



A Review on Nanobots and Their Application in Pharmaceutical and Health Care Industry and Their Future Prospective

Raagul.S

JSS College of Pharmacy, Ooty.

Corresponding Author: Raagul.S

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ABSTRACT:

Presently, the health care sector is concentrating on creating new approaches for treating and preventing diseases. New technologies such as membrane and tissue implants have been developed. Nanobots, or nanoscale robots, are one such innovation that has taken off. An emerging field of engineering known as nano-robotics produces devices or robots with parts that are at or very close to the nanometer size. Nano robots have great possibilities in medical, biological, and pharmaceutical applications because of their small size and broad functional features. The small size of nanobots makes them excellent candidates for therapies that require sophisticated procedures. Medications can be targeted at precise locations using nano-robotic technology, making the drug much more effective and reducing the risk of potential side effects. This review article outlines the pros and cons of nanobots as well as their applications and contribution to the healthcare industry.

KEYWORDS: Nanobots, Nanotechnology, Pharmaceutical field, Nanomite

I. INTRODUCTION:

The demand for targeted drug delivery systems is growing as current biomedical technologies necessitate the development of new and innovative systems to replace complex procedures. We can replace traditional methods and instruments by developing a nano-scale delivery system. Nanobots are a potential solution to these and other medical challenges. Nanobots are a subset of the nanotechnology engineering discipline that focuses on designing and building nano-robots with sizes ranging from 0.1 to 10 microns and constructed on a nanoscale. Nano-devices in research and development are currently referred to as nanobots, nanoids, nanite, nano-machine, or nanomite [1].

Nano-robots are of various shapes and sizes and are now capable of delivering drugs through veins into specific organs of the human

body. Nano-robots are nano-electromechanical devices (NEMS). Nanobots are made from organic materials like proteins and polynucleotide's or inorganic materials like metals or diamonds. The size or shape of nanobots directly affects its movement, permeability, and responsiveness. The nano-robots have an outer passive diamond coating, specifically to prevent attacks by the host's immune system. Because they are imperceptible to the naked eye, they are difficult to manipulate and work with. SEM and AFM are analytical techniques used to create a visual interface that allows us to differentiate the molecular geometry of these nanometer-scale devices. In nanoscience and biotechnology research, virtual reality (VR) techniques are being applied to improve operator perception. Sensors, actuators, control, power supply, communication, and special interfaces between organic and inorganic systems are used to build nano-robots [2].

Nanobots are important in the pharmaceutical industry, particularly in targeted interventions in the human body via the vascular network. By programming and causing blockages in the blood supply to the tumour at the site, the nano-robots can transport molecular payloads around the body, leading to tissue death and thus tumour shrinkage. The nanobots are programmed to perform specialized or specific biological tasks in conjunction with the drug and, when injected into the blood, act on cancer cells or other affected cells. The combination of nanobots and biological research will usher in a new era in medical research [3].

To achieve this common goal, nanobots requires the collaboration of doctors, biochemists, computer engineers, researchers, and other specialists. This field is still in its early stages, but great researchers from all over the world have made significant contributions to this ever-changing and exciting field [4].

Types of Nanobots:

1. **Chromalocytes:** This type of nanobots is capable of substituting the whole chromosomes in individual cells, trying to reverse the effects of genetic disease and other genetic defects or disorders and preventing ageing process. Within a cell, the nanobot first evaluates the case by investigating the contents and behavior of the cell, and then takes action by working on each and every molecule; nanobots will be able to repair the organelle that are damaged.
2. **Pharmacocyte:** It is also known as medical nanobot that is 1-2 μm in size and can carry up to 1 μm^3 of a given amount of drug in the tanks. They are controlled by mechanical classification pump systems. They consist of molecular markers or chemotactic sensors in them. Glucose and oxygen obtained from local environments such as blood, intestinal fluids and cytosol act as an energy source. After the completion of the tasks, the Nanobots may be removed or retrieved through centrifugal nanopheresis.
3. **Microbivores:** These are flattened spherical or circular devices for nano-medical applications with a diameter of 3.4 μm and 2.0 μm length. The Nanobot can consume power up to 200 pW continuously. This power is used to digest captured microbes. Another distinguishing feature relates to the ability to phagocytize approximately 80 times more efficiently than macrophage agents, expressed as the volume/second digested per unit volume of phagocytic agent.
4. **Clothocytes:** It is a type of nanobot which as unique biological property that they deliver the substances that promote coagulation.
5. **Respirocito:** It is also known as artificial oxygen transporter nanobot that are an artificial red blood cell. Nutrition is obtained from the body's own serum glucose. This Respirocito is capable of delivering more oxygen content to tissues than RBCs and thus controlling ulceration [5].

