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Review on Nanotechnology in Novel Drug Delivery System

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ABSTRACT: Nanotechnology is novel and having full scope of contribution in the field of humanhealth care. Recent advances suggest that nanotechnology will have a profound impact on diseases prevention, diagnosis and treatment. It will allow faster drug absorption, controlled dose release with minimized side-effects. Nanotechnology plays a crucial role in revolutionizing the field of surgery, detection of disease like cancer. Drugs with high toxic potential can be given with a better safety profile with the utility of nanotechnology. It is an ideal targeting system should have longcirculating time, it should be present at appropriate Concentrations at the target site, and it should not lose its activity or therapeutic efficacy while in circulation. Our aim is to review the potential applications and various drug delivery system of nanotechnology.

Nanotechnology is science of matter and material that deal with particle size in nanometers. Nanotechnology has received a lot of attention with never seen-before enthusiasm because of its future potential. It has provided fine lined diagnosis and focus treatment of disease at molecular level. This technology offers the advantageof protecting drugs from degradation; reduce the number of doses required. In thisreview, a discussion was carried out on different techniques for the preparation of nanodrug delivery systems like nanoparticles, solid lipid nanoparticles, nanocrystals, nanosuspensions, nano-emulsions. The concept of nanotechnology is widely expanded and applied to many drugs to the present. The ultimate applicationgoal of nano drug delivery system is to develop clinically useful formulation for treating diseases in patients.

KEYWORDS: Nanotechnology, health care, side-effects, revolutionizing, concentrations, Nanoparticle.

I. INTRODUCTION

Nanotechnology can be defined as the science and engineering involved in the design, synthesis, characterization and application of materials and devices whose smallest functional organization in at least one dimension is on the nanometer scale(one-billionth of a meter). In the past few years nanotechnology has grown by leaps and bounds, and this multidisciplinary scientific field is undergoing explosive development. It can prove to be a boon for human health care, because nanoscience and nanotechnologies have a huge potential to bring benefits in areas as diverse asdrug development, water decontamination, and the production of stronger, lighter materials. Human health-care nanotechnology research can definitely result in immense health benefits. The genesis of nanotechnology can be traced to the promise of revolutionary advances across medicine. A complete list of the potentialapplications of nanotechnology is too vast and diverse to discuss in detail, but without doubt, one of the greatest values of nanotechnology will be in the development of new and effective medical treatments.

Nanotechnology-based delivery systems can also protect drugs from degradation. These properties can help reduce the number of doses required, make treatment a better experience and reduce treatment expenses. A number of nano-based systemsallow delivery of insoluble drugs, allowing the use of previously rejected drugs ordrugs which are difficult to administer e.g. paclitaxel. At present these systems aregenerally used for existing, fully developed off-patent drugs, the socalled "low-hanging fruit" of nanotechnology-based delivery. These technologies include nanoarrays, protein arrays, nanopore technology, nanoparticles (NPs) as a contrivance in immunoassays and nanosensors, among others. Gold NPs and quantum dots (semiconductors) are the most widely used, but new materials are becoming available as more molecular entities are discovered as amenable to nanoscale design and fabrication. Crystal materials like those of gallium, phosphate, quartz, and ceramic are chosen for their durability and piezoelectric properties of developing and retaining an electric potential (charge) when subjected to mechanical stress.

Nanotechnology is a new arising branch of technology, which bears high prospects of its eventuality to change the world unnaturally. Some policy makers and technology inventors indeed speak about " the Next Industrial Revolution ", which advancing nanotechnology is supposed to bring along. still, the development of nanotechnology is in such an early state that there is n't indeed complete agreementabout the description of nanotechnology and its substance. Some claim that nanotechnology is a specific area of exploration and it can be defined as a general purpose technology(GPT). GPT refers to technologies that have the following three characteristics pervasiveness(has some function that's vital to the functioningof a large member of being or implicit products and product systems), invention begetting(fosters new inventions that directly or laterally affect from the early major invention) and compass for enhancement(technology improves mainly over time). Others argue that nanotechnology is just a new marker put on exploration systems in conventional fields of wisdom – similar as chemistry, drugs, biomedical engineering, accoutrements wisdom and electrical engineering
– to gain further exploration backing. still, there have been also sweats to definecolorful terms in the field of nanotechnology, and therefore make common understanding about the issue. Nanotechnology helps us to deliver medicine in the form of dendrimers, liposomes, nanoshells, mixes, nanotubes, amount blotches etc.for the manipulation of colorful conditions and their metabolic pathway. It's of great significance in treatment and opinion of cancer. Some of the retailed phrasings of nanotechnology which have been used for the treatment of colorful conditions are listed in Table 1.

