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PHARMACOLOGICAL STUDY OF NANOMEDICINE

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ABSTRACT

The idea that small nano robots and associated machinery may be created, put inside the human body, and use to heal cells at the molecular level was the original inspiration behind the field of nan medicine. Today, Nano medicine comprises hundreds of subfields, all of which are based on the fundamental idea that organizing materials and devices at the molecular level can have a significant positive impact on medical research and practice right now. The use of nano biotechnologies in medicine is known as nano medicine. The foundations of C are covered in this article, which then goes on to discuss its uses in molecular diagnostics, nanodiagnostics, and better drug discovery, design, and delivery, including nanopharmaceuticals. It will enhance biological treatments including gene therapy, cell therapy, and vaccination. Numerous novel medical and surgical instruments, including nanorobots, are being created on the foundation of nanobiotechnology. There are examples of its applications in almost every field of medicine, including cancer (nanooncology), neurological and cardiovascular disorders (nanocardiology), diseases of the bones and joints (nanoorthopedics), diseases of the eyes (nanoophthalmology), and infectious diseases in the field of nanomedicine. Concerns about the safety of using nanoparticles in vivo are also covered. The use of nanobiotechnology will make it easier to combine medicines and diagnostics.

KEYWORDS: Bioavailability, Nanobiotechnology, Neurological disease, Pharmacokinetics, Toxicity.

INTRODUCTION

The natural fusion of particular accomplishments in the two domains creates an exceptional societal and economic potential for the application of nanotechnology concepts to medicine, which unites two sizable cross-disciplinary fields. The molecular-scale characteristics pertinent to the two domains give rise to the shared foundation. Chemical approaches provide the ability to elaborate and address surfaces, for example, for targeted drug delivery, enhanced biocompatibility, and neuroprosthetic purposes. Local probes and molecular imaging techniques allow surface and interface properties to be characterized on a nanometer scale at predefined locations. However, toxicological issues and ethical ramifications are raised in this interdisciplinary field. An overview of a few recent advances and uses of nanomedicine is provided in this review.

Nanomedicine… is nano in medicine! Like for any breakthrough technology, the promising possibilities that nanomedicine offer in the future have to be counterweighted against risks. Safety of nanomedicine products is regulated exactly like drugs and medical devices, clinically evaluated for their benefit/risk ratio for the patients. As any medical devices or drugs, nanomedicines are strictly regulated and have to follow thorough characterization, toxicity assessment and multi-stage clinical trials evaluating for their benefit/risk ratio before benefiting patients with their whole potential. Nevertheless, it is of utmost importance to examine upfront with care and responsibility all possible side effects to human beings and the environment. Several European projects are already dealing with this highly important issue. Also ethical concerns and social acceptance have to be taken into account.

What is Nano medicine…?

Defination

1) Nanomedicine is defined as the application of nanotechnology in human health.[1]

2) Nanomedicine is among the numerous opportunities and advances promoted by nanotechnology. The definitions of nanomedicine accepted today were established by the National Institutes of Health of the United States and the European Science Foundation, which define nanomedicine as the "science that uses nanomaterials to the development of diagnosis, treatment and prevention of specific medical application.[2]

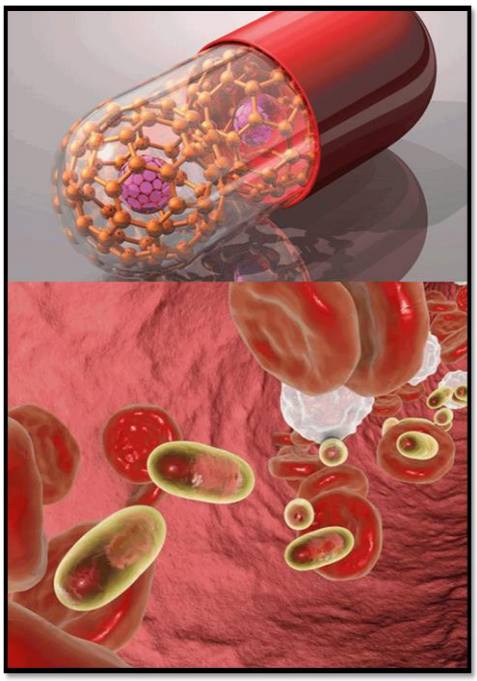

Fig. 1: Nanomedicine.[3]

