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Recent Developments In Pharmaceutical Nanotechnology

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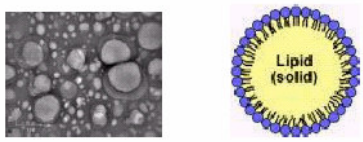
Drug particles in the nanometer size range have unique characteristics that can lead to enhanced performance in a variety of dosage forms. Formulated correctly, particles in this size range are resistant to settling and can have higher saturation solubility, rapid dissolution, and enhanced adhesion to biological surfaces, thereby providing a rapid onset of therapeutic action and improved bioavailability. Scientists use nanotechnology to approach classical and novel drug delivery applications. We provide services for producing, formulating, and characterizing Nanoparticles for a wide array of applications including, but not limited to, oral, pulmonary and parenteral delivery.

Controlled and targeted delivery is one of the most enviable requirements from a carrier, which involves multi-disciplinary site specific or targeted approach. Nanoparticulate drug delivery system may offer plenty of advantages over conventional dosage forms, which includes improved efficacy, reduced toxicity, enhanced biodistribution and improved patient compliance. Pharmaceutical nanoparticles are subnanosize structure, which contain drug or bioactive substances with in them and are constituted of several tens or hundreds of atoms or molecules with a variety of sizes (size from 5 nm to 300 nm) and morphologies (amorphous, crystalline, spherical, needles, etc). It is necessary to use additives (surfactants, dispersants, and metals) to obtain uniform and stable particles. With further processing steps, nanostructured powders and dispersions can be used to fabricate coatings, and components or devices. These different types of nanoparticles are prepared according to prerequisite and straightforwardly reaches to the desired site to deliver bioactive therapeutic and diagnostic agents.

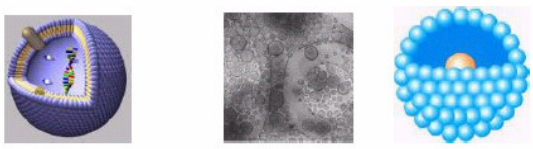
Although opportunities to develop nanotechnology-based efficient drug delivery systems extend into all therapeutic classes of pharmaceuticals, many therapeutic agents have not been successful because of their limited ability to reach to the target tissue. In addition, the faster growth opportunities are expected in developing delivery systems for anti-cancer agents, hormones and vaccines because of safety and

efficacy shortcomings in their conventional administration modalities. For example, in cancer chemotherapy, cytostatic drugs damage both malignant and normal cells alike. Thus, a drug delivery strategy that selectively targets the malignant tumor is very much needed. Additional problems include drug instability in the biological milieu and premature drug loss through rapid clearance and metabolism. Similarly, high protein binding of certain drugs such as protease inhibitors limits their diffusion to the brain and other organs. However, nanotechnology for drug delivery applications may not be suitable for all drugs, especially those drugs that are less potent because the higher dose of the drug would make the drug delivery system much larger, which would be difficult to administer.

Polymeric Nanoparticles



Solid Lipid Nanoparticles



Liposomes

Types of naoparticles used as carrier for Therapeutic and diagnostic agents

S. No.	Type of Nanoparticles	Material Used	Applications
1.	Polymeric Nanoparticles	Biodegradable Polymers	Controlled and targeted drug delivery
2.	Solid Lipid Nanoparticles	Melted lipid dispersed in an aqueous surfactant	Least toxic and more stable colloidal carrier systems as alternative materials to polymers
3.	Nanosuspensions & Nanocrystals	The drug powder is dispersed in a surfactant solution.	Stable system for controlled delivery of poorly soluble drugs.
4.	Polymeric micelles	Amphiphilic block copolymers	Systemic and controlled delivery of water-insoluble drugs
5.	Ceramic nanoparticles	Silica, alumina, titania	Drug targeting, Bio-molecules delivery
6.	Liposomes	Phospholipd Vesicles	Controlled and targeted drug delivery
7.	Dendrimers		Carriers for site specific drug delivery
8.	Magnetic nanoparticles	An inorganic core of iron oxide (magnetite Fe_2O_3, maghemite or other insoluble ferrites) coated with polymer such as dextran.	Drug targeting, Diagnostic tool in biology and medicine.
9.	Nanoshells coated with gold	Dielectric (typically gold sulfide or silica) core and a metal (gold) shell.	Tumor Targeting
10.	Nanowires or Carbon Nanotubes	Metals, semiconductors or carbon	Gene and DNA delivery
11.	Nanopores	Aerogel, which is produced by sol-gel chemistry	Controlled release drug carriers
12.	Quantum Dots	CdSe–CdS core-shell	Targeting, Imaging Agent
13.	Ferrofluids	Iron oxide magnetic nanoparticles surrounded by a polymeric layer	For capturing cells and other biological targets from blood or other fluid and tissue samples.

Final Fact

Polymeric systems have great potential in drug delivery applications. Their characterization is quite difficult, and expensive. Long processes of synthesis and purification are major drawbacks of Nanoparticles. Still none of the discussed systems is applied in practice to patients – FDA approval requires extensive toxicity investigations.