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Application of Nano Medicine Power in the Medical Field

Ashish K. Rai[1*], Rahul Singh[2], Heena Bano[2] and Priyanka Prasad[1]

[1]Department of Biotechnology, Bansal Institute of Engineering and Technology, Lucknow, 226021, Uttar Pradesh, India
[2]Department of Bioengineering, Integral University, Lucknow, 226026, Uttar Pradesh, India

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*Corresponding Author
Ashish K. Rai*

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INTRODUCTION

Nanotechnology is an area of modern research that deals with the synthesis, strategy, and manual manipulation of particle structures varying in size from 1 to 100 nm. All the characteristics (chemical, physical, and biological) of individual atoms/molecules and their corresponding bulk change in basic ways as a function of their size. Because of their entirely new or improved characteristics based on size, distribution, and shape, novel uses of nanoparticles and nanomaterials are quickly increasing on a daily basis (Ahmed, et al., 2016).

Nanoparticles size attracting the attention of many researchers because nanoparticles can produce in different size and shapes and due to this property nanoparticles can be used in advanced biotechnology. Nanoparticles are applied in pharmaceutical industries because of their strong antimicrobial and anticancer activity (Patil & Kim, 2017).

The National Institutes of Health (NIH) of US announced a four-year program involving nanoscience and nanotechnology in medicine in December 2002. A growing interest in nanotechnology's medicinal uses has given rise to a new field known as nanomedicine. Nanomedicine, in its broadest sense, is the process of employing molecular tools and understanding of the human body to diagnose, treat, and prevent disease and traumatic injury, relieve pain, and improve human health. Nanomedicine in simple words is the application of nanotechnology to medicine (Freitas Jr, 2005). Nanotechnology was beleived to be useful in biology and medicine because various components of cells are in the nanoscale range. Nanomedicine is an interdisciplinary field that combines biology, chemistry, engineering, and medicine to develop more effective methods for diseases prevention and treatment.

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For biomedical engineers and therapists, nanomedicine-based approaches have opened new possibilities in the prevention, detection, and treatment of severe diseases like cancer. Nanotechnology benefits in health and medicine have been known with significant achievements in drug delivery systems, medical imaging and diagnosis tools, implantable materials, and tissue regeneration methods. There is currently a variety of FDA-approved nanomedicine products are available in the market. However, producing more complex materials such as micelles, protein-based NPs, and a range of inorganic and metallic particles has recently received a lot of interest in clinical studies (Moghimi et al., 2005).

Nanomedicine affects all field of medicine

Nanomedicine is described as an important effective tool of personalized, targeted, and regenerative medicine by providing the next generation of medicines, therapies, and implantable devices to doctors and patients, resulting in significant healthcare achievements. Beyond that, Nanomedicine gives powerful techniques to deal with the problem of an ageing population and is believed to be essential for better and economically effective healthcare, one crucial component for making medication and treatments available and cheap to everyone (Kargozar & Mozafari, 2018).

