ISSN No:-2456-2165

Nanorobotics: A Step into New Medical Era

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Abstract:- Nano technology is derived from the oldest science that can address almost all of our latest issues, in an extremely précised and accurate manner. Keeping the uniqueness of Nano particles, Nano technology has been integrated with Robotics, and has given birth to a new interdisciplinary called Nanorobotics. Because of the rare phenomena that Nano particles possess like self-replication, high surface area, particle size compatible with biological cells, etc it has a divergent applications in the field of medicine, which needs a continuous advancement. It has been made active in the fields of Cardio-vascular surgery, Oncology, Pharmacology, Drug delivery systems, Orthopedics Dentistry, Gene therapy, etc. here, the most essential qualities that a Nanorobot possesses, its structural features, classification and working mechanism is emphasized with practical approach. A scope for comprehensive work, implementation is also mentioned. So, the dream of the best health care to all is going to be fulfilled by Nano technology, a dawn in the medical engineering.

I. INTRODUCTION TO NANOROBOTICS

➢ *Introduction*

A Nanorobot (also called as Nanobot or Nanoid) is a tiny machine designed to perform a specific task or tasks repeatedly and with precision in Nano scale that is, dimensions of a few Nano meters (1to 100nm) or less and a diameter about 0.5 to 3 microns. The principles of Nanotechnology and Robotics are used in Nanobot. They can directly interact with cell's surface, nucleus and perform manipulations in cellular level, which are beyond the human hand.

➢ *Building blocks of Nanorobot*

Carbon (widely 13C isotope),in the form of CNT's or CNT CMOS biochip is the primary building block of Nanorobots due to high inherent strength, inertness, etc and they are fabricated in Nano factories specialized for this purpose. To avoid the attack of host's immune system, the exterior wall can be coated with passive diamond/ fullerene Nanocomposites. Smooth and flawless coating gives less reaction from the body's immune system.

➢ *Application of Nanorobots in various fields*

Nanorobots have divisive and wide range of applications in various fields such as Medicine, Robotics, Environmental issues, Pharmaceuticals, Electronics industry, Engineering, Energy issues, etc.

➢ *Structure of Nanorobots*

The various components in Nanorobot include power supply, fuel buffer tank, sensors, sorting motors, propeller, manipulators, onboard computers, pumps, pressure tanks and structural support. The substructures in a Nanorobot include: Payload, Micro camera, Electrodes, Lasers, Ultrasonic signal generators, Swimming tail, motor or mechanical leg. They are controlled & monitored by an On-Board computer.

➢ *Qualities of Nanorobot*

- Safety: The Nanorobots will be safe and not hurt the formation process of other systems, especially the nervous and circulatory system.
- Biodegradability: Nanorobots can be expelled from the body without hurting the host or human immune system or through urine, feces or excreta.
- Intelligence: It should be intelligent enough to receive and execute according to our instructions.

II. TYPES OF NANOROBOTS

The major types of Nanorobots are as mentioned in the following with respect to applications.

➢ *Respirocytes*

They are artificial mechanical red blood cells which are blood borne spherical 1µm diameter sized. The outer shell is made of diamond. They have reversible molecule selective pumps. Respirocytes carry oxygen and carbondioxide molecules throughout the body using three rotors controlled by onboard Nanocomputer. The Respirocyte would deliver 236 times more oxygen to the body tissues when compared to natural red blood cells.

➢ *Microbivores*

These are artificial white blood cell or Nanorobotic phagocytes. It is a spheroid device made up of diamond and sapphire which measures 3.4µm in diameter along its major axis and 2.0µm diameter along minor axis. The main function of microbivore is to absorb and digest the pathogens in the blood stream by the process of phagocytosis using its in-built fundamental components as an array of reversible binding sites, telescoping devices, a morcellation chamber and a digestion chamber.

➢ *Clottocytes*

Hemostasis is the process of blood clotting when there is damage to the endothelium cells of blood vessels by platelets. The whole process of natural blood clotting can take 2-5 minutes. But, Nanorobots reduces clotting time and blood loss by delivering corticosteroids directly at the site. It is useful when ribs penetrate into lungs during accidents, brain hemorrhage, CSF leakage, etc. The answer for "what does the Nanorobot performs when it gets at the site or target" is as follows.

ISSN No:-2456-2165

III. NANOROBOTS IN DIAGNOSIS

Robotic diagnosis reduces invasiveness to the human body and improves the accuracy and scope of the diagnosis.

