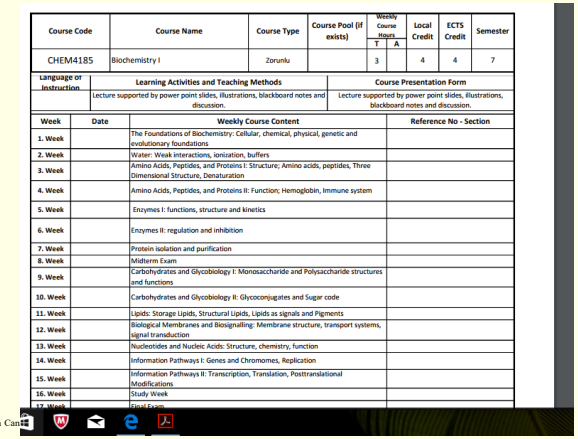
Course Code	Course Name	Course Type	Course Pool (if exists)	Weekly Course Hours T	Weekly Course Hours A	Local Credit	ECTS Credit	Semester
CHEM4185	Biochemistry I	Zorunlu		3		4	4	7

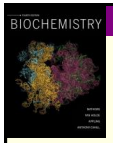
Language or Instruction	Learning Activities and Teaching Methods	Course Presentation Form
	Lecture supported by power point slides, illustrations, blackboard notes and discussion.	Lecture supported by power point slides, illustrations, blackboard notes and discussion.

Week	Date	Weekly Course Content	Reference No - Section
1. Week		The Foundations of Biochemistry: Cellular, chemical, physical, genetic and evolutionary foundations	
2. Week		Water: Weak interactions, ionization, buffers	
3. Week		Amino Acids, Peptides, and Proteins I: Structure; Amino acids, peptides, Three Dimensional Structure, Denaturation	
4. Week		Amino Acids, Peptides, and Proteins II: Function; Hemoglobin, Immune system	
5. Week		Enzymes I: functions, structure and kinetics	
6. Week		Enzymes II: regulation and inhibition	
7. Week		Protein isolation and purification	
8. Week		Midterm Exam	
9. Week		Carbohydrates and Glycobiology I: Monosaccharide and Polysaccharide structures and functions	
10. Week		Carbohydrates and Glycobiology II: Glycoconjugates and Sugar code	
11. Week		Lipids: Storage Lipids, Structural Lipids, Lipids as signals and Pigments	
12. Week		Biological Membranes and Biosignalling: Membrane structure, transport systems, signal transduction	
13. Week		Nucleotides and Nucleic Acids: Structure, chemistry, function	
14. Week		Information Pathways I: Genes and Chromomes, Replication	
15. Week		Information Pathways II: Transcription, Translation, Posttranslational Modifications	
16. Week		Study Week	
17. Week		Final Exam	



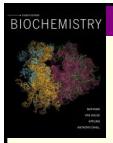
Chapter 1

The Scope of Biochemistry



***Chapter Outline*:**

- What Is Biochemistry?
- Biochemistry as a Chemical Science
- Biochemistry as a Biological Science



What Is Biochemistry?

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

• Biochemistry can be divided into three principal areas:

1. ***The structural chemistry*** of the components of living matter and relationships of biological function to chemical structure.

2. ***Metabolism***, the totality of chemical reactions that occur in living matter.

3. ***Genetic biochemistry***, the chemistry of processes and substances that store and transmit biological information.

    - This third area is also the province of ***molecular genetics***, a field that seeks to understand heredity and the expression of genetic information in molecular terms.

Founders of Biochemistry

- **One of the milestones for biochemistry is the synthesis of urea by Wohler in 1828**

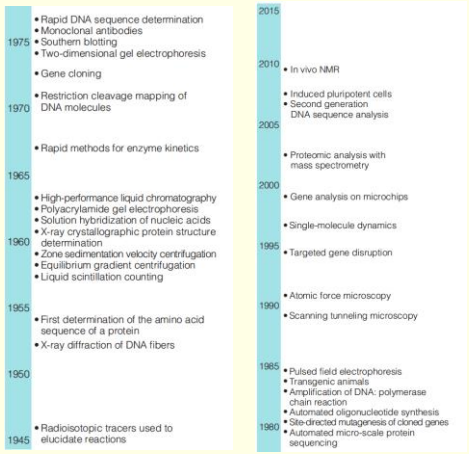
Founders of Biochemistry

- **German Chemist Carl Neuberg was the first who used the terminology «Biochemistry» in 1903**

Founders of Biochemistry

- **Chevreul; discovered the structure of lipids**
- **Emil Fischer; discovered carbohydrates and amino acids**
- **Miesche; nucleic acids**
- **Buchner; observed the fermentation of sugars and first proposed the terminology «enzymes»**
- **Embden & Mayerhof discovered the intermediary metabolism of carbohydrates**
- **Krebs found the citric acid cycle**

Recent history of biochemistry shown by the introduction of new techniques.



