The Fascinating World of NANO

Dr. Tanay Pramanik
Professor, University of Engineering and Management Kolkata.

Dr. Sayantan Sil
Associate Professor, University of Engineering and Management Kolkata.

Dr. Manas Roy
Assistant Professor, National Institute of Technology, Agartala.

THE FASCINATING WORLD OF NANO

The Fascinating World of Nano

Dr. Tanay Pramanik

Professor
University of Engineering and Management Kolkata

Dr. Sayantan Sil

Associate Professor
University of Engineering and Management Kolkata

Dr. Manas Roy

Assistant Professor
National Institute of Technology, Agartala

BIG BOOK DISTRIBUTOR
bigbookdistributor@gmail.com
8178465057, 8700124880
B – 507, Saya Zions, Greater
Noida West (U.P. - 201305)

Editors© : **Dr. Tanay Pramanik**
Dr. Sayantan Sil
Dr. Manas Roy

Publisher : Big Book Distributor
Sector 10-B, Vasundhara,
Noida West (U.P. - 201305)

Phone : 9810749840, 8700124880

E-mail : bigbookdistributor@gmail.com

Book : **The Fascinating World of Nano**

Edition : 2024

ISBN : 978-81-965714-0-5

Price : 699/-

Printed By : Swaranjali Printers

Content

Chapter 5

Nanotechnology: Enhancing Healthcare - A Quick Look

Bitaan Sarkar, Debdyutimoy Paria, Jishnu Garang, Jayanta Ghosh, Sayantan Sil and Tanay Pramanik

University of Engineering and Management, University Area, Action Area III, B/5, Newtown, Kolkata

Abstract

Nanotechnology's profound impact on the field of health is a testament to its potential to revolutionize healthcare. Nanotechnology allows to the ability to manipulate and engineer materials at the nanoscale, typically at dimensions less than 100 nanometers. Nanotechnology provides access to the creation of structures and devices with properties that can be finely tuned to address specific health-related challenges very efficiently and easily. The most notable area where nanotechnology has made a substantial impact is drug delivery. Normal Drug delivery lacks precision leading to inefficiencies. Nanoparticles and Nanocarriers, designed to transport therapeutic agents, can now be tailored to navigate the body's complex biological terrain. In the field of diagnostics, nanotechnology has brought a wave of all kinds of innovation, like, Nanoscale sensors and imaging agents have greatly improved our ability to detect diseases at earlier stages, with higher sensitivity and specificity. The Risk of a person dying can be lower to a much smaller percentage. Nanotechnology has created a path to the era of personalized medicine. Nanotechnology is contributing to various fields related to healthcare.

Key-Words: Nanotechnology, Healthcare, Revolutionary Medication, Effective Machinery Targeted therapy, Nanoencapsulation, Therapeutic nanoparticles

Introduction:

The impact of nanotechnology in healthcare has created a new era of possibilities, where the manipulation and engineering of materials at the nanoscale have revolutionized the way we approach medical diagnosis, treatment, and personalized care. Nanotechnology has given a new ray of hope that human beings do not have to die because there is no modern medication available in our society to cure that disease. Due to nanotechnology, the health problem can be solved more quickly and efficiently. The convergence of nanotechnology with healthcare has led to breakthroughs in drug delivery, diagnostics, and the development of targeted therapies. Nanotechnology has also empowered healthcare through the

creation of Nano scale sensors and imaging agents that have greatly improved our ability to detect diseases at their early stages.

This Nanotechnology was first invented in 1959 when physicist Richard Feynman presented a presentation on making things at the atomic and molecular levels. Moreover, the use of nanotechnology in healthcare has given rise to the concept of personalized medicine. It helps in customizing the process to an individual's unique gene so that healthcare providers can optimize the outcomes while minimizing adverse effects. Nanotechnology makes it much easier to deliver drugs quickly and safely. For this a special method is used to make the drugs it is called Nano encapsulation, by encapsulating the Liposomes it can prevent the degradation of the drug inside the cells and ensure the delivery of the small molecules at the target site. Nanoparticles loaded with specific drugs or other therapeutic agents can be designed to interact witha patient's genetic profile, offering more effective treatments precisely calibrated for each individual specifically.

