



**Cellular and Molecular Biochemistry [FHS1104]**

# **Introduction to Biochemistry**

## **Lecture {1}**

**MBCHB/BDS  
1<sup>ST</sup> YEAR SEM.-1  
2026**

**Yasser Khater**

# DETAILED COURSE CONTENT{OUTLINE}

- **Review of organic chemistry;** basic chemistry , organic chemistry, functional groups and their properties thermodynamics and major chemical reactions.
- **Cellular biochemistry;** cell structure and functions, types of cells , cell organelles, cellular organizations. etc.
- **Acid-Base biochemistry;** definition of acid , base ,buffer, and buffering capacity, **pH** in living organism, the Henderson- Hasebalch equation and its application , Acid-base disorders {**acidosis and alkalosis**}.

# DETAILED COURSE CONTENT{OUTLINE}

- **Carbohydrates;** definition, classification, monosaccharides, disaccharides, oligosaccharides and polysaccharides structures & functions and examples of each, chemical reactions of sugars (reducing properties and optical activities) and nomenclature of sugars.

# DETAILED COURSE CONTENT{OUTLINE}

➤ **Lipids;** definition of lipids, classification of lipids compounds, functions of lipids, **Fatty acids**, nomenclature of fatty acids and carbon chain numbering, structure of **triacylglycerol**, Phospholipids, Sphingolipids, Lipoproteins and **steroids** compounds.

# DETAILED COURSE CONTENT{OUTLINE}

➤ **Proteins;** constituents of proteins: structure of **amino acids** and chemical properties, amino acid classification, chemical **reactions** of amino acids and formation of **peptide bonds**, levels of protein organization, primary, secondary, tertiary and quaternary structures) and examples of each. **3-D** conformational structures of proteins e.g. **myoglobin and haemoglobin**, protein folding and denaturation. Biological functions of proteins, globular **conjugated** proteins, fibrous ...etc.

# DETAILED COURSE CONTENT{OUTLINE}

**Collagen;** types, structure, synthesis and strength.

**Elastin;** structure, function and differences.

**Proteoglycans;** and muscle movement.

# DETAILED COURSE CONTENT{OUTLINE}

➤ **Nucleic acids;** Structure of DNA and RNA, different forms of DNA molecules, types of nitrogen bases in DNA/RNA,( purine and pyrimidine bases), **level of organization** of DNA molecules, Nucleosomes and histones,

# DETAILED COURSE CONTENT{OUTLINE}

➤ **Enzyme;** definition, classification and general characteristics. Enzyme **kinetics** and **inhibition**: competitive, non-competitive inhibitors and un-competitive; **Michaelis- Menten** equation , **factors** that affect enzymatic (activities )/reaction rates: such as substrate concentration, enzyme concentration, temperature, **pH**. Allosteric effectors, cofactors, inhibitors. **Regulation** of enzyme activity.



# DETAILED COURSE CONTENT{OUTLINE}

Co-enzymes and their roles in enzyme catalysis.  
mechanisms of enzyme catalysis: acid base catalysis;  
covalent catalysis; metal ion catalysis. Examples:  
lysozyme, ribonucleases A, carboxy-peptidase ,  
Chymotrypsin...etc.

# DETAILED COURSE CONTENT{OUTLINE}

➤ **Vitamins** , classification of vitamins ,water soluble vitamins ,vitamin C and vitamins B derivatives ,fat soluble vitamins, vitamin A,D,E and K , properties of vitamins , structures and functions of vitamins ,hypervitaminosis and their treatment, vitamins as antioxidant.

➤ **Porphyrins**; Structure and functions of porphyrins, examples of Porphyrin containing compounds; cytochromes, haemoglobin.

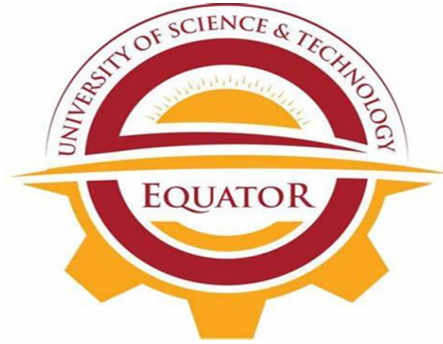
# Course Objectives / Competences:

At the end of this course the student **should be able to:**

- Describe the basic structures of **important biomolecules** in the cell
- Describe the classification of the **various biomolecules** in the cell.
- Identify the structures of common **biomolecules** and their relationship to **biological functions**.
- Explain the **biochemical** functions of the various **biomolecules** in a living cell or organism.

