

Research and Reviews: Research Journal of Biology

Biology and its Significance

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MINI-REVIEW

Received: 20/05/2015

Revised: 25/05/2015

Accepted: 30/05/2015

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Keywords: Anatomy and
physiology; Agriculture;
Nanotechnology; Astrobiology;
Biochemistry; Bioinformatics;
Biomechanics; Biotechnology;
Cell Biology; Genetics;
Microbiology; Zoology;
Psychology; Pediatrics;
Immunology

ABSTRACT

The word biology was first time appeared in the book named *Bibliotheca botanica* which was written by Swedish scientist Carl Linnaeus. The word biology is a Greek word in which *logia* means study of and *bios* means life. Biology can be defined as study of living organisms which growth, function, structure and evolution. Aristotle can be regarded as father of biology. There are different branches of biology which include anatomy and physiology, agriculture, nanotechnology, astrobiology, biochemistry, bioinformatics, biomechanics, biotechnology, cell biology, genetics, microbiology, zoology, psychology, pediatrics, immunology, etc. All these branches have interlinked with the daily life of all living creatures and thus increasing the significance of biology day by day.

INTRODUCTION

The word biology was first time appeared in the book named *Bibliotheca botanica* which was written by Swedish scientist Carl Linnaeus. The word biology is a Greek word in which *logia* means study of and *bios* means life. Biology can be defined as study of living organisms which growth, function, structure and evolution. Aristotle can be regarded as father of biology. Biology started emerging with the discovery of microscope by a Dutch scientist named Anton van Leeuwenhoek. Our ancestors came to know about different types of microorganisms like bacteria and spermatozoa which are invisible to the naked eye. There are different branches of biology which include anatomy, agriculture, astrobiology, biochemistry, bioinformatics, biomechanics, biotechnology, genetics, microbiology, molecular biology, neurobiology, pathology, zoology, physiology, etc.

ANATOMY AND PHYSIOLOGY

Anatomy and physiology are two different branches of biology which are dealing with function and structure of living organisms. Both of these branches got extended to study the developmental, ecological, comparative and evolutionary aspects of both structural and functional relationships [1]. If we would like to know more about anatomy and physiology we should understand more about remaining biological branches like microbiology, psychology, genetics, physics, kinesiology,

biochemistry, etc., as they got interlinked with one another [2]. The branch of physiology is rising rapidly and increasing the importance by engaging undergraduate students in interdisciplinary research [3].

AGRICULTURE

Agriculture is an area where new technologies are applied to improve the yield of crops [4]. Agriculture is the largest interface between environment and humans and is a main cause of climate change and ecosystem degradation. Fertilizer use leads to fundamental changes in the pools and its utilization to supplement soil nutrients, to promote plant growth and to develop crop productivity. Food quality is prevalent in modern agriculture. Global food security and crop production are highly dependent on fertilizers input to agricultural lands [5]. The selection and deployment of aims in stressed ecosystems therefore requires development of concerted research and technology [6].

Roots with absolute characteristics are significant for sustaining crop yields, especially when plants are grown in soils with inadequate water and nutrients [7]. Agriculture production is straightly dependent on climate change and weather [8]. A reliable and suitable irrigation can be improved agricultural production and irrigation efficiency [9]. antibiotics, agricultural fertilizers, pesticides and nutrients are typically by spray or drench application to soil or plants or over feed or injection systems to animals. Delivery of medicines or pesticides is either provided as preventative treatment or is provided the disease causing organism has multiplied and symptoms are evident in the plant [10]. Pesticides use has dramatic consequences both in developed and underdeveloped countries [11]. Sustainable agriculture aims at long term maintenance of natural resources and agricultural productivity with minimal adverse impact on the environment [12]. Adoption of Green Revolution technology has increased wide varieties of agricultural crop yield per hectare which increased food supply in developing countries [13].

