An Overview on Nanobots ands its Applications

Dr.G.Dharmamoorthy[1]*, Dr.Mallikarjuna B.P[2],Sreehitha.C ,K.Sowmya , B.Mahimaswaroopa, S.Anitha ,V.K .Trisha,S.Varsha,B.Rushitha. M.Lakshmi Manuhya ,

Department of Pharmaceutical Analysis Sree Vidyanikethan college of pharmacy (Erst while) Mohan Babu University.Sree Sainath Nagar.Rangampeta Tirupathi-517102 Andhrapradesh

CORRESPONDING AUTHOR Dr.G.DHARMAMOORTHY

Professor &HOD Deppartment of Pharmaceutical Analysis.Sree Vidyanikethan college of pharmacy(Erst while) Mohan Babu University Sree Sainath Nagar.Rangampeta Tirupathi-517102, Chittoor (dt).

Email id dharmamoorthy111@gmail.com

Abstract

Nowadays the health care industry is more focused on improving the quality of medical treatments by developing minimally invasive techniques for diagnosis and including with the help of new advances in the field of nanotechnology. Nanotechnology is the creation and utilization of materials, devices, and systems through the control of matter on the nanometer-length scale. Nanorobotics is also being developed for therapeutic manipulations... Nanotechnology through nanorobotics offers enormous advantages over the conventional methods for diagnosis and treatment, precisely because of the knowledge gained from converging domains like molecular biology, mesoscopic/supramolecular chemistry, and mesoscopic physics at the nanometer scale. Regardless of some limitations, nanorobots are fascinating nanodevices for the implementation of advanced biomedical instrumentation. Reliable applications for nanorobotics in medicine include early diagnosis and targeted drug delivery for cancer, arteriosclerosis, tissue engineering, dental surgery, pharmacokinetics monitoring of drug delivery, cellular assistance in inflammatory responses, ophthalmology, and many othersFinally, the safety issues of nanoparticles are discussed including measures to address these. The future prospects of nanobiotechnology are excellent.This chapter briefly describes some concepts about the design, mechanism, and classification of nanorobots, mainly focusing on the medical applications of these promising nanodevices.

Keywords: Nanorobotics,target drug delivery,diagnosis,nanodevices

Introduction

Nanoid robotics, or for short, nanorobotics or nanobotics, is an emerging technology field creating machines or robots whose components are at or near the scale ofa nanometer (10^{-9} meters).More specifically, nanorobotics (as opposed to microrobotics) refers to the nanotechnology engineering discipline of designing and building nanorobots with devices ranging in size from 0.1 to 10 micrometres and constructedof nanoscale or molecular components[1-3] The terms nanobot, nanoid, nanite, nanomachine and nanomite have also been used to describe such devices currently under research and development.

Nanomachines are largely in the research and development phase, but some primitive molecular machines and nanomotors have been tested. An example is a sensor having a switch approximately 1.5 nanometers across, able to count specific molecules in the chemical sample. The first useful applications of nanomachines may be in nanomedicine. For example,] biological machines could be used to identify and destroy cancer cells.[10][11] Another potential application is the detection of toxic chemicals, and the measurement of their concentrations, in the environment. Rice University has demonstrated a single-molecule car developed by a chemical process and including Buckminsterfullerenes (buckyballs) for wheels. It is actuated by controlling the environmental temperature and by positioning a scanning tunneling microscope tip.