S.No	Name ofDrug	Brand Name	Company Name	Use
1	Doxorubicin	Doxil	OrthoBiotech	Ovarian tumour
2	Amphotericin B	AmBisome	Astellas Pharma US	Fungal infection
3	Paclitaxel	Abraxane	Abraxis Oncology	Non small cell lung cancer
4	Iron Oxide	Combidex/Feru moxtran	AMAG Pharmaceuticals	MRI contrast agent
5	L-Lysine	VivaGel	Starpharma pty.	HIV/HSV

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			Ltd.	preventions

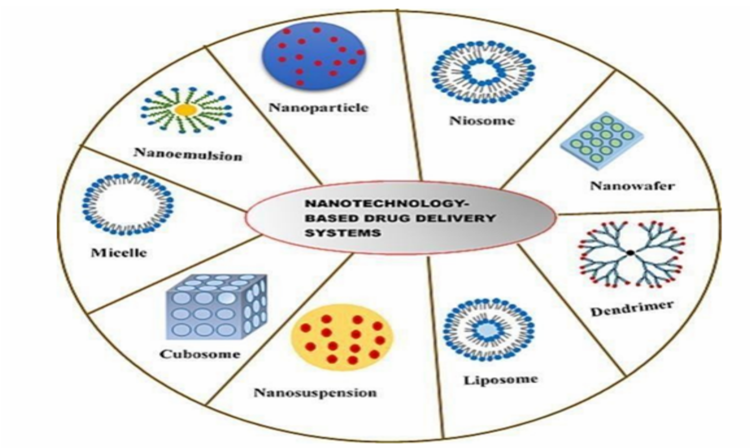
Table 1: List of some marketed formulations

ADVANTAGES OF NANOTECHNOLOGYs

1. Increased surface area
2. Enhanced solubility
3. Increased rate of dissolution
4. Increased in oral bioavailability
5. Less amount of dose required & reduces the number of doses
6. Protection of drug from degradation
7. More rapid onset of therapeutic action
8. Achievement of drug targeting
9. Passive targeting of drugs to the macrophages present in the liver and spleen.

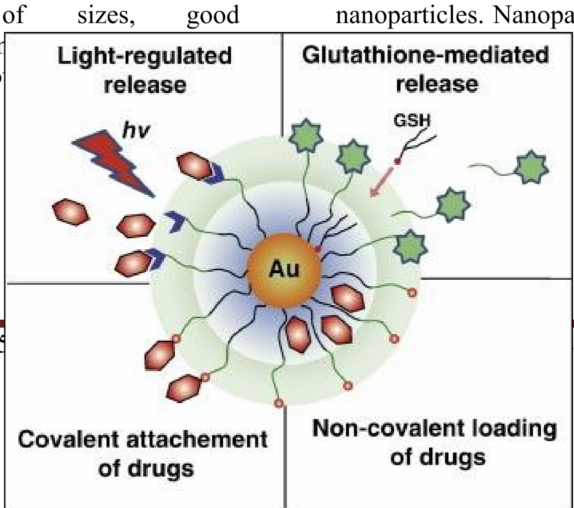
NANOTECHNOLOGY BASED DRUG DELIVERY SYATEM

There are so many types of drug delivery system used in nanotechnology techniques and these systems have considerable potential for the treatment of many diseases.



