Review on Nanotechnology Persecute Vital Role of Curative Applications in Medicinal Field and its Ailing Effects

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Abstract

Nowadays, nanotechnology impacts human life every day, and the potential benefits are many and various. In contrast, due to extensive human exposure to nanoparticles, there is an important concern about the potential health and environmental risks. These concerns led to the emergence of further scientific disciplines such as nanotoxicology and nanomedicine. Nano toxicology which is interesting in the study of potential adverse health effects of nanoparticles. While, Nanomedicine, which includes subsectors such as tissue biomaterials, engineering, biosensors, and bio imaging, was developed to study the benefits and hazards of nanomaterials that are used in medicine and medical devices.

In addition, a key promise of nanotechnology is for improved healthcare, including potentially revolutionary treatments for cancer diseases (detection of cancer cells at the early stage) and improved drug delivery (such as reducing side effects), reduced inflammation, antibacterial coverings of medical devices, better surgical tissue therapeutic. However, as result to lack of reliable toxicity data, the potential to affect human health still to be a major concern.

The purpose of this literature review is to contribute to a better understanding of the principles and processes the science concepts on which nanobiotechnology means and its applications in biomedicine will be discussed as well as to their side effects.

Keywords: Cancer therapy, Nanobiotechnology, Gene therapy, Nanomedicine, Toxicity of nanoparticles.

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Introduction

Nano is known to be as a prefix meaning one-billionth of a meter, or 10-9meters and it is abbreviated "nm". The nanometer is one-billionth of a meter which much too small in order to see with the naked eye or even with a traditional light microscope. For instance, a sheet of paper is about 100,000 nano-meters thick; while a single gold atom is about a third of a nano-meter in diameter. Dimensions between 1 and 100 nano-meters are known as the nanoscale [1].

Nanotechnology has been employing materials at the nano scale, which considers a relatively new area for researchers, with rapidly increasing marketable applications which hold the promise of providing important improvements in technologies for protecting the environment and humanity. These technologies are being used in new and exciting applications in several different fields, such as medicine, textiles, environmental remediation and computer chip manufacturing [2-5].

Furthermore, it well to mention that nanoscience and nanotechnology not actually new things in the scientific world. For instance, in the past 50 years, a blooming of immunology caused to several new challenges. Continuous developments drove researchers to the years of molecular biology and genomics, which is a band of micro-science and microtechnology. Currently, nanotechnology focuses on materials which have size from 1 to 100 nm. Where at these sizes, materials have new advents which assistance researchers to control the accuracy and precision of new nano-materials usage [2,6-8]. Likewise, with nano size unique phenomena enable novel applications not feasible in case working with bulk materials with molecules or even single atoms.

History and development of nanotechnology

The term nanotechnology has been explained by a wide spectrum of numerous technologies that nanotechnology covers, which are based on many kinds of chemical, physical, and biological processes realized at Nano-level [9,10]. The accurately established time span for the beginning of nanotechnology development is demonstrated by the fact that nanotechnology has its backgrounds in the remote past when were used by people without knowledge of it.

The name "nanotechnology" was introduced by Norio Taniguchi for the first time in Tokyo in 1974 at the International Conference on Industrial Production in order to explain the super thin processing of materials with nanometer accuracy and the establishment of Nano-sized mechanisms. Concepts of Nano technological approach, which were put forward by Richard Feynman (identified as Father of Nanotechnology) in 1959 in his lecture delivered at the session of the American Physical Society and were developed in 1986 by Eric Drexler.

Nanotechnology and Nanoscience got an improvement in the early 1980s with two main developments including both the birth of cluster science and the invention of the Scanning Tunneling Microscope (STM) in 1981. These developments caused to the discovery of Fullerenes in 1985 and when Carbon Nano-tubes was advanced by Japanese scientist in 1991. In the medial of 1980s and beginning 1990s several significant discoveries were made, which had an essential impact on the additional development of nanotechnology. For example, in 1991, the first Nano technological program of National Scientific Fund was started to operate in USA, and then in 2001, the National Nano technological Initiative (NNI) of the USA was approved. Since then, lots of technical research developments and scientific departments have taken place all over the world particularly in some countries such as England, Japan, China, Germany, France, South Korea and recently in the CIS countries [9-11].

consequent, the nanotechnology pattern was formed at the turn of the 1960s, whereas the 1980s and 1990s are the start of growth of nanotechnology in its own right. According to the light of the toxicity testing in the 21st century sugusted by the US National Research Council (NRC), high-throughput screening of nanomaterials looks promising and may be potentialin the not too distant future. Despite of the complex nature of the nanomaterials which makes the development of their safety assessment challenging, the future of the nanotechnology sounds to be bright [12].

