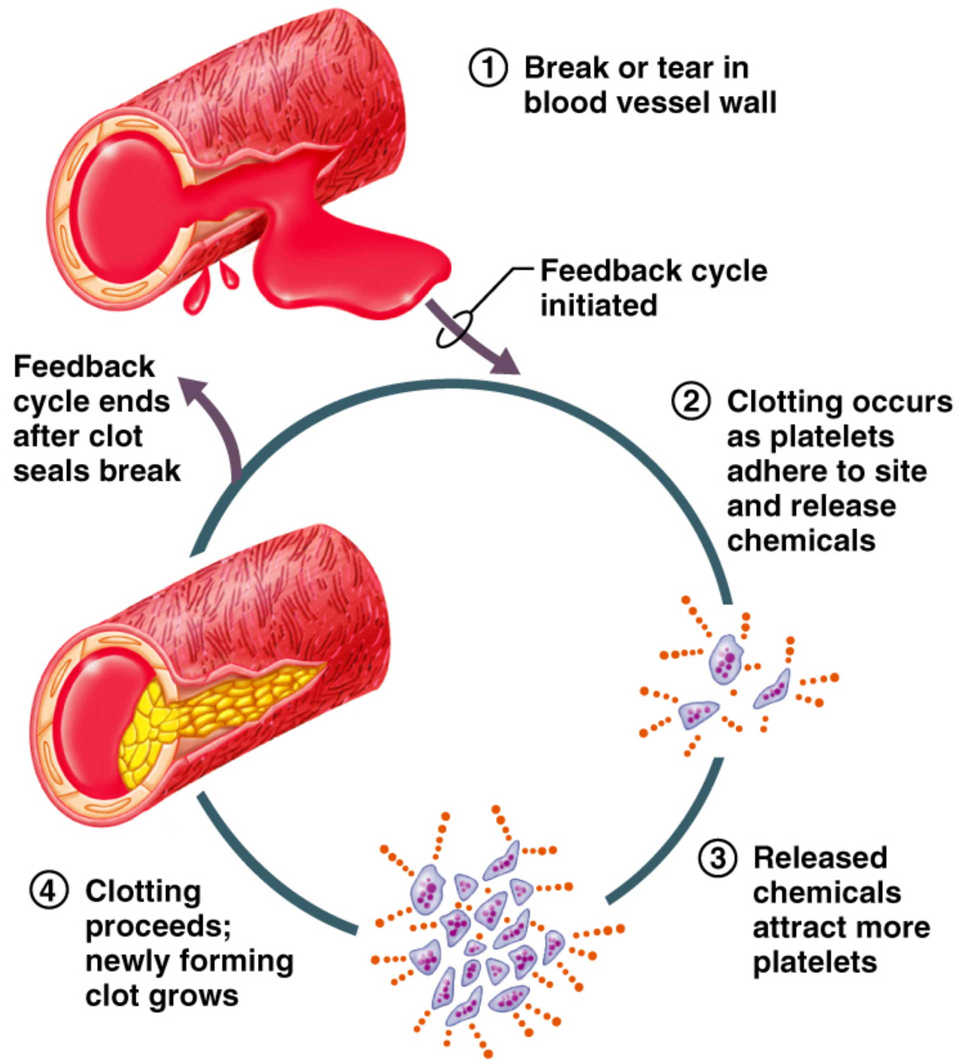


Figure 1.6

Feedforward system

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

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

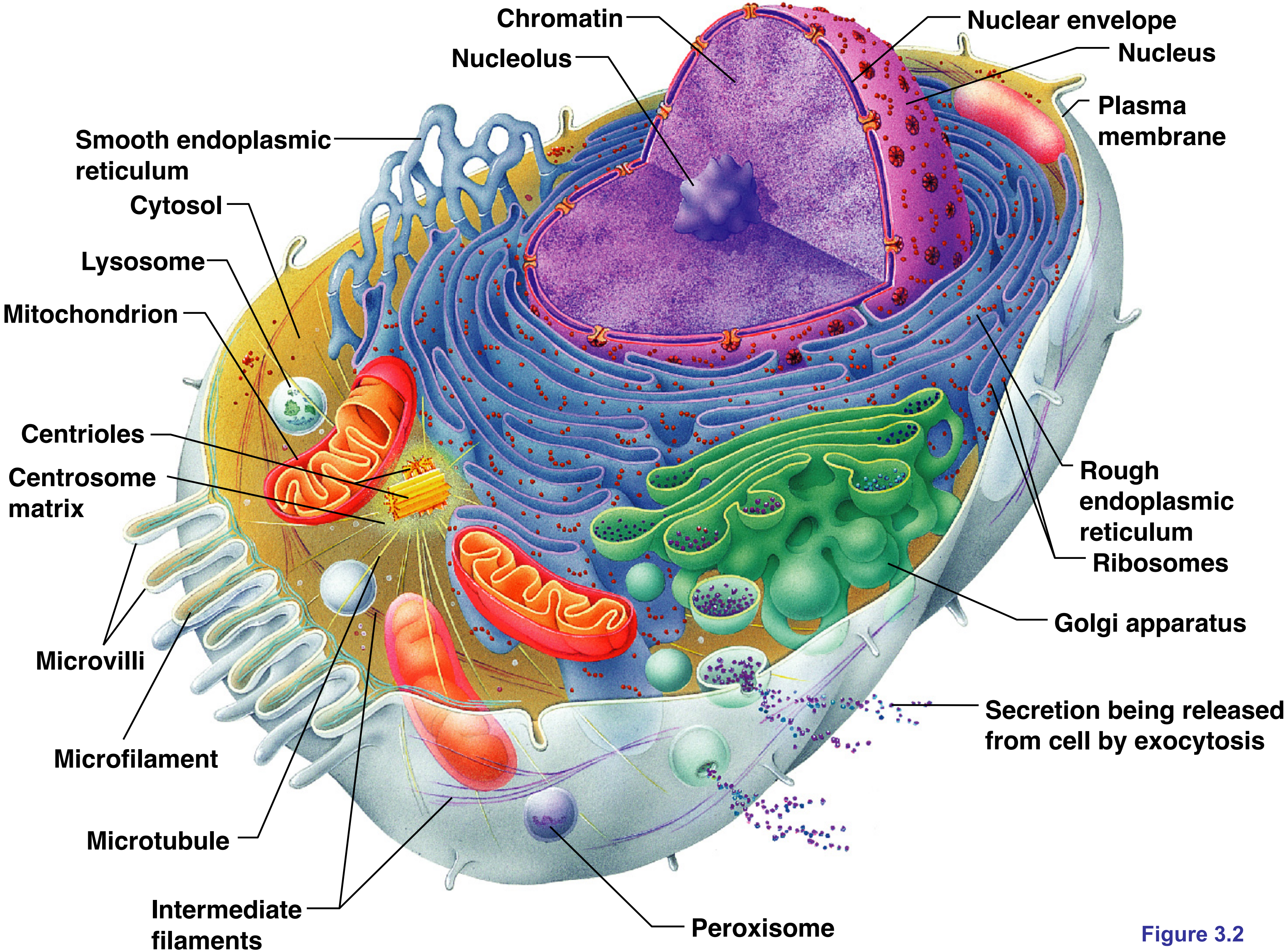

Chromatin
Nuclear envelope
Nucleus
Nucleolus
Plasma membrane
Smooth endoplasmic reticulum
Cytosol
Lysosome
Mitochondrion
Centrioles
Centrosome matrix
Rough endoplasmic reticulum
Ribosomes
Golgi apparatus
Microvilli
Microfilament
Secretion being released from cell by exocytosis
Microtubule
Intermediate filaments
Peroxisome