Gold Nanoparticles

Colloidal gold nanoparticles have been used for a fairly long time for the treatment of conditions including cancer, rheumatoid arthritis, multiple sclerosis andneurodegenerative conditions similar as Alzheimer " s complaint. The advantages of gold nanoparticles are their ease of medication in a range of sizes, good biocompatibility, fluently fur capability to conjugate with o



without altering their natural parcels. Gold nanoparticles with compasses ≤ 50 nm have been shown to cross the BBB. PEGylated gold nanoparticles conjugated with TNF(tumour necrosis factor) can enter tumour cells through their dense vasculature. Multi-functionalization is the main characteristics of nanoparticles. Nanoparticles can be integrated with

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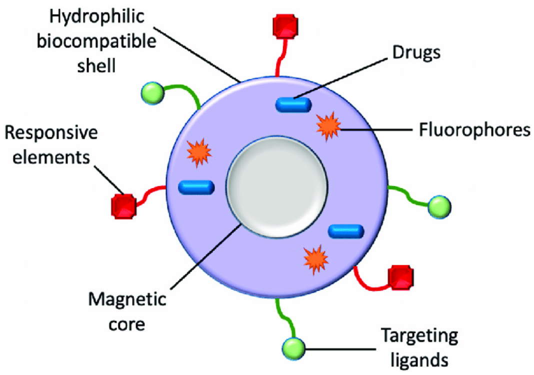
ligands, imaging markers, remedial agents and other functionalities for specific medicine delivery and cellular uptake. Aryal et al., 2009 was set up that Doxorubicin, an anticancer medicine can conjugate with gold nanoparticles and by conjugation there's increase in the energy of doxorubicin. So the cytotoxic effect ofdoxorubicin is increased. Through functionalization gold nanoparticles convert poor active medicine to high active medicine. therefore gol den nanoparticles have a great donation in cancer remedy, opinion of cancerous cell and significance in the remedy of HIV.

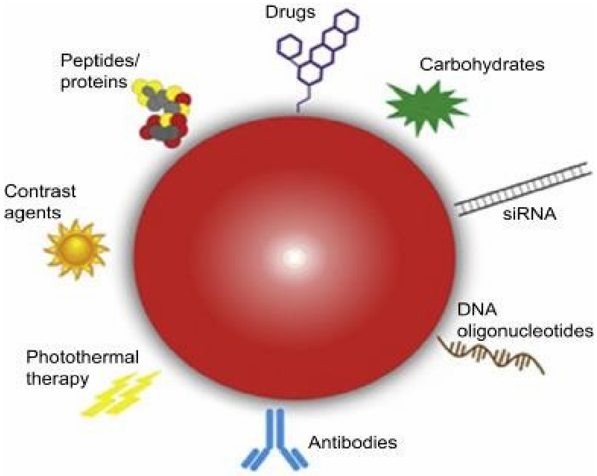
Magnetic Nanoparticles



nanoparticles have come one of the most studied and applied nanotechnology in the once many times. operations involving glamorous nanoparticles include target ed medicine delivery, as discrepancy agents in glamorous Resonance Imaging(e.g. Feridex), gene delivery and cell separation, cell labelling. forceful oxide nanoparticles are extensively studied due to their biodegradable nature, biocompatibility and uperparamagnetic parcels suited forMRI operations. glamorous nanoparticles thatcan be loaded with medicines and still retain their MRI parcels have been reported. The iron oxide nanoparticles were carpeted with oleic acid and loaded with anticancer agent ‟ s doxorubicin and paclitaxel witha lading effectiveness of over to 95. Artificial operations of glamorous nanoparticles cover a broad diapason simila r as glamorous seals in motors, glamorous inks for bank cheques, glamorous recording media and biomedical operations similar as glamorous resonance discrepancy media and rem edial agents in cancer treatment.

Ceramic Nanoparticles

Nanoparticles of silica, titanium, alumina etc. are typically classified under the heading ceramic nanoparticles. One of the advantages of these patches is that their medication is veritably simple. They're innocent by changes in pH or temperature. It's possible to manipulate numerous features of these nanoparticles, including size, shape, porosity, idleness etc., and they can fluently be modified to attach different biomolecules.



Their typical size is around 50nm.

Ceramic nanoparticles have been used to synopsize hydrophobic medicine motes, the acid labile model enzyme, serratiopeptidase and increase the transfection effectiveness of DNA(used with a DNA- dendrimer conjugate). Pottery have been used in bone towel engineering due to their osteoinductive and biocompatible parcels.

Liposomes

Liposomesdiscoveredinmedial1960s

were the original models ofnanoscaled medicine delivery bias. They're globular nanoparticles made of lipid bilayer membranes with an waterless innards but can be unilamellar witha single lamina of membrane or multilamellar with multiple membranes. They can be used as effective medicine delivery systems.