Materials with a spatial scale of 1-100 nm are referred to as nanomaterials. The term "nanomedicine" describes a range of nanomaterial applications that include illness detection, therapy, and prevention and control. A new product that comes from combining medicine and nanotechnology is called nanomedicine. There are two categories into which nanomedicine falls: medicine in the form of nanoparticles, which indicates that the medication is created through specific methods to make it nanoscale in size. Nano-carrier medicine is the loading of medication into nano-carriers, such as suspensions, tablets, capsules, and so forth, and utilizing the effects of the nano-carriers to better exert their curative effect. Like nanospheres, nanocapsules, and liposomes.

Numerous nano-drugs, including Doxil, Visudyne, and Vyxeos, are available in the market. Lipid nanoparticle (LNP) technology is used by Patisiran, the most recently developed RNA medication in clinical usage. The timing and location of the active pharmaceutical ingredients' actions in the body can be managed by utilizing the features of nanomedicine.[31]

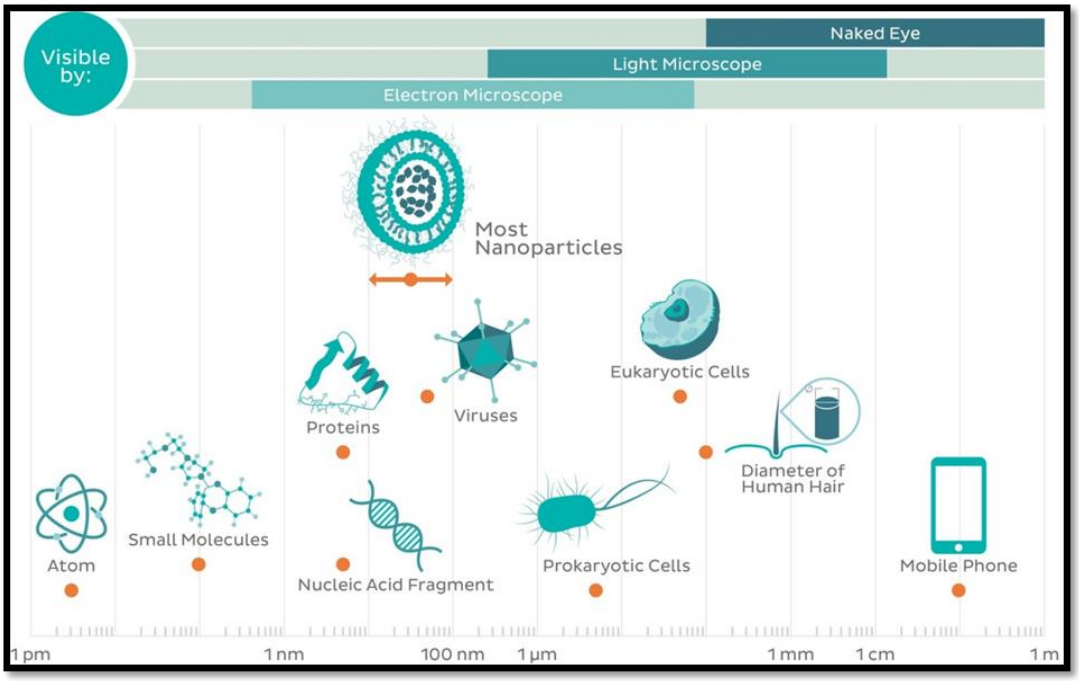

Fig. 5.[30]

Why we use nanomedicine….

Because nanoparticles are designed to bind to specific sites on cancer cells, nanornedicine enhances therapeutic target specificity. Leaky blood vessels are a feature that solid tumors frequently have. Because of their small size, nanomedicines tend to accumulate in tissue by leaking into blood arteries.[40]

Types

According to the type and structure of the carriers nanomedicines are primarily classified into:

- Liposome
- Antibody–drug conjugate
- Norganic nanoparticle
- Polymer nanoparticle
- Dendrimer
- Micelle
- Polymer–drug conjugate
- Virus-derived vector
- Nanocrystal
- Cell-derived carrier and protein-bound nanopartic.

