Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v30i3.3135

NANOPHARMACEUTICS: A NOVEL DRUG DELIVERY TECHNOLOGY

S. Venkateswara Rao[1*], L. Anusha[1], B. Harika Rathan[1], S. Soniya[1], K. Padmalatha[2]

[1]Department of Pharmaceutics, Vijaya Institute of Pharmaceutical Sciences for Women, Enikepadu, Vijayawada, Andhra Pradesh-521102, India.
[2]Department of Pharmacology, Vijaya Institute of Pharmaceutical Sciences for Women, Enikepadu, Vijayawada, Andhra Pradesh-521102, India.

[*]**Corresponding Author:** Dr. Sadhu Venkateswara Rao
[*]Professor & HOD, Department of Pharmaceutics, Vijaya Institute of Pharmaceutical Sciences for Women, Enikepadu, Vijayawada, Andhra Pradesh, India.

ABSTRACT
Nanopharmaceutics, an evolving branch of nanotechnology, offers a revolutionary and innovative approach to drug delivery systems. Nanopharmaceutics offering promising solutions to the challenges faced by conventional pharmaceutical formulations. This review provides an overview of recent advancements in nanopharmaceutics, focusing on the potential benefits it brings to the field of drug delivery. Nanopharmaceutics employs nanotechnology-based platforms, such as liposomes, micelles, polymeric nanoparticles, and solid lipid nanoparticles, to encapsulate drugs at the nanoscale level. These nanocarriers, often ranging from 1 to 100 nanometers in size, can encapsulate therapeutic agents, including drugs and biological molecules, offering controlled release, improved solubility of poorly water-soluble drugs, improved bioavailability, and targeted delivery to specific tissues or cells. By facilitating site-specific drug delivery, nanopharmaceutics not only enhances therapeutic outcomes but also reduces drug doses, potentially leading to cost savings and improved patient compliance. The reviw also highlights various breakthroughs in nanopharmaceutics, such as novel nanoparticle synthesis methods, surface functionalization techniques, and controlled release strategies. Finally concludes by highlighting the promising prospects of nanopharmaceutics in transforming drug delivery systems. As research continues to advance in this field, nanopharmaceutics holds immense potential to revolutionize the treatment of various diseases, providing safer, more effective, and personalized therapies. This innovative approach has the potential to reshape the landscape of pharmaceutical development and improve patient outcomes across a wide range of medical conditions.

Keywords: Drug Delivery Systems, Liposomes, Polymeric Nanoparticles and Solid Lipid Nanoparticles.

INTRODUCTION
One of the most important technologies of this century is widely acknowledged to be nanotechnology. Science fields as diverse as biology, chemistry, physics, materials science, and engineering all make use of nanotechnology and nanoscience. They include working with and learning about extremely small objects. The capacity to recognize and exert control over specific molecules and atoms is at the heart of nanotechnology and nanoscience. This technology has the potential to make a substantial

impact to healthcare by inculcating step changes in diagnosis of disease and its monitoring, implants and regenerative medicine, delivery of drug as well as research to for discovery of drug and biomedical science. The increased reactivity and medication molecules' capacity to passcell membranes with positive effects on health and safety are what attract people to nanomaterials(Jain,*et.al.,* 2005). Drug delivery refers to the process of administering a pharmaceutical to a living organism in order to produce a therapeutic effect. A Pharmaceutical product or compound maybe defined as the substance which is manufactured as a drug intended for medicinal and therapeutic use. "Engineered particles" used in medication delivery through nanotechnology have a unique method of action; first, they attach to damaged cells, allowing for direct therapy of those specific cells. This method is profitable ince as a lower propensity to harm the body healthy cells(Sagar,*et.al*-2011). Nanopharmaceutical is certainly one of the most promising fields under Nanotechnology. This is because nanomaterials enter our body through dermal exposure .Ocular contact, inhalation oringestion; they devote to future is novel drug delivery systems. Pharmaceutical research, formulation, toxicology studies and manufacture of pharmaceutical products require characterization of material to ensure persistent safety and efficacy of the drug. Nanopharmaceuticals have countless benefits for treating diseases and delivering therapeutic agents, as well as for releasing their innate subcellular or intracellular behavior, providing profound insight into diagnosis and prognosis, measuring treatment effectiveness, and developing better therapeutics. With the development of nanopharmaceutics as a field, bioactives may now be delivered both spatially and temporally, resulting in smart materials for tissue engineering. As a result of the success of its nanoengineered tools in medication delivery and disease treatment, the field has gained widespread attention in recent years. Only a few goods and delivery methods based on nanotechnologies are currently available .Nanopharmaceutics also presents opportunities to improve materials, medical equipment, and to contribute to the development of new technologies in areas where more established and traditional ones may have reached their limits. Additionally, nanopharmaceutics offers fresh, cutting-edge patented technology to the pharmaceutical industry, giving them renewed hope in light of income losses brought on by off-patent medications. World wide scientific communities, businesses, and governments are eagerly awaiting the promise of this technology and making every effort to seize it. Nanopharmaceutics has the potential to greatly improve our ability to diagnose diseases, cure them, and prevent them. Understanding the cell and the differences between healthy and diseased cells is a key part of pharmaceutical nanotechnology, which could have far-reaching implications for disease prevention. It could provide light on the underlying biological causes of illness. However, increasing bottom size raises an unidentified health risk. To take full use of this very intriguing and rapidly developing promising technology, some recommended action is required. Examples include (Md.Zubayer, *et.al.*, 2012):

1. Finding, naming, and analyzing prototypical nanomaterials
2. Developing methods for toxicity testing
3. Calculating and keeping tabs on doses
4. Determining the environmental effect
5. Creating the bio-compatible hybrid system

Advantages:

1. Enhanced bioavailability.
2. Less harmful effects.
3. Controlled and sustained discharge.
4. Avoid blocking the flow of blood to the brain and intra cellular spaces.
5. Preventh ostile biological environments from damaging delicate drugs or proteins.
6. More rapid,secure, and preciseillness diagnostics.
7. Less invasive and more precise surgery.
8. Large scale production is feasible.

Disadvantages:

1. The ability of polymeric nanoparticles to load drugs is restricted.
2. Toxic metabolism may develop with repeated ingestion of polymeric carriers that have under gone bio transformation.
3. The bio degradation of the polymeric nanoparticles occurs very slowly, which might have harmful effects through out the body.

TYPES OF NANOPHARMACEUTICALS:

Therapeutic agents that work as their own nanocarrier systems (i) and therapeutic agents that are functionalized, entrapped, or coated with nanoparticles carriers or nanoengineered medications (ii) make up the two primary groups of nanopharmaceuticals.

Due to the lack of a universal naming convention, nanopharmaceuticals have come to encompass a wide variety of nanoscale structures. Nanopharmaceuticals often take the shape of spheres (both hollow and solid), tubes, particles (both solid and porous), and tree-like branching macromolecules. Figure1 depict safe of the typical types of nanopharmaceutical dosage forms, and Table1 list safe of the FDA-approved dosage forms that are no won the market and accessible. Many different processes, like as self-assembly, vapour or electrostatic deposition, aggregation, nanomanipulation, imprinting, etc., are used in the production of nano medicines may be used. The particular therapeutic application of the medicine and the preferred method for dosage form distribution are factors that affect then a no pharmaceutical formulation technique. Nanopharmaceuticals' functional complexity is dependent on (BawaR*et.al*,2009).

