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NANOROBOTICS- A NOVEL TOOL FOR CANCER THERAPY

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ABSTRACT

During a 1959 dinner talk, the late physicist who won the Nobel Prize Richard P. Feynman made the very valid point that technological advancements are still possible and should not be stopped. He suggested utilizing mechanical instruments to create devices that are not as big as others, which can then be used to create even smaller mechanical devices, down to the tiniest measured atom. He stressed that this is "a growth which I consider cannot be avoided."Feynman suggested that a vast array of atomically precise microroscopic equipment and production tools, additionally a multitude of exceedingly tiny gadgets and other robotics at the nano and small-scale frameworks, may someday be built using nanomachines, nanorobots, and nanodevices.The fields of molecular biology, biotechnology, and molecular medicine may be utilized to develop Advanced tiny gadgets composed of nanoparticles are a fully autonomous nanorobots or nanobots. A Part of nanorobotics, which is seen as a magnificently desirable vision in medicine. With cancer being the most common cause of death for people under 85, it has a bright future in drug delivery technology. Nanorobots have the potential to transport and distribute significant quantities of cancer-fighting drugs specifically to diseased cells, while minimizing injury to healthy cells. This targeted delivery system aims to reduce the adverse effects associated with conventional treatments, such as chemotherapy. The final evolution of this invention will have a significant influence on avoiding illness, evaluation, and therapy. It will be achieved by a tight collaboration of experts in nanotechnologies, medical, and robotics. This article presents a research on several approaches to cancer treatment with nanorobots. It also provides insight into the potential scope of this field of study.

KEYWORDS:

Nanorobots, nanorobotics, drug delivery, chemotherapy, cancer treatment, nanotechnology.

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INTRODUCTION

In the world, cancer is the third most common cause of mortality, accounting for around six deaths per 100,000 people. By 2030, there is going to likely be twenty-six million fresh cases of the illness worldwide and about 17 million fatalities each year from the disease. By 2050, the percentage of cancer cases in low-to middle-income nations is predicted to rise to 61%. The International Agency for Research on Cancer (IARC) was founded in 1965 using the purpose of carrying out interdisciplinary studies into the factors that lead to cancer in people. [1]. Experts have come to the conclusion that after finishing multiple studies, particularly on the structure of genes, alterations regarding human way of life, eating habits, and surrounding factors have contributed to an increase in cases of cancer. [2]

The present diagnostic methods, such as imaging, molecular detection, and immune histochemistry (IHC), all have inherent drawbacks, such as subpar accuracy .[3] However, in order to more precisely target the cancerous cells and produce fewer side effects greater than those of drug therapy, scientists have been attempting to enhance anti-cancer medicine delivery systems. The desire for more effective drug delivery systems, however, will outpace current developments. [4]

Emerging A category of nano-devices called nanorobots is made of technology and is intended to perform precise tasks at the nanoscale (1-100 nm). [5] Nanorobots are designed to function at the cellular level in the medical sector in order to do these specialized functions. These are nanoscale devices having the ability to perceive, signal, react, and process information. Because of its rigidity, high heat conductance, and inertness, carbon is the most often employed element in the creation of nanorobots. [6] Additionally the diamond that is passive exterior covering is used to thwart immune system attacks from the host. [7]

Recent advancements in the field have led to the development of nanorobotic medication delivery techniques, which involve the use of small robots for cellular and surgical repair purposes. In 1986, Eric Drexler introduced the idea of introducing medical nanorobots into the human body. These nanorobots utilized artificial mechanical red blood cells (RBCs), white blood cells (microbivores), and platelets (clottocytes). Dr. Youngdo Jeong led a team of researchers in Korea that developed a nanorobot capable of first dispersing the outer layer of a cancerous cell and then destroying it internally. [8] The constituents of these machine nanoparticles consist of gold and undergo repetitive folding and unfolding in order to eliminate a cell, without the need for anti-cancer drugs. DNA-based nanobots are currently employed in the treatment of tumors to combat cancer. [9]

In a related study, a novel cancer therapy approach is put out in which nanorobots created from DNA fragments are said to be able to both destroy and really kill cancer cells.[10] However, there are some disadvantages to nanorobots, such as high cost, complexity, and invisibility during design and development. Despite the elevated blood viscosity, scientists are striving to find a solution to the problem of drug-loaded nanorobots having difficulty passing through blood vessels. [11]

