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Applications And Opportunities Of Nanorobotics In Biopharmaceutical And Biomedical Sciences.

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ABSTRACT

Nanorobotics is an emerging, advanced and multidisciplinary field that creates for scientific research and technical support of medical, pharmaceutical, engineering as well as other applied scientific fields. The purpose of this paper is to review the applications and challenges of nanorobotics at a might apply to micro and nano scale robotics is called nano robotics in the field of biomedical and biopharmaceutical sciences. These miniature nanorobots have unique advantages such as accessing to unprecedented and small areas, increased flexibility, functionality and robustness, and being low cost, adaptive and distributed. Nanorobots are the technology of creating machines or robots close to the microscopic scale to nanometer. These medicines are being developed to improve drug bioavailability. Target drug delivery is currently the most advanced application of nanorobots in medicine. Nanorobots have strong potential to revolutionize healthcare to treat disease in future.

Keywords: Nanorobotics; biomedical; drug delivery; treat disease

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INTRODUCTION

Nanoroboticsis the technology of creating machines or robots at or close to the microscopic scale of a nanometer (9 - 10 meters). More specifically, nanorobotics refers to the nanotechnology of designing and building nanorobots, devices ranging in size from 0.1-10 micrometers and constructed of nanoscale or molecular components. Nanotechnology is accomplished by manipulating matter at the atomic level, is measured in nanometers, roughly the size of two or three atoms. The term ‘‘nanotechnology’’ was coined by the student of Tokyo Science University in 1974 [1]. Nano- technology consists mainly of the processing, separating, consolidating, and deforming of materials by one atom or molecule. The nanotechnology, an impressive technological tendency has been highlighted by researchers in recent decades and it goes through the rapid growth of electronics for applications in communication, healthcare (called nanomedicine) and environmental monitoring. Nano in Greek means ‘‘dwarf,’’ which describes nanometer, nanotechnology, and nanorobot. A nanorobotics is essentially controllable machine at the nano meter or molecular scale that is composed of nanoscale components. The field of nanorobotics studies the design, manufacturing, programming and control of the nanoscale robots. Nanorobots would constitute any “smart” structure capable of actuation, sensing, signaling, information processing, intelligence, manipulation and swarm behavior at nano scale. These nanorobotic devices are comparable to biological cells and organelles in size. It is a multidisciplinary field requiring advanced level input from different areas of science and technology including, physics, chemistry, biology, medicine, pharmaceutical sciences, engineering, biotechnology and other biomedical sciences.

Nanorobots designed by the biological materials (peptides, DNAs) called bio nanorobotics. These are inspired not only by nature but machines too. Nanorobots could propose solutions at most of the nanomedicine problems. The application of advanced nanotechnology to nanomedicine in particular, the future engineering discipline of medical nanorobotics will eventually make possible the drug design, fabrication, and therapeutic deployment of pharmacytes. The technology of drug design, fabrication, and programming of these nanorobots is known as Nanorobotics[2, 3]. Drug molecules could be purposely delivered to one cell, but not to an adjacent cell, in the same tissue. To fully appreciate the scope of this future development, it is helpful to briefly review some of the background and recent history of medical and pharmaceutical nanorobotics. Nanomedicine is now within the realm of reality, though there is some unease about the safety of nanoparticles presented in the human body. There is a development in this field which opens up other technology using micro/nano electronic mechanical system (MEMS, NEMS) using artificial tiny chips to assembled bio nanorobotics. Like pace maker there is a growth of replacing body cellular parts with artificial nano components in near future.

