WORLD JOURNAL OF PHARMACY AND PHARMACEUTICAL SCIENCES

SJIF Impact Factor 7.421

Volume 7, Issue 11, 1611-1633 Review Article ISSN 2278 – 4357

APPLICATION OF NANOTECHNOLOGY IN DIAGNOSIS AND TREATMENT OF VARIOUS DISEASES AND ITS FUTURE ADVANCES IN MEDICINE

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Article Received on
18 September 2018,

Revised on 08 October 2018,
Accepted on 29 Oct. 2018,

DOI: 10.20959/wjpps201818-12703

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ABSTRACT

Nanotechnology is the study of extremely small structured molecule (size of 0.1 to 100 nm). Nano medicine is a relatively new field of science and technology. Nanomedicine ranges from the medical applications of nonmaterial's and biological devices to nanoelectronic biosensors used in medical field. Nanotechnology, or systems/device manufacture at the molecular level, is a multidisciplinary scientific field undergoing explosive development. This potential of nanomedicine, including the development of nanoparticles for diagnostic and screening purposes, DNA sequencing using nanopores, single-virus detection and manufacture of drug delivery systems has been explained in this. It has powerful impact in various medical fields such as biophysics, molecular biology; bioengineering, cardiology, oncology, ophthalmology, endocrinology immunology and its applications in various nano systems in cancer therapy such as carbon nano tube, dendrimers, nano crystal, nano wire, nano shells etc are also briefly explained in this article. The advancement in nano technology helps in the treatment of neuro degenerative disorders such as Parkinson's disease and Alzheimer's disease and also its Applications in tuberculosis treatment, the clinical application of nanotechnology in operative dentistry. In future many novel nanoparticles and nanodevices are expected to be used, with an enormous positive impact on human health. Our major role is to improve health by enhancing the efficacy and safety of nanosystems and nanodevices for improving health of people. Products based on nanotechnology in medicine and medical technology are reaching the market, with an anticipated enormous positive impact on human health, in the coming years. The development of specific guidance documents for the safety evaluation of nanotechnology products in medicine should be prepared and the need for further research in nanotoxicology is identified. This article highlights some of these areas with an emphasis on nanoparticles for diagnostic, screening and drug delivery purposes, DNA sequencing, viral detection, effective and safer treatment of various diseases on individual atoms, molecules, or compounds into structures to produce materials and devices with special properties and its future advances in the field of pharmacy and medicine.

KEYWORDS: Nanotechnology, nanomedicine, diagnosis, DNA sequencing, treatment, drug delivery, nanoscale.

INTRODUCTION

Nanoparticle is a rapidly growing multidisciplinary scientific field that applies engineering and manufacturing principles at an atom and molecular level. Nanotechnology is the study of extremely small structures as it deals with materials in the size of 0.1 to 100 nm.Hence, in Greek "nano" means "dwarf". The application of nanotechnology in medicines and pharmaceuticals and its advancement in it has revolutionized the twentieth century [2]. Nanomedicine will result in products that are better, faster and also cheaper. Nanotechnology involve work by reducing the size of large structures to smallest structure (i.e. from top down), e.g. photonics applications in nano electronics and nano engineering, top-down or to the bottom up, which involves changing individual atoms and molecules into nanostructures and more closely resembles chemistry biology. It is also inherent that these materials should display different properties such as electrical conductance chemical reactivity, magnetism, optical effects and physical strength, from bulk materials as a result of their small size [3]. Nanotechnology works on matter at dimensions in the nanometer scale length (1-100 nm) by a special scale that is being designed to calculate the activity of the nanoparticles(nano scale) and hence can be used broadly in various fields and the creation of various types of nano materials and nano devices.

Applications of Nanotechnology

The different fields that find potential applications of nanotechnology are as follows:

- Early diagnosis and screening

- Health and Medicine
- Electronics
- Transportation
- Energy and Environment
- Space exploration.

This article highlights some of these areas with an emphasis on nanoparticles for diagnostic, screening and drug delivery purposes, DNA sequencing, viral detection, effective and safer treatment of various diseases on individual atoms, molecules, or compounds into structures to produce materials and devices with special properties and its future advances in the field of pharmacy and medicine.[1]

