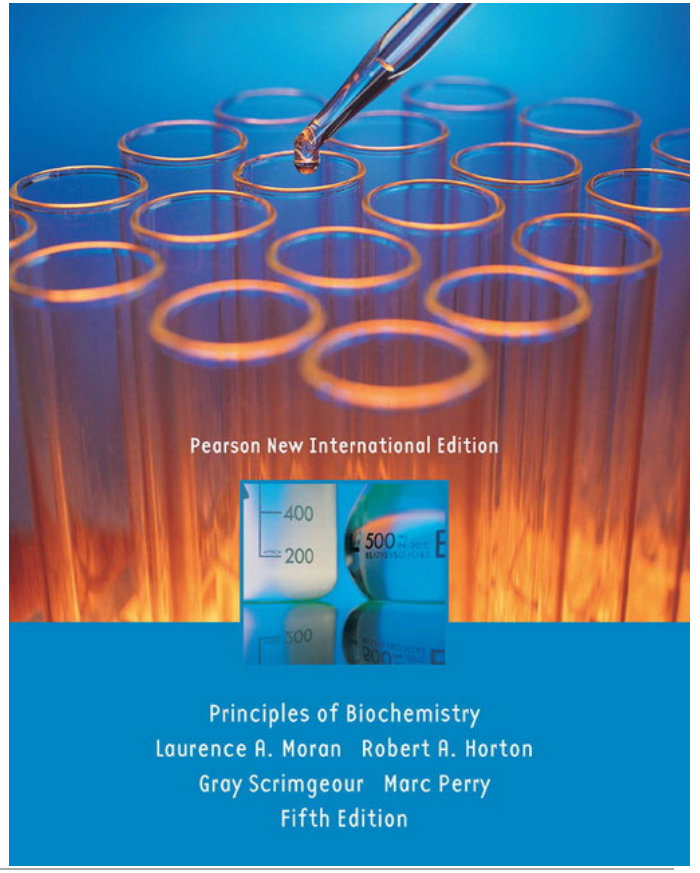
Introduction to Biochemistry



CHAPTER 1

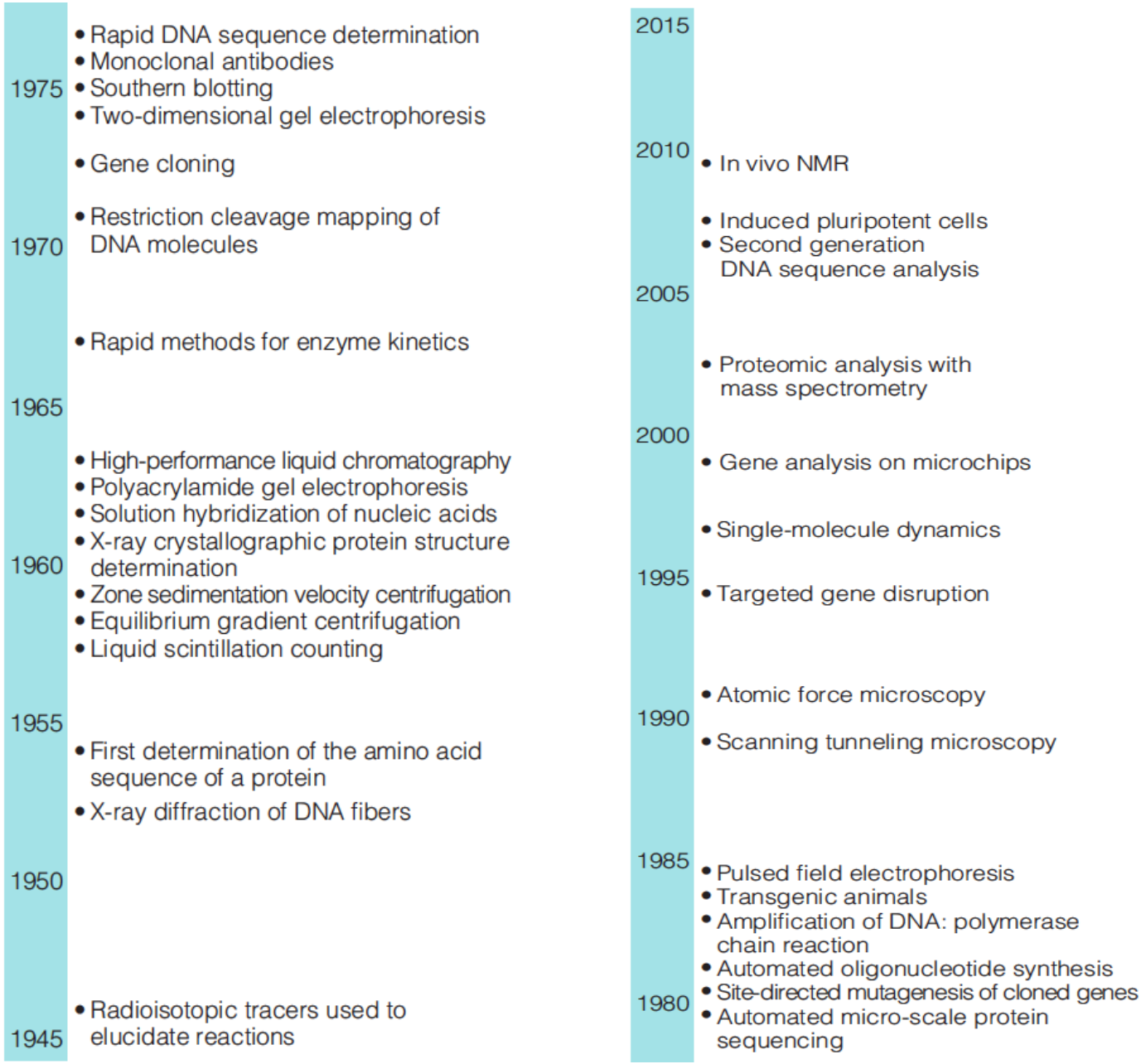
PREPARED BY WISSAM SALEH

What is biochemistry ?

- Biochemistry = chemistry of life.
- Biochemists use physical and chemical principles to explain biology at the molecular level.
- Basic principles of biochemistry are common to all living organism

❖ **Biochemistry** is the branch of science that seeks to describe the structure, organization, and functions of living matter in molecular terms.

Recent history of biochemistry shown by the introduction of new techniques



Applications of Biochemistry

- Medicine
- Industrial applications
- Agriculture
- Environmental applications

Principal areas of Biochemistry

- **The structural chemistry** of the components of living matter and relationships of biological function to chemical structure.
- **Metabolism**, the totality of chemical reactions that occur in living matter.
- **Genetic biochemistry**, the chemistry of processes and substances that store and transmit biological information.

Chemical elements of life

- Six nonmetallic elements: C, H, N, O, P, S account for 97% of the weight of most organisms.
- Metal ions (e.g., K^{+}, Na+, Ca^{+2}, Mg^{+2}, Zn^{+2} Fe^{+2} and Cl^{-}) play important roles in metabolism.