Figure 3.2

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

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

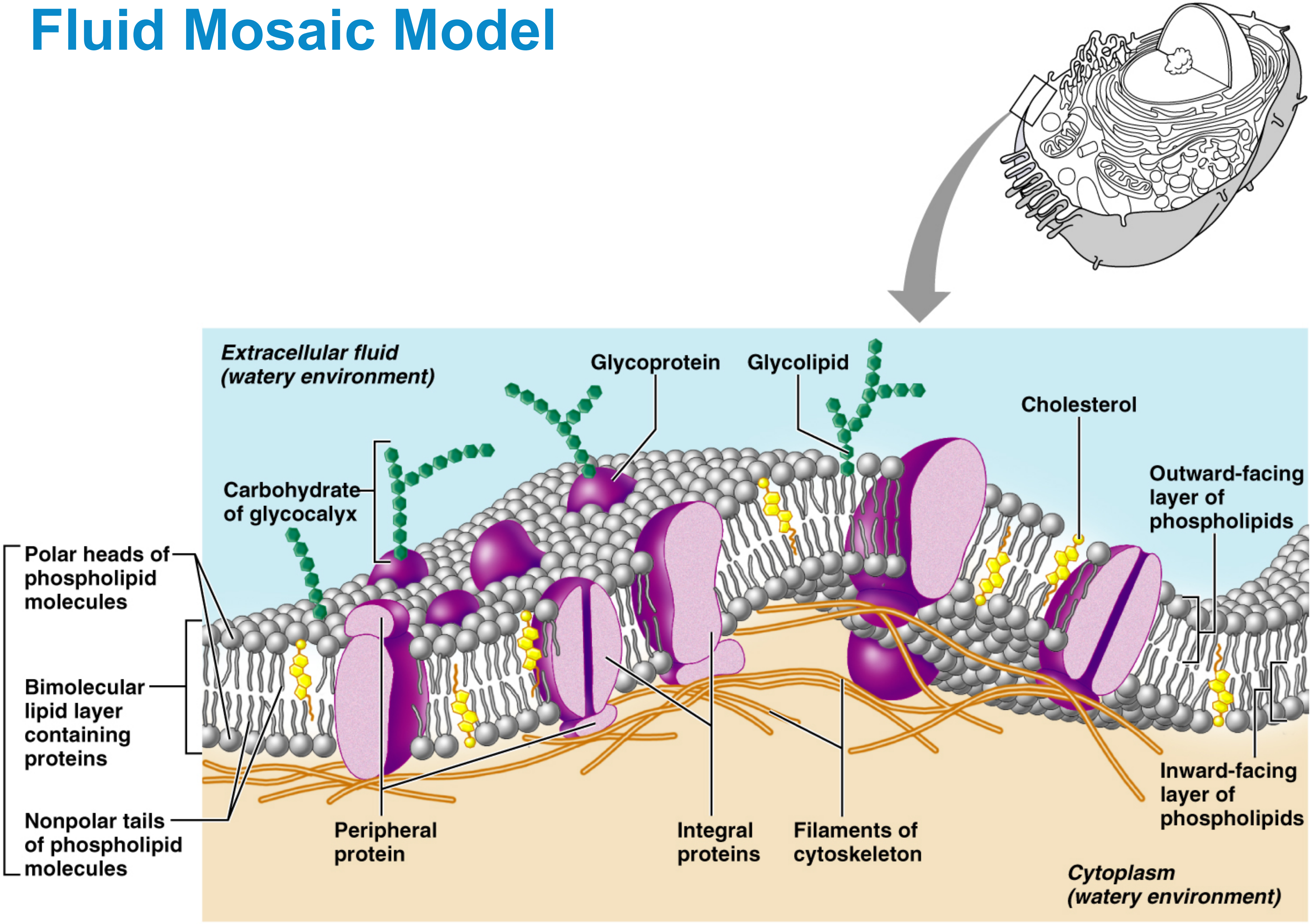
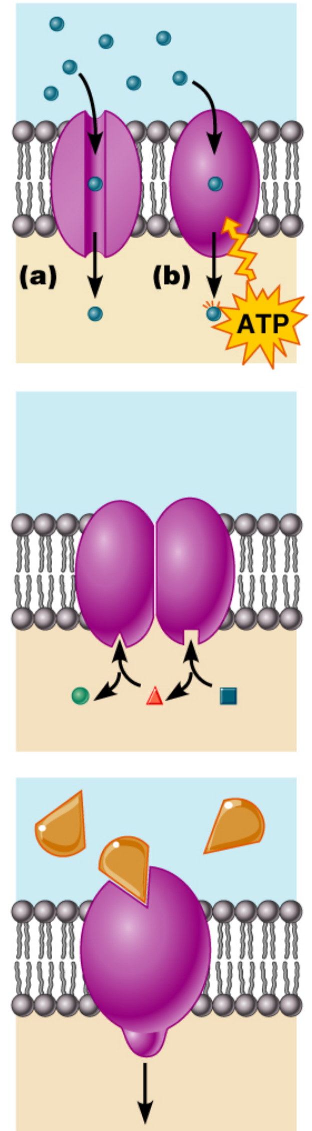


Figure 3.3

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.

