Chapter 1: Studying Life

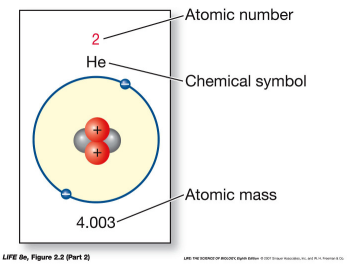
1. Most living organisms share key characteristics: consist of one or more cells, contain genetic information, reproduce themselves, have evolved, and carry out metabolism.
2. Metabolism involves conversions of matter and energy.
3. Evolution is a change in the genetic composition of a population over generational time.
4. Reproduction continues life and provides the basis for evolution.
5. Darwin's theory of evolution by natural selection is arguably the major unifying principle of biology.
6. Life arose from nonlife about 3.8 billion years ago when interacting systems of molecules became enclosed in membranes to form cells.
7. All organisms consist of cells, and all cells come from preexisting cells. Life no longer arises from nonlife.
8. The evolution of photosynthetic single-celled organisms that released large amounts of oxygen into Earth's atmosphere made possible the oxygen-based metabolism of large cells and, eventually, multicellular organisms.
9. All organisms share a common genetic language: a genome of DNA molecules that is expressed in proteins.
10. Complex eukaryotic cells evolved when some large prokaryotes engulfed smaller ones. Eukaryotic cells evolved the ability to "stick together" after they divided, forming multicellular organisms. The individual cells of multicellular organisms became modified for specific functions within the organism.
11. Speciation resulted in the millions of species living on Earth today.
12. Biology is organized into a hierarchy of levels, from molecules to the biosphere. Each level has emergent properties that are not found at lower levels.
13. Species are classified into three domains: Archaea, Bacteria, and Eukarya. The domains Archaea and Bacteria consist of prokaryotic cells. The domain Eukarya contains all the eukaryotic organisms.

Domains	**Kingdoms**
Archaea	Archaebacteria
Bacteria	Eubacteria
Eukarya	Animalia
	Plantae
	Protista
	Fungi

14. The Tree of Life depicts the latest consensus of ongoing research on the evolutionary relationships among all the species on Earth.
15. Like other fields of science, biology studies nature by using the hypothesis–prediction approach, in which hypotheses are tested by either controlled experiments or by the comparative method.
16. The study of biology is essential to understanding many complex issues affecting both human society and our effects on the larger environment.

Chapter 2: The Chemistry of Life

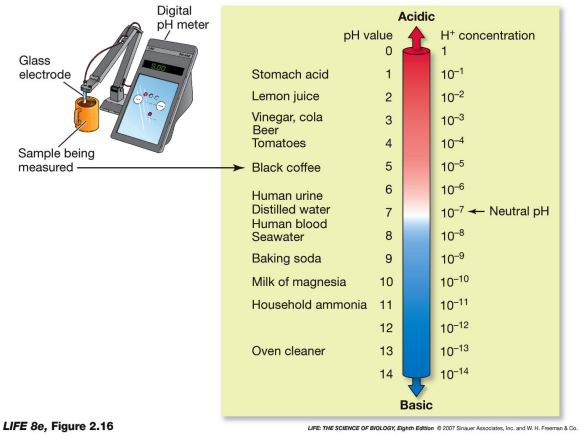
1. The mechanistic view of life states that life is based on the same types of chemicals as the nonliving parts of the universe and obeys the same universal physiochemical laws.
2. Matter is composed of atoms. Each atom consists of a positively charged nucleus of protons and neutrons, surrounded by electrons that bear negative charges and are located in orbital shells.
3. An element is made up of only one kind of atom, distinguished by having a unique number of protons.



LIFE 8e, Figure 2.2 (Part 2)

4. In losing, gaining, or sharing electrons to become more stable, an atom can combine with other atoms to form molecules.
5. Covalent bonds are strong bonds formed when two atomic nuclei share one or more pairs of electrons.
6. Ions are electrically charged bodies that form when an atom gains or loses one or more electrons. Ionic bonds are electrical attractions between oppositely charged ions.

7. Hydrogen bonds are weak electrical attractions that form between a positive hydrogen atom in one molecule and a negative nitrogen or oxygen atom in another molecule or in another part of a large molecule. Hydrogen bonds are abundant in water.
8. Nonpolar molecules do not interact directly with polar substances, including water. Nonpolar molecules are attracted to each other by very weak bonds called van der Waals forces.
9. In chemical reactions, substances change their atomic compositions and properties. Energy is released in some reactions, whereas in others, energy must be provided.
10. Water's molecular structure and its capacity to form hydrogen bonds give it unusual properties that are significant for life.
11. Solutions are produced when substances dissolve in water. Most biological substances are dissolved in water at very low concentrations.
12. Acids are substances that donate hydrogen ions. Bases are substances that accept hydrogen ions. Values lower than pH 7 indicate an acidic solution; values above pH 7 indicate a basic solution.

