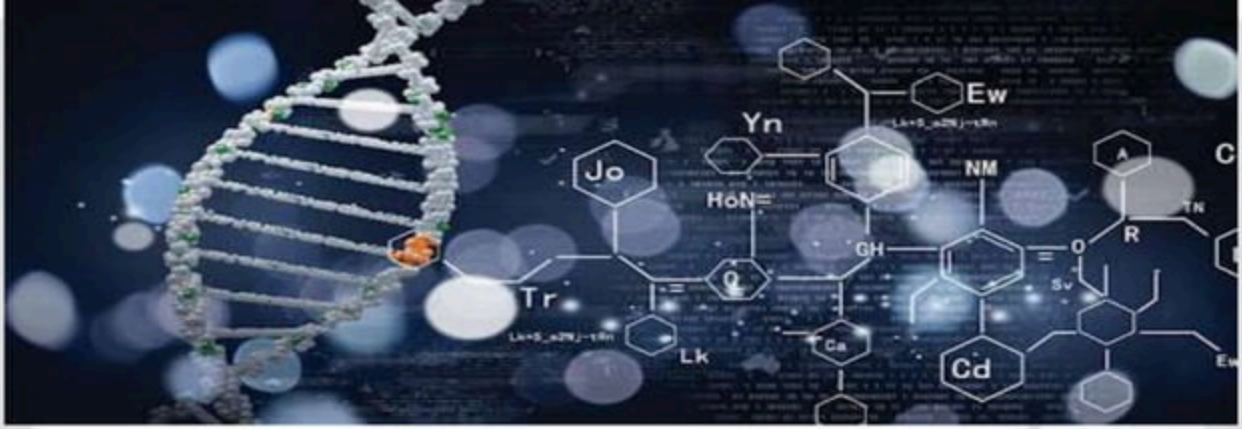


INTRODUCTION TO BIOCHEMISTRY

SUBMITTED BY: LUBYINA KHAN

CONTENTS

BIOCHEMISTRY

- The term biochemistry is derived from Greek word "bios" which means life.
- Biochemistry is defined as the science which deals with the chemical basis of life.
- It relates with the chemical constituents of living cells as well as their reactions and other processes.

AIMS OF BIOCHEMISTRY

Biochemistry provides important understandings and practical applications in medicine, agriculture, nutrition and industry. Its ultimate concern is with the wonder of life itself.

1) To explain biological structure and function in chemical terms.
2) To provide a complete understanding of all of the chemical processes associated with living cells at the molecular level.

AIMS OF BIOCHEMISTRY

3) To isolate the several molecules found in cells by using salt fractionation, chromatography, electrophoresis and ultracentrifugation.

- Salt fractionation is precipitation of proteins with ammonium sulfate.
- Chromatography are of many types e.g. paper chromatography, ion exchange chromatography, thin layer chromatography, gas liquid chromatography, high pressure liquid chromatography, gel filtration chromatography.

AIMS OF BIOCHEMISTRY

- Electrophoresis techniques are of many types e.g. paper, high voltage, agarose, cellulose acetate, starch gel, polyacrylamide gel.
- Ultracentrifugation is the separation of liquid phase from solid phase at high speed.

AIMS OF BIOCHEMISTRY

4) To determine the structures of several molecules by using elemental analysis, spectroscopy, x-rays crystallography.

- Elemental analysis is done for quantification of carbon, hydrogen nitrogen and Sulphur. Spectroscopy is done by using UV, visible, infrared and NMR spectroscopy.
- X-rays crystallography is done for the study of 3 dimensional arrangements of the atoms.

