Nanotechnology based approaches to fight against COVID 19 infection

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REVIEW ARTICLE

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ABSTRACT

Nanotechnology, the study of nanoparticles, is emerging as a leading pharmaceutical technique. It is used in various fields of drug delivery, bioimaging, biomedical diagnosis, tissue engineering, production of formulation, medical devices and many others, thereby playing a key role in future pharmaceutical and pharmacotherapy production. The ability to modify molecules and supramolecular frameworks for the development of devices or substances with altered functions or features is the most significant benefit of this technology. Nanoscience provides a solution to the spread of COVID-19 infection by aiding in its detection, including surface antiviral coatings, protection of facemasks, increased personal protection services, airborne filtration and therapeutic administration. Addressing the numerous clinical and wellbeing issues that have arisen as a result of the global dissemination of coronavirus infection. This study explores in depth the different uses of this technology in combating the pandemic situation of COVID-19 with an insight into the creation of a chemically engineered nanodevice that prevents its proliferation in the host cells. Low medication loading capability, low loading performance, and poor ability to monitor the delivery of sizes are the only problems with existing approaches. The use of nanotechnology, such as nanopatterning, could allow high loading efficiency and highly homogeneous particle sizes to generate nano / micro particles.

Keywords: Nanotechnology, drug delivery, nanoparticles, nanomaterial, COVID infection.

1. Introduction

Nanotechnology is a nanoscale (1 to 100 nanometers) research and technology used for its use in various fields of science, such as pharmacy, medical science, materials science and engineering. (1) Today, research in "nanotechnology" is moving around the world to upgrade modern medical methodologies and to develop novel techniques for manufacturing high-precision and durable products in the labs all over the world. In the pharmaceutical sector, genuinely innovative products, materials and applications are arriving. 'Nanotech' products currently on the market are mainly progressively improved materials (using advanced nanotechnology) where some type of nano-enabled material (such as carbon nanotubes, nanocomposite structures or nanoparticles of a specific substance) or nanotechnology processes (such as nanopatterning or medical imaging quantum dots) are used in the production process. (2)

At an American Physical Society conference at the California Institute of Technology (CalTech) on December 29, 1959, long before the word nanotechnology was used, the evidence and knowledge behind nanoscience and nanotechnology began with a talk entitled "There's Plenty of Space at the Bottom" by physicist Richard Feynman. In his lecture, Feynman outlined a mechanism in which individual atoms and molecules could be regulated and controlled by scientists. Professor Norio Taniguchi invented the term nanotechnology more than a decade back, in his explorations in ultra-precision machining. It was not until 1981 that modern nanotechnology began with the invention of the scanning tunnelling microscope that could 'see' individual atoms. (3)

The rise of nanoscience and nanotechnology, which develops and utilises nanometer-scale materials and instruments, has had a significant effect on a variety of industries, especially the pharmaceutical industry. (4) Much as recombinant technologies and biotechnology have altered the pharmaceutical business environment, nanotechnology is expected to push today's

cross-road pharmaceutical sector to new heights. (5)

However, nanotechnology has broader applications, unlike the biotechnology industry that primarily influenced the pharmaceutical industry, and therefore the nanotechnology instruments and materials developed for other industries also have potential opportunities in the pharmaceutical industry. (6) Furthermore, there is a common notion that the tools of nanotechnology are exotic, too futuristic, disruptive and not suitable for rapid product commercialization. (7) As nanotechnology tools are shown to add value to existing products for existing markets as well as open up opportunities in new markets, this notion is far from true.

This is not only true for the pharmaceutical industry, but for other fields as well. What is obviously missing, nevertheless, is a blueprint for sorting out the multitude of current nanotechnology resources and creatively correlating them with future prospects in various pharmaceutical R&D segments. (8) Furthermore, as a modern model of treatment that combines therapeutics with diagnostics, there will be a paradigm change in the pharmaceutical industry towards personalised medicine. Therefore, it is important to establish a more scientific approach for the strategic application in the pharmaceutical industry of nanotechnological instruments. (9)

With the worldwide burden of the COVID-19 pandemic accelerating, experts are actively looking for a suitable antidote or therapy to tackle the worldwide public health emergency. Main research breakthroughs and advancements that are currently ongoing are as follows:

- Business study of COVID-19 nano-based diagnostic devices, including gold nanoparticles, iron oxide nanoparticles, graphene, quantum dots, mercury quantum dots and carbon nanotubes containing nanosensors. Updated consumer sales to pandemic results. In-depth business profiles. Abbott Laboratories, Cardea, Ferrotec (USA) Corporation, E25Bio, Grolltex, Inc., Luminex Corporation, etc. are the businesses profiled.
- Business study of antiviral and antimicrobial nano-coatings for surfaces like cloth (masks, caps, doctor's suits, curtains, bed sheets), metal (lifts, door handles, nobs, tracks, public transport), wood (furniture, floors and partition panels), concrete (hospitals, clinics and insulation rooms) and plastics (switches, kitchens and appliances).
- Adjusted consumer revenues with pandemic results. In-depth market profiles. Advanced Materials-JTJ s.r.o., Bio-Fence, Bio-Gate AG, Covalon Technologies Ltd., EnvisionSQ, GrapheneCA, Integricote, Nano Came Co. are among the companies profiled. Ltd., Fabrics for NanoTouch, LLC, NitroPep and several more.
- Business study of airborne virus filtration, including Nano-TiO2 photocatalytic philtres, philtres of nanofiber, nanosilver, nanocellulose, filtration of graphene and carbon nanotube. Updated consumer sales to pandemic results. In-depth market profiles. G6 Fabrics, Daicel FineChem Ltd., NANOVIA s.r.o., Toray Industries, Inc., Tortech Nano Fibers, etc. are the businesses profiled.
- Nano-based facemask industry research and other PPE goods. Updated consumer sales to pandemic results. In-depth market profiles. Profiled firms include planarTECH LLC, RESPILON Group, s. r. O., SITA, Sonovia Ltd. and so on.
- The ongoing development of nanotherapies and drug delivery vehicles and clinical trials of COVID-19 vaccines. Updated consumer sales to pandemic results. In-depth market profiles. Profiled companies include Arcturus Therapeutics, Inc., BlueWillow Biologics, Arbutus Biopharma, Elastrin Therapeutics Inc., EnGeneIC Ltd., etc. (10)

