International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A REVIEW ON NANOROBOTS

Rutuja Sunil Bastapure[1], Sayali Arun Dongre[2], Rajlaxmi Sunil Kawale[3], Gopal Vijaykumar Lohiya[4], Kranti Limbajirao Satpute[5]

[1,2,3]Department of Pharmaceutics, Dayanand Education Society, Dayanand College of Pharmacy, Latur, Maharashtra, INDIA.
[4]Department of Pharmaceutical Quality Assurance, Dayanand Education Society, Dayanand College of Pharmacy, Latur, Maharashtra, INDIA.
[5]Department of Pharmacognosy, Dayanand Education Society, Dayanand College of Pharmacy, Latur, Maharashtra, INDIA.

ABSTRACT:

The field of nanomedicine has promise for developing potent new instruments to cure human illnesses and enhance human biological systems. Nanomedicine diagnoses, treats, and prevents disease and traumatic injuries, reduces pain, and preserves and enhances human health by using molecular tools and knowledge of the human body. Nanorobotics is the technology of creating machines or robots at or near a scale of 10-9 meters [nm]. Molecular or nanoscale components make up nanobots, sometimes referred to as nanoids. They are still simply a theoretical concept because no artificial non-biological nanorobots have been created as of yet. Because of its strength and inert properties, experts predict that the surface of a nanorobot will likely consist of carbon atoms arranged in a diamondoid pattern. Because of their incredibly smooth surfaces, which lessen the chance of stimulating the body's immune system, the nanorobots will be able to operate without hindrance. The history, makeup, workings, and uses of nanorobots are the main topics of this page.

Keywords: Nanorobot, Targeted drug delivery, Nanotechnology, Nanomedicine, Mehanism, Application.

INTRODUCTION:

As current biomedical technologies demand innovative, creative methods to replace demanding processes, the necessity for focused drug delivery systems is expanding. By creating a delivery mechanism at the micro level, we seek to eliminate the need for conventional techniques and tools. One potential remedy for these and other medical issues is the use of biomedical micro-robots.

Nanomedicine:

Medical applications of nanotechnology. Engineering and science operations at the atomic and molecular level are referred to as nanotechnology. A billionth of a meter is called a nanometer, which is 10 times that of a hydrogen atom, or around 1/80,000 of the diameter of a human hair. Medicine may be a means of identifying, Curing and avoiding illness and harm; it may be a way of reducing suffering and maintaining and enhancing human health by applying knowledge of the human body and molecular techniques.It involves using nanotechnology, which is a form of mechanical design, to predict and treat human diseases.

By creating robots at the nano or micro scale that move throughout the human body, nanomedicine has the possibility of developing potent new instruments for the purpose of treating illnesses in people and the enhancement of biological systems. These technologies have the potential to redefine traditional procedures.

"The use of molecular tools and molecular knowledge of the human body to diagnose, treat, and prevent disease and traumatic injury, to relieve pain, and to preserve and improve human health is known as nanomedicine."

Nanorobot:

The newly established field of nanorobotics is developing robots or machines with parts that fall within or close to the nanometer (10-9m) scale, with devices that range in size from 0.5-3 micrometers. Any "smart" structure able to act, perceive, signal, process information, exert intelligence, manipulate, and exhibit swarm-like behavior at the nanoscale is referred to as a nanorobot.

Biological organelles, including cells, are comparable in size to these nanorobotic systems. Nanorobotics is the field that addresses the planning, building, and programming of these nanorobots. A wide range of scientific and technological fields, including physics, biology, chemistry, medicine, pharmaceutical science, the field of engineering, biotechnology, and other biomedical sciences, are required to make high-level contributions to this multidisciplinary topic.

A nanorobot, sometimes referred to as a nanomachine, is a tiny mechanical or electromechanical apparatus made to carry out particular activities at the nanoscale. Adriano Cavalcanti is known as a pioneer of nanorobots. These draw inspiration from both machines and nature. Most of the issues in nanomedicine could be resolved by nanorobots.