Figure 3.4.1

Membrane Junctions: Gap Junction

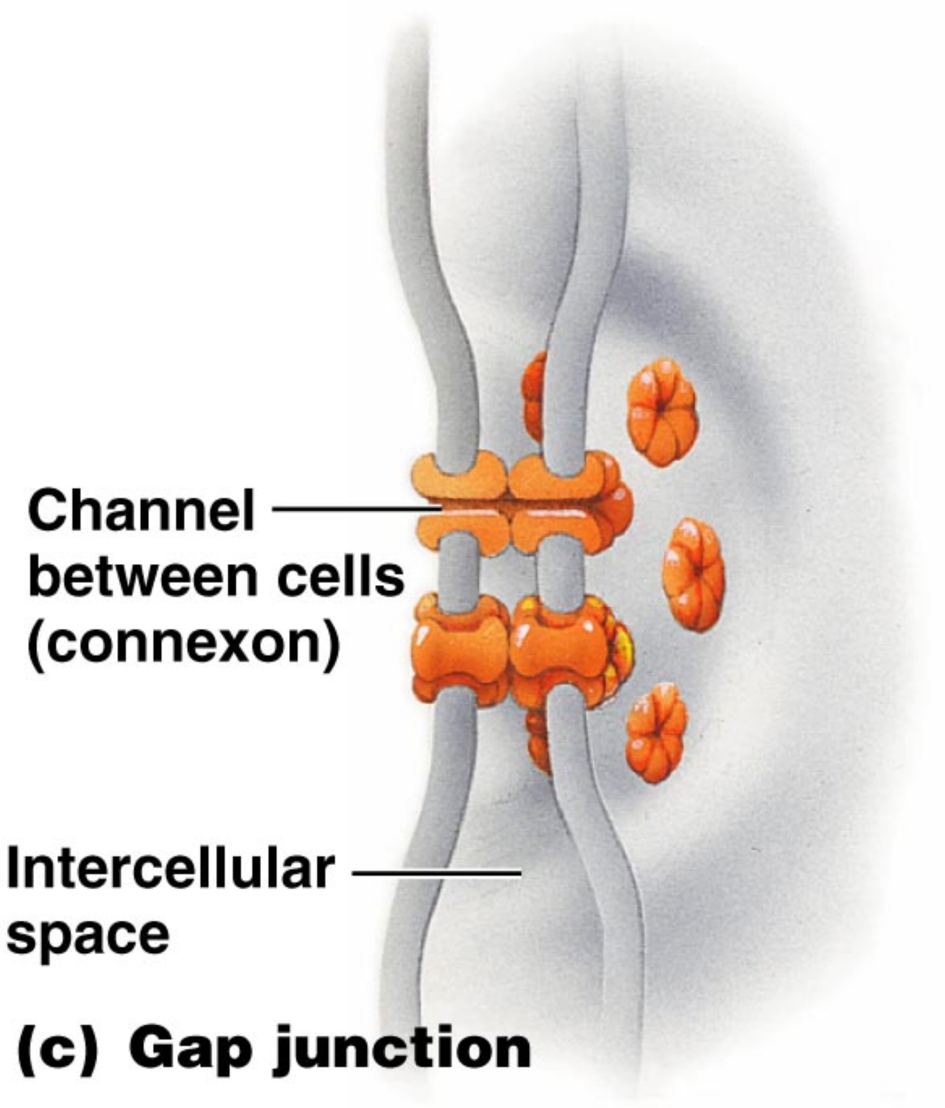
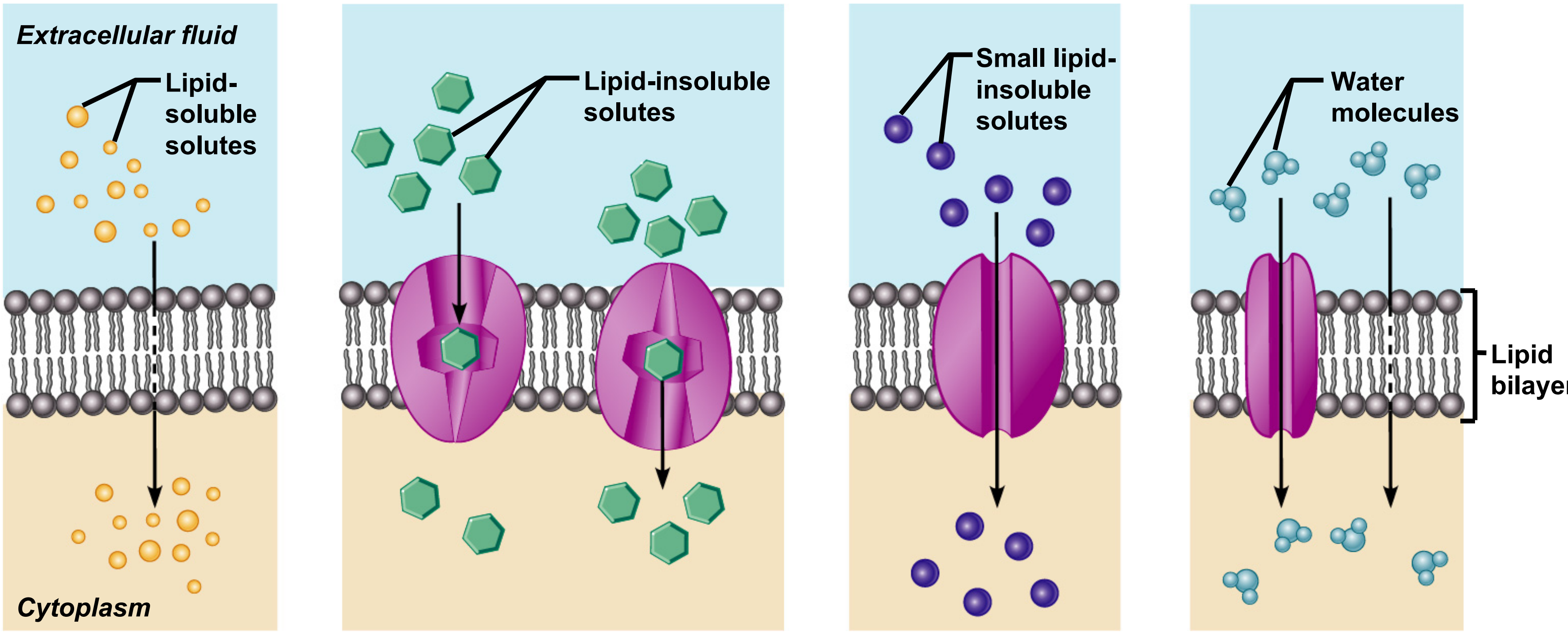


