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Nanobots in nanomedicine: An overview

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ABSTRACT

In this century, health care industries are mainly focusing on the development of minimally invasive techniques for diagnosing as well as for curing ailments. For implant of bones and membranes, a better-advanced technology is needed. As an advancement, scientists incorporated robots at the nanoscale to enhance the developments in the medical field. Nanorobotics is a growing area of nanotechnology in which they collaborate with machines or robots, which is at the nanoscale. There are many challenges for the growth of this technology, not only from the technical side but also from the introduction of a new material into the human body and environment. On the other side, the advantages of nanobots are immense. Nanobots can pave way for many creative approaches especially as good applicants for complex treatments. The goal of this paper is to peek into the applications of nanobots in medicine.

Keywords: *Nanobots, Nanosensor, Nanomotor*

1. INTRODUCTION

Nanobots are special miniature machines having very specific functions. The width of the nanobots is approximately 50-100 m wide. These nanomachines play a major role in medical applications such as targeted delivery mechanisms. Normally drug is transported through the entire body before they reach the affected area. But using this nanobots drug can be delivered to the target site directly without passing through the entire body. It reduces possible side effects. For implementing this in real-world applications are represented by actuation, fabrication and steering demonstration of nanobots. It has a huge impact on cancer therapy such as transporting therapeutic agents through the blood vascular system. Today we have self-propelled nanomotors and biodegradable nanodevices to carry drugs to targeted sites. Nanobots can be produced using proteins, polynucleotides. Inorganic material used is metals or diamonds. Diamond based nanobots stand out for its high strength and performance. Metals can be used as a base of the nanobot and for antibacterial effect. The solubility and interaction with cell membranes are determined by the surface properties of nanobots. Size, the shape of nanobots will affect their motion, reactivity and permeability. In the present scenario, the development of nanobots and its applications is fast. Not only in the medical field, but nanobots can also be used to perform a specific biological task. Nanobots clubbed with biological research will set a new milestone in the field of nanotechnology.

2. PARTS OF NANOBOTS

The main interest for developing a nanobot is to develop treatment targeting the exact site needed with the possibility of minimizing the healthy parts of the body that any regular treatment provides. This idea promotes to design nanobots to detect and mobilize to the targeted part of the body and send feedback. For these determined tasks, two devices are essential: sensors and propulsion equipment. For information passing, it can be incorporated with some other devices such as power supplies and molecular computers. It should include devices to develop a specific task such as manipulators or storage compartments.

2.1 Sensors

This is an important part of nanobots. This can be mechanical, optical, chemical, thermal and biological. A sensor that uses a nanoscale property for its operations is termed as nanosensors. Biosensors use biological reactions for the detection of the target. An example of this type of sensors is the utilization of cantilever as a Nano Electro Mechanical System (NEMS). The material will be attached to a cantilever leading to a change in masses and surface tension. Generally, sensors provide two functions to the surface. One is detecting the presence of the target molecule and the other is indirectly sensing the amount of damaged part. Many types of sensors were developed for the function to target molecules to be detected. The cantilevers are exploited due to their high sensitivity in providing a good atomic resolution image. Nanocantilevers are being used as sensors in nanobots by utilizing Atomic force microscopy as an effector. Due to this, the real-time detection is done quickly and directly. They can detect specific molecules, cellmass, biomolecules, nucleic acids, and arrange it in a predefined manner. The operation of cantilevers can be done by two methods: dynamic mode and static mode. A resonance frequency is produced by mass or rigidity of the target molecule. In the dynamic mode, cantilevers respond to biochemical interactions due to the change in resonance frequency. This frequency is

used to analyze the topography of the surface. In static mode, it depends on the absorption of determined analytes from a nonmoving cantilever. It further causes differential stress and deflection regarding the reference point. This can be used to detect the presence of target biomolecules. Carbon Paste Electrodes (CPE) is another type of nanosensors. They are used in voltammetric measurements. They are developed by graphite and pasting liquid. The advantages of CPE are they are easy to fabricate. They have good electrical properties and mechanical properties. These are used to detect nucleic acids.

2.2 Propulsion equipment

Propulsion is required for the movements of nanobots. Nanomotors are nanoscale devices with their own propulsions. They obtain energy from the chemical reactions produced by electric, magnetic, or acoustic fields. The main challenges for the transportation of nanobots are the viscosity and Brownian motion. So a nanobot should have sufficient energy to overcome these properties of a fluid at nanoscale. To facilitate transportation of nanobots there are two approaches: external and internal. In the external approach of propulsion, nanobot speed and direction is controlled from an external computer. The MRI devices can be used to get real-time feedback of nanobots, having all power depending on external machine. Concerning the internal approach the best expected models are biomotors.