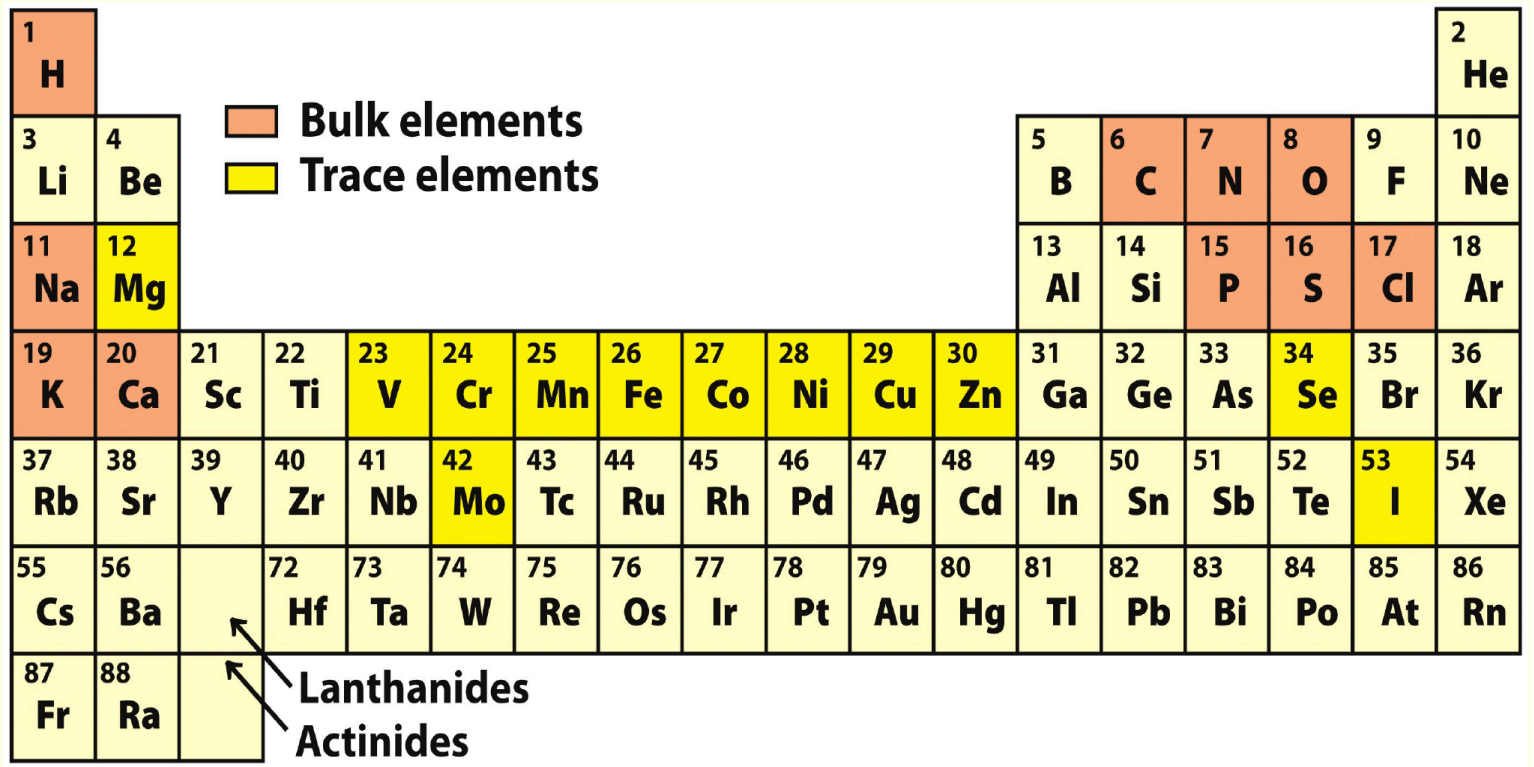
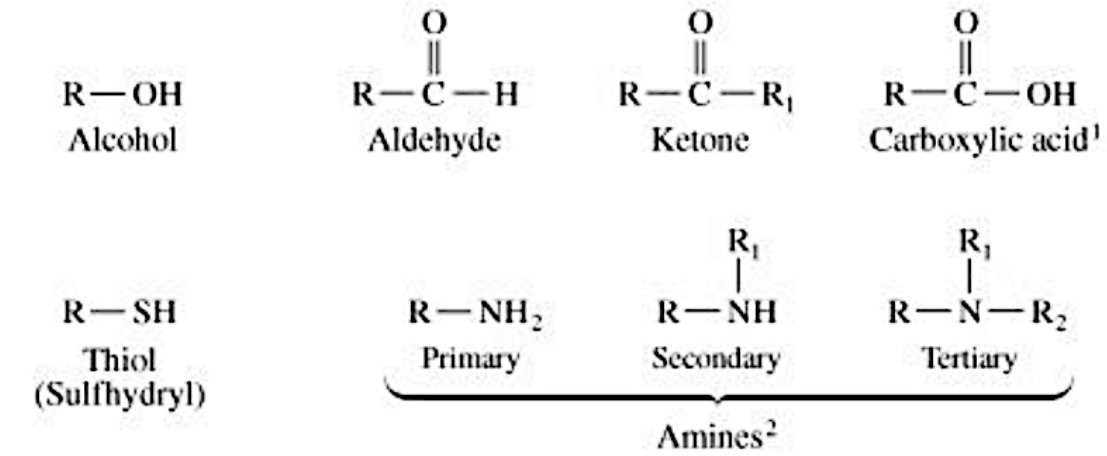