# Course Objectives/ Competences:

- Describe the classification of **enzymes**, properties of enzymes and enzyme catalysis.
- Discuss **enzyme kinetics** and **inhibition**.
- Describe **water-soluble (B- derivatives )** vitamins as coenzymes and their role in enzyme catalysis.
- Discuss the structure-function **relationship** of connective tissues and muscle tissues.



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# Introduction to Biochemistry

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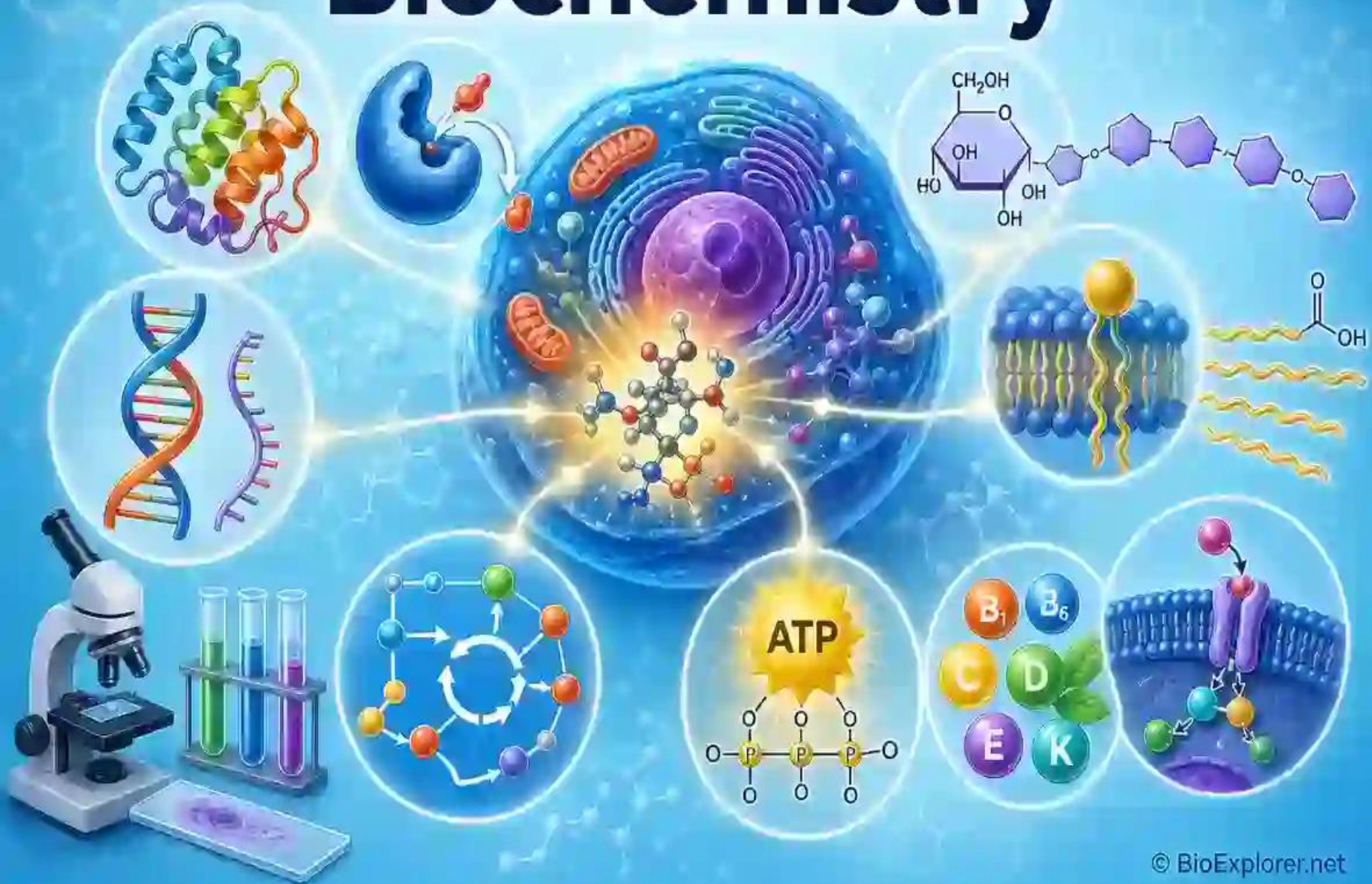
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# **What is Biochemistry?**

## **Definition:**

**Biochemistry:** is science concerned with the study the chemical basis of life. (Gk bio “life”). It seeks to understand the relationship between the structure and function of the ( **bio molecules**) that make up living organisms and their reactions.

