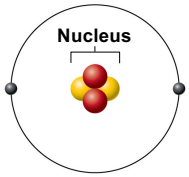
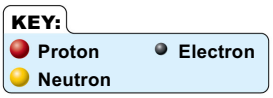
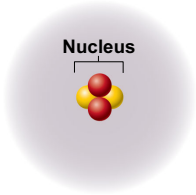


Helium atom

2 protons (p^+)
2 neutrons (n^0)
2 electrons (e^-)

(a) Planetary model

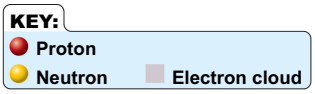


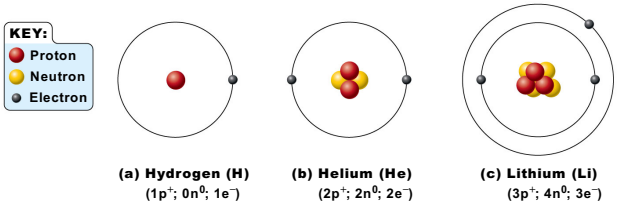


Helium atom

2 protons (p^+)
2 neutrons (n^0)
2 electrons (e^-)

(b) Orbital model





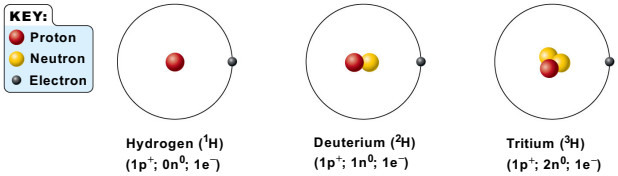
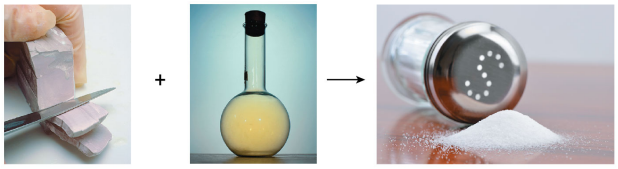


Table 2.3 Atomic Structures of the Most Abundant Elements in the Body

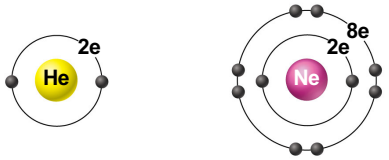
Element	Symbol	Atomic number (# of p)	Mass number (# of p + n)	Atomic weight	Electrons in valence shell
Calcium	Ca	20	40	40.078	2
Carbon	C	6	12	12.011	4
Chlorine	Cl	17	35	35.453	7
Hydrogen	H	1	1	1.008	1
Iodine	I	53	127	126.905	7
Iron	Fe	26	56	55.847	2
Magnesium	Mg	12	24	24.305	2
Nitrogen	N	7	14	14.007	5
Oxygen	O	8	16	15.999	6
Phosphorus	P	15	31	30.974	5
Sodium	Na	11	23	22.989	1
Sulfur	S	16	32	32.064	6



Sodium (silvery metal) | Chlorine (poisonous gas) | Sodium chloride (table salt)

(a) Chemically inert elements

Outermost energy level (valence shell) complete

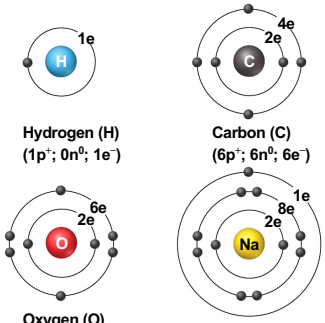


Helium (He)
($2p^+$; $2n^0$; $2e^-$)

Neon (Ne)
($10p^+$; $10n^0$; $10e^-$)

(b) Chemically reactive elements

Outermost energy level (valence shell) incomplete

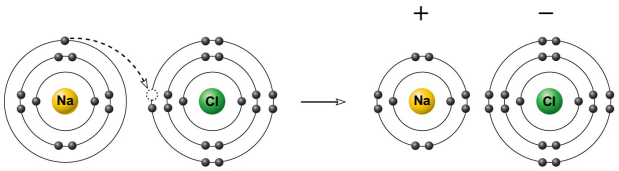


Hydrogen (H)
($1p^+$; $0n^0$; $1e^-$)

Carbon (C)
($6p^+$; $6n^0$; $6e^-$)

Oxygen (O)
($8p^+$; $8n^0$; $8e^-$)

Sodium (Na)
($11p^+$; $12n^0$; $11e^-$)