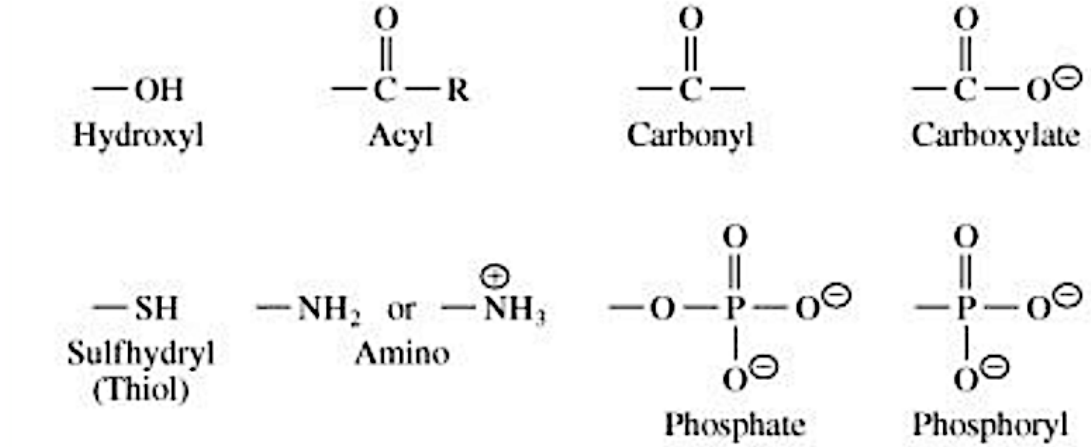