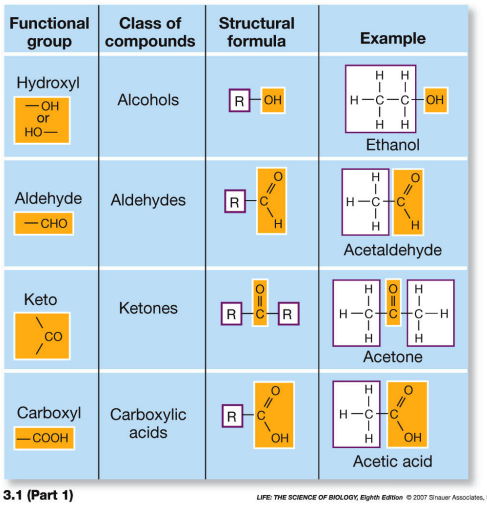


LIFE 8e, Figure 2.16

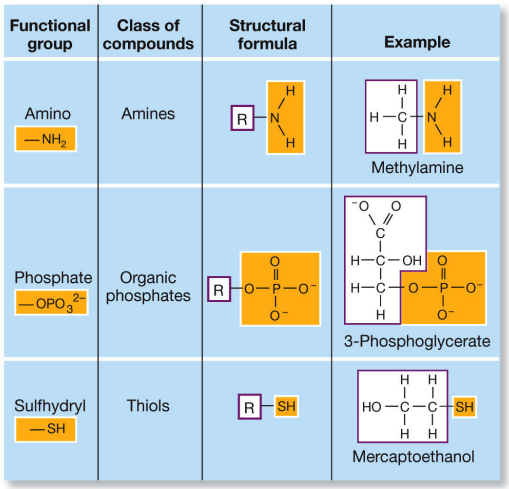
13. Buffers are systems of weak acids and bases that limit the change in pH when H^+ ions are added or removed.
14. The presence of water was essential to the origin of life.
15. Know how to balance a chemical equation.

Chapter 3: Macromolecules and the Origin of Life

1. Functional groups attach to larger molecules and give them specific properties.
2.



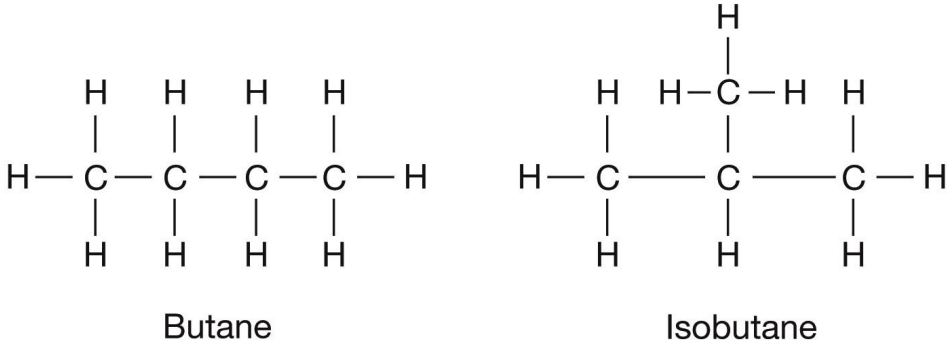
LIFE 8e, Figure 3.1 (Part 1)

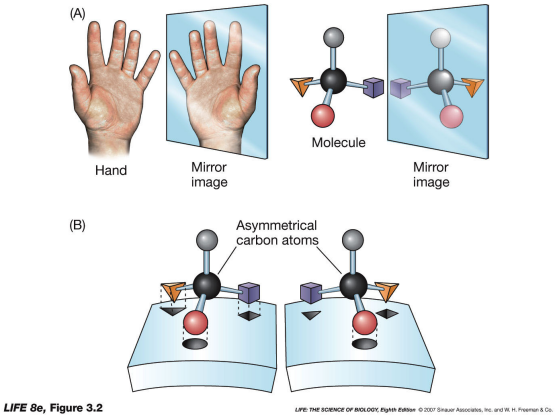


LIFE 8e, Figure 3.1 (Part 2)

3. Isomers are molecules with different arrangements of the same atoms.

For example: Butane is C_4H_{10} and Isobutane is also C_4H_{10} but the arrangement of the carbon atoms are different, thus making the properties of these two chemicals different. Actually, to a chemist isobutane is called 1-methylpropane



