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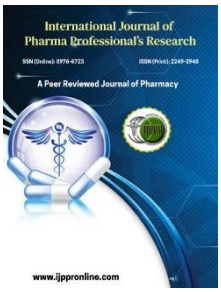

Nano Technology- A Comprehensive Review

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ABSTRACT:

At the intersection of physical sciences, molecular engineering, biology, biotechnology, and medicine, recent research on nanoscale biosystems and nanotechnology has generated one of the most active science and technology sectors. Improved comprehension of living and thinking systems, ground-breaking biotechnology techniques, the creation of novel medications and their targeted administration, regenerative medicine, neuromorphic engineering, and the creation of a sustainable environment are all included in this field. Research on nano bio-systems is a top priority in many nations, and its importance to nanotechnology is predicted to rise in the coming years. The bioavailability of drugs is improved when their particle sizes are decreased to the sub-micron range since this increases the pace at which they dissolve significantly.

The development of medication delivery employing nanoparticles (NPs) as carriers for tiny and big compounds has generated a lot of research attention. One of the most significant features of a medication delivery system is the ability to direct drug administration to sick areas. They have been utilized *in-vivo* to safeguard the drug entity in systemic circulation, limit drug access to the targeted locations, and deliver the drug to this site of action at a steady and controlled pace. For drug delivery studies, a variety of polymers have been employed to create nanoparticles that will boost therapeutic value while reducing side effects. The most noteworthy advancements in the use of nanotechnology as a medicine delivery mechanism are highlighted in this review article. Systems, techniques of preparation, applications, benefits, and drawbacks of pharmaceutical nanotechnology.

Introduction:

The use of nanoparticles as carriers for small and big molecules in the development of nanotechnology has generated a great deal of research attention over the past few decades. Nano particles have been created using a variety of polymers. The most noteworthy contributions to the field of nanotechnology are highlighted in this review. The Latin term for dwarf is the source of the English word "Nano." Nanometers are one thousand millionth of a metre (1n=109m), which is what is meant by the term "nano" size. Since several decades, the term "nanotechnology" has been most frequently used in the scientific domains of electronics, physics, and engineering. Pharmaceutical and biomedical disciplines, however, have not yet been fully investigated. Biophysics, molecular biology, and bio engineering are examples of applied fields that have come together to form the multidisciplinary field of nanotechnology.

Size reduction is an essential unit function with significant pharmacy applications.

1. One of the main benefits of nanosizing is that it increases surface
2. Improved soluble
3. Improved oral bioavailability and dissolution rate
4. Prompt reaction time
5. The area of pharmacy requires fewer doses.

These materials and technologies can be made to interact with a high degree of functional specificity for applications in medicine and physiology, enabling a level of interaction between technology and biological systems that were previously unachievable. It is important to recognize that the development of novel technologies requires a fusion of traditional sciences such as chemistry, physics, material science, and biology. This fusion of traditional sciences is what is known as nanotechnology.

The update discusses these opportunities while offering advice on how to handle significant advancements in these fields. Richchard Feynman advocated designing gadgets with each atom put precisely as early as 1959. In his landmark book Engines of Creation, written in 1986, Eric Drexler discussed some of the advantages and drawbacks of having such potential. If individual atoms can be joined to form molecules and devices with the aid of computers, it will be possible to create structures out of a diamond that is 100 times stronger than steel, create computers that are smaller than bacteria, and create assemblers and mini-factories of various sizes that are capable of producing complex goods and even replicating themselves.

The succeeding book by Drexler, nano-systems, confirmed these astounding claims and made further ones. In an hour, a self-contained tabletop factory could create a copy. Moving parts-based devices have the potential to be very effective. According to molecular manufacturing, activities could be performed with a failure rate of less than one in a quadrillion. If advanced nanotechnology is ever created, it is obvious that the results will be extremely potent. Risks linked with molecular manufacturing emerged as soon as it was suggested. One risk mentioned in Engines of Creation was grey goo, which is today thought to be unlikely but still a possibility. Theoretically, a tiny replicating nanomachine could duplicate itself excessively. If it has the ability to use biomass as a raw source and survive outside, it may cause significant environmental damage.[1-2]