Review of Literature:

In the field of healthcare, nanotechnology is being used to develop targeted drug delivery systems and new diagnostic tools. The main benefits of Nanotechnology are as follows: -

Targeted Drug Delivery: - Targeted drug delivery, sometimes called smart drug delivery,is a method for mainly delivering medication to any patient in a manner that increases the concentration of the medication that is to be given in any body part specifically than other. Ithelps in delivering the drug to the right area where the disease has spread the most with the help of Nanomedicine. The main purpose of targeted drug delivery is to keep the contamination minimum and also put the exact amount of medicine in that place at thesame time. This process releases the drug in a dosing system for it to be more efficient. It has been developed also to optimize regenerative techniques. In the system it delivers a certain amount of therapeutic agent for a prolonged period to a targeted diseased area of the body, it also helps in keeping the plasma and drug levels maintained in the body. There are mainly two types of Targeting drug delivery: - 1. Passive Targeting and 2. Active Targeting.

Passive Targeting- In case of unresisting targeting the nanoparticles are cloaked with some kind of coating and also incorporated into a macromolecule or nanoparticles that reach the body in an unresisting manner.

Active Targeting- In the case of active targeting there are numerous ways to do it but one way is by laboriously targeting the solely diseased towel in the body to know the nature of a receptor on the cell for which the medicine will

be targeted, also called specific ligands will allow it to bind to the specific reciprocal receptor. It's substantially used in curing excrescence cells.

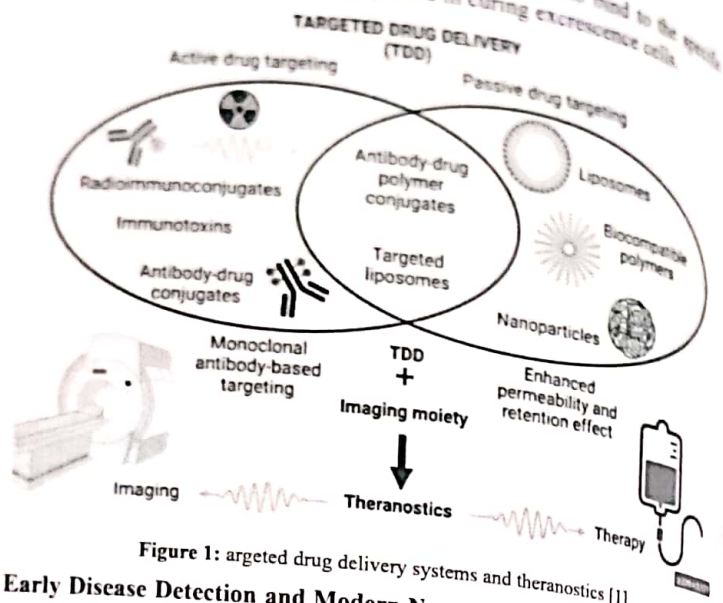

Figure 1: argeted drug delivery systems and theranostics [1]

Early Disease Detection and Modern Nanotechs: Nanoscale materials and structureshave high surface area-to-volume ratios generally, which allows for enhanced interaction with biomolecules. This helps in the detection of very low concentrations of biomarkers or disease-related molecules, even in the early stage it can detect the disease very easily without failing. Nanosensors area creation of nanotechnology that helps in detecting any disease at an early stage even before symptoms are seen. Early detection is a vital element in curing any person from any disease. Even portable machines are being discovered so that people can detect their diseases from home without worsening their health by going to the hospitals and standing in lines. Potable kits can be carried by doctors to remote areas where there are no hospitals or nursing homes. Also using nanotechs in surgery can reduce the pain suffered by the patients and they can feel comfort[2,3].

Reduces Toxicity: Drug carriers based on metal and metal oxide nanoparticles are an alternative to inorganic drug carriers which have been used nowadays for a long time. Drug carriers with nanoparticles can modify their inner surface by making bonds with their active surface and also the carrier which lets the gradual release of active substance after entering. Drugs made of nanoparticles are mainly used because they precisely flow the

drug in the required area at a particular time instead of releasing the whole amount immediately after entering the body which causes toxicity to enter the diseased area quickly. Controlled

Release is much more efficient and safe from every angle. Another additional advantage of nanoparticles in drug carrying is the ability to simultaneously use their properties to obtain a multifunctional material, which limits the amount of used drugs. There are various types of drugs with nanotech like ZnO nanoparticles, TiO2 nanoparticles, also iron oxide nanoparticles also known as SPIONS, silver nanoparticles etc. toxins appearing through normal drugs can cause a person's disease to be fatal. Even nanoparticles also have toxic ingredients in them but that should be processed out before any further usage.