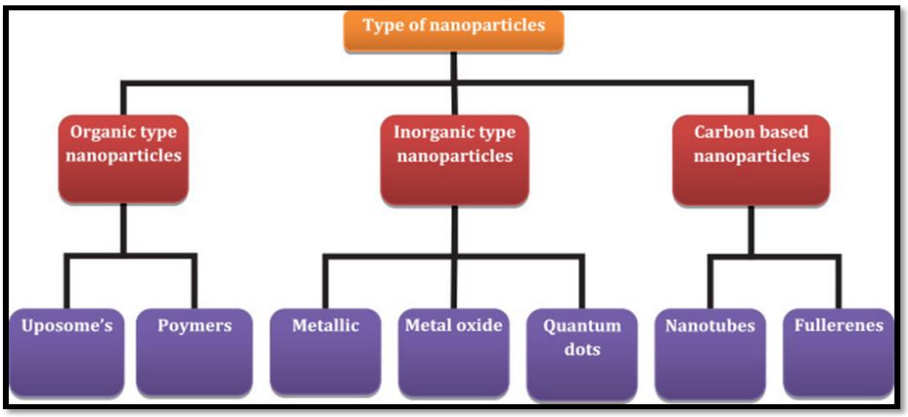

Fig. 4.[28]

Route of Administration

A. Oral

B. Intravenous[20]

What Conditions Could Nanomedicine Be Used For?

In addition to cancer, nanomedicine has potential for treating these conditions. Neurological disease: - Your brain has a protective layer of cells that keeps larger molecules out. This is called the blood-brain barrier (BBB), and it presents problems when drugs need to get to your brain. Nanoparticles, because of their size, can cross the BBB. This offers promise for treating brain tumors, stroke, Alzheimer's, and meningitis.

Eye problems

Your eyes also have barriers to protect them from foreign substances. Those defenses make it difficult for drugs to reach their targets. Drops, injections, oral medicines, and IVs -- the most common ways of delivering eye medicines -- all run into this problem. Nanomedicine offers ways to get the drugs where they're needed, using nanoparticles, special coatings on contact lenses, and implants. Nanomedicine can help treat conjunctivitis (pinkeye), cataracts, cornea injuries, macular degeneration, and glaucoma.

Infections

Nanomedicine can help detect bacterial infections and can deliver antibiotics in a targeted way. Medical devices like catheters and heart valves can be coated in nanomaterials that repel bacteria, which help prevent infection.

Menopause

Hormone replacement therapy can relieve some symptoms. Studies have shown that giving these hormones through the skin is effective and avoids some of the problems linked to medicines you take by mouth. When the hormones are delivered via nanoparticles, people have fewer side effects such as rashes and blisters.

Blood disorders

Conditions such as leukemia, lymphoma, anemia, and hemophilia have traditionally been treated with chemotherapy, bone-marrow transplants, stem cell therapy, and medicines. Researchers are focused on using nanomedicine to develop artificial components of blood, which could take over some of the functions that blood diseases disrupt.

Spinal cord injury

When you get this type of injury, the trauma sets off a chain reaction that creates further nerve damage. Like your brain, your spinal cord has a layer of protective cells. Doctors have traditionally used high doses of a steroid to ensure it gets across that barrier. But that drug can have serious side effects at high doses, and it breaks down quickly. Nanoparticles can cross the barrier, deliver drugs where they need to go, and stay in your body longer. Nanomaterials also could help your body repair nerve damage by limiting scarring and blocking substances that slow growth. Doctors eventually hope to use structures made of nanomaterials as "scaffolds" to guide the growth of new nerve tissue.[27]

Future Scope of Nanomedicine

Nanomedicine will surely play a major part in future customized medicine, from monitoring to prediction. Nanoscale materials serve as the foundation for ever-more-sensitive sensors and biomarkers that could be used to precisely and concurrently diagnose more ailments in the early stages. Highly precise mapping of disease with improved targeting and chemical sensitivity is made possible by nanomedicine. Once a disease has been identified, nanomedicine can be used more effectively to target cells while minimizing negative effects and damage to healthy cells. Numerous products, such as the doxorubicin nano-encapsulated product discussed earlier, are already in use. Essentially, the difficulties of the future lie in the development of metallic nanoparticles' potential for diagnosis and treatment, as well as in the loading and release of pharmaceuticals.

