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Nano Robots: Unravelling the Possibilities of Identifying Effective Nano Drug Carrier in the Medical Field

Bharathi Bernadsha S.,

Assistant Professor, Don Bosco College, Dharmapuri, Tamilnadu, India

Abstract: ***This paper intends to explore the field of nano-robotics and its medical applications. This article intends the findings of review of the literatures in area of nano-robotics. This is an era of technology and the amalgamation of technology with everyday life is undeniable. Everyday the technology tries to perfect itself. In the field of medicine, diagnosing and proper drugging of the disease play a vital role. Thus medical field is awaiting to utilize the advancement in nano science, especially in the field of nano-robotics, to account the diseases and admit the proper medication to the patients.***

Keywords: Nanorobots, drug delivery, drug carriers, cancer, biomarkers, nano medicines

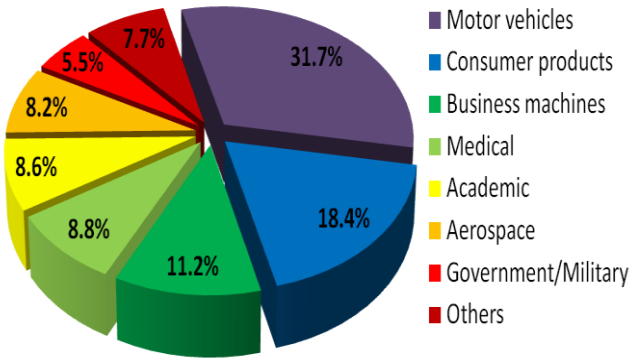
1. Introduction

Every part of human history reveals a number of new inventions and discoveries through someone to the rest of the human beings. From macroscopic to microscopic the revelation of the nature is spell-bounding. One of the indubitable wonders of human discovery is the *nanoscopic* world.

Two decades ago uttering the word 'nano' raised the brows of many because the world was mostly wondering about the top down technology, however, when the technology has created a path of bottom- up processes, the entire humanity wanted to know the results of it. [https://natgeoeducationblog.files.wordpress. com/2013/11/ rapid_prototyping_worldwide_by_zureks.png [accessed on 03rd March 2017]

Now researchers have moved into certain sophistications of advancing in the nanoscale material production. Nanotechnology can be defined as a field of studying materials at the level of atoms and molecules that have applications in the real world. Nanotechnology comprises of technological developments on the nanometer scale, usually on the order of 0.1 to 100 nm. A nanometer is one billionth of a meter (1 nm = 10 m). [Nathan A. Weir, Dannella P. Sierra and James F. Jones, A Review of Research in the Field of Nano Robotics, http://prod.sandia.gov/techlib/ access-control.cgi/2005/056808.pdf [accessed on 08th March 2017]7]

Nanotechnology is a multidisciplinary field which encompasses and draws from the knowledge of several diverse technological fields of study, including chemistry, physics, molecular biology, material science, computer science, and engineering. [Weir, A Review of Research in the Field of Nano Robotics, http://prod.sandia. gov/techlib/ access-control.cgi/2005/056808.pdf [accessed on 08th March 2017]7]



([https://blog.education.nationalgeographic.com/2013/11/25/ 3d-printers-3k-lawsuits/](https://blog.education.nationalgeographic.com/2013/11/25/3d-printers-3k-lawsuits/))

The above image lucidly portrays that at present how the nano-technology plays an indispensable role in all viable fields of our day to day life. In this paper, the readers are made to understand the specific application of this nano technology in the fields of medicine using nano-robots.

At present the medical world employs, mostly, the old technique of administering medicine orally. However, besides curing the affected part of the body, the medicine that taken orally is being inducted to other parts of the bodies too which in turn creates innumerable and intolerable side-effects to the consumer. The field of medicine also requires a lot of developments in diagnosing the diseases and administering the required medicines.