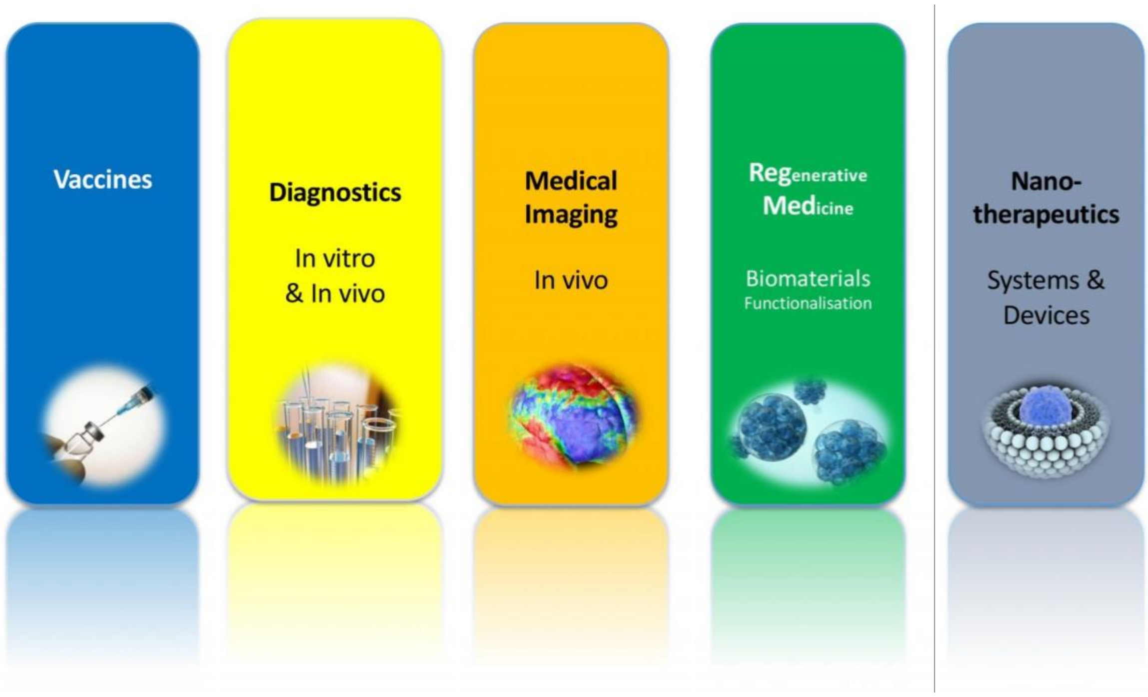

Fig: Nanomedicines used in twenty- first century

COVID- 19 nanomedicine

The COVID-19 outbreak has impacted negatively throughout the world and has emerged as one of the most difficult global health concerns in contemporary history. Rapid diagnostic tests and, perhaps more significantly, quickly produced vaccinations against SARS-CoV-2 have benefited from advancements in nanotechnology. The scientific community has reacted with remarkable speed to tackle the life-threatening problems of the present pandemic. At least three COVID-19 vaccines have resulted from nanomedical breakthroughs. The first two human vaccines (developed by Pfizer/BioNTech and Moderna) use lipid nanoparticles to cage, stabilize, and transport mRNA molecules, while the Novavax vaccine generates antigens derived from the SARS-CoV-2 spike protein using a specialized recombinant protein nanoparticle technology platform (Wankar et al., 2020).

Cancer nanomedicine

Cancer is one of the world's most fatal diseases, with more than 10 million new cases diagnosed each year. Cancer detection and treatment could be revolutionized because of nanotechnology. Novel nanoscale targeting methods have been developed as a result of advances in protein engineering and materials science that might provide new hope to cancer patients (Salamanca-Buentello & Daar, 2021). Traditional cancer treatments have significant drawbacks, prompting the development and application of several nanotechnologies for more effective and safer cancer therapy, called cancer nanomedicine. Many therapeutic nanoparticles (NP) channels, such as liposomes, albumin NPs, and polymeric micelles, have been accepted for cancer treatment, and many more nanotechnology-enabled treatment methods, such as chemotherapy, hyperthermia, radiation therapy, gene or RNA interference (RNAi) therapy, andimmunotherapy are attracting increasing attention in clinical trials (Peer et al., 2007).

Cardiology nanomedicine

Scientists are working on less invasive therapies for heart disease, diabetes, and many other diseases, and because of nanotechnology, there is hope. Identification of a protein that causes blood vessels to develop, synthesis and packaging of strands of DNA containing the gene for producing the protein, and delivery of the DNA to heart muscle are all examples of cardiovascular gene therapy. "Biobots" (a kind of nanorobots), another use of nanotechnology is the production of muscle-powered nanoparticles with the capacity to transport information into cells, which has the potential to replace numerous tissues that have lost biological function, such as the sinoatrial node. By improving the biocompatibility of cardiac implantable devices and regulating the main limit factors for Percutaneous Transluminal Coronary Angioplasty (PTCA) at a molecular level via nanoparticles, this effect could lead to the treatment of diseases that would otherwise be fatal or tough to cure for humans, such as Coronary Artery Disease (CAD). Another use of nanotechnology in cardiology is the detection of the complementary DNA strand, which is based on the finding of single-walled Carbon nanotube complexes with single-stranded DNA (Shi et al., 2017).

