Available online on 15.09.2014 at http://jddtonline.info
Journal of Drug Delivery and Therapeutics
Open access to Pharmaceutical and Medical research

REVIEW ARTICLE

NANOTECHNOLOGY IN NOVEL DRUG DELIVERY SYSTEM

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ABSTRACT:

Nanotechnology is novel and having full scope of contribution in the field of human health 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 long circulating 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.
Keywords: Nanotechnology, health care, side-effects, revolutionizing, concentrations.

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) [1-2]. In the past few years nanotechnology has grown by leaps and bounds, and this multidisciplinary scientific field is undergoing explosive development[3-6]. 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 as drug 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 potential applications 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[7-10].

Nanotechnology also providing us with the tools to prevent a disease before it attacks the body, like DNA vaccine. As far as nanoparticles are concerned, development of biodegradable polymeric nanoparticles have been a wonderful idea as they can deliver drugs, proteins and DNA to a target tissue and are able to release drug in a controllable manner irrespective of the route of administration[11].

Nanoconstructions could deliver medicines to particular targeted site, making possible the more precise treatment. Such devices would have a small computer and several binding sites to determine the concentration of specific molecules in the body, and small amount of poison can also be delivered at target site to destroy the selectively targeted cells. Similar machines equipped with specific 'weapons' could be used to remove obstructions in the blood circulatory system and to kill cancer cells. Nanorobots which are operating in the human body, has the ability to monitor the level of different compounds as well as store related information in its internal memory. They could be used to rapidly examine a given tissue; this would help in better disease diagnosing [12].

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 systems allow delivery of insoluble drugs, allowing the use of previously rejected drugs or drugs which are difficult to administer e.g. paclitaxel. At present these systems are generally used for existing, fully developed off-patent drugs, the so-called "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.

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 ISSN: 2250-1177 CODEN (USA): JDDTAO

Another area of development is nanobiosensors, in which antibody- based piezoelectric nanobiosensors are well developed. Nanoparticles take advantage of their dramatically increased surface area to volume ratio. Nanotechnology should not be viewed as a single technique that only affects specific areas. It is more of a 'catch-all' term for a science which is benefiting a whole array of areas, from the environment, to healthcare, to hundreds of commercial products[13]. Nanotechnology is an ideal targeting system should have long circulating 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. Various nanosystems, as a result of their larger size, are accumulated at higher concentrations than normal drugs. In addition, the increased vascular permeability coupled with an impaired lymphatic drainage in tumors allows an enhanced permeability and retention effect of the the tumors or inflamed tissue. Thus, this pathophysiological opportunity allows extravasation of the nanosystems and their selective localization in the inflamed tissues. The tendency of nanosystems to specifically localize in the reticuloendothelial system also presents an excellent opportunity for passive targeting of drugs to the macrophages present in the liver and spleen. Thus, this natural system can be used for targeting drugs for intracellular infections [14]. The therapeutic value of many promising drugs for the treatment of various neurological disorders is diminished by the presence of the blood-brain barrier[15]. The blood-brain barrier is a unique membrane that tightly segregates the brain from the circulating blood. Thus, drug delivery to this organ is a challenge, because the brain benefits from very efficient protection. Nanotechnology offers a solution for using the numerous chemical entities for treating brain disorders that are not clinically useful because of the presence of the blood-brain barrier. Nanoparticles can be effectively used to deliver relevant drugs to the brain [16].

Nanotechnology is a new emerging branch of technology, which bears high expectations of its potential to change the world fundamentally. Some policy makers and technology developers even speak about "the Next Industrial Revolution", which advancing nanotechnology is supposed to bring along. However, the development of nanotechnology is in such an early state that there is not even complete consensus about the definition of nanotechnology and its essence. Some claim that nanotechnology is a specific area of research 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 is vital to the functioning of a large segment of existing or potential products and production systems), innovation spawning (fosters new innovations that directly or indirectly result from the early major invention) and scope for improvement (technology improves substantially over time) [17]. Others argue that nanotechnology is just a new label put on research projects in conventional fields of science – such as chemistry, physics, biomedical engineering, materials science and electrical engineering – to gain more re-search funding[18]. However, there have been also efforts to define various terms in the field of nanotechnology, and thus build common understanding about the issue. Nanotechnology helps us to deliver drug in the form of dendrimers, liposomes, nanoshells, emulsions, nanotubes, quantum dots etc. for the manipulation of various diseases and their metabolic pathway. It is of great importance in treatment and diagnosis of cancer[19]. Some of the marketed formulations of nanotechnology which have been used for the treatment of various diseases are listed in Table 1.

