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Review Article

A Brief Review on Convergence of Diversifying Fields of Nanotechnology and Bioinformatics as an Advanced Revolutionized Device for Betterment of Humankind

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ABSTRACT

Nanotechnology has grown from an attractive idea to what is called a breakthrough advances technology in science World. The ability to precisely control and to build molecules at extremely small length scales coined as term, nanoscales which holds the promise for unprecedented achievements in healthcare, manufacturing, agriculture, energy and national security. In the recent years, it has diversified into different fields and sciences giving rise to tremendous developments and advancements with endless scope used for betterment of earth and humankind. Hence, this review discusses the different areas of this advanced scientific development which emerges as nanobiotechnology, nanorobotics, green nanotechnology and nanoscience. Especially, this review highlights the role of bioinformatics in nanotechnology as nano-informatics and the creation of what is called a nanolibrary which exactly, represents the application of the scientific blend of two advanced technologies as their convergence with their future role in revolution for betterment of mankind too with their applications in therapeutics, nutraceutics and pharmaceutics.

Keywords: Nanotechnology, nanolibrary, bioinformatics, nanobiotechnology, green nanotechnology

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1. INTRODUCTION

Over the period of time, biotechnology has earned a vast and advanced repute in research and innovation aspects as well as expanded its range of advanced applications in key areas of all concerned advanced technologies over a very short period of times. Nanotechnology is one that filed field in which biotechnological tools and methodologies have

imparted an overall considerable impact in betterment of humankind. Nanotechnology is promising answers to solve many types of problems in all scientific fields. Nanotechnology is coined only for the technology for nanometer sized particles which is one billionth of a meter and their application towards social welfare. [3] This whole wide world ranging from air to humans to space objects is made of these nanoscale particles. The study of these nanoscale molecules can do wonders in therapeutic and pharmaceutics. [7] The nanotechnology market is expected to expand to approximately $48.9 billion by the year 2017 whose growth comes from more than electronics and computer chips from forensics to plastics to energy to health, the smallest size dimensions are becoming the most important features. The most important implication of the nanoscience is to define science of quantum mechanics with least energy discretion at the nanoscale. [6] Role of nanotechnology in molecular biology is a proposed approach which involves manipulating single molecules in finely controlled, deterministic ways with its beyond current capabilities in clinical field. And, nanorobotics are started to develop on self-sufficient machines of some functionality operating at the nanoscale level which are new hopes for applying nanorobots in medicine too which may not be so easy to do their implementation because of some raised pro and cons of self operating devices. Apart this, still progress on innovative materials and methodologies at nanoscale has been demonstrated with some granted patents on this emerging advanced manufacturing devices for future commercial applications with their progressively outcome in the developing nanorobots with the use of embedded nanobioelectronics concepts as well in clinical practices. [1, 16, 17]

2. NANOSCIENCE AND ITS TOOLS

Nanoscience is of trans-disciplinary nature and fusion of physics, chemistry, mathematics, cognitive sciences and life sciences. A well as nanoscience represents a convergence of quantum physics, molecular biology, computer science, chemistry and engineering. Innovations arising from nanoscience are likely to be commercialized as greater control over atom-by-atom and molecule-by-molecule construction improves day-by-day. [7] The basic and the first tool that helped the visualization at nanoscale length was the “scanning tunnelling microscope” developed in the 1980 followed by the atomic force microscopy used today. Nanotechnology is promising answers to many types of problems in all fields of work. The scientists have developed a novel device which combines sub-wavelength laser imaging with broadband intensity spectroscopy that uses high intensity illumination. [8]

3. NANO-BIOTECHNOLOGY VS BIO-NANOTECHNOLOGY

Nanobiotechnology is an integration of biotechnology at nanoscale. It is different from bio-nanotechnology though sometimes these terms are used interchangeably but there is a distinction between the two. Bio-nanotechnology tries to achieve the goal of biotechnology with the help of nanotechnology. [10] A biosensor is an analytical device that detects an analyte by combining biological and physiological component. The multiple activities of a biosensor (physics, chemistry, and nanoparticle) are described by nanotechnology to examine specific nanoparticles of natural materials like proteins and antibodies. [2] Another threshold involves the research of nanospheres glazed with fluorescent polymers to resolve human health problems. The concept behind this concept is that the fluorescence of these polymers is degraded once they encounter a molecule. In this manner different polymers specific for different target molecules can be developed. Such nanosize particles could then be introduced into human body for identification of metabolites related to tumour or other

non-traceable health problems. [14] While, bio-nanotechnology is an intersection of biology and nanotechnology. It is the use of biotechnology as a motivation for nanoscale devices. The use of DNA, RNA, proteins and ATP as building blocks of nanomaterials is coined dry-wet technology which in turn, its futuristic concepts of bio-nanotechnology around the artificial cell. Now, these days bio-nanotechnology seeks to modify naturally occurring nanomotors of ATP synthase or scaffolds of enzyme complex of cellulosomes to make nanosomes. [13]

4. GREEN NANOTECHNOLOGY

Green nanotechnology makes use of Green engineering and green chemistry to achieve nanoproducts which are more ecofriendly and cause no harm to humans. [12] Green nanotechnology is an emerging field of nanotechnology which aims at producing nano-range products which help towards maintaining a sustainable environment. [9] James Hutchison was a chemist who developed eco-friendly to produce gold nanoparticles by catalysis and nano-porous filtration. [11]