Nanorobots are nano devices with a diameter of 0.5 to 3 microns and will be constructed within a dimension in the range of 1 to 100 nanometers. The main element used will be carbon in the form of diamond / fullerene nano composites for the strength and chemical inertness of these forms to avoid being attacked by the host’s immune system. Such devices have been designed in recent years but no working model has been built so far. The nanorobots are not to naked eye, which makes it hard to manipulate and work with. Techniques like Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) are employed to establish a visual interface to enable to sense the molecular structure of nano scaled devices. Virtual Reality (VR) techniques are currently being explored in nano science and biotechnology research as a way to enhance the operators’ perception by approaching more or less a state of ‘full immersion’ or ‘tele presence’. The development of nanorobots or nano machine components presents difficult fabrication and control challenges. Such devices will operate in micro environments whose physical properties differ from those encountered by conventional parts. The engineering of molecular products needs to be carried out by robotic devices, which have been termed nano robots.

Many human illnesses and injuries have their origins in nanoscale processes. Likewise, application of nanorobotics to the practice of biomedical and biopharmaceutical research opens up new opportunities to treat diseases, repair wounds, and upgrade human functioning beyond what is possible with macro scale techniques. At the nanoscale level, nanoparticles can attach to certain cells or tissues and provide medical images of their location and structure. Hollow or empty nanocapsules with pharmaceutical contents can attach to cancer cells and release their payloads into them by maximizing targeted delivery and minimizing systemic side effects. Nanomedibots may repair vital tissue damaged by injury or illness, or devastate cancerous tissue that has gone ashtray, without obstructive surgery [4].

A new approach within advanced graphics simulations is presented for the problem of nano-assembly automation and its application for medicine. The problem under study concentrates its main focus on nanorobot control design for molecular manipulation and the use of evolutionary agents as a suitable way to enable the robustness on the proposed model. (www.nanorobotdesign.com). Nano robots with complete artificial components have not been realized yet. The active area of research in this field is focused more on molecular robots, which are thoroughly inspired by nature's way of doing things at nano scale [5, 6]. This review chapter focuses on the state of the art in the emerging field of nano robotics, its applications and opportunities in biomedical and biopharmaceutical development to discusses in brief some of the essential properties, challenges and its future scope.

APPLICATIONS

The applications of the nano robotics are uses in the field of emerging druge delivery, health care, bio-medical application, cancer therapy, Brain Aneurysm, communication system, and new future ofnano technologies, etc. An ideal nanorobotic system is visualized as self-assembling, self-replicating and self-repairing systems. Although, such an advanced artificial system may not be seen in the near future, it could be possible by using very small particles as diagnosing, treating, and averting disease and traumatic injury, of dismissing pain, and of additive and enlightening person health, via molecular tools and molecular information of the human body.

Nano robotics in medical sciences

Nano robots are expected to enable new treatments for patients suffering from different diseases and will result in a remarkable advance in the history of medicine. Nano medicines can easily travel to the human body because the nanorobots are too small. Scientists report that nanorobot constructed of carbon atoms in a diamondoid structure because of its inert properties and strength. Nano robots could be used to process specific chemical reactions in the human body as ancillary devices for injured organs. Monitoring diabetes and controlling glucose levels for patients will be a possible application of nano robots [7]. Recent development in the field of bimolecular computing is a promising first step to enable future nano processors with increased complexity. Studies targeted at building biosensors and nano-kinetic devices required to enable medical nano robotics operation and locomotion, have also been progressing [8]. The use of nano robots may advance biomedical intervention with minimally invasive surgeries and help patients who need constant body functions monitoring, or ever improve treatments efficiency through early diagnosis of serious diseases [9]. Nano robots might be used to seek and break kidney stones. Another important possible feature of medical nano robots will be the capability to locate atherosclerotic lesions in stenosed blood vessels, particularly in the coronary circulation and treat them either mechanically, chemically or pharmacologically. Organic nano robots are the work on ATP and DNA based molecular machines, also known as bio-nanorobots[10].A large potential application for nanorobotics in medicine include early diagnosis and targeted drug delivery with treatmental medicine for cancer biomedical instrumentation, surgery, pharmacokinetics, monitoring of diabetes, and health care. In future medical technology is expected to nanorobots injected into the patient to perform treatment on a cellular level [11].

