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## The Future of Cancer Treatment-Nanorobotics

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### ABSTRACT

*This paper presents how effectively nanorobotics can be implemented for cancer treatment, prevention and detection. Over the years, nanoparticles like fullerenes, carbon nanotubes, nano crystals are used for drug delivery, diagnostics, and treatment of diseases at molecular level. Nanoparticles are typically of the range  $10^{-9}$  m or to say 100 times smaller than most human cells. This quality gives them ability to be easily injected to the blood stream as they are much less traumatic compared to other treatment used in cancer like Chemotherapy and cancer specific surgery. Moreover, it will preserve and improve human health using molecular knowledge in human body on nanosacle. Thus over the years, nanomaterials are successfully used to treat various diseases like Cancer, Arthritis, Blood Clotting, etc.*

**Keywords-** Nanotechnology; nanorobots; Cancer; Approaches and Applications.

### I. INTRODUCTION

Science's growing ability to work at molecular, atomic level combining biological material has given rise to a new field called biotechnology. Nanotechnology means ability to work atom by atom. Nanorobots means designing and construction of nanoparticles in the size of 0.1-10 micro meter. The science of using nanoparticles started in 29 December, 1959 where Richard Feynman gives the famous "There's plenty of room at the bottom" talk. But due to technical challenges, it took many years for this technology to be used in practical medical applications. In 1980, Nobel Prize Laureate Richard Smalley extended his vision to carbon nanotubes discovered by Sumio Iijima which is a new way to connect ultra small electronic devices [3]. Worldwide funding of nanorobotics in medicine was close to \$3 trillion in 2015. In 2015, there were an estimated 1,658,370 new cancer cases diagnosed and 589,430 cancer deaths in USA. This alarming number has increased the research in cancer manifolds.

### II. NANOROBOTS DEFINITION AND OVERVIEW

Nanorobot is defined as a tiny machine designed to perform a specific task at the dimensions of a few nanometers or less. They can easily traverse to the human body. This ability has given researchers in the medical industry a special interest in nanorobotics such that it has given rise to a field of nanomedicine. A fleet of nanorobots serve as antibodies and antiviral agents in patients with the same design of their immune system. Over the years, research in nanorobots has given rise to other potential applications including repair of damaged tissues, unblocking the arteries affected by plaques and construction of complete replacement of body once again.

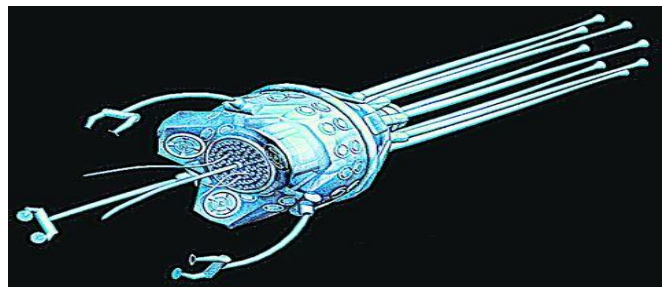


Figure 1. Nanobot is a tiny machine that performs a specific task in nanoscale

They are found to be durable, operational for years giving rise to the researchers about its potential use in cancer treatment.

### III. COMPONENTS OF NANOROBOTS (STRUCTURES)

#### 1. Payload

It is a void section holding small drugs or medicine that is used in affected area [4]. In Cancer, Nanorobots is used to carry chemicals used in Chemotherapy. Payload is used in a small quantity but drugs are more effective than traditional chemotherapy [11].

#### 2. Micro camera

It can navigate through the body during operation. This helps the nanorobot to view the parts of the body when the nanorobot is travelling [4].

#### 3. Electrodes

It can form battery through electrocytes in blood. These electrodes can kill cancer cells by generating electric current [4].

#### 4. Lasers

Lasers can burn harmful materials like blood clots, cancer cells, etc. Lasers vaporize cancer cells without harming surrounding cells [4].

#### 5. Ultrasonic signal generators

When Nanorobots are used to target and destroy kidney stones, ultrasonic signal generators are used [4].

#### 6. Swimming Tail

The nanorobots injected in the blood vessel will require propulsion to get into the body as they move against flow of blood [4].

#### 7. Microwave Emitters

Microwave Emitters provides nanorobots with a unique ability to break chemical bonds in cancer cells without breaking cell walls [4].

#### 8. Power Supply

Nanorobots get power from the body heat of the patient through blood stream. They work like Navigation System [4].