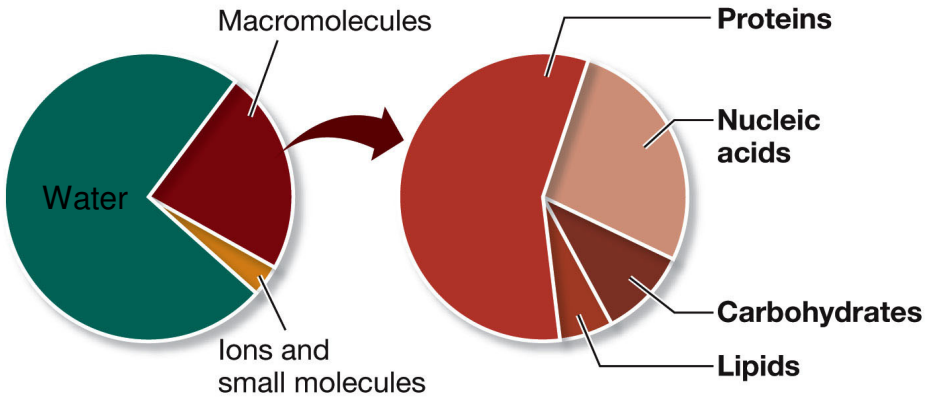


LIFE 8e, Figure 3.2

LIFE: THE SCIENCE OF BIOLOGY, Eighth Edition © 2007 Sinauer Associates, Inc. and W. H. Freeman & Co.

Some isomers are optical, meaning that their mirror images are completely different chemicals with different properties.

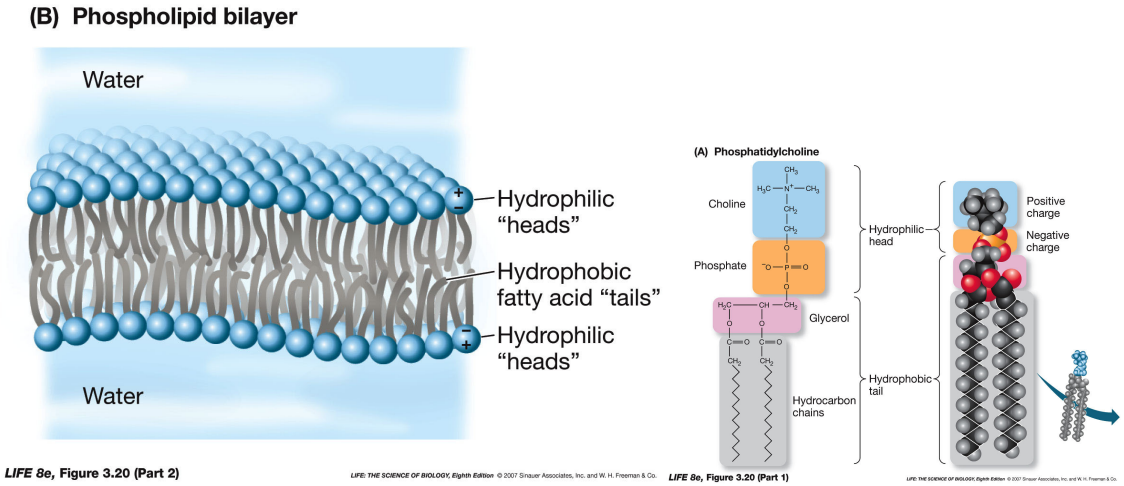
3. Macromolecules, or polymers, are constructed by condensation reactions involving the formation of covalent bonds between smaller molecules called monomers.



LIFE 8e, Figure 3.3

LIFE: THE SCIENCE OF BIOLOGY, Eighth Edition © 2007 Sinauer Associates, Inc. and W. H. Freeman & Co.

4. Amino acids are the monomers of proteins and covalently bond by peptide linkages. Amino acids have varying properties based on their side chains.
5. The polypeptide chains of proteins are folded into specific three-dimensional shapes. Four levels of structure are possible: primary, secondary, tertiary, and quaternary.
6. The functions of proteins include support, protection, catalysis, transport, defense, regulation, and movement.
7. Monosaccharides are the monomers of carbohydrates.
8. Cellulose, starch, and glycogen are three important carbohydrate polymers.
9. The functions of carbohydrates include support and energy storage.
10. Fats and oils are composed of three fatty acids covalently bonded to a glycerol molecule by ester linkages. The fatty acid chains may be saturated or unsaturated.
11. Phospholipids have a hydrophobic hydrocarbon "tail" and a hydrophilic phosphate "head."