Another definition is a robot that allows precise interactions with nanoscale objects, or can manipulate with nanoscale resolution. Such devices are more related to microscopy or scanning probe microscopy, instead of the description of nanorobots as molecular machines. Using the microscopy definition, even a large apparatus such as an atomic force microscope can be considered a nanorobotic instrument when configured to perform nanomanipulation. For this viewpoint, macroscale robots or microrobots that can move with nanoscale precision can also be considered nanorobots[4]

Nanorobotics theory:

According to Richard Feynman, it was his former graduate student and collaborator Albert Hibbs who originally suggested to him (the idea of a medical use for Feynman's theoretical micro-machines . Hibbs suggested that certain repair machines might one day be reduced in size to the point that it would, in theory, be possible to (as Feynman put it) "swallow the surgeon". The idea was incorporated into Feynman's case study 1959 essay There's Plenty of Room at the Bottom[5]

Since nano-robots would be microscopic in size, it would probably be necessary for very large numbers of them to work together to perform microscopic and macroscopic tasks. These nano-robot swarms, both those unable to replicate (as in utility fog) and those able to replicate unconstrained in the natural environment (as in grey goo and synthetic biology), are found in many science fiction stories, such as the Borg nano-probes in Star Trek and The Outer Limits episode "The New Breed". Some proponents of nano-robotics, in reaction to the grey goo scenarios that they earlier helped to propagate, hold the view that nano-robots able to replicate outside of a restricted factory environment do not form a necessary part of a purported productive nanotechnology, and that the process of self-replication, were it 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-foraging replicators.[6-7]

A detailed theoretical discussion of nanorobotics, including specific design issues such as sensing, power communication, navigation, manipulation, locomotion, and onboard computation, has been presented in the medical context of nanomedicine by Robert Freitas. Some of these discussions remain at the level of unbuildable generality and do not approach the level of detailed engineering.

Nanorobot race

In the same ways that technology research and development drove the space race and nuclear arms race, a race for nanorobots is occurring. There is plenty of ground allowing nanorobots to be included among the emerging technologies. Some of the reasons are that large corporations, such as General Electric, Hewlett-Packard, Synopsys, Northrop Grumman and Siemens have been recently working in the development and research of nanorobots; Surgeons are getting involved and starting to propose ways to apply nanorobots for common medical procedures. universities and research institutes were granted funds by government agencies exceeding $2 billion towards research developing nanodevices for medicine. bankers are also strategically investing with the intent to acquire beforehand rights and royalties on future nanorobots commercialisation. Some aspects of nanorobot litigation and related issues linked to monopoly have already arisen. A large number of patents has been granted recently on nanorobots, done mostly for patent agents, companies specialized solely on building patent portfolios, and lawyers. After a long series of patents and eventually litigations, see for example the invention of radio, or the war of currents, emerging fields of technology tend to become a monopoly, which normally is dominated by large corporations.

Nanobots and its Uses

Nanobots are robots that carry out a very specific function and are ~50–100 nm wide. They can be used very effectively for drug delivery. Normally, drugs work through the entire body before they reach the disease-affected area. Using nanotechnology, the drug can be targeted to a precise location which would make the drug much more effective and reduce the chances of possible side effects. Special sensor nanobots can be inserted into the blood under the skin where microchips, coated with human molecules and designed to emit an electrical impulse signal, monitor the sugar level in the blood.

The drug carriers have walls that are just 5–10 atoms thick and the inner drug-filled cell is usually 50–100 nm wide. When they detect signs of the disease, thin wires in their walls emit an electrical pulse which causes the walls to dissolve and the drug to be released. A great advantage of using nanobots for drug delivery is that the amount and time of drug release can be easily controlled by controlling the electrical pulse . Furthermore, the walls dissolve easily and are therefore harmless to the body. Elan Pharmaceuticals has already started using this technology in their drugs Merck's Emend and Wyeth's Rapamune . Nanomedicine could make use of these nanorobots (e.g., Computational Genes), introduced into the body, to repair or detect damages and infections. Using nanotechnology, the drug can be targeted to a precise location which would make the drug much more effective and reduce the chances of possible side effects. In the future, these nanorobots could actually be programmed to repair specific diseased cells, functioning in a similar way to antibodies in our natural healing processes.