Figure 1-13
Lehninger Principles of Biochemistry, Sixth Edition

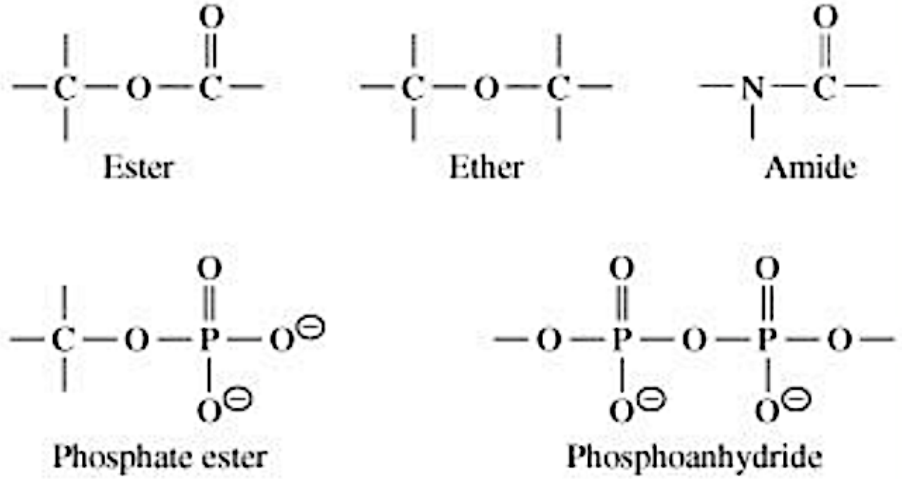
(a) *Organic compounds*



(b) *Functional groups*



(c) *Linkages in biochemical compounds*

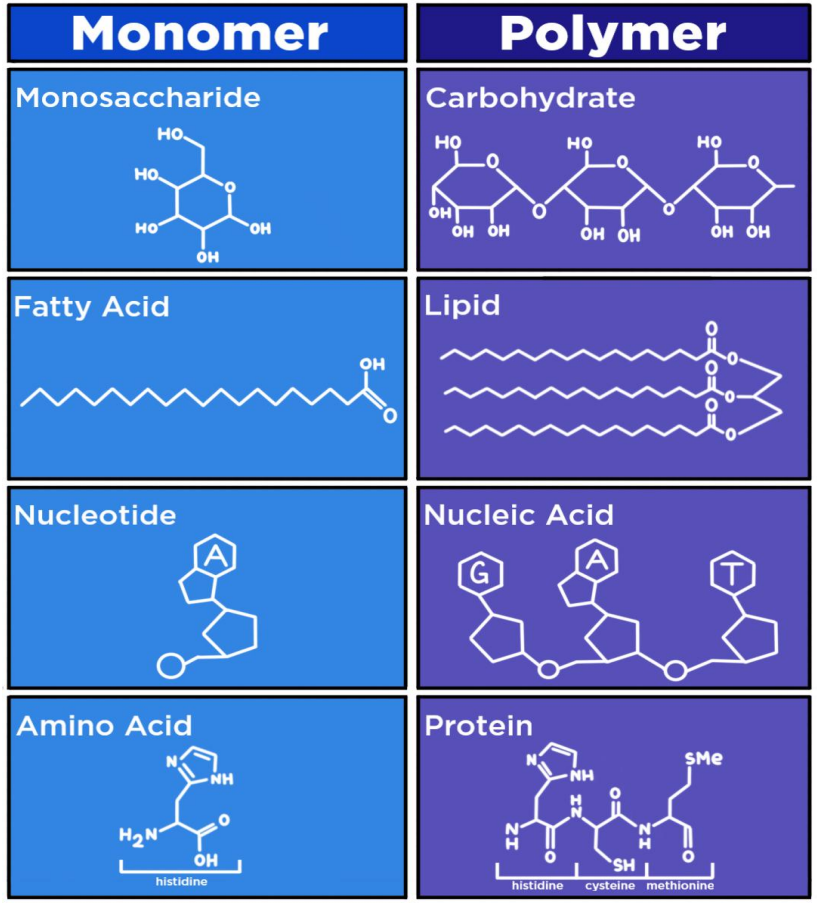


[1] Under most biological conditions, carboxylic acids exist as carboxylate anions: R—C(=O)—O⊖.

[2] Under most biological conditions, amines exist as ammonium ions: R—NH3⊕, R—NH2⊕—R1, and R—NH⊕(—R1)—R2.