IMPORTANCE OF BIOCHEMISTRY

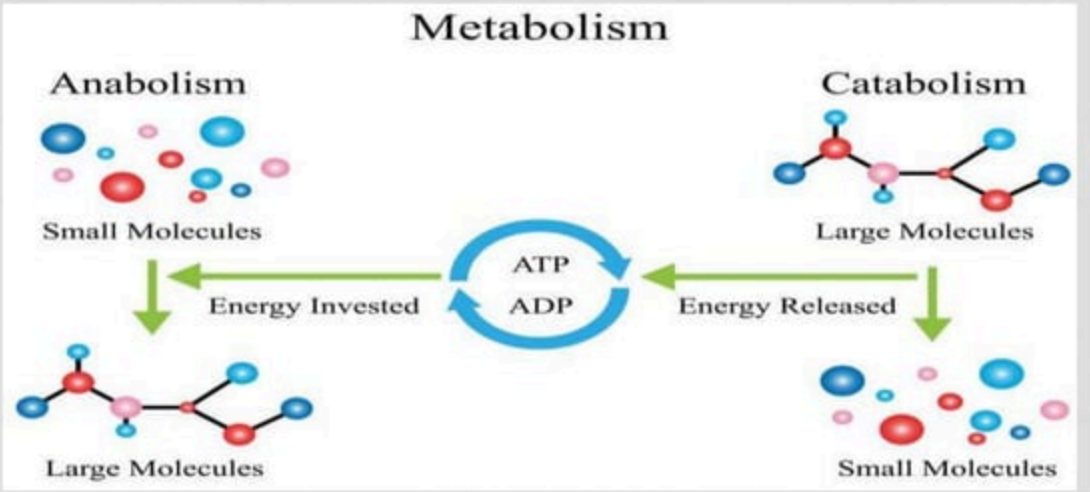
- Knowledge of biochemistry is important for all life sciences because life depends on biochemical reactions and processes.
- Knowledge of biochemistry is important for pharmaceutical sciences i.e. for physiology, immunology, pharmacology, toxicology, pathology etc.

BASIC BIOCHEMICAL PRINCIPLES

- **Catabolism:**
- It is the process of breakdown of complex molecules (proteins, polysaccharides, lipids, etc.) to the simpler molecules (CO_2, NH_3 & H_2O), accompanied by the synthesis of ATP.
- **Anabolism:**
- It is the process of biosynthesis of complex molecules (lipids, proteins, polysaccharides, etc.) from the simple precursor molecules (Acetyl CoA, Amino acids, Glucose, etc.), accompanied by utilization of energy.

BASIC BIOCHEMICAL PRINCIPLES

- **Metabolism:**
- The sum of catabolism and anabolism within the cells and tissues called metabolism.



BASIC BIOCHEMICAL PRINCIPLES

Pathways:

- In the cell, anabolism and catabolism rarely occur in a single step. These reactions are usually organized in multistep sequence called pathways. These pathways are called either anabolic pathways or catabolic pathways depending upon the ongoing process. Collectively, these pathways are called metabolic pathways.

BASIC BIOCHEMICAL PRINCIPLES

Principal ingredients of our dietary food:

- Humans are heterotrophs. They can synthesize their organic food only from other organic materials that they obtained from autotrophs. Principal ingredients of dietary food are carbohydrates, fats, proteins etc. Digestion of their dietary food occurs in three stages.

BASIC BIOCHEMICAL PRINCIPLES

Stage 1: Digestion of complex dietary fuel to their monomer units, which absorb from the gut e.g.

i) Carbohydrates convert into their respective monosaccharide.

ii) Proteins convert into their respective amino acids.

iii) Fats convert into their respective fatty acids.

Stage 2: Conversion of monomer units into simple molecules within the cells. Here, all monomer units include monosaccharides, amino acids and fatty acids converted into common breakdown product called Acetyl CoA.

BASIC BIOCHEMICAL PRINCIPLES

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Stage 3: Simple molecule like Acetyl CoA can either be catabolized to carbon dioxide and water or again anabolized to form the precursor monomer molecules. This stage also called amphibolic pathway.

ROLE OF PHARMACEUTICAL BIOCHEMISTRY IN HEALTH PROFESSION

- There is a mutual relationship exist between health profession and pharmaceutical biochemistry. The basic aims of health profession are to get the understanding and maintenance of health as well as to get the understanding and effective treatment of diseases.
- Biochemistry clarifies the both aspects of health and disease. Conversely, the study of various aspects of health and disease opened the new areas of biochemistry.