Biochemistry as a Chemical Science

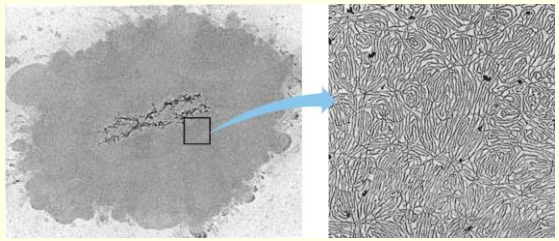
TABLE 1.1 Elements found in organisms

Element	Comment
First Tier	
Carbon (C)	Most abundant in *all organisms*
Hydrogen (H)	
Nitrogen (N)	
Oxygen (O)	
Second Tier	
Calcium (Ca)	Much less abundant but found in *all organisms*
Chlorine (Cl)	
Magnesium (Mg)	
Phosphorus (P)	
Potassium (K)	
Sodium (Na)	
Sulfur (S)	
Third Tier	
Cobalt (Co)	Metals present in small amounts in *all organisms* and essential to life
Copper (Cu)	
Iron (Fe)	
Manganese (Mn)	
Zinc (Zn)	
Fourth Tier	
Aluminum (Al)	Found in or required by *some organisms* in trace amounts
Arsenic (As)	
Boron (B)	
Bromine (Br)	
Chromium (Cr)	
Fluorine (F)	
Gallium (Ga)	
Iodine (I)	
Molybdenum (Mo)	
Nickel (Ni)	
Selenium (Se)	
Silicon (Si)	
Tungsten (W)	
Vanadium (V)	

Biochemistry as a Chemical Science

Macromolecules

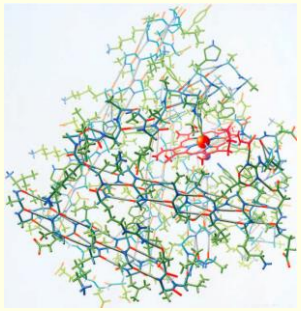
The ***DNA*** from one chromosome has a mass of ~20 billion Daltons



Biochemistry as a Chemical Science

Macromolecules

Protein molecules have masses of 10,000 to 1 million Daltons



Myoglobin has a mass of 16,000 Daltons

Biochemistry as a Chemical Science

Macromolecules

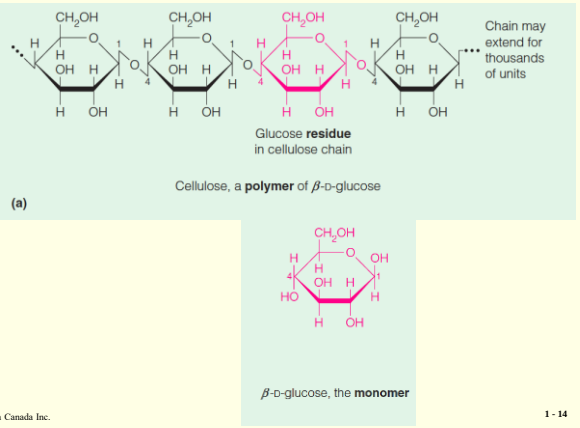
- ***Proteins***
- ***Polysaccharides***
- ***Nucleic acids***
- ***Lipids***

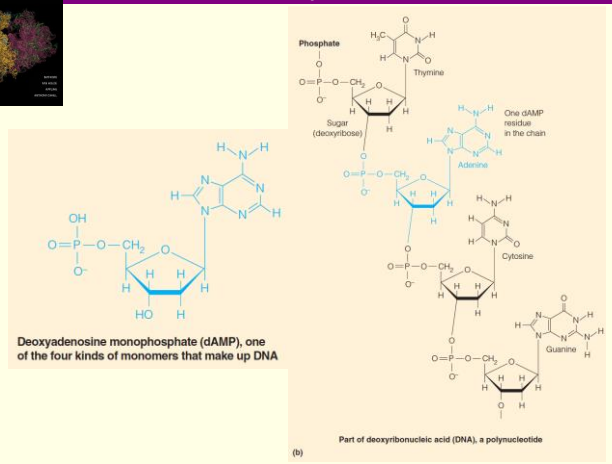
Many of the macromolecules are polymers, which are formed by condensation reactions of the monomers.

Biochemistry as a Chemical Science

Macromolecule	Monomer	Linkage
• ***Protein***	***amino acid***	***peptide (amide)***
• ***Polysaccharide***	***monosaccharide***	***glycoside (ether)***
• ***Nucleic acids***	***nucleotide***	***phospho-diester***
• ***Lipids (triglycerides)***	***fatty acids***	***ester***

Biochemistry as a Chemical Science





Biochemistry as a Chemical Science

Biological Functions of the macromolecules:

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

Biochemistry as a Biological Science

Koshland's seven "pillars of life"

1.Program - organized plan for constitution and regeneration of an organism (*e.g.*, DNA).