Regenerative nanomedicine

Tissue engineering combines engineering and biological science concepts and discoveries to strengthen, repair or replace tissue/organ function. By introducing a tissue tailored foundation that the body identifies as "self" and utilizes to create "neo-native" functioning tissues, the ultimate objective is to enable the body (cellular components) to repair itself. Furthermore, the demand for organs for transplantation probably outnumbers the supply, and regenerative therapy-based organ building has been proposed as a possible solution to this problem. Nanotechnology has the ability to produce devices that will speed up the development of organ engineering (Abeer, 2012). Future medical nanotechnology is predicted to use nanorobots implanted into patients to perform cellular-level therapy. Cells, bacteria, and viruses, for example, can be better understood. It is possible to identify and avoid the causes of relatively new disorders. Restore your ability to see. It is possible to make genome sequencing more easily. It is possible to track and identify the biological origins of mental illnesses. Curiosity may be roused and stimulated again. Nanomaterials might potentially be used in tissue engineering. Tissue engineering makes use of nanomaterial-based scaffolds and growth agents to artificially boost cell multiplication. Advances in nanotechnology-based tissue engineering may potentially help humans and other animals live longer lives (Shi et al., 2017).

Drug delivery using nanomedicine

Nanovehicles, nano substances employed as a therapeutic tool and intended to precisely accumulate in the areas of the body where they are needed in order to improve pharmacotherapeutic results, it has become one of the most important nanotechnology applications produced over the last decade. The major goal of this application is to improve therapeutic efficacy while lowering toxicity levels. As a result, nanodrugs and nanodiagnostics have been developed to improve bioavailability profiles, allowing for the administration of lower doses and, as a result, reducing the adverse reactions associated with conventional drugs in clinical practice and improving patient health compiles some drugs using nanocarriers and their routes of administration (Abeer, 2012).

Gene delivery using nanomedicine

Traditionally, three primary techniques of gene transfer have been used: viral, physical, and chemical systems. With the advent of nanotechnology, it has been claimed that NPs have a lot of promise as vectors for delivering various molecules like DNA, RNA, and so on. Nanotechnology-based gene delivery systems are now regarded as a subfield of nanomedicine that focuses on the synthesis, characterisation, and functionalization of nanomaterials for use in targeted gene delivery. A variety of nanomaterials, including lipids, polymers, graphene, carbon nanotubes (CNTs), nanospheres, and many types of inorganic particles, have been utilized as gene delivery methods. The functionalized kinds of nanomaterials-based gene delivery platforms were determined to be the most promising systems due to their sustained gene delivery effects in the target tissue and improved genetic material stability. Although there is considerable potential in employing NP-based gene delivery systems to cure numerous fatal hereditary and acquired illnesses, no gene delivery system has been authorized by the Food and Drug Administration (FDA). The reasons for this are the uncertain long-term toxicity of nanomaterials and their poor gene transfection efficacy in vivo (Boulaiz et al., 2011).

CONCLUSION

Our potential to shape materials and devices at the molecular scale in the short - term will have huge direct benefits and will transform medical research and practice. Nanotechnology has the potential to revolutionize the world of technology. When employed as tags or labels, nanoscale particles improve the sensitivity, speed, and flexibility of biological tests that measure the presence or activity of certain chemicals. Early identification of maladies like cancer increases the chances of a cure. Nanotechnology has a beneficial influence on clinical decision-making and treatment costs by decreasing the time necessary for tests. The opportunity to continue these advances at the level of individual cells will support initiatives to deliver potentially effective treatments directly to the dysfunctional location. Many of the greatest medical discoveries in the previous 20 years have come from imaging, diagnosis, and characterization of disease processes rather than treatment.

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