International Journal of Pharma Research and Technology

Review on Nanorobot as a Nanomachine and Biomedicine

Patil S P*[1], Shaikh A Z[2], Dr. Pawar S P[3], Jain A S[4], Patil D R[5], Shaikh S R[6]
Department of Pharmaceutics P.S.G.V.P.Mandal's College of pharmacy, Shahada
azamph46@gmail.com

Abstract

Nanorobotics is the technology of producing robots or machines with very small scale or Miniscale of a nanometer (10-9 meters), machines constructed at the molecular level (Nano machines) may Be used to detect or identify and cure the human body of its various diseases like cancer. Nano robots are Very good accuracy they perform a specific task with great accuracy and precision at very small scale or Nanoscale dimension. A recent discovery in the field of drug Delivery is target therapy, which improves the diagnostic tests and Medical devices. Nanotechnology is going to revolutionize the world. According to the National Nanotechnology Initiative (NNI). Nowadays these nano robots play a vital role in the field of Bio Medicine. In the pharma-world, the applications of Nanotechnology mean drugs containing nano-sized active ingredients. They are well used to cure HIV, Cancer, Surgery, Bloodstream, gene therapy, Kidney stone removal and other harmful disease they Can restore lost tissue at the cellular level, useful for monitoring, Diagnosing and fighting sickness. The main purpose is to cure many dreadful Diseases in human body.

Keywords-Nanotechnology, Nanorobot, Nanomachine, Biomedicine

Introduction

Nanotechnology can best be defined as a description of activities at the level of atoms and molecules that have applications in the real world. A nanometer is a billionth of a meter, that is, about 1/80,000 the diameter of a human hair, or 10 times the diameter of a hydrogen atom. The size-related challenge is the Ability to measure, manipulate and assemble matter with features on the scale of 1-100 nm. In order to achieve cost-effectiveness in nanotechnology it will be necessary automate molecular manufacturing.

The engineering of Molecular products needs to be carried out by robotic devices, which have been termed nano robots. This review chapter focuses on the state of the art in The emerging field of nano robotics, its applications and discusses in brief Some of the essential properties and dynamical laws which makes this field More challenging and unique than its macro scale counterpart. Some Proponents of nano robotics, in reaction to the grey goo scare scenarios, hold the view that nano robots capable of replication outside of a restricted factory Environment do not form a necessary part of a purported productive Nanotechnology and that the process of self-replication, if it were ever to be Developed, could be made inherently safe. They further assert that their current Plans for developing and using molecular manufacturing do not in fact include Free replicator.[1]

Nanorobot is an electrochemical device comprises of components that are Within the nanometer size range. Within medicine nano-Robotic application Have been successfully used for variety of microbiological hematological of Surgical application. Nanorobot is the technology of producing or creating the machine or robots close to the microscopic (very Small size) scale of a nanometer (10−9 Meters). Nanorobotics refers to nanotechnology- an engineering Discipline for Designing and building (developing) Nanorobot. These devices range from 0.1-10 Micrometers and are made up of nano scale or molecular components. As no artificial, non-biological Nano Robots (machines) have yet been created, they remain a pretending concept. The names nano robots, Nanoids, Nano mites have also been used to describe these hypothetical devices.[2]

What is Nanorobots

Nanorobots are the Nano technologically which originated from Nano Machine which work at nano level in the body. The Nanorobot words consist of NANO and BOT. Nano meaning highly small and bots mean robots. Nanorobots are the electromechanical devices measured on the scale of nanometers. Nanotechnology helps to design, program, manufacture and Control robots at the nanoscale which have a diameter of about 0.5 to 3 microns And will be constructed within dimensions in the range of 1 to 100nm6. Nanorobotics is the study of nanorobots. Nanorobots are capable of operate Objects that have dimensions in the nanoscale range with nanometer Resolution. Nanorobots can repair the cell damage by using surgical Therapeutic procedures in the human body and hence it is an advanced tool for the treatment of various human diseases and biological system. During

Surgery, doctors can communicate or contact with a robot using acoustic Signals which needs to be encoded using decoding system. The wave Frequency of signal ranges between 1-100 MHz.[3]

Components

Nanobearings and nanogears- Bearings and gears are manufactured by Either ball And stick or space filling representation or both. The Bearing is Made up of 206 carbon atoms, silicon, Oxygen and hydrogen. It contains a Small shaft Which has 2.2nm diameter rotate in ring. The Combination of ring And shaft gives low resistance In shaft rotation. Molecular gear assembly is 4.4nm long,4.3 nm in Diameter and has molecular weight 51009.84 Da And Has 12 moving parts. The gear is made up of Silicon shell with Sulphur atom Termination.