- The make-up of the employed polymeric nanoparticles. For instance, dendrimers, carbon nanotubes, and liposome.
- Fullerenes, nanocrystals, and colloidal gold
- The make up of pharmaceuticals included in nanomaterials . proteit, nucleic acid, and small molecule are examples.
- The kind of targeted molecules that a nano carrier may surface-functionalize. antibodies, ligands,etc.
- The medication delivery method. Examples include oral,topical, intravenous,etc.
- Nanopharmaceuticals' formandgeometry
- Then a nopharmaceuticals' chemical l make-up
- Then an oscal adimensions of nanopharmaceuticals, which have a high surface-to-volume ration.

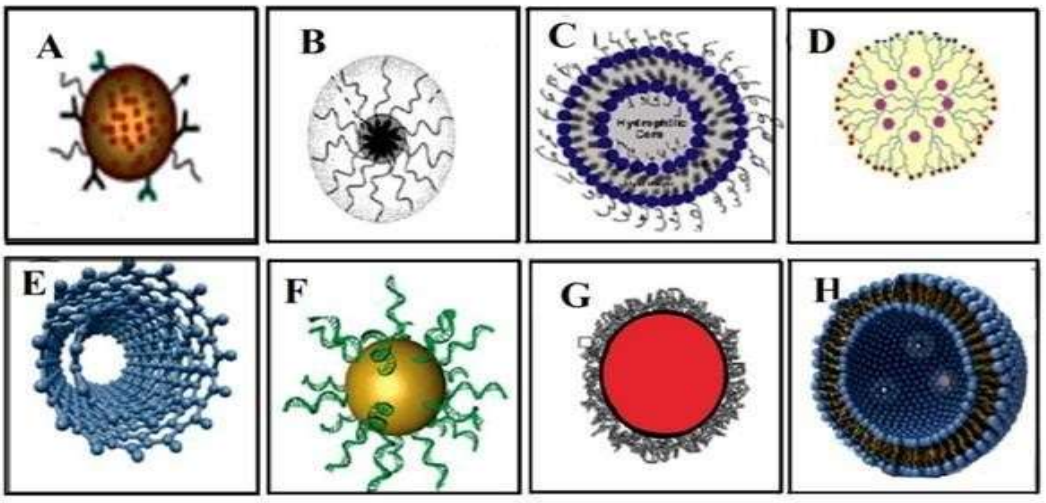

Fig-1:various dose forms for nanopharmaceuticals, A. solid nanoparticulate, B.Polymeric Micelle; C. PEGlyated Liposome s; D. Dendrimer; E. Nanotube; F. GoldNanoparticles;G. Lipid CoreNanocapsule[LNCs]; andH.Nanoshell.

Table-1: A few instances of commercial nanopharmaceutical dosage forms

Drug	Formulation& Route of administration	Brand name	Company	Therapeutic Indications
Amphotericin B	Lipocomplex (iv infusion)	Amphocil	Seguus Pharmaceuticals	Serious fungal infections
Amphotericin B	Lipocomplex (iv infusion)	Ambisome	NeXstar Pharmaceuticals	Serious fungal infections
Amphotericin B	Lipocomplex (iv infusion)	Abelcet	The Liposome Company (Princeton,new jersery)	Serious fungal infections
Paclitaxel	Albumin bound Nanoparticles (iv injection)	Abraxane	American Biosciences (Blauvelt,New York)	Metastatic breast cancer
Sirolimus	Nanocrystal Particles(oral)	Rapamune	WyelthElan (Madison,New Jersey)	Immunosuppressant in kidney transplant patients
Doxorubicin	Liposome (iv injection)	Doxil	Sequus Pharmaceticals	Kaposi sarcoma in AIDS
Daunorubicin citrate	Liposomes (intravenous)	Daunoxone	NeXstar Pharmaceuticals	Kaposi sarcoma in AIDS

NANOCARRIERS FOR TARGETING:

Targeted dosage forms based on nanocarriers have been developed to minimize the dose necessary for therapeutic effectiveness, boost therapeutic index, and reduce clearance targeted nanopharmaceuticals often buildup unevenly with in the body, and factors including size, dispersion, surface charge, and surface characteristics determine where they will eventually buildup and how they will be delivered. In reality, these characteristics maybe altered to provide either lengthy or brief circulation duration's. One can target to specific tissue sites, such as hepatocytes in the liver as opposed to kupffer cells, by attaching specific ligands or molecules to the polymeric carrier, such as antibodies, glycoproteins, etc., or by altering the surface properties of the polymeric carrier so that Sitevades there ticuloendothelial(RES) system.(Valdimir.et.al,2006),.

The following biological requirements must be met by nanopharmaceuticals in order for them to be successful and site-specifically targeted:

• Non-toxic, biodegradable, and traceable;
• Capability to avoid immunological reaction and assault by macrophages;
• Successful pharmacokinetic qualities with electivity for effective targeting.

NANOPHARMACEUTICAL DOSAGE FORMS:

Developed in the 1990s as a colloidal carrier system for controlled drug delivery of therapeutic drugs, solid lipid nanoparticles (SLN) are an alternative to emulsions, liposomes, and polymeric nanoparticles. The medicine is often integrated in the SLN at a size below 1 m, and the SLN itself are primarily made of physiological lipids and surfactants that have an approved GRAS (Generally Recognized as Safe) grade. Lower cytotoxicity, more drug loading capacity, and superior scalability of production are all reasons why solid lipid nanoparticles may be preferable to polymeric nanoparticles. High-pressure homogenization allows for the large-scale production of SLN without the need for organic solvents. There is evidence that it has been utilized as a pharmacological dosage form for oral, parenteral, pulmonary, and cutaneous delivery. (Basu.*et.al*,2010). Emerging solid lipid nanopharmaceuticals have several potential uses in drug delivery, clinical treatment, and pharmaceutical research .Nanoparticles made of lipids have been shown to advantages in terms of bioavailability augmentation, site-specific, and controlled drug administration, all of which depend on their size, open up vast avenues for the development of new therapeutics. Additionally, by

manufacturing poorly water soluble pharmaceuticals into solid lipid matrix, SLN were able to achieve controlled release characteristics and avoid the degradation of drug molecules that are vulnerable to environmental factors like light and water. Nanoparticles coated in a novel solid lipid matrix and poly(alkylcyanoacrylate) surfactant are being developed with the goal of penetrating the brain. Cationic lipid-modified SLN has also been studied as a potential new transfection agent. For instance, liposomes made from the same cationic lipid (DOTAP) and Transfection efficiency was comparable between SLN and SLN made with acationic lipid (DOTAP), but SLN has a broader spectrum of potent non-viral transfection agents that can be created at scale. (BlasiP.*et.al*,2007).

