ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 11| November 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402|| ISI Value

# A REVIEW ON NANOROBOTS IN CANCER TREATMENT

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**ABSTRACT**
*Nanorobots are small devices that target cancer cells while sparing healthy cells in order to treat the disease. By delivering medication straight to tumors, they improve treatment outcomes and lessen the negative effects of conventional therapies like chemotherapy. Because these robots are designed to exclusively deliver medications at cancerous locations, they can provide precise treatment without endangering healthy tissues. Nanorobots may be able to treat illnesses like Alzheimer's in addition to cancer. Nanorobots are becoming a reality thanks to recent technical developments. Future cancer treatments could include injecting nanorobots to remove tumors without the unpleasant side effects of radiation or chemotherapy, which would allow patients to recover more quickly and feel more comfortable.*

**KEYWORDS:-** *Nanobots, Nanomachine, Nanomedicine, Nanosensors, Nanomotors*

## A BRIEF OVERVIEW OF CANCER

A illness known as cancer occurs when some body cells proliferate out of control and spread to other bodily organs. With trillions of cells, cancer can begin practically anywhere in the human body. The body uses cell division to create new cells, which is how human cells normally develop and proliferate. Cells die and are replaced by new ones when they age or sustain injury. [1]

The Greek physician Hippocrates (460–370 BC), who is regarded as the father of medicine, is credited with coining the term "cancer." Hippocrates used the terms "carcinos" and "cancer" to refer to tumors that did not produce ulcers and those that did.

According to Hippocrates, the body contains four humors, or bodily fluids: blood, phlegm,

## CANCER CAUSES

1) Genetic factors.
2) Environmental aspects
3) Aspects of lifestyle
4) Infections
5) Hormonal factor
6) Age
7) Function of the immune system

**Cancer Symptoms Include**

1. Weight loss without explanation
2. Exhaustion and Pain
3. Skin alterations
4. Modifications to bowel or bladder habits
5. Unusual discharge or bleeding
6. Swallowing difficulties
7. Swelling or lumps
8. Night sweats or a fever

## SIDE EFFECTS OF CANCER TREATMENT

Chemotherapy: Changes in appetite, weight loss, nausea and vomiting, mouth sores, and low blood counts.

Radiation Therapy: Skin Responses and Long-Term Consequences

Pain, infection, scarring, and changes in function following surgery

Symptoms of the flu, skin reactions, and autoimmune reactions are examples of immunotherapy.

Targeted therapy for skin changes, liver problems, and diarrhea.

Hormonal therapy for mood swings, hot flashes, and loss of bone density.

## NANOTECHNOLOGY

The field of science and engineering known as "nanotechnology" is focused on creating, utilizing, and developing systems, devices, and structures through nanoscale atom and molecular manipulation.[4] When considering technical breakthroughs, nanotechnology has been at the forefront and has garnered a lot of attention over time. composed of biological materials, metal, metal oxides, or carbon[5].

A vital component of biotechnology and medicine, nanomedicine enhances illness prevention, diagnosis, and therapy. Nanotechnology has improved healthcare and aided in the development of novel illness diagnosis and treatment approaches [6].

Nanotechnology is being used in medicine by researchers to enhance instruments such as purification kits, sensors, and diagnostic surfaces. For early detection and therapy, new gadgets that operate inside the body are being developed. By fusing technology, medicine,

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Application of Nanotechnology in different subfields of the medical industry




**Fig: 2 Application Of Nanotechnology In Different Subfields In Medical Industry**

## NANOROBOTS

The study of robots at the nanoscale is defined as nanorobotics, and incorporated technology is known as nanotechnology. Nanorobots are devices capable of sensing, actuating, signalling, processing information, intelligence, or exhibiting swarm behaviour at the nanoscale [9]. They are comprised of various components that carry out specific tasks; the components are constructed at the nanoscale size and can range from 1–100 nanometers . Nanobots (A.K.A. nanorobots), which are currently the focus of an emerging field of research, are also referred to as nanites, nanoids, nanomachines, or nano-mites ; however, in general, nanobot consists of two words—'nano' and 'bot'. 'Nano' refers to very small or minute, and 'bot' refers to a device that can be controlled by a program, i.e. a short term for a robot [1].