Payload- It is a void section which holds the drug. Nanorobot When inside The body releases the drug through Payload on the site of action. [4]

Micro-camera- It helps the controller to navigate the path of Nanorobot in the Circulatory system. It helps in Monitoring the working of nanorobots.

Electrodes- Electrodes could have the ability to make battery With ions Present in the biological fluid. These Control may be protruding which can be Used to kill Tumor by producing electric current and inflaming The surface Control can be obtain which can be used To kill tumor.

Laser- Laser embedded nanorobots are used in the case of Destruction of Plaques in arteries and blood clots.

Ultra-sonic signal generator- Ultrasonic sounds are often utilized with the Help of Nanorobots which would irradiate kidney stone to provide mean of propulsion to travel Inside the Body against the flow of blood.

Nanocomputers-For the efficient activity Nanorobots essentially Requires onboard computers. This is a helpful tool to Control Nanorobot for the physicians For activity, Nanorobots are embedded With the Swarm intelligence. Swarm intelligence is a Technique embedded for The artificial intelligence. The three types of swarm intelligence are ant colony.[5]

Types of Nanorobots

1. **Smallest engine ever created:** A cluster of physicists from the University of Mainz in Germany Recently designed the littlest engine ever created from Simply one atom. Like all Alternative engine, it converts

energy into Movement however it will therefore on a smaller scale Than ever seen before. The atom is cornered in a very cone of electromagnetic energy and lasers Square Measure accustomed heat it up and cool it down, that causes the atom To move back and forth within The cone like an engine piston.[6,7]

2. **3D-motion nanomachines from desoxyribonucleic acid:** Mechanical Engineers at Ohio State University have designed and made advanced Nanoscale mechanical components using DNA origami‘ Proving that an Equivalent basic design principles that apply to typical full-size machine Components Will currently even be applied to DNA and might manufacture Advanced, controllable components For future nanorobots.[8,9]
3. **swimmers:** ETH Zurich an Technion researchers have developed an Elastic nanoswimmer‖ polypyrrole (Ppy) nanowire regarding fifteen Micrometers (millionths of a meter) long And two hundred nanometers thick That may move through biological fluid environments at nearly Fifteen Micrometers per second Then anoswimmers might be functionalized to deliver Medicine and Magnetically controlled to swim through the blood to focus on Cancer cells, as an example.[10,11]
4. **Ant-like nanoengine with 100x force per unit weight:** University of Cambridge researchers have Developed a little engine capable of a force per Unit-weight nearly 100 times over any motor or muscle. The new nano-engines May lead to nanorobots small enough to enter living cells to fight illness or Disease, the researchers say. Academician Jeremy Baumberg from the Cavendish Laboratory, who led The research, has named the devices actuating Nanotransducers (ANTs). Like real ants, they Manufacture massive forces for Their weight.[12,13]
5. **A Sperm-inspired microrobot:** group of scientist at the University of Twente (Netherlands) and German University in Cairo (Egypt) has created Sperm-inspired micro robots, which could be controlled By periodical weak Magnetic fields. They go to be used in advanced micro-manipulation and Targeted Medical aid tasks.[14]
6. **Bacteria-powered robots:** Bacteria-powered robots: Drexel University

Engineers have developed a Way for using electrical fields to help microscopic Bacteria Powered robots notice obstacles in their Setting and navigate around them. Uses include delivering medication, manipulating stem cells to direct Their growth, or building a microstructure, as an example.[15]

7. **Nanorockets:** Many teams of scientists (researchers) have recently made a High-speed, pilotless Nanoscale version of a rocket by combining Nanoparticles with biological molecules. The researchers to develop the Rocket therefore it will be utilized in any environment; as an example, to Deliver Medicine to a target area of the body.[16]

Application

Medical nanorobots can be used to perform various functions in diagnosis, Monitoring and treatment of diseases.