NANOTEHNOLOGY IN AGRICULTURE

Nanotechnology can be defined especially as growing and exciting technology at the scale of one-billionth of a meter sweeping away the barriers between the physics, chemistry and biology. Nanotechnology is the characterization, design, production and application of structures, devices and systems by controlling size and shape at nanometer scale [14]. Nanotechnology in biomedical research has emerged as an interdisciplinary science that has quickly found its own niche in clinical methodologies including imaging, diagnostic and therapeutics, drug delivery and tissue engineering [15]. Nano medicine can design, manipulate, build and optimize biological components at the nanoscale level. This includes the utilization of nano materials and the fabrication of nano devices to be used in Nano diagnostic, drug discovery and nano drug delivery [16]. Nanotechnology develops their performance and acceptability by increasing safety, effectiveness, patient adherence, as well as ultimately reducing health care costs [17]. The overall goal of the nanoparticles imaging is to reduce the number of unnecessary problems in agriculture [18].

ASTROBIOLOGY

Astrobiology is the study of evolution, distribution and future of life in the world. It is one of popular topics of natural sciences now a day. It mixes various disciplines and also provides a new way to bring science which is close to the public [19]. Modern expedition of astrobiology have been mainly concerned with studying the high survival properties of bacteria that make them exist for space travel and also with locating suitable astronomical habitats for life within the solar system and also further [20].

BIOCHEMISTRY

Biochemistry is the heart of life science dealing with chemistry of all biological processes [21]. There are different types of biochemical compounds which include proteins, carbohydrates, lipids, amino acids, etc. Lipids are naturally occurring compounds and hydrophobic or amphiphilic molecules that form structures such as liposomes, vesicles or membranes in an aqueous environment. Fats consist of

a wide group of compounds with the same chemical structure that are derivatives of fatty acids and glycerol bounded together through “ester” bonds [22]. Fluoroquinolones are the fastest growing antibacterials in terms of global revenue [23].

Biocatalysts are vital components of clinical and analytical methods and they are also utilized in various fields of life sciences, including physiological, biochemical and biomedical research [24]. Enzymes are the catalyzers of biochemical reactions which are very important components of not only analytical and clinical methods but they are also utilized in various other fields of life sciences, including physiological, biochemical and biomedical research [25]. Dopamine is a primary neurotransmitter associated with cognition, fine movement coordination, emotion, affect, memory and also the reward pathway [26].

Biochemistry is the study of the composition, structure and chemical reactions of substances in living systems. It has emerged as a separate branch when scientists combined biology with inorganic, organic or physical chemistry [27]. It has also contributed to our current understanding of human diseases and also to the development of drugs for the treatment of many diseases [28].

BIOINFORMATICS

Bioinformatics is an interdisciplinary branch of biology emerged by the combination of various other disciplines like mathematics, biology, computer science and statistics to develop methods for storage, retrieval and analyses of biological data [29]. The term ‘bioinformatics’ was coined in 1970’s by Paulien Hogeweg and the field of bioinformatics has become relatively mature allowing high-throughput whole genome sequencing and making computer-aided drug design an essential part of drug discovery [30,31]. Recent technological advances in genetics, proteomics, genomics and bioinformatics offer great opportunities for biomarker discovery [32]. Advances in bioinformatics and proteomics tools have increased our understanding of the metabolic pathways and function of the molecules [33].

Bioinformatics is a new field in biology that merges both computer science and information technology with wide applications such as, molecular marker discovery, genome sequencing, transcriptomics, taxonomy, etc. [34]. Major resources of bioinformatics are NCBI, ENSEMBL, Unigene, iHOP, Uniprot, etc. [35]. The analyses of bioinformatics especially by the means of sequence patterns for co-expression and subpathway will provide more clues than traditional methods [36]. Bioinformatics may also help to analyze pharmacogenomics study in terms of SNP-SNP interaction to predict the disease susceptibility and effectiveness of drugs [37].