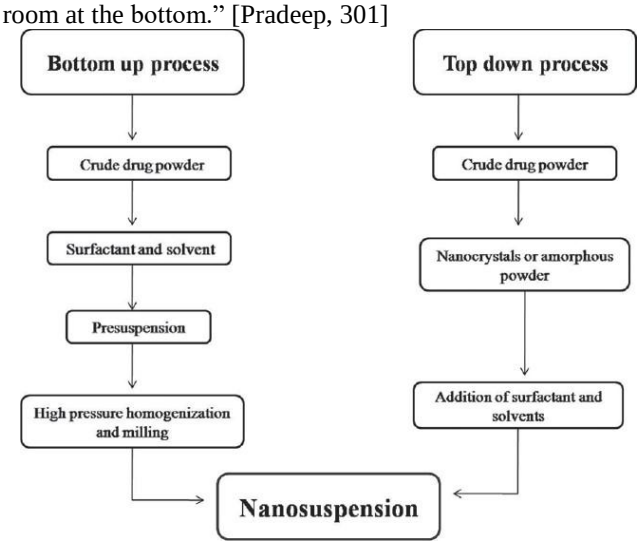
The diseases are on the increase and the sufferings of the humanity are immeasurable and hence the need to advance in the remedies are the dire need of the situation.

2. Nano Medicine

One of the most and important application of nano material is 'drug carriers'. Due to their small size, nano materials can be easily transported into cells and nuclei directly. By labelling the targeted part of the body which experience the ailments the desired medicines can be administered. The diagnostic and therapeutic applications of such systems are

being proposed. [T. Pradeep, *Nano: The Essentials*, Tata McGraw Hill Education Private Limited: New Delhi, 2007, 301]

The concept of the effective use of nanotechnology in disease treatment was suggested as early as 1959 by Nobel Laureate Richard Feynman in his famous talk on "Plenty of room at the bottom." [Pradeep, 301]



(*http://www.japtr.org/viewimage.asp?img=JAdvPharmTechRes_2011_2_2_81_82950_u1.jpg*)

With advancement in drug discovery processes, stress is on the drug delivery processes to the affected organ. The efficacy of the drug depends on its availability at the targeted point of delivery for a needed or desired period. It will result in reduction of the amount of drug that are supplied to the unnecessary parts of the body and the cost of the drug. This emphasizes on the effective drug delivery.

Due to their high surface-to-volume ratio enhanced detection feature, the use of nano particles for drug delivery purposes becomes important. Another reason for employing nano particle for drug delivery is the easier transport across the membrane and possible protection of drug molecules. [Pradeep, 302]

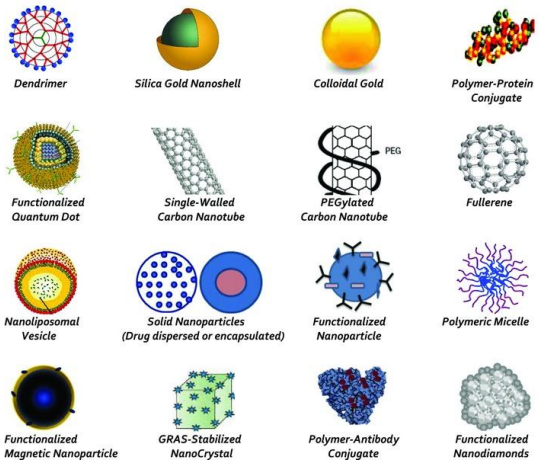
A high surface to bulk ratio ensures strong interaction between nanoparticles and the reacting species. The surface to bulk ratio bears a strong inverse dependence on particle size. Various studies confirm that the particle size should be sufficiently small for it to get across the membrane and this transport occurs more readily for nano particles rather than for micro particles. [Pradeep, 302]

3. Developing & Administering Nano Medicines Effectively

The size may vary from 10 to 1000 nm according to the preparation methods. The nano-drugs can be in the form of entrapped, encapsulated or attached also the synthesis of these drugs can be in the forms of nano-spheres (nano particles as capping agents), nano capsules(drug confined in a cavity surrounded by a polymeric layer), nanopores (nano particle surface perforated with holes, and the holes contain drug molecules), dendrimers, etc. [Pradeep, 302-303]

The conventional oral drugs follow first order kinetic leading to unsteady drug release. However the encapsulated nano-system based drugs show nearly zero order kinetic profile which assures a steady drug release under control. [Pradeep, 303]
The scientists are attempting to find biodegradable nano particles as potential drug delivery devices. The biodegradable polymeric nanoparticles have been found to be extremely effective in controlled and targeted drug release even though they are administered orally. [Pradeep, 303]