Cancer treatment- Presently available therapy for the treatment of cancer is Radiation therapy and chemotherapy. The technology like nanorobots can be Used to detect and cure cancer cells. Functions like searching for tumors, Diagnosis and destruction by nanomanipulation can be performed and Coordinated by nanorobots. The use of nanorobots in cancer therapy will reduce the side effects like nausea, vomiting, decreased immunity, alopecia18 Nanorobots can detect the tumor cells in the early stages of development and Reduces the severity of the stage. Nanorobots provides non-depressed therapy For the patients.[17]

Nanorobots in the bloodstream- The nanorobots maintain their positions Near the Blood vessel walls to improve the detection Response and biosensing Capabilities. After the one Nanorobot is attached to the target it is programmed to attract other nanorobots to help ahead for the Incisive chemotherapy on the Tumor target. It will also give accurate position of a tumor to Doctors using The software. Chemical concentrations And signal intensities can attract or Repel the Nanorobots at the target estimates the number Of bots present at the Site. Hence, nanorobots stop Attracting others as enough number is present.[18]

Helping the body clot- One particular kind of Nanorobot is the clottocyte, or artificial platelet. The Clottocyte carries a small mesh net that dissolves into a Sticky membrane upon contact with blood plasma. According to Robert A. Freitas, Jr., the man who designed the clottocyte, clotting could be up to 1,000

Times faster than the body's natural clotting mechanism.

Nanorobotics in Surgery- Surgical nanorobots act as semi-autonomous on-Site surgeon inside the human body and are Programmed or directed by a human surgeon. This surgical nanorobots are performs the varied functions Like find out the pathogens, and then kills them or diagnosis and correction of lesions by nano-Manipulation synchronized by an on-board computer while Conserving and contacting with the Supervisory surgeon through coded Ultrasound signals. Nanorobotics in Surgery Nowadays, the earlier forms of Cellular nano surgery are being explored.[19]

Nanorobotics in Gene Therapy- Nanorobots are applicable in curing genetic Diseases, by relating the molecular structures of DNA and Proteins in the cell. The modifications and irregularities in the DNA and protein sequences are Then Corrected (edited). The chromosomal replacement therapy is extremely Economical compared to the cell Repair. An assembled repair vessel is inbuilt In the physical structure of material or human body to perform The maintenance of genetics by floating inside the nucleus of a cell. Super coil of DNA when enlarged within its lower pair of robotic arms, the nanomachine Pulls the strand Which is unwounded for analysis, meanwhile the upper arms Detach the proteins from the chain.[20]

Nanorobots diabetic patients- Nanorobots can also be used as ancillary Devices for processing different chemical reactions in the affected Organs. These robots are also useful for monitoring and controlling the glucose levels In diabetic patients.[21]

Nanorobot Breaking up kidney stones- Kidney stones can be Intensely Painful the larger the stone the more difficult it is To pass. Doctors break up large kidney stones using Ultrasonic frequencies, but it's not always effective. A Nanorobot could break up kidney stones using a small Laser.[22]

Nanorobot for brain aneurysm- The nano robot 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 nano robots, Helping in the investigation To address major aspects on medical Instrumentation and device Prototyping. A similar approach was previously Taken by

industry to Build racing cars, airplanes, submarines, ICs and medical Devices.. [23]

Recent Developments

There have been promising developments in the field of nanorobots recent Years. Cancer treatment is the probably main reason for development of Nanorobotics. If nanorobots are used for drug delivery instead of Chemotherapy, cancer treatment will be easier because side effects of Chemotherapy will be disappeared.

Nanorobots could be used in central nervous systems by replacing damaged Neurons. It may provide benefits for brain surgeries. There may not be need to Drill a hole in the skull to access brain. In addition to these, motor neuron Diseases such as paralysis can be treated using nanorobots. When Nanorobots injected into body, they may locate themselves at specific places In the brain and act as motor neurons and pick up impulses which would Normally be delivered.

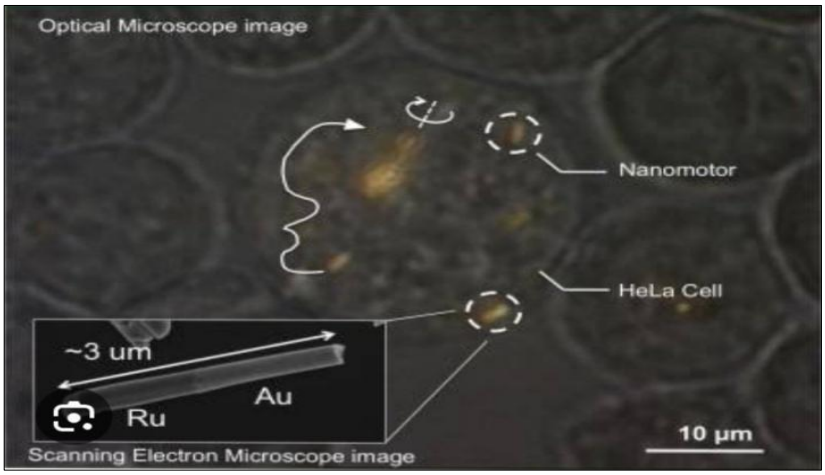

Figure No 1 : Optical microscope image of a HeLa cell containing several gold-ruthenium nanomotors