Engineering nanomedicine: nanobots and nanosponge

ENMs can also be dynamic and producing the effect on-site by changing its mechanical and structural conformation. The terms of nanobots do not rely for a little Transformers robot swimming in our body but to a chain of atoms that can be activate externally from light or other energetical sources. Robert Pal's lab pioneering described how mechanical atomic machine can act as a drill in cancer cells where a nanomechanical action is provided onto the tumor cell membrane and the light-driven motors inactivated by UV. The same photodynamic therapy can be adopted for hybrid nano(bot)system based on compatible silicon carbide nanowires conjugated with porphyrin derivative that release singlet oxygen when irradiated by the X-ray. Nanomachine can also be used to simulate some in vivo function, for example, muscle contraction. Nobel laureate Bernard Feringa recently proposed that artificial muscle–like function using nanofibers assembled into a linear bundle that makes strings centimeter long. When illuminate with light (so energy needs to be transferred somehow), the artificial muscle contracts toward the light source in a controlled and defined manner[8] .

A last fascinating aspect of ENMs is related to the possibility to create a "nanosponge" able to clean the district where it will be delivered or stick onto a given target for delivery their cargo. Recently, a nanosponge therapy has been proposed in the context of intraocular infection where cytolysin produced by bacteria can be absorbed by the nanosponge and reducing the infection and the hemolityic activity by 70%. The material of miracles, that is, graphene, can also be adopted as nanosponge;

So, ENMs for therapeutic purpose are certainty on its infancy requiring a multidisciplinary background for growing; the medical community aspect this therapeutic and healthcare revolution with open arms but with a technical, safety, and security aspects that needs to be controlled and assessed rigorously

Nanorobotics

Robotics is already developing for applications in life sciences and medicine. Robots can be programmed to perform routine surgical procedures. Nanobiotechnology introduces another dimension in robotics, leading to the development of nanorobots also referred to as 'nanobots'. Instead of performing procedures from outside the body, nanobots will be miniaturized for introduction into the body through the vascular system or at the end of catheters into various vessels and other cavities in the human body[9]. A surgical nanobot, programmed by a human surgeon, could act as an autonomous on-site surgeon inside the human body. Various functions such as searching for pathology, diagnosis, and removal or correction of the lesion by nanomanipulation can be performed and coordinated by an on-board computer. Such concepts, once science fiction, are now considered to be within the realm of possibility. Nanobots will have the capability to perform precise and refined intracellular surgery, which is beyond the capability of manipulations by the human hand[10-11]