# Biochemistry





# **What Does Biochemistry Study?**

# What Does Biochemistry Study?

Biochemistry studies the molecules and chemical reactions that allow cells and organisms to function. It explains how life depends on energy flow , molecular structure, chemical bonds, enzyme activity, and controlled reaction pathways.

# **What Does Biochemistry Study?**

- ✓ **Part I: Structural Biochemistry ( study of chemical constituents of cell ).**
- ✓ **Part II: Metabolic Biochemistry (is the sum of chemical reactions that happen in cells)**
- ✓ **Part III: Genetics and molecular biology study of central dogma of molecular biology ... etc.**

**What is major objective of biochemistry**

# What is major objective of biochemistry

- ✓ To complete understanding, **all** the chemical processes associated with **living organism**, at the molecular level.
- ✓ To assist in the **diagnosis** of diseases.
- ✓ To suggest the **treatment** of diseases.

# What is major objective of biochemistry

For the complete understanding of chemical processes associated with **living cells**, numerous **Biomolecules** found in cells should be **isolated or tracked**, to determine their **structures**, and analyze how they **functions**.

# BIOMOLECULES

# **Biomolecules**

## **➤ Macromolecule**

**1- Carbohydrates**

**2- Proteins**

**3- Lipids**

**4- Nucleic acids**

## **➤ Micro molecules**

**1- Glucose**

**2- Amino acids**

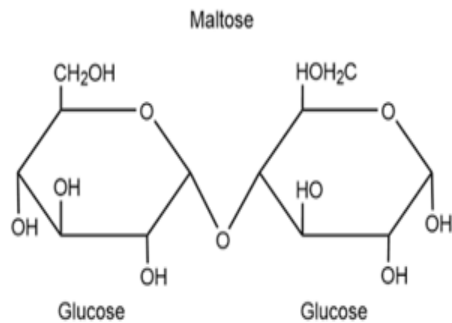
**3- Vitamins**

**4- Minerals**

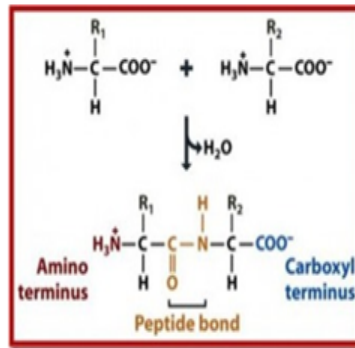


# Biomolecules

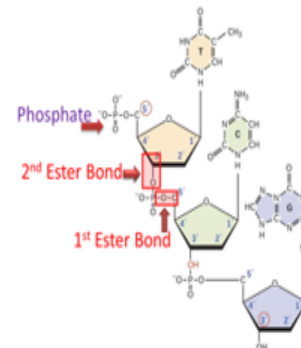
## Carbohydrates



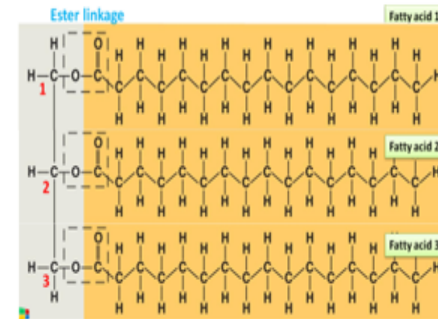
## Proteins



## Nucleic acids



## Lipids



### Monomers

Monosaccharides  
joined by  
glycosidic bond

Amino acids  
joined by peptide  
bond

Nucleotides joined  
by phosphodiester  
bond

Fatty acids and  
glycerol joined by  
ester bond

### Examples

Starch, Cellulose

Insulin, Collagen

DNA, RNA

Fats, Oils, waxes

### Elements

C, H, O

C, H, O, N, S

C, H, O, N, P

C, H, O

### Functions

Energy source  
Structural  
component  
Reserve food

Enzyme, structure  
movement,  
defence hormones

Stores genetic  
information

energy source,  
insulation, membrane  
components,  
hormone

# Macromolecules:

Are very **large** molecules essential for life. They are built by joining many small units called **monomers** together into long chains called **polymers**(created by **polymerization** of smaller subunits). **Most** biological macromolecules are made up of carbon, hydrogen, oxygen, nitrogen, and other elements.