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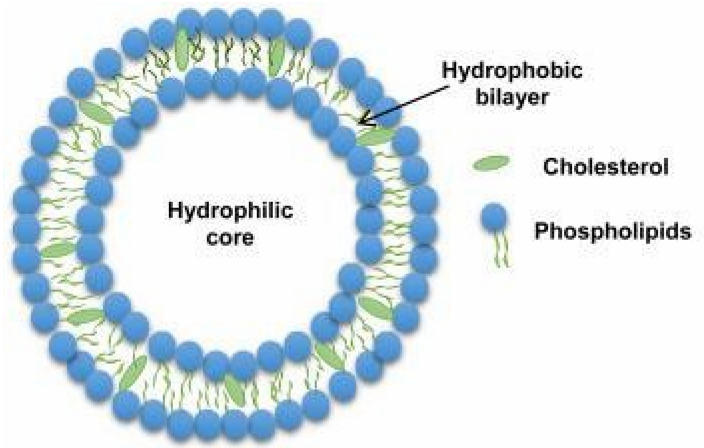
These liposomes can be loaded with medicines either in the waterless cube or in the lipid membrane. generally water answerable medicines are loaded in waterless cube an d lipid answerable medicines are incorporated in the liposomal membrane.The limitation of liposome is its rapid-fire declination and concurrence by the liver macrophages, therefore reducing the duration of action of the medicine it carries. Other ways of dragging the rotation time of liposomes are objectification of substance like cholesterol, polyvinyl pyrollidone polyacrylamide lipids and high transition temperature phospholipids distearoylphosphatidylcholine.

Targeting of liposomal medicines Liposomes can be targetedto specific organ or towel by unresistant as well as active styles. As the liposomal medicine acts minimally on other apkins, the safety profile isbetterthannon-liposomalmedicine. The

vascularity in tumour towel is inadequately organized and significant leak occurs from blood vessel in the tumour towel. The liposomal medicines get accumulated in the tumour towel passively and produce enhanced goods. Active targeting ofthe medicine can be achieved by using immunoliposomes and ligand directed liposomes.



Niosomes

Niosomes arenon-ionic surfactant vesicles with a analogous structure to liposomes.They can synopsize waterless solutes and act as medicine carriers. Niosomes are formed by the tone assembly ofnon-ionic amphiphiles in waterless media.

The operation of heat or physical agitation helps the process to attain a unrestricted bilayer structure. Their uptakeby organs similar as the liver and spleen make niosomes stylish suited as medicine delivery agents in condition s affecting these organs. They're also used in targeting cancer cells. Since niosomal antigens are potent stimulators of the cellular and humoral vulnerable responses they're also useful as adjuvants in vaccine delivery.

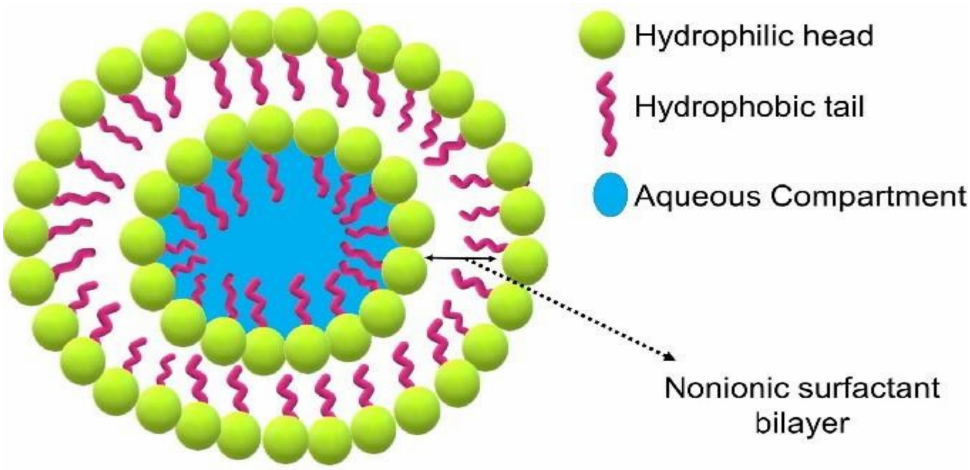


Figure 1:. A typical structure of niosome

High levels of drugs were found in the target location when administered via niosomes compared to conventional routes. They have also been used with anti- inflammatory agents and anti-