The nanorobotic experiments and research will give the very bright future and its development is increasing day by day in medical field. That's increase the human safety and health caring fields are expanding. They are many senior ill patients and there are living by the use of the nanorobotical treatment method. HIV, cancer and other harmful diseases are also under progress for curing. The nanorobots will treat and find disease, and restore lost tissue at the cellular level. It is useful for monotering, diagnosing and fighting sickness. In the health care field the nanorobotics is perform the good treatment by through biomedical. We are using the many field of the nanorobotics as like medical application, treatment of cancer, nanorobotics in gene therapy, nanorobots for brain aneurysm, nanorobots in dentistry, etc.

Cancer treatment

Cancer can be successfully treated with current stages of medical technologies and therapy with the help of the nanorobotics. However, a crucial factors to determine the probability for a patient with cancer to survive with earliestdiagnostic ability, detection of cancer before the metastasis stage and the development of efficient targeted drug delivery to decrease the side effects from chemotherapy [12]. Considering the

properties of nano robots to navigate as blood borne devices, they can help on such extremely important aspects of cancer therapy. Nanorobots with embedded chemical biosensors can be used to perform detection of tumour cells in early stages of development inside the patient's body[13].

Tumor theranostic methodusing bacteriobot

Korean research team has successfully developed bacteriobots that can diagnose and treat cancer. This bacteria-based robot is expected to be utilized to develop new treatments for cancer and various microrobots or nanorobots for medical purposes in the future. The bacteriobot concept will be of great influence in the development of biomedical theranosticmicrorobots, which can carry out versatile functions, such as the detection and eradication of incurable malignancies. Sung Jun Park et al., 2013 [14] proposed a new microrobot paradigm to target and treat solid tumors in which attenuated *Salmonellatyphimurium*acts as a micro actuator and micro sensor to deliver micro structures to solid tumors. A strong streptavidin/biotin-based conjugation method between bacteria and microstructures was proposed and used for the fabrication of the bacteriobot.

Cancer detection and treatment

Several companies connected with biotechnology are trying to find the precise way to operate the RNA and block the genes which generate proteins linked with different diseases such as cancer, blindness or AIDS. Though, this is the first mechanism which is capable to enter in a cell and operate the RNA. Once they are in the cells the chemical sensor gives the order to dissolve and when nanoparticles are softened they let free some substances which stimulate on the RNA of each cell disabling the gene accountable of the cancer. Exactly, what the nanoparticles neutralize is the "ribonucleic reductase", the protein related with the cancer development which is fabricated by the disabled gene. It has been explored that the therapy with nanoparticles works, but it is very early to say that this will be the definitive cure for the cancer. There is an alternative kind of nanoparticles for the cure of the cancer is magnetic particles. These ones are used in a dissimilar way. When they arrive to the cancer cells, microwaves are smeared from outside, the particles are motivated and they burn the cancer cells [15].

Oral cancer

Saliva is used as andiagnosticmediumthat contains proteomic and genomicmarkers for molecular disease identification. Exosome, a membrane bound secretary vesicle, is one such marker whose level is elevated in malignancy. This marker has been studied by using atomic force microscopy, which employs nanoparticles. The nanoelectro mechanical system, oral fluid nanosensor test, and optical nano biosensor can also be used for diagnosing oral cancer. Nanoshells, which are miniscule beads, are specific tools in cancer therapeutics. Nanoshells have an outer metallic layer that selectively destroys cancer cells, while leaving normal cells intact. Brachytherapy is an advanced form of cancer treatment. Still under trial are nanoparticle coated, radioactive sources placed close to or within the tumor to destroy it. Other uses of nanovectors include drug delivery across the blood– brain barrier in the treatment of Alzheimer's and Parkinson's diseases [16, 17].

Gene therapy

Nano robots can readily treat genetic diseases by comparing the molecular structures of DNA and proteins found in the cell to known or desired reference structures. Any irregularities can then be corrected, or desired modifications can be edited in place. In some cases, chromosomal replacement therapy is more efficient[18].