2. Pharmaceutical Nano Systems

In the pharmaceutical sector, different types of nano systems are prepared and used, some of which are as follows:

Polymeric Nanoparticles (PNPs)

They have a size range of 10-1000 nm and are biocompatible and biodegradable to provide

complete protection for drugs. PNPs are derived from synthetic polymers such as poly-caprolactone, polyacrylamide and polyacrylate, or from natural polymers such as albumin, DNA and chitosan gelatin. PNPs can be categorised as biodegradable on the basis of in vivo actions, i.e. poly(L-lactide) (PLA), polyglycolide (PGA), and non-biodegradable, e.g. polyurethane. In order to minimise immunological interactions (e.g., opsonization or introduction of PNPs to CD8 T-lymphocytes), as well as intermolecular interactions between surface chemical groups of PNPs (e.g., van d d-lymphocytes), PNPs are usually treated with nonionic surfactants. (11)

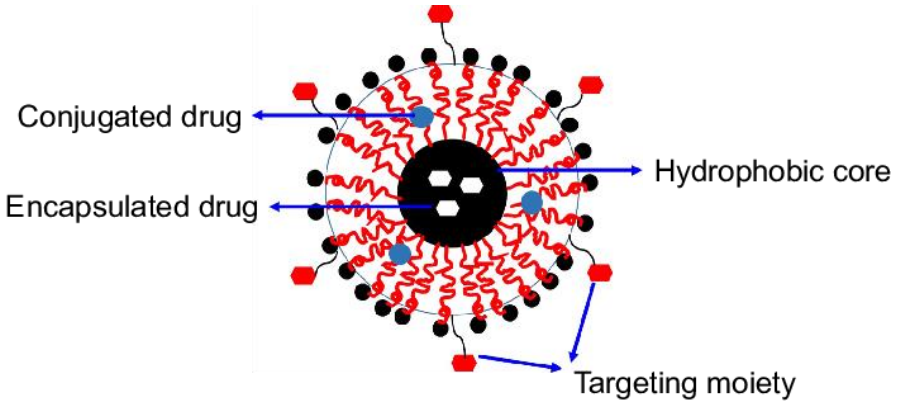

Figure 1. Polymeric nanoparticles with hydrophobic core and conjugated drug.

As carriers for regulated and continuous drug delivery, polymeric nanoparticles are used. Drugs may be immobilised during a polymerization reaction on the surface of PNPs (as seen in fig.1) or can be encapsulated after a polymerization process on the PNP structure. In addition, drugs in the target tissue may be emitted by desorption, diffusion, or nanoparticle erosion. Chemically engineered nanoparticle production that envelops flu viruses in a 'scaffold' that prevents them from infecting host cells. Further preclinical research must now be performed to examine if the nanoparticle induces immune responses in mammals and whether regular administration results in resistance until it can be tested in humans.

Dendrimers

Dendrimers are formed by controlled polymerization and have a size of < 10 nm. These are strongly branched polymeric mono-disperse structures of well-defined size and composition (as seen in Fig.2). One of the most common structures observed in all biological systems is dendritic architecture. Glycogen, amylopectin and proteoglycans are some of the examples of nanometric molecules containing dendritic structure. (12)

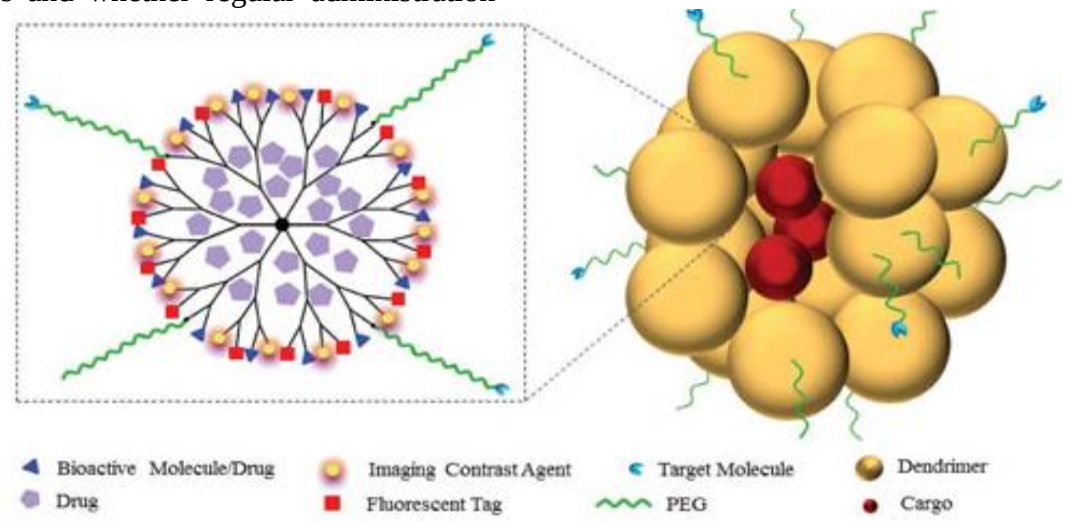

Figure 2. Dendrimer with highly branched polymeric system.

Unlike the linear polymer, the following elements can be identified in the dendrimer structure: the heart, the dendron, and the surface active groups. Dendrons are bound to the centre of a single atom or molecule (only if it has at least two similar functional groups). The dendrons (dendrimer arms) are core-related monomer molecules that form layers and create successive generations (their development is limited spatially). Surface functional classes decide the biocompatibility and physicochemical properties of dendrimers. The useability of dendrimers in medical applications is defined by the choice of a centre, type of monomer and surface functional groups.