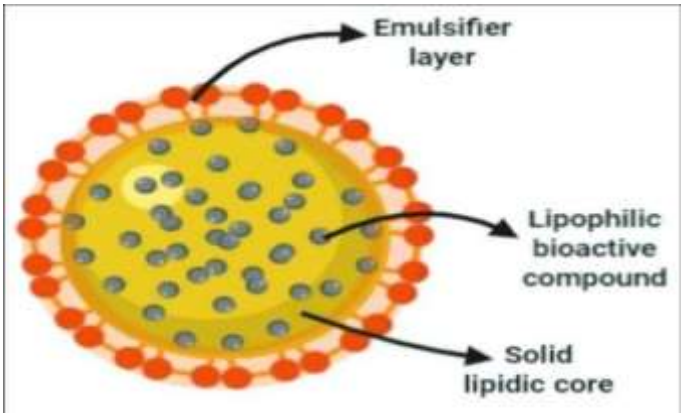

Fig-2: Nanopharmaceutical Dosage Forms

The method of solvent emulsification and diffusion was used to produce doxorubicin-loaded solid lipid nanoparticles (SLN). The lipid core was made of Glyceryl caprate, while the shell was made of curdlan. Both the lipid and the medication were dissolved using dimethyl sulfoxide(DMSO).As a surfactant, polyethylene glycol660 hydroxy Stearate was used .Important formulation factors were improved to produce high-quality nanoparticles. After a year of storage at 40C, cytotoxicity tests revealed that lyophilized SLN were still as effective. These findings imply that the current approach provides an intriguing means of delivering lipophilic anti an cermedications for tumor targeting (SubediRK.*et.al*,2009).

Polymeric Nanoparticles:

Both nano spheres and nano capsules are referred to as nanoparticles together. The matrix core of a nanocapsule is surrounded by a polymeric membrane, while the nanospheres themselves are viewed as a matrix system in which the drug is uniformly dispersed. Compared to conventional drug delivery techniques using polymeric biodegradable matrix systems, polymeric biodegradable nanoparticles are more efficient and efficacious. There are a number of ways to make nanoparticles, but they can be roughly classified into two categories: formulations that require a polymerization process, and those that can be generated directly from a macromolecule or premade polymer. Biodegradable polymers such as chitosan, gelatin, sodium alginate, polycyanoacrylate, poly (D, Llactide), and poly (lactide-co-glycolide) (PLGA) are used in polymeric nanoparticles drug delivery. The encapsulation, absorption, biodistribution pattern, elimination, and release of drugs are all affected by a wide range of factors. These include the nanoparticles' polymer composition, hydrophobicity, surface charge, and biodegradation profile, to name a few. Nanoparticles enhance the stability of pharmaceuticals and biologicals in addition to their capacity to regulate release. These particles may be selective in their drug delivery due to modifications to their surface charge or other characteristics (such as their location in the nasal cavity and the brain). Targeted antibiotic administration, vaccine distribution, contraceptive delivery, and cancer treatment are all excellent uses for polymeric nanoparticles. Additionally, polymeric nanoparticles are simple to integrate into various drug delivery methods, including tissue engineering and the administration of medications to animals other than humans. A variety of polymeric nanoparticles with distinct physicochemical properties are investigated in terms of their effects on lung surfactant adsorption and dynamic surface tension reduction. However,

poly(styrene) and poly(D, L-lac tide-co-glycolide) nanoparticles imply a dose-dependent effect on the biophysics of pulmonary surfactant, while positively charged poly(butyl methacrylate-co-(2-dimethylaminoethyl) methacrylate-co-methyl methacrylate) nanoparticles had no effect. This phenomenon is attributable to variations in surface hydrophobicity and zeta potential, which in turn result in a different pattern of positively charged surfactant proteins adhering to the nanoparticles. This study demonstrates the potential utility of polymeric nanoparticles as a drug delivery strategy for the inhalational treatment of respiratory diseases, as they do not dramatically alter the biophysical features of pulmonary surfactant. (MoritzB.*et.al*,2011) Biocompatible polymeric nanoparticles based on amino acids were recently produced, and another study indicated that they have the potential to be used as injectable drug delivery systems, which could increase the therapeutic index of therapeutically problematic, weakly water-soluble drugs.(DuttaP.*et.al*,2011). Grafting or adsorbing polyethylene glycol (PEG) to the surface of nanoparticles, or adding PEG and PEG-containing copolymers to the surface of nanoparticles, significantly extends the half-life of the particles in the blood circulation.This method generates a hydrophilic protective barrier around the nanoparticles, which may oppose the absorption of opsonin proteins via steric repulsion forces, therefore blocking and delaying the early phase in the opsonization process.

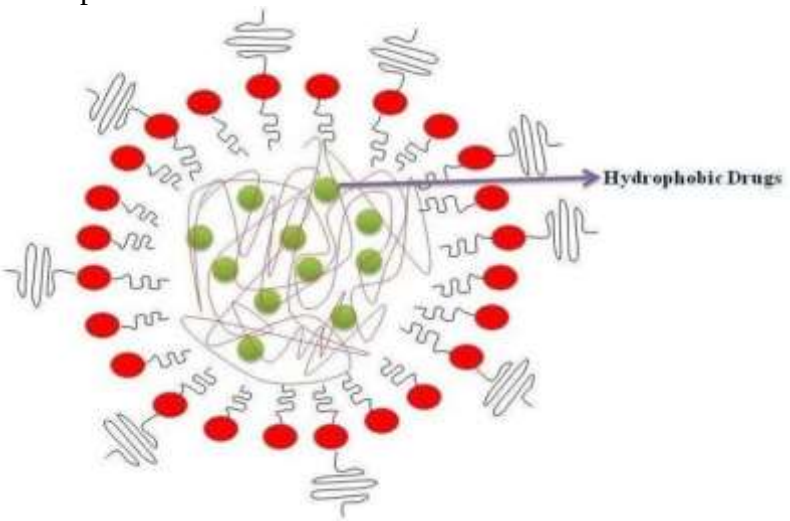

Fig-3: Polymeric Nanoparticles

Peglyated Nanostructures:

Given that a variety of common organic chemistry processes may readily change the terminal hydroxyl groups in polyethyleneglycol(PEG) or polyethylene oxide into reactive functional groups, it is a water-soluble substance that is often used in medicinal applications PEGlyation is a technique for joining PEG to any drug, peptide, polymer, or other substance, and it has biological applications that have been demonstrated PEGlyation can enhance the pharmacokinetics of medicines that contain proteins or peptides that could be broken down by proteolytic enzymes or have a brief half-life in circulation. PEGlylation protects proteins and peptide medicines from proteolytic enzymes, extending their half-lives, improving tissue acceptance, and enhancing medication delivery to target tissues. Doxorubicin PEGlyated Nanostructure Liposomes, for instance, have improved efficacy in the treatment of breast cancer. The next generation of liposomes for delivery systems will aim to maximize the delivery of anti-tumor medications to lung cancers involve molecular targeting, as is the case with immunoliposomes that have PEG-NLCs, which are nanostructured lipid carriers.

By melting, homogenizing, and loading 10-hydroxycamptothecin (HCPT)NLCs without PEG modification, PEG-100 NLCs modified with PEG-100 stearate (molecular weight 5000 Da), and PEG-40 NLCs modified with PEG-40 stearate (molecular weight 2000 Da) were produced. Furthermore, its physiological characteristics and biodistribution were investigated, cellular absorption, and in-vivo anti-tumor effects. After being incubated with plasma, the active lactone form of HCPT was protected by PEG-NLC encapsulation as opposed to HCPT solution.