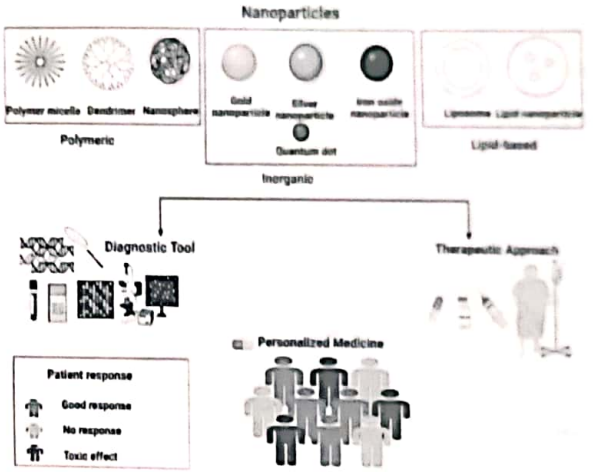

Figure 2: application of nanotechnology in personalised medicine [2]

Personalised Medicine: The definition of personalized medicine is that it is a tailored individualized management approach to achieve the right drug that is to be delivered to the right patient at the right time. Personalized medicine involves many different kinds of studies like proteomics, genomics and epigenetic studies, as well as any patient's specific health conditions and environmental influence. In nanotech, the size of a particle matters the most and in the case of nanotech, the size should be around 10-100 nm. Molecules in the range of Nano interact directly with a cell but the particles are bigger than 1μm. The use of Nano and personalized medicines has multiple uses.

Most important is the diagnostic area. In the area of diagnostic nanotechnology has a lot that it can offer like specific drug targets, pharmacokinetic testing, and the ability to perform both in the field of vivo and in vitro testing. Also due to the Nano medicine's targeting capability the dose can be controlled and given the exact amount without any excess. Nanomedicine can circumvent two major types of determinants in individualized drug response that are related to variability in drug transporters in different populations.

Antimicrobial Coating: Antimicrobial Coating utilizes nanoparticles using a cutting-edge solution for keeping the battle against infectious disease on-going. Mainly this type of coating is used in medicine or other medical equipment to harness the remarkable properties of any Nano scale materials which are willing to offer high resistance inside a human body or organ against harmful microorganisms Mainly metal or metal oxide nanoparticles for example, silver, gold, copper etc… the nanoparticles are incorporated on then into various surfaces a shield like covering is created that can easily restrict any growth or spread of bacteria, viruses and fungi. Whenever a material is in nan scale form it has enhanced surfacearea as well as reactivity, allowing for the release of ions which are being possessed by antimicrobial properties. Sometimes unrequired touch to either surface or textiles, the medicine can become damaged that's why this coating acts as a barrier defense so that the medicine created through nanotech doesn't get destroyed.

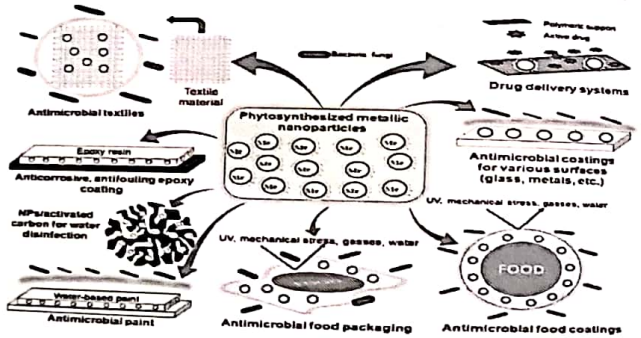

Figure 3: Application of phytosynthesized nanoparticles in various areas [4].

This coating also cnquite easily destroy the cellular structures created by pathogens which stops them from any further replication and survival inside the body of a person. One of the most impressive things about this kind of coating is that it has the highest durability and also the long-lasting efficacy. Unlike normal disinfectants where the disinfectant has to be applied

frequently for its continuation, the antimicrobial coating lasts for almost 10 times the duration of normal disinfectant. Being more versatile it can be used in various locations like hospitals, public spaces, and areas where food is prepared for preventing Infectious disease. Since the research area of nanotechnology is still not fully complete there will be more use of the anti-microbial coating in the future.

NANOROBOTS: The invention of Nano robots for surgery was an absolute revolution in the field of medicine and health. The Nano robots are sent through vascular systems and other cavities. The surgical nabobs act as semi-autonomous surgeons who are instructed and directed by human doctors to make the operation a little less painful for the patient. Nano robots are also used for testing and help in keeping a check on the blood flow through human veins. Suchsmall robots can detect and also keep records of any toxins present inside either body organs or blood vessels.

