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Study of Biology: insights from the past to the present

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ABSTRACT

The history of Biology has been traced to a period in which it was studied from anatomical dissections and studies, while the concept began from traditions of medicine and natural history in the 19th century. Biology is no longer just a descriptive science, as developments over the past scores of decades has shown Biology to have stepped into sub-cellular and molecular studies on organisms, with lots of applications to tackle and solve problems confronting mankind and survival. The early periods of study of Biology included taking records of plants and habits of animals to enhance knowledge required for maintenance of human existence. This is appropriately related to the earliest definition proffered for Biology by great Greek philosophers in the early 19th century as 'the study of life' and this basically was in form of wholesome organismal and population ecology related studies of life. Modern Biology is now a vast and electric field composed of many disciplines which have overlaps with the field of Biology. The discovery of the electron in 1897 turned around the history of the pure sciences of which includes Biology. Like the Physics and Chemistry, Biology now rely a lot on use of matter with small sizes within life organization frames (such as molecules, micro-organelles) to study and tackle life related issues.. The subsequent entry of electron microscope into the forays of scientific discoveries in the life sciences further helped move Biology into the sub-cellular and molecular age; with Cell Biology and Molecular Biology being active players in modern era Biology. Some of the most recent earliest breakthroughs by vaccine scientists to demystify SARS-COV-2 virus with its attendant COVID-19 disease drew knowledge, insights and probes from molecular biology (a couple of them had been through mRNA technology) to produce and roll out first set of significantly effective COVID-19 vaccines. The branches of Biology have increased over these decades with now over 15 branches in modern day Biology. As such, the scope of Biology has stepped up as a result of its phenomenal development over the past scores of decades, and helping to tackle some evolving life threatening challenges and problems.

INTRODUCTION

The birth of Biology has been traced to a period close to the 4th and 5th century BC. A man by name Akmaeon of Crotona in the 5th century practiced dissection aimed at finding out the source of human intelligence through Anatomy and Zoology and observed from his remarkable elucidation that the seat of intelligence is the brain and not the heart as conceived by earlier submissions by some other scientists (History World Net, 2020). The former set of scientists meant well for science but no man knows all, as science is ever growing and evolving.

The concept of Biology (as a science) sprung forth as a simple coherent field in the 19th century as Biological sciences emerged from traditions of medicine and natural history reaching back to Ayurveda, ancient Egyptian medicine and the works of Aristotle and Galen in ancient Greco-Roman world (Wikipedia, 2020).

History of Biology predates the period at which humans began to write and store records of non-poisonous food plants and understanding of habits of dangerous predators because they discovered that their survival was hinged on these aspects of existence of life and activities of living things.

Present day Biology has paced from being a largely descriptive science (dealing with just wholesome cells, organisms and wholesome life) to a discipline that increasingly emphasizes the sub-cellular and molecular aspects of organisms and attempts to relate structure with function at all levels of biological (life) organization (Encyclopedia Britannica, 2020). Garland (2016) opines on the change on level of practices in Biology and the history of complexity and diversity in twentieth century life sciences.

Morange (2000a) emphasized that it has become obvious that the possibilities from gene therapy in health care, and creation of new varieties of animals and plants through genetic engineering, have emanated from (significant) inputs from Molecular Biology.

Cobb, a historian of science in his translation of the same published work of Morange (2000b) on “Black box of Biology: The history of the Molecular Revolution”, opined that since 1930s, a molecular vision has been transforming Biology.

In the early to mid-nineteenth century when the concept of its being a modern science sparked-off, it drew on various traditions, practices and areas of inquiry (life issues that enhance and ensure human survival and healthier life). The traditional history aspects of beginning of Biology generally targeted medicine and natural history (Bioexplorer, 2020; Encyclopedia, 2020). Garland et al (2017) in their overview of the nature of process in science, with particular emphasis for Biology,exposited that there is a major revolution in Biology during the twentieth century with the introduction of new approaches associated with Molecular and Cell Biology, and Molecular Genetics. Corroborating this trend in development of Biology over the centuries.