Especially important for biomedical purposes is the cytotoxicity and polyvalence of dendrimers. (13) The cytotoxicity of dendrimers relies on the central material and is greatly affected by the surface structure of the dendrimers. Changing the surface amine groups into hydroxyl ones, for example, can contribute to lower levels of cytotoxicity. The word polyvalence determines the number of active groups on the surface of the dendrimers. The presence of many functional groups on the surface allows for sumultaneous contact with a range of receptors, thus increasing biological activity. Dendrimers are used to monitor the release of drugs and distribute drugs to macrophages and the liver in a controlled way.

Metallic nanoparticles

Metallic nanoparticles have a size of < 100 nm and are gold and silver colloids. They are very small in bulk, resulting in more surface area, and are preferably characterised by a substance with more bioavailability and stability. These are used for delivery of drugs and genes and are used in critical diagnostic assays, thermal ablation and enhancement of radiotherapy. (14)

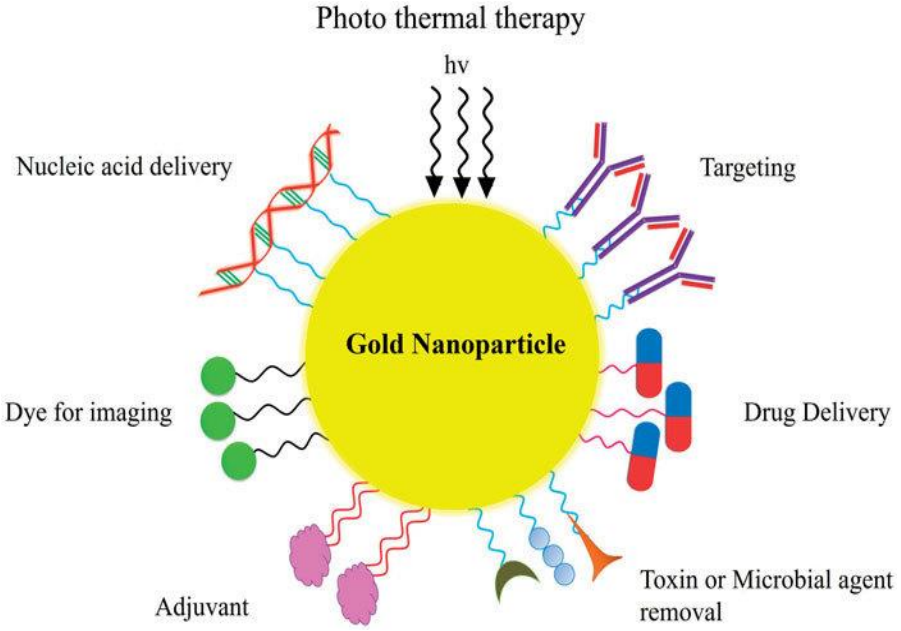

Figure 3. Gold nanoparticle with various applications.

For possible uses (as seen in Fig.3), gold nanoparticles (Au NPs) have been intensively studied in medical imaging (early identification and diagnosis) and cancer management (including tumour therapy) and drug delivery processes. Gold NPs consist of a nucleus of a gold atom surrounded by negative surface reactive groups that can be conveniently functionalized by adding a monolayer of surface moieties (active targeting links). Although they can be constructed using various chemical and physical pathways, Au NPs are usually prepared using the method of colloidal synthesis (using a metal precursor, a reductant, and a stabiliser) for biomedical applications.

Due to the presence of a negative charge on Au NPs, a wide range of different biomolecules, including drug molecules, or large biomolecules such as antibiotics, proteins, genes (DNA and RNA), and a variety of targeting ligands can be easily (bio)

functionalized (via ionic or covalent bonding or physical absorption), while recent research has shown their non-toxicity for some human beings Due to the existence of the surface plasmon resonance (SPR) bands, Au NPs are especially attractive, which allow them to convert light to heat and spread the heat produced to destroy the cancer cells. (15)

Silver nanoparticles (Ag NPs) can, with their antibacterial and antiviral properties, be used to deliver drugs. They can be mixed with cationic polymers that contribute to a nanomaterial that is bacteriostatic. As an environmentally safe material, silver nanoparticles can be efficiently used on microorganisms and viruses by adding them to medical instruments that suppress COVID infections in patients and medical teams.

Nanobots

Advanced sub-micron-sized nanobots or nanomotors are self-driven, biodegradable nanodevices made of bio-nano components that carry cargo to the target sites. Compared to traditional approaches, this active motor-based drug delivery strategy offers efficient and enhanced drug delivery. Gold nanoparticle loaded artificial micromotors based on PEDOT / zinc are tested via oral administration in mouse models. With high cargo-loading capacities, they displayed excellent acid-driven, self-propulsive properties. (16)

Nanoghost

One of the new technologies developed for smart drug / gene delivery is the Nanoghost system. Nanoghosts are a type of nanovesicles extracted from whole biological cells such as mesenchymal stem cells (MSCs) that are devoid of cytoplasm and organelles from naturally functionalized mammalian cell surface membranes. These naturally derived carriers solve problems with drug activation, prevent tumor-specific immune responses, provide greater stability of nanoparticles, and boost drug release profiles. (17)

Nanoclews

Nanoclew, or nanococoon, is a biocompatible drug delivery device based on DNA. Single stranded DNA renders complete nanococoons in this method (as seen in Fig.4). It assembles itself by rolling-circle amplification to look like a yarn or cocoon or a clew-like structure.