Table 1: List of some marketed formulations

S.No	Name of Drug	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/Ferumoxtran	AMAG Pharmaceuticals	MRI contrast agent
5	L-Lysine	VivaGel	Starpharma pty. Ltd.	HIV/HSV preventions

ADVANTAGES OF NANOTECHNOLOGYs

- Qdots that identify the location of cancer cells in the body.
- Nanoparticles that deliver chemotherapy drugs directly to cancer cells to minimize damage to healthy cells.
- Nanoshells that concentrate the heat from infrared light to destroy cancer cells with minimal damage to surrounding healthy cells.
- Nanotubes used in broken bones to provide a structure for new bone material to grow.
- Nanoparticles that can attach to cells infected with various diseases and allow a doctor to identify, in a blood sample, the particular disease[20-21].

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 relatively long time for the treatment of diseases including cancer, rheumatoid arthritis, multiple sclerosis and neurodegenerative conditions such as Alzheimer's disease. The advantages of gold nanoparticles are their ease of preparation in a range of sizes, good

biocompatibility, easily functionalised and their ability to conjugate with other biomolecules without altering their biological properties. Gold nanoparticles with diameters ≤ 50 nm have been shown to cross the BBB. PEGylated gold nanoparticles conjugated with TNF (tumour necrosis factor) can enter tumour cells through their leaky vasculature[22]. Multi-functionalization is the main characteristics of nanoparticles. Nanoparticles can be integrated with ligands, imaging labels, therapeutic agents and other functionalities for specific drug delivery and cellular uptake.

Aryal *et al*., 2009 was found that Doxorubicin, an anticancer drug can conjugate with gold nanoparticles and by conjugation there is increase in the potency of doxorubicin. So the cytotoxic effect of doxorubicin is increased[23]. Through functionalization gold nanoparticles convert poor active drug to high active drug. Thus gold nanoparticles have a great contribution in cancer therapy, diagnosis of cancerous cell and importance in the therapy of HIV[24].

Magnetic Nanoparticles

Magnetic nanoparticles have become one of the most studied and applied nanotechnology in the past few years. Applications involving magnetic nanoparticles include targeted drug delivery, as contrast agents in Magnetic Resonance Imaging (e.g. Feridex), gene delivery and cell separation, cell labelling. Iron oxide nanoparticles are widely studied due to their biodegradable nature, biocompatibility and superparamagnetic properties suited for MRI applications. Magnetic nanoparticles that can be loaded with drugs and still retain their MRI properties have been reported. The iron oxide nanoparticles were coated with oleic acid and loaded with anticancer agent's doxorubicin and paclitaxel with a loading efficiency of up to 95%[25]. Industrial applications of magnetic nanoparticles cover a broad spectrum such as magnetic seals in motors, magnetic inks for bank cheques, magnetic recording media and biomedical applications such as magnetic resonance contrast media and therapeutic agents in cancer treatment [26].

Ceramic Nanoparticles

Nanoparticles of silica, titanium, alumina etc. are normally classified under the heading ceramic nanoparticles. One of the advantages of these particles is that their preparation is very simple. They are unaffected by changes in pH or temperature. It is possible to manipulate many features of these nanoparticles, including size, shape, porosity, inertness etc., and they can easily be modified to attach different biomolecules. Their typical size is around 50 nm. Ceramic nanoparticles have been used to encapsulate hydrophobic drug molecules, the acid labile model enzyme, serratiopeptidase and increase the transfection efficiency of DNA (used with a DNA- dendrimer conjugate)[27]. Ceramics have been used in bone tissue engineering due to their osteoinductive and biocompatible properties. Yamashita *et al*, 2009 investigated the effects of rough and smooth surfaces of ceria stabilized zirconium dioxide - another ceramic material that holds promise as a dental implant material on the growth and attachment of murine osteoblast-like MC3T3-E1 cells and compared their results to those obtained with the same cell line grown on pure alumina oxide and titanium[28].