Various other methods of administering nano medicines through nasal and ophthalmic delivery drugs are employed by the medical world for the effective result. Nano size carriers of vitamin molecules such as vitamin A and E have potential applications in dermatology and cosmetics. [Pradeep, 303]



(https://www.researchgate.net/figure/261182396_fig3_Figure-1-Nanomedicines-for-drug-delivery-Copyright-C-2014-Raj-Bawa-All-rights-reserved)

4. Drug Carrier

This ideal vehicle would be biocompatible and virtually 100% reliable, with all drug molecules being delivered only to the desired target cells and none being delivered elsewhere so that unwanted side effects are eliminated. The ideal vehicle would remain under the continuous control of the supervising physician, including post-administration. Even after the vehicles had been injected 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, all of the vehicles could be removed intact from the body, leaving no trace of their presence. [Kh.Hussan Reza, Asiwarya. G, Radhika .G, Dipankar Bardalai, Nanorobots: The Future Trend of Drug Delivery And Therapeutics, International Journal of Pharmaceutical Sciences Review and Research, Volume 10, Issue 1, September – October 2011, 60]

5. Drug Delivery System

Dendrimers are a type of nanostructure that can be precisely designed and manufactured for a wide variety of applications, including the treatment of cancer and other diseases. Dendrimers carrying different materials and their

branches can do several things at one time, such as recognizing diseased cells, diagnosing diseased states (including cell death), drug delivery, reporting location, and reporting outcomes of therapy.

6. Robot

A Robot is not only a machine but it is much more than a machine. It is a combination of sensors, pressure, vision, signals to control, temperature, a control system and alike. [Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse] Robots are not only in the industries, controlled by the computer-controlled machines they can be also utilized in the field of science and possibly in the field of medicine.

7. Medical Nanobots

The research and development of nano-robots with embedded nano-biosensors and actuators is considered a new possibility to provide new medical devices for doctors. Nanorobots are nanodevices with a diameter of about 0.5 to 3 microns and will be constructed within a dimensions in the range of 1 to 100 nanometers. The main element used will be carbon in the form of diamond or fullerene nano-composites for the strength and chemical inertness of these forms to avoid being attacked by the host's immune system. Such devices have been designed in recent years but no working model has been built so far. [Reza, Nanorobots: The Future Trend of Drug Delivery And Therapeutics, 61.] In the same way the development of microelectronics in the 1980s has led to new tools for biomedical instrumentation, the manufacturing of nano-electronics , will similarly permit further miniaturization towards integrated medical systems, providing efficient methodologies for pathological prognosis.

The use of micro-devices in surgery and medical treatments is a reality which has brought many improvements in clinical procedures in recent years. Sensors for biomedical applications are advancing through tele-operated surgery and pervasive medicine, and this same technology provides the basis for manufacturing biomolecular actuators. A first series of nanotechnology prototypes for molecular machines are being investigated in different ways, and some interesting devices for propulsion and sensing have been presented. More complex molecular machines, or nano-robots, having embedded nano-scopic features represent new tools for medical procedures. [Pradeep, 302]

8. Constructing Nanorobots

Development of bio-nano components from biological systems is the first step towards the design and development of an advanced bio-nanorobot. The next step involves the assembly of functionally stable bio-nano components into complex assemblies. the basic computational architectures needs to be developed and rules need to be evolved for the bio-nanorobots to make intelligent decisions at the nano scale. The next step in nanorobotic designing would see the emergence of automatic fabrication methodologies of such bio-nano robots in vivo and in vitro. Energy management, self-repairing, and evolving will be some of the characteristics of these swarms.[Reza, Nanorobots: The Future Trend of Drug Delivery and Therapeutics, 65-66]

9. Pros and Cons

Power source problems at present, free moving robots are limited to about 1.5cm long and about 30gm weight. The use of solar cells may not solve this problem, since the robot is smaller also mean lighter. That means less power is needed for movement. If the robot is doing works like lifting carrying and analyzing the need of the power is much important. Thus nano materials which can produce energy can be utilized for producing the needed power. [Wilson, 236]