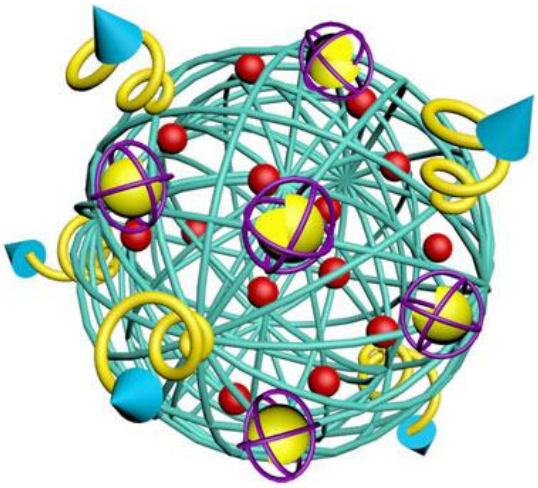

Figure 4. Nanoclew with a cocoon like structure.

Nanoneedles

In order to achieve high effectiveness and minimised side effects, direct supply of therapeutic molecules to cell cytoplasm is highly desirable in drug delivery. Yet biological membranes act as effective barriers to drug entry into the cell. To solve these problems, Nanoneedles may help. Nanoneedles are very small (as seen in Fig.5) and allow biological membranes to be briefly perforated. Hence, these needles can deliver the drugs without disturbing the body's biological functions. (18)

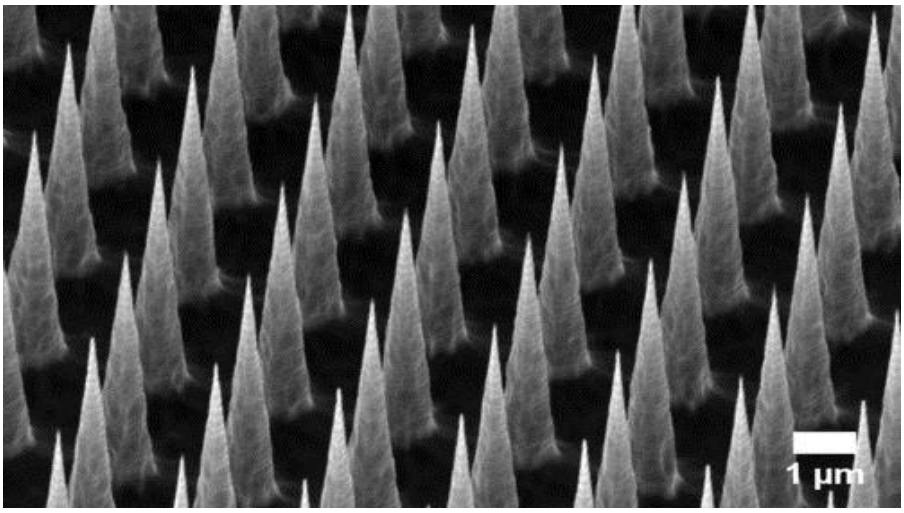

Figure 5. Nanoneedle like structure of size of very small range.

Nanobubbles

Sometimes stabilised by polymeric / lipid membranes, nanobubbles are gas-filled spherical nano-sized structures. These nanocarriers are used as more effective imaging and drug delivery agents in various clinical therapies in combination with thermal, ultrasound, acoustic or magnetic sensitivities. They are more stable and showed longer residence time in systemic circulation. (19)

Exosomes

Exosomes are small biological nanoparticles that transfer information between cells and provide tremendous potential for disease detection and treatment. Exosomes are the most promising nano-vehicles of the next decade for selective delivery of medicines and genomes. There are nano-sized vesicles (40-200 nm in diameter) originating from patients whose own healthy cells are extraordinarily capable of communicating with cell membranes. They have a peculiar property of 'cell-based tropism' (targeting specific cells by revealing receptors in the membranes) against the originating cells, which can be used to carry cargo consisting of medicines, proteins and microRNAs as a delivery technique. (20)

Magnetic nanoparticles

Magnetic nanoparticles possess a wide range of properties, making them highly promising drug delivery carriers. In specific, the following are: simple handling with the aid of an external magnetic field, the probability of using passive and active drug delivery methods, sensing ability (MNPs used in MRI) and increased target tissue penetration resulting in successful therapy at acceptable therapeutic doses. In certain cases, however, where magnetic nanocarriers have been used, problems have resulted in meeting these targets. (21)

Inappropriate characteristics of magnetic nanoparticles or an insufficient magnet device are most likely associated with this. For example, magnetic nanoparticles (fig.6) appear to accumulate into larger clusters, sacrificing the basic properties associated with their limited size and making them impossible to control physically. In contrast, the magnetic force will not be sufficiently effective to overpower the blood flow force and only absorb magnetic drugs at the target site. Therefore, the design of magnetic drug delivery systems needs several considerations to be taken into account, such as magnetic properties and particle size, magnetic field strength, drug loading ability, target tissue accessibility position, or rate of blood flow.

Liposomes

Liposomes are phospholipid vesicles with a 50-100 nm size range with good biocompatibility and trapping efficiency characteristics. They are spherical vesicles made up of phospholipids and steroids (e.g. cholesterol), bilayers (fig.7), or other surfactants that naturally develop as such lipids are distributed in an aqueous atmosphere where liposomes, e.g. sonic, may be prepared.

In order to increase the solubility of drugs and enhance their pharmacokinetic properties,

liposomes have been documented, such as the therapeutic index of chemotherapy agents, accelerated metabolism, decreased adverse side effects and improved efficacy of in vitro and in vivo anti-cancer drugs. (22)

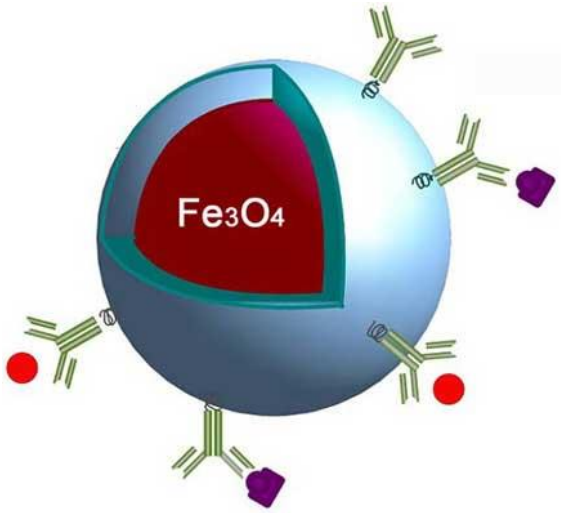

Figure 6. Magnetic nanoparticles with ferrous ferric oxide inside.