The chemically powered nanomotors generally have been studied “in vitro” (outside of the body) not “in vivo” (inside the body) since their fuels were Toxic. This was an important drawback for the safety and development of nanorobots inside the body as controlled nanomachines. Recently, two Studies have been reported. First one is the “Acoustic Propulsion of Nanorod Motors Inside Living Cells”[24] which was a result of Development of ultrasonic-wave powered minerals, which are safe for Living systems. The research was funded by the National science foundation (MRSEC grant DMR-0820404), the National Institute of Health, the Hurk Innovative and Transformative seed Fund (HITS) and Penn

State University The ultrasonic propulsion of rod shaped nanometre which is made of gold was Tested on living HeLa cells. Fig (1) shows optical microscope image of HeLa Cell containing several gold ruthenium nanomotors. In Fig (1) arrows Indicate the trajectories of the nanometre, and solid white line shows to the propulsion. Near the center of the image, a spindle of several nanomotors is spinning. According to authors, "The nanomotors have little effect on the cells. As the power is increased, the nanomotors spring into action, moving around and bumping into organelles structures within a cell that performs Specific functions. The nanomotors can act as egg beaters to essentially homogenize the cell's contents, or they can act as battering rams to actually Puncture the cell membrane." The results of this study may reveal that Nanomotors may safely be used to treat cancer and other diseases by Mechanical manipulation. Authors claim that "Nanomotors could perform Intracellular surgery and deliver drugs noninvasively to living tissues. Moreover, Autonomous motion might help nanobots selectively destroy the Cells that engulf them.[25]

Gao et al Reported an in vivo model of artificial micromotors in a living Organism. The model examines the distribution, retention, cargo delivery, And acute toxicity profile of synthetic motors in mouse stomach via oral Administration. The zinc based synthetic motors are based on chemical (acid – driven) propulsion. Authors demonstrate that "the acid-driven propulsion In the stomach effectively enhances the binding and retention of the motors As well as of cargo payloads on the stomach wall. The body of the motors gradually dissolves in the gastric acid, autonomously releasing their carried Payloads, leaving nothing toxic behind. This work is anticipated to significantly advance the emerging field of nano/micromotors and to open the Door to in vivo evaluation and clinical applications of these synthetic motors". This development may be an important step for the possibility of in vivo Applications of the drug delivery for the cancer treatment with decreasing The side effects of chemotherapy. [26]

Conclusion

Use of nanorobots in medical operation will Give a wealth of pledge. Nanotechnology in Colorful fields faces numerous challenges. The use of Nanorobots in medicine delivery will lead to rapidly Relieve. The cure for a Particular complaint will be Accessible and easy. The remedy using Nanorobots Will reduce the side goods significantly. Critical Surgeries can be Avoided and done with lower

pain to the case. Nanorobots covering a Nutritive attention in three- dimensional Workspaces Is a possible operation of nano-Robotics in the medical field than any other Biomedical problems. Nanorobotics has a strong Implicit to dominate Healthcare, to treat conditions in The future. Accordingly, they change the Shape of The assiduity, broadening product development. Nanorobotics has Made great development, but the Disadvantages related to it make it less Important. Hence we need to improve the ways to similar An extent that we Could hope nanorobot with all its Challenges and openings will come part of Our future.