Four Generations:

Four generations of nanotechnology development have been described by Mihail (Mike) Roco of the US National Nanotechnology Initiative. According to Roco, the contemporary period is one of passive nanostructures, or materials made specifically to carry out a single function. We are only starting the second phase, which introduces active nanostructures for multitasking, such as

actuators, drug delivery systems, and sensors. The third generation, which would include nano-systems with thousands of interacting components, is anticipated to start developing around 2010**.**

After then, it is anticipated that the first integrated nano-systems with hierarchical systems within systems that operate somewhat like a mammalian cell would be created. Although some specialists may still hold fast to the belief that the term "nanotechnology" can be used to describe measurement or visualization at the scale of 1-100 nanometers, Mike Roco of the NNI's hypothesis that control and restructuring of matter at the nanoscale is a required component seems to be gaining traction. Although CRN's definition is a little more specific, we believe it will become increasingly clear that "engineering of functional systems at the molecular scale" is what nanotechnology is as work progresses through the four generations of nanotechnology leading up to molecular nano-systems, which will include molecular manufacturing.

Pharmaceutical Nanotechnology-Based Systems:

Pharmaceutical nanotechnology consists of two basic types, which are nano-materials and nanodevices, which play a key role in pharmaceutical nanotechnology and other fields.

Nanomaterials:

These are made of biomaterials and are utilized as scaffolds for tissue-engineered products or in orthopaedic or dental implants. It is possible to modify or coat them to improve their biocompatibility with living cells. These are further divided into two groups of materials: nanocrystalline and nanostructured. Nanocrystalline These are easily produced and can take the place of bulk materials that perform less well. Drug encapsulation, bone replacement, prostheses, and implants all directly utilize these materials.

Nanostructured substances:

These are modified nanomaterials with unique shapes and capabilities. Quantum dots, dendrimers, fullerenes, and carbon nanotubes are a few of these.

Nanodevices These are nanoscale-sized miniature gadgets. Micro fluidics, nano and micro electromechanical systems (NEMS/MEMS), and micro tests are some of these. These also include diagnostic tools like biosensors and detectors.

Types of Pharmaceutical Nanosystems:

- **Carbon Nanotubes:** These carbon atoms are arranged in hexagonal networks. These tubes have a diameter of 1 nm and a length of 1–100 nm. Single-walled nanotubes (SWNTS) and multi-walled nanotubes (MWNTS) are the two types of nanotubes. These are tiny macromolecules with exceptional physical characteristics, a distinctive size, and a unique form.[3-4]

- **Quantum Dots:** These semi-conducting materials have a semi-conductor core that is covered in a shell to enhance their optical characteristics. Their physical size, which ranges in radius from 10-100A0, is where their characteristics come from. They significantly affect imaging, biomolecule detection and analysis in vitro and in vivo, immunoassay, DNA hybridization, and non-viral vectors for gene therapy. Its primary purpose is to mark cells and create therapeutic tools for the treatment of cancer[5.]

- **Dendrimers:** These feature compartmentalized chemical polymer and are hyperbranched, like trees. It has three distinct regions: the core, the branches, and the surface. The branches extend outward from the centre, creating an interior hollow and a sphere of groups. The core serves as the primary component. The branches can be changed or improved in accordance with needs. Depending on the needs, dendrimers

can be produced from more biocompatible chemicals with excellent permeability and low cytotoxicity. These can transport bioactive substances, such as drugs, vaccines, materials, and genes, to specific locations. Drugs or bioactive products are accommodated in the area between the core and branches. 1976's Kreuter and Speiser.