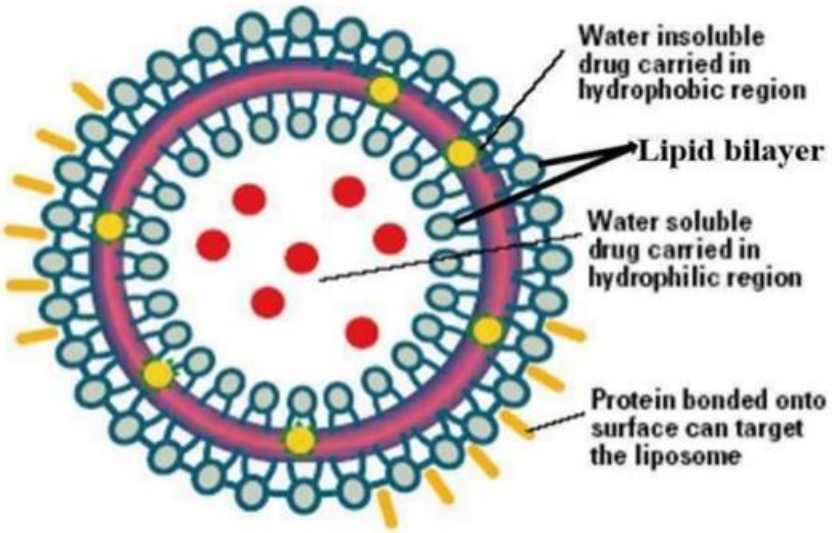

Figure 7. Liposome structure with lipid bilayer entrapping water soluble drug.

For passive and active transmission of mRNA, proteins and peptides, liposomes are often used. Modified liposomes are those lipid structures that are a fascinating sort. It is possible to use multifunctional liposomes containing particular proteins, antigens, or other biological substances to produce drugs that act selectively on a specific tissue. It is a successful path to guided clinical delivery.

Nanoparticles based on solid lipids

The types of carrier structures based on solid lipid matrix, i.e. solid lipids at body temperature, are SLN (solid lipid nanoparticles), NLC (nanostructured lipid carriers) and LDC (lipid drug conjugates). They were utilised for transmission to the dermal, peroral, parenteral, ocular, plumonary, and rectal. SLN are stable lipid fragments, e.g. strongly distilled triglycerides, complex mixtures of glycerides or waxes stabilised by different surfactants (as seen in fig.8). Good physical durability, safety of inserted drugs from deterioration, controlled drug release, and good tolerability are the key characteristics of SLN.

In addition, some drawbacks have been observed, such as lower loading potential

(limited by the lipid solubility of the drug and the lipid matrix structure and polymorphic state), drug expulsion following crystallisation, and relatively high dispersion water content. (23)

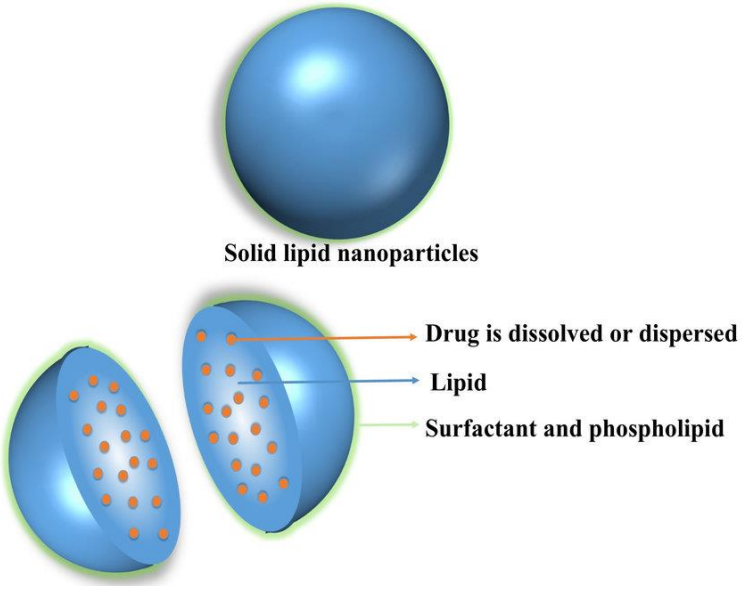

Figure 8. Solid lipid nanoparticles with surfactant and phospholipid.

NLC and LDC are lipid-based nanoparticle modifications that have been developed to overcome conventional SLN limitations. NLC is formed by combining solid lipids with liquid lipids, which leads to an improved payload of a special nanostructure and avoids drug expulsion. Three forms of NLC have been introduced: imperfect NLC type (general imperfections in the nanostructure matrix form free spaces for guest molecules accommodation), multiple NLC type (drugs are solved in oils and safe from solid lipid degradation) and amorphous NLC type (crystallisation that induces drug expulsion is avoided).

Silica materials

In controlled drug delivery systems, silica materials used are known as xerogels and mesoporous silica nanoparticles (MSNs), e.g. MCM-41 (Mobile Structure of Matter) and SBA-15 (Mesoporous Silica Substance of Santa Barbara University). As carrier structures, they show many benefits, including biocompatibility, a highly porous structure and ease of functionalization. Silica materials are the carriers (as seen in fig. 9) of inorganic nanoparticles that are most commonly picked for biological purposes.