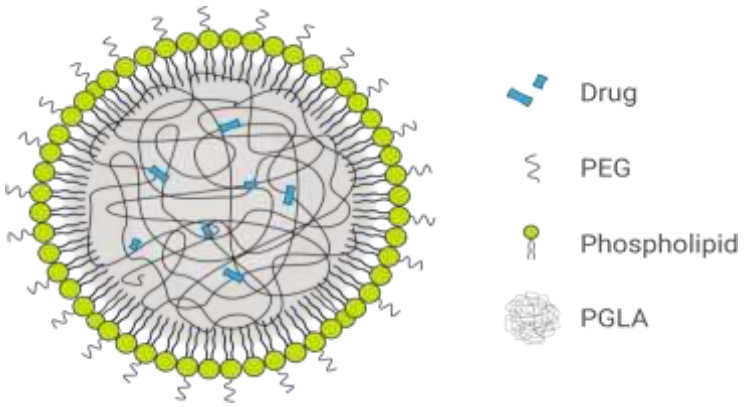

Fig-4:Peglyated Nanostructure

In comparison to unmodified NLCs, PEG-NLCs, particularly PEG-40 NLCs, showed longer circulation times and less reticuloendothelial system (RES) absorption.Following intravenous injection, PEG-NLCs accumulated in the lungs of mice. Improved cellular absorption by PEG-NLCs was demonstrated by human lung cancer epithelium A549 cells.According to in-vivo tests, PEG-NLCs loaded with HCPT are more effective againstA549lung cancer than NLCs plus HCPT solution. These findings point to PEG-NLCs as a potential HCPT delivery method for the treatment of lung cancer.PEG-40 NLCs modified with PEG-40 stearate (molecular weight 2000 Da), PEG-100 NLCs modified with PEG-100 stearate (molecular weight 5000 Da), and NLCs without PEG modification were produced by melting, homogenizing, and adding 10-hydroxycamptothecin (HCPT). Additionally, it was examined for its physiological traits, biodistribution, cellular absorption, and in-vivo anti-tumor effects. Unlike HCPT solution, PEG-NLC encapsulation protected the active lactone form of HCPT after it was treated with plasma. PEG-NLCs, especially PEG-40 NLCs, demonstrated reduced reticuloendothelial system (RES) absorption and longer circulation durations after modification compared to unmodified NLCs. Following intravenous injection, PEG-NLCs accumulated in the lungs of mice. Human lung cancer epithelium A549 cells demonstrated improved cellular absorption by PEG-NLCs. According to in-vivo tests, PEG-NLCs loaded with HCPT are more effective against A549lung cancer than NLCs plus HCPT solution. These results suggest PEG-NLCs as a possible HCPT delivery mechanism for lung cancer therapy. (ZhangX.*et.al*,2008).

Nanocrystals:

Nanonization is the process of creating nanocrystals and nanosuspensions. Numerous techniques, such as high pressure homogenization, wet milling, nano crystallization from supersaturated solution states, and spray drying, can be used to create this type of nanomaterial. Oral bioavailability of drugs that are weakly soluble in water can be enhanced by the increased surface area and drug solubility of nanocrystals, which allows for their administration via injection or infusion as an intravenous aqueous solution. The mononuclear phagocyticsys temingests nano crystals to enable localized administration. These nano particles target antimycobacterial, fungal, or leishmanicidal active macrophages when infections persist intracellularly, actingswiftly according to the literature.(KayserO .*et.al*,2005).The administration of the nanocrystals may take place orally, topically, mucosally, ocularly, pulmonaryly, or intravenously. The promise of nanocrystal technology for poorly soluble,non-pharmaceutical applications, such as in cosmetics or nutraceuticals, is also noted. When nanocrystal is compared to other commercially available formulations of paclitaxel, it is shown to be more effective in reducing toxicity and improving therapeutic effectiveness. Additionally, it has been claimed that CoQ10 nanocrystals and lipid nanoparticles may dissolve more quickly when combined with nanocrystals.

Dendrimers:

Dendrimers were first identified in the early 1980s, and the commercialization of their nano formulations is only getting started. Dendrimers contain internal branches and a central core .in three dimensions, and symmetrical distribution of terminal groupings. Mono-dispersed dendrimers can

supply a well-defined, regulated nanoscale sphere with a lot of attachment points and a hydrophobic core for entangling and releasing hydrophobic materials. The ability to connect therapy and detection with a dendrimer molecule is very promising.

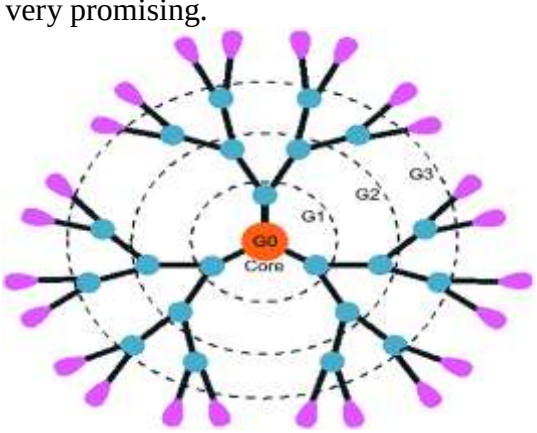

Fig-5: Dendrimers

Because of their branching nature, they offer a wide surface area that may be used to attach therapeutic active ingredients or other bioactive compounds, including peptides. One dendrimer may have molecules that recognize tumor cells, molecules that recognize the cell death signal, and therapeutic medications which are capable of killing those cancer cells. The biocompatible biotin-dendrimer combo may be a potential nano-platform for cancer therapy and cancer diagnostics.. (Yang W.*et.al*, 2009).

Nanotubes:

In biotechnological applications, carbon-based materials may be useful due to the wide range of qualities and forms they provide. These include carbon nanotubes, cyclic peptide nanotubes, self-assembled lipid microtubes, fullerene and template produced nanotubes, etc. The potential applications of chemistry and biology for the template approach are given careful attention. Mass manufacturing and high production costs, however, need to be addressed.

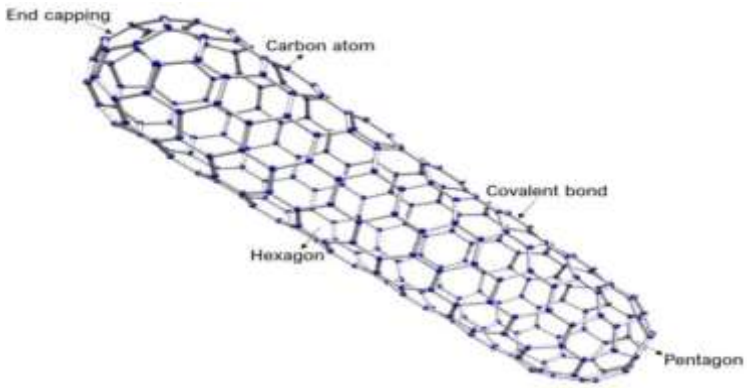

Fig-6: Nanotubes

Depending on the membrane and synthetic process employed, monodisperse nano wires or hollow nanotubes (cylinder-shaped nanostructures) can be generated. Materials as diverse as metals, polymers, semiconductors, and carbon can all be produced into nanowires and nanotubes using this approach. A functional excipient for pharmaceutical dosage forms, carbon nanotubes have lately surfaced as a potential possibility for usage in cancer treatment, bioengineering, gene therapy, and beyond.(Firme*et.al*,2010).