- **Polymeric Nanoparticles:** These are colloidal carriers with a size range of 10 nm to 1 m made of artificial or organic polymers. Due to their intrinsic qualities including biocompatibility, non-immunogenicity, non-toxicity, and biodegradability, these nanoparticles serve as an alternative to the nanosystems listed above. Nanocapsules and nanospheres are two types of polymeric nanoparticles. whereas nanospheres are systems in which the drug is spread throughout the polymer matrix, are systems in which the drug is restricted to a cavity bordered by a specific polymeric membrane. Gelatin, albumin, and alginate are examples of natural polymers utilized in the creation of nanoparticles. Synthetic polymers are also used. Preformed synthetic polymers may be utilized to create the nanoparticles of preparation. e.g.: polyesters such as polycaprolactone.[6-7]

- **Metallic Nanoparticles:** Metallic nanoparticles are more preferred for effective medication and biosensor distribution. Although several metals have been used to create nanoparticles, silver and gold nanoparticles are of particular significance for biological applications. Numerous ligands, including sugar, peptides, proteins, and DNA, have been coupled to nanoparticles. These nanoparticles are relatively simple to decorate with ligands and exhibit surface functionalization. These are employed for active bioactive delivery, drug discovery, bioassays, detection, imaging, and many other applications because of their potential to be functionalized.

- **Liposomes:** These are closed vesicles form when dry phospholipids are hydrated. These are of 3 types based on size and number of bi-layers.

  - **Multilamellar vesicles:** These consist of several lipid bi-layers separated from one another by aqueous spaces. These are heterogeneous in size, ranging from a few hundred to thousands of nm in diameter.

  - **Small unilamellar vesicles (SUV'S) and large unilamellar vesicles (LUV'S):** These enclose the trapped aqueous area in a single bi-layer. LUVs are greater than 100nm, while SUVs are less than that. Depending on the physicochemical properties of the drug, it is either intercalated into the lipid bi-layer of liposomes or trapped in the aqueous space. For both active and passive transport of bioactives, liposomes can be made with a wide variety of structure, content, size, flexibility, and surface modification techniques. They are employed in the treatment of leishmaniasis, cancer therapy, antigen delivery, pulmonary delivery, and ophthalmic medication administration.[8-9]

  - **Polymeric micelles:** Polymeric micelles are nanoscopic supramolecular core-shell structures made of amphiphilic block copolymers. These are typically less than 100 nm, and the hydrophilic surface prevents the reticuloendothelial system from absorbing them in an unintended manner. Micelles are aggregates of the component molecules that form in liquids and have a

hydrophobic core that is protected from the water by a mantle of hydrophilic groups. These are employed for the systemic administration of water-insoluble medications. Additionally, medications can be covalently attached to micelle component molecules or physically confined inside the hydrophobic cores of the molecules. These have a large loading capacity, are physiologically stable, dissolve more slowly, accumulate drugs at the target site, and may functionalize the end group for conjugation.

Polymer drug conjugate:

The pharmacokinetic distribution of the drug throughout the entire body and at the cellular level is drastically altered when low molecular weight medicines are conjugated with polymer. In order to promote their retention in cancer cells through the EPR effect when employing the passive administration strategy, they are therefore designed to have higher total molecular weights.[10]

Polyplexes or lipopolyplexes:

These are utilized in transfection techniques and form naturally between nucleic acids and polycations or cationic coupled to targeted ligands or hydrophilic polymers. The charge ratio of the nucleic acid to the cationic lipid or polymer determines the shape, size distribution, and transfection ability of these complexes. Examples include poly-l-lysine, branched and linear poly ethylene amine, poly amidoamine, poly-amino esters, and cationic cyclodextrin.[11]

Preparation of Nanoparticles:

The selection of the most appropriate approach for creating nanoparticles is primarily based on two factors. They are:

1) The polymer's physicochemical properties.

2) To be loaded drug. The inner structure, *In-vitro* release profile, and biological fate of the polymeric delivery system are determined by the production methods. two distinct system types with various internal structures are:

1) **Matrix type:-** Entanglement of oligomer or polymer units. Nanoparticles and nanospheres

2) **Reservoir type**:- Oily core and embryonic polymer shell. Nano capsules.[12]

The different methods are:

1) **Ampiphillic macromolecule cross linking**

a) Heat cross linking

b) Chemical cross linking

2) **Polymerization based methods**

a) Polymerization of monomers *in-situ*

b) Emulsion (micellar) polymerization

c) Dispersion polymerization

d) Interfacial condensation polymerization

e) Interfacial complexation

3) **Polymer precipitation methods**

a) Solvent extraction or evaporation

b) Solvent displacement (nano precipitation)

c) Salting out.