Liposomes

Liposomes discovered in mid 1960s were the original models of nanoscaled drug delivery devices. They are spherical nanoparticles made of lipid bilayer membranes with an aqueous interior but can be unilamellar with a single lamella of membrane or multilamellar with multiple membranes. They can be used as effective drug delivery systems. Cancer chemotherapeutic drugs and other toxic drugs like amphotericin and hamycin, when used as liposomal drugs produce much better efficacy and safety as compared to conventional preparations. These liposomes can be loaded with drugs either in the aqueous compartment or in the lipid membrane. Usually water soluble drugs are loaded in aqueous compartment and lipid soluble drugs are incorporated in the liposomal membrane[29]. The limitation of liposome is its rapid degradation and clearance by the liver macrophages[30], thus reducing the duration of action of the drug it carries. Other ways of prolonging the circulation time of liposomes are incorporation of substance like cholesterol[31], polyvinyl pyrollidone polyacrylamide lipids[32] and high transition temperature phospholipids distearoyl phosphatidylcholine[33].

Targeting of liposomal drugs: Liposomes can be targeted to specific organ or tissue by passive as well as active methods. As the liposomal drug acts minimally on other tissues, the safety profile is better than non-liposomal drug. The vascularity in tumour tissue is poorly organized and significant leak occurs from blood vessel in the tumour tissue. The liposomal drugs get accumulated in the tumour tissue passively and produce enhanced effects. Active targeting of the drug can be achieved by using immunoliposomes and ligand directed liposomes[34].

Niosomes

Niosomes are non-ionic surfactant vesicles with a similar structure to liposomes. They can encapsulate aqueous solutes and act as drug carriers. Niosomes are formed by the self assembly of non-ionic amphiphiles in aqueous media. The application of heat or physical agitation helps the process to attain a closed bilayer structure. Their uptake by organs such as the liver and spleen make niosomes best suited as drug delivery agents in diseases affecting these organs. They are also used in targeting cancer cells. Since niosomal antigens are potent stimulators of the cellular and humoral immune responses they are also useful as adjuvants in vaccine delivery. 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-infective agents. PEGylated cationic niosomes have been used for the cellular delivery of oligonucleotides. Niosomes improve percutaneous passage of 5- fluorouracil (5-FU) through human stratum corneum and epidermis, and are non-

 ISSN: 2250-1177 CODEN (USA): JDDTAO

toxic. Niosomes of frusamide have been reported, that increased skin permeability and sustained drug levels[35].

Dendrimers

A generally accepted definition of dendrimer is a monodisperse macromolecule with perfectly branched regular structure and having at least one branched junction at each repeat unit. Dendrimers are a type of nanostructure that can be precisely designed and manufactured for a wide variety of applications, including the treatment of cancer and other diseases. Dendrimers carrying different materials an their branches can do several things at one time, such as recognizing diseased cells, diagnosing diseased states (including cell death), drug delivery, reporting location, and reporting outcomes of therapy.

Dendrimers molecule has found use as diagnostic reagent for tumour imaging by magnetic resonance imaging and as contrast agent; by varying the size and hydrophilicity and by combining with tumour targeting antibodies, these compounds can be used for a range of specific imaging purpose[36]. The topical application of active drugs to the eye is the most prescribed route of administration for the treatment of various ocular disorders. Dendrimers provide unique solutions to complex delivery problems for ocular drug delivery. An ideal ocular drug delivery system should be non-irritating, biocompatible, sterile, isotonic and biodegradable[37]. The recent problems for ocular drug delivery focus on increasing the residence time of pilocarpine in the eye was overcome by using PAMAM (polyamidoamine) dendrimers with carboxylic or hydroxyl surface groups. These surface modified dendrimers were predicted to enhance pilocarpine bioavailability[38].

Carbone Nano Tubes

CNTs have the ability to transport drug molecules, proteins and nucleotides. Due to their size and shape, carbon nanotubes can enter living cells without causing cell death or obvious damage. Molecules can be covalently or non-covalently attached to the surface. The hollow structure of CNTs allows encapsulation of molecules but as yet there are very few examples of this for drugs delivery. For biological applications CNTs require covalent or non-covalent[39-40] fictionalization to prevent aggregation and increase their solubility. Several drugs have been successfully delivered, including amphotericin B[41], which is normally insoluble and toxic due to its tendency to aggregate. When delivered using CNTs there was increased solubility, low aggregation (and therefore lower toxicity) and increased anti-fungal action. A number of therapeutic applications of CNTs have been reported, including boron neutron capture therapy (BNCT), inducing immunoresponse, gene and siRNA delivery [42].