Nanomedicine, like any other cutting-edge technology, needs to weigh its alluring potential against potential risks down the road. Before using nanomedicine to treat patients to the fullest extent possible, toxicity assessment and multistage clinical studies are required, just like with any other medical equipment or treatment.

Nanotechnology will be able to identify problems directly in the future, instead of relying on a combination of data from probabilistic diagnostic algorithms, medical experience, and external sensors. Athletes may use nanotechnology as an additional tool to assess which muscles have superior circulation and produce less lactic acid. This would enable athletes to adjust their training and frequency in response to their less effective muscles. These can maximize the potential of their less effective muscles and modify their efficiency.[29]

MATERIALS AND METHODS

There are two well-known methods for synthesizing the nanomaterials. Both top-down and bottom-up methods are used. Top-down techniques involve mechanically machining the bulk materials into nanoscale tiny particles. Bottom-up procedures use co-precipitation or self-assembly techniques to assemble tiny particles into nanomaterials.

- Ball Milling through the Mechanical Method
- Sol-Gel Method
- Chemical Vapor Deposition Method (CVD)
- Physical Vapor Deposition (PVD) Method
- Lithography
- Chemical Co-Precipitation Method
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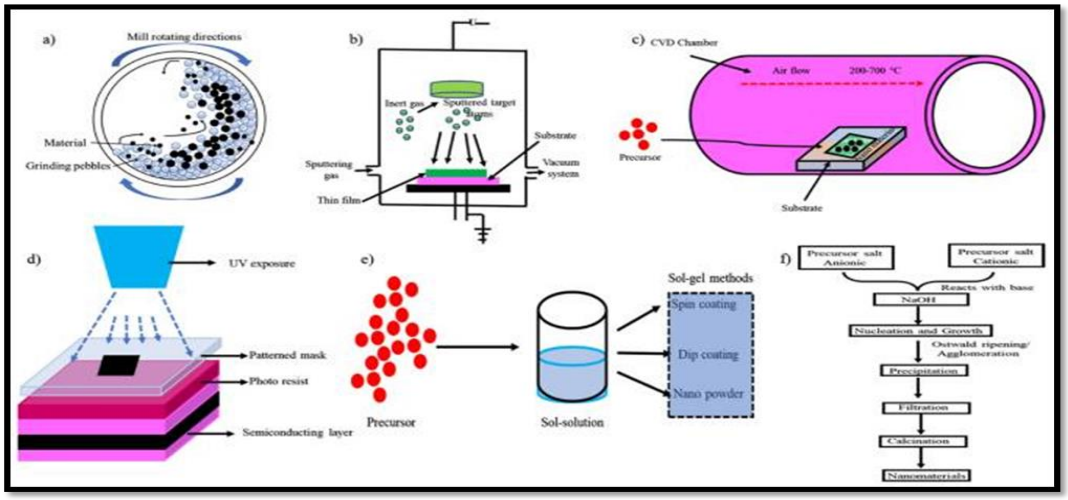

Fig. 7.[32]

Advantages

- Precision medicine: One of the biggest advantages of nanomedicine is its ability to deliver drugs and other therapeutic agents directly to the site of the disease. This precision medicine approach reduces the risk of side effects and maximizes the therapeutic effect of the drug.
- Early diagnosis: Nanotechnology-based imaging techniques, such as magnetic resonance imaging (MRI) and computed tomography (CT) scans, allow for earlier and more accurate diagnosis of diseases, such as cancer.
- Targeted therapy: Nanoparticles can be engineered to target specific cells or tissues in the body, which is particularly useful in cancer therapy. This targeted therapy approach reduces the risk of damage to healthy cells and tissues.
- Improved drug delivery: Nanoparticles can be used to improve drug delivery, by increasing the drug's solubility, bioavailability, and stability. This allows for lower doses of drugs to be used, reducing the risk of toxicity and side effects.
- Regenerative medicine: Nanoparticles can be used to deliver growth factors and other regenerative agents to damaged tissues, promoting tissue repair and regeneration.[21,22]

DISADVANTAGES

Regulatory Challenge

Newly formulated nanomedicines undergo strict regulatory approval phases before they can be used for diagnostic or therapeutic purposes in humans. These regulatory policies can slow down the development and implementation of new nanomedicines.

