Asian J. Pharm. Res. Vol 3, Issue 2, 80-83, 2013.

e-ISSN 2231 – 363X
Print ISSN 2231 – 3621

Asian Journal
of
PHARMACEUTICAL RESEARCH
Journal homepage: - www.ajprjournal.com

NANOROBOTICS – A REVIEW

G. Balammal*, [1]G. Surendra, [2]P.Jayachandra Reddy

*[2]Department of Pharmaceutical Analysis, Krishna Teja Pharmacy College, Tirupati, Andhra Pradesh, India.
[1]Department of Pharmaceutical Chemistry, Krishna Teja Pharmacy College, Tirupati, Andhra Pradesh, India.

ABSTRACT

The names nanobots, nanoids, nanites, nanomachines or nanomites have also been used to describe these devices currently under research and development. The first useful applications of nanomachines might be in medical technology, which could be used to identify and destroy cancer cells. Another potential application is the detection of toxic chemicals, and the measurement of their concentrations, in the environment.

Key words: Nanorobotics, Application, Nubots, Biochip.

INTRODUCTION

Nanorobotics is the emerging technology field creating machines or robots whose components are at or close to the scale of a nanometer (10^{-9} meters). More specifically, nanorobotics refers to the nano technology engineering discipline of designing and building nanorobots, with devices ranging in size from 0.1–10 micrometers and constructed of nanoscale or molecular components.

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, capable of counting specific molecules in a chemical sample. The first useful applications of nanomachines might be in medical technology, which could be used to identify and destroy cancer cells. 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 bucky balls 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 precision 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 machine. Following 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 perspective, macroscale robots or microrobots that can move with nanoscale precision can also be considered nanorobots.

According to Richard Feynman, it was his former graduate student and collaborator Albert Hibbs who originally suggested to him (circa 1959) the idea of a *medical* use for Feynman's theoretical micromachines. 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 doctor.

Since nanorobots 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 nanorobot swarms, both those incapable of replication (as in utility fog) and those capable of unconstrained replication in the natural environment (as in grey goo and its less common variants, are found in many science fiction stories, such as the Borg nanoprobes in *Star Trek* and The Outer Limits episode The New Breed.

Some proponents of nanorobotics, in reaction to the grey goo scare scenarios that they earlier helped to propagate, hold the view that nanorobots 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

Corresponding Author :- **G. Balammal** Email:- bala.hospira@gmail.com

Asian J. Pharm. Res. Vol 3, Issue 2, 80-83, 2013.

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-foraging replicators.

The most 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.

Biochip

The joint use of nanoelectronics, photolithography, and new biomaterials provides a possible approach to manufacturing nanorobots for common medical applications, such as for surgical instrumentation, diagnosis and drug delivery. This method for manufacturing on nanotechnology scale is currently in use in the electronics industry. So, practical nanorobots should be integrated as nanoelectronics devices, which will allow tele-operation and advanced capabilities for medical instrumentation.

Nubots

Nubot is an abbreviation for nucleic acid robot. Nubots are organic molecular machines at the nanoscale. DNA structure can provide means to assemble 2D and 3D nanomechanical devices. DNA based machines can be activated using small molecules, proteins and other molecules of DNA. Biological circuit gates based on DNA materials have been engineered as molecular machines to allow in-vitro drug delivery for targeted health problems. Such material based systems would work most closely to smart biomaterial drug system delivery,[26] while not allowing precise in vivo teleoperation of such engineered prototypes.

Positional nanoassembly

Nanofactory Collaboration, founded by Robert Freitas and Ralph Merkle in 2000 and involving 23 researchers from 10 organizations and 4 countries, focuses on developing a practical research agend a specifically aimed at developing positionally-controlled diamond mechanosynthesis and a diamondoid nanofactory that would have the capability of building diamondoid medical nanorobots.

Bacteria-based

This approach proposes the use of biological microorganisms, like the bacterium *Escherichia coli*. Thus the model uses a flagellum for propulsion purposes. Electromagnetic fields normally control the motion of this kind of biological integrated device.

Open technology

A document with a proposal on nanobiotech development using open technology approaches has been addressed to the United Nations General Assembly. According to the document sent to the UN, in the same way that Open Source has in recent years accelerated the development of computer systems, a similar approach should benefit the society at large and accelerate nanorobotics development. The use of nanobiotechnology should be established as a human heritage for the coming generations, and developed as an open technology based on ethical practices for peaceful purposes. Open technology is stated as a fundamental key for such an aim.

Nanorobot Race

In the same ways that technology development had 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 and Northrop Grumman 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 commercialization. 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 portfolio, and lawyers. After a long series of patents and eventually litigations, see for example the Invention of Radio or about the War of Currents, emerging fields of technology tend to become a monopoly, which normally is dominated by large corporations.

Potential applications

Nanomedicine

Potential applications for nanorobotics in medicine include early diagnosis and targeted drug-delivery for cancer, biomedical instrumentation, surgery, pharmacokinetics monitoring of diabetes and health care.

In such plans, future medical nanotechnology is expected to employ nanorobots injected into the patient to perform work at a cellular level. Such nanorobots intended for use in medicine should be non-replicating, as replication would needlessly increase device complexity, reduce reliability, and interfere with the medical mission.

