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NANOROBOTICS: THE EMERGING TOOLS IN MEDICINAL APPLICATIONS

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ABSTRACT

There are various medical tools, therapies and medicines available for the treatment of life-threatening diseases and syndromes. Target!ed drug delivery approaches are used for the purpose of diagnosis and treatment of endangering diseases and syndromes. This includes liposomes, nano shells, dendrimers, quantum dots and polymeric nanocomposites. Many scientists are working on Alzheimer disease and cancer with the help of nanorobotics. Amongst them nano technology is contributing more for the purpose of cancer treatment. Nanorobots are considered as an astonishing vision of the medicine in future. They are a nanoscale-devices generally made up of bio nanocomponents. They can easily carry and provide drug at the targeted sites. DNA nanorobots has set new milestone for the painless cancer treatment. There are various applications of nanorobots in different fields such as microbiology, hematology, neurosurgery, dentistry and brain aneurysm. Recent studies show that remarkable improvements have been achieved in nanorobots to solve powering, control, communication problems and introducing the robot into the living organism. The aim of this paper is to provide Introduction of nanorobotics and its application in medicinal field.

KEYWORDS: Nanorobotics; Nanomedicine, Magnetostatics bacteria, Cancer treatment, Nanotechnology. Hematology, Biochip, Nubots, Brain aneurysm.

INTRODUCTION

Nanotechnology is the application of scientific knowledge to the control and use of matter at the nanoscale where the size related phenomena and process may occur. Nanotechnology is nothing but making small stuff to do big things. As we know that human hair is 100,000 nm thick similarly consider the case of nanorobots dealing with the problems at molecular level

especially in medical field. Robotics at any scale involves sensing, control, actuation, propulsion, power, communications, interfacing, and programming and coordination. Emphasis on actuation, which is a fundamental requirement for robotics.

Nanomedicine are use in process of diagnosing, treating, and preventing disease and traumatic injury, of relieving pain, and of preserving and improving human health, using molecular tools and molecular knowledge of the human body.[1,2,3]

Targeted drug delivery systems

Polymer nanocomposites

A polymer or copolymer in which nanoparticles are dispersed in polymeric matrix. They have different shapes like platelets' and spheroids.

Quantum dots

They are typically 1-100nm in dimensions has application in various analytical methods. They are made up of semiconductor nanoparticles whose electronic energy levels are controlled by particle dimensions**.**

Nano shells

It is nothing but a is a tiny bead like structure with superficial metal layers which may absorbs the selective wavelengths of radiations and produce heat for specific devastation of the tumor cells sparing the normal cells.

Dendrimers

Dendrimers are highly branched, star-shaped macromolecules with nanometer-scale dimensions.

Approaches used for designing nanorobots

a) Biochip

Biochip are used for diagnosis and drug delivery. It is the combination of nanotechnology, photolithography and new biomaterials. This is the new approach of designing nanorobots used in electronic industries.

b) Nubots

Nubot is an acronym for “nucleic acid robots.” Nubots are manmade robotics devices at the Nano scale.

c) Positional nano assembly

Positional nano-assembly consist of components of the system arranged in non-random spatial distribution with respect to each other and the boundaries of the system.

d) Usage of bacteria

This is another approach for nanorobotics which uses bacteria such as E. coli. So that the model uses a flagellum for the propulsion purpose. In this mechanism electromagnetic field use to control the motion of biological integrated device and its limited application.[4,5,6]

Mechanism of action

Instead of building a single complex molecule for identifying multiple features of a cell surface, Dr. Stojanovic and his colleagues were using a different, and potentially easier, approach based on multiple simple molecules, which together form robot. To identify a cell possessing three specific surface proteins, he first constructed three different components for molecular robots. Each component in this robot contains a piece of double-stranded DNA which is attached to an antibody specific to one of the surface proteins. When we add these components to a collection of cells the antibody portions of the robot bind to their respective proteins and work in specific manner.[11,12,13]

On cells where all three components are attached, a robot is functional and a fourth component helps to initiates a chain reaction among the DNA strands. Each component exchanges a strand of DNA with another until at the end of the exchange when the last antibody obtains a strand of DNA which is fluorescently labeled.[8,14,16]

At the end of the chain reaction it takes less than 15 minutes for a sample of human blood-only cells with the three surface proteins are labeled with the fluorescent marker. We find out this concept with human blood cells because of their surface protein are well known to us but in principle our molecules could be deployed anywhere in the body. The system can be expanded for identifying four, five, or even more surface proteins.