➢ *Nano Biochip*

The combination of Nano-electronics and biomaterials enable to design and fabricate an important research tool means,a biochip useful in diagnosis, surgery and drug delivery. Eg: DNA chips, protein chips and carbohydrate chips.

➢ *Nanoporphyrin robots*

These increase the imaging sensitivity for tumor detection through back ground suppression in blood. After guiding the Nanoporphyrins robots to the unwanted tissue/target, they can differentiate between different cell types by checking their surface antigens (they are different for each type of cell). They are accomplished by the chemo-tactic sensors to target the specific antigens.

➢ *Transferrin Nanorobots*

These are made up of a mixture of polymer and protein can detect cancerous cells using embedded chemical biosensors. Programmed transferring Nanorobots can deliver chemotherapeutic drugs to the target by detecting the level of E-cadherin and betacatenin.

➢ *Bacteria Robot*

It is a genetically-modified non-toxic salmonella bacterium, with a sensing function to diagnosis cancer and delivers the drug by targeting tumors. The interesting feature is that it uses bacteria's brain while moving towards the tumor region with its flagella.

IV. NANOROBOTS IN MINIMALLY OR NON-INVASIVE SURGERY

Robotic surgery involves the use of surgeon assisted robotic equipment for performing surgical operations.

➢ *Cardiovascular Surgery*

The traditional heart bypass surgery involves cutting one foot length through skin, tissues, fascia, muscle, fascia, and then finally gets to the heart. But using Nanorobots, it is possible to perform cardiac surgery by making three small incisions in the chest, each about 0.5 cm in diameter, which is far smaller than the traditional foot-long incision. The similar procedure can be adapted to Brain surgery, so that heart and brain strokes can be avoided.

➢ *Nanoknife*

The use of Nanoknife accomplished by thin and flexible Lead (Pb) Nano fibre in Angioplasty enables to further reduce the cut size, so as to insert a device, around the hair size. Nanorobot with Lead+Nickel surgical mesh can trigger a drug and thus multiple purposes can be served simultaneously.

➢ *Cancer surgery*

- *Nanostars*

The nanostars are approximately 25 nanometers wide, made of gold nanoparticles and shaped like stars. It could also be used in surgery, where once the tumor is removed; the surgeon can then use gold nanostars and the light source to eradicate any stray cancer cells remaining in the surrounding tissue.

➢ *Working Methodology of Surgical Robots*

Surgical robots can give signals to the cells to sleep, die or regenerate and by suppressing bleeding, controlling pain or reducing inflammation. Different Nanorobots interact with each other using logic and conventions as AND, OR and XOR gates, built internally. Inputs are taken from molecules and the outputs are written in the form of drugs delivered to the body. Different locations in the body can be given numerical addresses.

➢ *Nanorobots in Controlled and Targeted Drug Delivery*

Nanorobots can be attached to antibodies, to the surface of cancer cells, which give the body's immune system, identify and destroy those cells on its own. The same method can be implemented for other diseased cells. In ideal Nanorobot, even after its injection into the body, the doctor would still be able to activate or inactivate them remotely, or alter their mode of action or operational parameters. Once treatment was completed, Nanorobots could be removed from the body, leaving no trace of their presence.

- *Nubots*

Nubot is an abbreviation for "Nucleic Acid Robot."They are organic molecular machines. DNA structure can provide means to assemble 2D and 3D Nano mechanical devices. DNA based machines can be activated using small molecules, proteins and other molecules of DNA. Nubots have DNA structure used for targeting drug delivery as a carrier.

- *Pharmacytes*

These Nanorobots, of 1–2nm in size and capable of carrying up to ∼1-3nm of pharmaceutical payload stored in .These ideal vehicles can be recharged, reprogrammed and recycled so that, they can be used for patients with different needs. Based on intensity of infection, the Pharmacytes may deliver its payload via direct Nano injection or by progressive cyto penetration through adjacent cells.

➢ *Nanobots to Repair Damaged Tissue*

Self-replication phenomenon/ property of Nanobots (bacteria or virus sized) enable "Cell replacement and re-growth of damaged tissues" in a weakened immune system, which greatly benefit the victims of high cholesterol, leukemia, AIDS other terrible diseases.

The answer for "How to remove the device when its job is completed" is as: After the completion of the task, Nanorobots can be retrieved by allowing themselves to effuse via centrifuges, usual human excretory channels.

V. CONCLUSION

The Nanotechnology in medicine has a huge and wide scope. A multidisciplinary study helps to acknowledge the reach of technologically sophisticated tools to the common man and make complex treatments cheaper, effective and almost painless.

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