Macromolecules

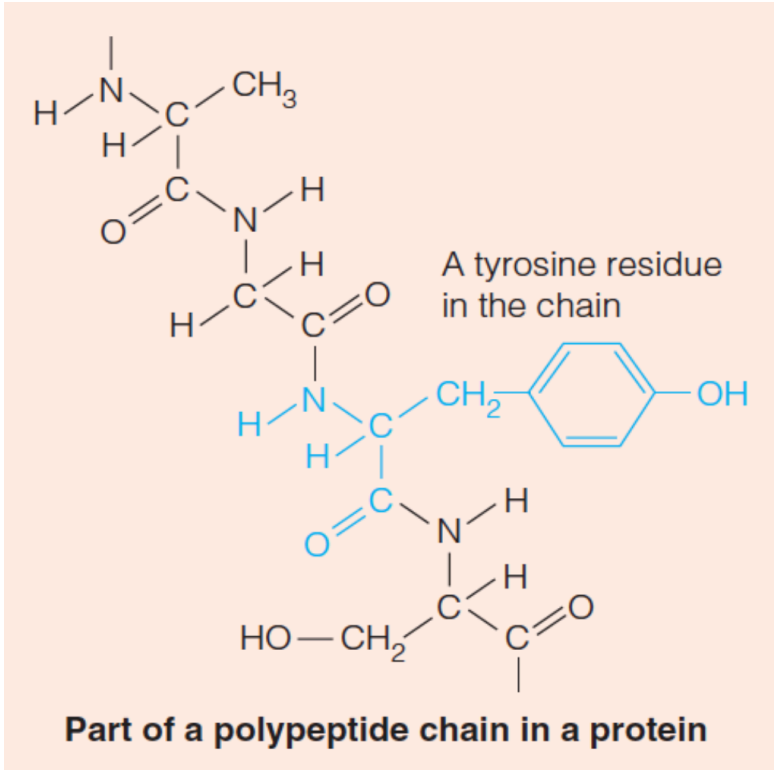
- Proteins
- Polysaccharides
- Nucleic acids
- Lipids
  - Many of the macromolecules are polymers, which are formed by condensation reactions of the monomers