1. Amphiphillic macromolecule cross-linking:

The materials used are Amphiphillic macromolecules, proteins and polysaccharides. These should have an affinity to both aqueous and lipid solubility. It occurs in 2 steps:

1) Aggregation of amphiphilic

2) Stabilization by heat denaturation or chemical cross-linking.

The aggregation takes place in o/w or w/o emulsion type. These sub-divide the amphiphiles prior to aggregative stabilization. The aggregation may also take place in-aqueous amphiphilic solution through removal, extraction and diffusion of solvent. The amphiphiles are aggregated as tiny particles and subsequently rigidized via chemical cross-linking.[13-15]

2. Polymerization-based methods

a. Polymerization of monomers *in-situ*: The polymers used are polymethacrylate, polyacrylamide, poly butyl cyano acrylate, N-N' methylene- bis-acrylamide etc. The two different approaches generally adopted for the precipitation of nanospheres using *in-situ* technique are:-

1. The monomer to be polymerized is emulsified in a nonsolvent phase (emulsion polymerization).

2. The monomer is dissolved in a solvent that is non-solvent for the resulting polymer (dispersion polymerization).

In emulsion polymerization, the monomer is dissolved in the internal phase. In dispersion polymerization, it is taken in the dispersed phase. In both cases the polymer is insoluble, thus resulting in an ordered suspension of nanospheres.[16]

b. Emulsion polymerization: The process can be conventional or inverse, depending upon the nature of the continuous phase in the emulsion. In the conventional case, the continuous phase is aqueous (o/w emulsion), in the inverse case it is organic (w/o emulsion). The two different methods proposed for the emulsion polymerization process are:[17]

1. Micellar nucleation and polymerization.
2. Homogeneous nucleation and polymerization.

1. Micellar nucleation and polymerization: The monomer is emulsified in the non-solvent phase with the help of surfactant molecules. This leads to the formation of monomers-swollen micelles and stabilized monomer droplets. Swollen micelles exhibit size in the nanometric range and this has more surface area than monomer droplets. The polymerization occurs in the presence of a chemical or physical initiator. The energy provided by the initiator creates free reactive monomers in the continuous phase, which collide with surrounding un-reactive monomers and initiate a polymerization chain reaction. The monomer molecules reach the micelles by diffusion from the monomer droplets through a continuous phase, allowing polymerization to progress within the micelles. In this case, monomer droplets act as monomer reservoirs. In this, the monomers are slightly soluble in the continuous phase.[18]

2. Homogeneous nucleation and polymerization: This process applies largely in cases where the monomer is sufficiently soluble in the continuous outer phase. The nucleation and polymerization occur directly in this phase, leading to the formation of primary chains called oligomers. Both micelles and droplets act as monomer reservoirs throughout the polymer chain length. When the oligomers have reached a certain length, they precipitate and form primary particles, which are stabilized by the surfactant molecules provided by the micelles and the droplets. Depending on bulk conditions and system stability, the end product nanospheres are formed either by additional monomer input into the primary particles or by fusion of the primary particle.[19-20]

c. Dispersion polymerization: The term emulsion polymerization is used when the monomer is emulsified in an immiscible (non-solvent) phase by means of surfactants. But this monomer is dissolved in an aqueous medium, which acts as a precipitant for the subsequently formed polymer. In *in-situ* controlled polymerization the drug may be added to the monomeric phase or may be added to the formed polymeric nanoparticles dispersion for adsorptive loading. The monomer is introduced into the dispersion medium of an emulsion or an inverse emulsion into non-solvent based polymeric solution. The polymerization is initiated by adding catalyst and proceeds with a nucleation phase followed by a growth phase (propagation). But in dispersion polymerization, the nucleation is directly induced in the aqueous monomer solution and the presence of stabilizer or surfactants is not absolutely necessary for the formation of stable nanospheres. This is used to prepare bio-degradable polyacrylamide and poly methyl- methacrylate (PMMA) nanoparticles.

d. Interfacial polymerization: In this the pre-formed polymer phase is transformed into an embryonic sheath. The polymer that becomes core and drug molecule to be loaded are dissolved in a volatile solvent. The solution is then poured into a non-solvent for both polymer and core phase. The polymer phase is separated as a co-acervate phase at o/w interphase. The resultant mixture turns milky due to the formation of nanocapsules. This is used for encapsulation of proteins, enzymes, antibodies and cells were employed.[21]

e. Interfacial complexation: This is based on micro-encapsulation. In this aqueous polyelectrolyte is dissolved in reverse micelles in an apolar bulk phase with the help of an appropriate surface-active agent. A competing polyelectrolyte is added to the bulk, which allows a layer of insoluble polyelectrolyte complex to co-acervate at the interface.