There are some issues that are tagged to the use of nano materials in our daily life. The nano particles which can not be seen through the naked eyes can spread easily over the atomosphere and affect all those who are around the product. There is a possibility that these nano particles can be misused by the anti-social groups also there is a problem of understanding the life cycle of these nano particles. How long they will be in the environment is not sure. [Debnath Bhattacharyya1, Shashank Singh1, Niraj Satnalika1, Ankesh Khandelwal1, and Seung-Hwan Jeon2 Nanotechnology, Big things from a Tiny World: a Review, http://www.sersc.org/journals/IJUNESST/vol2_no3/3.pdf [accessed on 24th February 2017]

10. Various Applications of Nanorobots

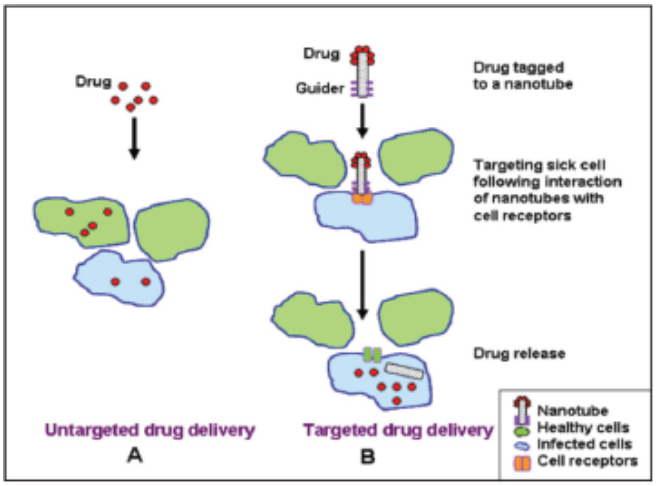
Nano robots are being desired in various fields like defense, cancer treatment, dentistry, industries, drug deliverer and alike. In the following paragraph the cancer therapy using nano robots is explained. It clearly shows how the nano particles can be used to target the affected parts and to deliver the drugs to the affected parts.

11. Cancer Therapy

In cancer therapy nano particles show much promise. By selectively gaining access to the cancerous tumor due to the small size and modifiability of the nano material, employing a nano drug carrier and nano identifiers is more effective. What is Cancer? Cancer, also called malignancy, is an abnormal growth of cells. There are more than 100 types of cancer, including breast cancer, skin cancer, lung cancer, colon cancer, prostate cancer, and lymphoma. Symptoms vary depending on the type. Cancer treatment may include chemotherapy, radiation, and/or surgery. [http://www.webmd.com/cancer/[accessed on 13th February 2017]

Nano particle drug delivery using biodegradable polymers is expected to provide a more efficient way to overcome some of these problems. The pharmacological properties of a polymer-drug conjugate can be manipulated by changing the physical and chemical properties of the drugs based on nanoscale. [Chetan C Anajwala, Current trends of Nanotechnology for cancer therapy,

http://ijpsnonline.com/Issues/1043_full.pdf.[accessed on 19th March 2017]1]



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Nano particles used for anticancer drug delivery can be made from a variety of materials including polymers, dendrimers, liposomes, viruses, carbon nanotubes and metals such as iron oxide and gold [Anajwala, Current Trends of Nanotechnology for Cancer Therapy, 2].

If the researchers can produce methods and instruments using nano technology to diagnose the cancerous cells in the beginning stages itself will eliminate the deaths due to advanced cancers.

Various new bio-markers and drug carriers are being developed keeping in mind that the cancerous cells can be easily marked and drugs are utilized properly to the needed and affected cells alone. In this numerous side effects of chemotherapy can be nullified.

12. Conclusion

This article highlights the findings of a review of the literature in the area of nanorobotics. Unravelling the mysteries that are present in the world is the task given to the humanity. In this regard, unwrapping the treasure of nano technology and using it for the betterment of the society is to be appreciated. As the nano technology inherits both for and against the human society let us make use of all the possible means to utilize the nano technology for the peace and harmony of the future generations. Technology is a sword which is sharp on it's both the sides. We need to train ourselves to handle the technology in a mature and selfless manner. We have understood from the above proceedings that a nano robot can assist the medicos in treating various diseases in the field of medicine effectively.

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