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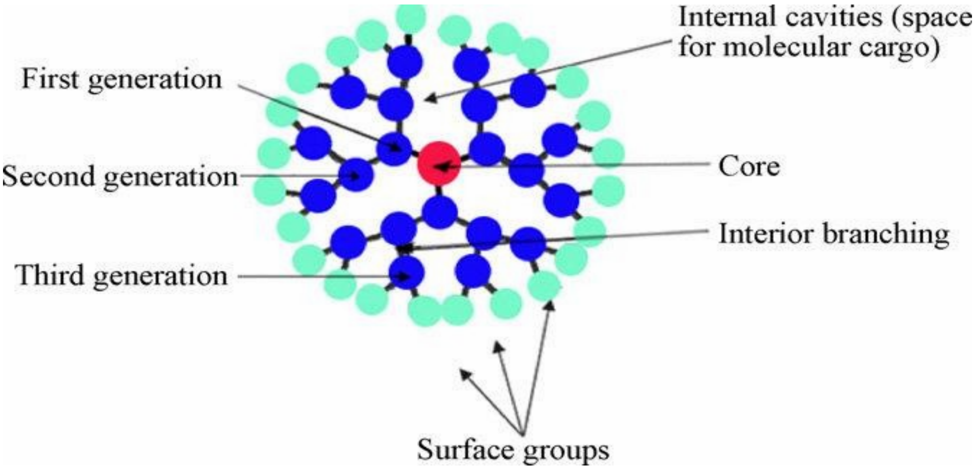
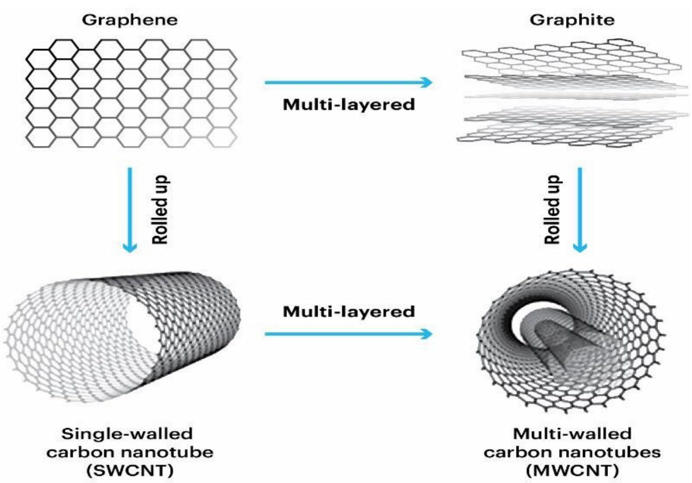
infective agents. PEGylated cationic niosomes have been used for the cellular delivery of oligonucleotides.

Dendrimers



A generally accepted description of dendrimer is a monodisperse macromolecule with impeccably fanned regular structure and having at least one fanned junction at each reprise unit. Dendrimers are a type of nanostructure thatbcan be precisely designed and manufactured for a wide variety of operations, including the treatment of cancer and other conditions. Dendrimers carrying different accoutrements on their branches can do several effects at one time, similar as feting diseased cells, diagnosing diseased countries(including cell death), medicine delivery, reporting position,and reporting issues of remedy.

Carbone Nano Tubes



CNTs have the capability to transport medicine motes, proteins and nucleotides. Due to their size and shape, carbon nanotubes can enter living cells without causing cell death or egregious damage. motes can be covalently or non-covalently attached to the face. The concave structure of CNTs allows encapsulation of motes but as yet there are veritably many exemplifications of thisfor medicines delivery. For natural operations CNTs bear covalent ornon-covalentfictionalization to help aggregation and increase their solubility.