Figure 3.5c

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

Figure 3.7

Active Transport

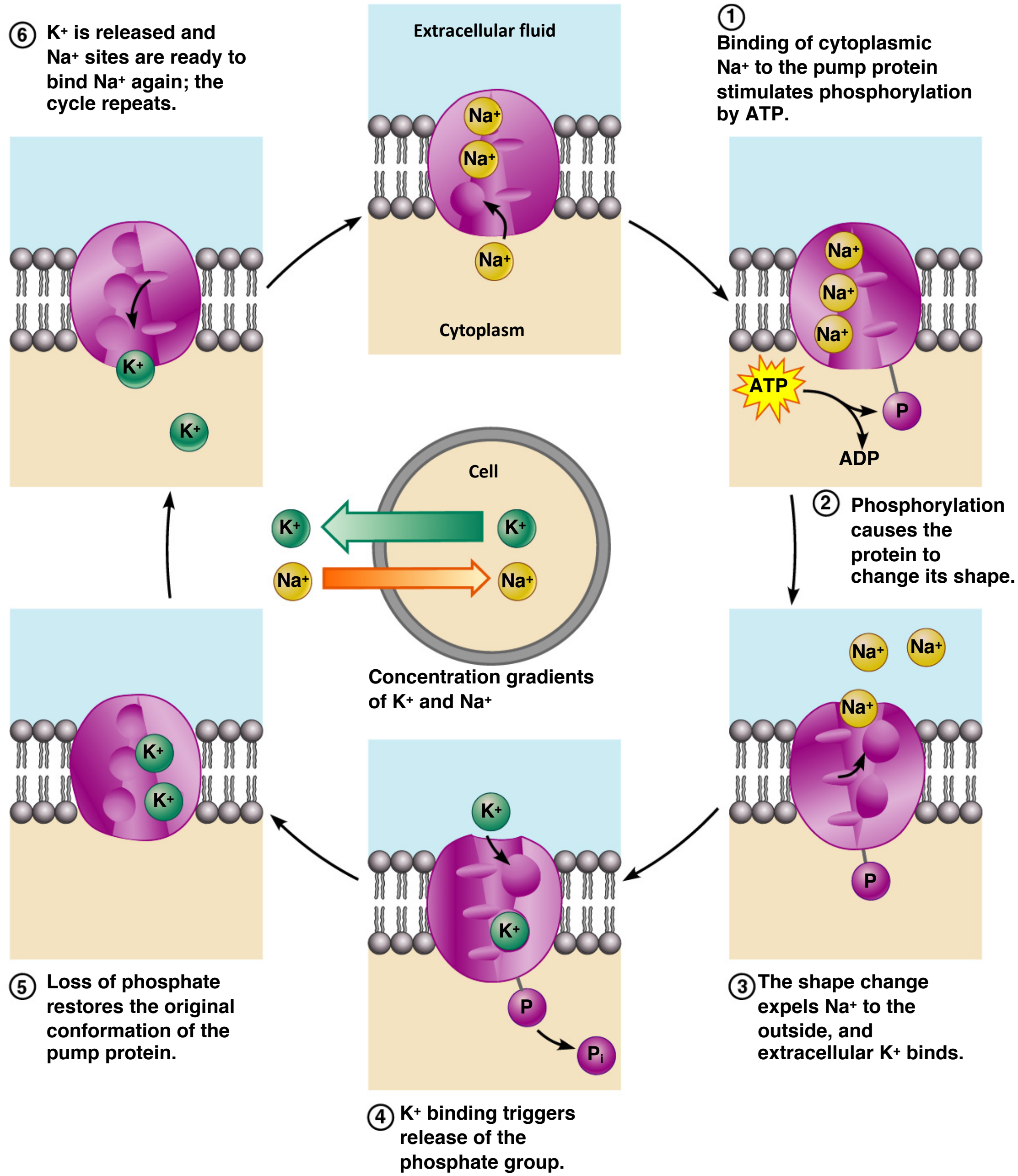
Active Transport

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

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 Na^+-K^+ pump) indirectly to drive the transport of other solutes

Primary Active Transport



6 K+ is released and Na+ sites are ready to bind Na+ again; the cycle repeats.
Extracellular fluid
Na+
Na+
Na+
Cytoplasm
1 Binding of cytoplasmic Na+ to the pump protein stimulates phosphorylation by ATP.
Na+
Na+
Na+
ATP
P
ADP
K+
K+
Cell
K+
K+
Na+
Na+
2 Phosphorylation causes the protein to change its shape.
Concentration gradients of K+ and Na+
Na+
Na+
Na+
P
K+
K+
K+
K+
P
P_i
5 Loss of phosphate restores the original conformation of the pump protein.
3 The shape change expels Na+ to the outside, and extracellular K+ binds.
4 K+ binding triggers release of the phosphate group.