From quantum molecular dynamics to kinematic analysis, designing nanorobotic systems involves a wide range of scientific disciplines. The laws that apply to nanorobotics vary depending on the kind of nanomaterial that is employed to create the systems. The main component that will presumably make up the majority of a medical nanorobot is carbon, probably in the shape of diamonds or diamondoid nanocomposites. Other light elements including silicon, fluorine, nitrogen, sulfur, oxygen, hydrogen, and others will be used for specific reasons in nanoscale gears and other components.

Advantages

- The use of nanorobots in pharmaceutical delivery systems with improved bioavailability.
- Targeted delivery, which solely addresses malignant cells.
- The procedure is quick and painless.
- Because of automation and computer control, there are fewer errors.
- Make contact with remote areas of the human anatomy that are not reachable from the operating table.
- During mass transfer, the advantages of a large interfacial area can be experienced as drug molecules are moved by nanorobots and released when required. The likelihood of any aftereffects or recurrences is zero.
- A non-invasive method.
- A computer-controlled system that uses knobs to adjust the release's quantity, frequency, and timing.
- Increased precision.
- To reduce unwanted side effects, drugs are inactive in places where therapy is not required.

Disadvantages

- The original cost of the design is extremely high.
- The nanorobot's design is quite complicated.
- Additional technological issues could arise from the technology, such as the emergence of artificial intelligence and reconstruction, which could cause humans to lose control over robots.
- Electrical nanorobots can be impacted by external electrical interference sources such as electric fields, EMP pulses, and stray fields from other in vivo electrical devices.
- Complex, difficult to customize and design.
- In human bodies, robots may sometimes become uncontrollable.
- Few external control systems.
- It might take several years for the technology to be used in practice.

IDEAL CHARECTERISTICS OF NANOROBOTS:

1. They lie within the 1-100 nm sections of the assess run of 0.5 to 3 microns; otherwise, they can fragment the capillary stream.
2. By keeping a valuable stone out of reach, nanorobots prepare for attacks by the secure system.
3. It can communicate with the master by encoding messages to acoustic waves at carrier wave frequencies between 1 and 100 MHz.
4. It has a feature known as self-replication that allows it to create several copies of itself in order to replace damaged units.

APPROACHES:

Nubot:
Nubot is an abbreviation for "nucleic acid robot." They are organic molecule-based devices. Nubots are nanoscale synthetic robotics devices. Nubots can be used as carriers to target the delivery of medications due to their DNA structure. DNA structure can be used to build nanomechanical devices in two and three dimensions. DNA-based devices can be activated by proteins, small chemicals, and other DNA molecules.

Biochip:
Photolithography, nanoelectronics, and new biomaterials can be used to create nanorobots for typical medical applications such as drug delivery, diagnosis, and surgical instrumentation. Nanotechnology has improved the commercial feasibility of biochips by enabling their implantation inside the body to dynamically transfer information and track any biological changes in vivo. Nowadays, biochips are employed in the electronics manufacturing sector. Nanorobots with biochips can be integrated with nanoelectronics devices to facilitate enhanced medical instruments and teleoperation.

Bacteria-based:
This method proposes employing biological microbes, such as the bacteria Escherichia coli. As a result, the model propels itself using a flagellum. Despite its restricted applicability, usually, the mobility of this kind of physiologically integrated device is managed by electromagnetic fields.

Positional nanoassembly:
Robert Freitas and Ralph Merkle created a practical research agenda in 2000 with the specific objective of building a diamonded nano factory that could produce positional-controlled diamond mechanic synthesis and diamonded medical nano robots.

NANOROBOT MECHANISM:

Developing nano robots with integrated nano biosensors and actuators is thought to be a novel way to give doctors access to new medical equipment.

In order to properly promote advanced medical innovations, controls are necessary. It is possible to build more effective methods for prediction of diseases by further downsizing towards integrated medical systems. The use of microdevices in surgery and medical therapies has resulted in a number of improvements in clinical procedures in recent years. Catheterization has been effectively used as the primary technique for both cardiac and cerebral surgery. We are now able to progress the shrinking of devices from micro to nano electronics thanks to the advent of bimolecular science and novel production techniques. The most recent technological advancements in biological sensors serve as the foundation for the creation of bimolecular actuators. Some personnel are also researching some motor and sensory devices, and the first series of nanotechnology prototypes for molecular machines are being analyzed in different ways.