LIFE 8e, Figure 3.20 (Part 2) *LIFE 8e*, Figure 3.20 (Part 1)

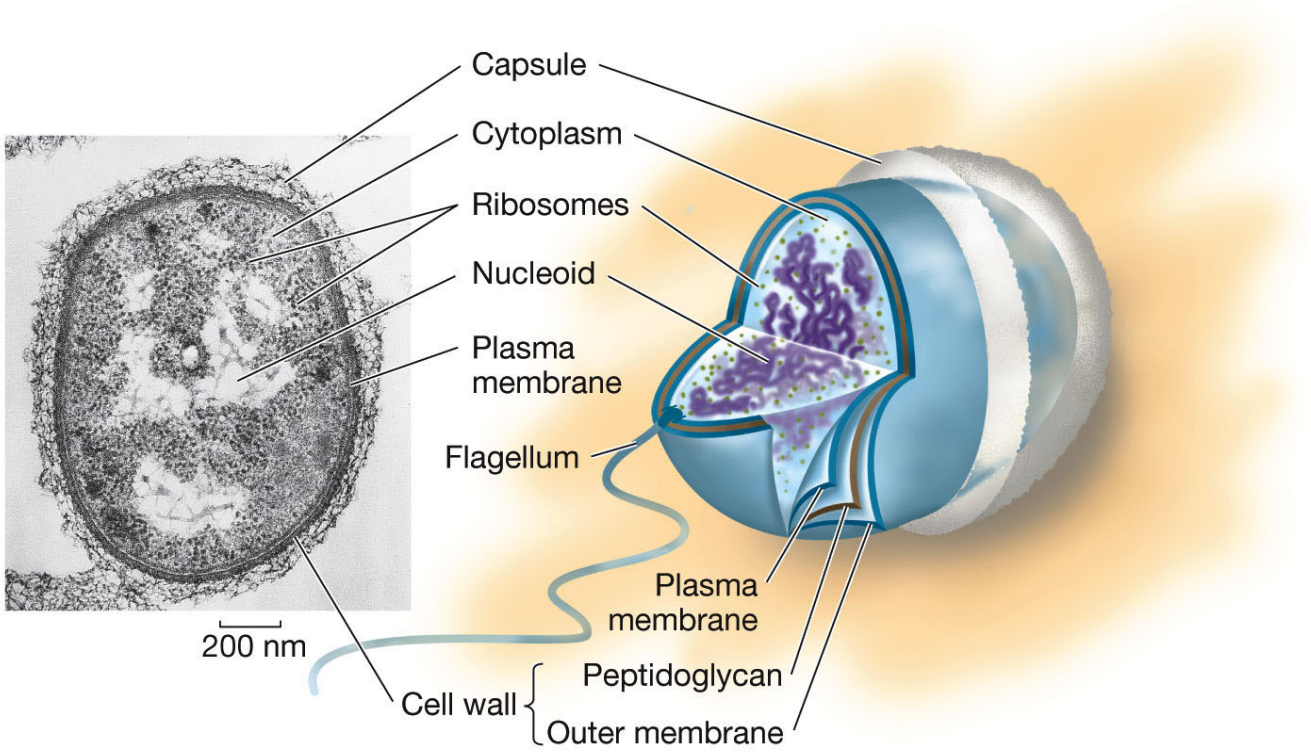
12. Lipids also include steroids, waxes, and some vitamins. Each type of lipid has a different function.
13. Lipids tend to be hydrophobic.
14. Nucleic acids are polymers made up of nucleotides. The sequence of nucleotides creates the uniqueness of each polymer.
15. In cells, DNA is the hereditary material. Both DNA and RNA play roles in the formation of proteins. Information flows from DNA to RNA to protein.
16. In addition to forming DNA and RNA, nucleotides also produce other important molecules such as ATP, GTP, and cAMP.
17. Two theories of the origin of life are that life came from extraterrestrial sources and that life originated on Earth through chemical evolution.
18. Laboratory evidence supports the theory that RNA may have been the first biological catalyst.
19. Experiments disproved the spontaneous generation of life under modern environmental conditions.
20. The four macromolecules of life include: Carbohydrates, Lipids, Proteins, and Nucleic Acids.

Chapter 4: Cells: The Working Units of Life

1. The cell is the basic unit of life. All cells come from preexisting cells and have certain processes, types of molecules, and structures in common.
2. Cells may have originated from structures similar to the cell-like structures that can be produced in the laboratory.
3. To maintain adequate exchanges with its environment, a cell's surface area must be large compared with its volume.
4. Microscopes are needed to visualize cells. Because of their greater resolving power, electron microscopes allow observation of greater detail than can be seen with light microscopes.
5. Prokaryotic cell organization is characteristic of the domains Bacteria and Archaea. Prokaryotic cells lack internal compartments.
6. Prokaryotic cells each contain a nucleoid region and cytoplasm. Many also have cell walls, internal membranes, flagella, pili, and/or a cytoskeleton.
7. Eukaryotic cell organization is characteristic of cells in the domain Eukarya. Eukaryotic cells have many membrane-enclosed organelles, including a nucleus that contains DNA.
8. Organelles can be studied by microscopy or isolated by cell fractionation.
9. The nucleus is usually the largest organelle in a cell and contains most of the cell's DNA.
10. The rough endoplasmic reticulum has attached ribosomes that synthesize proteins. The smooth endoplasmic reticulum lacks ribosomes and is associated with the synthesis of lipids.
11. The Golgi apparatus packages proteins inside vesicles and directs their transport.
12. Lysosomes contain digestive enzymes.