Nanofibers:

Electrospinning is a technique that has been used since the 1930s, but has only recently come to the forefront of the industry. Probably, people are more curious because of revitalized efforts to study

nanotechnology. A drug of interest and a polymer are generally dissolved in a solvent to start the electrospinning process. A significant voltage is applied to the needle once the solution has been transferred to a syringe. A very little quantity of the polymer solution is taken out of the syringe at the aylorcone. A charged fluid jet is launched when the voltage is raised, and it travels to the grounded target through chaotic trajectory of stretching and bending. A steady jet is produced when the charge is raised over a threshold voltage and the fluid's surface tension and the repellent nature of the charge distribution on its surface achieve equilibrium. The resultant fiber may be pulled endlessly and ranges in diameter from a few micrometers to a few nano meters.The outcome is a three-dimensional nanofiber mat with a sizable surface area relative to its volume. When compared with micro fibers, surface area Of the electro spun nano fiber can be as much as a thousand times larger .The biomedical and pharmaceutical sectors have shown a considerable lot of interest in this physical property, particularly for the delivery of therapeutic chemicals that are poorly soluble. If electrospinning were used in the last phases of the chemical production of the therapeutic component, it may be even more helpful since it would make the change from one to the other easier. Prior to the final result becoming a powder, purification is often the last step in the chemical manufacture of a drug. The powder is then transported to pharmaceutical facilities where it is often ground into granules and milled to a certain particle size before being converted into tablets. drug and polymer solution may then be electro spun without any delays into a completed pharmaceutical product once the chemical synthesis is accomplished. An efficient way to transport diclofenac sodium to the colon was electro spun Eudragit L 100-55 nanofibers. (ShenX*et.al*, 2011). Poly(-caprolactone) multi-walled carbon nanotubes (MWCNTs) composite nano fibers containing green tea poly phenols (GTP) inhibited tumor cell growth significantly. There is great potential for GTP, a multifunctional medication, to be used in the treatment of cancer when encased in polymer composite nanofibers.

Nano micelles:

The self-assemblies of block copolymers known as nano micelles hold great promise as a type of nanomedicine for the purposes of drug targeting and imaging-based diagnostics. Specific factors , like changes in temperature, pH, redox potential, ultrasound, or magnetic field, can trigger there lease of medicines from stimulus-responsive site-specific targeted nano micelles Nano micelles loaded with anticancer drugs are utilized to overcome problems caused by cancer cells (such as multi drug resistance and toxicity).

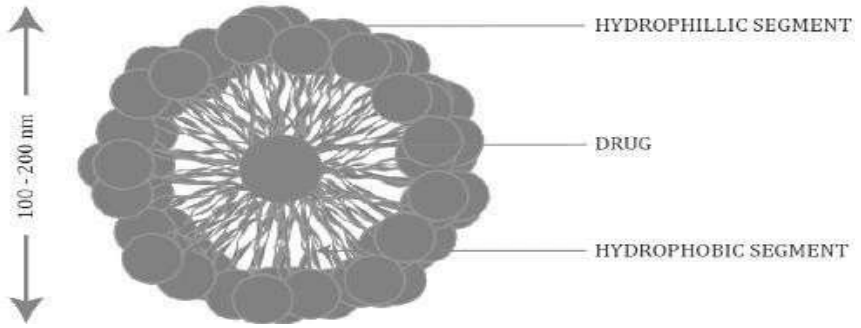

Fig-7: Nanomicelles

In addition to their potential use as a nanomedicine for cancer, bio-compatible, biodegradable, and sterically stabilized phosphor lipid nano micelles can improve cryopreservation capacity for a keratinocytes by boosting cell viability and plasma membrane integrity (CesurH.et.al,2009).

Nano shells:

Gold-coated little beads known as "nano shells" are a relatively new development in pharmaceutical research that makes use of nano technology. The nano shells' layer thickness can be adjusted to tailor the beads' absorption to a particular color of light. Nano shells that are able to absorb near-infrared

light, which may easily permeate human tissue to depths of several centimeters, are the most useful. Light is absorbed by nano shells and the resulting heat is extremely damaging to cells. Using antibodies in conjunction with nano shells, cancer cells can be identified. Researchers Li metal. Noticed that the nano shells 'ability to absorb light and generate heat was effective in killing tumor cells without harming healthy cells nearby .radiolabeled gold nano shells were examined for their bio distribution and in vivo PET imaging in rats bearing xenografttumors; These findings may one day be used to direct photothermal therapy for cancer treatment .Another study detailed how a temperature-sensitive hydrogel containing SiO2 – A nano shells and layer-by-layer self-assembled nano shells may be used for controlled drug administration.(BikramM*et.al*,2007).

Magnetic nano pharmaceuticals:

A magnetic nano pharmaceutical is created when a medicinal or diagnostic component is attached to magnetic nanoparticles (MNPs), such as magnetite or oxidized iron. In the medical industry, it is desired to use magnetic carriers that are water-based, biocompatible, nontoxic, and immune-suppressive. Iron oxide is the most widely employed carrier in the wide range of magnetic carriers because of its many advantageous properties, including its super paramagnetic effects, biocompatibility, and utility as a contrast agent in MRI.

This research shows how multifunctional magnetic nanoparticles can be used for precise medication administration. It explains how a simple external magnetic field may be utilized to guide a medication to a certain area within the body without requiring any modification to the nanoparticles. However, functionalized nanoparticles equipped with external magnets may prove to be a more effective method of medication delivery.(KumarA.*et.al*,2010).

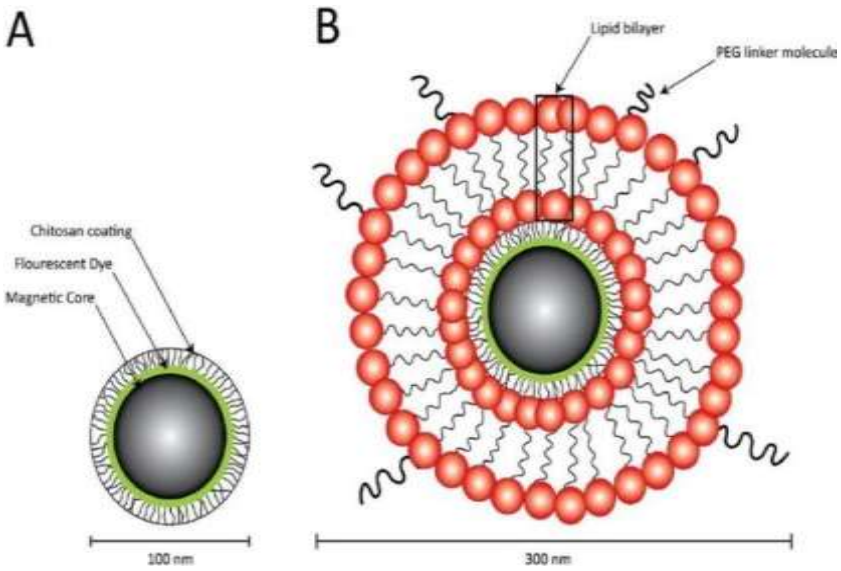

Fig-8: Magnetic nanopharmaceutic

Metallic nano particles:

Silver, gold, copper, and inorganic carriers like silica and alumina may all be used to create new carriers for medicinal formulations. Gold nanoparticles are among the most promising for drug delivery because of their exceptional unique optical and photoelectric properties, inertness, nontoxicity, increased stability, ease of synthesis, and potential for bioconjugation and biomodification with a wide range of functional groups, including thiols, disulfides, and amines. These find use in optical probes, medication delivery systems with pinpoint accuracy, and computer-controlled material creation. Silver nanoparticles' antibacterial activity is compared to that of amoxicillin, and the two substances' potential synergistic effects on wound healing are investigated.