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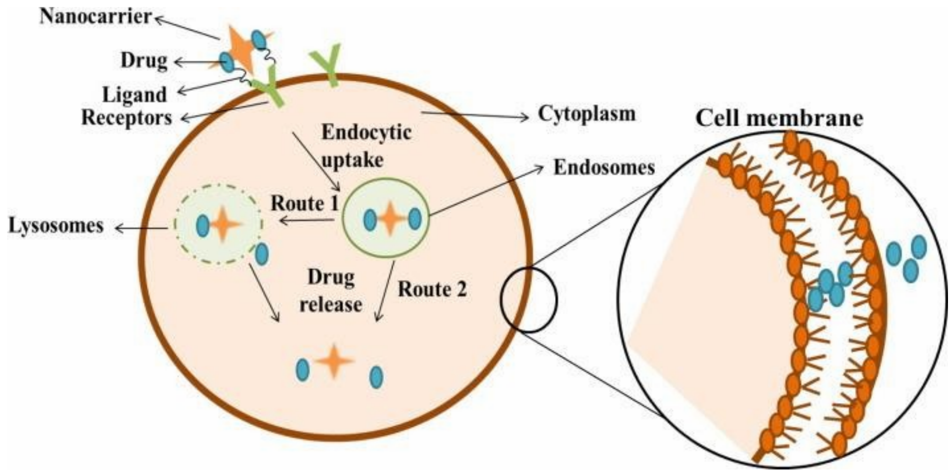
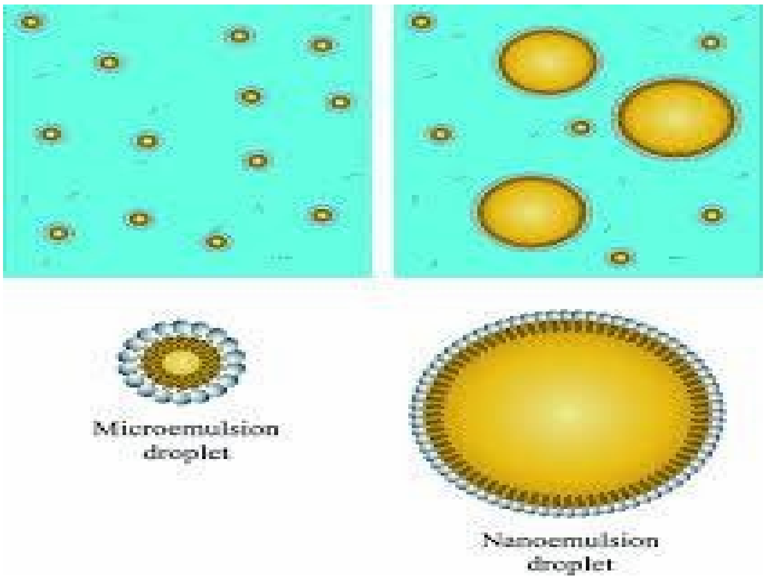
Nanopores



Nanopores designed by Desai and Ferrari(1997), correspond of wafers with high viscosity of pores(20 nm in periphery). The pores allow entry of oxygen, glucose and other products like insulin to pass through. still, it does n't allow immunoglobulin and cells to pass through them. Nanopores can be used as bias to cover transplanted apkins from the host vulnerable system, at the same time, exercising the benefit of transplantation. βcells of pancreas can be enclosed within the nanopore device and implanted in the philanthropist ‟s body.

Microemulsion/Nanoemulsion



Microemulsions are isotropic, thermodynamically stable systems composed of oil painting, water, and surfactant. Thermodynamic stability rather than size, isthe defining hallmark of a microemulsion, although the drop sizesare still below 100nm(and numerous times much lower).