ROLE OF PHARMACEUTICAL BIOCHEMISTRY

- Example:
- Knowledge of protein structure and function is necessary to elucidate the single biochemical difference between normal hemoglobin and sickle cell hemoglobin. On the other hand, analysis of sickle cell hemoglobin helps us to understand the structure and function of both type of hemoglobin.

ROLE OF PHARMACEUTICAL BIOCHEMISTRY

What is health?

- According to WHO, health is a state of complete physical, mental and social well-being and not only the absence of disease.
- From biochemical point of view, health is a state in which all intra and extracellular reactions of the body occur at rates, appropriate with the organism's maximal survival in the physiologic state.

ROLE OF PHARMACEUTICAL BIOCHEMISTRY

What is disease?

- A disease may be abnormalities of biomolecules, chemical reactions or of biochemical processes. The major factors that are responsible for causing diseases in humans may be physical, chemical, biological, lack of oxygen, genetic, immunologic, nutritional, endocrine etc.

1. Physical agents including mechanical trauma, extremes of temperature, sudden changes in atmospheric pressure, radiation, electric shock.

ROLE OF PHARMACEUTICAL BIOCHEMISTRY

2. Chemical agents, including drugs, certain toxic compounds, therapeutic drugs, etc.

3. Biologic agents including viruses, bacteria, fungi, higher forms of parasites.

4. Lack of oxygen including loss of blood supply, depletion of the oxygen-carrying capacity of the blood, poisoning of the oxidative enzymes.

5. Genetic disorders: Congenital, molecular.

ROLE OF PHARMACEUTICAL BIOCHEMISTRY

6. Immunologic reactions: Anaphylaxis, autoimmune disease.

7. Nutritional imbalances: Deficiencies, excesses. 8. Endocrine imbalances: Hormonal deficiencies, excesses.

These factors affect on important biochemical reactions as well as on biomolecules.

NATURE OF BIOCHEMICAL REACTIONS

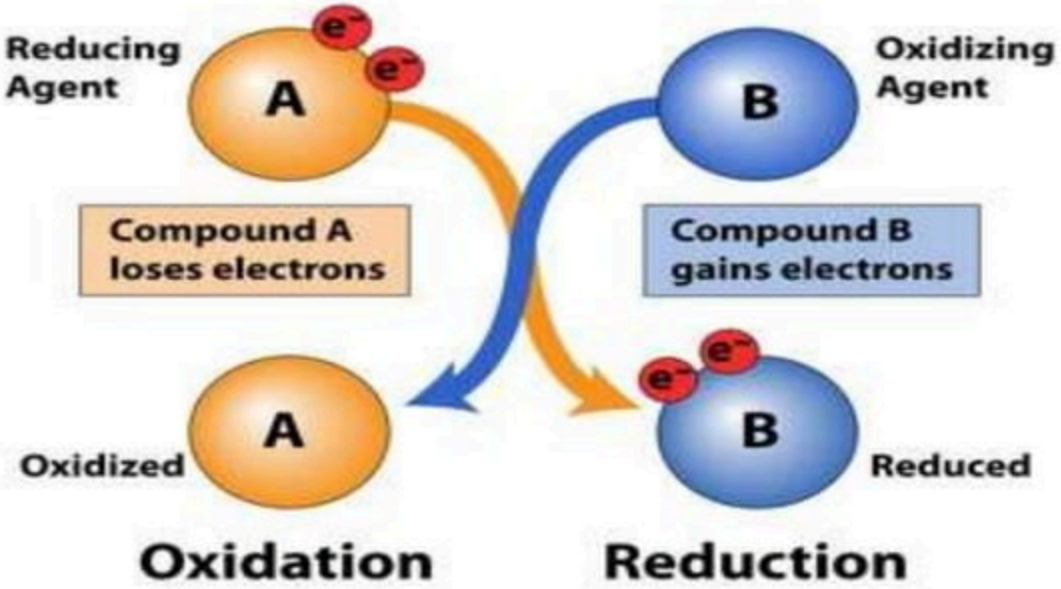
- Biochemical reactions are the complicated form of organic reactions in the living organisms. Living organisms have enzymes that accelerate the rate of these reactions. Although there are many possible biochemical reactions, they fall into only a few types.

