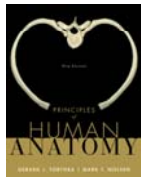


## Chapter 2

### Cells



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## Cells - Introduction

- The basic, living, structural and functional units of the body
- **Cell biology** - the study of cellular structure and function
- Cells perform chemical reactions to create life processes
- **Compartmentalization** - the isolation of specific kinds of chemical reactions inside specialized structures within the cell

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## A Generalized Cell - three principal parts

1. Plasma membrane
2. Cytoplasm
3. Nucleus

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## A Generalized Cell

### 1. Plasma membrane

- forms the cell's outer boundary
- separates the cell's internal environment from the outside environment
- is a selective barrier
- plays a role in cellular communication

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## A Generalized Cell

### 2. Cytoplasm

- all the cellular contents between the plasma membrane and the nucleus
- **cytosol** - the fluid portion, mostly water
- **organelles** - subcellular structures having characteristic shapes and specific functions

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## A Generalized Cell

### 3. Nucleus

- large organelle that contains DNA
- contains **chromosomes**, each of which consists of a single molecule of DNA and associated proteins
- a chromosome contains thousands of hereditary units called **genes**

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Fig. 2.1 Generalized Body Cell

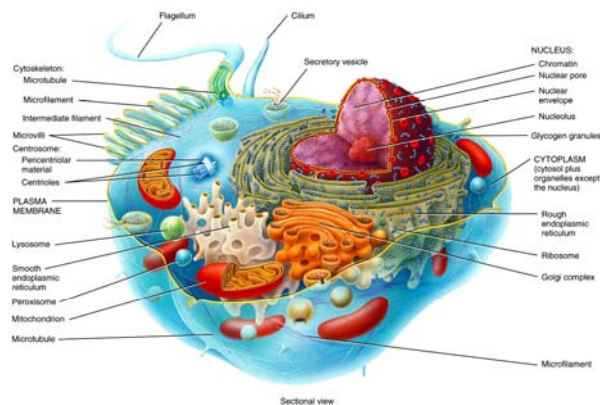


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## Plasma Membrane

- Flexible yet sturdy barrier
- The *fluid mosaic model* - the arrangement of molecules within the membrane resembles a sea of lipids containing many types of proteins
- The lipids act as a barrier to certain substances
- The proteins act as “gatekeepers” to certain molecules and ions (Fig. 2.2)

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## Structure of a Membrane

- Consists of a lipid bilayer - made up of phospholipids, cholesterol and glycolipids
- **Integral proteins** - extend into or through the lipid bilayer
- **Transmembrane proteins** - most integral proteins, span the entire lipid bilayer
- **Peripheral proteins** - attached to the inner or outer surface of the membrane, do not extend through it

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## Structure of the Plasma Membrane (Fig. 2.2)

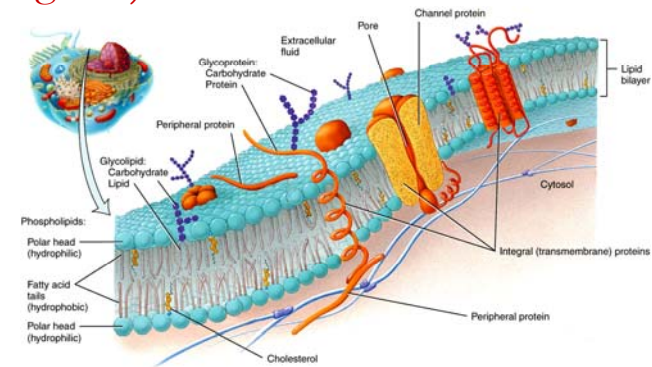


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## Structure of a Membrane

- **Glycoproteins** - membrane proteins with a carbohydrate group attached that protrudes into the extracellular fluid
- **Glycocalyx** - the “sugary coating” surrounding the membrane made up of the carbohydrate portions of the glycolipids and glycoproteins

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## Functions of Membrane Proteins

- Some integral proteins are **ion channels**
- **Transporters** - selectively move substances through the membrane
- **Receptors** - for cellular recognition; a **ligand** is a molecule that binds with a receptor
- **Enzymes** - catalyze chemical reactions
- Others act as **cell-identity markers**

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## Membrane Permeability

- The cell is either permeable or impermeable to certain substances
- The lipid bilayer is *permeable* to oxygen, carbon dioxide, water and steroids, but *impermeable* to glucose
- Transmembrane proteins act as channels and transporters to assist the entrance of certain substances, e.g., glucose and ions

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## Transport across the Plasma Membrane - locations of various fluids

- **Intracellular fluid (ICF)** - fluid within the cells, also called **cytosol**
- **Extracellular fluid (ECF)** - fluid outside cells
- **Interstitial fluid** - ECF filling the spaces between cells (intercellular fluid)
- **Plasma** - the ECF in blood vessels (Fig. 2.3)
- **Lymph** - the ECF in lymphatic vessels

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## Body Fluids (Fig. 2.3)