Reference

1. *Dr. M Sivasankar, Professor and Director of Bio-MedicalResearch, Arunai Engineering College, Velu Nagar, Mathur, Tiruvannamalai, Tamilnadu,India*
2. *Alfadul, S.M. and Elneshwy, A.A. (2010). Use of nanotechnology in food Processing, packaging and Safety review. African Journal of Food, Agriculture, Nutrition and Development.*
3. *Farokhzad O C, Langer R. Nanomedicine: Developing smarter therapeutic and Diagnostic modalities, Advanced drug Delivery reviews, 58(14), 2006, 1456-1459.*
4. *Cale T S, Lu J Q, Gutmann R J. Three Dimensional integration in Microelectronics: Motivation, processing, and Thermomechanical modelling, Chemical Engineering Communications, 195(8), 2008, 847-88.*
5. *Kharwade M, Nijhawan M and Modani S. Nanorobots: A Future Medical Device in Diagnosis and Treatment, Research heJournal Of Pharmaceutical, Biological and Chemical Sciences, 4(2), 2013, 1299-1307.*
6. *Farokhazad, O.C. and Robert, Langer. (2009). Impact of nanotechnology on Drug delivery. ACS Nano., 3(1): 16–20.*
7. *Feynman R.P. (1960). There is plenty of room at the bottom. California Institute of Technology. Journal Of Engineering Science, 4(2): 23–36.*
8. *Jain Kewal, K. (2007). Applications of nanobiotechnology in clinical Diagnostics. Clinical chemistry. Oak ridge conference., 53(11): 2002–2009.*
9. *Kubik, T., Bogunia-kubik, K. and Sugisaka, M. (2005). Nanotechnology On duty in medical Applications. Current pharmaceutical biotechnology, 6: 17–33*
10. *Kumar, S.S and Babu, P.S. (2006). Nanotechnology. Pharma Times, 38: 18–19.*
11. *Leary, S.P., Liu, C.Y. and Apuzzo, M.L.I. (2006). Toward the emergence of Nanoneurosurgery: Part III Nanomedicine: Targeted nanotherapy,*

nanosurgery And progress toward the realization of Nanoneurosurgery. Neurosurgery, 58(6): 1009–1025.

12. *Mandal, G. and Ganguly, T. (2011). Applications of nanomaterials in the Different fields of Photosciences. Indian Journal of physics, 85(8): 1229–45.*
13. *Parakh, S.R., Swati, C., Jagdale, S., Dodwadkar Namita, S. and Savalia Kashyap, D. (2008). Nanotechnology, The Indian pharmacist, 15–18*
14. *Qusimchaudhry. (2012). Nanotechnology applications for the food sector and Implications for Consumer safety and regulatory controls. www.jifsan.umd.edu accessed on 03 August 2012*
15. *Rathi, Ravindran. (2011). Naanotechnology in cancer diagnosis and treatment: An overview. Oral and Maxillofacial Pathology Journal, 2(1): 101–106.*
16. *Hill, C, Amodeo, A, Joseph, J V, Patel HRH; Nano and microrobotics: how Far is the reality? Expert Review of anti-cancer therapy, 2008; 8(12): 1891-1897.*
17. *Couvreur P, Vauthier C; Nanotechnology: Intelligent design to treat complex Disease. Pharmaceutical Research, 2006; 23(7): 1417-1450.*
18. *Freitas Jr. R A. Nanomedicine, Volume I: Basic Capabilities, Landes Bioscience, Georgetown, TX 1999, Sections (k) 10.4.1.2.*
19. *Elder J B, Huh D J, Oh B C, Heller A C, Liv C Y, Apuzzo M L; The future of Cerebral surgery a Kaleidoscope of opportunities. Neurosurgery, 2008; 62(6): 1555-1579.*
20. *LaVan D A, Mc Guire T, Langer R; Small-scale systems for invitro drug Delivery. Nature Biotechnology, 2003; 21(10): 1184.*
21. *Cavalcanti A. Assembly Automation with Evolutionary Nanorobots and Sensor-Based Control applied To Nanomedicine, IEEE Transactions on Nanotechnology, 2(2), 2003, 82-87. Cavalcanti A, Shirinzadeh B, Kretly L C. Medical nanorobotics for diabetes control. Nanomedicine*
22. *Lukeman Hakkim S, Ranjitha A. Replacement of Heart Bypass Surgery Using Nanorobots: A Review, International Journal of Novel Research in Engineering and Science, 2(2), 2016, 7-12.*
23. *Genov R, Stanacevic M, Naware M, Cauwenberghs G, Thakor NV (2006) 16-Channel integrated potentiostat for distributed neurochemical sensing. IEEE Transactions on Circuits and Systems I—Regular Papers 53: 2371–2376.*
24. *Buchanan JR, Kleinstreuer C (1998) "Simulation of Particle-Hemodynamics In a Partially Occluded Artery Segment with Implications to the Initiation of Microemboli and Secondary Stenoses". J Biomech Eng 120: 446-454.*

25. *K. Weidner, "Nanomotors Are Controlled, for the First Time, Inside Living Cells," [Online] Available From: http://science.psu.edu/news-and-Events/2014-news/Mallouk2-2014. [Accessed on September 21st 2015]*
26. *W. Gao, R.Dong, J. Wang, S. Thamphiwatana, J. Li, W. Gao, L. Zhang, And J. Wang, "Artificial Micromotors in the Mouse's Stomach: A Step toward In Vivo Use of Synthetic Motors", ACS Nano, Vol. 9, pp. 117–123, 2015.*