APPLICATION:

In Dentistry:

The growing interest in the possible applications of nanotechnology in dentistry is giving rise to a new field called nanodentistry. Oral pain relief (analgesia), tooth desensitization, tissue manipulation to straighten and realign an uneven set of teeth, and increased tooth durability are all accomplished using nanorobots. Additionally, the use of nanorobots for therapeutic, restorative, and preventive treatments has been revealed.

In nanodentistry, the patient's gingivae will be treated with a colloidal suspension of millions of active analgesic micron-sized dental nanorobots to create an oral anesthetic. After coming into contact with the mucosa or crown surface, the walking nanorobots move into the gingival sulcus. The lamina propria, the 1-3 µm thick layer of loose tissue at the cementoedentinal junction, is then gently penetrated to reach the dentin. The nanorobots use a mix of temperature differentials, chemical gradients, and even positional navigation to navigate toward the pulp after penetrating dentinal tubule holes that range in width from 1 to 4 µm under the guidance of an onboard nanocomputer.

The following are some prospective uses for nanorobots in dentistry:

- Major dental restoration
- lifespan and attractiveness of the tooth
- nanocomposite
- nanoimprint
- care of oral hygiene
- Cavity preparation and restoration
- Dentin hypersensitivity

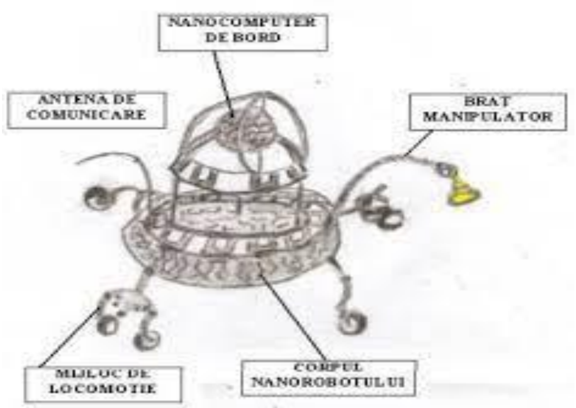

Fig1– Dental Nanorobot

The dental nanorobot seen in Figure 1 is made up of plank-mounted nanocomputers that store and carry out preprogrammed tasks. In order to ensure proper operation of the nanomechanical devices, It will gather, route, and store contextual information as well as connect with nanocomputers that react to external control and evaluation devices. Figure 1 depicts the structure of nanorobots.

In Cancer Detection and Treatment:

The nanorobot is seen attacking the cancer cell in the image below. According to the WHO, Currently, the major cause of death is cancer. Chemotherapy and radiotherapy are the conventional approaches used to treat cancer. However, the patient receiving this treatment must deal with a lot of discomfort and adverse consequences, such as exhaustion, loss of hair, loss weight, etc. In order to circumvent this, scientists have recently proposed the use of nanorobots in cancer treatment. As a result, nanorobots can completely heal a cancer patient without causing any negative side effects. This work offers a novel method for creating, managing, and tracking medical nanorobots for cancer diagnostics in its early stages prior to metastasis. The suggested work develops nanorobot architecture by utilizing RF CMOS, biological flows, and E-cadhering signal analysis in conjunction with mobile phones. The patient will receive an injection containing nanorobots using this technique. Any nanorobot should not be larger than three microns since larger nanorobots will block capillary flow.

To find and eliminate cancer cells, as a chemical parameter, a greater gradient of E-cadherin signal intensity is used. There will be no impact on the other healthy cells. A nanorobot can detect tumor cells more quickly by using chemical signals and certain proteins. To identify a tumor, medical diagnosis uses a single tumor cell in a small venal as a target. The individual undergoing this therapy will observe the improvement in his health even if he is unaware of the Nanorobots.

