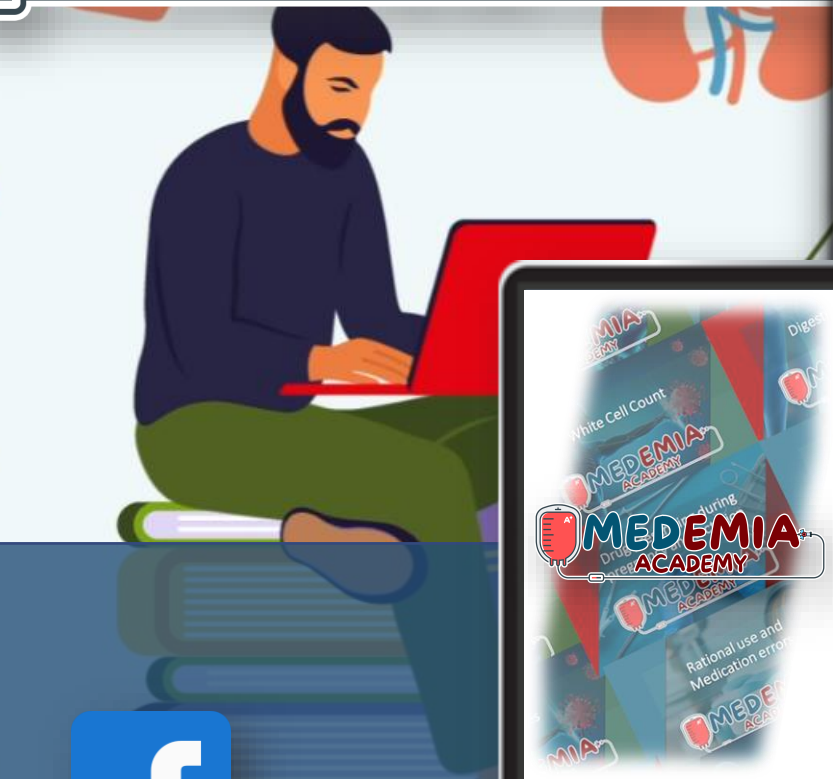


Biochemistry and Medicine



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Objectives

- ❖ To know what is meant by biochemistry.
- ❖ To understand the relationship between biochemistry and the other sciences.
- ❖ To explore the importance of biochemistry in understanding the causes of different diseases.
- ❖ To interrelate between the uses of biochemical testing and diseases.



What is Biochemistry?

- ❖ It is the application of chemistry to the study of biological processes (structure, composition and chemical reactions of substances in living systems) at both the **cellular** (in which organ) and **molecular** (in which organelle) levels.
- ❖ The combination between chemistry, physiology and biology allows investigating the chemistry of living systems by:
 - A. Studying the structure ,behavior and composition of the complex molecules found in biological material.
 - B. The ways these molecules interact to form organelles, cells, tissues ,organs and a whole organism.



Biochemistry and Other Sciences

❖ Biochemistry involves and incorporates with large areas of:

1. **Biology**

2. **Physiology**

3. **Cell biology**

- Gives an idea about the organization of biochemical reactions inside the cell.
- Not all reactions happen in the same organelles of the cell.

4. **Molecular biology**

- Identify the genes particular for producing different proteins.

5. **Molecular genetics**

- Localization of each gene on a chromosome and the effect of the genes around it.



What is Biochemistry? Cont.

❖ Biochemistry **describes:**

- **Origin**
- **Formation**
- **Function**
- **Deficiency**
- **Symptoms**
- All of these descriptions involves the macromolecules (proteins, carbohydrates, fats, nucleic acids, enzymes etc...) and their building units.



What is Biochemistry? Cont.

❖ Types of biomolecules

○ Small molecules:

- Lipid, phospholipid, glycolipid, sterol
- Vitamin
- Hormone, neurotransmitter
- Carbohydrate, sugar

○ Monomers (building blocks of polymers):

- Amino acids
- Nucleotides
- Monosaccharides

○ Polymers:

- Peptides, oligopeptides, polypeptides, proteins
- Nucleic acids, i.e. DNA, RNA
- Oligosaccharides, polysaccharides (including cellulose)



Biochemical Reactions

❖ **Metabolism:** total sum of the chemical reactions happening in a living organism, includes:

A. Anabolism: energy requiring biosynthetic pathways.

B. Catabolism: degradation/ oxidation of fuel molecules and energy production for cellular function.

○ Most of the reactions are catalyzed by enzymes.