Nanobiotechnology

Nanobiotechnology is biotechnology at the nano scale and it is terms that refer to the intersection of biology and nanotechnology, also it is a discipline in which tools from nanotechnology are developed and applied to study biological phenomena. For instance, nanoparticles can be serving as probes, sensors or vehicles for biomolecules delivery in cellular systems [11].

Nanomedicine

Nanomedicine is known as a new branch of medical science and holds five main sub-disciplines including: medical diagnosis, nanoimaging, chemotherapy analytical tools, and drug delivery systems. It can be said that the potential benefits of Nano biotechnologies raise great hopes in therapies for cancer diseases, antiviral and antifungal agents, diabetes, chronic lung diseases, and genetherapy. Besides medicine therapy, nanomedicine can be applied in surgery such as photodynamic therapy [11].

Nanomedicine for Diagnosis

Nanotechnologies can assistance physicians' diagnosis at single cell and molecule levels [12].

Nanoparticles, such as silver nanoparticles, gold nanoparticles, and quantum dots are the common used. While, various other nanotechnological devices for manipulation at thenanoscale as Nano bio-sensors are also valuable for potential clinical applied usages. In addition, nanotechnologies will provide the limits of present molecular diagnostics and assist in point of care diagnostics, combination of diagnostics with therapeutics, and development of personalized medicine. Despite of the potential diagnostic applied usages are not limited, the most significant current applied usages are expected in the areas of biomarker discovery, early cancer diagnosis, and detection of infectious germs.

Nanomedicine for Therapy

Treatment is a significant medical activity. Although it is preferred that prevention of diseases is better than treatment, but therapy for an already existing disorder is wanted. Therapy can be also specific or symptomatic treatment; the main goal of treatment is to reduce of the patient's pain. Development of treatment has been continuous for centuries. The advent of nanotherapy in medical treatment field has begun to be a new hope in medicine. The application of nanomaterials as a new supplement in order to the improvement of the conventional therapeutic protocol can be very beneficial.

Nano-pharmacology for nano-therapy

With the advent on nano-pharmacology, new medicine development becomes easier in comparison with previous days, where the pharmaceutical process obtains a lot of worth from the new Nano delivery system. Nano-pharmacology can be applied to nano-therapy and it is considered as the hope for treatment of presently untreatable diseases like cancer and human immunodeficiency virus.

Nano-surgery

Nano-surgery is the new concept in surgical medicine. As known that, a small wound is a wanted outcome of present surgery, where a small surgical wound means small blood loss and minimization the complication of intraoperative and postoperative. A small wound also reduces the postoperative hospitalization period for the patient. For example, there are some advents in eye surgery. Femtosecond laser pulses, which is emitted from lasers working in the near infrared, based on multiphoton effects allowing both imaging and laser effects to be produced which are in the sub-micron range and do not cause any collateral damage are available. According to the literature, near-infrared femtosecond laser pulses were used for a collection of microscopy and nano-surgery on fluorescently labelled structures inside living cells. It found that nano-surgery could be performed with sub micrometer precision and without visible damage to the cell.

In addition, Nano neurosurgery is considered as another interesting emerging nano-surgery. Also, several advents in nano-diagnosis can be applied to nano-surgery. Targeted nanotherapy based on Nano pharmacology is also found to be valuable in nano-surgery. Furthermore, the applied usage of nanobiotechnology for nano-surgery can also be easily described as the development of various nano-surgical tools. Although bone is a very diverse tissue providing different functions within the body, recent researches have caused new biomaterials with promise to solve orthopedic problems.

Nanomaterials and Chemotherapy

Using of unique nanomaterials in drug delivery has offered many advantages, such as increase of drug solubility, stability, and enhancement of drug half-lives in the blood circulation with little effects to healthy cells. Liposome is an important nanomaterial as a phospholipid vesicle with a bilayered membrane structure and has been extensively used for delivering anticancer drugs. For example, PEGylated liposome can encapsulate doxorubicin for chemotherapy and be surface-functionalized by fluorophores or gadolinium for imaging.

Cancer is still the leading cause of death around the world, despite the many treatments developed over the past 30 years. Nanotechnology has contributed to important advances in cancer treatment via targeting, detecting, and destroying cancer cells with minimal effect on healthy tissues.

In addition, nanotechnology-based delivery system offers several advantages to conventional chemotherapy treatment, such as delivery of a higher dose of drugs to the tumourcells and improved solubility of unwell soluble drugs.