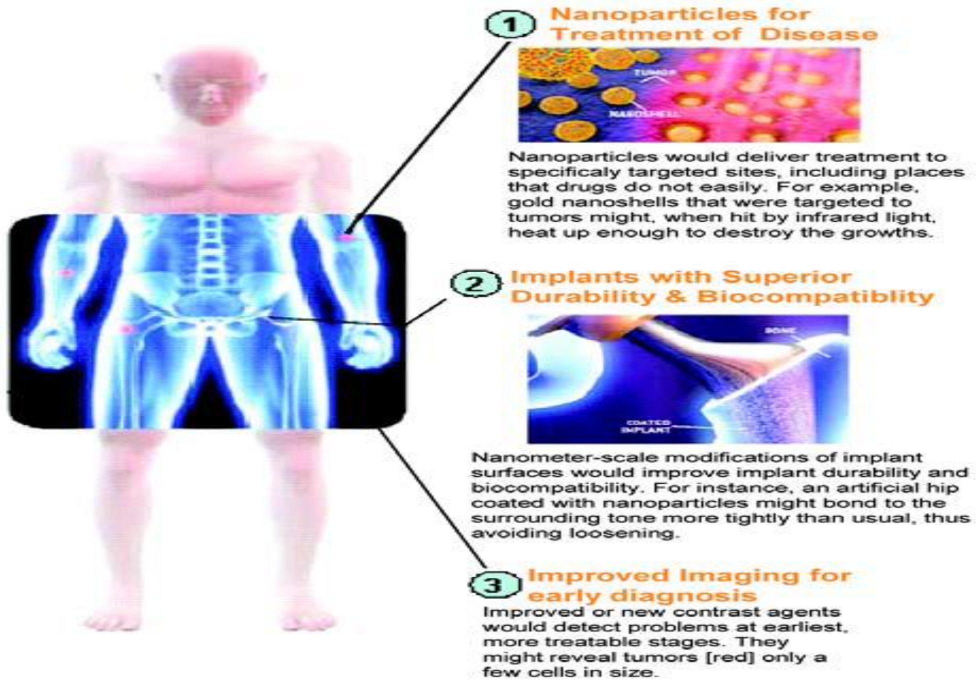

Figure 1:1) Use of nanoparticles for the treatment of diseases, 2) Implants with superior durability and biocompatibility, 3) Improved imaging for early diagnosis.

Use of Nanoparticles for diagnostic and screening purpose

The major and the first applications of nanomedicine are improved fluorescent markers for diagnostic and screening purposes. Conventional fluorescent markers require complex color-matched lasers, which can only be used once before fluorescence fading, and lack discriminatory capacity due to dye bleeding [3]. Fluorescent nanoparticles, like 'quantum dots', PEBBLES (probes encapsulated by biologically localized embedding) and per fluorocarbon particles, potentially overcome these issues.

Uses

- Nanoparticles may also be used for the simultaneous tagging of multiple biomolecules, both inside as well as outside the cells to monitor disease progression.
- Nanoparticles can be inserted into living cells as magnetic resonance contrast agents.

Example: It could be injected systemically to target the liver, spleen and lymph nodes.

- Polymeric nanospheres can selectively target different tissues for imaging purposes.
- Furthermore, Work by Lanza *et al.*[8-10] has demonstrated the targeted local drug delivery and real-time imaging of individual nanospheres in various sites

Example: Thrombi and revascularization during tumourigenesis both *in vitro* and *in vivo*

- Its application in transdermal monitoring of changes in interstitial fluid constituents.
- Nanoparticle use in electrostatic, self-assembling processed and solid nanoparticles coated with fluorescent enzyme-containing thin films, as well as hollow nanocapsules containing fluorescent indicators and enzymes or glucose-binding proteins, are being used to monitor glucose concentrations.
- Other applications include using gold nanoparticles for DNA diagnostics.
- DNA microarrays for genotypic analysis.[6]
- Assessment of drug responses.
- Nanotechnology deals with materials in the size of 0.1 to 100 nm; however it is also inherent that these materials should display different properties such as electrical conductance chemical reactivity, magnetism, optical effects and physical strength, from bulk materials as a result of their small size.[3]
- Nanotechnology works on matter at dimensions in the nanometer scale length (1-100 nm), and thus can be used for a broad range of applications and the creation of various types of nano materials and nano devices.

Use of Nano Scale and Nanostructures in Diagnosis and Screening

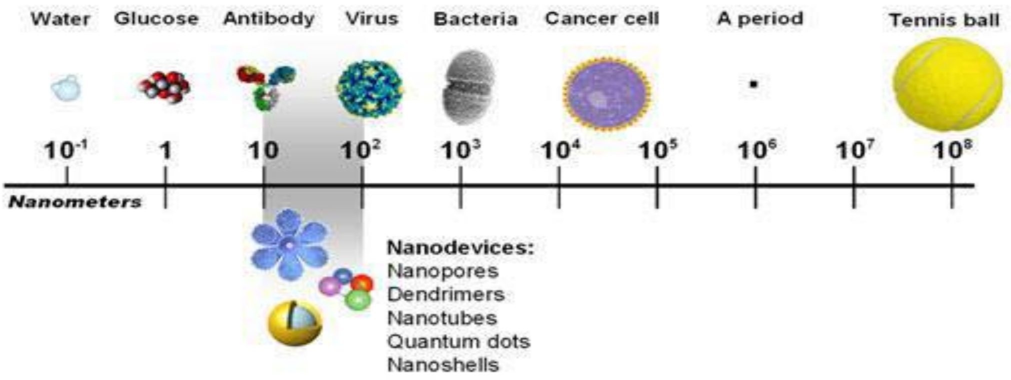

Figure 2: Nanoscale and nanostructure.

The nano scale is the place where the properties of most common things are determined just above the scale of an atom. Nano scale objects have at least one dimension (height, length, depth) that measures between 1 and 999 nanometers (1-999 nm). The brief explanation of pharmaceutical nano system is as follows

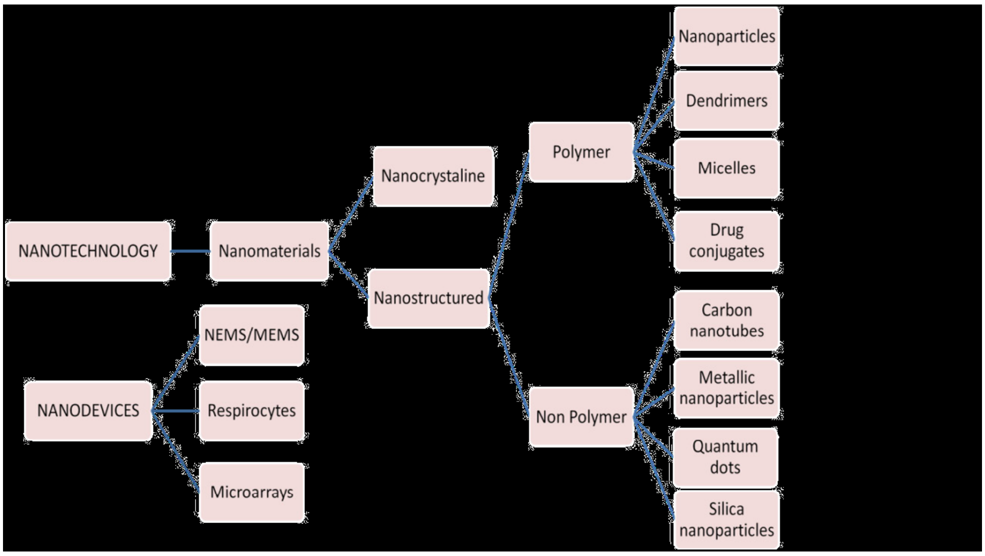

Figure 3: pharmaceutical nanosystems.

