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Application of Nanoscience and Nanotechnology in Medical Science

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Abstract

Nanoparticle hold tremendous potential in medical science. In this review drug delivery and therapeutic aspect of nanoparticle have been discussed. To achieve efficient drug delivery, it is important to understand the action of nanoparticles with the biological environment of human organisms. The use of gold nanoparticles with some anticancer drug have been presented. This paper presents the motivation of drug delivery approaches based on nanoparticles in treatment of other diseases.

1 Introduction and Preliminaries

The word nano is like a boon from 20th century to till date. It is a Greek word having dimensions of length with one nanometer equal to $10^{-9}m$ and is equivalent to length scale obtained by alignment of 10 hydrogen atoms hand to hand in a line.We all live in macro world and feel that we are surrounded by the bulk form of materials. As we look inside the atomic word at nanoscale we observe some existence of some unique and distinctive properties which are quite different form those of bulk counter parts. Origin of these interesting properties of materials in nano dimensions region has opened a new field in Science called nanoscience, technology linked with nanoscience is known as nanotechnology. Nanoscience is being used in developing countries to help treat diseases and present health issues. The umbrella term for this kind

of nanotechnology is nanomedicine is manipulation of matter on an atomic, molecular and super molecular scale. Nanomaterials are important because they exhibit special properties as bulk cannot. This is due to the fact that at small sizes quantum effects start coming into picture. Also, their surface area, which is exposed to physical effects, becomes larger. Therefore, special phenomena start taking place. Because of similarity in size in nanomaterials with that of most of biological molecules and structures, thus can be used in both vivo and in vitro biomedical research and application. The integration of nanomaterials with biology has led to development of diagnostic devices, contrast agent, physical therapy applications and drug delivery vehicles. In this paper, application of nanoscience in drug delivery has been presented, which has potential for efficient treatment with minimum side effects. The action of drugs on human body is called pharmacodynamics and what the body does with the drug is called pharmacokinetics. The drugs that enter the human body tend to stimulate certain receptors, ion channels, acts on enzymes or transport proteins. Once the receptors are activated, they either trigger a particular response directly on the body or they trigger the realease of hormones in the body to stimulate a particular response. Almost all medicines have unwanted side effects. Many prescription drugs, cause stomach problems like nausea, diarrhea because they pass through digestive system and also require large amount of drugs. Another type of drug like steroids used in treatment of multi-inflammatory diseases turns off inflammation, but raises the blood levels of sugar and causes thinning of bones. Even then many drugs cannot cure chronic diseases.
Nanoscience and nanotechnology has the potential to overcome these limitations of medicines by using novel drug delivery techniques with nano medicines.

2 Nanoscience and Nanotechnology in Drug Delivery

Current cancer therapy involves surgery, radiotherapy and chemotherapy, despite of their great responses, these are required in high amounts [1]. These treatments decreases the blood half life and have many other serious irreversible harmful effects. To overcome these issues, there is demand for less toxic and more efficient target specific therapies towards cancer cells.

The development and optimization of drug delivery approaches based in nanoparticles concerns the early detection of cancer cells and the enhancement of the efficiency of the treatments applied.
Nanoparticles provide favourable blood half life, effective clearance from the human organism and minimal or no toxicity to healthy tissues because nanoparticles have high surface area to volume ratio. This allows for many functional groups to be attached to a nanoparticle which ca seek out and bind to certain cells. Additionally, the small size of nanoparticles($5 - 100nm$) allows them to preferentially accumulate at tumor cells.

The efficiency of drug delivery system(DDS) through nanomedicine is largely based on

1. Efficient encapsulation of the drugs
2. Successful delivery of drugs to the targeted region of the body that bypass the biological barriers and reaches the cancer cell
3. Successful release of drugs at targeted region of the body due to enhance of the permeability and retention effect (EPR) promoted by angiogenic vessels with defective vasculature [2].

DDSs can be formed by direct conjugation with the drugs and further surface modifications can lead to better delivery for such systems, promoting targeted delivery to specific types of cells in human organisms [3]. One of the most common nanoparticle for drug delivery is metallic nanoparticles(for example AuNPs). The selection criterion of nanoparticles is based on size, surface properties and possibility of a variety of specific ligands in their surface. The specificity of target require some functionalization of nanoparticle's surface with a plethora of functional moieties such as biomolecules that can identified specific biomaker of tumor cell[4].
The aggregation of the nanoparticles is the major concern in the synthesis of nanoparticles. To avoid aggregation of nanoparticles chemical syntheiss of nanoparticles require some capping agents that adsorb in the surface of nanoparticles. AuNPs can be synthesized with different sizes through the reduction of gold with different agents such as thiol group or charged end group. AuNPs can be incorporated in two layer structures such as polymeric nanoparticles efficiently encapsulate drugs for concurrent therapy.

The application of AuNPs for in vitro diagnosis, in vivo imaging, therapy and also as DDSs relies in their chemical stability, high solubility in water, suitable morphology and limited dispersity, high surface to volume ratio, nontoxicity in biological systems and an easy synthesis and functionalization with a plethora of biomolecules and drugs.
The well known application of AuNPs in cancer therapy led to further investigation of new potential therapautic strategies [5].AuNPs as a potential nano carrier have the possibility to carry different pay loads such as small drug molecule for drug delivery or biomolecule like DNA, proteins and RNA being recognized as an attractive gene delivery system.

3 Conclusion

Current therapeutics(drugs and molecules) shows serious cell toxicity that is not merely directed at the cancer cells but instead promote target cellular damages usually reported systemic toxicity.
Nanomedicine has potential for several therapeutic concepts that disrupts the way we are dealing with cancer therapy. Furthermore, nanoparticles provide platforms for selective targeting by encapsulating novel anticancer drug. The use of multiple nanoparticles that can be used together any overcome limitations of each individual nanoformulation alone. It appears nanodrug delivery system hold great potential to overcome the barriers to efficient targeting of cells and tumors. The challenge however, precise characterization of molecular targets. Furthermore, because nanosystems increase efficiency of drug delivery, the doses may need calibration. Nevertheless the future remains exciting and wide open.

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