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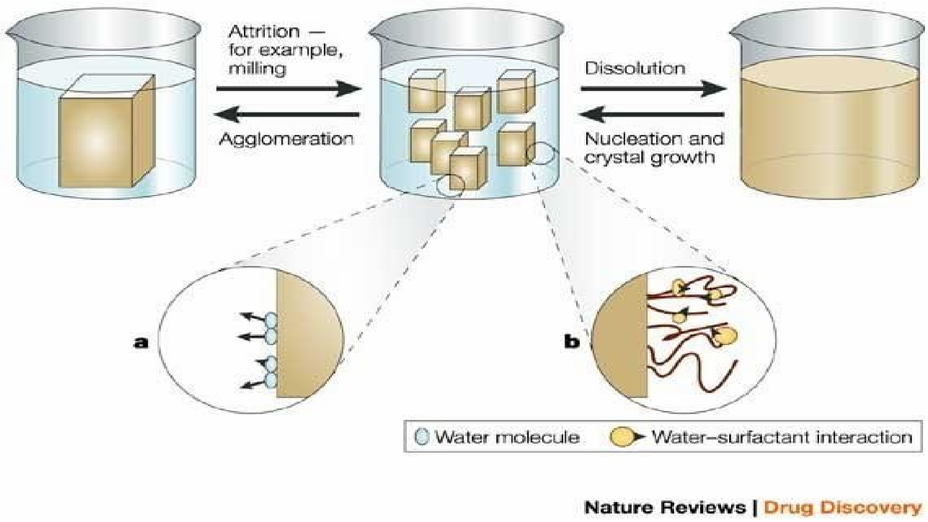
Be that as it may, what's critical about microemulsions is that, they contain two phases conforming of two immiscible liquids that are mixed together and stabilized with the aid of a surfactant with or without a co- surfactant. They may have driblets in the range of 5–100nm. The difference between microemulsions and mixes is that, the latterly are opaque fusions of two immiscible liquids, thermo- stoutly unstable and generally bear the operation of high necklace mecha nical mixing or homogenization to produce dispersed driblets in the range of 0.2 –25 mm. Both types can be made as water- in- oil painting(w/ o) or oil painting- in-water(o/ w).

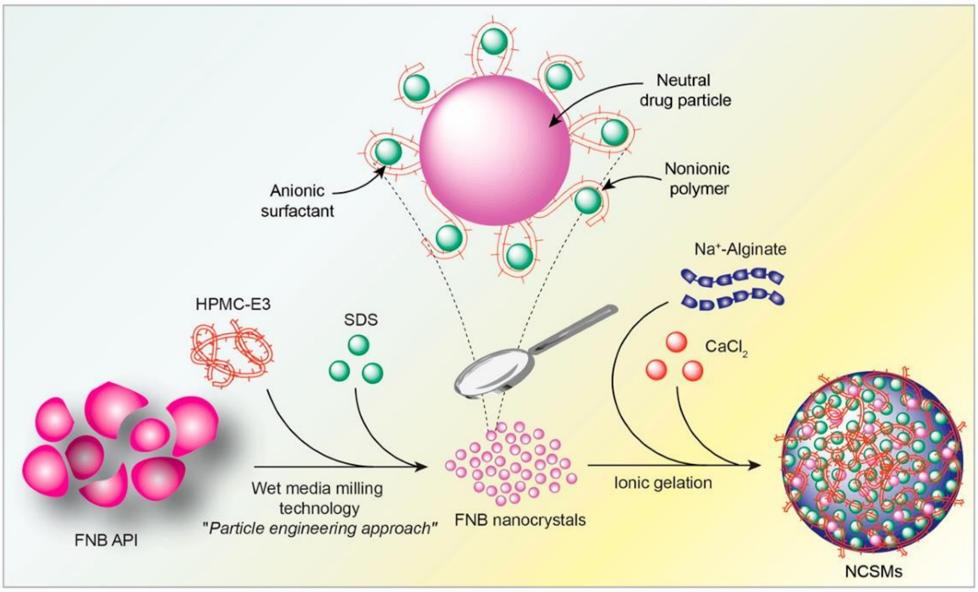
Nanosuspensions

Nanosuspensions are colloidal dissipations of nanoparticles of an undoable patch, which are stabilized by surfactants. Nanosuspensions can be used to maintain these medicines in a preferred crystalline state of sufficie ntly small size for intravenous administration. Their advantages are analogous to those of nanoemulsions. Theycan also achieve indeed advanced situations of medicine lading because the medicine is in the solid state. Several studies have demonstrated the use of nanosuspensions for medicine delivery with bettered efficacity and release.