2. Improvisation - the ability of living matter to change the program to assure survival as the surroundings change.

3. Compartmentalization - the ability of an organism to separate itself from the environment, such as with membranes.

4. Energy - living matter must create complexity in order to sustain the program and the other pillars of life.

Biochemistry as a Biological Science

Koshland's seven "pillars of life"

5.Regeneration - the ability to compensate for the inevitable wear involved in maintaining a physical state far from equilibrium.

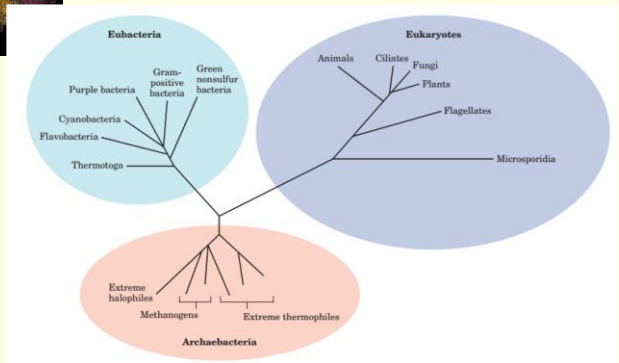
6.Adaptability - the capacity of an organism to respond to environmental changes.

7.Seclusion - the metabolic processes and pathways must operate in isolation from one another, even though they may take place within the same compartment of a cell.

Biochemistry as a Biological Science

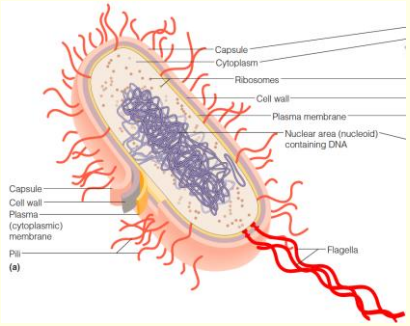
Interconnected with all seven pillars of life is the function of:

- ***Semipermeable membranes*** - surround cells and intracellular ***organelles***, such as the mitochondria, maintaining
- ***Homeostasis*** - a condition in which the chemical composition of a biological system is held constant.



Biochemistry as a Biological Science

The ***cell*** is the basic unit of biological organization.



Biochemistry as a Biological Science

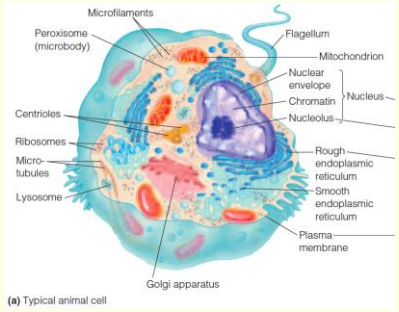
- The ***prokaryotes*** are always unicellular.

  Includes 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.
- The cell surface may carry ***pili***, which aid in attaching the organism to other cells or surfaces, and ***flagellae***, which enable it to swim.

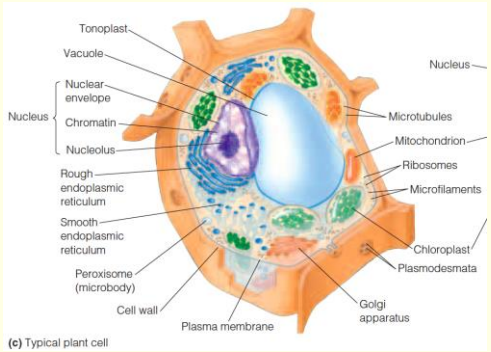
Biochemistry as a Biological Science

The ***cell*** is the basic unit of biological organization.



Biochemistry as a Biological Science

The ***cell*** is the basic unit of biological organization.



Biochemistry as a Biological Science

The ***cell*** is the basic unit of biological organization.

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]

Biochemistry as a Biological Science

Eukaryotic cells are characterized by the presence of ***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.

A portion of this DNA is subpackaged into a dense region within the nucleus called the ***nucleolus***. Surrounding the nucleus is a nuclear envelope, pierced by pores through which the nucleus and cytoplasm communicate.

Biochemistry as a Biological Science

Animal and plant cells also have specialized ***organelles***:

•***Animal cells*** contain digestive bodies called ***lysosomes*** and are surrounded only by a ***plasma membrane***.

•***Plant cells*** have ***chloroplasts***, the sites of photosynthesis; and usually a large, water-filled ***vacuole***.

•Plant cells often have a tough cellulosic ***cell wall*** outside the membrane.

•***Basal bodies*** act as anchors for cilia or flagellae in cells that have those appendages.

Biochemistry as a Biological Science

Bioinformatics can be considered as information science applied to biology.

- mathematical analysis of DNA sequence data
- computer simulation of metabolic pathways
- analysis of potential drug targets (enzymes or receptors) for structure-based drug design.

Genetics concerns itself with the location, expression, and function of individual genes or small groups of genes.

Genomics concerns itself with the entire genome. The totality of genetic information in an organism.

- determining the nucleotide sequence of the whole genome
- assessing the expression and function of each gene
- evolutionary relationships among genes in the same genome and with genomes of different organisms.