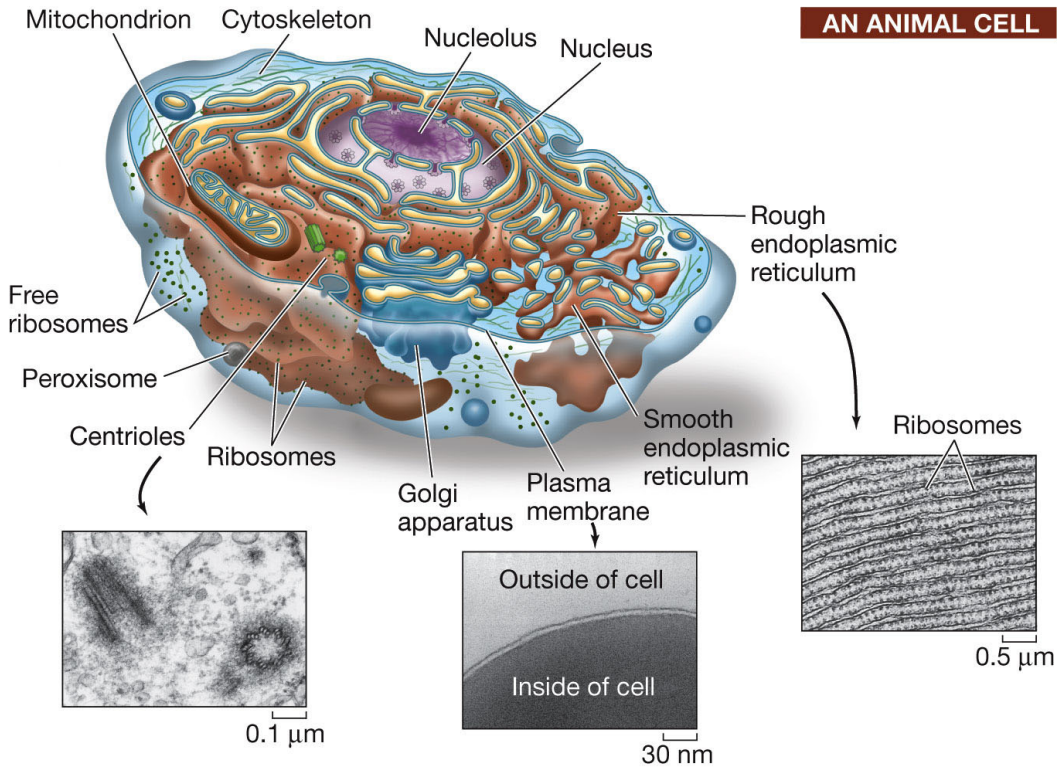
13. Mitochondria are enclosed by an outer membrane and an inner membrane that folds inward to form cristae. Mitochondria contain the proteins needed for cellular respiration and the generation of ATP.
14. Chloroplasts are enclosed by two membranes and contain an internal system of thylakoids organized as grana. Chloroplasts carry out photosynthesis. Other types of plastids include chromoplasts and leucoplasts.
15. Peroxisomes and glyoxysomes contain special enzymes and carry out specialized chemical reactions inside the cell.
16. Vacuoles are prominent in many plant cells and consist of a membrane-enclosed compartment that contains water and dissolved substances. By taking in water, vacuoles enlarge and provide the pressure needed to stretch the cell wall and provide structural support for the plant.
17. The cytoskeleton within the cytoplasm of eukaryotic cells provides shape, strength, and movement. It consists of three interacting types of protein fibers: microfilaments, which strengthen cellular structures and provide movement, intermediate filaments, which add strength to cell attachments in multicellular organisms, and microtubules, which are involved in the structure and function of cilia, flagella, and centrioles.
18. The cell wall of plants consists principally of cellulose. It is pierced by plasmodesmata that join the cytoplasm of adjacent cells.
19. In multicellular animals, the extracellular matrix consists of different kinds of proteins, including proteoglycan. In bone and cartilage, the protein collagen predominates.
20. The endosymbiosis theory of the evolutionary origin of mitochondria and chloroplasts states that these organelles originated when larger prokaryotes engulfed, but did not digest, smaller prokaryotes. Mutual benefits permitted this symbiotic relationship to be maintained and to evolve into the eukaryotic organelles observed today.