DNA hacking with nanorobots

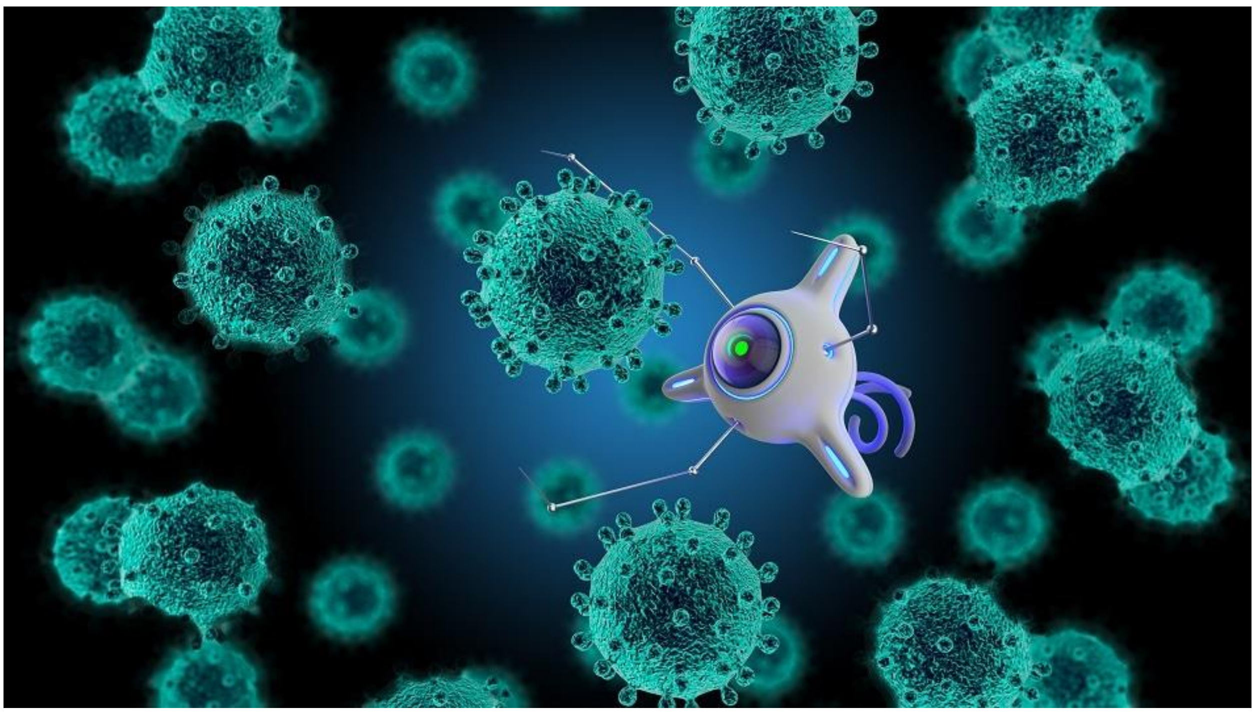
A nanorobot is an autonomic preprogrammed structure of atomic level. It belongs to the nanorobotics engineering discipline. It is a machine that can build and manipulate things precisely. It is a robot that can arrange atoms like Lego pieces and is able to build any structure from basic atomic elements such as C, N, H, O, P, Fe, Ni, and so on. In fact, we should realize that each of us is alive today because of billions of nanobots operating inside our trillions of cells. We give them biological names like “ribosome,” but they are essentially machines programmed with a function like “read DNA sequence and create a specific protein[12].”

The DNA processing pipeline begins with DNA strands in a test tube. Hence, we start our security explorations from this point. The first option is to evaluate if we can compromise a computer program using physical DNA. Nanorobots are activated by logical AND gates (circuits that produce an output signal only when signals are received simultaneously through all input connections) to demonstrate their ability to navigate nanorobots' functions. A nanorobot is any active structure that is capable of the following functions: actuation, sensing, manipulation, propulsion, signaling, and information processing at the nanoscale. But most importantly, nanorobots can participate in a variety of DNA hacking mischiefs. It can happen during the binary synthesis stage by merging the payload with the code of the target program. The payload, after its entry in the host strand, will open a socket for remote control, pretty much like conventional hacking. Moreover, the payload starts producing copies of itself to replace worn-out units, a process called self-replication[13-14].

Financing Nanotechnology

We need only consider the two most typical types of nanotech-nology company:

(1) the very large company that is well able to undertake the developments using internal resources; and (2) the very small university spin-out company that in its own special field may have better intellectual resources than the large company, but which is cash-strapped. Examples of (1) include IBM (e.g., the "Millipede" mass data storage technology) and Hewlett-Packard ("Atomic Resolution Storage" (ARS) and medical nanobots



Nanorobotics describes the technology of producing machines or robots at the nanoscale. 'Nanobot' is an informal term to refer to engineered nano machines. Though currently hypothetical, nanorobots will advance many fields through the manipulation of nano-sized objects.