Nano sized powder:
Another term for this nano powder is solid solution. Gadolinia-doped ceria nano powders were produced by pyrolyzing a precursor metal complex that included citric acid as the complexant agent. Temperatures used for gel breakdown should be changed to enable trapped gaseous species to develop by breaking up the resultant porous structure. This low-cost and straight forward synthesis method can be used to create dense sintered specimens . (RochaRA*et.al*,2003).

Nano-emulsion:
Nano emulsions can be thought of as a system of multiphase colloidal dispersions. Although their content resembles nano emulsions and their shape can be described as nanoscale, some lyotropic liquid crystalline phases are actually extremely distinct in nature and are also known as micelles, mesophases, and microemulsions. The lyotropic fluid Liquids and surfactants create crystals during thermodynamic self-assembly, which are equilibrium structures like lamellar sheets, hexagonally packed columns, and micellar phases. However, nano emulsions don't develop on their own; instead, you need to use an external shear to separate larger droplets into smaller ones in order for them to form. Surface tension must be overcome and the droplets must be ruptured into the nanoscale realm using very high shear pressures, which are beyond the capability of conventional mixing devices. As opposed to microemulsion phases, the method for creating and working with nano emulsions is not as well known. In the realm of nanomaterials, nano emulsions have the potential to be very useful dispersions of deformable nanoscale droplets with a variety of optical characteristics. Nano emulsions are expected to become more significant commercially since they can be produced on a regular basis with a lot less surface area than nanostructured lyotropic microemulsion phases. A novel ultrasonic-mediated chemotherapeutic technique involves intravenous injections of drug-loaded nano emulsions that spontaneously degenerate into microbubbles in the presence of therapeutic ultrasound. With the use of tumor-directed therapeutic ultrasonography, paclitaxel-loaded nano emulsions that transform into microbubbles locally in tumor tissue have shown encouraging outcomes in the treatment of ovarian, breast, and pancreatic malignant tumors in animal models.
The buildup of nano emulsion in tumors was verified by ultrasound imaging. Ovarian, breast, and orthotopic pancreatic cancers responded dramatically to systemic injections of drug-loaded nano emulsions and therapeutic ultra sonography. Ultra sound-induced drug release from nanodroplets collected in tumors.

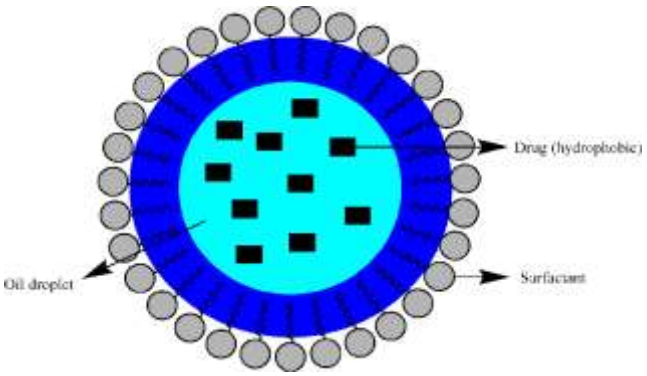

Fig - 9: Nano emulsion

The process of drug release during this transformation of drug-loaded nanodroplets into microbubbles using therapeutic ultrasound is studied. A unique cilexetil-loaded nano emulsion was created to improve candesartan's oral absorption. The intestinal absorption of the candesartan cilexetil loaded nano emulsion was significantly improved as compared to free drug. Candesartan cilexetil-loaded nano emulsion was taken up by enterocytes via the clathrin-mediated endocytosis pathway and subsequently transported into the systemic circulation through the portal vein and lymphatic system. Candesartan oral absorption was increased via nano emulsion, and the results demonstrated the technology's strong therapeutic potential (GoaF, *et.al.*, 2011).

Nanosuspension:
Dispersing pure drug particles in an aqueous solution where their diameter is less than 1nmand being stabilized by surfactants is called nanosuspension.

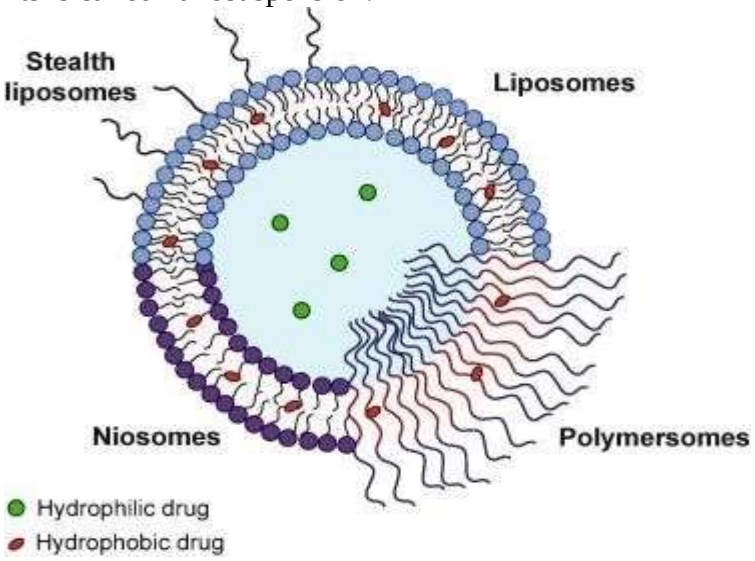

Fig-10: Nanosuspensions.

A drug's solubility in aqueous and lipid environments can be improved with the use of an Nano suspension. This expedites the process of reaching the maximal plasma level and speed of the flooding of the active chemical. The advantages of nanosuspensions over more conventional suspensions include improved biological performance, medicine saturation solubility, increased dissolve rate, longer physical stability, and scalable manufacture. .Researchers (Dandagi et al.) compared the efficacy of a novel ocular nanosuspension for the sustained release of acyclovir to that of conventional colloidal carriers. To maximize ocular absorption and dispersion, an acyclovir-loaded Eudrag It RS100 ophthalmic nanosuspension was prepared by evaporating the solvent in an a quassia-emulsion. According to the results, nano suspension is superior to colloidalCarriers systems in terms of overcoming draw backs such in stability in cul-de-sac and short half-life through improved drug encapsulation and controlled release. Bioavailability was also improved, showing that the medication was released slowly overtime from the ocular nanosuspension. (DandagiP*et.al*,2009).