- **Carbon Nano Tubes:** These are small macromolecules that are unique for their size, shape, and have unique physical properties. Nano tubes have some special advantages over other drug delivery and diagnostic systems (Figure 3) due to their unique physical properties.

- **Metallic Nano Particles:** Metallic nano particles have used in drug delivery, especially in treatment of cancer and also in biosensors. Amongst various metals, silver and gold nano particles are of prime.[3]
- **Quantum Dot:** in this type the nanocrystals, are manufactured to several nanometers in diameter with a nearly unlimited range of sharply defined colours.These particles are excited using white light and can be linked to biomolecules to form long-lived sensitive probes.

USE: Separate biological events can be monitored by simultaneously tagging different proteins or DNA sequences with nanodots of a specific colour.

Ultra-Fast Dna Sequencing Using Nanopores

- The flow of DNA through nanopores can be used to discriminate low copy numbers of DNA, permitting very rapid genome sequencing.

The first demonstration of this principle used an array of cylindrical gold nanotubules with inner diameters as small as 1.6 nanometres.[11] In this when the tubules were positively charged, positive ions were excluded and negative ions were transported through the membrane and when the membrane was negatively charged, only positive ions passed through.

- This technology has been even used in electric fields to push RNA and DNA polymers through the central nanopore of a α-haemolysin protein channel mounted in lipid bilayer.[12]

In these Individual nucleotides pass single-file through the 2.6 nanometre wide nanopore, and changes in ionic current are used to measure the length of the polymer. Recording the translocation duration and current flow during traversal of individual polynucleotides yields a unique pattern of events for different polymers, upto a level where nanopores can discriminate between pyrimidine and purine nucleotide bases along a single RNA molecule and can distinguish between DNA chains of similar length and composition that differ only in base pair sequence.[12]

- DNA-nanopores can also discriminate between individual DNA strands up to 30 nucleotides in length differing by a single base substitution as shown by the detection of a drug resistance-conferring mutation in the reverse transcriptase gene of HIV.[12]

- Finally, this technique was also used to sequence a complete codon in an individual DNA strand tethered to a nanopore. In principle, nanopore detection and characterization of single molecules represents a new method for directly reading information encoded in linear polymers. With single-nucleotide resolution, it will be possible to determine nucleic acid sequences at rates exceeding a thousand bases per second.[13]

Advantages: refinement of these resources may provide

- Low-cost
- Easy and accurate detection and
- High throughput method of analyzing DNA polynucleotides.
- Future nanodevices may even combine voltage gating with pore size, shape and charge constraints to achieve precise control of ion transport with significant molecular specificity.[2]

Single-Virus Detection

Real-time detection of individual viruses would greatly impact our ability to diagnose and provide early intervention to a wide range of diseases. Although traditionally impossible, it has recently been reported that single virus particles could be detected with high selectivity using nanowire field-effect transistors to measure discrete conductance changes characteristic of binding and unbinding on nanowire arrays modified with viral antibodies [14]. The arrays detected and differentiated influenza A viruses, paramyxoviruses and adenoviruses based both on the specific receptors used to bind them and the duration of binding of each virus to its receptor. If this approach can be successfully scaled for clinical use then it might be possible to use nanowire devices for the simultaneous detection of numerous distinct viruses down to the level of the individual particle.[12]

Use of Nanotechnology In Health And Medicine

Even today various disease like diabetes, cancer, Parkinson's disease, Alzheimer's disease, cardiovascular diseases and multiple sclerosis as well as different kinds of serious inflammatory or infectious diseases (e.g. HIV) constitute a high number of serious and complex illnesses which are posing a major problem for the mankind. Nano-medicine is an application of nanotechnology which works in the field of health and medicine. Nano-medicine makes use of nano materials, and nano electronic biosensors. In the future, nano medicine will benefit molecular nanotechnology.[1] The medical area of nano science application has many projected benefits and is potentially valuable for all human races.

With the help of nano medicine early detection and prevention, improved diagnosis, proper treatment and follow-up of diseases is possible.[2] Certain nano scale particles are used as tags and labels, biological can be performed quickly, the testing has become more sensitive and more flexible. Gene sequencing has become more efficient with the invention of nano devices like gold nano particles, these gold particles when tagged with short segments of DNA can be used for detection of genetic sequence in a sample.

With the help of nanotechnology, damaged tissue can be reproduced or repaired. These so called artificially stimulated cells are used in tissue engineering, which might revolutionize the transplantation of organs or artificial implants.[3]

Advanced biosensors with novel features can be developed with the help of Carbon nano tubes. These biosensors can be used for astrobiology and can throw light on study origins of life. This technology is also being used to develop sensors for cancer diagnostics. Though CNT is inert, it can be functionalized at the tip with a probe molecule. Their study uses AFM as an experimental platform.[2]

1. Probe molecule to serve as signature of leukemia cells identified.
2. Current flow due to hybridization will be through CNT electrode to an IC chip.
3. Prototype biosensors catheter development.