Parts/Components of Nanobots:

1. **Pumps:** These are the molecular pumps, which would be a major part or component of Respirocite and Pharmate nanobots. It works by detecting, then sorting, and then finally pumping the single molecules via molecular sorting rotors, allowing molecule-by-molecule interaction with the environment.

2. **Sensors:** Sensors are an essential component of nanobots. In nanobot applications, physical, thermal, visual, electromagnetic, biochemical, and biologic sensors have been investigated. A nanosensor is any sensor that operates by utilizing microscopic phenomena. On the organic side, biosensors uses biological processes to detect target analytes, and given the necessity to achieve the target therapeutic goals of nanobots in medicine, this sort of sensor is the most obvious device to investigate in the field of nanorobotics. The nanobot, about 1 micron in diameter, could use about 10^4 - 10^5 sensors of different types to control the device.
3. **Lasers:** These lasers have the potential to burn hazardous material such as arterial blockage, blood clots, or cancerous cells.
4. **Energy:** controls onboard energy generation or reception systems, including thermal, mechanical, acoustic, chemical, electrical or nuclear sources, photonic; energy storage management on board; controlling the conversion, conditioning and conversion of connected energy sources; and control of internal energy distribution and charge balance by a nanorobotic device.
5. **Electrodes:** The electrode linked to the nanobot might create a battery by using the electrolytes in the blood. These protruding electrodes may also be capable of killing tumor cells by creating an electric current and heating them to destruction.
6. **Navigation:** generating an absolute and relative physical position in a variety of regimes, including the plasma, muscles, systems, and cellular; Positioning using dead reckoning, and macro and/or micro transponder networks.
7. **Payload:** A minimal dosage of drug/medicine is stored in this empty region. The nanobots might go through the blood and deliver the medicine to the location of illness or harm.
8. **Swimming tail:** As nanobots go beyond the flow of blood in the body, they will need a form of propulsion to enter the body.
9. **Micro-camera:** A small camera may be attached in the nanobot. When manually moving through the body, the operator can direct the nanobot [6].

Approaches:

- **Biochip:** The integration of nanotechnology, photolithography, and novel biomaterials might be viewed as a feasible approach to

creating technologies for the development of nanobots for medical purposes such as diagnostics and pharmaceutical delivery. This process is employed in the electronic industry while constructing nanobots.

- **Nubots:** It is nucleic acid nanobot. Nubots are nanoscale robotics devices created by humans.
- **Nano-factory:** Robert and Ralph founded the nano-factory, which is an ongoing project including few companies and researchers from different countries. This project intends to develop or create positionally controlled mechano synthesis able to produce diamondoid nanobot [7].

Ideal Characteristics of Nanobots:

- The size of Nanobots ranges from 0.5-3.0 microns with 1-100nm parts.
- If the nanobot's size is greater it may block the capillary blood flow.
- The nanobot's diamond surface protects it from being damaged by the immune system.
- It will communicate with physicians by sending messages and signals from the body with a carrier wave frequency of about 1-100MHz.
- It has the capability to produce multiple copies of it to replace the damaged or worn out units, and this process may be termed as self replication [8].