Development Cost

The high manufacturing cost of nanoparticles could limit their availability.

Limited Information

More research is required for comprehensive elucidation of the interactions between nanoparticles and the human body. These studies must focus on the potential risks and benefits of nanomedicines.

Toxicity

Most research on nanomedicine has focused on precise drug delivery; however, it is essential to understand the safety, pharmacokinetics, and toxicity of nanomaterials. Scientists face tremendous challenges in validating every nanotherapeutic agent.[23,24]

Mechanism of action

Nano-particles (NPs) having their own intrinsic antimicrobial activity kill microbes by mimicking natural course of killing by phagocytic cells i.e., by producing large quantity of Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS).[26]

Drug Delivery System

Using nanoparticles, nanotechnology has made it possible to deliver medications to particular cells. By simply putting the active ingredient in the morbid region and at the lowest possible dose, side effects and overall drug intake can be considerably reduced. The goal of targeted drug delivery is to lessen pharmacological adverse effects while simultaneously lowering treatment costs and drug intake. Targeted drug distribution also lessens the adverse effects of crude medication by limiting its exposure to healthy cells. The goal of drug delivery is to maximize bioavailability at particular sites in the body as well as over an extended period of time. This might be accomplished by using Nano engineered devices to target molecules.

A benefit of using nanoscale for medical technologies is that smaller devices are less invasive and can possibly be implanted inside the body, plus biochemical reaction times are much shorter. These devices are faster and more sensitive than typical drug delivery. The efficacy of drug delivery through nanomedicine is largely based upon: a) efficient encapsulation of the drugs, b) successful delivery of drug to the targeted region of the body, and c) successful release of the drug. Several nano-delivery drugs were on the market by 2019.

Drug delivery systems, lipid. or polymer-based nanoparticles, can be designed to improve the pharmacokinetics and bio distribution of the drug. However, the pharmacokinetics and pharmacodynamics of nanomedicine is highly variable among different patients. When designed to avoid the body's defence mechanisms. Nanoparticles have beneficial properties that can be used to improve drug delivery. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell membranes and into cell cytoplasm. Triggered response is one way for drug molecules to be used more efficiently. Drugs are placed in the body and only activate on encountering a particular signal. For example, a drug with poor solubility will be replaced by a drug delivery system where both hydrophilic and hydrophobic environments exist, improving the solubility. Drug delivery systems may also be able to prevent tissue damage through regulated drug release; reduce drug clearance rates; or lower the volume of distribution and reduce the effect on non-target tissue. However, the biodistribution of these nanoparticles is still imperfect due to the complex host's reactions to nano- and microsized materials and the difficulty in targeting specific organs in the body. Nevertheless, a lot of work is still ongoing to optimize and better understand the potential and limitations of nanoparticulate systems. While advancement of research proves that targeting and distribution can be augmented by nanoparticles, the dangers of nanotoxicity become an important next step in further understanding of their medical uses. The toxicity of nanoparticles varies, depending on size, shape, and material. These factors also affect the build-up and organ damage that may occur. Nanoparticles are made to be long-lasting, but this causes them to be trapped within organs, specifically the liver and spleen, as they cannot be broken down or excreted. This build-up of non-biodegradable material has been observed to cause organ damage and inflammation in mice. Magnetic targeted delivery of magnetic nanoparticles to the tumor site under the influence of inhomogeneous stationary magnetic fields may lead to enhanced tumor growth. In order to circumvent the pro-tumorigenic effects, alternating electromagnetic fields should be used.