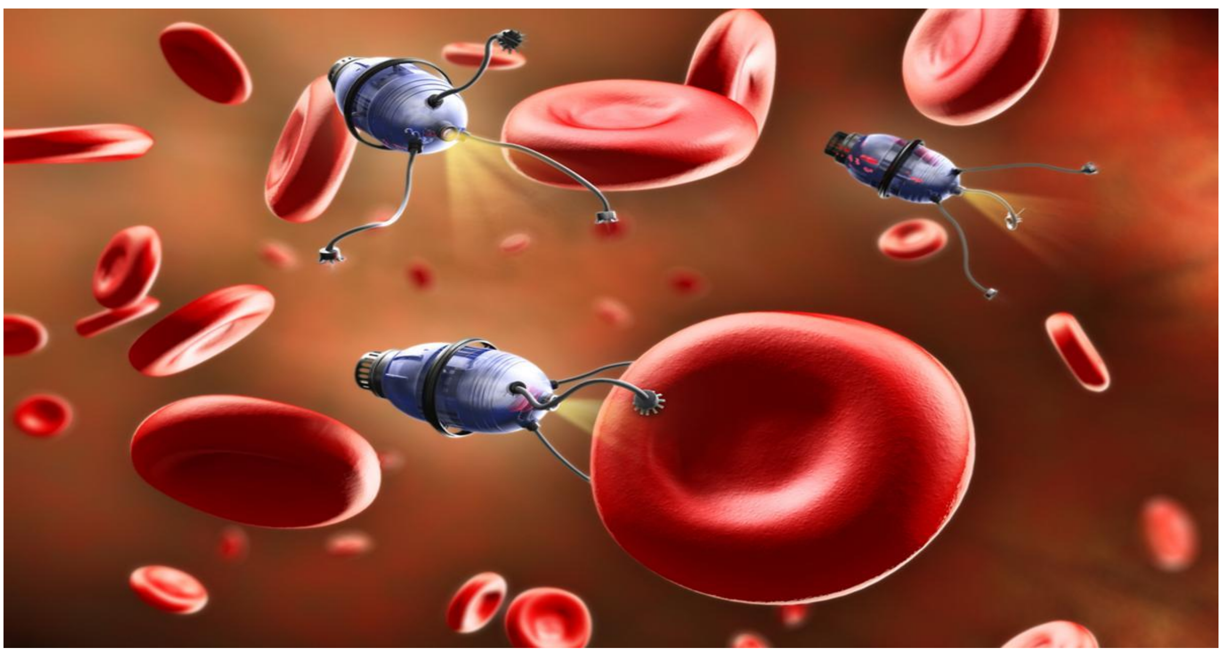
Nanorobotic Applications in the Field of Hematology

Current research is developing nanorobotic applications for the field of hematology. This ranges from developing artificial methods of transporting oxygen in the body after major trauma to forming improved clotting capabilities in the event of a dangerous hemorrhage.

Respirocytes are hypothetical nanobots engineered to function as artificial red blood cells. In emergencies where a patient stops breathing and blood circulation ceases, respirocytes could be injected into the blood stream to transport respiratory gases until the patient is stabilized[15].

Current proposals suggest respirocytes would be able to supply 200 times more respiratory gas molecules than natural red blood cells of the same volume. Clottocytes are another type of nanobot which function as artificial platelets for halting bleeds.

Clottocytes would mimic the natural platelet ability to accumulate at the bleed, in order to form a barrier, by unfurling a fiber mesh which would trap blood cells when the nanobot arrives at the site of the injury. The clotting ability of one injection of clottocytes would be 10,000 times more effective that an equal volume of natural platelets



Nanorobots wade through blood to deliver drugs

Nanorobotics Applications for Cancer Detection and Therapy

As cancer survival rates improve with early detection, nanorobots designed with enhanced detection abilities will be able to increase the speed of a cancer diagnosis and therefore enhance the prognosis of the disease. Nanobots with embedded chemical sensors can be designed to detect tumor cells in the body. Proposed designs currently include the employment of integrated communication technology, where two-way signaling is produced. This means that nanobots will respond to acoustic signals and receive programming instructions via external sound waves along with transmitting data they have accumulated[16].

A simple reporting interface could be produced through strategically positioned nanobots in the body which are able to log information supplied by active nanobots traveling through the blood stream. Instructions could be adapted in vivo to provide active targeting for monitoring or healing.

Nanorobots with chemical sensors can also be utilized for therapy. Through specific programming to detect different levels of cancer biomarkers such as e-cadherins and beta-catenin, therapy can be provided in both primary and metastatic phases of cancer. Nanobots have the advantage of producing targeted treatment. Current cancer treatments have severe side effects caused by the destruction of healthy cells. Targeted treatment can be formed by designing nanorobots with chemotactic sensors on their surface which correspond to specific antigens on the cancer cells[17].