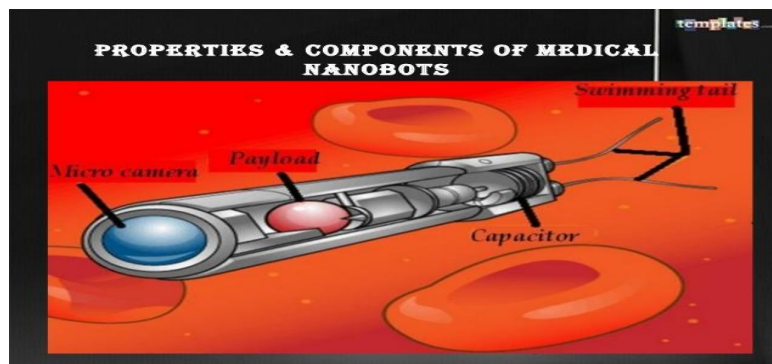


Figure 2. Properties & Components of Medical Nanobots. Device will have mobility, the ability to process information or to be programmed, and have a power supply.

Nanorobots have components like Payload, Micro camera, Electrodes that are used in the treatment of Cancer.

### IV. NANOTECHNOLOGY IN CANCER

For detection of cancer at an early stage, a major challenge is to determine what comes between cancer biomarkers and clinical pathology. Treatment should be such that it attacks only the cancer cell leaving non-cancerous cell unharmed. Nanotechnology has ability to treat cancer with minimum or no damage to healthy tissue and organ. In previous trial, cancer cell was destroyed in 3 days and none of the healthy cells were damaged.

### V. WORKING OF NANOROBOTS

Surgical nanorobots are introduced in the body through various vessels of the vascular system in the body. A surgical nanorobot programmed or guided by a human surgeon and can work on the particular site in the human body. The technology invented is according to our body's own self-defense. Like white blood cells in the body

which are used for defense, the nanorobots are injected into the blood stream which look for signs of distress in the human body. Nanorobots can have multiple payloads so that they can expose off that particular drug at that particular site [5].

## VI. VARIOUS TYPES OF NANOMATERIALS USED IN CANCER TREATMENT

Nanomaterials are made from organic and inorganic materials. Various materials like liposomes, micelles, quantum two dots, gold nanoparticles, magnetic nanoparticles, carbon nanotubes and dendrimers.

### 1. Liposome

It is a tiny vessel made of material which is found in the cell membrane. It is filled with drugs. Thermo sensitive magnet liposome (TMs) encapsulates with methotrascate (MTx) achieve good magnetic targeting effect and can rapidly release drugs in cancer cells.



Figure 3. Liposome is a vessel having medicines.

Gold nanoparticles encapsulated in liposomes can be used in treatment of breast cancer. Out of all nanoparticles, liposomes are the most commonly used nanoparticles.

### 2. Micelles

It was first discovered in early 1980 by Ringsdort. Colloidal dispersion constructed from amphiphilic molecules are used as a chemotherapeutic agent to treatment.

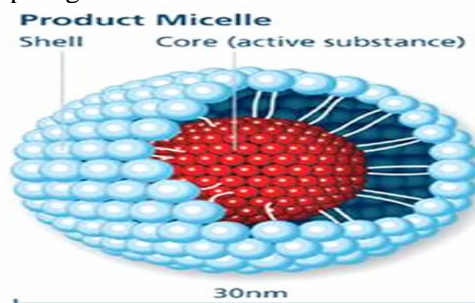


Figure 4. Micelles are amphiphilic molecules used in Cancer Treatment.

It has also been effectively used in treatment of ovarian cancer [1].

### 3. Quantum Dots

High brightness, long term stability, simultaneous detection of multiple signal and tunable emission spectra are the amazing properties of Quantum dots.

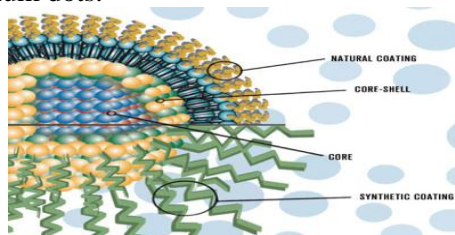


Figure 5. Quantum Dots are used in detection of multiple signals.

It is effective in treatment of breast cancer and is used in diagnosis of prostate cancer [1].

### 4. Gold Nanoparticles

Gold Nanoparticles (AuNpS) are usually of 2 nm to 100 nm.

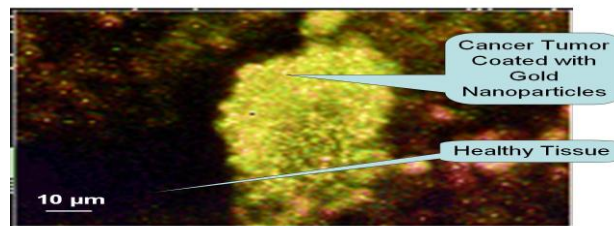


Figure 6. Gold Nanoparticles are used in detection of tumour cells.

It is made by controlled reduction of an aqueous  $HuCl_4$  solution using different reducing agents. It is used in diagnosis of tumour cells [1].

#### 5. Carbon Nanotubes

It is a tube shaped particle made of carbon with diameter ranging from 1 nm to 50 nm. But with recent advancement in nanotechnology nanotubes are much longer and smaller in diameter.