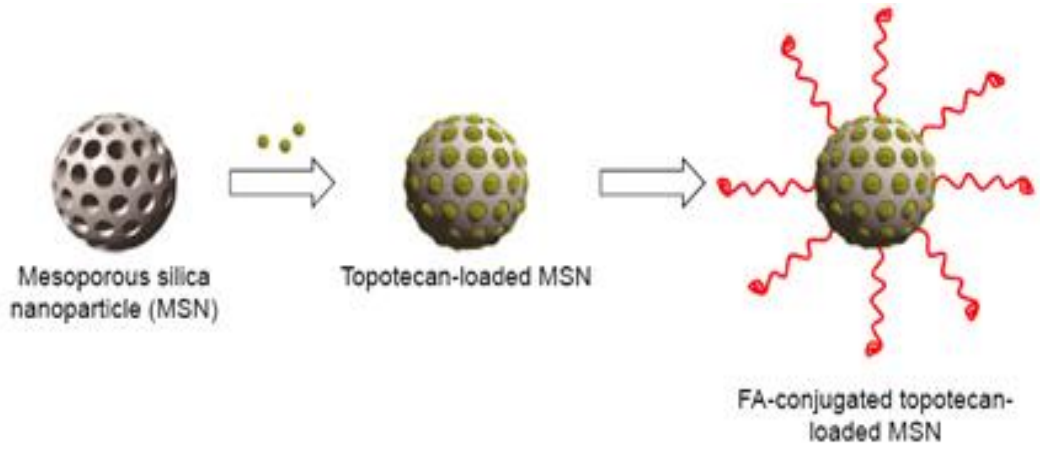

Figure 9. Mesoporous silica nanoparticles (MSN) in different stages.

With high porosity and immense surface area, Silica xerogels have an amorphous composition. A porous structure is dependent on synthesis parameters (shape and pore dimensions). The sol-gel technique is frequently used to form drug-loaded silica xerogels. The alteration of the synthesis conditions, such as the reagent ratio, temperature, catalyst concentration and drying strain, causes the properties of xerogels used in the regulated release of drugs to be changed.

Carbon nanomaterials

Carbon nanocarriers are differentiated into nanotubes (CNTs), carbon dots, nanofibers, nanodiamonds, and buckminsterfullerence (as seen in fig. 10) used in the drug delivery system. CNTs are distinguished by the special construction of single (SWNCTs, single walled carbon nanotubes) or multi (MWCNTs, multi walled carbon nanotubes) graphite layers with a large surface area and excellent electronic and thermal conductivity. By chemical modification of its surface, the biocompatibility of nanotubes may be improved. Such adjustment can be implemented by covalent anchoring of PAMAM dendrimers, amphiphilic diblock copolymers or PEG layers on CNTs surface or dispersion within a hyaluronic acid matrix. SWCNTs have been used as a help for enhancing the properties of other carriers, such as polymeric or non-polymeric composites, due to their mechanical strength.

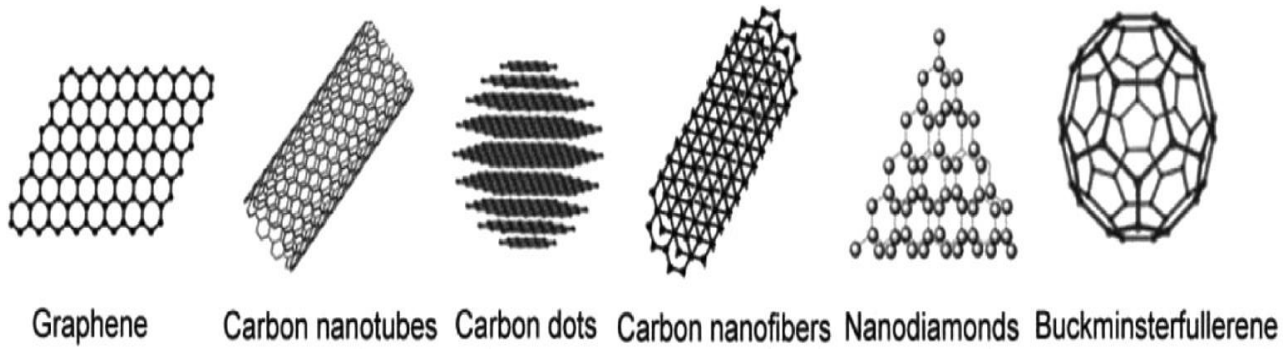

Figure 10. Carbon nanocarriers in different forms and design.

In carbon nanocarriers, there are three forms of drug immobilisation: drug encapsulation in the carbon nanotube, chemical adsorption on the surface or in spaces between nanotubes (electrostatic, hydrophobic and hydrogen bonds), and binding of active agents to functionalized nanotubes of carbon (f-CNTs). Encapsulation has the advantage over the other two types, since during its delivery to the cells; the drug is shielded from degradation and released only under particular conditions. (24)

It is possible to electrically or chemically regulate drug release from carbon nanotubes. The open ends of CNTs have been sealed with polypyrrole (PPy) films to avoid the unintended release of the compound.

Hydrogel nanoparticles

In recent years, due to their unusual properties, hydrogel nanoparticles have gained significant popularity as one of the most promising nanoparticulate drug delivery mechanisms. Hydrogels are cross-linked hydrophilic polymer networks (as seen in fig.11) that can consume and hold more than 20% of their weight in water while preserving the polymer network's distinct 3D form at the same time. External stimuli or physiological parameters may influence the swelling properties, network structure, permeability or mechanical stability of hydrogels. Hydrogels for controlled release of therapeutics, stimulus-responsive release and applications in biological implants have been extensively studied. (25)

Theranostics, where it is possible to use a nanoparticle to diagnose and cure pathogens that have previously been used with influenza and tuberculosis. This method may be modified to create nanoparticles of a size comparable to COVID-19 that, when applied with a combination of infrared light treatment, can be connected to the virus that disrupts its

structure. This will halt the virus' ability to live in the body and replicate.