Nanorobots have several potential applications in the medical field including cancer treatment , surgery, precision medicine [7], diabetes monitoring, dentistry, blood monitoring and drug delivery . Currently, mobile phones are proving to be a useful feedback device in accomplishing data transmission for communication, control, and energy supply inside the body.[10] Due to their small sizes, nanorobots can directly interact with cells and even penetrate them, providing direct access to the cellular machineries. As an interdisciplinary technology, nanorobots address the assembly and utilization of functional nano-to-molecular scale machines and have been widely used in cancer diagnosis and treatment. [11]

Cancer is the 3rd leading cause of death globally as almost every six deaths is caused by it [1]. By 2030, it's expected to be 26 million new cases of cancer with almost 17 million deaths per anum [2]. The countries with low-to-middle income account for most cancer cases that are expected to be 61% by 2050 [3]. In 1965, the International Agency for Research on Cancer (IARC) was established, with the mission of conducting multidisciplinary investigations into the causes of human cancers [4]. After conducting several studies, particularly on the structure of genes, experts have concluded that changes in human lifestyle, diet, and environmental factors have resulted in an increased number of cancer cases . [12]

## CONVENTIONAL METHODS OF CANCER THERAPY TREATMENTS

Most people with cancer receive surgery, chemotherapy, radiation therapy, or other conventional therapies at some point during treatment, and many will have a combination of these treatments. Injection of drugs affects both cancerous and non cancerous cells in conventional method. So, the main types of cancer treatment include : Surgery, Radiation Therapy, Chemotherapy, Immunotherapy, Targeted Therapy, Hormone Therapy.

## THE MAJOR DRAWBACKS OF THE CONVENTIONAL METHODS USED IN THE CANCER THERAPY

Injection of drugs affects both cancerous and non cancerous cells in conventional method. There are various side effects with the conventional methods as it effects both the cancerous and non cancerous cells. Surgery and radiation therapy remove, kill, or damage cancer cells in a certain area which also effects healthy cells. The time to heal is longer with the conventional methods that includes methods like surgery, radiation therapy. Some of the side effects that that occur when conventional method

## THE MODERN TECHNOLOGY USED TO CURE CANCER THERAPY

Nanotechnology offers promising advancements in cancer therapy. Nanorobots, like Nanokillers, can target cancer cells directly and deliver drugs precisely where needed, minimizing side effects. These tiny robots can find and repair damaged organs, detect tumors, and even destroy them with controlled doses of chemotherapy drugs.

Respirocytes are nanorobots that help identify tumors and release drugs directly at cancer cells. They can also track their progress, reporting the number of cancer cells they've encountered and treated. Nanomedicine enables non-invasive devices that can enter the body, detect cancer in early stages,

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and deliver targeted treatments with minimal harm to healthy tissue. These nanorobots have vibrating cilia-like structures and nanosensors to identify cancerous tissues, while gold-coated shells allow them to attach to and treat malignant cel

**CHEMOTHERAPY DRUG DELIVERY USING NANOROBOTS IN CANCER TREATMENT**

Recent advancements in drug delivery use nanorobots with nanosensors to target specific cancer cells and regulate drug release. Traditional chemotherapy drugs kill rapidly dividing cells, but they also harm healthy cells, causing side effects like immune suppression, hair loss, and organ damage. Nanorobots can deliver chemotherapy drugs directly to cancerous cells, minimizing damage to healthy tissue. By targeting only tumor cells, they reduce side effects and improve treatment effectiveness. These robots help maintain the correct drug levels in the bloodstream for longer, ensuring better outcomes for cancer therapies [20].

**TYPES OF NANOROBOTS**

1. Drug Delivery Nanorobots: Targeted delivery of chemotherapy drugs directly to tumor cells, minimizing side effects.
2. Diagnostic Nanorobots: Equipped with sensors to detect cancer biomarkers, enabling early diagnosis
3. Thermal Nanorobots:Use heat to destroy cancer cells selectively, often in combination with imaging techniques.
4. Gene Editing Nanorobots:
   Deliver CRISPR/Cas9 systems to modify genes in cancer cells, potentially reversing maligImmunotherapy Nanorobots: Enhance the body's immune response against tumors by delivering immune-modulating agents.

**Applications**

1. Medical Applications: o Drug Delivery: Targeting specific cells (e.g., cancer cells) to minimize side effects.
   o Surgery: Performing precise operations at a microscopic scale.
   o Diagnostics: Detecting diseases or biomarkers at an early stage.

2. Environmental Applications:
   o Pollution Cleanup: Breaking down pollutants at a molecular level.
   o Monitoring: Detecting hazardous materials in the environment.

3. Industrial Applications:
   o Manufacturing: Assembly of components at the nanoscale for electronics or materials.
   o Quality Control: Monitoring the properties of materials at the molecular level.