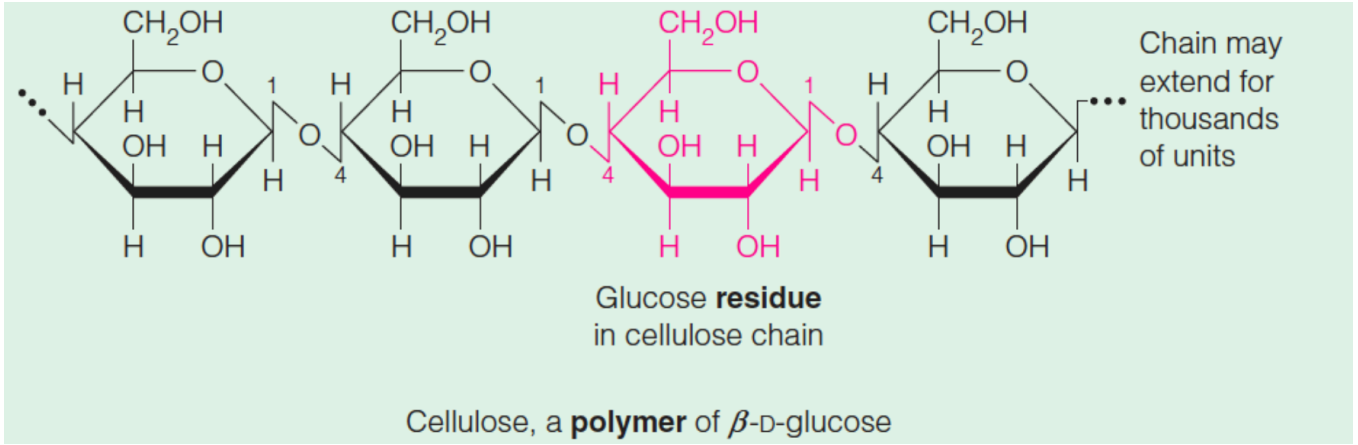


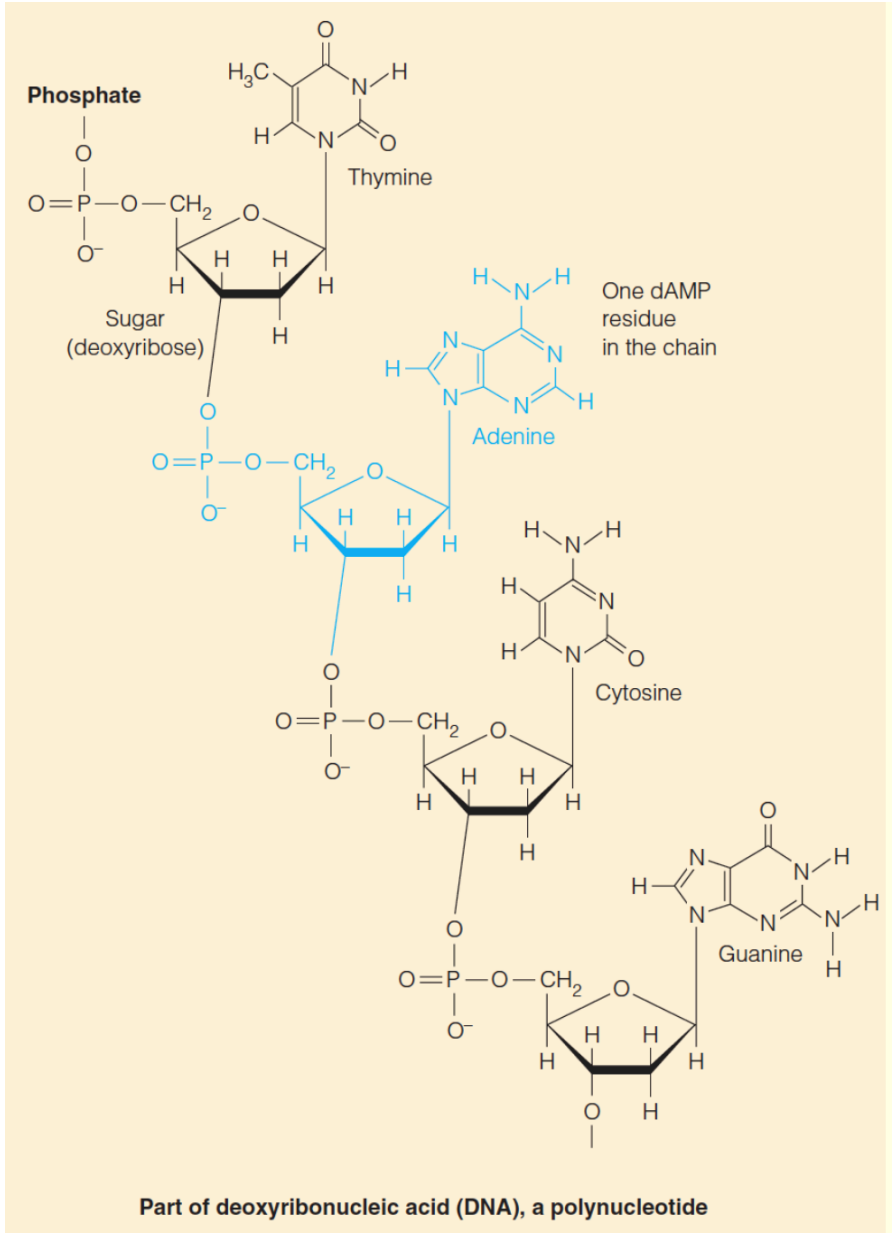
Macromolecules

Macromolecule	Monomer	Linkage/bond
• *Protein*	*amino acid*	*peptide (amide)*
• *Polysaccharide*	*monosaccharide*	*glycosidic (ether)*
• *Nucleic acids*	*nucleotide*	*phosphodiester*
• *Lipids (triglycerides)*	*fatty acids*	*ester*

Polymers


A tyrosine residue
in the chain
Part of a polypeptide chain in a protein


Chain may
extend for
thousands
of units
Glucose **residue**
in cellulose chain
Cellulose, a **polymer** of β-D-glucose


Phosphate
Thymine
Sugar
(deoxyribose)
One dAMP
residue
in the chain
Adenine
Cytosine
Guanine
Part of deoxyribonucleic acid (DNA), a polynucleotide

Biological functions of macromolecules:

- **Polysaccharides** – structure, energy storage
- **Nucleic acids** – storage and transmission of genetic information
- **Proteins** – structure, enzymes, hormones, receptors
- **Lipids** – energy storage, membranes, hormones, signaling

Metabolism

- **Metabolism** describes the chemical reactions in which organic compounds are synthesized and degraded, and useful energy is extracted, stored and used.
- These reactions maintain the living state of the cells and the organism.
- Metabolism can be divided into: catabolism and anabolism.