Nanopores

Nanopores designed by Desai and Ferrari (1997), consist of wafers with high density of pores (20 nm in diameter). The pores allow entry of oxygen, glucose and other products like insulin to pass through. However, it does not allow immunoglobulin and cells to pass through them. Nanopores can be used as devices to protect transplanted tissues from the host immune system, at the same time, utilizing the benefit of transplantation. βcells of pancreas can be enclosed within the nanopore device and implanted in the recipient's body. This tissue sample receives the nutrients from the surrounding tissues and at the same time remains undetected by the immune system and hence do not get rejected[43]. This could serve as a newer modality of treatment for insulin dependent diabetes mellitus[44].Nanopores can also be employed in DNA sequencing. Branton's team at Harvard University[45] has worked on modified nanopores that have the ability to differentiate DNA strands based on differences in base pair sequences. Nanopores are also being developed with ability to differentiate purines from pyrimidines. Further, incorporation of electricity conducting electrodes is being designed to improve longitudinal resolution for base pair identification [46]. Such a method could possibly read a thousand bases per second per pore. These can be used for low cost high through put genome sequencing[47] which would be of great benefit for application of pharmacogenomics in drug development process.

Microemulsion/Nanoemulsion

Microemulsions are isotropic, thermodynamically stable systems composed of oil, water, and surfactant. Thermodynamic stability rather than size, is the defining hallmark of a microemulsion, although the droplet sizes are still below 100 nm (and many times much smaller). Be that as it may, what is critical about microemulsions is that, they contain two phases consisting 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 droplets in the range of 5–100 nm. The difference between microemulsions and emulsions is that, the later are opaque mixtures of two immiscible liquids, thermo- dynamically unstable and usually require the application of high torque mechanical mixing or homogenization to produce dispersed droplets in the range of 0.2–25 mm. Both types can be made as water-in-oil (w/o) or oil-in-water (o/w). Choice of the dispersed and continuous phases for microemulsions formulations is based on the hydrophilicity of the model drug. Also, surfactants that have hydrophilic–lipophilic balances (HLB) of 3–6 tend to promote the formation of w/o microemulsions while those with HLB values of 8–10 tend to promote the formation of o/w microemulsions. It has been reported[53] that, the formation and stability of microemulsions are dependent on the interfacial tension between the dispersed and continuous phases. Microemulsion instability can lead to Ostwald ripening leading to dissolution of the small droplets with a resultant increase in the size of the large droplets, therefore, stabilization against Ostwald ripening is very critical, this is because, the resultant change in the size of the droplets could lead to loss of physical stability of the dosage form. Choice of the components of microemulsions affects its stability. Safety is also another important factor that must be considered during component selection. Attwood, 1994 had concluded that,

the irritant and toxic properties of some alcohols (1-butanol and 2-butanol) could limit their potential use. Microemulsions have been proposed as drug delivery systems to enhance the absorption of drug across biological membranes. Some of the advantages of microemulsions include (i) Increased solubility and stability of drugs (ii) ease and economy of scale-up. Some of the disadvantages are; (a) premature leakage/release of incorporated drug (b) phase inversion (c) Many of the effective surfactants and/or co-surfactants do not have a pharmaceutically acceptable toxicity profile; and (d) microemulsion systems often require development of complex systems that may be time consuming[49].

Nanosuspensions

Nanosuspensions are colloidal dispersions of nanoparticles of an insoluble molecule, which are stabilized by surfactants. Nanosuspensions can be used to maintain these drugs in a preferred crystalline state of sufficiently small size for intravenous administration. Their advantages are similar to those of nanoemulsions. They can also achieve even higher levels of drug loading because the drug is in the solid state. Several studies have demonstrated the use of nanosuspensions for drug delivery with improved efficacy and release[50].

Nanocrystals

Nanocrystals are aggregates comprising several hundred to tens of thousands of atoms that combine into a "cluster". Typical sizes of these aggregates are between 10-400 nm and they exhibit physical and chemical properties somewhere between that of bulk solids and molecules. By controlling the size and surface area, other properties such as bandgap, charge conductivity, crystalline structure and melting temperature can be altered. The crystals must be stabilized to prevent larger aggregates from forming. Nanocrystals are produced by nanosonication. First, a nanosuspension is formed by high speed stirring, followed by wet milling, high pressure homogenisation, nanocrystallisation and spray drying to create nanosized crystals. The advantages of nanocrystallisation are the ability to solubilise poorly soluble drugs, high bioavailability, major decrease in dosage volume, and an increase in tolerated dose[51].