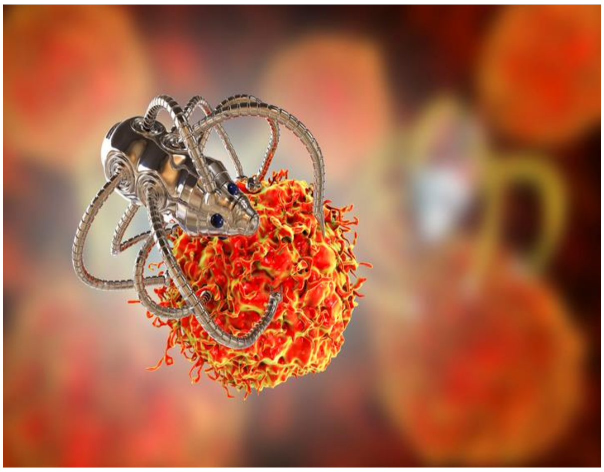

Fig – Nanorobot attacking the cancer cells

In identifying and managing diabetes:

Medical nanorobots keep an eye on diabetes by regulating the body's nutritional concentrations, including diabetic patients' blood glucose levels. To regulate their blood sugar levels, diabetic patients need to draw little amounts of blood several times a day. Procedures like these are very inconvenient and uncomfortable. Inadequate control of blood glucose levels can result in serious issues with the blood vessels. Medical nanorobotics can be used to continuously monitor amounts of glucose to identify the body's sugar content. This crucial information may help medical professionals in monitoring and enhancing patient medication and food plans.

Patients with diabetes may have their blood glucose levels defined by the hSGLT3 molecule. This protein's ability to detect glucose as a sensor is its most interesting attribute. Nanobioelectronics made of Complementary Metal Oxide (CMOS) semiconductors are incorporated into the model of the simulated nanorobot.

It may move freely inside the body because to its size of roughly 2 microns. Whether blood glucose levels are apparent or invisible to immune reactions, the nanorobot detects them with ease. Even when the body's immune system reacts, white blood cells cannot damage the nanorobot since it is biocompatible. For glucose monitoring, the nanorobot employs an integrated chemosensor that alters the hSGLT3 protein glucosensor's activity. Because of its built-in chemical sensor, the nanorobot can effectively determine whether the patient needs insulin injections or any other activity, including taking any prescription that has been prescribed by a clinician.

In Gene Therapy:

Genetic issues can be readily fixed by medical nanorobots by comparing the cell's proteins and DNA molecules to desired or known reference structures. The appropriate changes can then be made in place, or any irregularities can be fixed. In several instances, chromosomal replacement therapy works better than cytorepair. An assembler builds a repair vessel that floats inside a human cell's nucleus and performs some genetic maintenance. Stretching a supercoil of DNA between its lower set of robot arms, the nanomachine carefully pulls the unwound strand through a prow aperture for inspection. Meanwhile, the regulatory proteins of the chain are separated by the top arms and inserted into an intake port. A communications link connects the cell-repair ship to a bigger nanocomputer outside the nucleus, which compares DNA and protein molecular structures to information in its database. Once any abnormalities in either structure are corrected, the proteins are reattached to the DNA chain, which re-coils into its original form. The repair vessel would have a diameter of just 50 nanometers, making it smaller than the majority of bacteria and viruses but still able to provide treatments and cures that are far above the current medical community's capabilities. The term "internal medicine" would have new significance when trillions of these devices were running through patient's blood. Targeting illness at the molecular level might eliminate viral infections, cancer, and arteriosclerosis.

In Surgery:

The catheter ends or the vascular system could be used to introduce surgical nanorobots into different human bodily cavities and channels. A surgical nanorobot can function as a semiautonomous on-site surgeon within the human body if it is programmed or directed by a human surgeon.

An internal computer might organize the device's many tasks, which could include seeking out pathology, diagnosing and repairing lesions by nanomanipulation, and communicating using coded ultrasound messages with the supervising surgeon.

The first forms of cellular nanosurgery are still being studied. For instance, dendrites from single neurons have been fully severed using a Rapidly vibrating (100 Hz) micropipette with a diameter at the tip of less than 1 micron without compromising cell viability. Femtosecond laser surgery was used to conduct an axotomy on roundworm neurons, and the axons subsequently underwent functional regeneration. Similar to a pair of "nano-scissors," a femtolaser vaporizes tissue locally without harming nearby tissue.

