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Student's Perspective for Importance of Biochemistry in Medical Sciences

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Mini Review

To begin with, let us first know, what is Biochemistry? According to the Oxford Dictionary, Biochemistry is the Branch of Science concerned with the chemical and physico-chemical processes and substances which occur within living organisms. To quote the Lehninger Biochemistry, it is the molecular logic of life [1,2]. The study of Biochemistry helps one understand the actual chemical concepts of biology and go into the micro and nano level to realize how every molecule is working to make a particular reaction and how a human body is reacting to any drug. The importance of Biochemistry can be elaborated in a variety of ways: starting from understanding the body conditions in health, diagnostic tests for diseases, from the manufacture of various biological products to nutrition to treatment of diseases, its uses are innumerable. Let us discuss some of them:

A. Importance of Biochemistry in Health or Physiology

The assessment of various biochemical parameters of a human being which are found to be within normal range gives the idea about a person in good health or without any obvious disease condition. This also helps in studying the deviations of the parameters in different healthy person i.e. the physiological variations.

B. Importance of Biochemistry in Nutrition

Here, Biochemistry describes the food chemistry. For maintenance of health, optimum intake of many biochemicals like macro and micro-nutrients, vitamins, minerals, essential fatty acids & water are necessary. The function and role of the vitamin in the body are described only by biochemistry. Hence, biochemical estimation of the various nutrients and vitamins in body fluids/tissues gives us the idea about the status of nutrition in the person. Any deficiency found could be treated with the appropriate ingredient.

C. Importance of Biochemistry in Hormonal and Enzymatic Effects

The Biochemistry defines the formation, role and status of hormones in an individual. There are many disorders due to hormonal imbalance especially in women and children. Hence, their biochemical estimation gives the clinician an idea about the status and thus, prescribing the treatment. Similarly, the formation and action of various body enzymes are also based on biochemical principles and their estimation gives us the status of function and guides us in treatment.

D. Importance of Biochemistry in Disease Diagnosis

In this case, clinical application of Biochemistry is used and as professional Medicos, we ought to concentrate on this aspect because here, the science helps us to diagnose a particular disease condition as well as to study the disease course and the outcome of the treatment. Some of the biochemical tests which help in the diagnosis of diseases are [3].

E. Importance of Biochemistry in Pharmacology

The biochemical studies of the drugs and their mechanism of actions help us know the drug's composition, their metabolism in the body, their mode of action, duration of action, excretion, as well as their physical storage conditions [4].

a) Drug composition and metabolism: Biochemistry gives an idea of the chemical composition of the drug, its mechanism of action, biochemical reactions in the body, and chances of degradation with varying temperature or climatic conditions etc. We also get to understand as to how modification in the medicinal chemistry helps improve efficacy of a particular drug, the synergistic and antagonistic actions, minimize side effects and how it will be metabolized by the body. This also

suggests the possible 'drug interactions' with other drugs/ chemicals.

b) The shelf-life: This information tells us as to how long a drug is stable when kept at particular temperature and guides us to define the storing conditions of the drug to reduce its degradation. The storage condition required can be estimated by the biochemical test. For example many enzymes, hormones are stored for dispensing. These get deteriorated over time due to temperature or oxidation, contamination and also due to improper storage.

c) The half-life: This is the time which defines the duration of action of a particular drug and when it is excreted from the body. Based on this information, we can approach to increase the half-life, which is generally a desirable quality, by making a combination with other drugs or inhibiting its quick metabolism.

d) Mode of administration: The biochemistry of a particular drug guides us to decide the mode of its administration or application i.e. orally, subcutaneously, intramuscularly, intravenously, intra-peritoneal or locally. For example: the drugs in the form of a tablet or capsule are given orally to act on the target organ only when the drug can withstand the gastric environment and absorbed from the intestines; some gut acting drugs are given orally in an enteric coated form; an inject able drug with aqueous base has a shorter absorption time than an oil based inject able; Intravenous inject ables or fluids always have aqueous base; a pain relieving gel should have quick skin penetrating powers when applied locally.

e) Importance of Biochemistry in Genetic engineering: Genetic Engineering, also called genetic modification [5], is the direct manipulation of an organism's genome using biotechnology. New DNA may be inserted in the host genome by first isolating and copying the genetic material of interest, using molecular-cloning methods to generate a DNA sequence; or by synthesizing the DNA, and then inserting this construct into the host organism. Genes may be removed, or "knocked out", using a nuclease. It is the most recent advancements which is completely based on Biochemistry. Advancements in Genetic Engineering focused on the areas such as Mutant organisms, DNA Replication, Recombinant DNA, Genetic linkage analysis, Genetically Modified Plants, Genetically Modified Animals, DNA Microarray, Green Fluorescent Protein, Protein Sequencing, Genetic Probes, RNA Splicing, Functional Genomics, Antisense RNA, RFLP, Bio safety of GMO, GMO Ethics, Genetically Engineered Microorganism. Genetic engineering has applications in medicine, research, industry and agriculture and can be used on a wide range of plants, animals and microorganisms.