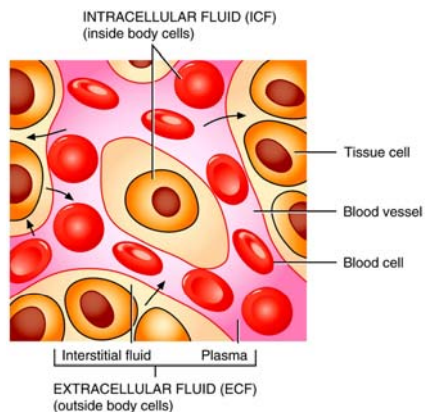


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## Passive vs. Active Processes

- Passive processes - substances move across cell membranes without the input of any energy; use the *kinetic energy* of individual molecules or ions
- Active processes - a cell uses energy, primarily from the breakdown of ATP, to move a substance across the membrane, i.e., against a concentration gradient

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## Transport across Plasma Membranes

### *Kinetic Energy Transport*

- **1. Simple diffusion** - the *net* movement of a substance from a region of high concentration to a region of lower concentration
- **2. Osmosis** - the net movement of water through a selectively permeable membrane from an area of high concentration of water (lower concentration of solutes) to one of lower concentration of water

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## Transport across Plasma Membranes

### *Transport by Transporter Proteins*

- **3. Facilitated diffusion** - integral proteins act as transporters
- **4. Active transport** - substances, usually ions, are transported across plasma membranes with the use of energy, from an area of lower concentration to an area of higher concentration

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## Transport in Vesicles

- **Vesicle** - a small spherical sac formed by budding off from a membrane
- **Endocytosis** - materials move into a cell in a **vesicle** formed from the plasma membrane (Fig. 2.4)
  - three types: receptor-mediated endocytosis
  - phagocytosis
  - bulk-phase endocytosis (pinocytosis)
- **Exocytosis** - vesicles fuse with the plasma membrane, releasing their contents into the extracellular fluid (Fig. 2.5)
- **Transcytosis** - a combination of endocytosis and exocytosis

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## Cytoplasm - Two components

- **1. Cytosol** - intracellular fluid, surrounds the organelles
  - 55% of total cell volume
  - 75-90% water
  - the site of many chemical reactions
  - energy is usually released by these reactions
  - reactions provide the building blocks for cell maintenance, structure, function and growth

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## Cytoplasm

- **2. Organelles**
- Specialized structures within the cell
- The **cytoskeleton** - network of protein filaments throughout the cytosol
  - provides structural support for the cell
  - three types according to increasing size: *microfilaments*, *intermediate filaments*, and *microtubules* (Fig. 2.6)

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## The Cytoskeleton (Fig. 2.6)

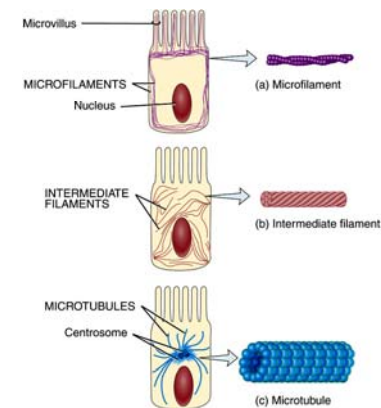


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## Organelles

- **Centrosome** - located near the nucleus, consists of two centrioles and pericentriolar material (Fig. 2.7)
- **Cilia** - short, hair-like projections from the cell surface, move fluids along a cell surface
- **Flagella** - longer than cilia, move an entire cell; only example is the sperm cell's tail (Fig. 2.8)

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## The Centrosome (Fig. 2.7)

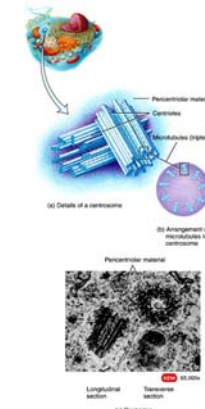
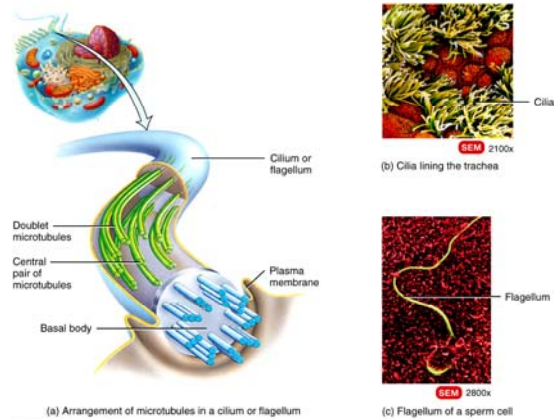


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## Cilia and Flagella (Fig. 2.8)



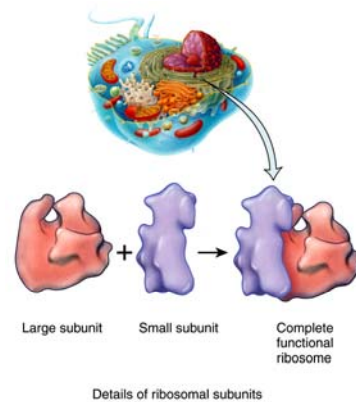
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## Organelles