Nanorobotics Applications for Biohazard Defense

Nanorobots will also have useful applications for biohazard defense, including improving the response to epidemic disease. Nanobots with protein based biosensors will be able to transmit real-time information in areas where public infrastructure is limited and laboratory analysis is unavailable. This is particularly applicable for biomedical monitoring of areas devastated by epidemic disease as well as in remote or war torn countries during humanitarian missions[18].

Nanorobotics may also reduce contamination and provide successful screening for quarantine. In the event of an influenza epidemic for example, increased concentrations of alpha-NAGA enzyme in the blood stream could be used as a biomarker for the influenza infection. The increased concentration would trigger the nanorobot prognostic protocol which sends electromagnetic back propagated signals to portable technology such as a mobile phone. The information would then be retransmitted via the telecommunication system providing information on the location of the infected person, increasing the speed of contamination quarantine[19].

Nanobots: Applications in space missions

Development in nanomaterials oblige nanobots play a very important role in the space missions such as nanobots can be used in satellites in order to lightweight solar sails and cable for space elevator attainable. The cost of reaching and travelling in space can be depleted by purposefully minimizing the desirable amount of rocket fuel. The field where nanotechnology made considerable beneficence is radiation shielding. NASA allege that the threats of subjections to space radiations are the most essential factor restricting human's capacities to indulge in long haul space missions. The radiations that human experience in space are comparatively distinct than that of form of charged atomic particles travelling close to the speed of light. Highly charged, highly-energetic HZA particles jeopardize humans in space[20]. A long term subjection to this radiation can cause DNA damage and cancer. In order to shield their human cargo spacecraft shall require special shields comprising materials that consists lighter elements such as hydrogen, boron, lithium. Nevertheless, extra shielding attains significant amount in form of extra weight, more fuel and upsurge flight cost. A team of young researchers from N-E University are putting their work forward which comprises of using of nanobots in space. They be giving certain measurements like tempature.

CONCLUSION

The paper provides a brief review of the nanobots which will be used in the field of biomedical engineering and for providing a proper cure of the deadly diseases in the entire world. By staying on the old conventional methods for curing the deadly diseases that hardly provides the proper cure it is better to shift to the new technology that is using the nanobots for the cure of the same. The day is not that far when the cure for deadly disease using nanobots will not be just a paper review but will be helping in serving the cure of the patients practically. In addition to this nanobots will be used for space exploration and in the drone technology as it will be helpful in making them stronger and lighter. Moreover nanobots can protect the humans from cosmic radiation.

Conflicts of Interest:

The authors declare no conflicts of interest

References :

