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NANOTECHNOLOGY IN MEDICINE

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ABSTRACT

In recent years, researchers and medication designers have focused more on new nanotechnology approaches to improve drug delivery to the central nervous system (CNS). Nanotechnology holds great promise for improving neurological disorders treatment, primarily Alzheimer's disease, Parkinson's disease, brain tumours, and stroke.[1] In order to treat retinal illnesses, nanotechnology-based medications can offer a crucial platform for sustaining, releasing, and a targeted targeting design. The most popular biocompatible and biodegradable polymer that has been authorised by the Food and Drug Administration is poly-lactic-co-glycolic acid. The development of specialised instruments for the slow and reliable delivery of proteins, other macromolecules, and small-molecule medications has been the subject of numerous investigations.[2] Because of their small size(10–100 nm), which enhances circulation and permits superior accumulation of therapeutic medications at the tumour sites, nanotechnology is used in drug delivery. Passive targeting will be made possible by the use of nanotechnology in the future, and targeting moieties will allow for even more advancements.[3] In the pharmaceutical biotechnology industry, nanoparticles enhance the therapeutic index and offer answers for potential delivery issues with novel kinds of "biotech" medications, such as oligonucleotides and recombinant proteins. The subject of this review is nanoparticulate drug carriers.technologies, other than liposomes, that are currently in use, as well as the potential and constraints of nanoparticles in the field ofbiotechnology in pharmaceuticals is.[4]

KEYWORDS: *nanotechnology, nanoparticles, Liposomes, cancer therapy, gene delivery, drug delivery, brain drug delivery, nanotechnology in medicine*

INTRODUCTION

The study of nanotechnology allows us to modify matter at the molecular level, enabling the creation of devices with innovative chemical, physical, and biological properties. One can construct properties . A nanoscale (nm) is one hundred thousandth of a metre, or one-billionth of human hair's breadth Particles called nanoparticles that are smaller than 100 nm in size [5]Nanotechnology is widely used in tissue regeneration, cell culture, targeted medication therapy, diagnostics, and other fields.biosensors and further molecular instrumentation biology. Numerous nanotechnology platforms, including asnanotubes, quantum dots, nanopores, and fullerenesLiposomes, magnetic nanoprobes, dendrimers, andThe development of radio-controlled nanoparticles is underway.[6]Nanotechnology is a fast developing field of study that involves manipulating matter at the atomic and molecular size to produce materials with strikingly diverse and novel features. study having enormous promise across numerous fields, including from electronics to construction and healthcare. In medicine, it is expected to transform drug administration, genetic therapy, diagnostics, and numerous study fields, creation and use in healthcare settings.[7]