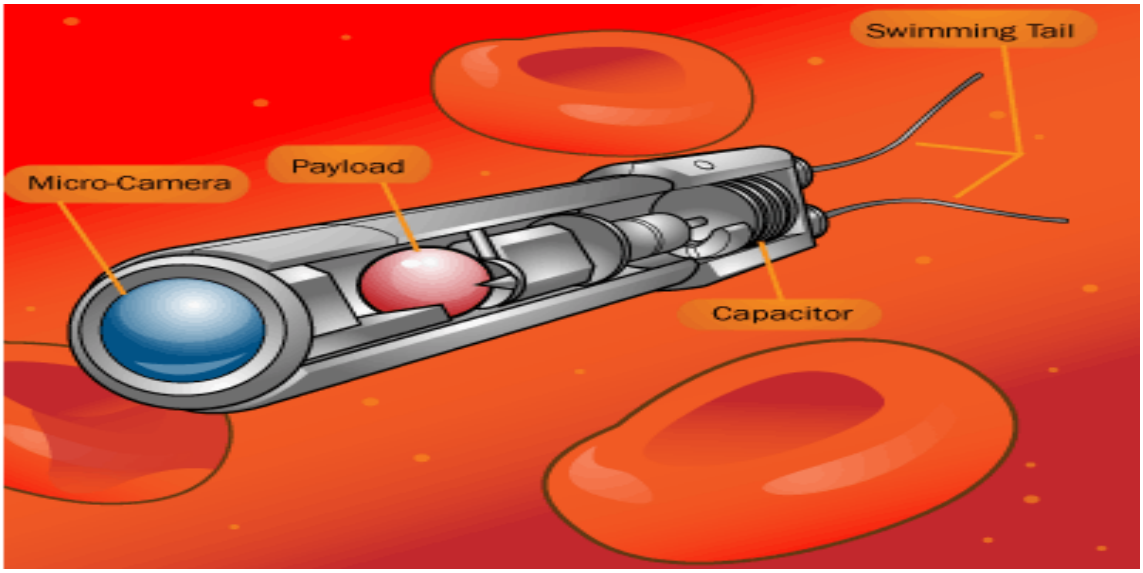

Fig. 1: The robot in this illustration swims through the arteries and veins using a pair of tail appendages.

Methodologies used for successful application of nanorobots

a) Microbiology

The stream of the microbiology has been successfully used as a spring board for the initial modification of robotic functions in nanobiotechnology. Although micro robots and Nanorobots can be constructed and have functioned, their use within the vascular system is limited by challenges with transportation and propulsion. An effective strategy for enabling propulsion of micro robots and nanorobots is coupling them to magneto tactic bacteria such as Magneto coccus, Magneto spirillum magnetotacticum or Magneto spirillummagneticum.[20,24]

The largest components of these nanorobots integrated into magneto-tactic bacteria would be the bacterial cell component. The smallest known species of magneto-tactic bacteria is the marine magneto-tactic spirillum, which is 0.5 µm (500nanometers), just above the upper limit of the NNI's definition of the nanoscale. However, the marine magneto-tactic spirillum's usefulness is limited by their speed, and magneto-tactic Cocci are more useful for intravascular function.[25,26]

b) Hematology

Nanorobotics may also have applicability in Hemostasis process. Hemostasis involves several steps with a number of promoters and inhibitors balancing thrombosis and fibrinolysis. With its proper mechanism of working can be very effective in halting bleeding and promoting

vessel repair. Still there are natural limitations to physiologic hemostasis, such as an average bleeding time of about five minutes. With the help of nanorobotics, it can be overcome. Emphasis on impairment of our physiologic hemostatic mechanisms, such as with thrombocytopenia, our current methods of correcting this impairment have inherent risks. On other hand platelet transfusions risk causes infection with pathogens which results in triggering an immune response.

The proposed nanorobot for this is "colonocyte". It is two-micron nanorobot with mesh as thin as 0.8 nm and included with hemostasis promoting proteins. They are fired at areas of vessel injury to carry out hemostasis. Finally, another potential use of nanorobots is as phagocytic agents.