Objectives of this review are to:

- Trace the history of study of Biology.
- Exposit various developments in study of Biology over the past decades to date.
- Suggest some attributes of modern day definition for Biology based on trends and developments.

1.1. Background History of study of Biology and the good age long definition

The tradition of medicine dates back to the records of great ancient Greek medical practitioners such as Hippocrates of Kos (460 BCE) who contributed to early understanding of Anatomy and Physiology while tradition of natural history dates back to the works of remarkable men like Aristotle (384 – 322 BCE) with his exposited history of animals and related natural learning; and the works of Theophrastus (287 BCE) on understanding of plants, as these studies made inputs into Botany and Zoology and later into Comparative Biology (Science Encyclopedia, 2020). Centuries later, other contributions went into the records of history of Biology from men like Leonardo da Vinci’s ground breaking anatomical drawings, Andrea Cesalprino’s early period classification of plants based on flower, seeds and fruits characteristics and Harvey’s great discoveries that made mankind know the true nature of the human circulatory system which stands as one of greatest discoveries on human body before the other high level insightful discovery of structure of deoxyribonucleic acid (DNA) in 1953 by James Watson and Francis Crick in the 20th century (which provided the biochemical basis of transfer of gene information of inheritance from parent to offspring across generational lines). Then the discovery of the microscope in the 1660s helped through descriptive elucidations on the structures of minute organisms and sub-cellular features of live such as blood corpuscles, semen, nerve cells, among others (History World Net, 2020). Humagain (2017) regarded Aristotle as the father of Biology. However, from the contributions of modern Cell Biology, Matlin et al (2018) in a landmark contribution to developments and the current shape of Biology, opined that with Molecular Biology at the forefront and modern Cell Biology following in this emerging trend in Biology, the boundaries’ of Biological understanding are being propelled forward. The writer here is a member of the committee on conceptual and historical studies of science at the University of Chicago, in the United States of America. It is pertinent to recall that Cowdry’s classic watershed work titled “General Cytology” (Cowdry, 1924)) has been inspirational to the development of modern Cell Biology as it contributes to the current shape and developments in Biology, and as a field of science.

As these great Greek philosophers curiously looked with interest at the range of living creatures, from the lowest (which were known to be plants by then) to the highest (which is man), from standings on taxonomical hierarchy, a German naturalist coined a Greek words in the early 19th century for study of Biology, from the words 'bios' meaning life and 'logos' meaning discourse or study (Bioexplorer, 2020; History World Net. 2020) and the divisions of Biology at this period in history were mainly Botany and Zoology or Anatomy (History World Net. 2020).

1.2. Developments in study of Biology over the recent decades to date and breathtaking inputs from molecularization

Having peeped into where we came from in the concept of Biology, albeit this historical life science subject, we take a foray into recent and current studies, concepts and issues in Biology, and some typical problems it has been used to solve for mankind. Based on history over the centuries, there is an increasingly rapid development of the Life sciences over the past decades (Meunier and Nickelsen, 2018).

Modern Biology is based on several unifying themes, such as the cell theory, genetics and inheritance (Biology Uni Hamburg, 2020). Drawing form the history of Biology, the science of Biology in the earliest period was defined as the study of life and living things through rigorously tested and peer-reviewed scientific methods. Evolving present day Biology, being now a vast and electric field is composed of many disciplines that study the structure, function, growth, distribution, evolution and other features of living organisms (Lumen Learning, 2020). Encyclopaedia Britannica, (2020) defined modern Biology as study of living things and other life processes and added that the modern tendency of Biology is towards cross-disciplinary research that has resulted in significant overlap of the field of Biology with other scientific disciplines in pure Medicine, Chemistry and Physics, with emerged Biological disciplines in Biomedicine, Biochemistry and Biophysics respectively. Matlin et al (2018) published a remarkable work in which they emphasized that even the discipline of modern Cell Biology, though clearly overshadowed by Molecular Biology, has stretched beyond the bounds of purely microscopic observation to include Chemical, Physical and Genetic analysis of cells.