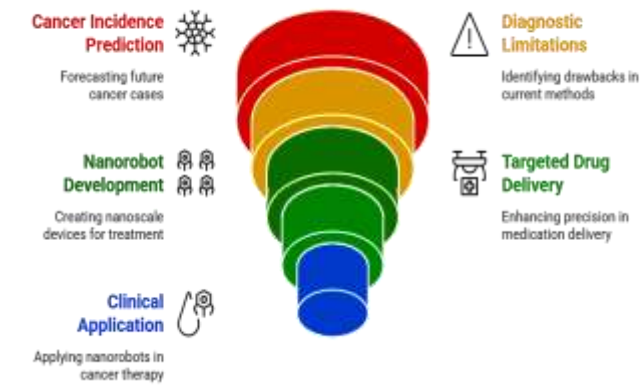

Figure 1: Advanced cancer treatment with Nanorobotics

The potential of nanotechnology is to increase the physical, chemical, and biological methods' selectivity and effectiveness methods to kill cancer cells while minimizing non-malignant cell harm. [12] For very accurate cancer cell targeting, nanoscale materials are being employed more and more. This review article's primary objective is to emphasize the significance, nature, range, and applications of nanorobots, particularly in the context of DNA-based cancer therapy. [13]

Properties of nanorobotics

Outside, there are two spots. The blood vessels in the circulatory system are driven by an electrical motor that is connected. [14] The revolving needle, camera, microprocessor, and arterial thermometer are all integrated. The complete management of the nanorobot is handled by the microprocessor-based control unit. In order to aid the nanorobot at any moment, radioactive material is employed as part of the outer surface. [15]

Method

Many scientists are inventing and developing interesting methods on nano robots all through the world. [16]

A team of Korean researchers, led by Dr. Youngdo Jeong, has developed a nanorobot capable of breaking down the outer membrane of cancer cells and then destroying the cells internally. These gold nanoparticles, which are comprised of gold, have the ability to repeatedly bend and straighten a cell, causing its death, without the need for any anti-cancer drugs. [17]

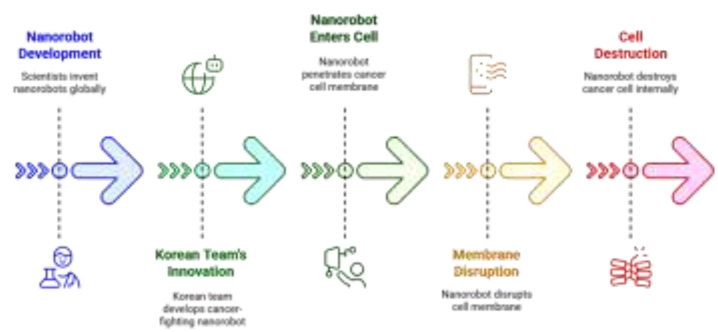

Fig. 2: Nanorobot Cancer Cell Destruction Sequence

Nanobots made of DNA that fight cancer are being used to treat tumors. In a related study, a novel cancer therapy approach is put out in which nanorobots created from DNA fragments may not only destroy cancer cells but also eliminate them from the body. [18] By using various techniques, such as surface markers or specific chemicals present on the cancer cells, nanobots can be taught to target certain cancer cells.[19]

Sensors or receptors that are made to bind to particular cell markers can be added to nanobots. One-of-a-kind proteins or molecules that are present on the surface of various cell types can serve as these markers. [20] These markers may be recognized and bound to by the nanobots when they come into contact with cells, enabling them to distinguish between different cell types and interact with them. It's like to possessing a unique key that opens a certain lock. [21] Nanobots can communicate with one another wirelessly or through chemical signals, for example. They collaborate and coordinate their activity using these signals in order to eliminate cancer cells. Other cell types can also connect with nanobots. They have the ability to transmit and receive messages to communicate with various bodily cells. They can carry out specific activities and provide tailored chemotherapy thanks to this communication. [22]

Pro's and Con's of nanorobotics

Advantages:

Surgery: Medicinal nanorobots can be implanted into human bodies for surgical procedures through arterial networks and other cavities. A human surgeon programs or controls surgical nanorobot to do semi-autonomous on-site surgery inside the body of a person. [23]

Evaluation and Diagnosis: Diagnostic, testing and keeping an eye on circulatory tissues, cells, and bacteria are all possible uses for medical nanorobots. These nanorobots can continually record and relay vital indicators including temperature, pressure, and immune system characteristics of various human body sections. They can even identify viruses or poisons inside the body. [24]

Genomic Medicine: Nanorobots can be used to cure genetic problems due to the same molecular structures of DNA and proteins in cells. Subsequently, the aberrations and alterations in the DNA and protein sequences are rectified. [25]

Finding and treating cancer: Cancer is successfully treated with the use of modern medical technology and therapeutic techniques. The development of effective medication delivery to reduce chemotherapy side effects is the key factor in achieving a successful treatment. In order to find tumor cells inside a patient's body that are in the early stages of developing cancer, nanorobots with chemical biosensors inserted are utilized.[26] Nanorobots can also be employed as auxiliary equipment to process various chemical processes occurring in the harmed organs. The monitoring and management of glucose levels in diabetic patients is another use for these robots. [27]