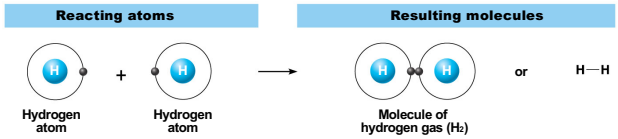


Sodium atom (Na)
($11p^+$; $12n^0$; $11e^-$)

Chlorine atom (Cl)
($17p^+$; $18n^0$; $17e^-$)

Sodium ion (Na^+) Chloride ion (Cl^-)

Sodium chloride (NaCl)

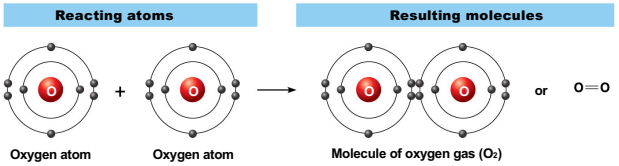


Hydrogen atom

Hydrogen atom

Molecule of hydrogen gas (H_2)

(a) Formation of a single covalent bond

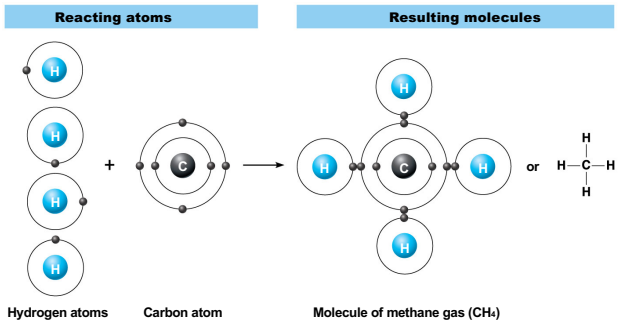


Oxygen atom

Oxygen atom

Molecule of oxygen gas (O_2)

(b) Formation of a double covalent bond



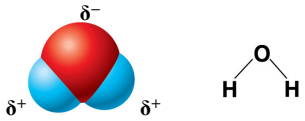
Hydrogen atoms

Carbon atom

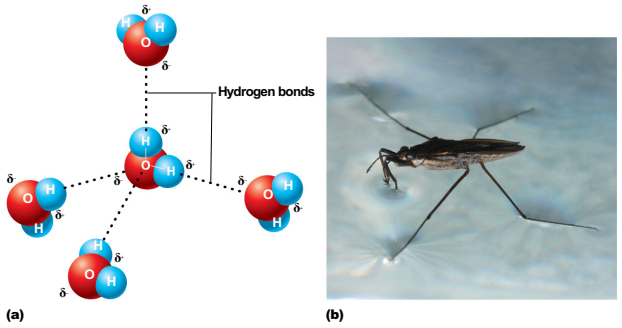
Molecule of methane gas (CH_4)

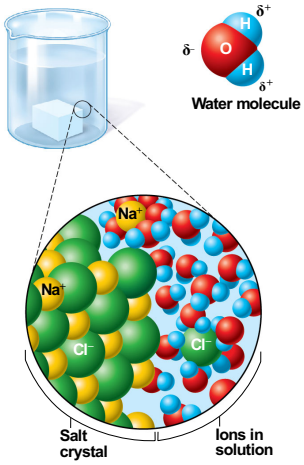
(c) Formation of four single covalent bonds

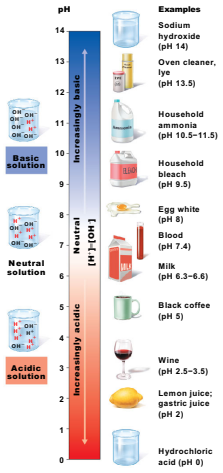
(a) Carbon dioxide (CO_2)

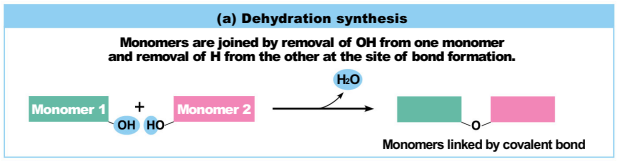


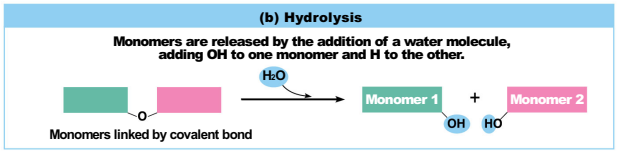
(b) Water (H_2O)