In medicine, genetic engineering has been used to mass-produce insulin, human growth hormones, fillister (for treating infertility), human albumin, monoclonal antibodies, anti-hemophilic factors, vaccines, and many other drugs. One of the earliest uses of genetic engineering in pharmaceuticals was gene splicing to manufacture large amounts of insulin, made using the cells of *E. coli* bacteria. Interferon, which is used to eliminate certain viruses and kill cancer cells, also is a product of genetic engineering, as are tissue plasminogen activator and urokinase, which are used to dissolve blood clots. Another byproduct is a type of human growth hormone; it's used to treat dwarfism and is produced through genetically-engineered bacteria and yeasts. The Insulin genetics provides instructions for producing the hormone insulin, which is necessary for the control of glucose levels in the blood. Glucose is a simple sugar and the primary energy source for most cells in the body. Insulin is produced in a precursor form called proinsulin, which consists of a single chain of protein building blocks (amino acids). The proinsulin chain is cut (cleaved) to form individual pieces called the A and B chains, which are joined together by connections called disulfide bonds to form insulin. In research, organisms are genetically engineered to discover the functions of certain genes.

i. Industrial applications include transforming microorganisms such as bacteria or yeast, or insect mammalian cells with a gene coding for a useful protein. Mass quantities of the protein can be produced by growing the transformed organism in bioreactors using fermentation, then purifying the protein.

ii. In agriculture, it is used to create genetically-modified crops or genetically-modified organisms and bring about the process of biofortification. Imagine in a country like India where iron deficiency anemia is so widely prevalent, just imagine, incorporating iron into a staple cereal like rice or wheat can have huge health benefits.

iii. Human Genetic engineering is the deliberate, controlled manipulation of the genes in an organism with the intent of making that organism better in some way. This is usually done independently of the natural reproductive process.

f) Importance of Biochemistry in Gene Therapy: The evolving field of gene therapy involves manipulating human genes to treat or cure genetic diseases and disorders [6]. Modified plasmids or viruses often are the messengers to deliver genetic material to the body's cells, resulting in the production of substances that should correct the illness. Sometimes cells are genetically altered inside the body; other times scientists modify them in the laboratory and return them to the patient's body. Since the 1990s, gene therapy has been used in clinical trials to treat diseases and conditions such as AIDS, cystic fibrosis, cancer, and high cholesterol. Drawbacks of gene therapy are that sometimes the person's immune system destroys the cells that have been genetically altered, and also that it is hard to get the genetic material into enough cells to have the desired effect.

g) Importance of Biochemistry in Stem Cell Therapy: Stem Cell Therapy in different forms has been in use with varied success around the globe. But some of the newer approaches made the scientists in the last couple of years have increased the scope of its much wider use with minimum of side or adverse effects [7].

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i. **Stem Cell Transplant:** During the last three decades, stem cell therapy using bone marrow has been the only treatment for patients with leukemia and lymphoma. But, most of the growing cells were killed by the cytotoxic agents due to their inability to discriminate between the neoplastic cells, and the hematopoietic stem cells. This side effect is avoided in the stem-cell transplant wherein a donor's healthy bone marrow reintroduces functional stem cells to replace the cells lost in the host's body during treatment. The transplanted cells also generate an immune response that helps to kill off the cancer cells.

ii. **Mesenchymal Stem Cell:** A stem-cell therapy called Prochymal was conditionally approved in Canada in 2012 for the management of acute graft-vs-host disease in children who are unresponsive to steroids. It is an allergenic stem cell therapy based on mesenchymal stem cells (MSCs) derived from the bone marrow of adult donors. MSCs are purified from the marrow, cultured and packaged, with up to 10,000 doses derived from a single donor.

iii. Hematopoietic stem-cell products derived from umbilical cord blood are now used for the treatment of blood and immunological diseases.

iv. In 2014, the European Medicines Agency recommended approval of Holoclar, a treatment involving stem cells, for use in the European Union. Holoclar is used for people with severe limbal stem cell deficiency due to burns in the eye [8].

v. Trials are still on to use stem cells in other fields and we hope the day is not too far when stem cells will find a cure to most dreaded conditions like brain and spinal cord injury, infertility and even AIDS.

h) Importance of Biochemistry in Genome Sequencing: Genome sequencing is the process of determining the precise order of nucleotides within a DNA molecule. This Knowledge of DNA sequences is used for medical diagnosis, biotechnology, forensic biology, virology and biological systematics. DNA sequencing is used in molecular biology to study genomes and the proteins they encode. These information allows researchers to identify changes in genes, associations with diseases and phenotypes, and identify potential drug targets. The genes from patients could be sequenced to determine if there is risk of genetic diseases. DNA sequencing may be used along with DNA profiling methods for forensic identification and paternity testing. Finding out about the human genome can tell us about the expression of the various proteins of the human body and how similarly or differently an individual's body will react to a certain drug. Genomes of microbes and parasites will tell us about the areas in them which are responsible for their pathogen city and the potential drug targets.

From the above scientific achievements, one can surely imagine the possibility of having 'personalized drugs' which would be prescribed for someone basing on his/her own genome. Soon the day will come when genome sequencing will give the answers to most of the genetic diseases and will help us find out about the cure to the "incurable diseases". But, remember, it is the basics of Biochemistry that would help us achieve these greater heights in future. I agree that these are the things of the future. Coming back to the present, it can be concluded that Biochemistry like other first-year-subjects makes us understand the basis of all body functions and this knowledge is a must for understanding the para-clinical and clinical subjects in due course: after all we have to learn to walk first before we can start running!

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