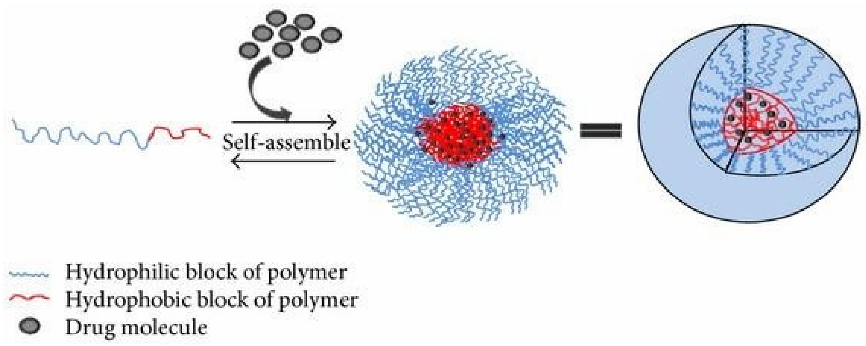


Nanocrystals

Nanocrystals are summations comprising several hundred to knockouts of thousands of tittles that combine into a" cluster". Typical sizes ofthese summations are between 10- 400 nm and they parade physical and chemical parcels nearly between that of bulk solids and motes. By controlling the size and face area, other parcels similar as band gap, charge conductivity, liquid structure and melting temperature can be altered.
The chargers must be stabilized to help larger summations from forming.



Micelles



Micelles are also globular lipid nanostructures but they do n't have a bilayeror inner depression. The hydrophobic ends of the phospholipids point inwards and the hydrophilic ends face the outside, forming a globular structure. Rear micelles hav e this opposition the contrary way. The typical size of micelles for medicinal operations ranges from 10- 80 nm. Compared to liposomes, micelles have a short rotation time within the body due to their lower size.

PARTICLE SIZE RANGE FOR DIFFRENT NANO-TECHNIQUES

S.N.	Technique	Particle Size
1	Nanoparticles	10-1000nm
2	Gold Nanoparticles	5-50nm

3	Magnetic Nanoparticles	5-500nm
4	Liposomes	15nm to several nm
5	Niosomes	20nmto severalmicrometers
6	Dendrimers	1.5-10nm
7	Carbon Nano Tubes	Less then 100nm
8	Nanoemulsion	50-1000nm
9	Nanosuspension	10-1000nm
10	Nanocrystals	10-400nm
11	Micelles	10-80nm

CHALLENGES OF NANO DRUG DELIVERY

Although nanotechnology in medicine delivery has been successful, as substantiated by some nano medicine products in the request, not all approaches have met with the same success. New nanomaterials being developed come with challenges which have to be surmounted. still some of the challenges encountered have been andare still being dived by revision of the physicochemical characteristics of thenanomaterials to ameliorate on parcels similar as long rotation in the blood, increased functional face area, protection of incorporated medicine fro m declination, crossing of natural walls and point-specific targeting.

Another challenge of exploration and development(R&D) of nanomaterials for medicine delivery is large scale product. There's always a need to gauge up laboratory or airman technologies for eventual commercialization. A number of nano medicine delivery technologies may not be scalable due to the system and process of product and high cost of accoutrements employed.

The challenges of spanning up include low attention of nanomaterials, agglomeration and the chemistry process – it's easier to modify nanomaterials at laboratory scale for bettered performance than at large scale.

APPLICATION OF NANOTECHNOLOGY

The importance of nanotechnology in therapeutics and the role played by it in combating some of the chronic diseases, such as cancer. Areas in drug delivery where nanotechnology can make a difference include:

1. Developing systems that improve the solubilityand bioavailability of hydrophobic drugs.
2. Designing delivery vehicles that can improvethe circulatory presence of drugs.
3. Eliminating or minimising toxicity.
4. Increasing specificity.
5. Targeting drugs to specific cells or tissues.
6. Improving vaccine adjuvants and delivery.
7. Developing novel nanostructures that can be used in specific applications, e.g.ocular,cancer therapy, neurology, orthopaedics.
8. Delivery of repaired genes or the replacement of incorrect genes is fields in whichnanoscale objects couldbe introduced successfully.

II. CONCLUSION

Nanotechnology offers the ability to build large numbers of products that are incredibly powerful by today's standards. This possibility creates both opportunity and risk. It would be difficult to deny the potential benefits of nanotechnology and stop development of research related to it since it has already begun to penetrate many different fields of research. However, nanotechnology can be developed using guidelines to insure that the technology does not become too potentially harmful. Humans have the potential to live healthier lives in the near future due to the innovations of nanotechnology. Like this disease diagnosis, prevention and treatment of disease, better drug delivery system with minimal side effects and tissue reconstruction.

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