APPLICATION:
- Liposomes— Transport of a Wide Range of Biomolecules (Enzymes, Hormones, Antisense, Oligonucleotides, and More (MoghadamF*et.al*,2007).
- Micelles transporting a wide variety of water-in soluble medicines ,such as paclitaxel and SN-38.
- Dendrimers—carrying a wide range of medications, from piroxicam and methotrexate to others.
- Carbon nano tubes-Bone cell growth can be supported by using carbon nano tubes as scaffolds. Chemo photothermal therapy
- Vaccine distribution Cancer therapy Brain glioma therapy.
- Mesoporous silica nanoparticles for the delivery of drugs and genes.
- Biosensing Target specific Delivery Diagnostic agent Antidote agent.
- Magnetic NPs-Surface functionalization Use as a contrastagent.

EVALUTION:
Yield of nano particles:
Weighing the entire quantity of created nanoparticles and comparing it to the original amounts of copolymer and medication utilized allowed us to determine the nanoparticle yield.
Amount of nanoparticles

$$\%yield = \frac{\text{Amount of nanoparticles}}{Amount of drug + polymer} \times 100$$

Particles size and zeta potential:
Malvern zeta sizer used to assess the value of the particle size and zetapotential of manufactured nano particles.

Drug Content/Surface entrapment/Drug entrapment:
The medication concentration in the supernatant was measured by UV spectrometry after centrifugation. .Then, using a standard calibration curve, the drug concentration in the supernatant was determined. Subtracting the quantity of drug used to make the nanoparticles ([W]) from the total amount used ([W-w]) yields the percentage of drug entrapment .

Surface Morphology:
In order to analyze the surface morphology of the nanoparticles employed in the preparation, scanning electron microscopy [SEM] was used.

Poly Dispersity Index:
Malvern Zetasizer was used to measure the poly dispersity index of the nano particle preparations.

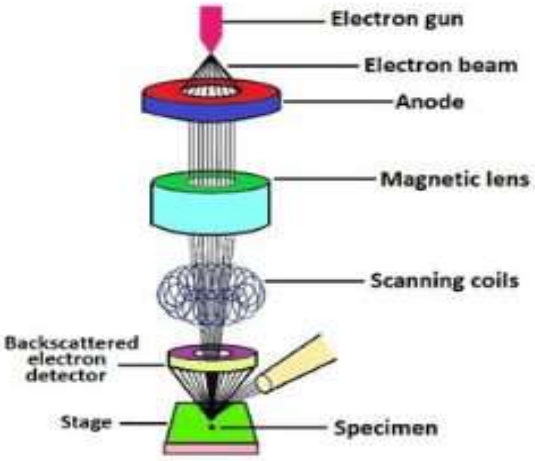

Fig: Scanning electron microscope

***In-vitro* Release Study:**
Researchers used a USP type2 dissolving equipment spinning at 50rpm to study drug release in vitro. The sample was kept at 37 degrees Celsius while submerged in 900 milliliters of a phosphate buffer solution. To maintain the flask's capacity, 5 ml of the medium were periodically taken out and replaced with new dissolving liquid. UV spectrophotometer was used to examine the samples obtained by drawing them.

MARKET INVESTIGATION:
It's fair to say that the nanopharmaceutical business is global in scope. As a result, judging the size of the market in countries outside of the United States and Europe is difficult be cause official numbers are rarely made available. However, the United States is both the leading manufacturer and consumer of nanopharmaceutical.

GLOBAL MARKET SIZE:
The value of nanopharmaceuticals above conventional drugs is often rather great. It is difficult to determine reliable data on the worldwide nanomedicine market size due to the fact that different nations have varied definitions of what comprises nanotechnology and nanopharmaceuticals,as well

as different assessments from scientific and regulatory bodies. One analysis estimated that the nanomedicine market would be worth around $1trillion in 2015.Due to the accelerating growth rate of some nanopharmaceuticals and the rising demand for more effective medications for the treatment of cancer, immune and nervous system diseases, and the mitigation of infectious diseases like aids, the global market for NPs in the life sciences as a whole is predicted to grow at a compound annual growth rate (CAGR) of 22%.In 2020, market for nanopharmaceuticals based on proteins is projected to be worth $14.7 billion, while that for nanopharmaceuticals based on nucleic acids will be worth $7.3 billion, and that for small molecules will be worth $3.3 billion. According to Grand View Research, Inc. (BowmanDet.al, 2017), "the global nanomedicine. market is anticipated to reach USD 350.8billionby2025." The market may expand much further if safety concerns and societal implications were carefully considered.In view of the high costs of nanomaterials and nanomaterial intermediates, cost-effectiveness evaluations as well as assessments of the required buying power of nations with centralized healthcare systems and nations with private market healthcare systems should be conducted.

FUTURISTIC SCENARIO:

Conventional medicines on front many obstacles, such as poor bioavailability and intrinsic toxicity,as a result of the rapid develop mentinuses of nanotechnology in various aspects of human live,particularly in biomedicine.They have significantly decreased the therapeutic effectiveness of several otherwise beneficial drugs. The market for nanopharmaceuticals has grown quickly, from $406 million in 2004 to $3 billion in 2009 and $16.6 billion in 2015 (Wissingetal.2004). Nanopharmaceuticals are now a must have in order to keep the pharmaceutical sector expanding. Vision gain projects that the global market for nanopharmaceuticals would be worth $130 billion in 2017. Improved standings in the pharmaceutical and other healthcare sectors are the outcome of continuous vigorous research and rising demand for nanopharmaceuticals (Wissinget al., 2004; Qadiret al.,2016;Ahmadetal.,2015a).Nanopharmaceuticals will have a big influence on medical practice and healthcare in the future since they can, in many cases, shorten the time market for active prescriptions, lengthen the economic life of patented products, and create new in come streams.

CONCLUSION:

Nanoparticulate systems offer significant potentials, being able to transform poorly soluble, poorly absorbed, and labile biologically active material into viable deliverable medications, according to a review of the literature and research on nanopharmaceuticals. However, further in-depth knowledge of the many biological interaction processes, as well as particle engineering and characterization, is still required to enhance this nanopharmaceuticals delivery system. The notion of nanoparticle technology has to be developed further in order to become a viable, workable application as the next generation of medication delivery systems. Nanopharmaceuticals' potential to, in many circumstances, reduce the time-to-market for active agents, increase the economic life of patented treatments, and generate new income streams will have a significant impact on medical practice and healthcare in the future. Creating nanoparticles for biomedical and biotechnological purposes is a difficulty for nanotechnology, as is ensuring that the medicine is delivered at the proper time and location. Legal, environmental, safety, ethical, and regulatory issues, as well as developing thickets of conflicting patent claims, are some imposing obstacles. Although there aren't many FDA-approved nanopharmaceuticals on the market, these formulations have a significant influence on treatment management and provide more potential for drug delivery and design.

REFERENCE

1. Bagul R, Mahajan V, Dhake A. New approaches in nanoparticulate drug delivery system: A review. *IntJ Curr Pharm Res*2012;4:29-38.
2. Basu B, Garala K, Bhalodi R, Joshi B, Mehta K (2010) Solid lipid nanoparticles: A promising tool for drug delivery system. *J Pharm Res* 3(1): 84-92.
3. Bawa R (2009) Nanopharmaceuticals for Drug delivery-A review. *Touch Briefings* 6: 122- 127.