Nanotechnology in the field of stem cell research

- Magnetic nanoparticles (MNPs) have been successfully used to isolate and group stem cells.
- Quantum dots have been used for molecular imaging and tracing of stem cells, for delivery of gene or drugs into stem cells.[2]
- Unique nanostructures were designed for controllable regulation of proliferation and differentiation of stem cells is done by designed unique nano structures.
- All these advances speed up the development of stem cells toward the application in regenerative medicine.[15]
- The recent applications of nanotechnology in stem cell research promises to open new avenues in regenerative medicine.
- Nanotechnology can be a valuable tool to track and image stem cells, to drive their differentiation into specific cell lineage and ultimately to understand their biology. This

will hopefully lead to stem cell-based therapeutics for the prevention, diagnosis and treatment of human diseases.[16]

Nano devices can be used in stem cell research in tracking and imaging them. It has its applications for basic science as well as translational medicine. Stem cells can be modulated by mixing of nano carriers with biological molecules .Nano devices can be used for intracellular access and also for intelligent delivery and sensing of biomolecules.[3] These technologies have a great impact in stem cell microenvironment and tissue engineering studies and have a great potential for biomedical applications.

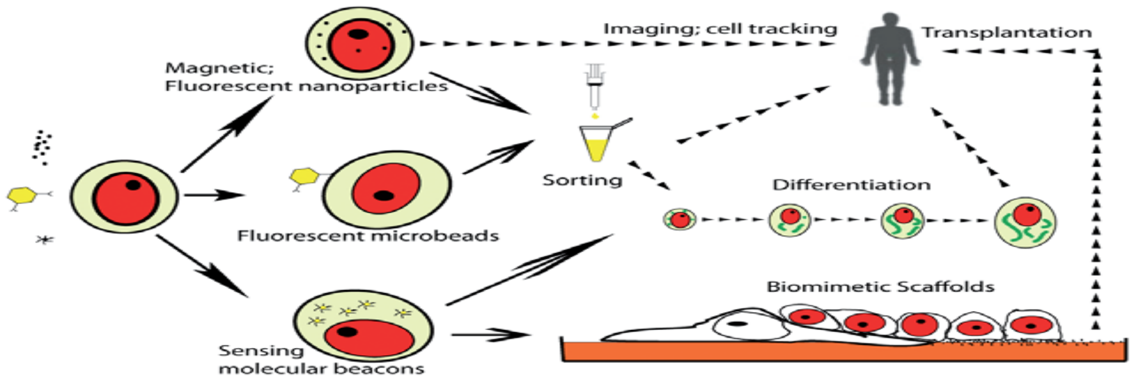

Figure 4: nanotechnology in stem cells.

Nanotechnology in Drug Delivery

In nanotechnology nano particles are used for site specific drug delivery. In this technique the required drug dose is used and side-effects are lowered significantly as the active agent is deposited in the morbid region only. This highly selective approach can reduce costs and pain to the patients. Thus variety of nano particles such as dendrimers, and nano porous materials find application. Micelles obtained from block co-polymers, are used for drug encapsulation. They transport small drug molecules to the desired location. Similarly, nano electromechanical systems are utilized for the active release of drugs. Iron nano particles or gold shells are finding important application in the cancer treatment. A targeted medicine reduces the drug consumption and treatment expenses, making the treatment of patients cost effective.[1]

Nano medicines used for drug delivery are made up of nano scale particles or molecules which can improve drug bioavailability. For maximizing bioavailability both at specific places in the body and over a period of time, molecular targeting is done by nano engineered devices such as nano robots.[9] The molecules are targeted[4] and delivering of drugs is done with cell precision. *In vivo* imaging is another area where Nano tools and devises are being developed for *in vivo* imaging. Using nano particle images such as in ultrasound and MRI, nano particles are used as contrast.

A third drug delivery approach mentioned here uses ‘nanoshells’ or dielectric-metal (gold-coated silica) nanospheres. One exciting area of potential use for nanoshells is the delivery of chemotherapeutics to tumors. These nano engineered materials are being developed for effectively treating illnesses and diseases such as cancer.[3] With the advancement of nanotechnology, self-assembled biocompatible nano devices can be created which will detect the cancerous cells and automatically evaluate the disease, will cure and prepare reports.[3]

The pharmacological and therapeutic properties of drugs can be improved by proper designing of drug delivery systems, by use of lipid and polymer based nano particles.[17] The strength of drug delivery systems is their ability to alter the pharmacokinetics and bio-distribution of the drug. Nano particles are designed to avoid the body's defense mechanisms can be used to improve drug delivery. New, complex drug delivery mechanisms are being developed, which can get drugs through cell membranes and into cell cytoplasm, thereby increasing efficiency. Triggered response is one way for drug molecules to be used more efficiently. Drugs that are placed in the body can activate only on receiving a particular signal. A drug with poor solubility will be replaced by a drug delivery system, having improved solubility.[1]

Proteins and Peptide Delivery

Protein and peptides are macromolecules and are called biopharmaceuticals. These have been identified for treatment of various diseases and disorders as they exert multiple biological actions in human body. Nano materials like nano particles and dendrimers are called as nano biopharmaceuticals, are used for targeted and/or controlled delivery.[3]