A Typical Prokaryotic Cell

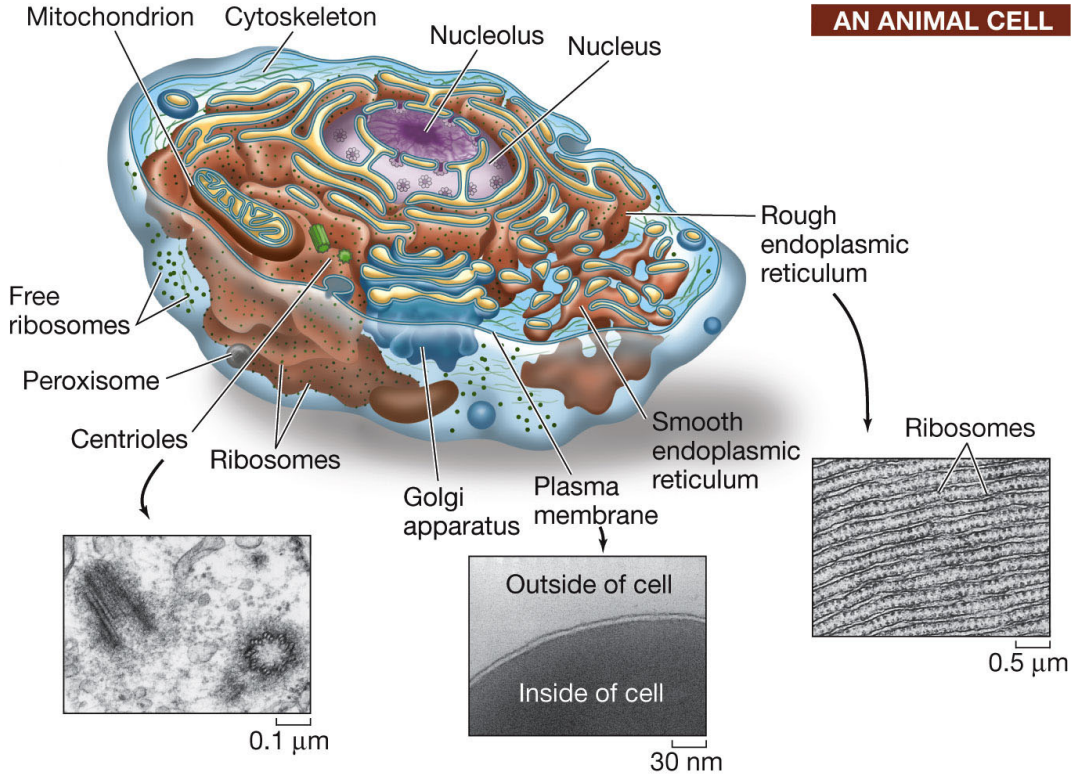


***LIFE 8e*, Figure 4.4**

A Typical Eukaryotic Cell



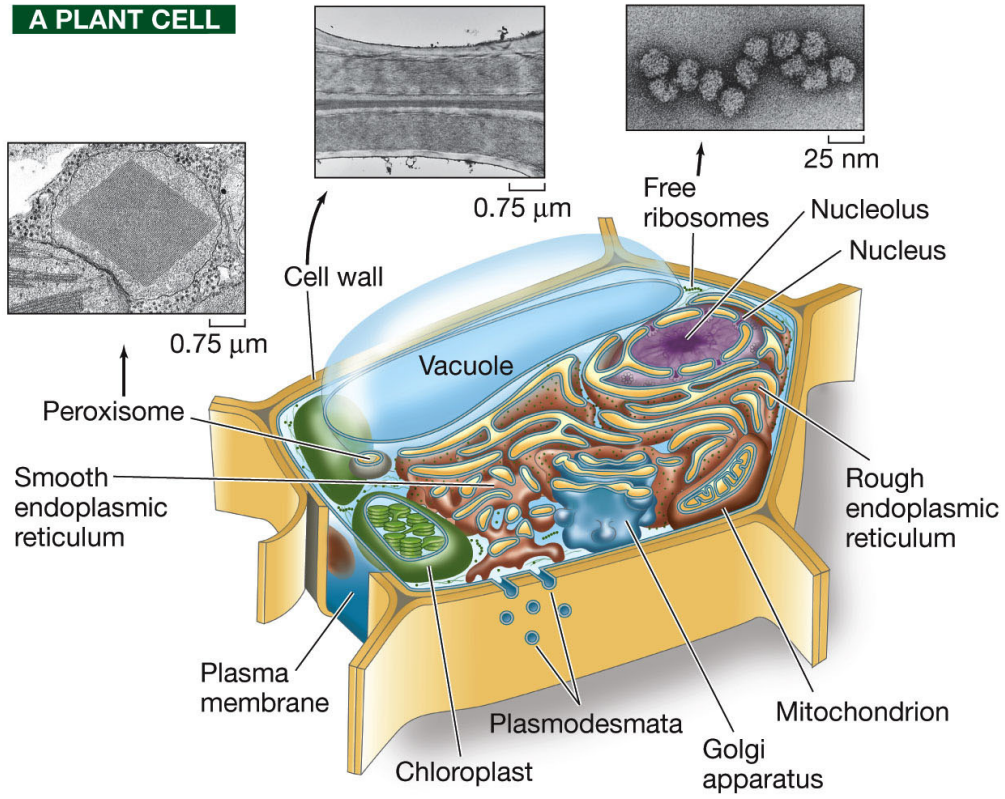