Identification and Examination:

Numerous diagnostic, testing, and monitoring functions involving bloodstream and tissue may be performed by medical nanorobots. From any part of the body, these devices may continually monitor and report all important indicators, including temperature, pressure, chemical composition, and immune system activity.

When a patient swallows a nanorobot for diagnostic purposes, it moves toward the surface of the stomach lining to begin searching for signs of an infection.

Nano Impression:

With the application of nanotechnology, impression materials are available. Vinyl polysiloxanes are used as nanofillers to create a special siloxane impression material. The main advantage of the material is its increased flow and hydrophilic properties, which decrease margin voids and improve model pouring and detail accuracy.

Nanomedicine:

Some potential medical applications for nanorobotics include pharmacokinetics, diabetes monitoring, biomedical devices, surgery, early cancer diagnosis, and targeted drug delivery. These suggestions predict that injectable nanorobots will be used in future medical nanotechnology to treat patients at the cellular level. Such nanorobots shouldn't be able to duplicate as doing so would unnecessarily complicate the gadget, reduce its dependability, and obstruct its therapeutic purpose. Instead, it is suggested that medical nanorobots be manufactured in fictitious, tightly controlled nanofactories where tiny tools would be securely integrated into a purported desktop-scale apparatus that would generate macroscopic goods.

Conclusion:

The fast developing science of nanorobotics has the potential to significantly alter medicine. Nanorobots are a promising technology that could improve medicine delivery, allow for precise surgical interventions, and even encourage desirable cellular behavior. The challenges and barriers that nanorobots provide during development are outweighed by their advantages and applications in engineering and medical. Nanotechnology, an emerging medical tool, has shown how actual breakthroughs in new manufacturing technologies are enabling innovative works that could help in the most effective construction and use of nanorobots for biomedical problems. This is especially true for diabetes, arteriosclerosis, dentistry, cancer, and gene therapy. In the future, tailored medicine delivery using nanorobots would be tremendously advantageous. Early diagnosis, better treatment, and better follow-up care are all possible with nanomedicine, which might increase the effectiveness and affordability of healthcare. By taking advantage of the profound knowledge of molecular disorders, nanomedicine will also enable more individualized treatment for a wide range of illnesses. Compared to current drug delivery techniques, nanorobots can provide a variety of benefits. These include increased bioavailability, targeted treatment, reduced surgical mistakes, access to distant human anatomy, a wide interfacial area for mass transfer, computer-controlled distribution, enhanced accuracy, fewer side effects, and a quicker pace of drug action.

ACKNOWLEDGEMENT:

The authors would like to thank Dayanand College of Pharmacy, Latur, for giving support during the composition process. We acknowledge the advice provided by Mr. Lohiya G. V. during the manuscript preparation process.

CONFLICT OF INTEREST:

The authors declare that there is no conflict of interest.

REFERENCE:

1. Abhilash M; Nanorobots; International Journal of Pharma and Bio Sciences 2010, (1): 105-115.
2. Ignatyev, M. B. "N ecessary and sufficient conditions of nanorobot synthesis". Doklady Mathematics 82 (2010), (1): 671–675.
3. Scheufele, D. A., Lewenstein, B. V. "The Public and Nanotechnology: How Citizens Make Sense of Emerging Technologies". Journal of Nanoparticle Research 7 (2005). (6): 659–667.
4. Cerofolini, G., Amato, P., Masserini, M., Mauri, G. "A Surveillance System for Early-Stage Diagnosis of Endogenous Diseases by Swarms of Nanobots". Advanced Science Letters 3(2010). (4): 345–352.
5. Wang, J. "Can Man-Made Nanomachines Compete with Nature Biomotors?". ACS Nano (2009). 3 (1): 4–9.
6. Elder, J.B., Hoh, D.J., Oh, B.C., Heller, A.C., Liu, C.Y. & Apuzzo, M.L. "The future of cerebral surgery: a kaleidoscope of opportunities". Neurosurgery (2008). 62 (6): 1555–1579.
7. Martel, S., Mohammadi, M., Felfoul, O., Lu, Z. & Pouponneau P. "Flagellated Magnetotactic Bacteria as Controlled MRItrackable Propulsion and Steering Systems for Medical Nanorobots Operating in the Human Microvasculature". International Journal of Robotics Research (2009). 28 (4): 571–582.
8. Wong, P. C., Wong, K.-K. & Foote H. (2003). "Organic data memory using the DNA approach". Communications of the ACM 46 (1): 95–98.
9. Seeman. N. C. (2005). "From genes to machines: DNA nanomechanical devices". Trends in Biochemical Sciences 30 (3): 119–125.