This bot checks the stability of vital organs i.e. whether the organs are functioning properly or not. Other than this Nano robots have a wide range of applications in the medical field such as it can be used as a sensor, actuators, controls and many more. In comparison to normal disease stage detection or situation, these small Nano robots help in detecting any kind of disease even cancer at an early stage where even thesymptoms have not fully developed. Since Nano robots are so small it helps in minutely assessing the eye of a human which is a sensitive organ with quite precision and ease. Despite having such usefulness in the medical field Nanorobots are costly and cannot be mass-produced in this era it is difficult to find them in local areas. When this kind of life-saving machinery can be made in much more quantities lots of human life can be saved easily.

A huge number of diseases can be cured with the help of nanotechnology and medical sciencebut there is one disease by which many people have lost their life for ages i.e. CANCER. This disease has been considered one of the deadliest diseases for more than 100 years sometimes people whose cancer was spotted in 1st die even after being cured as their organs get damaged badly to be able to regenerate. But nanotechnology has given a ray of hope to thosepatients suffering from cancer.

Cancer Treatment Using Nanotech: Traditional cancer treatments are only done through multitudinous surgeries, radiation and chemotherapy which results in making that person extensively weak against complaint as their impunity power decreases with each remedy. This process has an advanced chance of destroying normal napkins inside the body as well as deficient treatment of cancer as a result that person does not come out of cancer completely beget numerous cancer cells remain inside the body.

Nanotechnology offers help in this situation as it's substantially used for targeted remedies. The operation of nanoscale accoutrements in cancer exploration relies substantially on their design inflexibility and tenability For illustration, gold nanoparticles can be readily decorated with different ligandson their shells to give an understanding of how they interact with live cancer cells. By enabling rapid-fire and sensitive discovery of cancer-related motes, nanotechnology empowers scientists to describe molecular changes, indeed in a small chance of cells. also, nanotechnology has the implicit to induce entirely new and effective remedial agents

Other Achievements: Other than curing this kind of deadly disease, Nanoparticles also can make many medical items more advanced like smart pills, smart thermometers etc. Smart Capsules combine nanotech-grounded detectors and nanoparticles to form a complex pharmaceutical lozenge. still, the nanoparticle aspect of these smart capsules allows them to synopsize, carry and deliver medicines across the body. The standard principle of electrochemical Nanosensors is a chemical response in which electrons release, accept or consume ions. This chemical response takes place between a subdued ligand and an analytic of interest that measurably affects the transduced signal, similar to an electrical current or implicit.

Conclusion: In the end, we can say that nanotechnology has a lot of potential to save a person's life. Nanotechnology gives a new ray of hope and joy among the diseased people who lost their will to live after suffering from incurable diseases. Nanotechnology is still under research as scientists don't fully know the depths of this revolutionizing technology in the healthcare department. In my opinion, that day is not far away where scientists will have an in-depth knowledge about nanoparticles and their use in modern technology. But despite having such usefulness there are still two major problems that need to be overcome for the technology to be successful completely.

One is that there is a particular size of particles that apply to the human body. The particle should be around 100 nanometers only not more than that, if the size is too large it will cause the blockage of many organs and will lead to a passage of toxins to enter inside the body easily, so it is advised to take caution regarding the size of nanoparticles. Now the other and most important drawback of nanotechnology is its production. The production of nanotechnology is so costly that it is produced in very limited areas around the world so not every region can enjoy the nanotechnology. When there is a way to mass produce these nanotech then it will bring a wave of revolutionizing technology era where lots of incurable diseases will be able to be cured easily and also not at a tremendously high price.

References

[1] Etrych T, Braunova A, Zogala D, Lambert L, Renesova N, Klener P. Targeted Drug Delivery and Theranostic Strategies in Malignant Lymphomas. Cancers 2022;14:626. https://doi.org/10.3390/cancers14030626.

[2] Alghamdi MA, Fallica AN, Virzì N, Kesharwani P, Pittalà V, Greish K. The Promise of Nanotechnology in Personalized Medicine. JPM 2022;12:673.

[3] Spear BB, Heath-Chiozzi M, Huff J. Clinical application of pharmacogenetics. Trends in Molecular Medicine 2001;7:201–4.

[4] Fierascu I, Fierascu IC, Dinu-Pirvu CE, Fierascu RC, Anuta V, Velescu BS, et al. A Short Overview of Recent Developments on Antimicrobial Coatings Based on Phytosynthesized Metal Nanoparticles. Coatings 2019;9:787. https://doi.org/10.3390/coatings9120787.