***LIFE 8e,* Figure 4.7 (Part 2)**



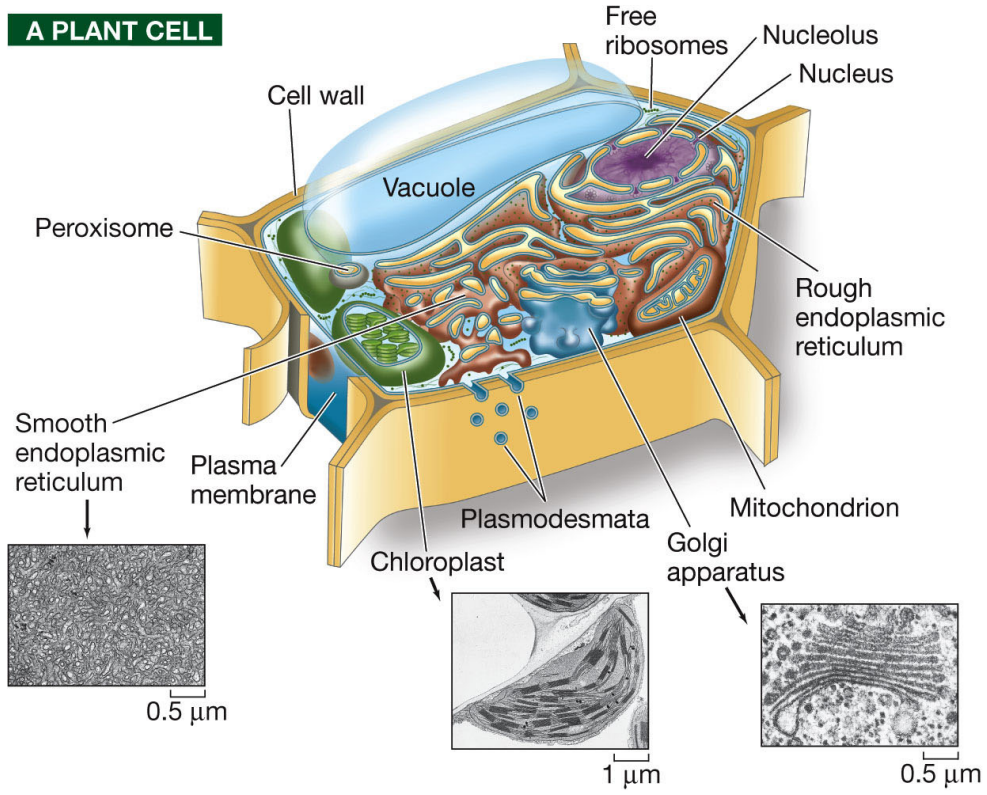
***LIFE 8e,* Figure 4.7 (Part 2)**

LIFE: THE SCIENCE OF BIOLOGY, Eighth Edition © 2007 Sinauer Associates, Inc. and W. H. Freeman & Co.