NATURE OF BIOCHEMICAL REACTIONS

- **1. Oxidation-Reduction Reactions**

- When a biochemical reaction results in the loss of electrons it is called an oxidation reaction. When electrons are gained in a reaction it is a reduction reaction.
- Oxidations and reductions always go together since electrons are passed from one molecule to another. Such coupled reactions are referred to as **redox reactions**.
- The metabolic processes of the human body like **Glycolysis, Kreb's Cycle, and Electron Transport Chain** involve the transfer of electrons by redox reactions.

NATURE OF BIOCHEMICAL REACTIONS



NATURE OF BIOCHEMICAL REACTIONS

2. Reactions involving movement of functional groups within or between molecules:

For example, the transfer of phosphate groups from oxygen atom of one molecule to the oxygen atom of other molecule.

Glucose + ATP  ***Glucose 6-Phosphate + ADP***

NATURE OF BIOCHEMICAL REACTIONS

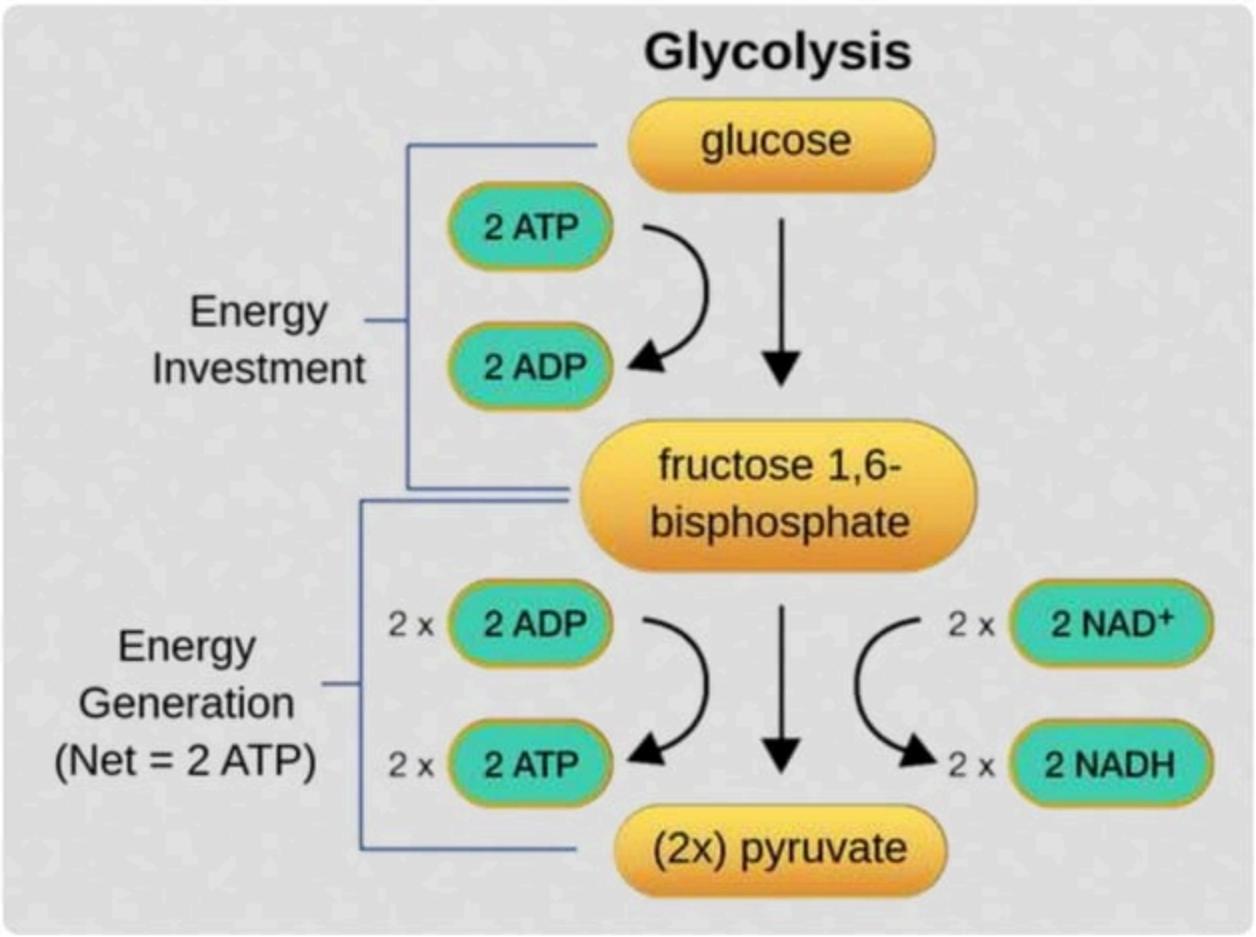
3. Reaction involving the addition and removal of water:

For example, breakdown of amide linkage in to amine and a carboxyl group.

Asparagine + H2O  ***Aspartic acid + NH3***

4. Bond-breaking reactions:

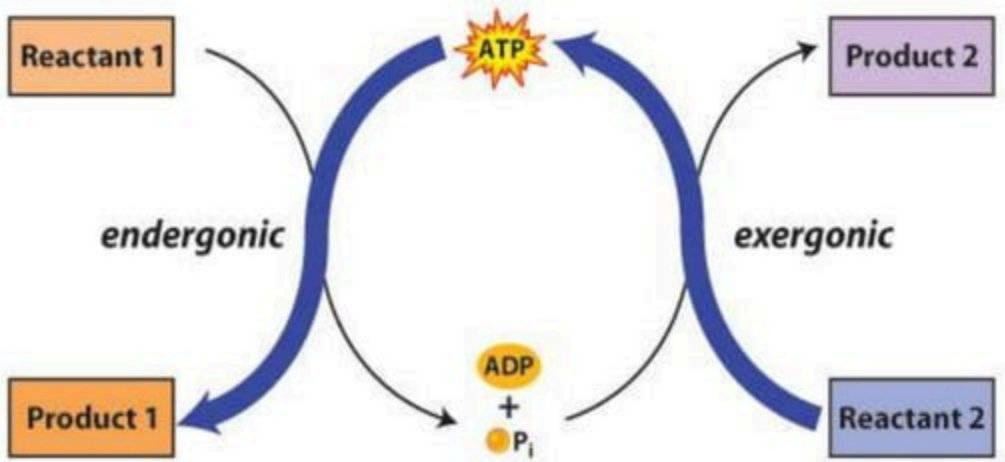
For example, carbon-carbon bond breakage. A reaction of glycolysis e.g. breakdown of **F1,6-biphosphate to glyceraldehydes-3-phosphate & dihydroxyacetone phosphate**


Glycolysis
glucose
2 ATP
2 ADP
Energy Investment
fructose 1,6-bisphosphate
2 x
2 ADP
2 x
2 NAD+
Energy Generation (Net = 2 ATP)
2 x
2 ATP
2 x
2 NADH
(2x) pyruvate

NATURE OF BIOCHEMICAL REACTIONS

- **Regulation of biochemical reactions**:
- Biochemical reactions should not go too fast or too slow. These reactions should occur at required state for proper functioning of the cell. That is why there is a very good regulation system for these reactions.
- **Exergonic and endergonic reactions:**
- Reactions that produce the energy are termed as exergonic reactions and the reactions that require energy to initiate the reaction are known as endergonic reactions.