One of the most vital tasks of bioinformatics is to bridge the gaps among various knowledgeable domains [38]. Advancements in the field of bioinformatics to handle large amount of data has also played a major role to find the answers for complex biological questions [39,40]. Bioinformatics tools have further emerged as an essential prerequisite to accommodate further strategic development and improvement of output results [41]. Systems biology and bioinformatics are playing key role in rapidly developing research areas such as computing architectures [42]. Bioinformatics technologies as well as access to bioinformatics databases are emerging day by day [43].

Bioinformatics is conceptualizing biology in terms of molecules and applying informatics techniques which are derived from disciplines such as applied computer science mathematics and statistics to understand the information associated with molecules on a large scale [44]. Many bioinformatics tools have been developed to interpret and analyze the large lists of proteins or genes, such as BABELOMICS, DAVID, Ingenuity and GeneGO for function and pathway analysis of large-scale data. [45].

Bioinformatics is currently acting as a resource tool for the development of SSR with the availability of the expressed sequence tags and genomic sequences as molecular databases [46]. Bioinformatics tools are playing vital role in finding the cause of genetic variation to drug responses and complex diseases [47].

BIOMECHANICS

Biomechanics is a branch of mechanics applied to biology in particular to human biology [48]. Biomechanics along with forensic medicine are able to provide a wide scope of expertise [49]. Biomechanical models of human movement have emerged as an important tool in the investigation of possible injury pathways towards forensic applications and insurance claims [50]. Biomechanics methodologies and tools may explain how an aspect of an injury was happened which continues to be considerable limitations regarding causation aspect [51]. The goal of forensic biomechanics is to apply the principles of science and engineering to understand what occurs in given events and then this raises the question of what can be done to reconcile the sources of information [52].

BIOTECHNOLOGY

Biotechnology is all about using techniques, skill and knowledge with living things as catalytic agents [53]. The branch biotechnology is emerging day by day by using organisms or their products for commercial purposes [54]. Biotechnological tools focus on ability to detect and transfer genes of interest from one organism to other [55]. Biotechnology employs the tools of genetic engineering to improve animals, plants and microorganisms for food production [56,57]. Biotechnology is playing vital role in solving problems related to malnutrition and also in the development of major drugs [58,59]. The use of biotechnology in orthodontics is gaining popularity in now a day [60].

The history of biotechnology begins with the improvement of wide variety of novel techniques and procedures particularly in relation to viable organisms in terms of their possible risks and potencies [61]. Environmental biotechnology utilizes the biochemical potential of microorganisms and plants for the restoration and preservation of the environment [62]. Development of genetically engineered plants with enhanced tolerance to drought and salinity is a major challenge in the research of rice biotechnology [63]. It also goals at accelerating the biodegradation of petroleum contaminated soils [64]. Marine biotechnology is a technology which will contribute to the sustainable development of our planet [65]. It is considered as an area of great interest and potential due to the contribution for the building of highly efficient and eco-sustainable society [66]. Environmental sensors to biotechnology applications, the complexity of systems and diversity of areas are both indicating number of opportunities in the coming future [67].

CELL BIOLOGY

Extracellular vesicles have been emerged as key player of cell-to-cell communication in stem cell biology [68]. Cell biology of brain-derived neurotrophic factor has developd and now aimed at the understanding of pathological mechanisms of brain disorders [69]. Dental cell biology investigates the regeneration and development of biochips and dental tissues are therefore major tools in an advanced molecular research [70].

GENETICS

Genetic testing for the diagnosis of type 2 diabetes in high risk individuals is currently of little value in clinical practice [71]. Geneticists have reevaluated the external factors and environment as key factors for the regulation of gene expression in some animals [72,73]. Generally, genetic information flows from DNA to RNA and then to protein [74]. There are a lot of genetic disorders and one of the most often diseases is Alzheimer's disease [75].

Genetic diseases were generally caused by variations in the DNA sequences of a particular gene which affect its function and thus cause a particular disease [76].

Genetic test is a test generally conducted for various genetic disorders to determine the molecular basis of the condition and to establish the recurrence risk and mode of inheritance [77]. Genetic testing might also be used to select appropriate drug doses [78,79]. Genetic variability in genes coding for drug

receptors, drug-metabolizing enzymes and proteins involved in pathway signaling is an important factor determining inter-individual variability in drug response [80]. Genetic factors arising from both noncancerous cells and tumor will lead to alterations in drug metabolism [81-83].

