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Review Article

Nanomedicine in Drug Delivery Applications

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Abstract

Medical application of nanotechnology is called nanomedicine. It is the incorporation of science and technology that is employed for diagnosis, treatment and prevention of diseases and achieve best health care.

Drug delivery to certain target cells is now available by using nanoparticles via nanotechnology. Biomedical nanomaterials are used *in vivo* and *in vitro* in the clinical researches, because of its large similarities in size and structure to many biological molecules. This aids in integral of nanomaterials with biology, which end up with the development of diagnostic procedures, contrast agents, analytical tools, and techniques for physical therapy and vehicles for delivery of drug. However, it is important to understand the interactions of nanomaterials with the biological environment, targeting cell-surface receptors, drug release, multiple drug administration, stability of therapeutic agents under research.

Keywords: Nanomedicine; Drug; Disease; Nanotechnology; Environment

Introduction

Converting from molecular size into nanoscale size of material will alter its characteristics, for example, surface region, electrical and attractive properties, the surface zone to volume ratio. For example, copper that is unclear at huge scale ending unpretentious at nano scale. physical and synergist properties of gold in nanoscale will be totally changed, like increasing in melting point 200°C to 1068°C and color shifting from yellow to blue- violet [1]. According to increase study the nano medicines and its impact on health, scientists are screening for more material for drug deliver arrangement like egg white and gelatin. The possible assembly with tissues and cells, and the chance for harming, incredibly relies onto the actual size of the nanoparticle detailing [2]. Presently, nanoparticles including renewed medications wrapped via films from red platelets and these nanoparticles will inflow in a mouse's circulatory system for two days, rather than two hours as observed for nanoparticles employing ethylene glycol particles. Nanoparticles can be used as a part of concentrated medication transportation in infected area to promote taking the poorly water soluble medications [3,4] the centering of medications to a specific site, and medication bioavailability. A few drugs including paclitaxel [5,6], doxorubicin [7], 5-fluorouracil [8] and dexamethasone [9] have been effectively detailed utilizing nano materials by the studies. Polylactic/glycolic corrosive (PLGA) and polylactic corrosive (PLA) founded nanoparticles to exemplify dexamethasone, a glucocorticoid with an intracellular site of activity. Dexamethasone is medication under corticosteroid group [10]. Treat rheumatic problems, skin diseases, chronic obstructive lung disease, and along with antibiotics in tuberculosis. It binds to cytoplasmic receptors and the eventual complex of medication-receptor is transferred to the core bringing about the declaration of certain qualities that monitor cell multiplication [11] the nanoparticles that emptying elevated medications dos for belated timeframe completely restrict extension of vascular smooth muscle cells have been improved. Furthermore, specialists have created a nanoparticle which employs a protein to link to hurt veins regions [12] this help medications to be delivered directly to the damaged artery part. Nanomedicine is the medical application of nano-sized measure, nanofiber and nanodevices to

deliver medications to certain tissue target inside human body and for the detection and therapy of diseases with diminishing the damage of healthy cells, therefore minimizing the possible adverse effects [13]. Present troubles related from nanomedicine using include realizing of problems linked to nanoscale substances environmental effect and toxicity [14,15].

Nanocarriers

Nanocarriers are generally applied micelles, polymers, carbon-based substances, liposomes or other substances. Lipid-nanocarriers involve: Liposomes and micelles (contain both hydrophobic and hydrophilic medication) [16,17] Nanocarriers varies from sizes of diameter 1–1000 nm [18,19], Because of the width of microcapillaries being 200 nm, nanomedicine oftentimes indicates to devices < 200 nm [19]. Due to their small size, nanocarriers can deliver medications to inaccessible areas inside the body, it is often difficult to supply high medication doses via them. The emulsion techniques employed to produce nanocarriers also result in decreased medication loading and encapsulation, leading to obstacle using in clinical field.

Several advantages and disadvantages of popular Nano carriers are listed below [20,21].

Figure 1: Advantages of common Nano carriers.

Liposome Nanoparticles

A liposome is a spherical vesicle having at least one lipid bilayer, employed as a vehicle for administration of nutrients and medications [22]. Liposomes are composed of phosphatidylcholine, may involve different lipids, like egg phosphatidylethanolamine [23]. Hydrophilic substances can be encapsulated in the inner aqueous layer and hydrophobic substances can be carried in the hydrophobic domains of the lipid bilayer. via mixing commercially available lipid molecules, physicochemical characteristics of liposomes can be altered to control surface charge, functionality, and size which has an advantage compared to other carriers that required more controlled synthesis processing with extra chemical changes. DSPE (1,2-distearoylsn-glycero-3-phosphoethanolamine), HSPC (hydrogenated phosphatidylcholine from soybean lecithin), EggPG (egg yolk phosphatidylglycerol) and DSPC (1,2-distearoyl-glycero-3-phosphocholine) have been utilized to prepare vesicular formulations after FDA approval. Lipids like this type can be formed by PEG that have critical role in enhancing the produced liposome surface. Doxil a novel discovering medication which is a pegylated liposome used clinically treat several cancer types. Aphios Corp company designed nanosomes which are very small liposomes <100 nm, in several medications for example bryostatin-1, camptothecin, and vitamin D analog via utilized a manufacturing technology established on a critical treatment process The liposomal preparations can alter zeta potential with solution pH changes that may end up into fusion during endocytosis uptake that allows nanocarriers into the cytoplasm for therapeutic capacity [24,25].