The cell is the basic unit of life

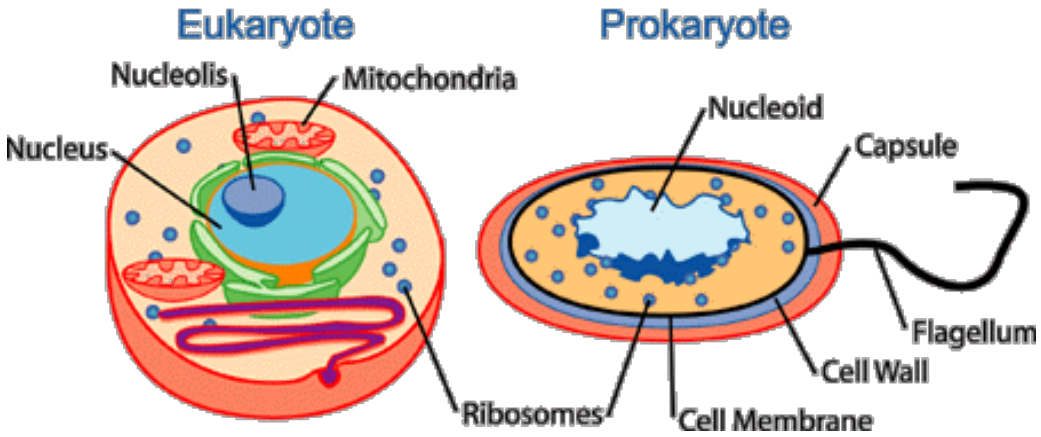
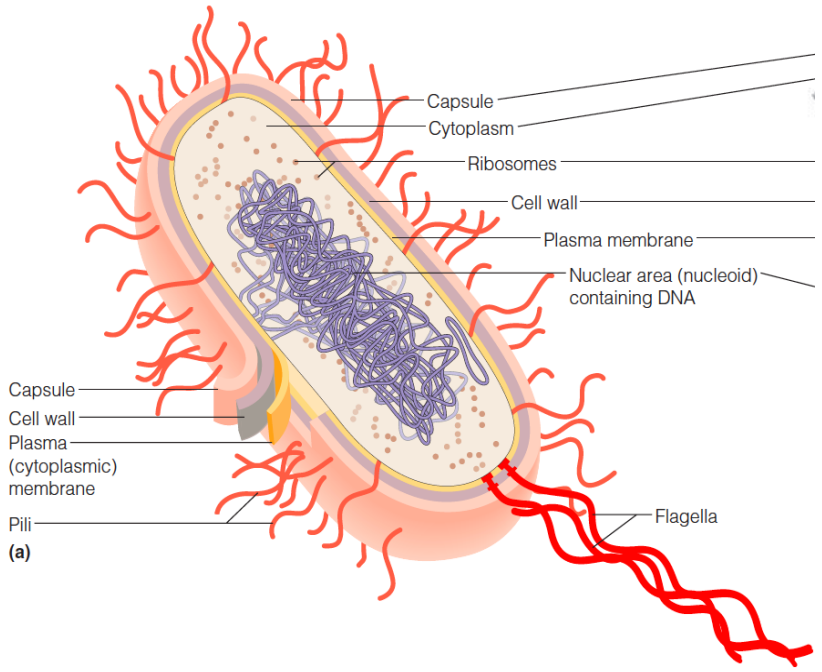


TABLE 1.2 Comparison of some properties of prokaryotic and eukaryotic cells

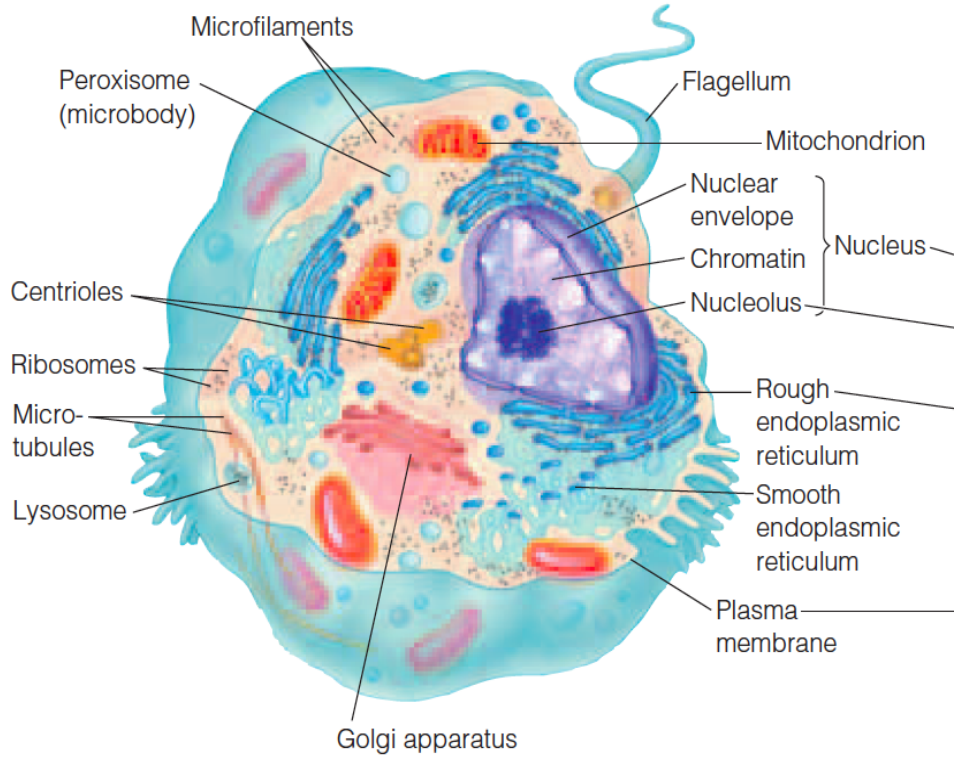
	Prokaryotic Cells	Eukaryotic Cells
Size	0.2–5 μm in diameter	Most are 10–50 μm in diameter
Internal compartmentation	No	Yes, with several different kinds of organelles
Containment of DNA	Free in cytoplasm as nucleoid	In nucleus, condensed with proteins into multiple chromosomes
Ploidy[a]	Usually haploid	Almost always diploid or polyploid
Mechanism of cell replication	Simple division following DNA replication	Mitosis in somatic cells, meiosis in gametes[b]

