NANOMEDICINE: THE CHANGING SCENARIO IN MEDICAL SCIENCE

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ABSTRACT

Nanotechnology is one of the most exciting and dynamic fields which have been emerged as major subject over the last two decades in various Governments, industry and academia sectors. The interdisciplinary nature of nanotechnology brings people together from various disciplines, facilities and regions with the common objective of improving lives of everyone regardless of their background, culture and geographical location. The majority of studies have focused on materials sciences with some applications emerging in the biomedical field. New insights have emerged in various fields by developing various promising tools for the advancements in medical sciences in diagnostic, drug/gene therapy, biomedical imaging for their unique physicochemical and biological properties etc. The various properties of nanomaterials such as size, shape, chemical composition, surface structure, surface charge, aggregation, agglomeration, and solubility greatly influence their interactions with biomolecules and cells. It provides not only great scientific potential in terms of output but also provides a framework through which we can shape some of the most dynamic and exciting multidisciplinary research currently in practice. The nanomedicine and nano- biomaterials will revolutionise medical treatments and healthcare when interfaced with appropriate control of electronics. The application is clear and promising; however, the basics of nanoscience in drug delivery are poorly understood. The sound investigations in the basic properties of nanomaterials with having great scope in nanomedicine within the invisible nano world which seems poised to result in a revolution in medical world, is widely expected to have a massive impact on commercial applications in the near future.

Key words: Drug Delivery, Biomaterials, Nanobiotechnology, Nanomedicines, Metal Nanoparticles

I. INTRODUCTION

In medieval period most of doctors believed that it is necessary to treat organic problems with organic drugs, which gave them a limited arsenal of plant and animal therapies to choose specific substance, but in 16th Century it was Dr. Para Celsus who revolutionized medicine by using minerals and inorganic compounds to treat human diseases first time. Since then the progress has been made continuously in medical Sciences by researchers all over the world in different forms advancement of research and development by using a number of techniques. Nanoparticle research is currently an area of intense scientific interest due to its wide potential applications in biomedical, health care, optical and electronic fields. The metal nanoparticles are having wide range of applications in controlling various pathogens as they are tiny particles and due to its unique size-dependent, optical, electrical and magnetic properties, these nanoparticles are used in catalysis which are acting against different microbes' viz., bacteria, virus and fungi [1,2]. The biological and medical research communities have exploited the unique properties of nanomaterials for various applications (e.g., contrast agents for cell imaging and therapeutics for treating various diseases like cancer, AIDS, Tuberculosis, Multi drug resistant disease etc). The terms *nanobiotechnology* and *nanomedicine* are used to describe this hybrid field. Nanomedicine is the simply described as medical application of nanotechnology [3], which ranges from the medical applications of nanomaterials to nanoelectronics biosensors, and its possible future applications of molecular nanotechnology which is one of the hotspot of modern research. The functionalities can be added to nanomaterials by interfacing them with biological molecules or structures. The size of nanomaterials is one of the most important factors, which is almost similar in structure to that of most biological molecules; which can be useful for both in vivo and in vitro biomedical research and applications. The integration of nanomaterials with biology has led to the development of diagnostic devices, contrast agents, analytical tools, physical therapy applications, and drug delivery vehicles [4,5].

Currently by the application of Nanotechnology in the field of genetics, medical devices and pharmaceuticals has revolutionized the diagnosis and treatment of diseases disability. Advances may include new methods for using magnetic, nuclear and optical imaging techniques at the molecular level to enhance the detection of diseases such as potential cancerous tumors or areas of plaque built up in the heart and neck arteries that can lead to heart attacks. The treatment of cancer is evolving towards "targeted therapeutics" whereby antibodies or other agents can find and destroy specific cancer cells and other "smart drugs" will be able to target specific diseases but needs advanced studies, so that the drugs that release antibiotics only in the presence of infection. Human bodies are filled with intricate active molecular structures and when these structures are damaged, the health suffers. The modern medicine can affect the workings of the body in many ways, but from a molecular view point it remains crude indeed. The molecular manufacturing with the implementation of nanotechnology can construct a range of medical instruments and devices with far greater abilities. In short we can say that the human body is enormously complex world of molecules and with the help of molecular nanotechnology we can learn to repair it [3,4].

To understand what nanotechnology can do for medicine, we need a picture of the body from a molecular perspective. The human body can be considered as a work yard, or a construction site or a battle ground for molecular machines. It works remarkably well, using system so complex that medical science still does not understand many of them, though the failures cannot be ruled out at certain stages. While considering the human body as a work yard, the molecular machines are doing the daily work to maintain the metabolism of the various reactions with the involvement of enzymes, hormones etc. In the same way the human body is like a battlefield, which is always in the aggression and defending with the major concerns in various pathogens from parasitic worms to protozoa to fingi to bacteria to virus. The various organisms have learned to live by entering in the body and using their molecular machinery to build more of them from the host [5,6].