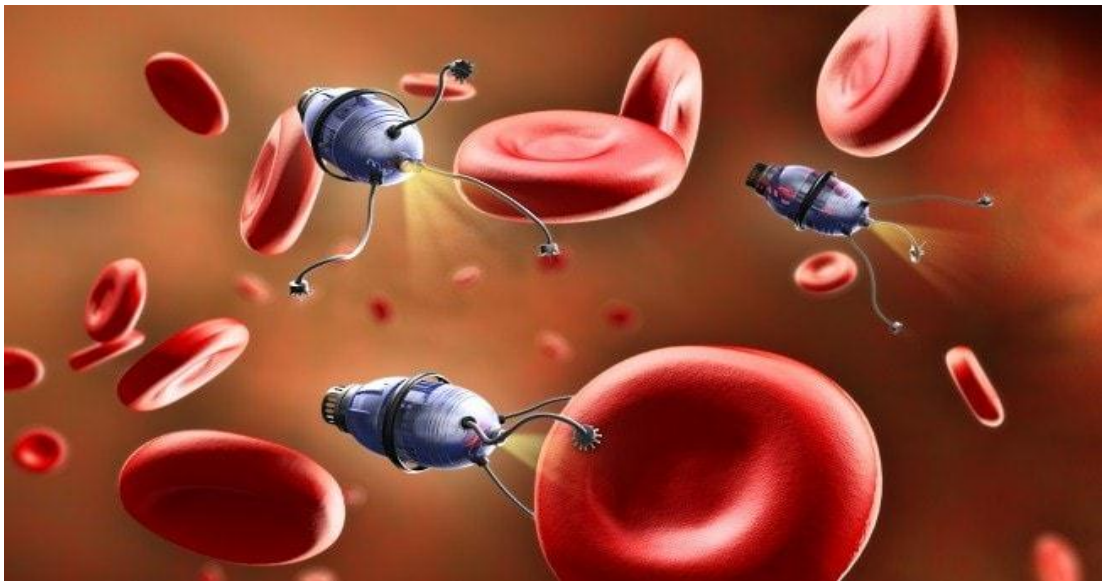

Fig. 2: Nanorobots targeting red blood cells.

"Microbivores. "designed to have a large number of customizable binding sites on their 3external surface, for antigens or pathogens for anything from HIV to E. Coli. Microbivores are 80 times more effective than our physiologic phagocytic capabilities, and could have the potential to clear septicemia within hours of administration.

Breaking up blood clots: Nanorobots may have applicability in breaking of blood clots and remove blockages. clots can cause complications like muscle death to a stroke. It is is one of the advance uses for nanorobots to remove the blockage without losing small pieces in the bloodstream, which could then travel elsewhere in the body and cause more problems. due its nano size it doesn't block the flow of blood itself.

Fighting cancer

Researchers are working on its application of nanorobots for the treatment of cancer by attacking tumors directly using lasers, microwaves or ultrasonic signals. By delivering precise doses of medication to the patient, side effects will be minimized without a loss in the medication's effectiveness.

c) Dentistry

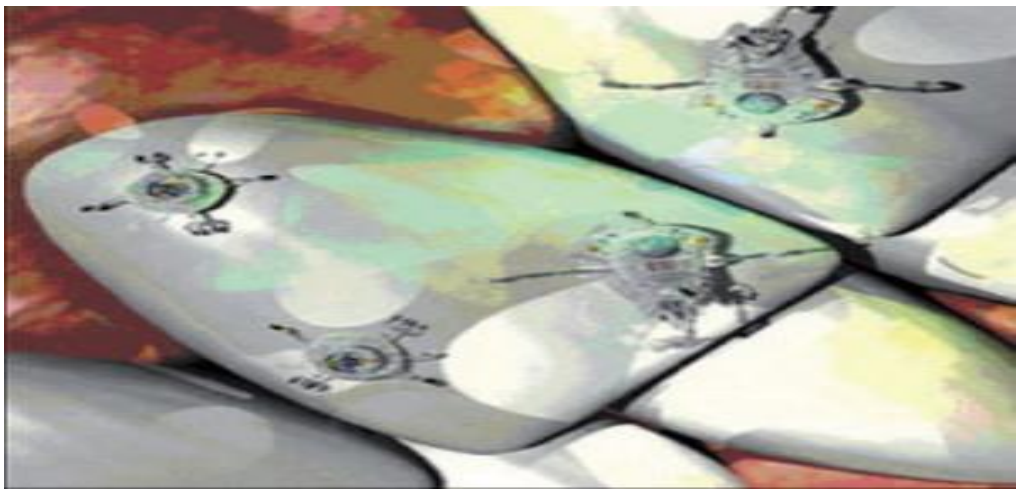

Fig. 3: Mechanism of nanorobots in dentistry.