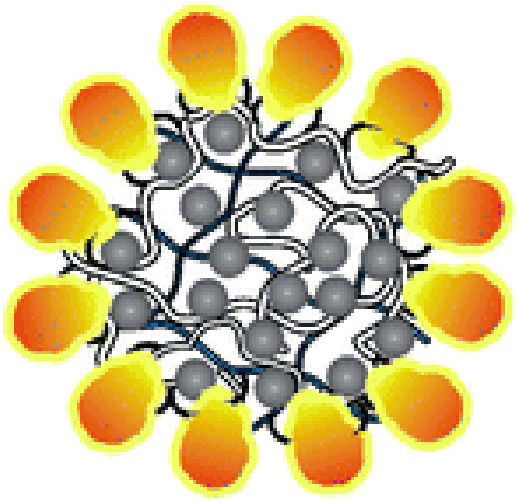

Figure 11. Hydrogel structure with cross-linked networks of hydrophilic polymers.

3. Characterization of nanoparticles

Size

Both in vitro and in vivo, the size of a nanoparticle can dictate its behaviour, so quantitative data on this feature is important. Particle sizing, assembly, numbering, and differentiation can be broken down into three groups. Ensemble methods, which involve multiple spectroscopies such as light and acoustic scattering, allow a single device calculation and then apply sufficient mathematics to derive population size. (26)

Surface properties

The particle surface's contact with its surroundings can determine the interaction of the particles with each other and may have a significant effect on their in vivo behaviour, e.g. clearance. Charge, typically calculated as zeta potential, is a primary descriptor and is most easily determined using methods such as scattering of electroacoustic and electrophoretic radiation.

Particle morphology

Scanning electron microscopy, either in transmitting or scanning mode, is the main instrument of the analyst, considering the size of the particles. The use of atomic force microscopy (AFM) in the study of pharmaceutically related nanoparticles has recently been of considerable importance. It is possible to acquire very high-resolution photographs of particles in their native environment using AFM, but at the cost of time because it is a form of rastering. Although the scale of the particles is below the technique's resolution, optical microscopy can be very useful. Darkfield methods, for instance, allow the presence of nanoparticles and hence their number-weighted concentration to be observed even though the particles themselves are not specifically imaged. (27)

Structure

Its conduct and stability can be determined by the arrangement of components inside the nanoparticle. If one is interested in overall structural characteristics such as crystal structure or degree of amorphous character, a variety of traditional techniques such as differential scanning calorimetry and powder X-ray diffraction are suitable. Relevant structural elements, such as layers, may be on the molecular scale, considering the limited size of nanoparticles. In such cases , higher energy dispersion methods such as small-angle neutron and X-ray dispersion are needed to determine the orientation of molecules. (28)

Drug release

Drug release from various formulations composed of nanomaterials depends on several factors, including pH , temperature, solubility of drugs, surface-bound or adsorbed drug desorption, nanoparticle matrix drug diffusion,

swelling and erosion of the nanoparticle matrix, and the combination of erosion and diffusion processes. The release of medicine can vary depending on the type of nanoparticle being used. Various devices such as tablet dissolution apparatus and capsule dosage type can be tested. (29)

4. Nanotechnology Applications

Nanotechnology is a modern approach to problem solving that can be used as a set of instruments that principle that can be found in the pharmaceutical industry. The use of nanotechnology instruments in pharmaceutical R&D is expected to lead to the industry switching from the 'blockbuster drug' paradigm to 'personalized medicine'. (30) In the pharmaceutical industry, there are convincing uses where efficient techniques for nanotechnology can be used. (31)

Targeting cancer cells with nanoparticles

Cancer remains one of the most challenging illnesses nowadays, and brain cancer is one of the most challenging malignancies to diagnose and cure, largely due to the difficulty in bringing imaging and medicinal agents into the brain and over the blood-brain barrier. Many studies have found that nanoparticles are promising to deliver these agents through the brain, such as anti-cancer medications, doxorubicin, which is attached to polysorbate-coated nanoparticles, can cross the intact blood-brain barrier and be released into the brain at therapeutic concentrations. Smart superparamagnetic iron oxide particle conjugates can be used sooner and more reliably than recorded approaches to target and locate brain tumors. (32) It is understood that the targeting and intracellular diffusion of nanoparticles can be further improved by folic acid mixed with polyethylene glycol. Therefore, nanomaterial has a huge ability to kill cancer cells as a drug carrier. (33)

Nanoparticle-mediated delivery of siRNA

With a wide number of applications, short interfering RNA (siRNA) is emerging as a versatile means of regulating gene expression. Important improvements in the delivery system would include the translation of nucleic acid-based therapy into clinical trials. To control RNAi transmission, Quantum dots (QD) were used. For in vitro RNAi transmission, PLGA and PLA dependent nanoparticles have also been used. Although the delivery of siRNA using different nanomaterials has had some success, it is difficult to track their transmission and control their transfection performance without an effective monitoring agent or marker. (34)

Targeting angiogenesis with nanoparticles

Aggressive tumour growth underlies vigorous angiogenesis. Therefore, starving tumour cells is one of the pathways used to prevent angiogenesis. Via a diverse series of mediators, angiogenesis is regulated and recent research suggests that integrin alpha-vβ3 and vascular endothelial growth factors (VEGFs) play significant regulatory roles. Therefore, a promising anti-angiogenesis technique for treating a wide spectrum of solid tumours is the selective activation of alpha-vβ3 integrin and VEGFs. One technique is to coat nanoparticles with peptides that bind directly to the integrin of alpha-vβ3 and the receptor of VEGF. It is known that the synthetic peptide containing the Arg-Gly-Asp (RGD) sequence binds directly to the alpha-vβ3 integrin expressed in angiogenic blood vessels on endothelial cells, which can potentially inhibit tumour growth and proliferation. (35)

Targeting macrophages to control inflammation

A rational approach to macrophage-specific targeting with nanoparticles has been established by the ability of macrophages for rapid identification and clearing of foreign particles. The capacity of macrophages to secrete a multitude of inflammatory mediators helps them in many diseases to suppress inflammation. Thus, in many human and animal illnesses, macrophages are important therapeutic targets. While most microbes can be destroyed by macrophages, certain microorganisms (Toxoplasma gondii, Leishmania sp, Mycobacterium tuberculosis and Listeria monocytogenes) have evolved a possible capacity to withstand macrophage phagocytosis operation. This pathogens subvert the molecular machinery of a macrophage engineered to kill them and in transformed lysosomes come to live. To remove cellular reservoirs, nanoparticles-

mediated delivery of antimicrobial agent(s) into pathogen-containing intracellular vacuoles in macrophages may also be useful.