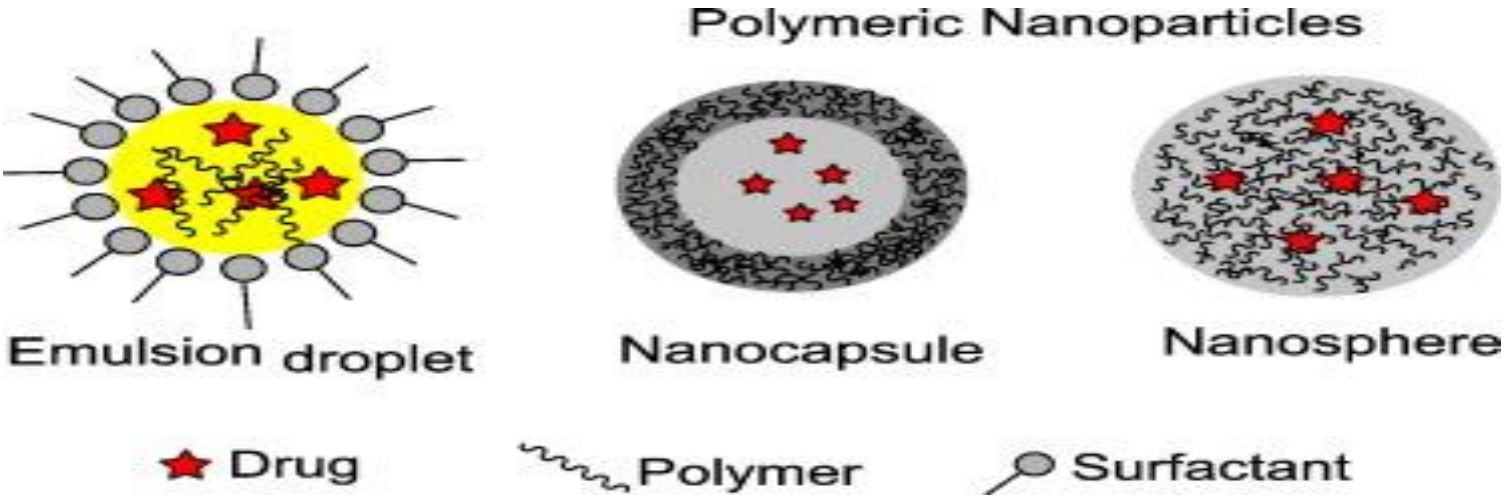
NANOPARTICLES

These are colloidal particles, submicron in size, that have an attractive medicinal substance conjugated or adsorbed onto their surface, or enclosed inside their polymeric matrix .The particles known as nanoparticles includedirected to particular locations by surface alterations, which offerparticular biochemical exchanges with the expressed receptorson the cells of interest [8]It is possible to create nanoparticles chemically or biologically. Chemical synthesis processes have been linked to numerous negative impacts since they contain certain harmful chemicals. absorbed at the surface. environmentally friendly substitutes for chemicals biological means of nanoparticles, as well as physical techniques synthesis with the aid of microbes, enzymes ,as well as plants or their derivatives.The creation of these environmentally techniques for creating nanoparticles are becoming increasingly significant area of nanotechnology, particularly in silver nanoparticles, which are widely used.[9]Nanoparticles have received a lot of interest recently because of their unusual features and prospective uses in a variety of industries.

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*** Synthesis Techniques**
1. Sol-gel technique
2. Chemical vapour deposition (CVD)
3. Synthesis by hydrothermal means
4. Milling by machine

***Type of Nanoparticles**
1. Metal (Au, Ag, Cu)
2. Oxide (TiO2, ZnO, Fe3O4)
3. Semiconductor (CdSe, CdTe)
4. Nanoparticles of polymers
5. Nanoparticles based on lipids