In biochemistry, macromolecules are:

Carbohydrates, Lipids, Proteins and Nucleic acids

## Micromolecules:

Are molecule of relatively **low** molecular weight.

Monomers are considered as micromolecules that can be linked together to form **polymer**.

example of micromolecules.

- Organic substances like **Vitamins**
- Inorganic compounds like **minerals**

# What Are Micronutrients?

## 13 Vitamins

### Water Soluble

Vitamin C  
B1 Thiamin  
B2 Riboflavin  
B3 Niacin  
B5 Pantothenic Acid  
B6 Pyridoxine  
B7 Biotin  
B9 Folate  
B12 Cobalamin

### Fat Soluble

Vitamin A  
Vitamin D  
Vitamin E  
Vitamin K

## 16 Minerals

Calcium  
Chloride  
Chromium  
Copper  
Fluoride  
Iodine  
Iron  
Magnesium

Manganese  
Molybdenum  
Phosphorus  
Potassium  
Selenium  
Sodium  
Sulfur  
Zinc

## **Micromolecules: Organic substances**

Vitamins – are essential for normal metabolism, growth and development, and regulation of cell function. Vitamins are **either** fat soluble or **water-soluble**. Water soluble vitamins include **Vitamin B** and C. Fat soluble vitamins are Vitamin A, D, E and K

# Micromolecules: Inorganic compounds

Minerals – are found in ionized form in the body. They are further classified **into** macro- minerals and micro- minerals (or trace minerals).

1. **Macro- minerals** present in the body include Calcium, Potassium, Iron, Sodium and Magnesium. **Macro- minerals are needed in more amounts**, as compared to micro-minerals.
2. **Micro- minerals** include Copper, Zinc and Fluoride, are needed only **in minor quantities**.

(Approximately **4%** of the body's mass consists of minerals.)



They are classified in to two categories depending on their molecular weight and solubility.

### **Micromolecules**

- They are small sized chemicals.
- They have low molecular weight, higher solubility and simple conformation.
- Micromolecules include water, minerals, gases, sugars, amino acids and nucleotides, secondary metabolites.

### **Macromolecules**

- They are large sized complex chemicals.
- They have high molecular weight, low solubility, and complex conformation.
- They are formed by the polymerization of micromolecules or organic molecules.
- Ex.- Proteins, Nucleic Acid, Lipids, Polysaccharides.

# Biochemistry as basic biomedical science:

What happens if we have **imbalance** or disturbance of normal biomolecules..... ?

✓ **Answer is Disease.**

- **Health** depends on a harmonious balance of chemical constituents and biochemical reactions occurring in the body.
- **Disease** reflects **abnormalities** in biomolecules, biochemical reactions, or biochemical processes.



# Why is Biochemistry important?

In medicine Health Core  
(diagnose and treat diseases)