Four genetic causes such as translocations, aneuploidies, multifactorial and mitochondrial mutations are playing key role in causing various genetic disorders [84]. Preimplantation genetic diagnosis is presently a realistic option for at risk couples to have a genetic disease free offspring of their own and avoid affected pregnancies [85]. Cockayne syndrome is a genetic recessive disorder characterized by impairment of nervous system development, growth retardation and hypersensitivity to sunlight and premature aging [86]. The general treatment of genetic diseases would consist of taking a normal defective gene and transferring it into the patient's cells, which should express it [87]. Acquired defects in host immune response pathways greatly increase the risk of progressive disease [88].

Inheritance mechanism related to the concept of incomplete dominance of classical genetics [89]. Phylogenetic analysis will generally provide the basic information of conserved sequence regions and it will be beneficial to make further progress [90-92]. There is strong evidence that genetic factors may predispose individuals to the occurrence of psychiatric disorders [93]. Chromosomal abnormalities are playing vital role in causing of genetic diseases [94]. Pharmacogenetics is the study of genetic variability in individuals to related drugs [95-98]. It has led to the discovery of some genetic variants that can be used to develop the safety and efficacy of drugs in the market [99]. Basics of molecular genetics are important for researchers to understand unprecedented insights into the pathogenesis of various genetic disorders which reveals promising treatment targets for future development of drugs [100]. Pharmacogenetics and Ppharmacogenomics have the potential to improve discovery, development and use of medicines [101].

Genetic counseling and the diagnoses are usually made in general practice when it is presented with a severe complication [102]. Genetic improvement generally depends on the alien gene transfer from its secondary and tertiary gene pool [103]. Chemical genetics screening is the use of chemical assays to find biological repercussions in living systems [104]. Genetic polymorphisms play an important role in the pharmacokinetics of meglitinides [105]. Genetic diversity will affect expression of drug targets and drug metabolism [106].

EPIGENETICS

Epigenetics is a new scientific field which is targeting the particular chemical pathways through which modifiable factors such as lifestyle choices and diet can alter gene expression, determining the onset and development of chronic diseases [107]. Epigenetics can be defined as a mechanism that generally contributes to stable changes of gene expression without change in the primary nucleotide sequence [108-113]. It refers to the modulation of gene expression due to a variety of lifestyle-related and environmental factors [114]. Non-coding RNA is an important factor in epigenetic regulation of gene expression [115]. Epigenetic factors are relatively stable and have regulatory roles in numerous genomic activities that translate into phenotypic outcomes [116,117].

British Biologist Conrad Waddington coined the term "Epigenetics" by mixing the terms both epigenesis and genetics [118]. Epigenetic changes are targeted to the DNA as well as chromatin core histones and making them attractive targets for therapeutic purposes [119]. Epigenetic modifications refer to the reversible changes in the genetic material of cells that do not involve any alteration in the DNA sequence [120]. Epigenetic mechanisms, such as DNA methylation, histone modification and acetylation, miRNA, shRNA, and piRNA are scattered throughout the genome and may serve as a switch to turn on or off the target gene [121].

Histone epigenetic modifications are one of the often observed epigenetic alterations in leukemic cells [122]. Epigenetics involves genetic control by factors other than individual's DNA sequence [123]. Epigenetic control is highly complex and involves multi-layered and co-ordinated regulation [124]. Epigenetic change is an alternative mechanism in development of cancer [125].