It is a known fact that in the earliest period in history of Biology, microscopy, molecular studies and cell division, transmission of genetic materials, molecular and cellular basis of embryology and reproduction where unknown to scientists and invariably man. Science is not static but developmental and growing from the past. As such, we now find exposition of contents and branches of modern Biology to include but not explicitly Anatomy, Actinobiology, Bioinformatics, Biotechnology, Biochemistry, Cytology, Cell Biology, Ethology, Etiology, Genetics, Forensic Biology, Environmental Management, Limnology, Molecular Biology, Nidology, Pathology/Pathobiology, Serology, Sedimentology, Systems Biology/Computational and Mathematical Biology, Sitology and Therapeutics (Bioscience, 2020). Modern Biology is in the middle of a paradigm shift (Murphy, 2020). Apparently, this goes beyond study of living things. For instance, the entry of Systems Biology and Synthetic Biology into the framework of Biology is innovatively contributing to science of human and animal health care, and environmental management. They have brought in synergized collaborative inputs of Biology, Bioinformatics, Computer Science, Chemistry, Physics and Engineering- tackling and solving life related tasks as accompanying goals, through developed robust predictive indices. Then, introduction of high-throughput Molecular Biology techniques has immensely contributed to open up other important areas of System Biology to include study of linked genetic diversity and developmental biological mechanisms (Kirschner, 2005). Systems Biology takes into account the interactions of key molecular elements such as DNA, RNA (ribonucleic acid), proteins and cells with respect to one another and (complimentarily) integrated with knowledge and insights from Computer Science (Shiel Jr, 2018). Systems Biology has shown to be a holistic approach to study molecules (including DNAs and RNAs) and cells in Biology (Ma'ayam, 2017). Good Systems Biology balances the breaking of a system apparatus, define the synthesis and functions of these parts and understanding how these parts cooperate to produce the behavior (including observed processes and identity) as a whole (Hillmer, 2015).

In the book "The Black Box of Biology", Morange (2020b) opined that what led to the incredible transformation of Biology was molecularization of a large part of Biology, and not a simple accumulation of new results.

One of the recently emerged branches of Biology known as Computational Biology on its part uses biological data to develop algorithms or models and unravels the relationship between them, which Systems Biology then holistically engages to tackle issues confronting mankind. These models can describe what biological tasks are carried out by particular nucleic acid or peptide sequences, and how changes in cell organization influence cell behavior. In Bioinformatics we look at how we can efficiently store, annotate, search and compare information from Biological measurements and observations (Murphy, 2020). This is now present age Biology spanning across structure, function, processes, behavior, cell, molecule, proteins, informatics, and computer science in features.

We recall a recent attempt by Humagain (2017) to redefine Biology and this author defined it as "the science which deals with the study of structure, organization, life processes, interactions, origin and evolution of living organisms'.

Also, we draw cues from the very inclusive Lionel Robbins' definition normally engaged for the subject "Economics", which is stated that: "Economics studies human behavior as a relationship between ends and

scarce means, which have alternative uses" and dated back to 1935 when it was proposed (Shizgel, 2012). This definition makes it easier to actually get the highlights and concepts of this subject from its embracive nature of developments and trends in economics. Today's Economics has taken some further deeps based on developments and our evolving world.

Revolutionary changes in Biology of the last few decades before 1964 was a combination of rapid and radical shifts in Biological concepts and techniques that marked the period about a century ago when Biology in its modern form came into being in several fields at the same time (Everet,1964).

The incredible transformation of Biology has involved the fusion of molecular principles and concepts with those of other disciplines that includes Physics, Structural Chemistry and Computational Biology (Morange, 2020a; Tanghe, 2020). This has enabled developments that produced human genome sequencing, emergence of Synthetic Biology, Systems Biology and Epigenetics, with its attributes of breathtaking persuasive and original inputs applied to Biology.

Science as a matter of fact is an endless (and evolving) search for truth as scientific advance is a succession of newer representations superseding (developing in actual fact) older ones and is impelled by two main factors that are namely technological advance and a guiding vision, and there should be a balance between them (Woese,2004). Molecular Biology which has dominated our 20th century Biology has been a mixed grill of these two, being of mixed blessing but more with positive attributes as the negative attributes that could be wrongly exploited in unethical practices are screened and checked by the organizations regulating its practice.