3. Polymer precipitation method: In this, the hydrophobic polymer and or a hydrophobic drug is dissolved in a particular organic solvent followed by dispersion in a continuous aqueous phase, the polymer is insoluble. The external phase also contains the stabilizer. The solvent miscibility techniques, are also known as solvent extraction or an evaporation method. The polymer precipitation occurs due to solvent extraction or evaporation. This can be done by.

1) Increasing the solubility of organic solvent in the external medium by adding alcohol.

2) By incorporating an additional amount of water into the ultra-emulsion (extract or diffuse solvent).

3) By evaporation of the organic solvent at room temperature or at accelerated temperature or by using a vacuum.

4) Using an organic solvent that is completely soluble in the continuous aqueous phase (acetone) – nanoparticles.[22]

a. Solvent extraction method: This method involves the formation of a conventional o/w emulsion between a partially water-miscible solvent containing the stabilizer. The subsequent removal of solvent (solvent evaporation method) or the addition of water to the system so as to affect diffusion of the solvent to the external phase (emulsification diffusion method) is two variances of the solvent extraction method. Recently the emulsification-diffusion method has been used on a regular basis for solvent extraction purposes. The solvent used for the polymer is often poorly miscible with dispersion phase and thus diffuses and evaporates out slowly on continual stirring of the system. The dispersion medium miscible polymer solvent instantaneously diffuses into the aqueous phase and as a result, the polymer consolidates and precipitates as tiny nanospheres

.

b. Double emulsion solvent evaporation method: The emulsion solvent evaporation technique has been further modified and a double emulsion multiple emulsion of water in oil in water type has been used. Following evaporation of the organic solvents nanoparticles are formed which are then recovered by ultracentrifugation, washed repetitively with buffer and lyophilized. PLGA nanoparticles were prepared loaded with bovine serum albumin using the double emulsion solvent evaporation method Due to the high solubility of protein in water, the double emulsion technique has been chosen as one of the appropriate methods.

c. Solvent displacement or nanoprecipitation: This is based on the interfacial disposition of a polymer following displacement of a semi-polar solvent miscible with water from a lipophilic solution. This method involves the use of an organic phase, which is completely soluble in the external aqueous phase, inducing immediate polymer precipitation because of the complete miscibility of both phases. Separation and extraction of the solvent are not required for polymer precipitation. After nanoparticles preparation, the solvent is eliminated and the free-flowing nanoparticles can be obtained under reduced pressure.

This method is useful for slightly soluble drugs in water. If the drug is highly hydrophilic, it diffuses out into the external aqueous phase, if the drug is highly hydrophobic, it may precipitate in the aqueous phase as nanocrystal, which further grows on storage. In the case of hydrophilic polymer, an aqueous solution of polymer is dispersed or emulsified in oil phase. The precipitation of polymer proceeds with addition of acetone. By this technique, ovalbumin-loaded dextran nanospheres of approximately 1micrometer size were prepared. The nanospheres were fairly stable and uniform in size. However, the loading efficiency of lipophilic

drugs, such as indomethacin, metripranol, betaxolol in nanoparticles of PLA, PLGA and PECL has been increased using a modified solvent displacement method. In this, the drug is dissolved in a small volume of appropriate oil and the diluted in the polar organic solvent (acetone/ethanol/methanol). When the organic solution is dispersed in the aqueous, the polymer precipitates around the nanodroplets, forming a reservoir system.[23]

d. Salting out: It is one of the most commonly adopted methods used to prepare nanoparticles. The method involves the incorporation of a saturated aqueous solution of polyvinyl alcohol (PVA) into an acetone solution of the polymer under magnetic stirring to form an o/w emulsion. The process differs from nanoprecipitation technique as in the latter the polymeric solution (acetone) is completely miscible with the external aqueous medium. But in the salting-out technique, the miscibility of both phases is prevented by the saturation of the external aqueous phase with PVA. The precipitation of the polymer occurs when a sufficient amount of water is added to external phase to allow complete diffusion of the acetone from internal phase into the aqueous phase. This technique is suitable for drugs and polymers that are soluble in polar solvents, such as acetone or ethanol.[24]