Nanotechnology provides a wide range of new technologies for developing customized solutions that

Asian J. Pharm. Res. Vol 3, Issue 2, 80-83, 2013.

optimize the delivery of pharmaceutical products. Today, harmful side effects of treatments such as chemotherapy are commonly a result of drug delivery methods that don't pinpoint their intended target cells accurately. Researchers at Harvard and MIT, however, have been able to attach special RNA strands, measuring nearly 10 nm in diameter, to nano-particles, filling them with a chemotherapy drug. These RNA strands are attracted to cancer cells. When the nanoparticle encounters a cancer cell, it adheres to it, and releases the drug into the cancer cell. This directed method of drug delivery has great potential for treating cancer patients while avoiding negative effects (commonly associated with improper drug delivery).

Another useful application of nanorobots is assisting in the repair of tissue cells alongside white blood cells. The recruitment of inflammatory cells or white blood cells (which include neutrophils, lymphocytes, monocytes and mast cells) to the affected area is the first response of tissues to injury. Because of their small size nanorobots could attach themselves to the surface of recruited white cells, to squeeze their way out through the walls of blood vessels and arrive at the injury site, where they can assist in the tissue repair process. Certain substances could possibly be utilized to accelerate the recovery.

CONCLUSION

The science behind this mechanism is quite complex. Passage of cells across the blood endothelium, a process known as transmigration, is a mechanism involving engagement of cell surface receptors to adhesion molecules, active force exertion and dilation of the vessel walls and physical deformation of the migrating cells. By attaching themselves to migrating inflammatory cells, the robots can in effect hitch a ride across the blood vessels, bypassing the need for a complex transmigration mechanism of their own.

REFERENCES

1. Vaughn JR. Over the Horizon: Potential Impact of Emerging Trends in Information and Communication Technology on Disability Policy and Practice. *National Council on Disability, Washington DC.* 2006, 1–55.
2. Ghosh A, Fischer P. Controlled Propulsion of Artificial Magnetic Nanostructured Propellers. *Nano Letters,* 9 (6), 2009, 2243–2245.
3. Sierra DP, Weir NA, Jones JF. A review of research in the field of nanorobotics. *U.S. Department of Energy - Office of Scientific and Technical Information Oak Ridge, TN*. 2005, 1–50.
4. Tarakanov AO, Goncharova LB, Tarakanov YA. Carbon nanotubes towards medicinal biochips. *Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology,* 2 (1), 2009, 1–10.
5. Ignatyev MB. Necessary and sufficient conditions of nanorobot synthesis. *Doklady Mathematics,* 82 (1), 2010, 671–675.
6. 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 (4), 2010, 345–352.
7. Yarin AL. Nanofibers, nanofluidics, nanoparticles and nanobots for drug and protein delivery systems. *Scientia Pharmaceutica Central European Symposium on Pharmaceutical Technology,* 78 (3), 2010, 542.
8. Wang J. Can Man-Made Nanomachines Compete with Nature Biomotors?. *ACS Nano,* 3(1), 2009, 4–9.
9. Amrute-Nayak M, Diensthuber RP, Steffen W, Kathmann D, Hartmann FK, Fedorov R, Urbanke C, Manstein DJ, Brenner B, Tsiavaliaris G. Targeted Optimization of a Protein Nanomachine for Operation in Biohybrid Devices. *AngewandteChemie,* 122 (2), 2010, 322–326.
10. Patel GM, Patel GC, Patel RB, Patel JK, Patel M. Nanorobot: A versatile tool in nanomedicine. *Journal of Drug Targeting,* 14 (2), 2010, 63–67.
11. Wang J et al. Micromachine Enables Capture and Isolation of Cancer Cells in Complex Media. *Angew Chem. Int . Ed,* 50, 2011, 4161–4165.
12. Cavalcanti A, Shirinzadeh B, Zhang M &Kretly LC. Nanorobot Hardware Architecture for Medical Defense. *Sensors,* 8 (5), 2008, 2932–2958.
13. Hill C, Amodeo A, Joseph JV & Patel HRH. Nano- and microrobotics: how far is the reality?. *Expert Review of Anticancer Therapy,* 8 (12), 2008, 1891–1897.
14. Cale TS, Lu JQ & Gutmann RJ. Three-dimensional integration in microelectronics: Motivation, processing, and thermomechanical modeling. *Chemical Engineering Communications,* 195 (8), 2008, 847–888.
15. Couvreur P &Vauthier C. Nanotechnology: Intelligent Design to Treat Complex Disease. *Pharmaceutical Research,* 23 (7), 2006, 1417–1450.
16. Elder JB, Hoh DJ, Oh BC, Heller AC, Liu CY & Apuzzo ML. The future of cerebral surgery: a kaleidoscope of opportunities. *Neurosurgery,* 62 (6), 2008, 1555–1579.
17. Wong PC, Wong KK& Foote H. Organic data memory using the DNA approach. *Communications of the ACM,* 46 (1), 2003, 95–98.
18. Seeman NC. From genes to machines: DNA nanomechanical devices. *Trends in Biochemical Sciences,* 30 (3), 2005, 119–125.

Asian J. Pharm. Res. Vol 3, Issue 2, 80-83, 2013.

19. Montemagno C &Bachand G. Constructing nanomechanical devices powered by biomolecular motors. *Nanotechnology,* 10 (3), 1999, 225–231.
20. Yin P, Choi HMT, Calvert CR & Pierce NA. Programming biomolecular self-assembly pathways. *Nature,* 451 (7176), 2008, 318–322.