5. WHAT IS BIOINFORMATICS?

With the fast developments in the research and innovation, it became important to find a means to store, manage and analyse the data which are accumulated out of the research and innovative activites. This lead to the sprouting of bio-informatics where computers and information technology combine to solve these emerging biological problems from 1960 when it began just as storage of DNA and protein sequence data it has grown into computational biology in the 1990. The main line in the projects of bio-informatics is the use of mathematical tools to extract information from “noisy” data on DNA and proteins. The use of bioinformatics has been in sequencing of the genomes, protein profiling, biodiversity assessment and study of evolutionary history. [4, 16, 17] A phenomenon called fractional sequencing has also come into use which has made sequencing easier. The future of bioinformatics is integration of a wide variety of data sources such as clinical and genomic data will allow us to use disease symptoms to predict genetic mutations and vice versa. The integration of Geographic Information system data such as maps and weather systems with crop health and genotype data that will allow us to predict successful outcomes of agriculture experiments. The task of converting electrocardiograms, genotypes, phenotypes behavioural changes etc into computer readable forms is the main challenge of bioinformatics which is in a cycle starts from cells to organism to environment to biomolecules to DNA to RNA to proteins to signalling molecules which exactly, showed the integration and application of informatics in various area of biotechnology. [5, 1,4]

6. ROLE OF BIOINFORMATICS IN NANOTECHNOLOGY: CREATION OF NANOLIBRARY

Bio-informatics has helped in various technologies so far. Being engineering disciples integration of both nanotechnology and biotechnology can provide a major fuelling to the development of nanoscale objects. The emerging collaboration can help building ultimate pathogens which can be identified on the basis of their already existing nucleic acid sequences in informatics library. [12] By studying human genome we have been able to block cancer channels to inhibit their activity at nutritional level and starve them to death. Therefore by analysing genomes of other organisms as offered by bioinformatics, we can create nanodevices to destroy cancer cells using computing techniques. Also assessing, collecting and manipulating information of nanoscale research on a separate level can be done by computational nanotechnology. [2, 7] Application of bioinformatics in drug discovery can prove to be a major help in nanotechnology. Cheminformatics aims at designing drugs and modifying them structurally to

study their effects theoretically based on computer algorithms. Therefore, this technology can be used to develop the structure, path and consequence of therapeutic nanoparticles as in silico (computer based, silicon chip technology). This would obviously save the time of *in vitro* and *in vivo* experimental discovery of useful nanodevices. [15]

7. NANO-INFORMATICS

In order to manage the plethora of data gathered as a part of nanoscience and technology it has become important to develop tools for the analysis and manipulation of this data to coined a term "nano-informatics" as ultimate achievement which leads to creation of a Nanolibrary. Therefore computational nanotechnology is the study, design, analysis, operation and optimization of nano-scale systems. [4] The approach is included establishment of databases by gathering of information of biomolecules such as proteins or nucleic acids can be incorporated into the nanoshells in which nanomaterial has highest penetrating power to targeted areas by having their site specificity as well as to explore relationships and interactions between biomolecules and atoms [5]. Nano-informatics can play an important role in converting solar energy into electrical energy thus supporting the design of nano-scale solar cells. And, new computational nanotechnology resulted reveal mechanical properties of carbon nanotubes (CNTs) that are optimized by hierarchical assembly of smaller protein domains. [6, 15]

8. UPCOMING ISSUES

Hence, nanobiotechnology is the next miraculous turn with its benefits in every fields especially in therapeutics and pharmaceutics. Besides, microspheres and nanoparticles which are mostly used for cell selective delivery of drugs, they have more recently been studied for their application in oral delivery of peptides and peptidomimetics. [16] However linking data from so many technologies where each has its own culture and own terminology is a very difficult task. This gives rise to a question whether nanoinformatics will come to reality or not. But with so many scientists and computer biologists working towards it we definitely see a bright and positive future. [12, 13] There are also so many ethical issues related to the rapid advances being made through this new field. An attempt to change everything and shift completely to a nanoscale world has obviously given rise to concern among the people whether to accept it or not. But undoubtedly nanotechnology along with its associated fields has the power to revolutionize and rejuvenate the lives of people all over the world. [14, 17] Recently, role of glucose oxidase bound bovine serum albumin nanoparticles was observed as eco-friendly biodegradable preservative for soft drinks and non-alcoholic beverages to make them opalescent and free from any type of microbial growth which occurs due to the presence of used glucose as sweetener in these kind of beverages. [18] The chemotherapeutic agents with nanoparticles offers improvement in the solubility and stability of antitumor agents, avoidance of drug degradation and reductions in therapeutic dose and toxicity, increasing drug levels in tumor tissue and decreasing them in healthy tissue too. [19] Nanotech may be able to create many new nanomaterials and nanodevices with at least one dimension sized from 1 to 100 nanometres with its wide range of applications especially in medicine, electronics, biomaterials and energy production which, in turn, increases its lots of new possibilities come into account in relation to use of nanotechnology in medicines via involves the prospective applications of nanomaterials and nano-robots in medicine to make repairs at the cellular levels. [20]

9. CONCLUSION

Tools, nanoscale building and informatics are the three fields whose integration should be given impetus to go ahead with application of nanotechnology. A good deal of advancement in these areas can help to solve the issues of present which include better medical treatments and healthcare issues. Researchers are trying to work things out by combination of nanotechnology and bioinformatics and their application in agricultural, food and environmental engineering. Nanoparticles consists of biocompatible which are smaller (0.2– 0.5 μm) may have site specific drug loading capacity than microspheres of the soluble polymers due to having smallest size [16]. Nanotechnology will evolve in ways which might be beyond our imagination at present but will certainly help humanity and fuel human potential to resolve the possible issues that crop up. Hence, matter at such a small scale called nanotechnology may lead to revolutionized clinical practices in favour of betterment of humankind to make our world a better place.

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