Advantages of Nanobots:

Homo sapiens or human beings have always been fascinated by our own anatomy. Many approaches for diagnosing and treating physical disorders have been developed. The progress of mankind has been quite a bit in terms of the safety and reliability of the procedure. The development of endoscopy results in better knowledge about the innermost parts and aid in diagnosis. But as we all know that all technology will eventually have to be phased out. Since the historical procedures were developed to overcome the disadvantages of their predecessors, nanobots are employed to overcome the following disadvantages of current medical technology:

- Ablation of layers of harmful tissue that heal slowly.
- For a shorter period of time painful anesthesia may be used.
- There is still no 100 percent success rate for delicate surgical procedures such as eye operations.

- In all invasive techniques, the patient's life is entirely in the hands of the physician, and operator.

Conventional research and diagnostic techniques have become widespread in recent centuries and will therefore soon be expired as the technology develops. Also, all of these processes will soon be controlled by machines robotically. However, scientists are working on a reliable, convincing and biocompatible approach. Instead of curing an illness from the outside, they aim to defend it from within the body. The features of this technology are as follows:

- Quick reaction to sudden changes.
- Significantly shorter recovery time.
- Minimal or no follow-up care is required after treatment.
- Minimal or no tissue trauma.
- Monitoring and continuous diagnosis from inside.

Nanobots also allow us to store and process previous data's, recognize patterns and thus helps to predict the onset of a disease. The nanobots can be guided from the outside as programmed and deliver payloads such as medicines or healthy cells to a specific parts in the body [9].

Disadvantages of Nanobots:

1. The main disadvantage is that nanobots are expensive to design and there are also many complications in their design.
2. The biggest hurdle or problem is the power supply.
3. When nano-bacteria's are present in our body, they can have serious effects, which mean that nanobots are foreign to the body.
4. More research is needed to allow nanobots to bypass the immunological reaction of the body.
5. With so many foreign particles in the body, biodegradability will be a big issue.
6. A malicious version of nanobots could be created if nanobots replicate themselves, and our immune systems could be challenged if we rely heavily on nanotechnology.
7. If terrorists misuse nanobots, they could even be used as biological weapons and become a threat to society.
8. Therefore, vigorous attention must be paid to overcome all these disadvantages [10].

Nanobots in Medicine:

Robots to Monitor Sugar Levels:

Blood glucose levels can be monitored by inserting specialized sensor nanobots into the blood stream, inside which microchips coated with human molecules that emits an electrical pulse signal. Drug carriers consist of walls that range from 5-10 atoms thick and an inner drug-filled cell that is typically 50 to 100 nm wide. The fine wires in their walls produce an electrical pulse that dissolves the walls and releases the medicine when they notice any evidence of the disease. An advantage of using these nanobots for drug delivery is that the electrical impulse can be controlled, making it easy to control the amount and timing of drug release at the specific site. In addition, the walls are capable of melting and dissolve easily, so they are harmless to the body.

Enzyme-propelled nanobot:

Nano-tubes coated with urea are converted into a urea-containing liquid in a propulsion system because the enzyme breaks down urea into gaseous products. Since there are always slight asymmetries in the tubes, the reaction products cause a flow in the liquid. This active motor-based approach to drug delivery promises improved and efficient drug delivery compared to traditional methods. These nanobots exhibit excellent acid-powered self-propelling properties with high charge carrier capabilities.

Nanobots to detect and treat cancer:

Nanobots are programmed to detect and shrink cancer brain tumors. At 25 million nanometers per inch, these miniature robots can give oncologists the extra help they need to shrink cancer, for example by improving their ability to diagnose, detect and treat cancer cells. Nowadays, the administration of cancer drugs is difficult to control. Chemotherapy stresses both healthy tissue and malignant tissue. The adverse outcomes of chemotherapy on other areas of our body are unavoidable. However, nanobots don't work like that.. The nanobots could be used to deliver drugs only to tumor cells, bypassing the drug's helper effect. Mainly the nanobots are sent to target tissues or tumors to provoke them, which are part of the machine gun approach, but many of the bots are wasted. However, only the tumour is activated; no other tissues in the body are harmed. The actual chemotherapy drug is then delivered to the target tissue via a second wave of nanobots. Only after detecting the provoked tissue does it release its

payload, i.e. the drug. As a result, we have a very concentrated directional effect with no side effects [11].