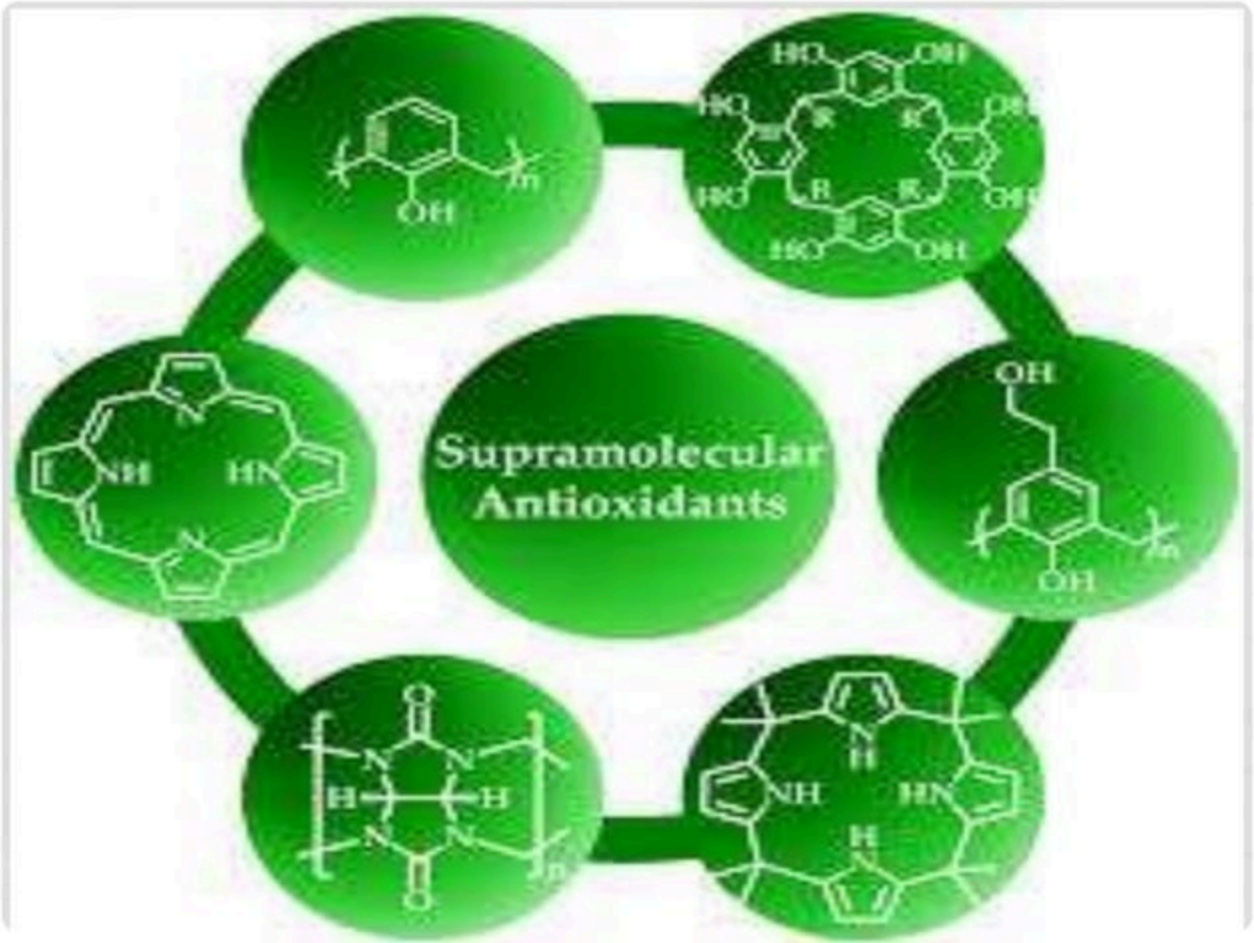
NATURE OF BIOCHEMICAL REACTIONS



NATURE OF BIOCHEMICAL REACTIONS

Supra-molecules:

- Macromolecules that are linked with each other by non-covalent bonds are called supra-molecules
- Example: Complex of nucleotides and peptides (DNA and Proteins).
- Supra-molecules further assembled into cell organelles.


Supramolecular
Antioxidants
OH
HO
OH
HO
R
R
HO
R
R
HO
OH
NH
HN
OH
N
N
H
H
N
N
O
O
n
NH
HN
H
N

NATURE OF BIOCHEMICAL REACTIONS

Elemental composition of human body:

- More than 99% mass of human body is made up of six nutrients that are carbon, oxygen, hydrogen, nitrogen, calcium and phosphorous.

Normal chemical composition of human body:

- Chemical composition of normal human body is water 60-70%, proteins 15%, lipids 15%, carbohydrates 2% & minerals 8%.

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