○ Both of those processes are coupled together (they aren't separate).

○ Not all the energy produced from oxidizing fuel molecules is utilized in the form of ATP! (~ 60% of energy will be liberated for the maintenance of the body temperature).



Biochemical Reactions cont.

- The primary **functions of metabolism** are:
 - a. Utilization of energy.
 - b. Synthesis of molecules needed for cell structure and functioning (proteins, nucleic acids, lipids, & CHO).
 - c. Removal of waste products.
 - d. Transporting molecules across cell membrane.
 - e. Muscle contraction.
 - f. Transmission of impulses along neurons.



Biomolecules - Structure

Anabolism



Building Block (monomers)	Macromolecule (polymers)
Simple sugar	Polysaccharide
Amino acid	Protein (peptide)
Nucleotide	RNA , DNA
Fatty acid	Lipids

Catabolism



Principles of Biochemistry

- ❖ Cells (**basic structural and functional units of living organisms**) are highly organized and constant source of energy is required to maintain the ordered state.
- ❖ Living processes contain thousands of chemical pathways.
- ❖ The regulation and integration of these pathways are required to maintain life (**Cell economy**).
- ❖ Certain important pathways (**e.g. glycolysis**) are found in almost all organisms both aerobic and anaerobic.
- ❖ All organisms use the same type of molecules (**carbohydrates, proteins, lipids and nucleic acids**).
- ❖ Instructions for growth and reproduction for each organism are encoded in their DNA.