**ADVANTAGES**

1. Targeted delivery
2. Enhanced Efficacy
3. Reduce Dosage
4. Immunotherapy Enhancement
5. Multi Functionality

**DISADVANTAGS**

1. Cost
2. Public Acceptance
3. Limited Control

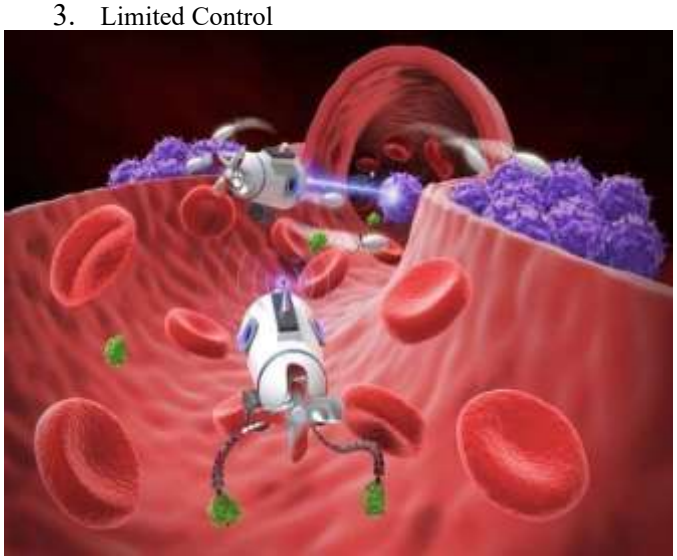


FIG**: 3 Nanorobots In Bloodstream**

**The key components of nanorobots [ Particularly in the context of cancer treatment.]**

\focusing on sensors

1. actuators
2. propulsion systems.

1.Sensors

- Detect cancer-specific markers like proteins or enzymes.
- Types include chemical (biomarker detection), optical (fluorescence for visualization), and biosensors (antibody-based).
- Help monitor tumors in real time and target cancer cells precisely.

2.Actuators

- Convert sensor signals into actions like drug release or movement.
- Types: chemical (pH-triggered), electrochemical (electric field-driven), and thermal (temperature-based).
- Ensure controlled drug delivery and assist in navigation.

3.Propulsion Systems:-

- Allow nanorobots to move through the body to target tumors.
- Methods: flagellar motion, magnetic fields, or ultrasound waves.
- Enable precise navigation and adaptability in various environments.

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**MECHANISM OF ACTION OF NANOROBOTS**

Drug Loading
⬇
Nanorobots are equipped with the anticancer drug for precise delivery.
Targeting Cancer
⬇
Nanorobots use specific ligands to locate and bind to cancer cells.
Cell Entry
⬇
The cancer cell internalizes the nanorobots through endocytosis.
Drug Release
⬇
Inside the cancer cell, nanorobots release the drug into the cytoplasm.
Cancer Cell Death
⬇
The released drug causes the cancer cell to die by disrupting its function.

**AIM**: An Overview of Nanorobots in the Treatment of Cancer

**The following are the goals**

- Targeted Drug Delivery
  minimize harm to healthy tissue by precisely delivering chemotherapy or other treatments to tumor cells.
- Early Detection
  Improve biosensing and imaging capabilities to find cancer early.
- Minimally Invasive Surgery:
  Reduce recovery time and hazards by performing accurate cellular-level surgical treatments.
- Feedback and Monitoring:
  Provide real-time data for therapy modifications and continuously track tumor responses.
- Gene therapy:
  Make it easier for genetic material to enter cancer cells and alter or repair their DNA.

**FUTURE ASPECTS**

1. Precision Targeting
↓
2. Early Detection
↓
3. Minimally Invasive
↓
4. Multimodal Therapy
↓
5. Immune System Activation
↓
6. Overcoming Drug Resistance
↓
7. Theranostics
↓
8. Real-Time Feedback
↓
9. Cost and Accessibility
↓
10. Future Research
↓
Challenges:
Safet
Scalability
Regulatory Hurdles

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## THE OUTCOME IS

Because they provide individualized therapeutic approaches, early diagnosis, and focused, precise medication administration, nanorobots have the potential to revolutionize the treatment of cancer. Drug resistance may be circumvented and more effective therapies with fewer adverse effects result from these developments. But there are obstacles to overcome, including making sure it's safe, scalable, and approved by the government. Nanorobots have the potential to be a vital tool in cancer treatment in the future, greatly enhancing patient outcomes, if certain challenges are resolved.

## CONCLUSION

Through individualized therapy, early diagnosis, and targeted medication administration, nanorobots hold great potential for revolutionizing cancer treatment. They could provide a more efficient, less intrusive method of treating cancer by reducing side effects, improving therapeutic efficacy, and conquering obstacles like drug resistance. Furthermore, their combination of therapy and diagnostics (theranostics) creates new opportunities for dynamic treatment and real-time monitoring. But there are obstacles to overcome, such safety, scalability, and governmental approval. Nanorobots have the potential to transform cancer treatment and enhance patient outcomes and quality of life with further technological and scientific development

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ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
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