There are two important issues in developing nanomaterials used for cancer treatment: identification of the tumour and ability of the nanomaterials in order to reach the tumour site desired. Also, established and functionalized nanomaterial can convey novel advantages for cancer therapy, such as enhancing the efficiency of drugs delivered to wanted areas via declining the toxicity and side effects of the drugs. Functionalised nanomaterials should be having ability to carry a high concentration of imaging agents or chemotherapeutic agents as well as to targeting moieties to the site of tumours, which are connected with blood vessels [11]. Some of the chemical structure of some anticancer drugs, including Doxorubicin (DOX), Cisplatin, Cytarabine are showed in Figure 1, these drugs can be conjugated to nanomaterials to increase their bioavailability and water solubility. Nanobiotechnology is biotechnology at the nano scale and it is terms that refer to the intersection of biology and nanotechnology, also it is a discipline in which tools from nanotechnology are developed and applied to study biological phenomena. For instance, nanoparticles can be serving as probes, sensors or vehicles for biomolecules delivery in cellular systems [11].

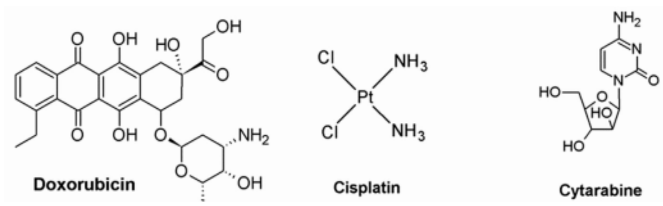

Figure 1. *Chemical structure of some anticancer drugs such as, Doxorubicin (DOX), Cisplatin, and Cytarabine.*

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Biological Clearance

It is well to mention that the other side to remove nanoparticles before delivery of the drug is the harmful toxicity associated with the nanoparticles themselves. Nanoparticles as a whole, or the decomposition products of these nanoparticles, are known to cause symptoms such as dermal changes, neurotoxicity, sensitization, growth toxicity, cardiac toxicity. It should also be noted that studies that monitor the long-term effects of these nanoparticles are still on-going and data are still collected on the toxic effects of some nanoparticles. Biodegradable Nano polymers, such as Polylactide (PLA), Polyglycolic Acid (PGA), and Poly (Lactic-co-glycolic Acid) (PLGA) can be fully dissolved and widely used for the packaging of many anticancer drugs to minimize toxicity.

Nanoparticles in the bloodstream are alien organisms and undergo different ways of getting rid of the body, such as the immune system, organs such as kidneys and liver [10,11]. In order to effectively uptake the tumor, nanoparticles need to overcome these cleansing forces that are actively driving them out of the body. The single-core phagocytic system contains of phagocytic cells, such as macrophages, Kupffer cells, and monocytes found in organs like the liver, spleen and bone marrow that can engulf nanoparticles and make degradation [11].

The phagocytes recognize nanoparticles through the presence of opsonin such as immunoglobulin proteins, complement proteins, albumins, fibronectin, and apolipoproteins found in the serum. Once nanoparticles are opsonized and engulfed, they are subjected to enzymatic degradation, with non-degradable parts being sent to organs such as the liver and spleen. Kupffer cells and hepatocytes cells in the liver are used in the cleaning of NPs products. NPs that are larger than 250 nm accumulate and are cleared by the spleen. Various ways were used to reduce the clearance of NPs before delivering their drug cargo. The charged NPs are opsonized faster than the neutral particles. Therefore, by neutralizing the surface charge, shading can be minimized. In addition, coating nanoparticles with PEG reduces opsonization, which causes increasing the plasma rotation time of nanoparticles. Kidney removal is a volume-based filtration process where the kidneys remove nanoparticles smaller than 8 nanometer.

Conclusion

Many areas of science converge to study science at a basic or block level, namely nanoscience. Most studies focused on materials science with some emerging applications in the field of biomedicine. Some of basic studies have been conducted in the field of medicines to discuss the fundamentally different properties of nanoparticles. The applications of nonmaterial compounds are clear and promising. However, the toxicity of nanomaterials is still poorly understood.

The review of available literature has revealed a great deal of literature on this subject, and the literature describes the gradual evolution of the concept of nanotechnology and its applications.

Based on a review of available literature, the following concluding observations are made: Developers and researchers of nanotechnology concepts should work together with more application-based researchers to ensure that developments can lead to useful products and the nano science seems poised to be leading to a revolution in the world of medicine.

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