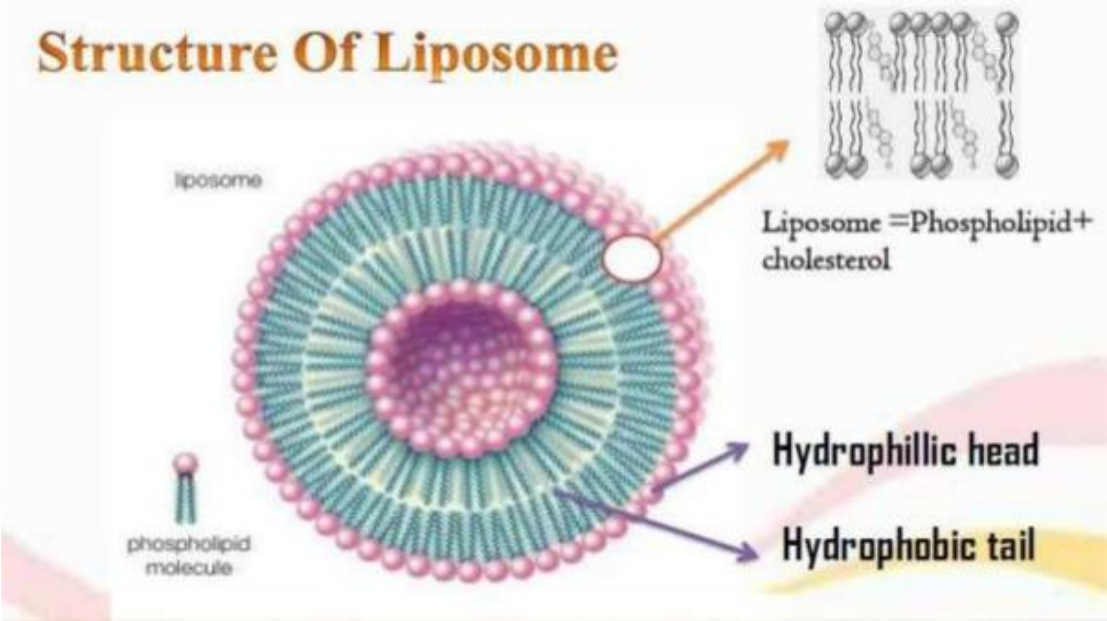
LIPOSOMES

Liposomes: Liposomes are bilayered, spherical vesicles. Similar to micelles, these are similarly amphiphilic in nature. The hydrophilic tips face the The orientation of the hydrophobic ends and the aqueous side distant from the water. Drug transportation occurs either in the lipid or the aqueous compartment (if hydrophilic).bilayers if they are hydrophobic. These carriers in vesicles can both fit through even the tiniest arterioles and because they are tiny, flexible, and able to biocompatible[10]Liposomes were first described by Bangham et al. in 1965 .They are composed of a phospholipid bilayer that encloses an aqueous compartment

***Structure and Properties**:*
Liposomes can be classified into different types based on their size, charge, and composition .Their properties include:
1. Biocompatibility and biodegradability
2. Controlled release of encapsulated compounds

Liposomes have shown great potential in various fields due to their unique structure and properties.

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APPLICATION OF NANOTECHNOLOGY

1: Cancer Therapy

The utilisation of nanotechnology in cancer treatment has shown a number of obstacles and disadvantages. vasculature endothelial cell barriers, cellular absorption of therapeutic agent, the removal of medications from the market, The current issues are related to tumour heterogeneity. In summary, current cancer treatment requires progress. But cancer nanotechnology undoubtedly able to make a breakthrough in the fight against cancerconnected demise. Numerous kinds of nanotechnology have been created that is useful in the treatment of cancer treatments and evaluations[11]Cancer is the top cause of mortality in the United States among those under 85 years old. Statistics show that the number of cancer-related deaths has remained relatively stable. Early identification of cancer is universally considered as necessary, even before anatomic Anomalies are visible. A major difficulty in cancer diagnostics in the twenty-first century is the ability to Determine the precise link between cancer biomarkers and clinical pathology, such as well as being able to detect tumours at an early stage for maximal therapeutic effectiveness.[12] Why Does Nanotechnology Affect Cancer?Nanoscale devices are easily able to interact with biomolecules inside and on the surface of cells due to their small size. Having obtained entry to so many bodily parts, they possess the capacity to identify illness and administer therapy. It offers numerous novel cancer treatment ideas. therapy. These new platforms' developing functions for cancer imaging and treatments are the the main topic of this review. To direct nanoparticles to tumour locations, two methods have been employed: active as well as indirect targeting. Targeting actively includes attaching ligands to tumor-specific nanoparticles particular. Through passive targeting, the size of the nanoparticles is exploited.The tumor's form is less pronounced. [13]

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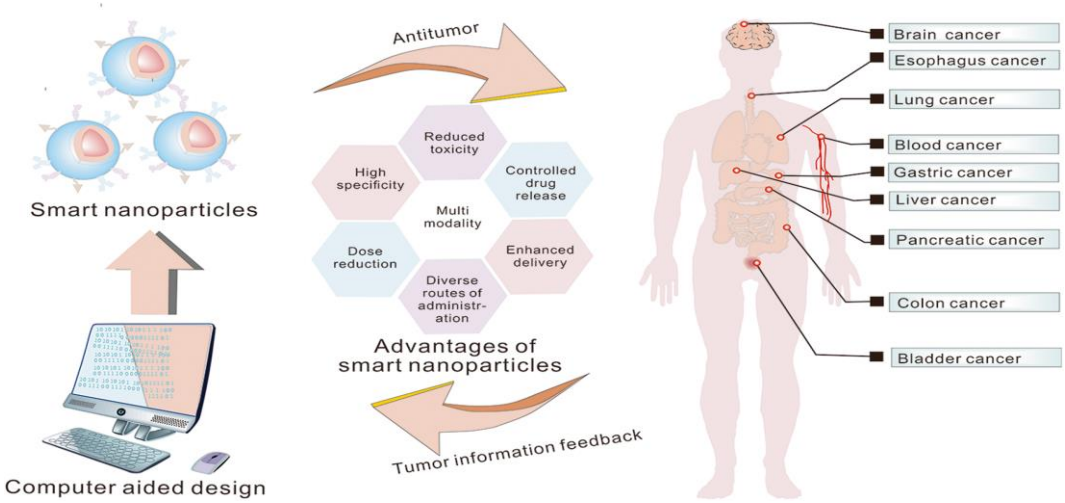