Nanobots application in the pharmaceutical industry:

Detection of Bacteria:

Many of the potential uses for nanobots are related to healthcare in some way. It is expected that nanobots will be able to detect the presence of bacteria and other germs in the human body, allowing them to determine whether someone is infected and what sort of reaction should be established based on the type of illness.

Tumour Detection:

Nanobots are capable of working as an early detection system in the human body, detecting changes that indicate the mutation of healthy cells into malignant cells. As a consequence, they would be ready to enact solutions on time.

Determines the Effectiveness of Drug:

One of the most difficult issues in pharmaceutical field is determining the effect that a certain drug has on the patient so that the medical expert can address the issue by reducing the side effects. Furthermore, determining the efficacy of a medication is crucial since it allows the medical professional to treat the patient as soon as possible. Nanobots will help with both of these tasks.

Detection of Particular Chemicals:

Nanobots will be able to detect the presence of certain compounds in the human body, providing critical information to medical experts about the patient's state and allowing for more efficient and successful treatment.

Deliver Cancer-Fighting Drugs:

Chemotherapy may be brutal to a cancer patient since it kills both cancer cells and healthy cells that surround the malignant cells. There has been considerable discussion of using nanobots to ensure that cancer-fighting medications are delivered directly to cancer cells, limiting collateral harm. This indicates that nanobots can be utilized to target more difficult-to-reach parts of malignant tumours, potentially boosting the possibility of effective therapy.

Clearing of Blocked Blood capillaries and vessels:

By clearing the blocked blood vessels, arteries and capillaries, the cardiovascular diseases can be avoided. Nanobots have the potential to unblock blockages in blood arteries that cause both strokes and heart attacks. However, even if these

bots cannot completely fix the problem, they can minimize the risks of dying from either of these circumstances, which is a significant improvement.

Serve as Antibodies:

Nanobots are utilized to supplement existing antibodies for patients with weakened immune systems who are unable to handle all of the bacteria and other pathogens that await them. The nanobots in this case are being employed to possibly eliminate hazardous foreign compounds in the human body. Alternatively, this may include nanobots that drive current immune systems toward potential threats.

Clean up Pollution:

In the future, it may be feasible to utilize nanobots to clean up pollution, recovering contaminated surroundings to their original state. When considering the effects that pollution may have on the health of entire ecosystems, including human health, nanobots can be regarded an inestimable advantage since nanobots can be deployed in hazardous places, lowering the danger to human equivalents.

Nanobots used Dentistry (Dentifrobots):

Nanobots may be also employed to clean the mouth and they are given either through mouthwashes or toothpastes. It has an ability to kill or destroy pathogenic bacteria that exist in plaque. These Dentifrobots are invisible and can be safely deactivate when these are swallowed.

Nanobots used for Curing Skin Disease:

The nanobots are also used to remove dead skins and excess oils presents in the skin and nanobots are given with the moisturizer, creams and ointments and they clean the pores present in the skin [12].

II. CONCLUSION:

Nanorobotics is an emerging future discipline of research that has the potential to make a significant impact on a variety of functional sectors such as medical, bio-medical, and pharmaceutical domains. Nanobots are a combination of two fields such as engineering and medicine. This field of study has a bright future in pharmaceutical drug development and surgical treatments. Nano-medicine will also enable more tailored therapy for many diseases by using an in-depth understanding of diseases at the molecular level. Nanobots will provide personalized treatments with improved efficacy and reduced side effects. This research area may sound like science fiction right now, but Nanobots has the potential to change healthcare in the future. It offers up new

avenues for large amounts of study. Nanobots technology will be used in future healthcare to improve personalized risk assessment.

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