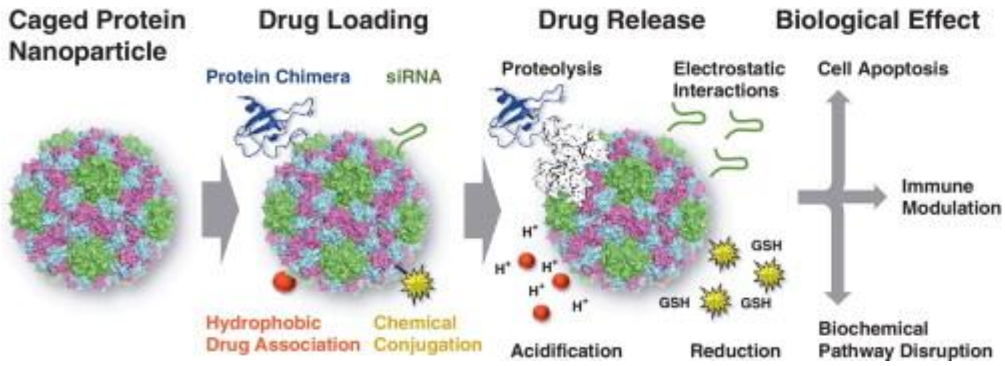

Figure 5: protein and peptide delivery.

Applications

Nano particles were found useful in delivering the myelin antigens, which induce immune tolerance in a mouse model with relapsing multiple sclerosis. In this technique, biodegradable polystyrene micro particles coated with the myelin sheath peptides will reset the mouse's immune system and thus prevent the recurrence of disease and reduce the symptoms as the protective myelin sheath forms coating on the nerve fibers of the central nervous system. This method of treatment can potentially be used in treatment of various other autoimmune diseases.[18,19]

Application of nanotechnology in Cancer

Due to the small size of nano particles can be of great use in oncology, particularly in imaging. Nano particles, such as quantum dots, with quantum confinement properties, such as size-tunable light emission, can be used in conjunction with magnetic resonance imaging, to produce exceptional images of tumor sites. As compared to organic dyes, nano particles are much brighter and need one light source for excitation.[1] Thus the use of fluorescent quantum dots could produce a higher contrast image and at a lower cost than organic dyes used as contrast media. But quantum dots are usually made of quite toxic elements.

Nano particles have a special property of high surface area to volume ratio, which allows various functional groups to get attached to a nano particle and thus bind to certain tumor cells. Furthermore, the 10 to 100 nm small size of nanoparticles, allows them to preferentially accumulate at tumor sites as tumors lack an effective lymphatic drainage system. Multifunctional nano particles can be manufactured that would detect, image, and then treat a tumor in future cancer treatment.[20] Kanzius RF therapy attaches microscopic nano particles to cancer cells and then "cooks" tumors inside the body with radio waves that heat only the nanoparticles and the adjacent (cancerous) cells.

Nano wires are used to prepare sensor test chips, which can detect proteins and other biomarkers left behind by cancer cells, and detect and make diagnosis of cancer possible in the early stages from a single drops of a patient's blood.[21]

Nano technology based drug delivery is based upon three facts
i) Efficient encapsulation of the drugs
ii) Successful delivery of said drugs to the targeted region of the body and
iii) Successful release of that drug there.

Nano shells of 120 nm diameter, coated with gold were used to kill cancer tumors in mice by Prof. Jennifer at Rice University. These nano shells are targeted to bond to cancerous cells by conjugating antibodies or peptides to the nano shell surface. Area of the tumor is irradiated with an infrared laser, which heats the gold sufficiently and kills the cancer cells.[22]

Cadmium selenide nano particles in the form of quantum dots are used in detection of cancer tumors because when exposed to ultraviolet light, they glow. The surgeon injects these quantum dots into cancer tumors and can see the glowing tumor, thus the tumor can easily be removed.

Nano particles are used in cancer photodynamic therapy, wherein the particle is inserted within the tumor in the body and is illuminated with photo light from the outside. The particle absorbs light and if it is of metal, it will get heated due to energy from the light. High energy oxygen molecules are produced due to light which chemically react with and destroy tumors cell, without reacting with other body cells. Photodynamic therapy has gained importance as a noninvasive technique for dealing with tumors.

The applications of various nano systems in cancer therapy[23] are summarized as

Carbon nano tubes, 0.5–3 nm in diameter and 20–1000 nm length, are used for detection of DNA mutation and for detection of disease protein biomarker.

Dendrimers, less than 10 nm in size are useful for controlled release drug delivery, and as image contrast agents.

Nano crystals, of 2-9.5 nm size cause improved formulation for poorly-soluble drugs, labeling of breast cancer marker HeR2 surface of cancer cells.

Nano particles are of 10-1000 nm size and are used in MRI and ultrasound image contrast agents and for targeted drug delivery, as permeation enhancers and as reporters of apoptosis, angiogenesis.

Nano shells find application in tumor-specific imaging, deep tissue thermal ablation.

Nano wires are useful for disease protein biomarker detection, DNA mutation detection and for gene expression detection.

Quantum dots, 2-9.5 nm in size, can help in optical detection of genes and proteins in animal models and cell assays, tumor and lymph node visualization.[23]

Nanotechnology in the treatment of neurodegenerative disorders

One of the most important applications of nanotechnology is in the treatment of neuro degenerative disorders [24]. For the delivery of CNS drugs, various nano carriers such as, dendrimers, nano gels, nano emulsions, liposomes, polymeric nano particles, solid lipid nano particles, and nano suspensions have been studied. Transportation of these nano medicines has been effected across various *in vitro* and *in vivo* BBB models by endocytosis and/or transcytosis, and early preclinical success for the management of various CNS conditions mentioned below is possible.

Examples

- Alzheimer's disease
- Brain tumors
- HIV encephalopathy
- Acute ischemic stroke.