Disadvantages:

Pricing: The creation and development of nanorobots is a time-consuming and expensive process, and the price of this technology may prevent it from being widely used. [28]

Lack of control: Once nanorobots have been introduced into the body, it may be challenging to regulate their behavior and stop them from harming healthy cells and tissues. [29]

Hazardous toxicity: Due to the materials employed in the production of nanorobots, their usage in medical applications may have hazardous effects on the body. [30]

Social problems: The use of technology to alter the human body and its functions is questioned by the development of nanorobots. [31]

Inadequate knowledge: Since nanorobots we are still in the early stages of technology, nothing is known about how these machines will interact with human physiology and react to their surroundings. [32]

Environmental impact: The repercussions of releasing nanorobots into the environment are unknown, and it is unclear how they will affect the environment. [33]

EVALUATION OF NANOROBOTICS

Researchers have developed a new class of small remote-controlled nanorobots that may one day enable medical professionals to detect illnesses and administer medications from inside the human body. [34] The bots were made from a biodegradable substance called spirulina algae by a team led by Professor Li Zhang from the Chinese University of Hong Kong, which also included Professor Kostas Kostarelos from The University of Manchester [35] The algae were a source of food for the Aztecs in their day and are now available as a meal alternative in health food stores. But French scientists who were studying Lake Texcoco in Mexico made a new discovery of it in the 1960s. [36]

An iron magnetic coating helps to precisely control the pace of the bots' biodegradation, according to a team report that was just published in Science Robotics. Magnetic fields enable highly accurate remote control of the nanorobots in intricate biological fluids.[37] The group also explains how the bots may discharge powerful chemical substances that can assault cancer cells. However, additional research must be done before clinical studies can be conducted on motion tracking, biocompatibility, biodegradation, and therapeutic and diagnostic effects. [38] Rather than creating a functioning microrobot from scratch using intricate laboratory procedures, Professor Zhang explains, "We set out to directly engineer smart materials in nature, which are endowed with beneficial functionalities for medical applications due to their intrinsic chemical composition. [39] With the help of such agents, we can easily locate and activate a swarm of them inside the body. Fluorescence imaging and magnetic resonance imaging because these biohybrid bots have a naturally fluorescent biological inner and a magnetic iron-oxide outside. [40]

APPLICATIONS OF NANOROBOTS

• **Better Medical Treatments:** Nanorobots might carry out medical treatments more precisely and accurately than people. As a consequence, patients may receive more effective care with fewer side effects and a quicker recovery. [41]

• **Environmental Cleanup:** Nanorobots may be able to assist people in the removal of hazardous waste, oil spills, and other environmental contaminates. As a result, people may encounter hazardous trash less frequently, potentially lessening the impact of pollution as well as human danger. [42]

• **Improved Manufacturing:** By using nanorobots, firms might increase the effectiveness and standard of their production methods. Nanorobots might carry out activities with a degree of accuracy and precision that is challenging to accomplish with conventional manufacturing techniques. This may aid in enhancing product uniformity and quality, cutting down on waste, enhancing worker safety, and minimizing mistakes. [43]

• **Enhanced Scientific Understanding:** Researchers may use nanorobots to better comprehend the nanoscale universe, which could result in innovative new technologies. The realm of matter that is commonly measured in nanometers (nm), or one billionth of a meter, is referred to as the nanoscale. [44]

• **Advances in materials science:** By manipulating and assembling materials at the nanoscale, nanorobots may enable the creation of new, better materials with distinctive features. By utilizing nanorobots to arrange atoms and molecules in particular ways, we may create materials with improved durability, rigidity, and conductivity, for instance. [45]

• **Space Exploration:** Nanorobots might be used for satellite and other spacecraft production, maintenance, and repair in space. The nanorobots may be employed, for instance, to seal tiny holes in spacecraft. [46]

CONCLUSION

Micro/nanorobotics has become a cutting-edge and adaptable platform for combining the benefits of nanotechnologies with robotic sciences during the past ten years. Thus, the creation of extremely effective and specialized micro/nanorobots has been made possible by a varied range of design ideas and propulsion systems. These micro/nanorobots have a variety of special and versatile functionalities, such as quick movement in intricate biological media, powerful cargo towing for directional and long-distance transport, simple surface functionalization for accurate capture and isolation of target subjects, and excellent biocompatibility for in vivo operation. Micro/nanorobots' alluring features and powers have assisted biomedical applications, including focused payload delivery, precise cellular surgery, extremely sensitive biological molecule identification, and quick toxin elimination. These changes have improved from chemical labs and test tubes to complete biological systems, micro/nanorobots are used. These in vivo experiments represent a significant advance in the clinical application of micro/nanorobots.

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