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Foundations of Biochemistry: An Overview

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ABSTRACT

Good knowledge of biochemistry helps us understand several other concepts related to our life processes. The branches of biochemistry lay the foundation of various sub-disciplines of medicine, chemistry, and biology. Biochemistry is a discipline of Chemistry that deals with the chemical composition of living organisms. It deals with interactions between living organic cells and their surrounding fluids/matter and is the study of important chemical processes occurring within living organisms. In this study the researcher has made an attempt to study the branches of Biochemistry. It also studies the scope and importance of Biochemistry. Moreover the study focuses on the foundations of the biochemistry.

KEYWORDS: *Medicine, Chemistry, Biology, Chemical Processes*

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INTRODUCTION

Biochemistry, in simple terms, can be defined as a vast branch of science that combines both Biology and Chemistry. It is a study focussing on the life processes of living organisms at both biological and chemical levels. The topic holds a lot of significance in the day-to-day life of every living thing. In simple terms, biochemistry can also be called "the chemistry of everyday life". Biochemistry also deals with the functions and structure of biomolecules such **as** proteins**,** carbohydrates**,** lipids, etc. We know for a long time that, biochemistry deals with the living beings' in a wide range of species, from prokaryotes to eukaryotes. As said Berg and co-authors in their book, "Are we ready now our journey into biochemistry that begin more than 3 billion years ago?". So, what is that biochemistry?" Biochemistry is a wonderful and charming body of knowledge (or knowledge of body), and is greatly influencing all living fields (Brewster, J.H. 1986). According to Biochemical Society, "Biochemistry explores the chemical processes within and related to living organisms. He Chemistry of Life" concentrates on handles with happening at a molecular level that, what's happening inside the living cells and organelles, studying components like proteins, enzymes, lipids, carbohydrates, DNA, and RNA". Biochemistry contains in a very broad range of scientific disciplines, including molecular biology, genetics, physiology, microbiology-virology, forensics, animal and plant sciences and medicine. Some chemical, physical and physico-chemical rules play important roles in biology of living systems which make regulation from complex city. If we want to make "chemistry of LIFE" understandable, we first need to have knowledge about atoms, elements, bonds, and functional groups of organic chemistry, the physical chemistry of kinetics, kinetics of enzyme, and equilibria and homeostatic balance. Magic of life is meaningful with miracles that only can be explained with biochemistry (Barta, N.S. & Stille, J.R. 1994).

Objectives: The present study has been undertaken with the following objectives-

- To study the branches of Biochemistry
- To discover the scope and importance of Biochemistry.
- To study the foundations of Biochemistry.

Significance of the Study:

Biochemistry is the study of structures and the interactions of biological macromolecules. These macromolecules include protein, nucleic acids, lipids,

and carbohydrates present in your body. As a result, Biochemistry is being used in research related to botany, medicine, and gene enhancement. Biochemistry is now working on finding the secret of life and how biological molecules boost the processes that occur within the living cells. This study will help in understanding the whole working organism.

Branches of Biochemistry:

Due to the continuous progress in Biology, Chemistry, and Physics, the branches of biochemistry are growing diversely and vastly. The significant branches include:

Molecular Biology

- This scientific discipline attempts to study and analyze the processes in living organisms from a molecular level.
- The branch is often considered as the 'root of biochemistry'.
- The branch aims to study and investigate in detail the biochemical, metabolic cycles in living beings, the integration-disintegration of molecules, thereby understanding the functions of the living systems.
- The field focuses on analyzing the behavior, interactions of biological macromolecules like DNA, RNA, Proteins, enzymes, hormones, etc., and their synthesis within the cells, thereby explaining the biological living functions of organisms at the molecular level.

Cell Biology

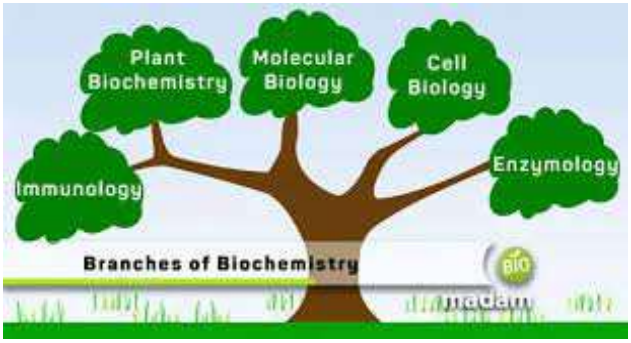
- The branch deals with the structure and functions of cells in living organisms. The cell biology branch of biochemistry is also called Cytology.
- An area that focuses on studying the morphology and psychology of eukaryotes and prokaryotes at the cellular level.
- The study reveals the properties, functions, structure, biochemical composition, the lifecycle of cells in organisms.
- Cell biology is essential to understand the intrinsic cellular processes that cells carry out during their life cycle, like respiration, nutrition, cell division, synthesis of compounds, defense mechanisms, cell death, etc.
- The branch is closely associated with fields like physiology, histology, and microbiology.