II. MEDICAL USE OF NANOMATERIALS

Nanotechnology and nanoscience are very useful in developing entirely new schemes for increasing bioavailability and improving drug delivery by delivering the specific drug directly to the site of a target like tumor before the tumor metastasizes and without interacting with the rest of the body, the chemotherapy could come more effective and much less unpleasant. This would be an effective method for creating time released drugs so that a pill taken once a day or once a week can continue to deliver the drug smoothly over an extended period of time. Another even simpler scheme, which has the effect of maximizing overall bioavailability for a short time is to grind solid drug into fine powder, so that the particles are in the nanoscale size, which will increase the surface area and reactivity. Much more complex drug delivery schemes have also been developed, with having ability to get drugs through cell wall and into cells. Efficient drug delivery is important in drug delivery because many diseases ranging from Sickle Cell Anemia to diabetes are depending upon processes within the cell and can only be interfered with by drug delivered into the cell. Many drug molecules cannot pass through the membrane that surrounds the cell, essentially because of difficulty associated with putting polar molecules into non-polar membrane [6].

III. NANOMEDICINE: A BRIEF OF DRUG DELIVERY

The Proteins and peptides are exerting multiple biological actions in human body and they have been identified as showing great promise for treatment of various diseases and disorders. The nanotechnology is becoming efficient tool in solving this problem by encapsulating the polar drug in a non-polar coating which will easily pass through the cell membrane. For example small molecules of DNA that combines with Alien pathogenic within the cell can be used as a drug. To make these artificial DNA drugs highly available within the cell, however one must pass them through membrane. One way of doing this is to coat the DNA with cholesterol. Cholesterol is a fatty hydrophobic molecule that easily passes through the oily cell membrane. By enclosing the DNA drug within a blanket of cholesterol, it can be delivered into cell where it can be most effective. Liposome, structures based on balls of fatty molecules enclosing the drug work. Similarly, Liposome's have been used in cancer treatment, delivering soluble proteins (cytokines) such as interferon to cancer cells [7,8,9].

The magnetic nanoparticles can also be used for drug delivery. Here, the nano magnet is bound by a molecular recognition method to the drug to be delivered. Then magnetic field external to the body can manipulate the position of the nanodots and therefore control local bioavailability of the drug. Effectively the doctor can drag the drug through the body in the same way that you drag iron fillings across a table with a hand magnet. One interesting combination of smart materials and drug delivery involves triggered response. This consists of placing drug molecules within the body in an inactive form that “wakes up” on encountering a particular signal. A simple example would be an antacid enclosed in a coating of polymer that dissolves only in highly acidic conditions; the antacid would then be released only when the outer polymer coat encounters a highly acidic spot in the digestive track [10, 11]. Artificial bone materials are another example – The molecules that come together to form the artificial bone cylinder can be placed either inside or outside the body and can be programmed by design to come together to form the rigid cylinder only when exposed to a trip signal which might be something as simple as exposure to liquid water or a cut or an impact. They might operate in such a way as platelets in the blood stream.

Molecular design and molecular nanobiology are resulting in many new smart drugs. Two particularly intriguing examples are the so- called inhibitors and DNA molecule therapies. Suicide inhibitors are not actually intended to discourage suicidal behavior among people as the name implies, though they can be used to treat depressions. Instead, they are designed to block the action of certain enzymes by causing the enzymes in effect to commit suicide. They start their journey as being molecules structured so that the enzyme they are supposed to destroy recognizes than and tries to do its normal job and modify them. But these molecules are slightly different than most molecules that the enzymes modify in that [13, 14,15].

IV. CONCLUSION

This paper highlights various aspects and dimensions of medical nanotechnology. The various advances in nanoscience and its dimensions, with main focus on medical applications in the treatment of diseases, by the developing of innovative tools which could be a suitable substitute with having advanced applications as compared to existing production equipment with less consumption of energy and materials. The nanomedicines are becoming the advanced to cope up with antimicrobial resistance and to control various pathogens, while as the nano-robotics and drug delivery are having great achievement to treat targeted diseases. The nanobiotechnology needs to grow further by exploring many more possible applications in various fields like medical imaging; optical devices, sensor technology, cancer treatment or drug delivery systems etc with sufficient time and research will achieve a mile stone for the welfare of science and humanities.

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