5. Applications of Pharmaceutical Nanotechnology:

Miniaturization is beneficial in pharmaceutical technology. Since it has increased complexity and also imparts a large number of benefits in drug delivery and diagnosis. The various pharmaceutical and biochemical areas where nanosystems are used are:

a. Nanomaterials for tissue engineering: The nanomaterials are used for tissue repair and replacement, Implant coatings, Tissue regeneration, Structural implant materials, Bone repair, Bio-reusable materials, Implantable devices (sensory aids, retina implants), Surgical aids, Operating tools and also in Smart instruments.

b. Drug carrier system Nanotech enabled drug delivery system with optimized physical, chemical and biological properties, which can serve as effective delivery tools for currently available bioactives. Some nano-based carrier systems are polymeric nanoparticles, liposomes, dendrimers, polymeric micelles, polymer-drug conjugates and antibody-drug conjugates.

These can be classified as:

1. Sustained and controlled delivery system.
2. Stimuli sensitive delivery system.
3. Functional system for delivery of bioactive.
4. Multi-functional system for combined delivery of therapeutics, biosensing and diagnostic.
5. Site-specific targeting (intracellular, cellular, tissue).

6. The Carrier Systems are Widely Used in the given Regions:

a. Cancer treatment: Nanotech has a revolutionary impact on cancer diagnosis and therapy. Available therapies for cancer are surgery, chemotherapy, immunotherapy and radiotherapy. Nanotech is used to improve these conventional therapies by virtue of its nanotools. Carbon nanotubes: D.N.A mutation detection, disease protein biomarker detection. Dendrimers are controlled release drug delivery, and image contrast agents. Targeting and localized delivery are the key challenges in cancer therapy. The approaches to treat cancer are basically attributed to the pathophysiology of diseased sites like leaky vasculature of the cancer tissues. The nanocarriers can alter the biodistribution and pharmacokinetic parameters of the anticancer drug. The nanotool identifies biomarkers or detects mutations in cancer cells and treats the abnormal cells by thermotherapy, photothermal therapy using silica nanocells and carbon nanotubes. Magnetic field-induced thermotherapy using magnetic nanoparticles. Photodynamic therapy- quantum dots.

Chemotherapy: Nanostructural polymer nanoparticles, dendrimers and nanoshells.

Radiotherapy: Carbon nanotubes, dendrimers

b. Implantable delivery systems: Nanoparticles can act as the delivery systems by virtue of its size, controlled and approximately zero order kinetics, otherwise they may cause toxicity when compared to I.V. Carriers are liposome, ethosome and transferosome. These help in minimizing peak plasma levels and reduce risk of adverse reactions, allow for a more predictable and extended duration of action, reduce the frequency of re-dosing and improve patient acceptance and compliance.[25] Site-specific drug delivery Liposomes, polymeric micelles, dendrimers, ironoxide, proteins using manipulation in passive and active uptake of drug. The tumor targeting of drugs is done by passive delivery using enhanced permeation and retention (EPR) effect of nanoparticles taking the advantages of nanoparicles taking the advantages of leaky vasculature of tumor. Surface modification using site-specific ligands via covalent binding or adsorption with carrier system enhanced their site specificity. In chemotherapy of tuberculosis with active delivery to lung cells is reported to have improved drug bioavailability, reduction in dose frequency and overcame the non-adherence problem encountered.