Fig :smart nanoparticles for cancer therapy

2. Gene Delivery

Attention was drawn to the target tissue and nanocarriers due to the nucleic acid's effective distribution. Typically, the targeted cells' nucleus has to receive the external genetic material in order for them to produce the protein. outcomes of the added gene. The optimal vector sends a exact quantity of genetic material into a certain type of cell that brings transgenic expression to the desired level and duration. adequate to fix the flaw, non-immunogenic, and innocuous, permitting the gene product to be expressed without generating poisoning (Shillitoe 2009)[14]

3. Drug Delivery

Generally speaking, medications enclosed in nanostructures are shielded from enzymatic and hydrolytic breakdown in the gastrointestinal system; aim to administer a many medications to different parts of the body for extended periods of time and can therefore to distribute medications, proteins, and DNA via the oral administration route[15] Despite hurdles such as high costs and regulatory requirements (both preclinical and clinical), phases - Phases 1 - 4 are required. To get regulatory approval before A medication can enter the market; some nano Drug delivery systems have reached the market.displays a list of some Nano drug delivery devices on the market:[16]Novel medication delivery technologies serve as a tactical instrument for expanding pharmaceutical markets. Technology can deal with problems.connected to current t ph arm aceuticals, includingas prolonging the life of a product (line extension), or can improve their performance and acceptability, either by increasing effectiveness or by providingsecurity as well as patient compliance .Furthermore, the newer medications created with the assistanceof composition alchemy employing the knowledge acquired from the human genome as a general object of studyneed medication delivery methods for their effective use[17]

4. Brain Drug Delivery

: Engineered adjustable devices with a size in the order of billionth of meters have been offered as an attractive tool potentially able to answer the unmet problem of increasing medication transport across the blood-brain barrier in the recent years with the emergence of nanomedicine .. The technology of nanoparticles (NPs) is one area of devices that is developing quickly. NPs are objects with sizes ranging from 1 to 100 nm that function as a single entity in terms of transport and characteristics.[18]

5. Nanotechnology in Medicine

Novel medicine delivery systems utilising nanotechnology techniques are being explored for ailments such as cancer, diabetes, fungal infections, and viral both in genetic treatment and infections. The primary benefits of this therapeutic approach are the medication targets.as well as an improved safety profile. Additionally, nanotechnology has discovered its application as contrast agents in diagnostic medicine,magnetic nanoparticles and fluorescent dyes were used .[19]

NEXT GENERATION OF DRUG DELIVERY SYSTEMS

The primary causes of their possible toxicity can be attributed to their distinct physical attributes. Because of this, nanoparticles can become poisonous.acquire catalytic qualities and transform into biological absorbable. Unlike microparticles, cellular absorption of Favoured are nanoparticles and conventional histology assays.demonstrated that a pulmonary dosage of carbon nanoparticles applied stayed intact for ninety days. Should nanoparticulateas medicine delivery techniques proliferate, worries regarding The toxicity of

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nanoparticles needs to be addressed.Potential applications of nanotechnology in pharmaceutical biotechnology will have a favourable impact on medical and pharmaceutical science across the board. enhanced diagnosis will enable using Point-of-Care devices in addition to close not only to provide the patients with diagnostic andtherapeutic effects in drug delivery systems at the nanoscale.[20].

CONCLUSION

Nanotechnology in medicine represents a revolutionary approach to diagnosis, treatment, and prevention of diseases at the molecular level. By manipulating materials at the nanoscale, researchers can develop innovative drug delivery systems that enhance the efficacy of treatments while minimizing side effects. This technology enables targeted therapies, allowing medication to be delivered directly to diseased cells, improving outcomes in conditions such as cancer.Additionally, nanotechnology facilitates the development of advanced diagnostic tools that can detect diseases earlier and more accurately. Nanosensors and imaging agents can provide real-time information about biological processes, leading to personalized medicine tailored to individual patient needs.The potential of nanotechnology extends to regenerative medicine, where nanoparticles can aid in tissue engineering and repair.

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