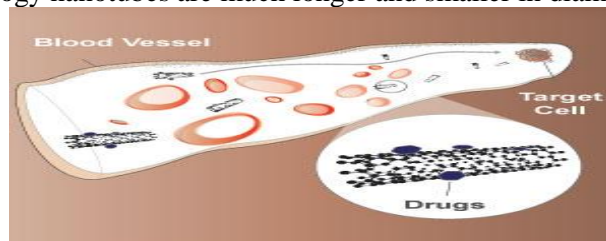


Figure 7. Carbon Nanotubes can easily diffuse through cell membrane in order to attack Cancer Cells.

This property has made the material to diffuse across lipid layer whereby it can be attached to the surface of cell and engulf in cell membrane.

#### 6. Dendrimers

They consist of tree like arms or branches. They have different biological property.

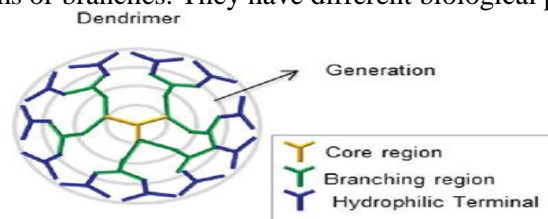


Figure 8. Dendrimers are used as a vehicle for drug delivery.

They have a capacity to carry conjugate surface molecule making them as a potential vehicle for drug delivery [1].

### VII. TYPES OF CANCER

#### 1. Blood Cancer

Scientists are working on a tiny robot built entirely of DNA that can save critically ill leukemia patients. These robots destroy cancer cells leaving healthy cell undamaged similar to our body system's white blood cells. It flows through blood stream searching for cancer cells. It is a biocompatible and biodegradable material without harming immune system.

'Nanobots' used in treatment of blood cancer are called DNA Nanobots. It is shaped like a hexagonal tube. It has two halves connected by a latched hinge. When it recognizes a cancer cell, two halves open like a clamp to deliver tiny but deadly cargo of drug or nanoparticle. Half the cell will be destroyed in days.

#### 2. Brain Tumor

A surgery to remove tumor will require a lot of care and precision as brain is a complete part of human body. Nanorobotics can be used to perform this operation efficiently. They travel through blood vessel and sensors inside nanorobots locate tumor area of brain. These robots then release its particle and destroys tumor without affecting brain [2].



### 3. Breast Cancer

Scientists in South Korea developed a microscopic robot that can actually detect and treat cancer. Though it was designed for all type of cancers, it was found that it could only detect solid cancer like breast cancer and colorectal cancer. Breast cancer can be detected by microwave breast imaging techniques. It has a unique identity to differentiate breast cancer using dielectric property. But it is sensitive to physiological or pathological factors of clinical element. Challenges can be overcome by using a contrast medium such as carbon nanotubes to alter the dielectric property of tumor.

### VIII. ADVANTAGES

The greatest advantage of nanorobots is that the particles do not generate any harmful activities like putting other cells in danger, damaging body parts and hence it does not have any side effects. It operates only in a specific site. Moreover, currently cancer does not have a permanent vaccine and the currently available drug could only increase a patient's life up to few years and hence the intention of nanorobotics will make patients get rid of this disease.

### IX. DISADVANTAGES

Nanorobotics is an emerging field in the world of science. Hence the research and initial design cost is high. The design of nanorobotics is a complicated one. They are hard to interface, customize and design. Nanorobots can be brutal risk in the field of terrorism. They can use nanorobots to destroy human body at a molecular scale. They should be very accurate otherwise harmful effects may occur [5].

### X. CONCLUSION

Medical science continues to make a significant progress in cancer treatment. But the main challenges before medical experts is to diagnose the cancer of brain, breast and bladder which are increasing the death of men and women at an alarming rate are raising huge concerns across the globe. Therapeutic devices used for treatment could increase effective standard chemotherapy. But nanorobotics promises to make significant contributions in diagnosis and therapy of cancer affected people all over the world.

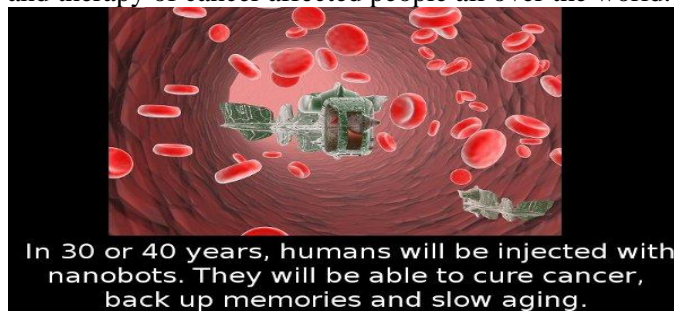


Figure 4. Nanorobots is an emerging field and will be the first ever treatment to treat Cancer.

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