4. Bikram M, Gobin AM, Whitmire RE, West JL (2007) Temperature-sensitive hydrogels with SiO2–Au nanoshells for controlled drug delivery. *J ControlledRelease* 123(3): 219–227.
5. Blasi P, Giovagnoli S, Schoubben A, Ricci M, Rossi C (2007) Solid lipid nanoparticles for targeted brain drug delivery. Adv *Drug Deliv Rev59* (6): 454-477.
6. Bowman D, Marino AD, Sylvester DJ. The patent landscape of nanomedicines. *Med. Res. Arch.* 2017;5. 20. Rocha RA, Muccilo ENS (2003).
7. Cesur H, Rubinstein I, Pai A, Onyuksel H (2009) Selfassociatedindisulam in phospholipid-based nanomicelles: A potential nanomedicine for cancer. Nanomedicine 5(2): 178-183.
8. Dandagi P, Keru S, Mastiholimath V, Gadad A, Kulkarni A (2009) Polymeric ocular nanosuspension for controlled release of acyclovir: in vitro release and ocular distribution. *Iran J Pharm Res* 8: 79-86
9. Donald EO, Peppas NA (2006) Opsonization, biodistribution, and pharmacokinetics of polymeric nanoparticles. *Int J Pharm* 307(1): 93-102
10. Dutta P, Dey J (2011) Drug solubilization by amino acid based polymeric nanoparticles: Characterization and biocompatibility studies. *Int J Pharm* 421: 353-363.
11. Firme III CP, Bandaru PR (2010) Toxicity issues in the application of carbon nanotubes to biological systems. *Nanomedicine* 6(2): 245-256.
12. Gao F, Zhang Z, Bu H, Huang Y, Gao Z (2011) Nanoemulsion improves the oral absorption of candesarten.
13. Harris JM, Chess RB (2003) Effect of PEGylation on pharmaceuticals. *Nat RevDrug Discov* 2:214–221
14. Hollis CP, Weiss HL, Leggas M, Evers BM, Gemeinhart RA, Li T. Biodistribution and bioimaging studies of hybrid paclitaxel nanocrystals: lessons learned of the EPR effect and ima.
15. Jain, K.K. The role of nanobiotechnology in drug discovery. *Drug DiscoveryToday* (2005)10(21).1435-42.
16. Kayser O, Lemke A, Hernandez-Trejo (2005) The impact of nanobiotechnology on the development of new drug delivery systems. *Curr Pharm Biotechnol* 6(1): 3 -53
17. Kumar A, Jena PK, Behera S, Lockey RF, Mohapatra S, et al. (2010) Multifunctional magnetic nanoparticles for targeted delivery. Nanomedicine 6(1): 64-69Characterization and biocompatibility studies. *Int J Pharm* 421: 353-363.
18. Liu M, Kono K, Frechet JMJ (1999) Water soluble dendrimer poly (ethylene glycol) star like conjugates as potential.
19. Liu Z, Jiao Y, Wang Y, Zhou C, Zhang Z. Polysaccharides-based nanopar-ticles as drug delivery systems. *Adv Drug Deliv Rev*. 2008;60:1650–62
20. Md. Zubayer Hossain Saad et al.: Nanopharmaceuticals: A New Perspective of Drug Delivery System, Asian Journal of Biomedical and Pharmaceutical Sciences 2(14) 2012, 11-20
21. Moritz B, Ruppert C, Schmeh T, Guenther A, Betz T et al. (2011) Biophysical investigation of pulmonary surfactant surface properties upon contact with polymeric nanoparticles in vitro. *Nanomedicine* 7(3): 341-350.
22. Otsuka H, Nagasaki Y, Kataoka K (2003) PEGylated nanoparticles for biological and pharmaceutical applications.
23. Panda BP, Varaprasad R, Priyanka K, Swain RP. Current trends in design and development of nanopharmaceutical dosage forms. *BioequivBioavailab Int J*2017;1:104.
24. Rasoulianboroujeni M, Kupgan G, Moghadam F, et al. Development of a DNA-liposome complex for gene delivery applications. *Mater. Sci. Eng. C.* 2017;75:191–197
25. Rocha RA, Muccilo ENS (2003) Physical and chemical properties of nanosized powders of gadolinia-doped ceria prepared by the cation complexation technique. *Mater Res Bull* 38: 1979-1986
26. Roman JA, Niedzielko TL, Haddon RC, Parpura V, Floyd CL. Single-walled carbon nanotubes chemically functionalized with polyethylene glycol promote tissue repair in a rat model of spinal cord injury. *J. Neurotrauma.* 2011;28(11):2349–2362.
27. Sagar. Or *et.al*., Nanoparticles: Emerging carriers for drug delivery, *Saudi Pharmaceutical*

Journal Volume 19, Issue 3, July 2011.
28. Said Soflaei, In Vitro Antiparasitic and Apoptotic Effects of Antimony Sulfide Nanoparticles on Leishmania infantum, Journal of *Parasitology Research Volume* 2012 (2012), Article ID 756568 (1-7)
29. Sershen SR, Westcott SL, West JL, Halas NJ (2001) An optomechanical nanoshell-polymer composite. *Appl Phys B Lasers Opt* 73:37
30. Shen X, Yu D, Zhu L, Branford-White C, White K, et al. (2011) Electrospun diclofenac sodium loaded Eudragit® L 100-55 nanofibers for colon-targeted drug delivery. *Int J Pharm* 408(1-2): 200-207.
31. Subedi RK, Kang KW, Choi H (2009) Preparation and characterization of solid lipid nanoparticles loaded with doxorubicin. *Eur J Pharm Sci* 37(3-4): 508–513.
32. Vladimir PT (2006) Nanoparticulate as Drug Delivery. Imperial College Press 499-506.
33. Wissing SA, Kayser O, Muller RH (2004) Solid lipid nanoparticles for parenteral drug delivery. *Adv Drug Deliv* Rev 56:1257–1272
34. Wu Z, Wu Z-K, Tang H, Tang L-J, Jiang J-H. Activity-based DNA-gold nanoparticle probe as colorimetric biosensor for DNA methyltransferase/glycosylase assay. *Anal. Chem.* 2013;85(9):4376–4383ge-guided drug delivery. *J. Control. Release.* 2013;172(1):12–21
35. Yang J, Lee H, Hyung W, Park SB, Haam S (2006) Magnetic PECA nanoparticles as drug carriers for targeted delivery: synthesis and release characteristics. *J Microencapsul* 23:203–212
36. Yang W, Cheng Y, Xu T, Wang WL, Wen LP (2009) Targeting cancer cells with biotin dendrimer conjugates. *Eur J Med Chem* 44(2): 862-868.
37. Yoo HS, Kim TG, Park TG. Surface-functionalized electrospun nanofibers for tissue engineering and drug delivery. *Adv Drug Deliv Rev*2009;61:1033-42.
38. Zanello LP, Zhao B, Hu H, Haddon RC. Bone cell proliferation on carbon nanotubes. *Nano Lett.* 2006;6(3):562–567.
39. Zhang X, Gan Y, Gan L, Nie S, Pan W (2008) PEGlyated nanostructured lipid carriers loaded with 10-hydroxycamptothecin: An efficient carrier with enhanced anti-tumour effects against lung cancer. *J Pharm Pharmacol* 60(8): 1077-1087.