10. Brindle, J.A. Tactical military communications: IEEE Common. Mag: 30 (1): 1992: 62–72.
11. Geddes, A.M: The history of smallpox: Clin. Dermatol: 24 (3): 2006: 152–157.
12. Couvreur, P, Vauthier C: Nanotechnology: intelligent design to treat complex disease: Pharm. Res.23 (7): 2006: 1417–1450.
13. Adamson, P.B, Conti, J.B, Smith A.L., Abraham W.T., Aaron M.F., Aranda J.M., Baker J., Bourge R.C., Warner-Stevenson L., and Sparks B: Reducing events in patients with chronic heart failure (Reduce) study design: Continuous hemodynamic monitoring with an implantable defibrillator. Clin. Car diol.: 30 (11): 2007: 567–575.
14. Narayan, R.J.; Kumta, P.N.; Sfeir, C.; Lee, D.-H. Olton, D.; Choi, D. Nanostructured ceramics in medical devices: applications and prospects. JOM56 (10): 2004: 38–43.
15. Hede, S.; Huilgol, N.: Nano: the new nemesis of cancer: J. Cancer Res. Ther.2 (4): 1998:186–195.
16. Murphy, D.; Challacombe, B.; Nedas, T.; Elhage, O.; Althoefer, K.; Seneviratne L.; Dasgupta, P: Equipment and technology in robotics: Arch.Esp.Urol.,60 (4): 2006: 349–354.
17. Roue, C.C.: Aneurysm liner. 6350270US Feb.200831), McNeil J.S.: Nano robot Pioneer Reveal Status of Simulator, Stem Cell Work: Nano Biotech News, Vol.2: 2004: 4-5.
18. Cavalcanti A., Freitas Jr. R.A.: Nanorobotics Control Design: A Collective Behavior Approach for Medicine: IEEE Transactions on Nanobioscience: Vol. 4: 2005: 133-140.
19. Katz E., Ricin A., Heleg-Shabtai V., Willner I., Bückmann A.F.: Glucose Oxidase Electrodes via Reconstitution of the Apo-Enzyme: Tailoring of17Novel Glucose Biosensors: Anal. Chime. Acta.385:1999: 45-58.
20. Mc Devitt M.R., Ma D., Lai L.T., Simon J., Borchardt P, Frank R.K., Wu K., Pellegrini V., Curcio M.J., Miederer M., Bander N.H., Sheinberg D.A.: Tumor Therapy with Targeted Atomic Nano generators: Science 294: 2001:1537-1540.
21. Kumar M.N.V.R.: Nano and Micro particles as Controlled Drug Delivery Devices: J. Pharmacy Pharmaceutical Science: 3(2): 2000:234-258.
22. Adelman L.M., "On Constructing A Molecular Computer", DNA Based Computers II: Dimacs Workshop, Jun. 10-12, 1996 (Dimacs Seriesin Discrete Mathematics and Theoretical Computer Science, V. 44), American Mathematical Society: 1996:1-21.
23. Hagiya M.: From Molecular Computing to Molecular Programming: in Proc.6th DIMACS Workshop on DNA Based Computers, Leiden, and the Netherlands: 2004: 198-204.
24. Fluorescent CdTe: Nanoparticles: J. of Nanoscience and Nanotechnology: 1(2): 2001:133 136.