- **Ribosomes** - sites of protein synthesis (Fig. 2.9)
- **Endoplasmic reticulum** - network of membranes in the shape of flattened sacs or tubules (Fig. 2.10)
  - *Rough ER* - connected to the nuclear envelope, a series of flattened sacs, surface is studded with ribosomes, produces various proteins
  - *Smooth ER* - a network of membrane tubules, does not have ribosomes, synthesizes fatty acids and steroids, detoxifies certain drugs

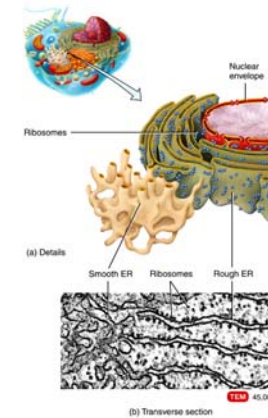
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## Ribosomes (Fig. 2.9)



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## Endoplasmic Reticulum (Fig. 2.10)



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## Organelles

- **Golgi complex** - consists of 3-20 flattened, membranous sacs called **cisternae** (Fig. 2.11)
  - modify, sort, and package proteins for transport to different destinations
  - proteins are transported by various vesicles (Fig 2.12)

**Lysosomes** - vesicles that form from the Golgi complex, contain powerful digestive enzymes (Fig. 2.13)

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## Golgi Complex (Fig. 2.11)

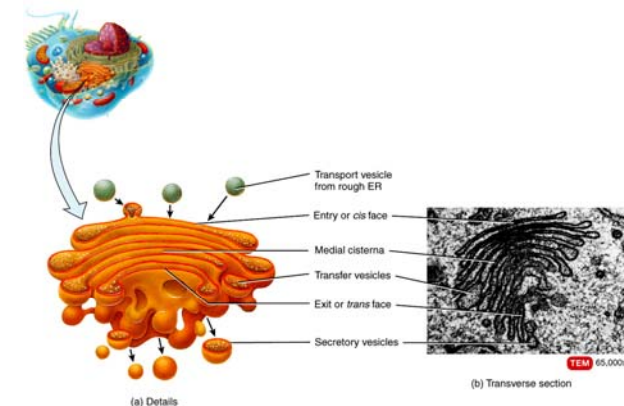
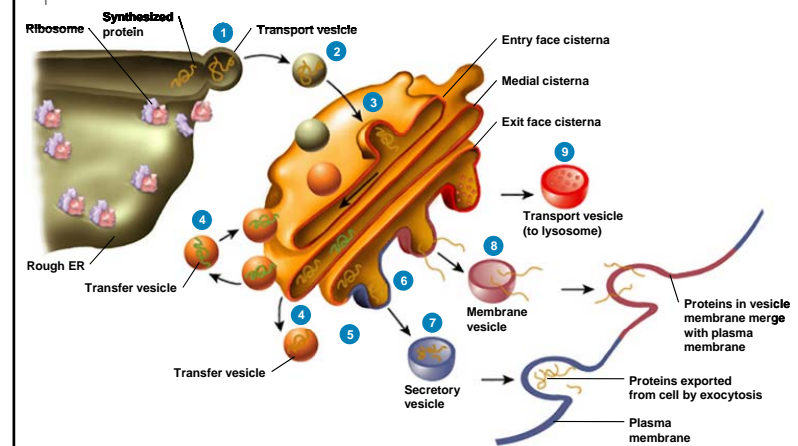


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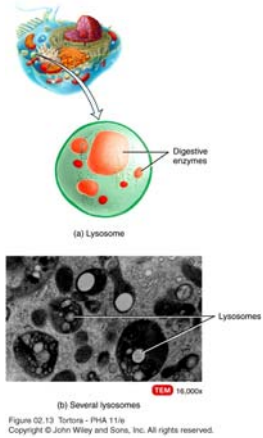
## Processing and Packaging Process Diagram Step-by-Step Figure 2.12



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## Lysosomes (Fig. 2.13)



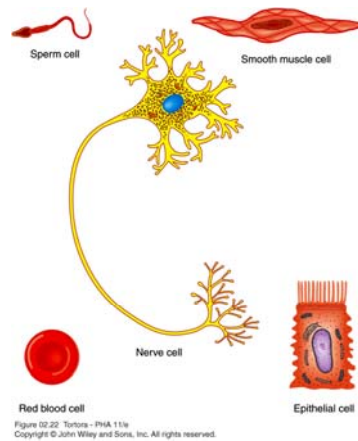
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## Cellular Diversity

- The average adult has nearly 100 trillion cells
- There are about 200 different types of cells
- Cells come in a variety of shapes and sizes
- Cellular diversity permits organization of cells into more complex tissues and organs (Fig. 2.22)

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## Cell Diversity (Fig. 2.22)



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