The growing interest in the future of dental applications of nanotechnology is leading to the emergence of a new field called Nano dentistry. Virtually all the elements of dental treatment could incorporate nanorobots and benefit from their use by providing a higher level of care. These uses range from a routine cleaning, teeth whitening, hypersensitivity, and even orthodontics including initial analgesia. When the suspension of millions of nanorobots is administered orally to the patient. it was observed that robots are small enough to enter the gingival sulcus, and eventually travel through the micron sized dental tubules to reach the pulp. Central control of these nanorobots would allow activation of analgesic activity in highly specific areas. Nanorobots can be enveloped in highly specific proteins to bind the targeted pathogens for the treatment of infection. For a root canal, the use of a tiny camera can provide visualization of the root, reducing any guesswork. Nanorobots has potential to increase the success rate of the root canal It was found that in 2011, the National Health Service had a 70% success rate for root canal procedures, which leaves plenty of room for improvement.

d) Neurosurgery

The process of utilizing nanorobots for neurosurgery includes introduction of nanorobots into the vascular system or body cavities, programmed and controlled remotely by the surgeon, and perform various diagnostic and therapeutic functions in a very precise and minimally invasive manner leading to faster recovery of the patient. nerve damage and spinal cord injury are the major areas of concern in the field of the neurosurgery because it has significant effect on the life of the patient. In current situation, there are many different routes being pursued with the goal of optimizing and improving nerve reconnection outcomes which includes promoting the regeneration of axons via growth factors and enriched scaffolds. Restoration of connectivity to transected axons is an integral step to the restoration of function.

A nano knife of less than 40 nanometer of diameter has been found to be beneficial for the surgery. The dielectrophoretic, involves the use of electrical fields to manipulate polarizable objects in space, has been found to be effective in achieving controlled movement of axons within a surgical field. After that fusion between the two ends can be induced via electro fusion, polyethylene glycol, or laser-induced cell fusion, amongst other methods. nanorobots are enabling a new dimension of precision and control with the reconnection of nerves.

e) Nano robot for brain aneurysm

In case of brain aneurysm prognosis, nano robots required 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 Equipment prototyping, the manufacturing approach, and inside-body transduction this are the three main approaches. The computational nanotechnology provides tool for the fast and effective development of nano robots, helping in the investigation to address major aspects on medical instrumentation and device prototyping. A same approach was previously taken by industry to build submarines, racing cars, airplanes, ICs, and medical devices. Currently the same approach can be used to benefit the development and research of medical nano robots The Manufacturing technology for manufacturing purposes of the nano robot should be integrated as a biochip device.

Human bodies cell morphology, microbiology, and proteomics are used as parameters for nano robot morphology and inside-body interaction Changes on chemical gradients and telemetric instrumentation are used for medical prognosis, with the nanorobots activation

based on proteomic over expression. As per the research these three points are the key pieces required to advance the development and implementation of medical nano robotics. Most proven and effective ways to prevent morbidity and mortality in the field of neurosurgery is nothing but the treatment of cerebral aneurysms before rupture. Nanorobotics can be a potential option for screening for a new aneurysm and monitoring of an identified aneurysm.

CONCLUSION

Nanotechnology as a diagnostic and treatment tool for patients with cancer and diabetes showed how actual developments in new manufacturing technologies are enabling innovative works which may help in constructing and employing nano robots most effectively for biomedical problems. Nano robots hold a wealth of promise from eradicating disease to reversing the aging process such as wrinkles, loss of bone mass and age-related conditions. Nano robots not only have industrial applications but also provides personalized treatments with improved efficacy and reduced side effects that are not available in current scenario. In future nanorobots will provide combined action – surgery with instant diagnostic feedback, drugs marketed with diagnostics, imaging agents acting as drugs. future of molecular nanotechnology will expand enormously the effectiveness, comfort and speed of future medical treatments while at the same time significantly reducing their risk and cost. It is expected that within 10 years, tiny nano robots in your blood might help keep you from getting sick or even transmit your thoughts to a wireless cloud

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