Nanoparticles are under research for their potential to decrease antibiotic resistance or for various antimicrobial use Nanoparticles might also be used to circumvent multidrug resistance (MDR) mechanisms.[4],[5],[6],[7],[8],[9],[10],[11],[12],[13],[14],[15],[16],[17]

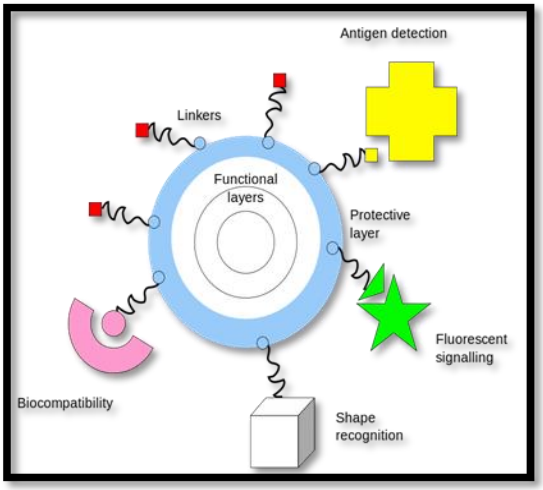

Fig.2.[18]

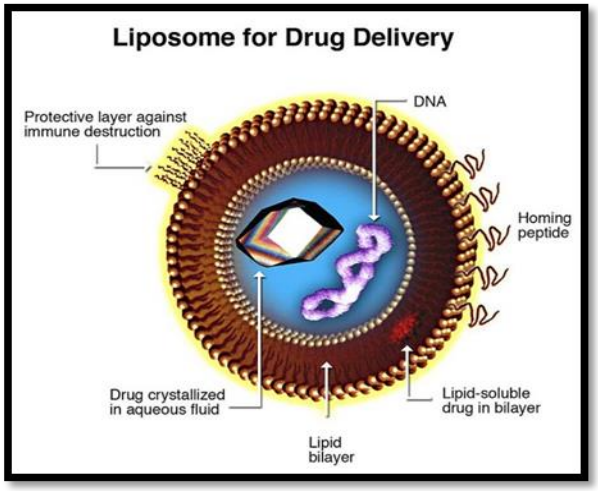

Fig.3.[19]

RESULT AND DISCUSSION

In Above study we conclude the nano medicine is the effective safe Dosage, nano medicine is more fast than general medicine it important for us. Nano medicine is safe pharmaceutical preparation.

CONCLUSION

The reformulation of pre-existing medicines or the development of new ones has been largely boosted by the increasing research in nanomedicine. Changes in toxicity, solubility and bioavailability profile are some of the modifications that nanotechnology introduces in medicines. In the last decades, we have assisted to the translation of several applications of nanomedicine in the clinical practice, ranging from medical devices to nanopharmaceuticals. However, there is still a long way toward the complete regulation of nanomedicines, from the creation of harmonized definitions in all Europe to the development of protocols for the characterization, evaluation and process control of nanomedicines.

A universally accepted definition for nanomedicines still does not exist, and may even not be feasible at all or useful. The medicinal products span a large range in terms of type and structure, and have been used in a multitude of indications for acute and chronic diseases. Also, ongoing research is rapidly leading to the emergence of more sophisticated nanostructured designs that requires careful understanding of pharmacokinetic and pharmacodynamic properties of nanomedicines, determined by the respective chemical composition and physicochemical properties, which thus poses additional challenges in regulatory terms. EMA has recognized the importance of the establishment of recommendations for nanomedicines to guide their development and approval. In turn, the nanotechnology methods for the development of nanomedicines bring new challenges for the current regulatory framework used. EMA have already created an expert group on nanomedicines, gathering members from academia and European regulatory network. The main goal of this group is to provide scientific information about nanomedicines in order to develop or review guidelines. The expert group also helps EMA in discussions with international partners about nanomedicines. For the developer an early advice provided from the regulators for the required data is highly recommended.

The equivalence of complex drug products is another topic that brings scientific and regulatory challenges. Evidence for sufficient similarity must be gathered using a careful stepwise, hopefully consensual, procedure. In the coming years, through all the innovation in science and technology, it is expected an increasingly higher number of medicines based on nanotechnology. For a common understanding among different stakeholders the development of guidelines for the development and evaluation of nanomedicines is mandatory, in order to approve new and innovative nanomedicines in the pharmaceutical market. This process must be also carried out along with interagency harmonization efforts, to support rational decisions pertaining to scientific and regulatory aspects, financing and market access.

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