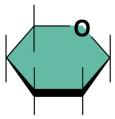




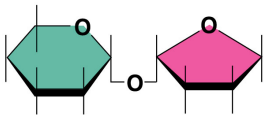




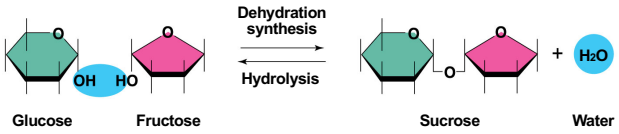




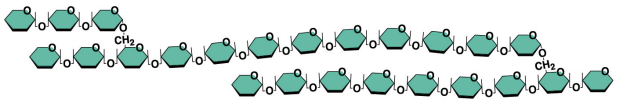
(a) Simple sugar (monosaccharide)



(b) Double sugar (disaccharide)

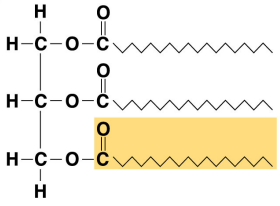


(c) Dehydration synthesis and hydrolysis of a molecule of sucrose

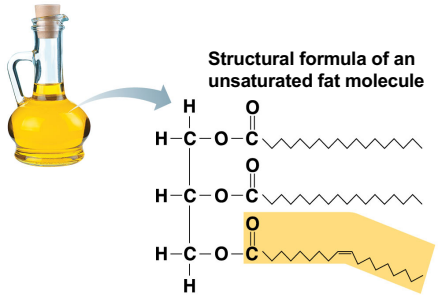


(d) Starch (polysaccharide)

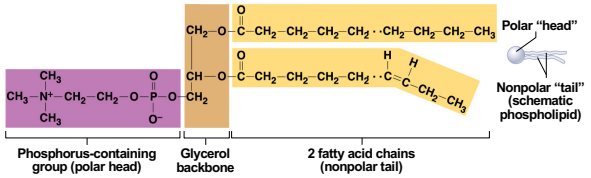
Structural formula of a saturated fat molecule



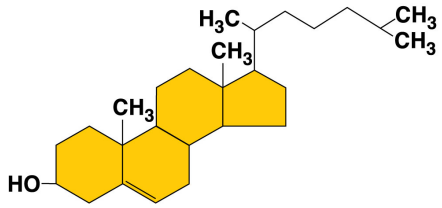
(a) **Saturated fat.** At room temperature, the molecules of a saturated fat such as this butter are packed closely together, forming a solid.



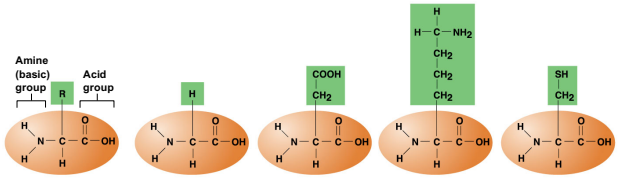
(b) Unsaturated fat. At room temperature, the molecules of an unsaturated fat such as this olive oil cannot pack together closely enough to solidify because of the kinks in some of their fatty acid chains.



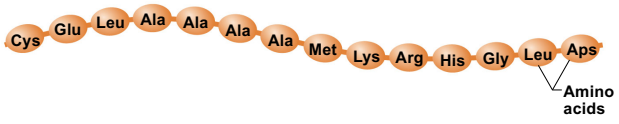
(b) Typical structure of a phospholipid molecule (phosphatidylcholine). Two fatty acid chains and a phosphorous-containing group are attached to a glycerol backbone.



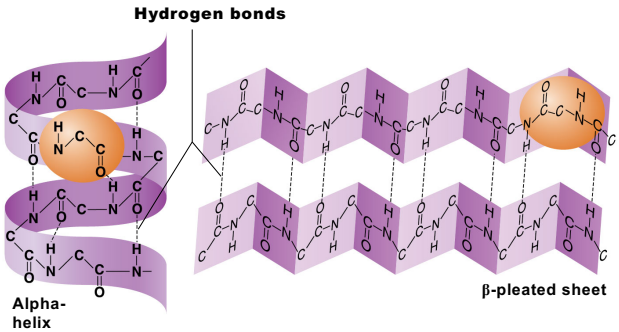
(c) Cholesterol. Simplified structure of cholesterol, a steroid, formed by four interlocking carbon rings.



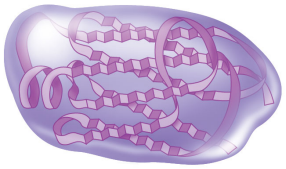
(a) Generalized structure of all amino acids. **(b) Glycine is the simplest amino acid.** **(c) Aspartic acid (an acidic amino acid)** has an acid group (—COOH) in the R group. **(d) Lysine (a basic amino acid)** has an amine group (—NH_2) in the R group. **(e) Cysteine (a basic amino acid)** has a sulfhydryl (—SH) group in the R group.