Moreover, proceed in liposome research have been able to permit liposomes to avoid detection by the body's immune system, specifically, the cells of reticuloendothelial system (RES). These liposomes are "stealth liposomes"[26].

Nanotechnology in Cancer treatment

In treatment of cancer, nanotechnology has given important improvement in the diagnosis, treatment and prevention. It is more effective and more targeted therapies that have supplied modern techniques and potentials for treatment of disease [27,28] is minimal because of determination of cancer cells is not significant. Nanoparticles are employed as targeted delivery into tumor which

Figure 2: Liposomes are structures prepared of phospholipids and may contain small amounts of other molecules. Although liposomes can be different in size from low micrometer range to tens of micrometers, unilamellar liposomes, as pictured here, are typically in the lower size range with various targeting ligands linked to their surface permitting for their surface-attachment and accumulation in pathological sites for disease cure.

can stimulate a local interaction with tumor cells and aids to raise the preparation of biomarkers. Nano medicines are used for exact cancer imaging. Iron oxide nanoparticles are unitized as one of the techniques for cancer imaging. Because of certain coating of iron nanoparticles are binding especially to the tumor cells and due to Cancer biomarkers are employed as indicator in cancer detection. In early stage of cancer, concentration of biomarkers their magnetic characteristics they are used as imaging agents in MRI-scans and providing a very high resolution and accurate mapping of lesions [29,30].

Preparation of local delivery of cytotoxic drugs in malignant tumor via non-target liposome with types of lipids that cause damaging phospholipase A2 (PLA2) that up regulated in tumor microenvironment [31,32]. in human xenograft mice models clinical experiment in researches in human xenograft mice models for prostate, pancreatic, and non-small-cell lung cancer (NSCL cancer) showed a partial tumor suppression in 90% PC3 tumor xenograft model, this done by encapsulation Docetaxel into the liposome bilayer and added albumin for stability and prevent leakage of medication. In cancer therapy nanoparticles are injected in the tumor cells and stimulated for secreted heat that results in the damaging of cancer cells locally with the aid of magnetic fields, X-Rays or light. Along with this encapsulation of presenting chemotherapy drugs or genes are permitting more localized delivery.

Polymer-Drug Conjugates Nanoparticles

It's the most attractive discovered type of nanoparticarries, they under clinical experiments in stage III, it prepared via side-anchor joining with chains of polymer allowing them to convey high doses of chemotherapy medications. Although of the truth which the physicochemical characteristics of different details are not exposed, the measure of polymer-tranquilize conjugates is for the most part underneath 20 nm. The first engineered polymer-anticancer drug conjugated is HPMA-doxorubicin (N-(2-hydroxypropyl) methacrylamide) copolymer (PK1) used in clinical researches through 10 years before clinical stage II stages for cutting edge bosom disease in females is as yet under research. Also, Prolindac (AP5346) is made out of a HPMA spine copolymer with platinum linked via pH-touchy chelator to the side chains prepared for sedative emptying in tumor site [33,34]. The pre-clinical experiments showed that there is common efficacy of lymer-medicate conjugates via using many malignant manners that involving a M5076 sarcoma platinum-safe tumor xenograft mice display, colon xenograft different modesand 0157 hybridoma models [35]. Oxaliplatin medicate stacking was ~10% (w/w) utilizing a polymer chain of 25 kDa and the medication emptying was moderate.

Tissue engineering

Re-building died or damaged cells became possible by use the nanotechnology in regeneration medicine. Routine treatments can be simply changed via utilizing the tissue engineering which will cure from difficult disorders and helper in organ transplantation and useful in artificial implants. In tissue engineering, especially in bone supporting techniques, nanoparticles can be used strongly in this field, for example molybdenum disulfide, graphene and tungsten disulfide, in order to manufacture potent polymeric biodegradable nanocomposites. Employing polymer matrix of nano particles in a very low concentration [0.2 weight %] will improve and enhance the compressive and flexural mechanical and development the characteristics of nonoparticles as a whole [36,37].

Application of nanomedicine

Nanomedicines are used for Imaging and identification of cell, delivering medicine in exact location, destruction of bacteria, viruses and cancer cells and for repairing of damaged cells [38,39].

Advantage of nanomedicine [40,41]

Figure 3

Disadvantage of nanomedicine [42,43]

Figure 4

Further aspects of nanomedicine

Nanotherapeutics is supplying targeted drug delivery, develop drug solubility, extend drug half-life, enhance drug's therapeutic index, and reduce a drug's immunogenicity that has resulted in the potential to transform the treatment of several diseases [44,45] nanomedicine will speed many process to develop human health more efficiently than either could do individually [46,47].

Conclusion

Several factors controlling the nano devices capacity and ability to deliver drug into target sit, including the surface charge the hydrophobicity and hydrophobicity, and the molecular size of medication. According to the poisonous quality in nano devices it has a great attention to try decreasing the toxicity due to its restricted information. The most motivated examination in nanoparticle generation via using supercritical liquids that are natural accepted and free of poisonous solvents There are grow-researches are making to find solutions for this obstacle and therefore introduce an effective way for drug delivery via using nano devices to achieve high therapeutic effect.

In the future, many patients will be convinced of the advantages of nanotechnology in medicine and therefore development more advanced therapies.

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