c. Gene therapy: The normal gene is inserted in place of an abnormal disease-causing gene using a carrier molecule. Nanotech enabled effective and promising tools in systemic gene treatment. Chitosan, gelatin and poly-1-lysine and modified silica nanoparticles are used in gene therapy. These have increased transfection efficiency and decreased cytotoxicity. Nanotechnology provides ideal vectors in gene delivery.[25]

d. Molecular diagnostics (molecular imaging): It is representing, characterizes and quantifies sub-cellular biological processes including gene expression, protein-protein interaction, signal transduction and cellular metabolism. They are used in magnetic resonance imaging, optical imaging, ultrasonic imaging and nuclear imaging. Other applications are specific labeling of cells and tissues, useful for long-term imaging, multicolor multiplexing, dynamic imaging of sub-cellular structures and fluorescence resonance energy transfer (FRET) and magnetic resonance imaging (MRI). MRI agents are replaced by nanomaterials like dendrimers, quantum dots, carbon nanotubes and magnetic nanoparticles. They are very efficient, stable, intense, clearer images due to high intensity, photostability, resolution, resistance. Quantum dots, iron oxide nanocrystals and metallic nanoparticles.

e. Biosensor and bio-labels These tools are employed for determination of various pathological proteins and physiological-biochemical indicators associated with disease or disrupted metabolic conditions of the body. Biosensor is a measurement system that consists of a probe with a sensitive biological recognition element or bio-receptor, a physiochemical detector component and a transducer to amplify and transducer these signals into measurable form. A nano biosensor or nanosensor is a biosensor that has dimensions on the nanometer size scale. Biosensors are used in target identification, validation, assay development, ADME, toxicity determination.[26-30]

f. Drug discovery Nanotech: Helps in the identification and validation of target by identifying the protein present on the surface or target surface. Nanotech will enhance drug delivery process, through miniaturization, automation, aped and reliability of assays. Single-walled nanotubes are successfully used to identify surface proteins of pathogens. Quantum dots-track individual glycine receptors and analyze their dynamics in the neuronal membrane of living cells, for periods ranging from milliseconds to minutes. Gold nanoparticles and nanobodies (smallest, available, intact antigen-antibody fragments) produced by ablynx are some commonly used nanomaterials in diagnosis. The pharmaceutical nanotechnology is used in the detection of pathogens in humans, separation and purification of molecules and cells and detoxifying agents. Future nanomachine (respirocyte) is the nano-on-board mini-computer, that can be used for detection of disease-causing markers or antigens, to view the

diseased site and to deliver the therapeutic agent at the site. The main advantages of nano-technology in the pharmacy field are improved bioavailability, reduced toxicity, sustained and controlled release, targeted delivery, do not occlude in blood capillaries, passing easily through most of the physiological biobarriers, providing effective delivery to brain and intracellular compartment, protecting fragile drugs or proteins from harsh biological environment, faster, safer and more accurate disease diagnosis, more accurate less invasive surgery, inexpensive and the large-scale production is feasible. Some of the main disadvantages of nanotechnology in the pharmaceutical field are high aggregation in biological systems due to high surface energy, poor solubility and poor incompatibility in case of carbon nanotubes, quickly scavenged by RES system of body resulting in low biological half-life, poor target and site specificity, high immunogenicity of foreignness, undefined and unpredictable safety issue and acute and chronic toxicity.[31]

Conclusion: Pharmaceutical nanotechnology has emerged as a discipline having enormous potential as a carrier for spatial and temporal delivery of bioactive and diagnostics and provides smart materials for tissue engineering. It offers new tools, opportunities and scope, which are expected to have a great impact on many areas in disease, diagnostics, prognostic and treatment of diseases through its nano-engineered tools. Pharmaceutical nanotechnology provides opportunities to improve materials, medical devices and help to develop new technologies where existing and more conventional technologies may be reaching their limits. It raises new hope to industries by providing new patenting technologies in view of revenue loss caused due to off-patent drugs. Pharmaceutical nanotechnology has a profound influence on disease prevention efforts because it offers innovative tools for understanding the cell as well as the difference between normal and abnormal cells. It could insights into molecular basis of disease. Some of the advantages are:

1. Identifying, defining and characterization of model nanomaterials.
2. Developing toxicity testing protocol.
3. Detecting and monitoring exposure levels.
4. Assessing the impact of environment.
5. Developing the biocompatible hybrid system.

But still, we lack sufficient data and guidelines regarding safe use of these nanotechnology-based devices and materials. There are several confounding unresolved issues, which warrant the application in its full boom.

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