Brain aneurysm

The nanorobotis for brain aneurysm prognosis, using computational nanotechnology for medical device prototyping. This is consist of three main aspects are equipment prototyping, the manufacturing approach and inside-body transduction. Equipment prototyping is the computational nanotechnology provides a key tool for the fast and effective development of nanorobots, helping in the investigation to address major aspects on medical instrumentation and device prototyping. Now, the same can be used to benefit the

development and research of medical nanorobots[19, 20, 21]. The Manufacturing technology for manufacturing purposes of the nano robot should be integrated as a biochip device. Thus, new materials, photonics and nano bioelectronics are presented with a description of the nanorobot architecture. And the Inside body transductions are cell morphology, microbiology and proteomics are used as parameters for nanorobot morphology and inside-body interaction. Changes on chemical gradients and telemetric instrumentation are used for medical prognosis, with the nano robots activation based on proteomic over expression. For brain aneurysm prognosis, nano robots need to track the vessel endothelial injury before a subarachnoid hemorrhage occurs. These changes on chemical concentration are used to guide the nano robots to identify brain aneurysm in the early stages of development. The main morphologic aspects related to brain aneurysm are taken for modeling the study of nano robots sensing and interaction within the deformed blood vessel [22].

Anti HIV using nanorobotics

Nanorobots will be applied in chemotherapy to combat cancer through precise chemical dosage administration and a similar approach could be taken to enable nanorobots to deliver anti-HIV drugs.

Drug delivery

Pharmacytes are the nanorobots designed for the action of drug delivery. The dosage of drug will be loaded into the payload of the pharmacyte. The pharmacyte will be capable of precise transport and targeted delivery of drug to specific cellular targets. The pharmacytes upon arriving at the vicinity of tumor or any target cell would release the drug via nanoinjection or by progressive cytopenetration until the payload delivery is reached [23].

Dentistry:

The nanorobots designed for dental treatment are referred to as dentifrobots. These nanorobots can induce oral analgesia, desensitize tooth, manipulate the tissues to realign and straighten irregular set of teeth [11].

ADVANTAGES / CHALLENGES

Current improvement in drug delivery is to identify the specific cells with the self of nanosensors and regulate the discharge by use of smart drugs. Currently there is no permanent vaccine or medicine is available to cure the disease. At present available drugs in the market can increase the patient's life to a few years only, so the invention of this nanorobot will make the patients to get rid of the disease with no side effects. It operates at specific site only [24].

Cancer research illustrates many of the medical potentials of nanotechnologies in the longer term. It is hoped that nanoscale devices and processes will help to develop. Imaging agents and diagnostics will allow clinicians to detect cancer in its earliest stages. Multifunctional, targeted devices capable of by passing biological barriers to deliver multiple therapeutic agents directly to cancer cells and those tissues in the microenvironment that play a critical role in the growth and metastasis of cancer.

Challenges in nanorobotics

Nanorobotics is still misunderstood by a majority of the public. The reality of matter is that it alludes to a rather broad range of study that can encompass quite a few different disciplines. All in all, nanotechnology is concerned with the creation of microscopic objects. A large number of these objects are so small that they are constructed not with regular materials but with the very atomic building blocks of life [25].

The nanodevices are very smaller molecules than the full stop at the end of this sentence, experience water as a viscous, nectar-like matter (flowing blood or other bodily fluids are even thicker) and require considerable energy consumption to be able to propel and navigate towards a target. A diagnostic or therapeutic activity by the nanorobot will need to be timed at specific sites in the body and this will require

sophisticated and well controlled initiation of activity that is currently not feasible. The nanodevice which is using to the patients will need to be toxicologically inert and degradable from the body.

SUMMARY AND FUTURE OF NANOROBOTS

Nanorobot is a nanoscale device these are able to flow through bloodstream, so with the help of this we can cover almost all organs for curing illness. The potential use of such nanodevices can improve the status of human health system. Researchers are taking actions to maximize the enormous benefits of this nanorobot technology by keeping the associated risks at minimum.

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