MICROBIOLOGY

Microbiology is the study of living objects, which are invisible to the naked eye [126]. Microbial growth was determined by measuring the zone of inhibition diameter [127]. Antibiotics produced by microorganisms inhibit the activity of the toxin produced by pathogen [128]. Antimicrobial agent usage is common in animal agriculture for prophylactic and therapeutic purposes [129]. Polymorphism is present in nucleotide sequence of all organisms including microbes [130]. Antimicrobial Photodynamic Therapy has been proposed as a treatment for a large variety of localized microbial infections [131]. Regular microscopic examination sometimes fails to determine the state of intestinal flora and number of bacteria [132,133]. Most anti staphylococcal agents are ineffective against Multi drug resistant staphylococcus aureus [134]. Microbes represent an excellent source of many therapeutic enzymes owing to their broad biochemical diversity and their susceptibility to genetic manipulations [135]. Antibiotic susceptibility profile of microbes vary from province to province, country to country, town to town and hospital to hospital in the same town as well as between public and private healthcare facilities in the same area [136].

Microbes generally grow in an environment of high moisture contents and nutrients [137]. There are many diseases caused by microbes and some of the microbial diseases include tuberculosis, leprosy, cholera, typhoid, anthrax, measles, rabies, small pox, etc. Tuberculosis is the most common and deadly infectious disease associated with significant mortality and morbidity. Mycobacterium tuberculosis is the causative agent of tuberculosis disease which is transmitted through respiratory tract in the form of aerosol droplets particularly in upper part of the lungs. Mycobacterium tuberculosis is responsible for more human mortality and lives longer than most other bacteria which affects all ages and remains one of the world's top ten leading causes of death [138-151].

Leprosy is a most infectious disease caused by mainly two bacteria named Mycobacterium leprae and Mycobacterium lepromatosis which is otherwise called Hansen's disease. Factors, Immunology, symptoms, transmission, diagnosis and treatment have been explained through several articles [152-164]. Botulism is a Food borne disease, which is caused by the bacterium named Clostridium botulinum [165]. It is generally caused by intentional or accidental exposure to botulinum toxins [166]. Cholera remains a major health problem due to poor sanitation and poor hygienic conditions and its causative agent of cholera is Vibrio cholera [167-169]. Typhoid is a food and water born disease caused by bacterium Salmonella typhi which can survive through host parasite interactions and some of the symptoms include headache, epigastric pain, nausea, etc. [170-172].

Anthrax infection caused by Bacillus anthracis which is a gram-positive, rod-shaped bacterium [173-175]. Measles is a high contagious infectious disease caused by Measles virus which is an enveloped RNA virus spreads through respiration by showing manifestations like fever and skin eruption and it is more complex in nature [176-180]. Rabies is a viral zoonotic disease caused by Lyssa virus that causes acute encephalitis to humans and animal species. It is having single-stranded negative-sense RNA virus. Various types of anti-rabies vaccines have been produced but, vaccination against rabies is unique [181-186]. Smallpox is an infectious disease that was caused by both Variola major and Variola minor which belongs to the family Poxviridae and having similar clinical symptoms with monkey pox virus [187-190].

Plants are acting as antimicrobial drugs [191]. Microbial degradation and decolorization of dyes has seen as a cost-effective method for removing pollutants from the environment [192]. Biological control offers an environmental friendly strategy to control agricultural phytopathogens by using microbes to repress plant diseases [193]. Probiotics are defined as live and vital microorganisms which can be able to benefit human health when consumed as part of a food or a nutritional supplement in adequate amount [194]. The new discipline of microbial forensics represents a powerful approach for tracking pathogens associated with bioterrorism [195].

ZOOLOGY

Zoology is the branch of biology which deals with animals and their life that includes structure, physiology, development and classification of all animals. The term zoology has derived from the Greek word "animal". It has again differentiated into numerous sub-disciplines such as, primatology (the study of primates), ornithology (the study of birds), ichthyology (the study of fish) and entomology (the study of insects). Zoology encompasses an important and fascinating body of knowledge that enables us to better understand animals, wildlife, our environment and ourselves. Aristotle has been considering as father of zoology [196].