(a) Primary structure. A protein's primary structure is the unique sequence of amino acids in the polypeptide chain.

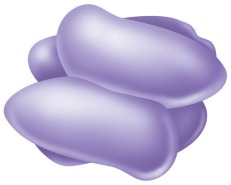


(b) Secondary structure. Two types of secondary structure are the alpha-helix and beta-pleated sheet. Secondary structure is reinforced by hydrogen bonds, represented by dashed lines in this figure.



Protein (if > 50 amino acids) or polypeptide (if < 50 amino acids)

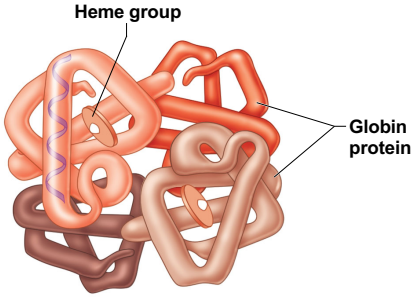
(c) Tertiary structure. The overall three-dimensional shape of the polypeptide or protein is called tertiary structure. It is reinforced by chemical bonds between the R-groups of amino acids in different regions of the protein chain.



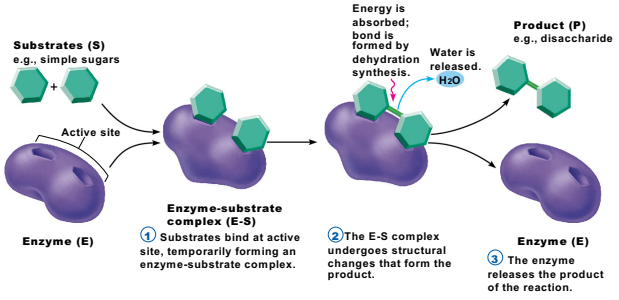
Complex protein with four polypeptide subunits, each with tertiary structure

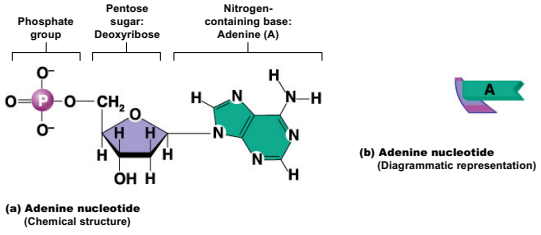
(d) Quaternary structure. Some proteins consist of two or more polypeptide chains. For example, four polypeptides construct the protein hemoglobin, a blood protein.

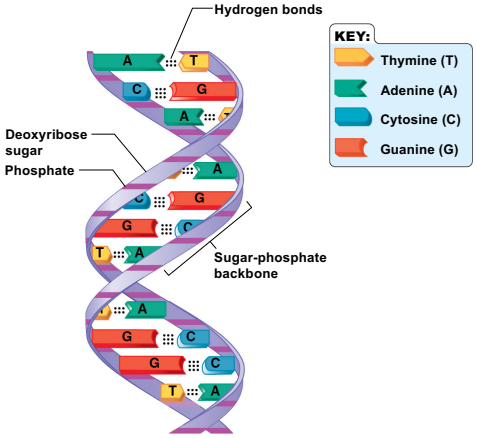
(a) Triple helix of collagen (a fibrous or structural protein).



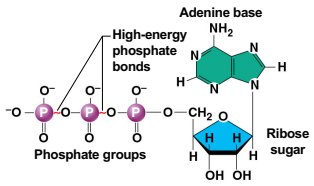
(b) Hemoglobin molecule composed of the protein globin and attached heme groups. (Globin is a globular, or functional, protein.)



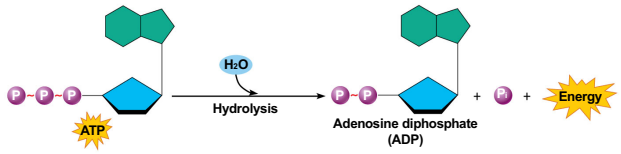




(d) Diagram of a DNA molecule

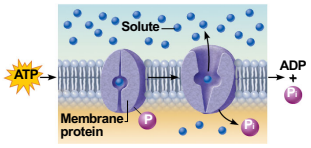


(a) Adenosine triphosphate (ATP)

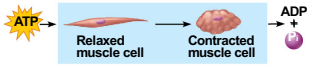


(b) Hydrolysis of ATP

(a) **Chemical work.** ATP provides the energy needed to drive energy-absorbing chemical reactions.



(b) **Transport work.** ATP drives the transport of certain solutes (amino acids, for example) across cell membranes.



(c) **Mechanical work.** ATP activates contractile proteins in muscle cells so that the cells can shorten and perform mechanical work.