Genetics

- Genetics, an important branch of biochemistry focuses on the study of genes, their mutations/variations, and the characteristics of heredity in living organisms.
- Here, the structure, function, variation, and distribution of genes are studied within the context of the cell, the organism, and the population.
- Genetics is a broad field, having several subfields like molecular genetics, population genetics, and epigenetics.
- Molecular genetics and genetic engineering are fields under biochemistry and molecular biology that study genes, heritage, and expressions.

Metabolism

- Metabolism is one of the most essential and fundamental processes taking place in living beings. It refers to the series of activities that happen in the body when food gets converted into energy.
- The process involves many interconnected cellular pathways to provide cells with the required energy to carry out their functions.
- Metabolism can be the array of biochemical processes that take place in living beings. It includes both anabolisms or builds up of substances and catabolism or breakdown of substances.



Other major branches of biochemistry include:

- Animal and Plant Biochemistry
- Biotechnology
- Molecular Chemistry
- Genetic engineering
- Endocrinology
- Neurochemistry
- Immunology
- Virology
- Chemotaxonomy
- Xenobiotics
- Nutrition
- Environmental Biochemistry
- Toxicology

Scope of Biochemistry

Biochemistry is the study of life; hence the scope it offers is as broad as life itself. The field has seen unprecedented growth, especially in the present times. Biochemistry offers a lot of scope in fields like:

1. **Medical Sciences:** There is a huge scope in areas like pathology, immunology, pharmacy, vaccine development, etc. People can also find a job as Biochemists, lab assistants, medical transcriptionists, clinical coordinators, marketing executive**s** after having relevant degrees in any field of biochemistry. Another advanced scope of biochemistry is in **Genetic Engineering or Recombinant DNA Technology**.
2. **Agriculture**: Plant biochemistry offers enormous scope. Students of this branch can become **agricultural scientists** and develop agricultural crop variants that are high-yielding and disease-resistant. Knowledge of biochemistry can also help in setting up own farms or nurseries.
3. **Food Industry**: Nutritionists and **dieticians** help in monitoring and regulating the nutrient richness in the body. These roles have an enormous scope, especially in today's world where everyone is leading a sedentary lifestyle. Being a Food analyst or a Food security officer are other job prospects in this area.
4. **Academics and Research**: The field offers plenty of research opportunities. Every area underneath biochemistry is worth learning and researching.

FOUNDATIONS OF BIOCHEMISTRY

Cellular Foundations the unity and diversity of organisms become apparent even at the cellular level. The smallest organisms consist of single cells and are microscopic. Larger, multicellular organisms contain many different types of cells, which vary in size, shape, and specialized function. Despite these obvious differences, all cells of the simplest and most complex organisms share certain fundamental properties, which can be seen at the biochemical level *(Roberts, K., & Walter, P. 2002).*

Chemical Foundations Biochemistry aims to explain biological form and function in chemical terms. As we noted earlier, one of the most fruitful approaches to understanding biological phenomena has been to purify an individual chemical component, such as a protein, from a living organism and to characterize its structural and chemical characteristics. By the late eighteenth century, chemists had concluded that the composition of living matter is strikingly different from that of the inanimate world. Antoine Lavoisier (1743–1794) noted the relative chemical simplicity of the "mineral world" and contrasted it with the complexity of the "plant and animal worlds"; the latter, he knew, were composed of compounds rich in the elements carbon, oxygen, nitrogen, and phosphorus. During the first half of the twentieth century, parallel biochemical investigations of glucose breakdown in yeast and in animal muscle cells revealed remarkable chemical similarities in these two apparently very different cell types; the breakdown of glucose in yeast and muscle cells involved the same ten chemical intermediates. Subsequent studies of many other biochemical processes in many different organisms have confirmed the generality of this observation, neatly summarized by Jacques Monod: "What is true of E. coli is true of the elephant." The current understanding that all organisms share a common evolutionary origin is based in part on this observed universality of chemical intermediates and transformations.