PSYCHOLOGY

Several psychosocial factors and individual characteristics can explain people's mentality [197]. The prevalence of psychiatric disorders is influenced by a large number of psychological, biological and social factors [198]. Stress is one of the most emotional of psychological events [199]. Psychology education aimed at creating awareness for long-term potentials [200]. Social psychologists play a major role in explicating responses to threats of terror [201]. Premature termination of therapy is a major problem in group therapy as well as in individual psychotherapy for its high prevalence and more number of negative consequences [202]. A clinical psychotherapist will be dealing with his clients by taking a more active therapeutic stance than the traditional psychoanalytic blank screen approach [203].

Psychological need is going deeper and demand got increased which brings the need to incorporate possibility of psychiatric treatment in addition to the psychological approach used to treat people with parapsychological manifestations [204,205]. Psychometric instruments are very much useful in determining severity of depressive symptomatology [206]. Psychological education is effective in the relapse of major depressive disorders and seems to be more cost-effective without psychological education [207]. Psychotherapy is the assessment and treatment of emotional, cognitive or behavioral disturbances by psychotherapeutic means, delivered through a therapeutic relationship based primarily on non-verbal or verbal communications [208]. Clinical depression and anxiety occur about twice as often among persons with both type 1 and type 2 diabetes compared with the general population [209].

PEDIATRICS

Pediatrics is a branch of biology that deals with the medical care of infants, children and adolescents. An eminent scientist named Abraham Jacobi has been considered as the father of pediatrics because of his more number of contributions to this field [210]. Respiratory tract infections are the most frequently encountered clinical conditions and upper respiratory tract infections are one of the most common reasons for pediatrics consultations in primary health care [211]. The prevention of disease flares was achieved in pediatric population with the use of azathioprine in the majority of Crohn disease patients and with an almost equivalent use of aminosalicylates and immunomodulators in ulcerative colitis patients [212]. Pediatric palliative care is defined as the comprehensive care and management of the psychological, physical, emotional and spiritual needs of children and their families with chronic, debilitating or life-threatening illness [213].

IMMUNOLOGY

Immune related diseases are the conditions which generally result from abnormal activity of the body's immune system [214]. The immune system has two divisions, known as innate and adaptive immunity [215]. The immune system refers to the cells, tissues and molecules which protect the body from infectious agents [216]. Regulation of the immune system depends upon both genetic and epigenetic factors [217]. Cells that play a critical role in initiating the innate immune response are the macrophages and dendritic cells [218]. T cells play a primary role in initiating and mounting effective adaptive immune responses [219]. Natural killer T cells are involved in the regulation of immune responses by bridging the gap between innate and adaptive immune system cells [220].

Programmed cell death which can be otherwise called apoptosis is one of the major contributions in the development of normal immune system [221]. Immune cells undergo apoptosis as part of the well-known phenomenon of negative and positive selection of T cells in the thymus [222]. Heat shock proteins play a complex role in the maintenance and mediation of immune functions majorly in the trimming transport and presentation of antigenic peptides to immune molecules [223]. Mucosal immune system plays a vital role in protecting the host against many environmental antigens and pathogens [224]. Immunosenescence is the steady degeneration of immune system that occurs with age in animals and humans [225]. Osteoimmunology is an emerging interdisciplinary field that mainly focuses on the cellular and molecular events underlying between bone and immune systems [226].

Autoimmune disorders are group of diseases believed to be arising from immune-mediated attack against self-antigens [227]. Type 1 diabetes mellitus which can be otherwise called autoimmune diabetes most commonly present in patients with mid and late childhood [228]. Immunotherapy is developing as a novel treatment option for different types of malignancies [229]. Recombinant viral vectors are playing major role gene therapy, vaccination and immunotherapy [230]. Recent progress in cancer immunology and the development of cancer immunotherapy has been truly remarkable. [231].

CONCLUSION

There are many more branches in the field of biology along with the branches like anatomy, physiology, agriculture, nanotechnology, astrobiology, biochemistry, bioinformatics, biomechanics, biotechnology, cell biology, genetics, microbiology, zoology, psychology, pediatrics, immunology which are serving to the present world by significant emergence. All these branches have interlinked with the daily life of all living creatures and thus increasing the significance of biology day by day.

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