The nanomedicine can be advanced further by improving their BBB permeability and reducing their neurotoxicity.[23]

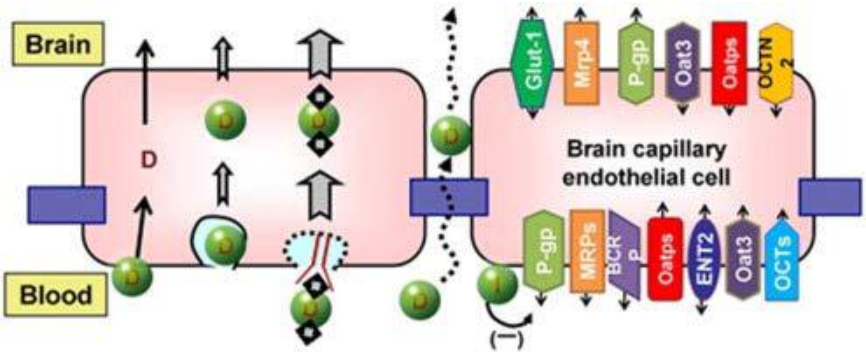

Figure 6: Delivery of nanomedicine to CNS through BBB.

Parkinson's disease: This can improve current therapy of Parkinson's disease (PD). Parkinson's disease (PD) is the second most common neurodegenerative disease after Alzheimer's disease and affects one in every 100 persons above the age of 65 years, PD is a disease of the central nervous system; neuro inflammatory responses are involved and leads to severe difficulties with body motions. The present day therapies aim to improve the functional capacity of the patient for as long as possible but cannot modify the progression of the neurodegenerative process.[24]

Aim of applied nanotechnology is regeneration and neuro protection of the central nervous system (CNS) and will significantly benefit from basic nanotechnology research conducted in parallel with advances in neurophysiology, neuropathology and cell biology. The efforts are taken to develop novel technologies that directly or indirectly help in providing neuro protection and/or a permissive environment and active signaling cues for guided axon growth. In order to minimize the peripheral side-effects of conventional forms of Parkinson's disease therapy, research is focused on the design, biometric simulation and optimization of an intracranial nano-enabled scaffold device (NESD) for the site-specific delivery of dopamine to the brain, as a strategy. Peptides and peptidic nano particles are newer tools for various CNS diseases.[1]

Nanotechnology will play a key role in developing new diagnostic and therapeutic tools. Nanotechnology could provide devices to limit and reverse neuro pathological disease states, to support and promote functional regeneration of damaged neurons, to provide neuro protection and to facilitate the delivery of drugs and small molecules across the blood–brain barrier.[23] For the delivery of CNS therapeutics, various nanocarriers such as dendrimers, nano gels, nano emulsions, liposomes, polymeric nano particles, solid lipid nano particles, and nano suspensions have been studied. Transportation of these nanomedicines has been effected across various *in vitro* and *in vivo* BBB models by endocytosis and/or transcytosis, and early preclinical success for the management of CNS conditions such as, Alzheimer's disease, brain tumors, HIV encephalopathy and acute ischemic stroke has become possible. Future development of CNS nanomedicines needs to focus on increasing their drug-trafficking performance and specificity for brain tissue using novel targeting moieties.

Alzheimer's disease: Worldwide, more than 35 million people are affected by Alzheimer's disease (AD), which is the most common form dementia. Nano technology finds significant applications in neurology.[25] These approaches are based on the, early AD diagnosis and treatment is made possible by designing and engineering of a plethora of nanoparticulate entities with high specificity for brain capillary endothelial cells. Nano particles (NPs) have high affinity for the circulating amyloid-β (Aβ) forms and therefore may induce “sink effect” and improve the AD condition. In vitro diagnostics for AD has advanced due to ultrasensitive NP-based bio-barcodes and immune sensors, as well as scanning tunneling microscopy procedures capable of detecting Aβ1−40 and Aβ1−42 The recent research on use of nano particles in the treatment of Alzheimer’s disease.[21]

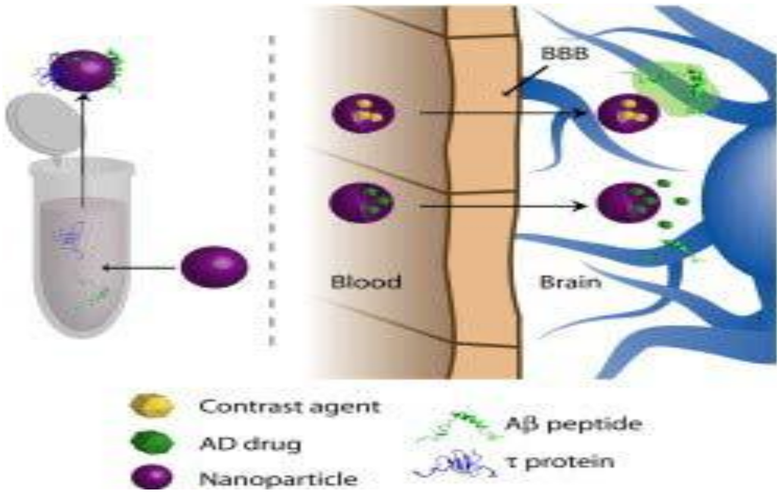

Figure 7: Nanotechnology in Alzheimer’s disease.