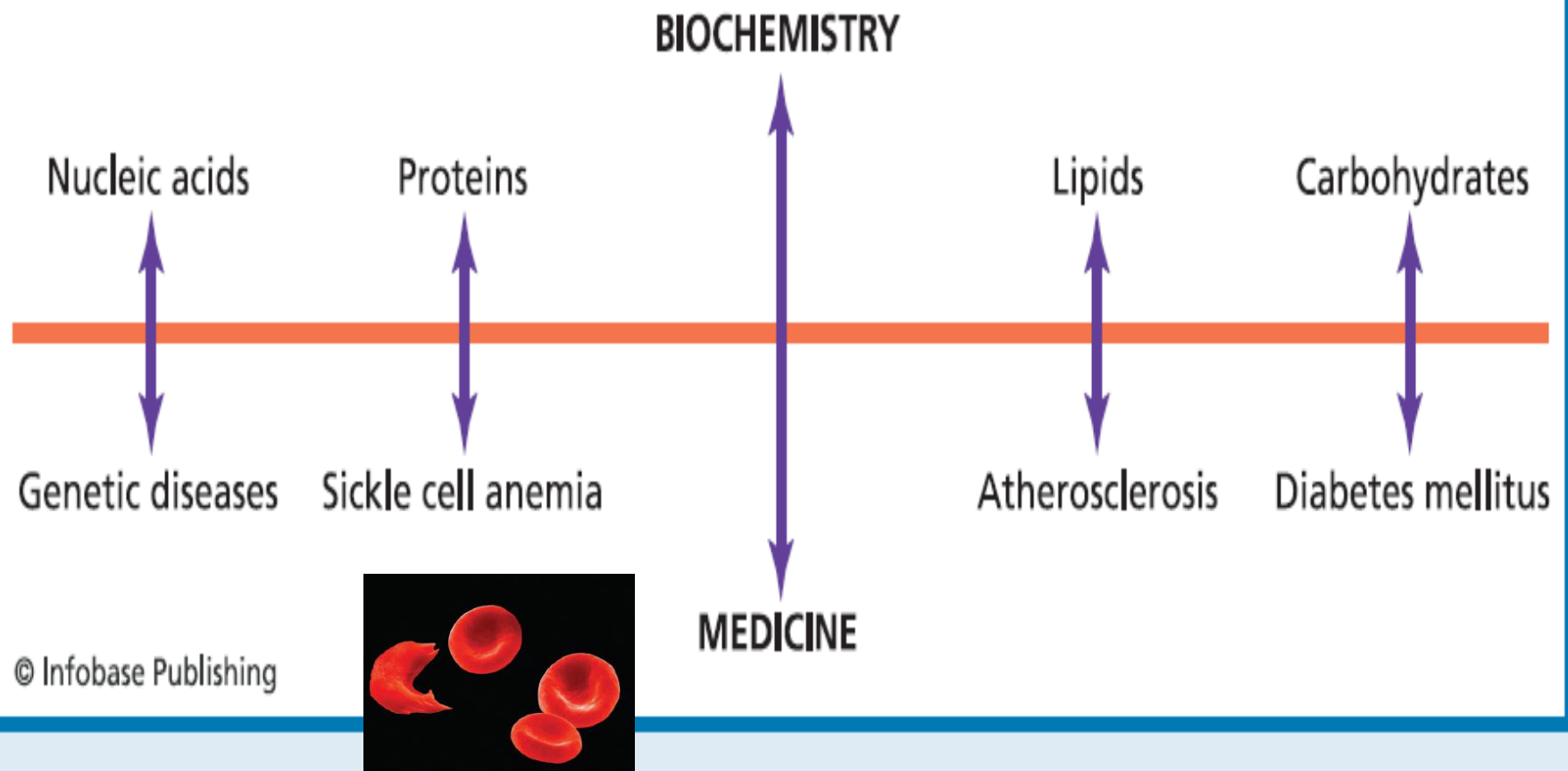
In biotechnology  
vaccine development  
genetic testing

Genetics (personalized  
medicines)

Pharmaceuticals  
(drug development)

# Why is Biochemistry important?

- Biochemistry is important because it explains how life works at the chemical level. Every organism **depends on** biochemical reactions to use energy, build cells, repair damage, respond to the environment, and pass information to the next generation.
- In **medicine, biochemistry** helps scientists understand **disease mechanisms**, blood chemistry, hormones, enzymes, **genetic disorders**, nutrition, cancer biology, immune responses, and drug action. Many diagnostic tests **measure** biochemical **markers** in blood, urine, tissues, or cells.



**Figure 1.1** The relationship between biochemistry and medicine is illustrated above. Medical researchers attempt to find cures for the diseases shown in the bottom half of the diagram by investigating the molecules shown in the top half.

# Why is Biochemistry important?

In **biotechnology**, biochemistry supports protein and enzyme design, vaccine development, **genetic testing** and drug discovery,....etc.

In **Pharmacology** , biochemistry is foundation allows pharmacist to discover how drugs interact with specific cell targets, **how** the body processes medications, and **how** to design safer, more effective treatments.

# Why is Biochemistry important?



# Biochemistry as a Basic Biomedical science:

Life is based on **chemical reactions** in living cells.

We want to know these reactions, the reacting molecules, their nature, properties, in which form we **get** them from the environment, how do they **gain** access to our cells, their effect on cell **growth** and cell **division** and **differentiation**.....all activities of living organisms.. thinking.. emotions...etc.

# Biochemistry and Other Biomedical sciences:

Because human body depends on biochemical reactions and processes, understanding of most of biomedical sciences (Physiology , Nutrition, Pharmacology, Toxicology, Pathology, Microbiology and Medicine) rely on adequate knowledge of Biochemistry.

## References:

- 1-lipincotts biochemistry 8<sup>th</sup> edition 2022**
- 2. Harpers 25<sup>th</sup> , 27<sup>th</sup> and 32<sup>nd</sup> edition 2023**
- 3- Lehninger principles biochemistry 8<sup>th</sup> edition 2021**
- 4- Medical biochemistry 6<sup>th</sup> edition 2023**
- 5- Mark Basic Medical biochemistry 6<sup>th</sup> edition 2023**
- 6- Stryer biochemistry**