This method can be used to obtain the concentration of medicinal drugs in the vacuoles of compromised macrophages and to reduce the side effects of drug administration and the production of pro-inflammatory cytokines. The nanoparticles of polyalkyl-cyanoacrylates (PACA) have been used as a carrier to attack anti-leishman drugs in macrophages. (36)

Treatment of Cardiovascular Diseases

In human life and wellbeing, cardiovascular diseases (CVDs) have been a significant threat. While several medications that work by various modes of action are present on the market as traditional CVD treatment formulations, due to poor water solubility , low biological effectiveness, non-targeting, and drug tolerance, they are still far from satisfactory. With the advancement of nanotechnology, nano drug delivery systems (NDDSs) offer a modern drug delivery approach for the treatment of CVDs, demonstrating significant advantages in solving the above-mentioned problems. (37)

Glaucoma treatment

Nanodiamonds that are found in contact lenses are connected to medications to combat glaucoma. The nanodiamond-released drug molecules come in contact with tears, offering a more stable dose than frequently happens with eye drops.

Dental implants

By attaching nanotubes to the implant material's surface, researchers are developing dental implants. They also shown the potential to inject anti-inflammatory drugs into the nanotubes, which can be added directly to the region surrounding the implant. They have also demonstrated that bone adheres more to nanotubes of titanium dioxide than to the surface of regular titanium implants. (38)

Diabetes treatment

Researchers have created nanoparticles which, when glucose levels increase, release insulin. The nanoparticles include insulin as well as an enzyme that dissolves at high glucose levels. Insulin is released as the enzyme dissolves. These nanoparticles were able to regulate blood sugar levels for several days during a laboratory examination.

A sponge-like matrix that contains insulin as well as nanocapsules containing an enzyme is another strategy being created to release insulin. The nanocapsules emit hydrogen ions that bind to the fibres that make up the matrix as the glucose level increases. The hydrogen ions positively charge the fibres, repel each other and build openings in the matrix from which insulin is emitted. (39)

Autoimmune diseases treatment

Nanoparticles are used to transmit antigens to the blood stream with a specific condition in a process that is being established to treat autoimmune diseases. The antigens reset the immune system, preventing healthy cells from being damaged by white blood cells. This procedure was tested with positive results in the laboratory on mice with a condition similar to multiple sclerosis. (40)

Prevention to aging

A system designed to tackle ageing uses mesoporous nanoparticles with a coating that, when an emzyme contained in ageing cells is present, releases the nanoparticle material.

Face creams that use stem cell-derived proteins to avoid face ageing. These proteins are encapsulated in nanoparticles of the liposome that combine with skin cell membranes to allow the proteins to be delivered.

A nanoparticle that can pass through mucus-coating surfaces such as lung tissue has been developed by researchers. This ability to penetrate the mucus layer can include preventive medications for the ability to coat lung tissue. (41)

Medical implants

Medical implants are made of porous plastic and coated with carbon nanotubes. For example, when a shift in blood chemistry signals a problem, medicinal drugs that are bound to the nanotubes may be released into the bloodstream. These devices, referred to as biocapsules, are being designed by NASA to

shield astronauts from the effects of radiation, but the devices can also be useful for releasing insulin to patients with diabetes or for administering chemotherapy drugs directly to tumors. (42)

Diagnostics

Carbon nanoparticles (CNPs) and carbon quantum dots (CQDs) provide enticing opportunities for the delivery and tracking of visual drug effects for medicinal treatment and bioimaging diagnostics. (43)

5. Hazards of Nanotechnology

In contrast to bulk materials, nanomaterials are designed for their special (surface) properties. As the surface is the body tissue touch layer and a primary determinant of particle reaction, these particular properties need to be studied from a toxicological point of view. It should be predicted that these same features would also have an effect on the toxicity of certain particles as nanoparticles are used for their particular reactive properties. Although existing drug and system assessment tests and procedures could be sufficient to identify certain risks associated with the use of these nanoparticles, it cannot be assured that all possible risks can be identified by these assays. Therefore, it can need additional assays. (44)

The qualitatively distinct physico-chemical properties of nanoparticles are related to micron-sized particles, which may result in changed body distribution, blood brain barrier flow, and blood coagulation pathways becoming activated. Special focus should be put on investigations of (pharmaco)kinetics and propagation studies of nanoparticles in terms of these characteristics. What is currently missing is a clear understanding of the biological activity of nanoparticles as regards both organ and cellular dissemination *in vivo*. (45)

6. Conclusion

A creative approach to problem solving is all about nanotechnology which is essentially a set of instruments which concepts that have possible uses in the pharmaceutical industry. There are convincing uses in the pharmaceutical industry where affordable nanotechnology techniques can be used, against the prevalent notion that nanotechnology techniques are exotic, too advanced, disruptive and not ideal for fast commercialization of drugs. Although it is clear that many techniques are still at the design stage of the nanotechnology toolbox, a variety of them can also be extended to the method and product production of pharmaceuticals.

In addition to the drug delivery systems in cancer have many barriers such as immune clearance or hepatic, renal. Thus, to improve treatment and overcome these problems the nanoparticle-loaded drug is one the solution. (46)

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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