Tuberculosis treatment: Tuberculosis (TB) is the deadly infectious disease. The long duration of the treatment and the pill burden can hamper patient lifestyle and result in the development of multi-drug-resistant (MDR) strains. Tuberculosis in children constitutes a major problem. There is commercial non availability of the first-line drugs in pediatric form. Novel antibiotics can be designed to overcome drug resistance, cut short the duration of the treatment course and to reduce drug interactions with antiretroviral therapies. A nanotechnology is one of the most promising approaches for the development of more effective and compliant medicines. The advancements in nano-based drug delivery systems for encapsulation and release of anti-TB drugs can lead to development of a more effective and affordable TB pharmacotherapy.[24]

The clinical application of nanotechnology in operative dentistry

Nanotechnology aims at the creation and utilization of materials and devices at the atomic, and molecular level, supra molecular structures, and in the exploitation of unique properties of particles of size 0.1 nm to 100 nm. Nano filled composite resin materials are believed to offer excellent wear resistance, strength, and ultimate aesthetics due to their exceptional polish ability and luster retention. In operative dentistry, nano fillers constitute spherical silicon dioxide (SiO2) particles with an average size of 5-40 nm. The real innovation about nano fillers is the possibility of improving the load of inorganic phase. The effect of this high filler load is widely recorded in terms of mechanical properties. Micro hybrid composites with additional load of Nano fillers are the best choice in operative dentistry. It is expected that in near future, it would be possible to use a filler material in operative dentistry, whose shape and composition would closely mimic the optical and mechanical characteristics of the natural hard tissues (enamel and dentin). It also explains the basic concepts of fillers in composite resins, scanning electron microscopy and energy dispersive spectroscopy evaluation, and filler weight content. Nanocomposite resins are non-agglomerated discrete nanoparticles that are homogeneously distributed in resins or coatings to produce nanocomposites have been successfully manufactured by nano products Corporation. The nano-filler used is aluminosilicate powder with a mean particle size of 80 ran 1:4 M ratio of alumina to silica and a refractive index of 1.508. These nano composites have superior hardness, flexural strength, modulus of elasticity, decreased polymerization shrinkage and also have excellent handling properties particle size of 80 ran 1:4 M ratio of alumina to silica and a refractive index of 1.508.[26,27]

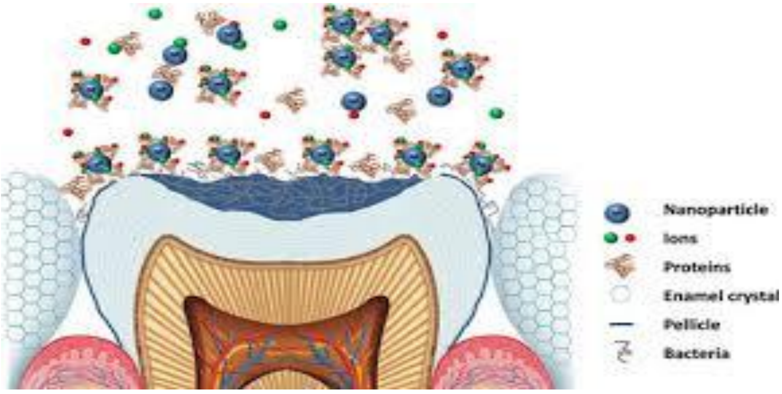

Figure 8: Nanotechnology in dentistry.

Applications in Ophthalmology

The aim of nano medicine is the to monitor, control, construct, repair, defense, and improve human biological systems at the molecular level, with the help of nano devices and nanostructures that operate massively in parallel at the unit cell level, in order to achieve medical benefit. Principles of nanotechnology are applied to nano medicine such as bio mimicry and pseudo intelligence. Some applications of nanotechnology to ophthalmology are include treatment of oxidative stress; measurement of intraocular pressure; the agnostics; use of nano particles for treatment of choroidal new vessels, to prevent scars after glaucoma surgery, and for treatment of retinal degenerative disease using gene therapy; prosthetics; and regenerative nano medicine. The current therapeutic challenges in drug delivery, postoperative scarring will be revolutionized with the help of nanotechnology and will help in various unsolved problems such as sight-restoring therapy for patients with retinal degenerative disease.[30] Treatments for ophthalmic diseases are expected from this emerging field. A novel nanoscale-dispersed eye ointment (NDEO) for the treatment of severe evaporative dry eye has been successfully developed [9]. The excipients used as semisolid lipids were petrolatum and lanolin, as used in conventional eye ointment, which were coupled with medium-chain triglycerides (MCT) as a liquid lipid; both phases were then dispersed in polyvinyl pyrrolidone solution to form nanodispersion. A transmission electron micrograph showed that the ointment matrix was entrapped in the nano emulsion of MCT, with a mean particle size of about 100 nm. The optimized formulation of NDEO was stable when stored for six months at 4°C, and demonstrated no cytotoxicity to human corneal epithelial cells when compared with commercial polymer-based artificial tears (Tears Natural® Forte). The therapeutic effects of NDEO were evaluated and demonstrated therapeutic improvement, displaying a trend of positive correlation with higher concentrations of ointment matrix in the NDEO formulations compared to a marketed product. Histological evaluation demonstrated that the NDEO restored the normal corneal and conjunctival morphology and is safe for ophthalmic application.[31] Recent research.[8] shows applications of various nanoparticulate systems like micro emulsions, nanosuspensions, nanoparticles, liposomes, niosomes, dendrimers and cyclodextrins in the field of ocular drug delivery and also depicts how the various upcoming of nanotechnology like nanodiagnostics, nanoimaging and nanomedicine can be utilized to explore the frontiers of ocular drug delivery and therapy.