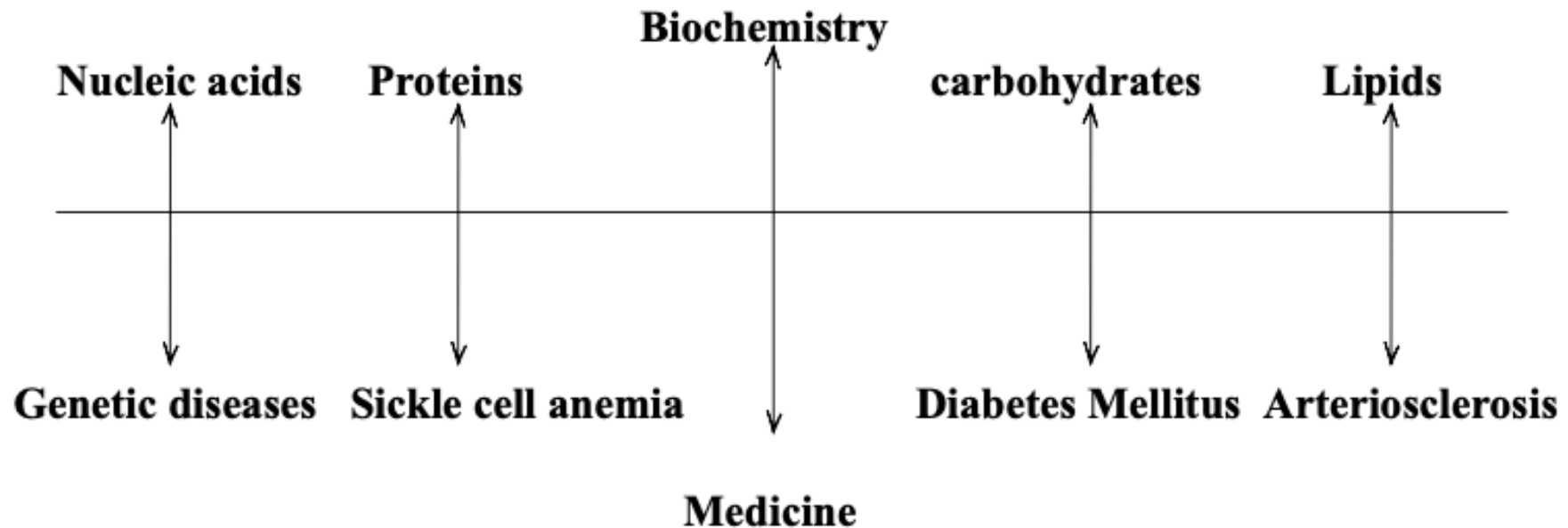
The Aim of Biochemistry

- ❖ Is the complete understanding, at molecular level all the chemical processes associated with living cells.
- ❖ Also, structures and functions, metabolism and its regulation, gene expression modulation and how the life has begun (DNA → RNA → Proteins).
- ❖ To realize these targets, biochemists have to isolate numerous molecules found in cells, determine their structures, and analyze how they function.
 - Many techniques have been used for these purposes as
 - **For Isolation:**
 - Chromatography, electrophoresis and ultracentrifugation.
 - **For Analysis:**
 - Elemental analysis, mass spectrometry and X-ray crystallography.



The Aim of Biochemistry cont.

- ❖ The interrelationship of biochemistry and medicine is a wide two-way street.



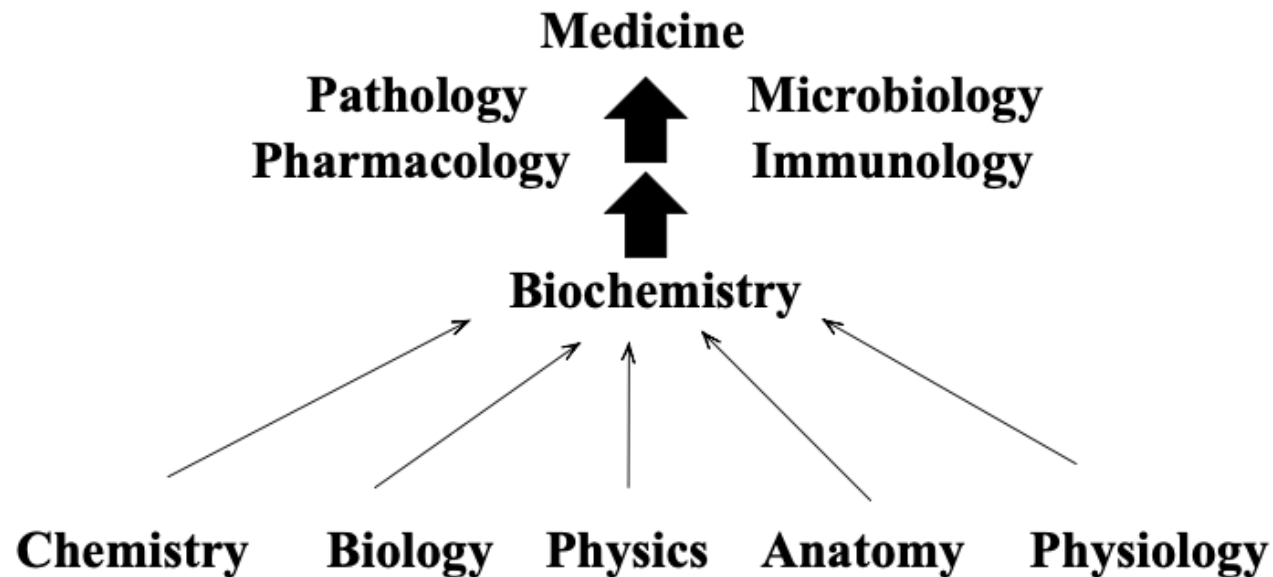
Biochemistry and Life Sciences

- ❖ **Genetics:** nucleic acids, their structures, and functions constitute the core of genetics.
- ❖ **Physiology:** biochemistry overlaps almost completely with physiology (the study of biological processes and functions).
- ❖ **Immunology:** a science that deals with defense mechanisms against diseases, is considered a branch of biochemistry.
- ❖ **Pathology:** biochemistry explains, at the molecular level, the symptoms and pathogenesis of diseases.



Biochemistry and Life Sciences cont.

- ❖ **Pharmacology and toxicology:** advances in these sciences depend primarily on knowledge gained from biochemistry as drugs and poisons are metabolized inside the body in enzyme-catalyzed biochemical reactions.
- ❖ **Biological sciences (microbiology, botany and zoology)** use biochemical approaches in the study of different aspects of these sciences.