Figure 3.10

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

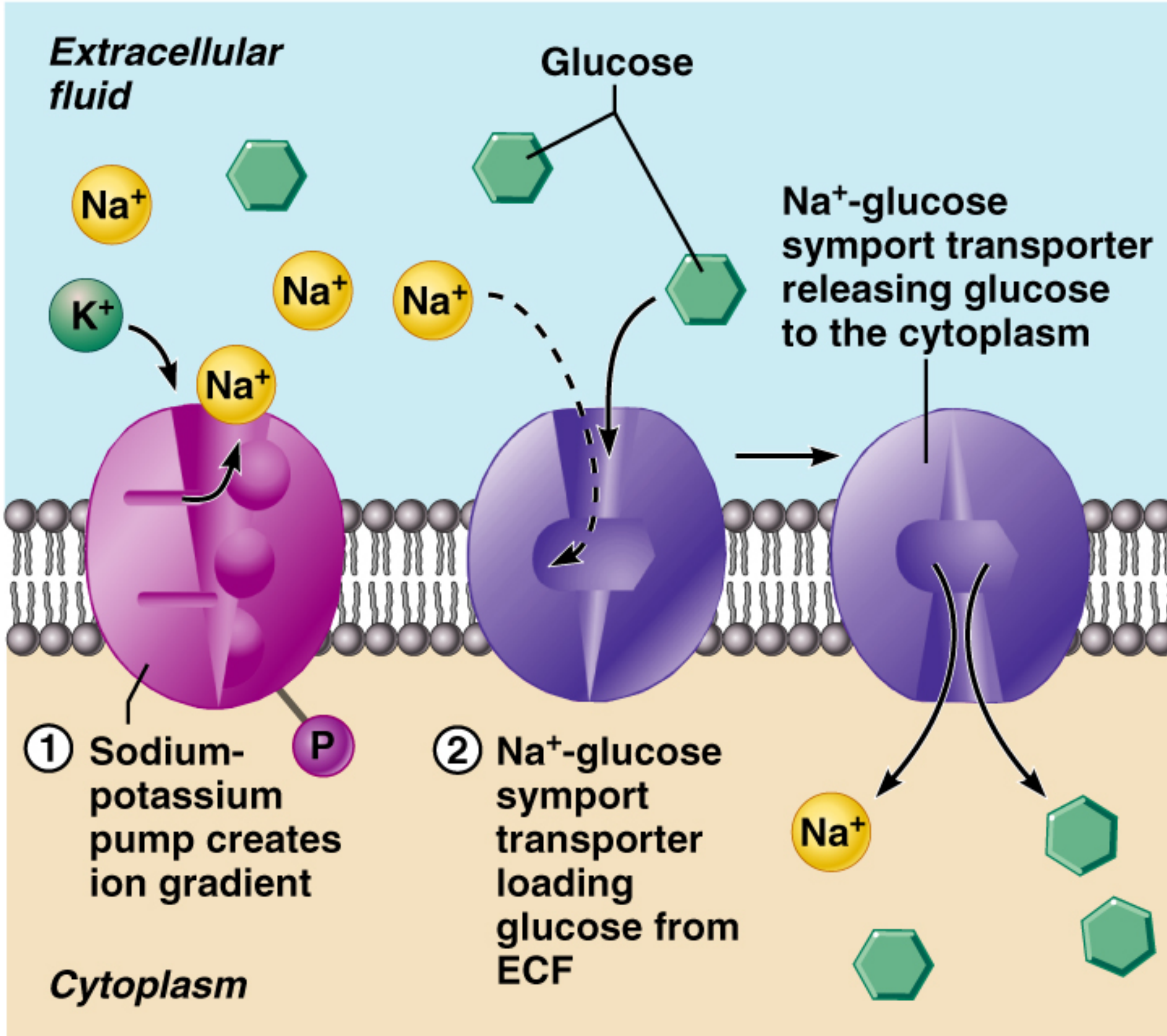


Figure 3.11

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