Prokaryotes

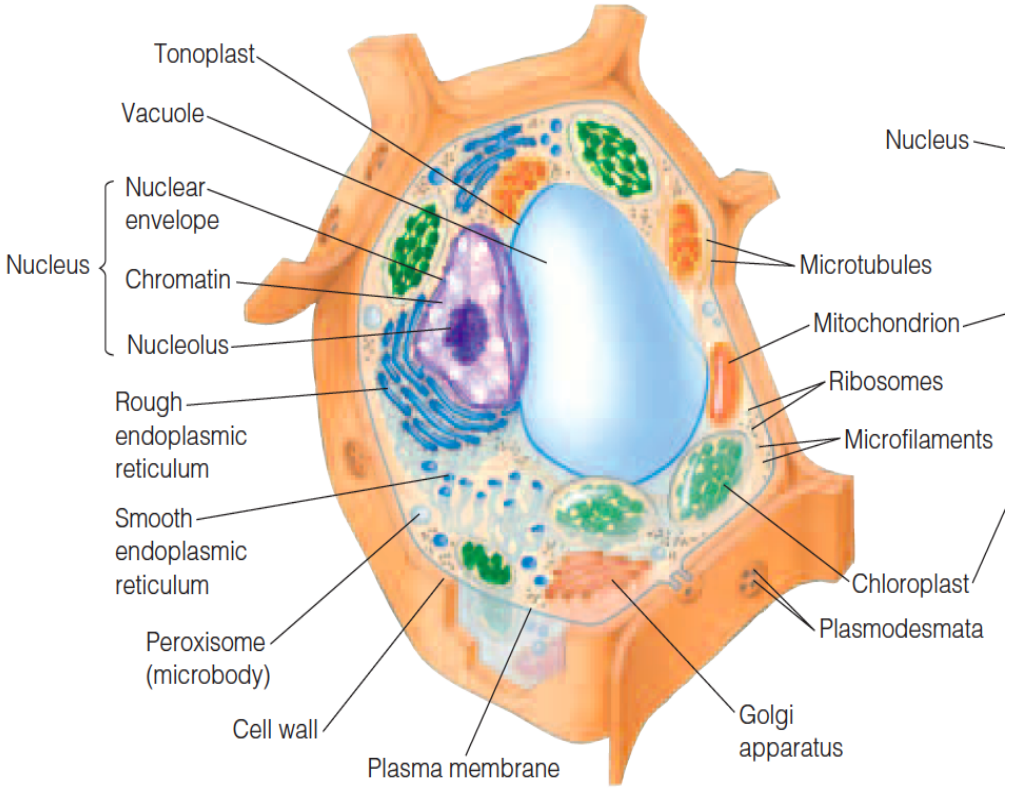
- The prokaryotes are always **unicellular.** They include the true bacteria (eubacteria) and an ancient class called archaea.
- A **plasma membrane** and usually a rigid cell wall surrounds the cell.
- The **cytoplasm**, containing the cytosol is inside the cell.
- The **DNA** is in the form of one or more molecules that exist free in the cytosol.
- The **ribosomes**, where protein synthesis occurs is free in the cytosol.



Eukaryotes



(a) Typical animal cell



(c) Typical plant cell

Organelles

- **Mitochondria** - specialize in oxidative metabolism
- **Endoplasmic reticulum** - a folded membrane structure rich in **Ribosomes**, where much protein synthesis occurs
- **Golgi complex** – membrane-bound chambers that function in secretion and the transport of newly synthesized proteins to their destinations
- **Nucleus** - contains the cell's genetic information, encoded in DNA that is packaged into chromosomes.

Biochemistry is multidisciplinary!