3. USES IN MEDICINE

3.1Enzyme-propelled nanobot

Enzyme propelled nanobots are urea coated nanobots. It can turn into a propulsion system which contains urea-containing liquid. It is because the enzyme breaks down the urea into gaseous products. The reaction products create a current in the liquid because the tube always has small asymmetries. This motor based delivery approaches have more advantages than any conventional methods. These have excellent acid-driven properties and self-propulsive properties.

3.2 Sugar-level monitoring nanobots

A special sensor nanobot is inserted into the blood. An electrical impulse signal is emited by the microchips, which are coated with human molecules. The drug carriers are 5-10 atoms thick. The width of the inner filled drug is 50-100 nm. When nanobot detects a sign of disease, the thin wires in their walls emit an electric pulse. These melt the walls and the drug is released. The advantage of using nanobots is that the electric impulse can be controlled and thereby controls the amount and time of the drug release to the specific site. These are harmless since the walls melt and easily dissolve.

3.3 Cancer detection

The scientists from Arizona state university and China's National Centre develop specific nanobots for Nanoscience and Technology to detect and shrink the cancerous tumors. Executing 25 million nanometers per inch, these nanobots provide gives help to doctors dealing with cancer patients. They enhance the capability to detect, diagonise, and treat cancer cells. The drug delivery of cancer is very difficult to control. Chemotherapy torment healthy tissues. The harmful effects of chemotherapy are not replaced. Nanobots are less harmful. They can be used for the drug delivery to target site without affecting the surrounding. Here only the tumor is provoked and no other tissue is affected. A second wave of nanobots is send to the targeted site, which contains actual chemotherapy drug. The payload is released only after sensing the provoked tissue. So there is no possibility of peripheral impact.

4. FUTURE OF NANOBOTS IN NANOMEDICINE

4.1 Serve as antibodies

Nanobots help to boost the existing antibodies for people with a low immune system. They can potentially destroy foreign substances in the human body. At the source of danger, nanobot can direct the existing immune process.

4.2 Delivering cancer-fighting drugs

Chemotherapy can damage healthy tissues in the human body. Nanobots can make sure that they implement drugs only on the specific site. They will not affect the existing healthy tissues. Nanobots can be used for delivery of drugs to hard to reach cancerous tumors also. Therefore using nanobots for drug delivery is more effective than conventional chemotherapy.

4.3 Clearance of blocked blood vessels

There is a lot of interesting scope in cardiovascular disease. Blockage of blood vessels can cause strokes and heart attacks. Nanobots can be used to clear the blockages in the blood vessels. Even though it cannot fully solve the problem, the chances of dying can be reduced.

4.4 Detection of specific chemicals

Detection of specific chemicals will be a piece of crucial information for medical expounders about the condition of the patient. Nanobots can be used for the detection of particular chemicals in the human body,that helps for the advanced treatment.

4.5 Determination of the effectiveness of a drug

Nanobots will help to determine the effect that a particular medicine is having. This will help the doctors to treat the patient as soon as possible.

4.6 Cancer detection

Nanobot can act as an early warning system about changes in the human body that conveys signal of any damages in the healthy cells. So the early detection and treatment for any damage in the healthy cells are possible.

4.7 Detection of bacteria

Most of the uses of nanobots are helpful to the medical field. Nanobot can detect the presence of bacteria and other microbes in the human body. They can detect whether someone has infected with any deadly bacterias and doctors can set easy responses for such bacterias.

5. RISKS

As we know nanobots always interact with the human body and its environment. The number of innovations associated with nanobots is very vast. Wide use of this kind of miniature technology raises many questions related to the safety and unpredictable functionality. The main disadvantage of this kind of machines is that it is too expensive to manufacture with a lot of complications as well. The main obstacle is the power supply. To overcome the body's immune there should be more research in the ability of nanobots. Another prominent disadvantage is that terrorists can misuse these nanobots. Even it can be used as bioweapons which is a threat to society. Since nanobots act as a foreign body, sometimes it may affect the body environment. Due to this, it can alter the biodegradability of the body. They can also massively affect the immune system of the body. This kind of electrical system can create stray fields, which may activate bioelectric-based molecular recognition in the body.

6. CONCLUSION

The use of nanobots has a wider scope than any other field that emerged to till date. The main use of nanobots is in the health sector. It has enormous advantages over the conventional method that is practiced over the years. They are very quick and almost low invasion. The precision of nanobots is a unique quality that should be discussed. Nanobots can deliver the drug to the targeted site without disturbing the body environment. This is a great revolution in the health industry which reshapes the world in the age of integrative activities. We can be free from diseases with life expectancy by these miniature things. Pipeline monitoring, data storage, and cancer detection offers some strong foundation of development using nanobots. Thus nanobots are the ideal field to explore progressively.

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8. AUTHOR'S CONTRIBUTION

The author has written the manuscripts.

9. CONFLICTS OF INTEREST

The author declares that she does not have any conflicts of interest

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