Physical Foundations Living cells and organisms must perform work to stay alive and to reproduce themselves. The synthetic reactions that occur within cells, like the synthetic processes in any factory, require the input of energy. Energy is also consumed in the motion of a bacterium or an Olympic sprinter, in the flashing of a firefly or the electrical discharge of an eel. And the storage and expression of information require energy, without which structures rich in information inevitably become disordered and meaningless. In the course of evolution, cells have developed highly efficient mechanisms for coupling the energy obtained from sunlight or fuels to the many energy consuming processes they must carry out. One goal of biochemistry is to understand, in quantitative and chemical terms, the means by which energy is extracted, channeled, and consumed in living cells. We can consider cellular energy conversions—like all other energy conversions—in the context of the laws of thermodynamics *(Kotz, J.C. & Treichel, P., Jr. 1998).*

Genetic Foundations Perhaps the most remarkable property of living cells and organisms is their ability to reproduce themselves for countless generations with nearly perfect fidelity. This continuity of inherited traits implies constancy, over millions of years, in the structure of the molecules that contain the genetic information. Very few historical records of civilization, even those etched in copper or carved in stone (Fig. 1–29), have survived for a thousand years. But there is good evidence that the genetic instructions in living organisms have remained nearly unchanged over very much longer periods; many bacteria have nearly the same size, shape, and internal structure and contain the same kinds of precursor molecules and enzymes as bacteria that lived nearly four billion years ago.

Among the seminal discoveries in biology in the twentieth century were the chemical nature and the three-dimensional structure of the genetic material,

deoxyribonucleic acid, DNA. The sequence of the monomeric subunits, the nucleotides (strictly, deoxyribonucleotides, as discussed below), in this linear polymer encodes the instructions for forming all other cellular components and provides a template for the production of identical DNA molecules to be distributed to progeny when a cell divides. The continued existence of a biological species requires its genetic information to be maintained in a stable form, expressed accurately in the form of gene products, and reproduced with a minimum of errors. Effective storage, expression, and reproduction of the genetic message defines individual species, distinguishes them from one another, and assures their continuity over successive generations.

Aims of Biochemistry: The science of life's chemistry has great influence and will go on to have extensive effects on many aspects of human and all other living organisms, mainly human and animal medicine and other life science fields [1,4]. Biochemistry makes possible the rational design of new drugs, including scientific inhibitors of enzymes required for the replication of viruses for the treatment of many life-threatening deadly illnesses [1]. Biochemistry that a logical answer to all the mysteries of life, responses to such questions that once seemed faraway and are likely to be more thoroughly bring to light in the near future [1,4]. Biochemistry do substantial in both animal and human medicine, because of the important for physiology (helps to comprehend the biochemical changes related to physiological alteration), for pathology (based on the symptoms described by the patient), for nutrition deficiency. The functions of the vitamins and the minerals in vivo), and for hormonal deficiency The role of hormones, peptides and neuropeptides in the organisms' systems is understandable by biochemical mechanisms) [4]. This science that works for every fields of life, is used in agriculture (farming, fisher\poultry, sericulture, beekeeping, food chemistry, etc.), in pharmacy (enzyme-inhibitor mechanism, synthetic hormones and derivatives, etc. for drug design & synthesis), in plant and animal sciences, as a huge research area (Kornberg, A. 1987)

Importance of Biochemistry

At present, biochemistry is one of the most developing and critical areas of study in science. The field offers a significant avenue for research.

- Biochemistry helps understand the chemical aspects of different biological processes such as digestion, respiration, reproduction, excretion, the behavior of hormones, contraction, and relaxation of muscles, and many more.
- It plays a vital role in health and nutrition.
- The field generally studies different body substances like enzymes, amino acids, carbohydrates, proteins, fats, DNA, RNA, Pigments, hormones, etc., at the fundamental level.
- Biochemists make use of chemical information and procedures to solve biological problems. Biochemistry solves fundamental problems in biology and medicine.
- Biochemistry provides interdisciplinary knowledge in science as it has many branches underneath, covering everything regarding organisms and their existence.
- It is essential in designing and manufacturing various chemical and biological products, clinical diagnosis, nutrition, treatment of diseases, agriculture, etc.
- Biochemistry ensures sustainability. It is a vast branch of science that offers endless possibilities-enormous scope for employment, hence reducing global poverty and starvation. Therefore biochemistry is essential as a sustainable tool.

Conclusion:

Thus Biochemistry helps in understanding the chemical basis that gives rise to the process through biological molecules that are occurring between the living cells and within the cells. This, in turn, relates to the understanding of tissues and organs as well as the structure of the organisms and their functions. Therefore, Biochemistry can alternatively be defined as the study of molecular Biology that relates to the molecular mechanisms of biological phenomena.

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