BIOLOGY TEACHING AND RESEARCH IN INDIA

Nature of Biology

Biology is the science of life. It is the story of life on earth. It is the science of life forms and living processes. Biological systems often appear to challenge physical laws that govern the behavior of matter and energy in our world. Historically, biological knowledge was ancillary to knowledge of human body and its function. The latter as we know, is the basis of medical practice. However, parts of biological knowledge developed independent of human application. Fundamental questions about the origin of life, the origin and growth of biodiversity, the evolution of flora and fauna of different habitats, etc. caught the imagination of biologists.

The very description of living organisms, be it from a morphological prospective, a physiological perspective, a taxonomical perspective, etc. engaged scientists to such an extent that for sheer convenience, if not for anything else, the subject matter got artificially divided into the sub-disciplines of Botany and Zoology and later, even into Microbiology. Meanwhile physical sciences made heavy inroads into biology, and established Biochemistry and Biophysics as new sub-disciplines of biology. Mendel's work and its rediscovery in the early 20th century led to the promotion of the study of Genetics. The discovery of the double helical structure of DNA and the deciphering of three-dimensional structures of many macromolecules led to the establishment of and phenomenal growth in the dominating area of Molecular Biology. In a sense, functional disciplines laying emphasis on mechanisms underlying living processes received more attention, support, intellectual and social recognition. Biology unfortunately got divided into classical and modern biology. To the majority of practicing biologists, pursuit of biological research became more empirical rather than a curiosity and hypothesis driven intellectual exercise. Fortunately and quietly, general and unifying principles of biology were also being discovered, rediscovered and emphasized. The work of Mayr, Dobhzhansky, Haldane, Perutz, Khorana, Morgan, Darlington, Fisher, and many others brought respect and seriousness to both classical and molecular biological disciplines. Ecology and Systems Biology got established as unifying biological disciplines. Every area of biology began developing interface with not only other areas of biology but also other disciplines of Science and Mathematics. Pretty soon, the boundaries became porous. They are now on the verge of disappearing altogether. Progress in Human Biology, Biomedical Sciences, especially the structure, functioning and evolution of the human brain brought in respect, awe and philosophical insights to biology. Biology even stepped out of laboratories, museums and natural parks and raised social, economic and cultural issues, capturing the imagination of the general public and hence, political attention. Educationists did not lag behind and realized that biology should be taught as interdisciplinary and integrating science. A new synthesis of all areas of basic and applied biology is the need of the hour. Biology has come of age.

Biology is the science of life forms and living processes. The living world comprises an amazing diversity of living organisms. Early man could easily perceive the difference between inanimate matter and living organisms. Early man deified some of the inanimate matter (wind, sea, fire, etc) and some among the animals and plants. A common feature of all such forms of inanimate and animate objects was the sense of awe or fear that they evoked. The description of living organisms including human beings began much later in human history. Societies, which indulged in anthropocentric view of biology, could register limited progress in biological knowledge. Systematic and monumental description of life forms brought in, out of necessity, detailed systems of identification, nomenclature and classification. The biggest spin off of such studies was the recognition of sharing of similarities among living organisms both horizontally and vertically. That all present day living organisms are related to each other and also to all organisms that ever lived on this earth, was a revelation, which humbled man and led to cultural movements for conservation of biodiversity.

The description of the diverse forms of life on earth was made only by observation through naked eyes or later through magnifying lenses and microscopes. This description is mainly of gross structural features, both external and internal. In addition, observable and perceivable living phenomena were also recorded as part of this description. Before experimental biology or more specifically, Physiology was established as part of biology, naturalists described only biology. Hence, biology remained as natural history for a long time. The description, by itself, was amazing in terms of detail. Hence, this description became meaningful and helpful in framing research questions in physiology or evolutionary biology.

Biology is the study of living organisms. The detailed description of their form and function only brought out their diversity. It is the Cell Theory that emphasized the unity underlying this discovery of forms, i.e.- the cellular organization of all life forms. The Cell Theory also created a sense of mystery around living phenomena, i.e.- physiological and behavioral processes. This mystery was the requirement of integrity of cellular organization, for living phenomena to be observed or demonstrated. In studying and understanding the physiological processes, one can take a physicochemical approach and use cell free systems to investigate. This approach enables us to describe the various processes in molecular terms. In other words, we answer the question, what is the molecular basis of physiological processes. It can also explain the abnormal processes that occur during any deceased condition. This approach of trying to understand and explain systems and phenomena by the study of properties of the components of the system is popularly called Reductionist Biology. One can notice that many areas of biology like behavior are yet to be reduced to description in molecular terms.

The description of structure and variation of living organisms over a period of time, ended up as two apparently irreconcilable perspectives on biology. The two perspectives essentially rested on two levels of organization of life forms and living phenomena. One described at organismic and above level of organization while the second described at cellular and molecular level of organization. The first resulted in ecology and related

disciplines. The second resulted in Physiology and related disciplines. The relation of the physiological processes to the environment was often ignored.

The reductionist approach to the study of life forms resulted in increasing use of physicochemical concepts and techniques. A majority of these studies employed either surviving tissue models or straightaway, cell free systems. An explosion of knowledge resulted in Molecular Biology. Molecular Physiology became almost synonymous with Biochemistry and Biophysics. However, it is now increasingly realized that neither a purely organismic approach nor a purely reductionistic molecular approach would reveal the truth about biological processes or living phenomena. Systems biology makes us believe that all living phenomena are emergent properties due to interaction among components of the system under study. A regulatory network of molecules, supra-molecular assemblies, cells, tissues, organisms and indeed, populations and communities, each create emergent properties.