Surgery

The technique developed by Rice University, two pieces of chicken meat is fused by a flesh welder, by placing two pieces of chicken touching each other.[32] In this technique, green liquid containing gold-coated nano shells is allowed to dribble along the seam and two sides are weld together. This method can be used arteries which have been cut during organ transplant. The flesh welder can be used to weld the artery perfectly.[7]

Visualization

Drug distribution and its metabolism can be determined by tracking movement. Cells were dyed by scientists to track their movement throughout the body.[5] These dyes excited by light of a certain wavelength to glow. Luminescent tags were used to dye various numbers of cells. These tags are quantum dots attached to proteins which penetrate cell membranes. The dots were of various sizes and bio-inert material. As a result, sizes are selected so that the frequency of light used to make a group of quantum dots fluoresce, and used to make another group incandesce. Thus both groups can be lit with a single light source.

Tissue engineering

In tissue engineering, nanotechnology can be applied to reproduce or repair damaged tissues. By using suitable nanomaterial-based scaffolds [3] and growth factors, artificially stimulated cell proliferation, in organ transplants or artificial implants therapy nano technology can be useful, which can lead to life extension.

Antibiotic resistance

Antibiotic resistance can be decreased by use of nano particles in combination therapy. Zinc Oxide nano particles can decrease the antibiotic resistance and enhance the antibacterial activity of Ciprofloxacin against microorganism, by interfering with various proteins that are interacting in the antibiotic resistance or pharmacologic mechanisms of drugs.[6]

Immune response

The nano device bucky balls have been used to alter the allergy/ immune response. They prevent mast cells from releasing histamine into the blood and tissues, as these bind to free radicals better than any anti-oxidant available, such as vitamin E.[5]

Nano pharmaceuticals

Nano pharmaceuticals can be used to detect diseases at much earlier stages and the diagnostic applications could build upon conventional procedures using nanoparticles. Nano pharmaceuticals are an emerging field where the sizes of the drug particle or a therapeutic delivery system work at the nanoscale. Delivering the appropriate dose of a particular active agent to specific disease site still remains difficult in the pharmaceutical industry. Nano pharmaceuticals have enormous potential in addressing this failure of traditional therapeutics which offers site-specific targeting of active agents. Nano pharmaceuticals can reduce toxic systemic side effects thereby resulting in better patient compliance.[4]

Pharmaceutical industry faces enormous pressure to deliver high-quality products to patients while maintaining profitability. Therefore pharmaceutical companies are using nanotechnology to enhance the drug formulation and drug target discovery. Nano pharmaceutical makes the drug discovery process cost effective, resulting in the improved Research and Development success rate, thereby reducing the time for both drug discovery and diagnostics.

Expectations of Nanotechnology in Medicine

Expectations	Years
Improvement in the average five-year survival rate for all types of cancer to more than 70% Widespread use of regenerative treatment technology for damaged organs using embryonic Stem cells, of treatment methods capable of completely curing Alzheimer's disease.[3]	2020
Elucidation of individual aging mechanisms.	2021

CONCLUSION

Nano materials have increased surface area and nano scale effects, hence used as a promising tool for the advancement of drug and gene delivery, biomedical imaging and diagnostic biosensors, analytical, detection and therapeutic purposes and procedures, such as targeting cancer, drug delivery, improving cell-material interactions, scaffolds for tissue engineering, and gene delivery systems, and provide innovative opportunities in the fight against incurable diseases.[2] There has been a huge progress on understanding the function of biological structures and their interaction and integration with several,[3] non-living systems, but there are still open issues to be answered, mainly related to biocompatibility of the materials and devices which are introduced into the body. Nano materials have unique physicochemical and biological properties as compared to their larger counterparts. The properties of nano materials [4] can greatly influence their interactions with bio molecules and cells, due to their peculiar size, shape, chemical composition, surface structure, charge, solubility and agglomeration. For example, nano particles can be used to produce exceptional images of tumor sites; single-walled carbon nanotubes, have been used as high-efficiency delivery transporters for biomolecules into cells.

The use of nanomedicine can provide much more advances across the various fields like medicine, communications, genomics and robotics etc.[2] On the surface, miniaturization provides cost-effective and more rapidly functioning mechanical, chemical and biological components. Less obvious, though is the fact that nanometre-sized objects are under the control of forces quite different from macro-objects. These unique behaviors are what make nanomedicine possible, and by increasing our understanding of these processes, new approaches to enhancing the quality of human life will be developed. However, this will take time. In the next few years, many applications of nanotechnology will become commonplace within medical practice. Because these advancements will be incremental and will be initially derived from ongoing 'wet science'[1] instead of scaled-down machining and computing they might ironically sometimes be too small to be noticed.

There is a very bright future to nano technology, by its merging with other technologies and the subsequent emergence of complex and innovative hybrid technologies. Biology-based technologies are intertwined with nanotechnology-nanotechnology is already used to manipulate genetic material, and nano materials are already being built using biological components. The ability of nanotechnology to engineer matter at the smallest scale is revolutionizing areas such as information technology cognitive science and biotechnology and is leading to new and interlinking these and other fields. [3]By further research in nanotechnology, it can be useful for every aspect of human life. Medicine, regenerative medicine, stem cell research and pharmaceuticals are among the leading sectors that will be modified by nanotechnology innovations.[1]

Many novel nanoparticles and nanodevices are expected to be used, with an enormous positive impact on human health. The vision is to improve health by enhancing the efficacy and safety of nanosystems and nanodevices. In addition, early diagnosis, implants with improved properties, cancer treatment and minimum invasive treatments for heart disease, diabetes and other diseases are anticipated.[2] In the coming years, nanotechnology will play a key role in the medicine of tomorrow providing revolutionary opportunities for early disease detection, diagnostic and therapeutic procedures to improving health and enhancing human physical abilities, and enabling precise and effective therapy tailored to patient.

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