1. Vaughn JR (2006). "Over the Horizon: Potential Impact of Emerging Trends in Information and Communication Technology on Disability Policy and Practice". National Council on Disability, Washington DC: 1–55.
2. Ghosh, A.; Fischer, P. (2009). "Controlled Propulsion of Artificial Magnetic Nanostructured Propellers". Nano Letters. **9** (6): 2243–2245. Bibcode:2009NanoL...9.2243G. doi:10.1021/nl900186w. PMID 19413293.
3. Sierra, D. P.; Weir, N. A.; Jones, J. F. (2005). "A review of research in the field of nanorobotics" (PDF). U.S. Department of Energy – Office of Scientific and Technical Information Oak Ridge,TN. SAND2005-6808: 1-50. doi:10.2172/875622. OSTI 875622.
4. Tarakanov, A. O.; Goncharova, L. B.; Tarakanov Y. A. (2009). "Carbon nanotubes towards medicinal biochips". Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology. **2** (1): 1–10. *doi*:*10.1002/wnan.69*. *PMID* *20049826*.
5. Ignatyev, M. B. (2010). "Necessary and sufficient conditions of nanorobot synthesis". Doklady Mathematics. **82** (1): 671-675. doi:10.1134/S1064562410040435. S2CID 121955001.
6. 6.Cerofolini, G.; Amato, P.; Asserini, M.; Mauri, G. (2010). "A Surveillance System for Early-Stage Diagnosis of Endogenous Diseases by Swarms of Nanobots". Advanced Science Letters. **3** (4): 345–352. doi:10.1166/asl.2010.1138.
7. 7.Yarin, A. L. (2010). "Nanofibers, nanofluidics, nanoparticles and nanobots for drug and protein delivery systems". Scientia Pharmaceutica Central European Symposium on Pharmaceutical Technology. **78** (3): 542. doi:10.3797/scipharm.cespt.8.L02.
8. Wang, J. (2009). "Can Man-Made Nanomachines Compete with Nature Biomotors?". ACS Nano. **3** (1): 4–9. doi:10.1021/nn800829k. PMID 19206241.
9. Amrute-Nayak, M.; Diensthuber, R. P.; Steffen, W.; Kathmann, D.; Hartmann, F. K.; Fedorov, R.; Urbanke, C.; Manstein, D. J.; Brenner, B.; Tsiavaliaris, G. (2010). "Targeted Optimization of a Protein Nanomachine for Operation in Biohybrid Devices". Angewandte Chemie. **122** (2): 322–326. doi:10.1002/ange.200905200. PMID 19921669.
10. Jump up to:[a] [b] Patel, G. M.; Patel, G. C.; Patel, R. B.; Patel, J. K.; Patel, M. (2006). "Nanorobot: A versatile tool in nanomedicine". Journal of Drug Targeting. **14** (2): 63–67. doi:10.1080/10611860600612862. PMID 16608733. S2CID 25551052.

11. Balasubramanian, S.; Kagan, D.; Jack Hu, C. M.; Campuzano, S.; Lobo-Castañon, M. J.; Lim, N.; Kang, D. Y.; Zimmerman, M.; Zhang, L.; Wang, J. (2011). "Micromachine-Enabled Capture and Isolation of Cancer Cells in Complex Media". Angewandte Chemie International Edition. **50** (18): 4161–4164. doi:10.1002/anie.201100115. PMC 3119711. PMID 21472835.
12. Feynman, Richard P. (December 1959). "There's Plenty of Room at the Bottom". Archived from the original on 2010-02-11. Retrieved 2016-04-14.

13.Yamaan Saadeh, B.S. & Dinesh Vyas, M.D. 2014. Nanorobotic Applications in Medicine: Current Proposals and Designs, American Journal of Robotic Surgery, 1, pp. 4-11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4562685

14.Saha, M. 2009. Nanomedicine: promising tiny machine for the healthcare in future – a review, Oman Medical Journal, 24, pp. 242-247. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243873/

15.Saxena, S. et al. 2015. Design, architecture and application of nanorobotics in oncology, Indian Journal of Cancer, 52, pp. 236-241. https://www.ncbi.nlm.nih.gov/pubmed/26853420

16.Cavalcanti, A. et al. 2008. Nanorobotic hardware architecture for medical defense, *Sensors*, 5, pp. 2932-2958. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3675524/

17. A. S. Lubbe, C. Alexiou, and C. Bergemann, "Clinical applications of magnetic drug targeting," Journal of Surgical Research, vol.5 ,95, pp. 200- 206, 2001.

18. C. Montemagno, G. Bachand, ―Constructing nanomechanical devices powered by biomolecular motors‖, Nanotechnology 10:225-231, 199

19. Merkle R.C., Design-Ahead for Nanotechnology, in Markus Krummenacker, James Lewis, eds., Prospects in Nanotechnology: Toward Molecular Manufacturing, John Wiley & Sons, New York, 1995, pp. 23-52.

20. Merkle R.C., Freitas Jr. R.A., Theoretical analysis of a carbone carbon dimer placement tool for diamond mechano synthesis Nanosci Nanotechnol 2003; 3:319e24. Also available: From: http://www.rfreitas.com/Nano/JNNDimerTool.pdf..