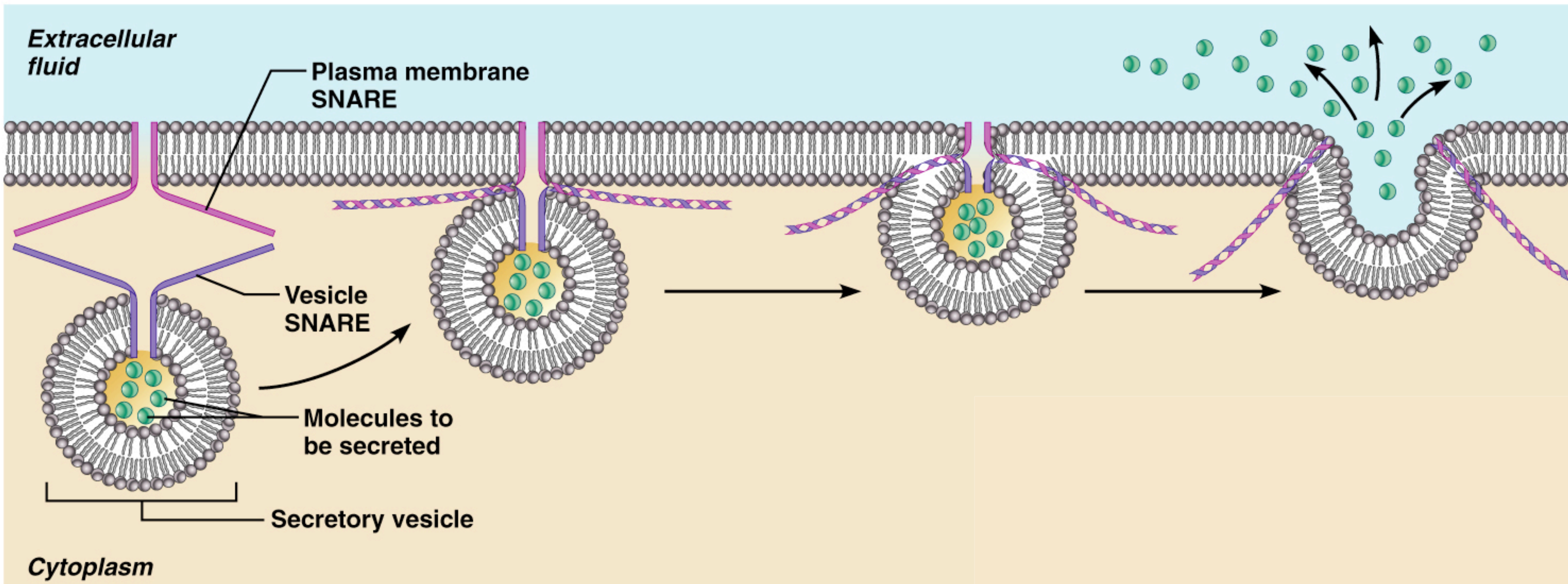
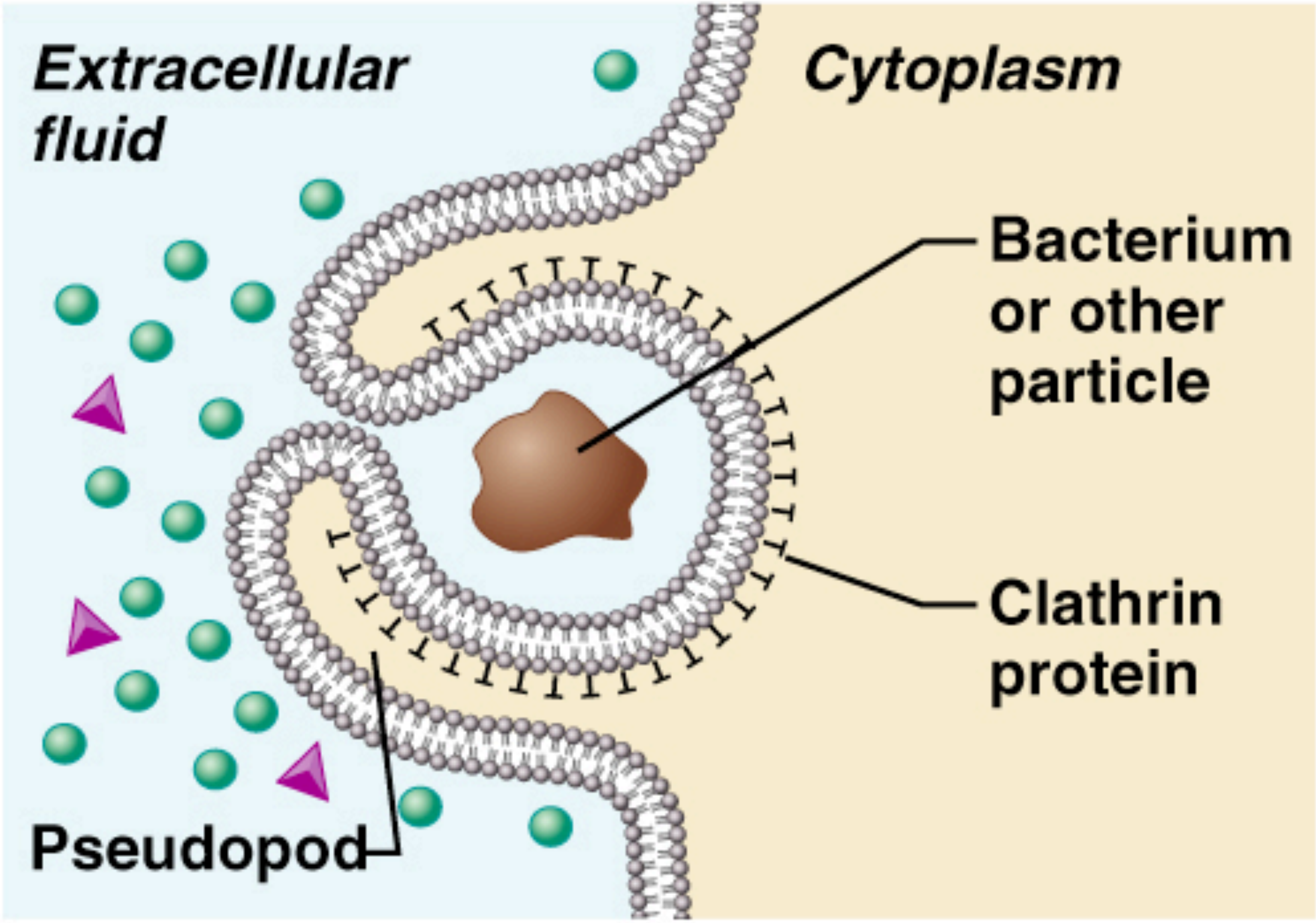


Figure 3.12a

Phagocytosis



(b) Phagocytosis

Figure 3.13b