The discovery of the electron in 1897 marked the beginning of a major turning point in the history of science (National Research Council of the United States, 2009). This now enables efficient and robust use of increasing large volume of data for inquiry, insights, elucidations, discoveries and wide range applications that supports healthcare (for therapeutic discoveries and innovative life support systems), industry, agriculture (to increase yields and in disease controls), environmental management (bio-remediation, eco-friendly environment and protection of rare species) and space explorations. The Life sciences have been in a midst of historical period analogous to the 20th century in the Physical sciences, with the entry of the electron microscope into the forays of scientist discoveries (National Research Council of the United States, 2009). Biology, like Physics and Chemistry now relies a lot on studies and use of matter with small sizes within life organization frames, such as molecules, micro-organelles and other forms of very minute cell and tissue inclusions to study and tackle issues that help promote life on earth.

Molecular Biology is an active player in the reductionist concept, helping to unravel the bio-molecular components of cells at various levels of organization- which are organismal, communities and ecosystems. The concept of reductionism emphasis that the understanding of more smaller parts of a system is important for understanding the umbrella system itself, which is the whole organismal big picture, the minute or sub-unit molecules and cell inclusions of small parts make up the big organism (Stanford Encyclopedia of Philosophy, 2017). Thus, scientists now walk from the smaller parts into the bigger one. The recent success at developing COVID-19 vaccine, following a SARS-COV-2 microbe-man war in the most recent pandemic that started late 2019, has significantly involved use of the tools of Molecular Biology such as mRNA and other forms of gene technology, with inputs from Bioinformatics, Biochemistry (a strongly close ally of Molecular Biology) and finally Production line technology to produce large quantities of these vaccines to meet mass demands and support wellbeing of man in the midst of devastating effects of COVID-19 pandemic Invariably, coordinated distribution and use of effective vaccines, and engagement of preventive measures compliments each other during fight backs against epidemics or pandemics.

Kay (2000) remarked that for those who haven't noticed, genetics make ample use of communication concepts and imagery; genes are information, DNA is a language, the genome is an encyclopedia, and organisms are genetic communication systems. This brings to fore, how Molecular Biology and Molecular Genetics are transforming Biology, enlightening the community of Biologists and Bio-related scientists, making significant inputs that are solving problems in human health, agriculture, veterinary animal life and in our ecosystem as now done through Molecular Ecology, a novel entry to support environmental management and ecosystem sustenance.

As Biological science advanced during the 20th century, different fields in science such as Computer science, Informatics, Physics, Astronomy, Mathematics and Earth Sciences, came into use and play in Biology to study and tackle the complex sub-systems and factors that influence life of hierarchically dominant living systems on earth, in the various modern and ancient branches of Biology (that included applications in Genetics, Cell Biology, Ecology, Entomology, Botany, Physiology, Anatomy, Microbiology, Biochemistry, Parasitology, Epidemiology, Conservation Biology and Microbiology among others). These have helped to handle and analyze large complex data, digitize platforms and frameworks, test intricately woven models and hypothesis and more efficiently share useful information.

As such, over the scores of decades, the scope of Biology has emerged with a broader and more intricate framework that has gone beyond the earliest definition engaged. This has been buffered by emerging challenges confronting man and life.

1.3. Some suggested attributes for modern day definition for Biology based on trends and developments

In the glimpse of the fore-going, attributes of modern day definition for Biology could incorporate features such as: "*study of living things, molecular and synthetic features, and bio-process technologies applied to life systems*'. This is a build-up on the earliest definition of Biology. Garland et al (2017) remarked that Biology is always an ongoing exploration of unsolved problems. We acknowledge the remarkable effort of the great earliest Philosopher scientists in Biology, who developed the earliest definition. Concepts and findings from modern day Biological investigations are being used to tackle and solve old and emerging problems in agriculture, health, veterinary science and the environment, and as the components of the Pure and Applied Sciences of Biology, Chemistry and Physics keep evolving and supporting each other.

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