Micelles

Micelles are also spherical lipid nanostructures but they do not have a bilayer or inner cavity. The hydrophobic ends of the phospholipids point inwards and the hydrophilic ends face the outside, forming a spherical structure. Reverse micelles have this polarity the opposite way. The typical size of micelles for pharmaceutical applications ranges from 10-80 nm. Compared to liposomes, micelles have a short circulation time within the body due to their smaller size. However, this gives them the advantage of being able to enter tumour cells more easily, because of the EPR effect. Micelles can also be made from polymers. Polymeric micelles are formed by block- copolymers consisting of hydrophilic (e.g. PEG) and hydrophobic monomer units with longer hydrophilic blocks and shorter hydrophobic blocks. They have a hydrophobic core stabilized by hydrophilic units. These micelles are more stable than conventional micelles and are preferred for drug delivery applications as the circulation time is longer and they offer better biodistribution. Lipid-polymer conjugate micelles can also be made. They can carry different types of chemicals like paclitaxel, diazepam and captothecin. They also exhibit good longevity and stability. Micelles with improved solubility and intracellular delivery have been prepared using PEG-phosphatidylethanolamine (PEG-PE) conjugates. Micelles conjugated with transferrin can target cancer cells and deliver DNA. Similarly folate residues attached to micelles have been used to deliver adriamycin to cancer cells.The advantage of such agents is enhanced target penetration due to the smaller size and easy movement to the target location[52-53]. The particle range of different nanotechnology techniques are listed in Table 2.

Table: 2 Particle size range for different nanotech 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	20nm to several micrometers
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 drug delivery has been successful, as evidenced by some nano drug products in the market, not all approaches have met with the same success. New nanomaterials being developed come with challenges which have to be surmounted. However some of the challenges encountered have been and are still being tackled by modification of the physicochemical characteristics of the nanomaterials to improve on properties such as long circulation in the blood, increased functional surface area, protection of incorporated drug from degradation, crossing of biological barriers and site-specific targeting.

Another challenge of research and development (R&D) of nanomaterials for drug delivery is large scale production. There is always a need to scale up laboratory or pilot technologies for eventual commercialization. A number of nano drug delivery technologies may not be scalable due to the method and process of production and high cost of materials employed. The challenges of scaling up include low concentration of nanomaterials, agglomeration and the chemistry process – it is easier to modify nanomaterials at laboratory scale for improved performance than at large scale. Maintaining the size and

composition of nanomaterials at large scale is also a challenge [54].

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:

- Developing systems that improve the solubility and bioavailability of hydrophobic drugs.
- Designing delivery vehicles that can improve the circulatory presence of drugs.
- Eliminating or minimising toxicity.
- Increasing specificity.
- Targeting drugs to specific cells or tissues.
- Improving vaccine adjuvants and delivery.
- Developing novel nanostructures that can be used in specific applications, e.g. ocular, cancer therapy, neurology, orthopaedics.
- Delivery of repaired genes or the replacement of incorrect genes is fields in which nanoscale objects could be introduced successfully.

Some Patents of nanotechnology are listed in Table 3.

Table: 3 List of Some Patents on Nanotechnology

S No.	Patent No	Filing Date/Publication Date	Applicant	Title
1	W02010010431A1	Apr 2, 2009/ Jan 28, 2010	NIPER	Self-nano-emulsifying curcuminoids composition with enhanced bioavailability
2	W02010106191A1	Mar 22, 2010/ Sep 23, 2010	Bioxtract S.A	Pharmaceutical composition presenting anti-inflammatory properties
3	US20030165438	Jun 29, 2002/ Sep 4, 2003	Dariush Behnam	Water-free ubichinon concentrate
4	US20040258744	Oct 23, 2003/ Dec 23, 2004	Counsell Raymond E.	Surface modified lipoprotein-like oil in water emulsion having lipophilic core surrounded by monolayer of amphiphilic or polar lipids; polyoxyethylene glycol linked lipid and (choles)terol; radioactive or stable, synthetic polyhalogenated triglycerides as contrast agents; radiographic imaging
5	US20080199523	Jun 19, 2006	Australian Nuclear Science and Technology Organisation	Emulsion with hydrophilic, hydrophobic phase ; reacted in presence of catalyst; anticancer agents, aids, antiarthritic agents, antidiabetic agents, analgesics
6	US20080255247	Nov 22, 2006/ Oct 16, 2008	Nestec S.A.	Droplets exhibit a nano-sized self-assembled structurization, a diameter size of 0.5 to 200 nm; a lipophilic additive, an active element; solubilizing nutrients, drugs, aromas or chemicals

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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