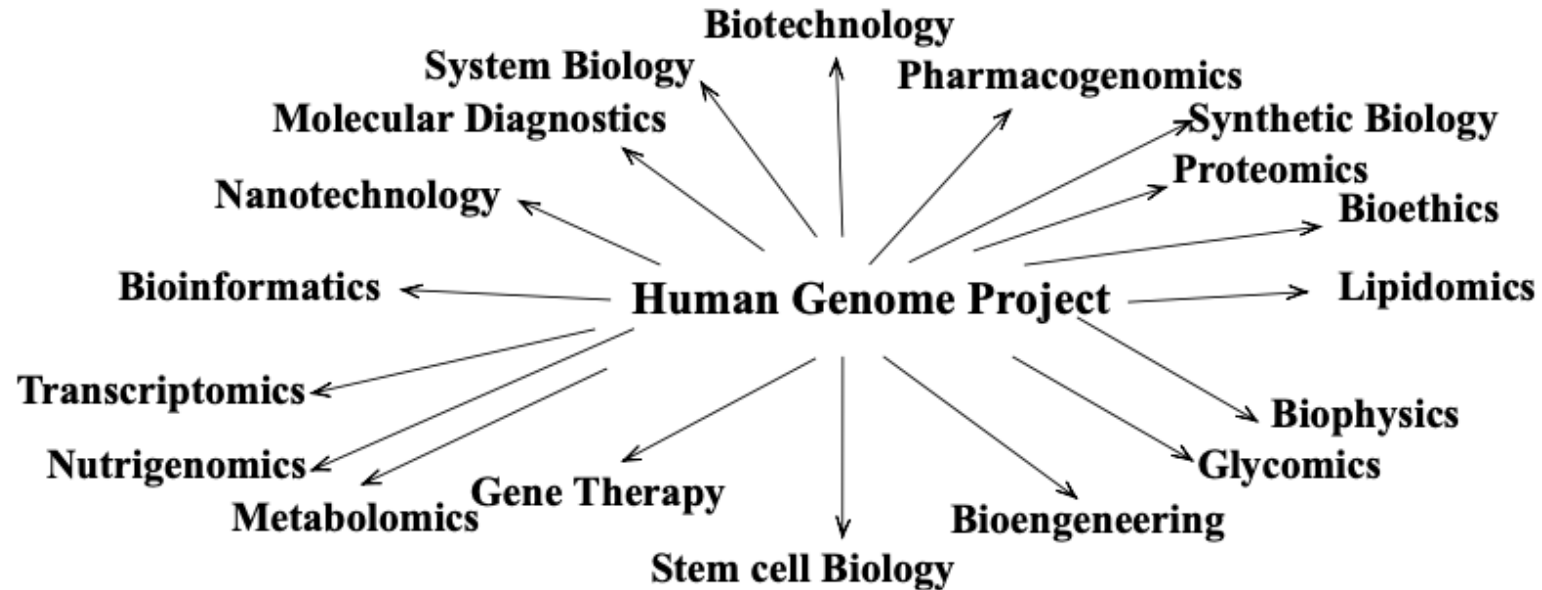
Biochemical Research ,Nutrition and Preventive Medicine

- ❖ Normal biochemical processes are the basis of health
- ❖ World Health Organization (WHO) **definition of health:** situation in which all intra and extracellular reactions that occur in the body are proceeding at rates with maximal survival of the organism in the physiologic state.
- ❖ One major item for the maintenance of health is that there be optimal dietary intake of a number of chemicals; the chief of these are vitamins, certain amino acids, certain fatty acids, various minerals, and water.
- ❖ Because much of the subject matter of both biochemistry and nutrition is concerned with the study of various aspects of these chemicals.
- ❖ Moreover, the systematic attempts to maintain health and prevent disease is called **preventive medicine**.
- ❖ Thus, nutritional approaches depend to a great extent on a knowledge of biochemistry.



Human Genome Project

- ❖ The Human Genome Project (HGP) has influenced many disciplines and areas of research. Biochemistry was underway long before the HGP commenced.
- ❖ However, a number of the disciplines shown (e.g., bioinformatics, genomics, glycomics, lipidomics, metabolomics, molecular diagnostics, proteomics, and transcriptomics) are very active areas of research by biochemists.