A Typical Plant Cell



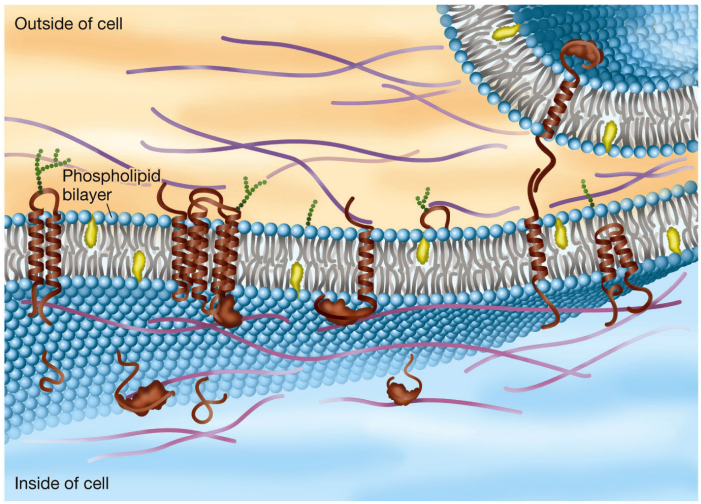
***LIFE 8e*, Figure 4.7 (Part 3)**



***LIFE 8e*, Figure 4.7 (Part 4)**

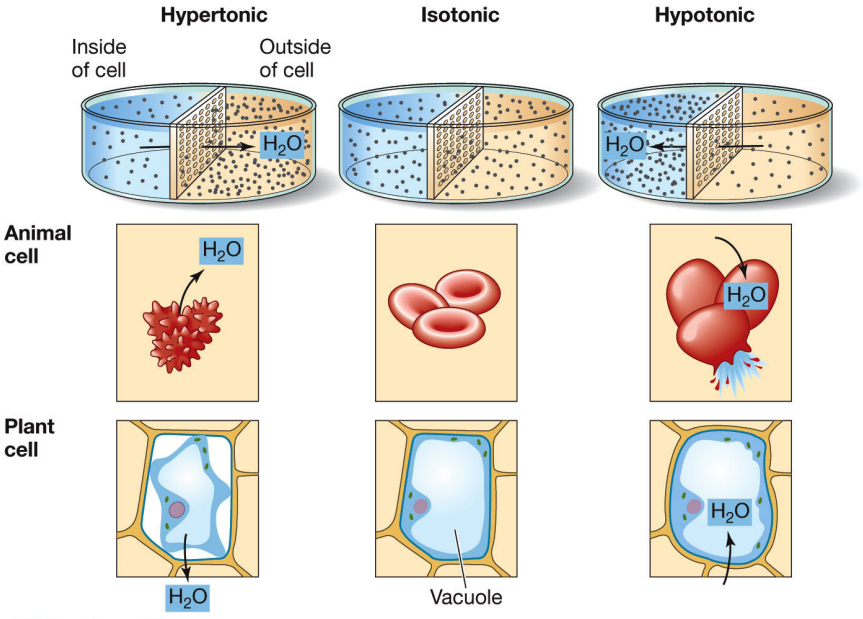
Chapter 5: The Dynamic Cell Membrane

1. The fluid mosaic model of membrane structure describes a phospholipid bilayer in which membrane proteins can move about laterally within the membrane.



***LIFE 8e*, Figure 5.1**

2. The two surfaces of a membrane may have different properties because of their different phospholipid composition, exposed domains of integral membrane proteins, and peripheral membrane proteins. Defined regions of a plasma membrane may have different membrane proteins.
3. Membranes are dynamic, constantly forming, changing, and breaking down.
4. Carbohydrates, attached to proteins or phospholipids, project from the external surface of the plasma membrane and function as recognition signals for interactions between cells.
5. In an organism or tissue, cells recognize and bind to each other by means of membrane proteins that protrude from the cell surface.
6. Some cells are connected by specialized cell junctions. The three types, tight junctions, desmosomes, and gap junctions, each have unique functions.
7. Substances can diffuse across a membrane by three processes: unaided diffusion through the phospholipid bilayer, diffusion through protein channels, or diffusion by means of a carrier protein (facilitated diffusion).
8. The rate of simple diffusion across a membrane is directly proportional to the concentration gradient across the membrane. An important factor in simple diffusion across a membrane is the lipid solubility of the solute.
9. In osmosis, water diffuses from regions of higher water concentration to regions of lower water concentration. Animal cells must remain isotonic to the environment to prevent destructive loss or gain of water. The cell walls of plants and some other organisms prevent the cells from bursting under hypotonic conditions. The turgor pressure that develops under these conditions keeps plants upright and stretches the cell wall during plant cell growth.



***LIFE 8e*, Figure 5.9**

10. Channel proteins and carrier proteins function in facilitated diffusion. The rate of ion movement through a voltage-gated channel protein depends on both concentration and electrochemical gradients.
11. Active transport requires the use of energy to move substances across a membrane against a concentration gradient via active transport proteins.
12. Primary active transport uses energy from the hydrolysis of ATP to move ions into or out of cells against their concentration gradients, while secondary active transport couples the passive movement of one solute with its concentration gradient to the movement of another solute against its concentration gradient. Energy from ATP is used indirectly to establish the concentration gradient that results in the movement of the first solute.
13. Endocytosis transports macromolecules, large particles, and small cells into eukaryotic cells through engulfment by the plasma membrane.
14. Exocytosis secretes materials in vesicles from the cell by causing the vesicles to fuse with the plasma membrane.
15. Membranes function as sites for recognition and initial processing of extracellular signals, for energy transformations, and for organizing chemical reactions.

TABLE 5.1

Membrane Transport Mechanisms

TRANSPORT MECHANISM	EXTERNAL ENERGY REQUIRED?	DRIVING FORCE	MEMBRANE PROTEIN REQUIRED?	SPECIFICITY
Simple diffusion	No	With concentration gradient	No	Not specific
Facilitated diffusion	No	With concentration gradient	Yes	Specific
Active transport	Yes	ATP hydrolysis (against concentration gradient)	Yes	Specific

***LIFE 8e*, Table 5.1**