Biochemistry and Diseases

- ❖ Most & perhaps all diseases have a biochemical basis (according to the WHO, a disease is a manifestation of abnormal biochemical reactions).
- ❖ Most if not all diseases are manifestations of molecules abnormalities, chemical reactions, or biochemical processes.
- ❖ The major factors responsible for causing diseases in animals and humans are affecting one or more critical chemical reactions or molecules in the body.



Biochemistry and Diseases cont.

❖ The major causes of diseases:

1. **Physical agents:** mechanical trauma, extremes of temperature, radiation and electric shock.
2. **Chemical agents:** including drugs and toxic compounds.
3. **Biologic agents:** viruses, bacteria, fungi, higher forms of parasites.
4. **Oxygen lack:** loss of blood supply, depletion of the oxygen-carrying capacity of the blood, poisoning of the oxidative enzymes.
 - Affects production of energy.
5. **Genetic disorders:** congenital, molecular.
6. **Immunologic reactions:** anaphylaxis, autoimmune disease.
7. **Nutritional imbalances:** deficiencies, excesses.
8. **Endocrine imbalances:** hormonal deficiencies, excesses.



Uses of Biochemical Lab Tests in Relation to Diseases

Use	Example
1. To reveal the fundamental causes and mechanisms of diseases	Demonstration of the causes of genetic defect as in cystic fibrosis
2. To suggest rational treatments of diseases based on 1 above	A diet low in phenylalanine for treatment of Phenylketonuria
3. To assist in the diagnosis of specific diseases	Use of the plasma enzyme creatine kinase MB (CK-MB) in the diagnosis of myocardial infarction
4. To act as screening tests for the early diagnosis of certain diseases	Use of measurement of blood thyroxine or (TSH) in the diagnosis congenital hypothyroidism.
5. To assist in monitoring the progress , e.g: recovery, worsening, remission, or relapse of certain diseases	Use of the plasma enzyme ALT in monitoring the progress of infectious hepatitis
6. To assist in assessing the response of diseases to therapy	Use of measurement of blood CEA in patients who have been treated for cancer colon.



MCQ 1

- ❖ What does the study of genetics concern?
- a. The study of nucleic acids, their structures and functions.
 - b. The study of biological processes and functions.
 - c. The study of defense mechanisms against diseases.
 - d. The study of life and living organisms.



MCQ 1 Answer

❖ What does the study of genetics concern?

- a. **The study of nucleic acids, their structures and functions.**
- b. The study of biological processes and functions.
- c. The study of defense mechanisms against diseases.
- d. The study of life and living organisms.



MCQ 2

- ❖ Which of the following is/ are very active areas of research by biochemists?
- a. Lipidomics and glycomics.
 - b. Pharmacogenetics and genomics.
 - c. Microbiology.
 - d. Zoology and botany.



MCQ 2 Answer

- ❖ Which of the following is/ are very active areas of research by biochemists?
- a. Lipidomics and glycomics.
 - b. Pharmacogenetics and genomics.**
 - c. Microbiology.
 - d. Zoology and botany.



MCQ 3

- ❖ One group of these sciences can lead to the understanding of the basis of biochemistry?
- a. Anatomy, physiology, physics and immunology
 - b. Chemistry, pathology, anatomy and pharmacology
 - c. Chemistry, pharmacology, biology and pathology
 - d. Biology, chemistry, physiology and anatomy
 - e. Biology, immunology, anatomy and microbiology



MCQ 3 Answer

- ❖ One group of these sciences can lead to the understanding of the basis of biochemistry?
- a. Anatomy, physiology, physics and immunology
 - b. Chemistry, pathology, anatomy and pharmacology
 - c. Chemistry, pharmacology, biology and pathology
 - d. Biology, chemistry, physiology and anatomy**
 - e. Biology, immunology, anatomy and microbiology



MCQ 4

- ❖ There is an overlapping between biochemistry and one of the following subjects of science:
- a. Pathology
 - b. Toxicology
 - c. Pharmacology
 - d. Physiology
 - e. Biology



MCQ 4 Answer

- ❖ There is an overlapping between biochemistry and one of the following subjects of science:
- a. Pathology
 - b. Toxicology
 - c. Pharmacology
 - d. Physiology**
 - e. Biology

